Universidade Federal de Minas Gerais

Pressões antrópicas em múltiplas escalas espaciais na estruturação de comunidades bentônicas

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Programa de Pós-Graduação em Ecologia, Conservação e Manejo da Vida Silvestre

Tese de Doutorado

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Orientador: Prof. Dr. Marcos Callisto (UFMG)

Co-orientadora: Profª Drª. Núria Bonada (Universidade de Barcelona)

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Tese apresentada ao Programa de Pós-graduação em Ecologia, Conservação e Manejo da Vida Silvestre do Instituto de Ciências Biológicas da Universidade Federal de Minas Gerais como parte dos requisitos para a obtenção do título de Doutora em Ecologia.

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⁂ *Esta tese é carinhosamente dedicada aos meus pais, Maura e Vanderli* ⁂

Bolsas

Doutorado

CNPq
Conselho Nacional de Desenvolvimento
Científico e Tecnológico

Doutorado Sanduíche

CAPES

Financiamentos

PROGRAMA
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CEMIG
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P&D ANEEL

GT - 487

Apoios

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Agradecimentos

Aos recursos financeiros provenientes dos projetos "Desenvolvimento de índices de integridade biótica para avaliação de qualidade ambiental e subsídio para a restauração de habitats em áreas de soltura de alevinos" (Programa Peixe Vivo/CEMIG) e "Desenvolvimento de Índices de Integridade Biótica: macroinvertebrados bentônicos como indicadores de qualidade de água em bacias hidrográficas de empreendimentos hidrelétricos da CEMIG em Minas Gerais" (P&D ANEEL/CEMIG GT-487).

Aos colegas das instituições: Universidade Federal de Lavras, Pontifícia Universidade Católica de Minas Gerais e Centro Federal de Educação Tecnológica pelas parcerias nos projetos supracitados.

Ao Conselho Nacional de Desenvolvimento Cientifico e Tecnológico (CNPq, nº 142191/2015-9) e ao Programa de Doutorado-Sanduíche no Exterior (PDSE-CAPES, nº 88881.131740/2016-01) pelas bolsas de estudos.

Ao prof. Marcos Callisto por amigavelmente me orientar durante todos esses 10 anos! Obrigada por dar asas à minha criatividade científica, e também por apará-las quando eu começava a dispersar-me para longe demais de meus objetivos.

Al professora Núria Bonada per amablement acceptar-me en al grup de recerca i contribueixen molt a la meva formació. Moltes gràcies!

Às professoras Claudia Jacobi, Sónia Carvalho Ribeiro e Tatiana Cornelissen; e aos professores Victor Saito, Adriano Paglia e José Fernadez Bezerra Neto que gentilmente aceitaram o convite para participar da banca avaliadora desta tese.

Às professoras e aos professores do Programa de Pós-graduação em Ecologia, Conservação e Manejo da Vida Silvestre pelos ensinamentos durante todos esses anos.

Ao Fred e à Cris pela prontidão e eficiência na secretaria do PPG-ECMVS.

Aos professores Rapha Ligeiro e Leandro Juen pela parceria no primeiro capítulo e por me apresentarem a rica cultura paraense.

Ao professor Diego Macedo por toda parceria científica e por aceitar pacientemente minhas sugestões nos mapas.

A Miguel y Tano por la asociación científica y invitaciones para los conciertos, cervecitas y por enseñarme la rica cocina del Mediterraneo.

To Bob, to training, co-authorship and funny moments during field sampling.

A um time de professores que de alguma forma contribuíram para esta tese: Carla Penz, Mônica Bucciarelli, Eduardo Domínguez, Frededrico Salles, Jani Heino, Matthew Baker, Manuel Graça, Narcís Prat, Phill Kaufmann, Silvain Dolédec e Tadeu Siqueira.

A Diego Pujoni, Arleu Viana e Pol Capdevila por gentilmente sanarem minhas dúvidas no R.

Às amigas e aos amigos do LEB pela agradável convivência, momentos de descontração e parceria: Ju, Gigi, Debra, Bela, Katiene, Marden, Wandin, Waldercy e aos que recém conheci Moana, Dennis, Igor, e Rogério. Obrigada especial a Diego Castro, pelas inúmeras dicas e conselhos. Agrego ainda os professores Raphael Leitão e Ricardo Solar, e o Cacá, a quem agradeço por todo apoio logístico.

A estas mulheres incríveis com quem tive o prazer de dividir um lar: Paloma, Alice, Carina e Jana.

À Todxs Baianxs, pela grande amizade e parceria nos rolêzinhos: Suy, Pati, Ju, Dieguito, Marcinho, Gingola, Xande e Matheus. Agrego a Pamela, chegada da galera e que sempre torceu por esta tese.

A las amigas y los amigos en Barcelona: Lili, Tina, Sandra, Aleja, Ana, Will, Hernan, Roberto y Juanjo. Muchas grácias por los lunes de festivo y sobretodo por disminuir la nostalgia de casa.

A tots amics del FEHM, per la benvinguda, fiestas y birras: Pau, Iraima, Maria, Pol, Raul, Césc y Romain; y de la UB: Sílvia, Astrid, Hares, Aida, Marta, Zé, Rebeca, Verônica, Alba, Eneko, Victoria, Aiza, Luiza e Samuel. Moltes gràcies especialment a Nuria Cid y Daniel Castro (el chaparrito!) per la gran amistat!

À Lets, pela amizade de sempre, incentivo constante e vibrações positivas.

Ao Alysson, por todo amor, carinho, compreensão e apoio. Obrigada por deixar tudo mais suave!

Aos meus pais, por toda dedicação, amor incondicional e por apoiar minhas decisões, mesmo que isto significasse estar cada vez mais longe do ninho. Aos meus irmãos, Thiago e Naná pelo companheirismo, e a doce inocência da pequena Laurinha.

À toda minha grande família: avós e avô, tias e tios, primas e primos, afilhada e afilhados. Obrigada pelos momentos de descontração nos almoços de domingo.

À energia positiva, que permeia o universo e me faz acreditar no bem.

Sumário

Apresentação da tese

Esta tese de doutorado é estruturada em uma introdução geral e dois capítulos. A introdução geral apresentada as bases conceituais, na metodologia geral são descritas a área de estudo e as principais etapas de aquisição e processamento de dados e a conclusão geral sintetiza as principais contribuições dos dois capítulos, e nas perspectivas futuras são propostas abordagens futuras para possíveis desdobramentos. As bases conceituais desta tese integrarão o capítulo intitulado "Abordagens ecológicas" do livro "Bases conceituais para conservação e manejo de bacias hidrográficas" (editores: Marcos Callisto, Diego R. Macedo, Diego Castro & Carlos Bernado M. Alves). Os capítulos foram formatados conforme as regras de revistas científicas. O primeiro capítulo foi publicado no periódico *Ecological Indicators* em 2017.

Esta tese é o produto final de quatro anos de dedicação ao doutorado, entretanto, minha história na Ecologia começou há mais tempo. Em 2008 integrei-me à equipe do laboratório de Ecologia de Bentos (LEB) e fui orientada pelo professor Marcos Callisto durante toda a minha trajetória acadêmica: iniciação científica (2008 a 2011), mestrado (2012 a 2014) e doutorado (2014 a 2018). A meu ver, uma das principais habilidades que desenvolvi dentro do LEB foi a de trabalhar em equipe. Os dados analisados nesta tese foram obtidos em colaboração com colegas do LEB e parceiros de outras instituições ao longo de anos. Participei de todas as etapas de pesquisa (reconhecimento em campo, coleta, processamento de amostras, redação de relatórios e manuscritos científicos, e divulgação dos resultados à comunidade). Assim, outros colegas gentilmente colaboraram para desenvolvimento desta tese, e eu também pude oferecer alguma contribuição aos trabalhos desenvolvidos por eles. Ressalto ainda que ao longo desses anos tive oportunidade de colaborar em diversas atividades e projetos desenvolvidos no LEB, incluindo educação ambiental, consultorias, aulas para alunos de graduação, cursos de capacitação, organização de eventos e projetos desenvolvidos em colaboração com professores visitantes. Reconheço que todas essas experiências contribuíram positivamente para minha formação acadêmica e também pessoal.

Durante a iniciação científica eu avaliei a diversidade de gêneros de Ephemeroptera em riachos a montante de empreendimentos hidrelétricos. Na época, a maioria dos organismos era rotineiramente identificada até o nível de famílias. As ninfas de Ephemeroptera eram as que mais me chamavam atenção e fiquei interessada em identificá-las ao menos em nível de gênero. Meu treinamento foi conduzido principalmente pelo professor Frederico Falcão Salles, mas participei também de um pequeno curso de identificação ministrado pelo professor Eduardo Domínguez realizado na *Universidad San Francisco de Quito* (Equador), organizado pela Prof^{a}. Andrea Encalada. Naquela época, outros colegas do LEB que desenvolviam dissertações e teses utilizando os mesmos dados aprofundaram a identificação taxonômica das ordens Trichoptera e Plecoptera. Desde então, a identificação em nível de gênero de todos os imaturos de Ephemeroptera, Trichoptera e Plecoptera passou a ser rotina no LEB. Ainda durante a iniciação científica (outubro de 2011), tive a oportunidade de apresentar os resultados de meu projeto de iniciação no *Workshop on Ecology*

Assessment: the Foundation for Evaluating Biological Patterns realizado no *United State Environmental Protection Agency* (USA – Corvallis) juntamente com outros parceiros de pesquisa. Neste evento iniciaram-se as primeiras trocas de ideias sobre meu projeto de mestrado e um futuro manuscrito sobre ninfas de Ephemeroptera como bioindicadoras de pressões antrópicas.

Durante o mestrado fui co-orientada pelo professor Raphael Ligeiro (doutorando do LEB naquela época) e avaliei o efeito de pressões antrópicas sobre as assembleias de Ephemeroptera como previamente discutido no *workshop* em Corvallis. Durante minha defesa de mestrado o professor Leandro Juen sugeriu uma forma mais elegante e robusta de analisar os dados. Em 2015 realizei um pequeno estágio científico com os professores Raphael e Leandro na Universidade Federal do Pará a fim de analisar os dados segundo as sugestões do professor Leandro, e redação do manuscrito que foi publicado no periódico *Ecological Indicators*. Após as correções sinalizadas pelos revisores e a incorporação de dados de áreas de referência o manuscrito foi aceito para publicação e é o capítulo 1 desta tese.

Um dos objetivos iniciais de meu projeto de doutorado era avaliar de forma experimental como a dispersão de macroinvertebrados influenciaria os padrões de metacomunidade em riachos. Realizei alguns testes piloto com a instalação de armadilhas de interceptação de voo nas margens de riachos. Como esta abordagem apresentava uma série de desafios metodológicos e logísticos que poderiam colocar em risco o desenvolvimento da tese dentro do cronograma estabelecido (p. ex. necessidade de elevado número de riachos amostrados periodicamente, tempo de treinamento para identificação de insetos adultos) fui aconselhada pelo meu orientador a não colocá-la em prática neste momento. A partir de então, o segundo capítulo da tese teve como objetivo avaliar a dispersão de organismos bentônicos de forma indireta. Desde o início do doutorado fui estimulada pelo meu orientador a desenvolver uma parte de meu doutorado no exterior. Entre março de 2017 e abril de 2018 tive a oportunidade de realizar o estágio de doutorado sanduíche na Universidade de Barcelona sob a co-orientação da professora Núria Bonada. Considero esta experiência como a realização de um sonho profissional e pessoal por todo o aprendizado obtido (p. ex. aprofundamento em análise de dados, desenvolvimento de habilidades linguísticas e vivência com a cultura européia). Um dos objetivos do grupo de pesquisas da professora Bonada é avaliar a importância da dispersão de macroinvertebrados bentônicos para os padrões de metacomunidades em riachos de clima mediterrânico. Ela me colocou em contato direto com os doutores Miguel Cañedo-Argülles e Cayetano Gutiérrez-Cánovas que trabalham em seu grupo de pesquisas. Desde então, meu projeto tomou novos rumos e fiquei extremamente motivada em abordar a dispersão desses organismos de forma mais detalhada. A professora Bonada me incentivou a trabalhar em uma medida de dispersão mais integradora, Gutiérrez-Cánovas sugeriu integrar o efeito de impactos antrópicos condições locais e que *traits* de tolerância à poluição fossem incorporados às medidas de dispersão. Cañedo-Argülles sugeriu utilizar abordagens de ecologia da paisagem para avaliar se características da paisagem restringiriam o movimento de organismos, como as distâncias entre riachos considerando a rede de drenagem e a variação na topografia. Além desses aspectos, eu estava particularmente interessada em avaliar se os usos e cobertura do solo influenciaria o movimento de organismos entre riachos, algo pouco explorado em estudos de metacomunidades. Eu propus uma medida de distância com base na hipótese de que a intensificação nos usos do solo diminuiria a probabilidade de dispersão de organismos entre riachos. Em colaboração com o professor Macedo, foram realizados os cálculos de medidas de distância com base na resistência da paisagem à dispersão de organismos. Eu realizei as análises estatísticas e redigi o manuscrito em colaboração com todos os co-autores (Miguel Cañedo-Argülles, Cayetano Gutiérrez-Cánovas, Diego Macedo, Núria Bonada e Marcos Callisto). Assim, o segundo capítulo desta tese pode ser considerado também como o início de mais uma parceria científica do LEB, agora entre Brasil e Espanha.

Resumo

Rios de cabeceira preservados e em boas condições ecológicas abrigam alta biodiversidade e fornecem múltiplos bens e serviços ao bem-estar humano tais como recursos hídricos para múltiplos usos incluindo água para consumo humano e irrigação de culturas agrícolas. A intensificação de atividades humanas, entretanto, tem alterado severamente a integridade desses ecossistemas em diferentes escalas espaciais, o que consequentemente tem levado à perda de biodiversidade em escala global. O objetivo geral desta tese foi avaliar os efeitos de pressões antrópicas em múltiplas escalas espaciais na estruturação de comunidades bentônicas em riachos de cabeceira na savana neotropical. Para alcançar o objetivo geral, esta tese foi dividida em dois capítulos. No primeiro capítulo foi avaliada a importância dos efeitos de pressões antrópicas com base nos limiares de assembleias de Ephemeroptera. Foram selecionados estressores antrópicos observados em escalas local e de bacia de drenagem sem correlação significativa com a variabilidade ambiental natural. Foi encontrado que a maioria dos gêneros de Ephemeroptera respondeu de forma negativa aos limiares detectados em função do aumento do percentual de áreas urbanas (escala de bacia de drenagem); alterações na zona ripária, aumento de assoreamento, e diminuição de qualidade de água (escala local). No segundo capítulo foi avaliada a importância de seleção de habitat e de limitação de dispersão para a estrutura de metacomunidades de macroinvertebrados bentônicos. Os macroinvertebrados bentônicos foram classificados em função de suas tolerâncias à poluição e habilidades de dispersão em ambientes aquático e terrestre. Foram calculadas a distância ambiental (escala local) e quatro distâncias físicas (escala regional), a fim de avaliar a importância de seleção de habitat e de limitação de dispersão para a estrutura de metacomunidades. A distância ambiental foi calculada com base em métricas de habitat físicos e parâmetros de qualidade de água. As distâncias físicas foram calculadas com base na rede de drenagem e na resistência da paisagem à dispersão, considerando (i) distância nula (substituta da distância Euclidiana), (ii) distância topográfica e (iii) distância de usos do solo. Os processos ecológicos mais importantes para a estruturação de metacomunidades foram seleção de habitat e limitação de dispersão devido à resistência da paisagem à dispersão. A distância ambiental explicou o aumento na dissimilaridade de todos os macroinvertebrados considerados dispersores fracos e moderados, independentemente de suas tolerâncias à poluição. A distância da rede de drenagem explicou o aumento da dissimilaridade de macroinvertebrados classificados como dispersores moderados e sensíveis à poluição, e daqueles considerados dispersores fortes e tolerantes à poluição. A dissimilaridade de todos os macroinvertebrados, exceto aqueles considerados dispersores moderados e resistentes à poluição aumentou em função da resistência da paisagem devido à intensificação nos usos do solo. Os resultados desta tese evidenciam a importância de avaliar pressões antrópicas sobre ecossistemas aquáticos em múltiplas escalas espaciais (de riachos a unidades hidrológicas) utilizando organismos bentônicos como bioindicadores de qualidade de água e degradação ecológica por atividades humanas.

Palavras-chave: Cerrado, dispersão, limiares de biodiversidade, macroinvertebrados bentônicos, metacomunidade, resistência da paisagem, uso e ocupação do solo.

Abstract

Headwater streams in adequate ecological conditions harbor high biodiversity and provide multiple ecological services to human well-being (e.g., water for human uses including water supply and agriculture irrigation). However, the intensification of human activities has altered the integrity of these ecosystems at different spatial scales, leading to biodiversity loss at global scale. The main goal of this PhD thesis was to evaluate the effects of anthropogenic pressures on multiple spatial scales on benthic macroinvertebrates community structure, at headwater streams in the Neotropical savanna. The thesis was divided into two chapters. The first chapter shows the importance of anthropogenic stressors based on Ephemeroptera assemblage thresholds. Anthropogenic stressors observed at the local and catchment scales without significant correlation with natural environmental variability were selected. Most of Ephemeroptera genera responded negatively to the threshold values detected as percentage of urban areas increased (catchment scale); riparian zone changes, siltation, and water quality decreased (local scale). The chapter two shoes the importance of habitat selection and dispersal limitation to benthic macroinvertebrate metacommunities structure. The benthic macroinvertebrates were classified according to their pollution tolerances and dispersal ability in aquatic and terrestrial environments. The environmental distance (local scale) and four physical distances (regional scale) were calculated to evaluate the importance of habitat selection and dispersal limitation for the metacommunity structure. The environmental distance was calculated based on physical habitat metrics and water quality parameters. Physical distances were calculated based on the drainage network and landscape resistance to dispersal ability, as (i) null distance (surrogate of Euclidean distance), (ii) topographical distance and (iii) land use distance. The most important ecological processes for metacommunity structure were habitat selection and dispersal limitation due to landscape resistance. The environmental distance explained the increase in dissimilarity of all macroinvertebrates considered as weak and moderate dispersers, regardless of their pollution tolerances. The drainage network distance explained the increase in dissimilarity of macroinvertebrates classified as moderate and sensitive to pollution and, for those classified as strong dispersers and tolerant to pollution. The dissimilarity of all groups, except for those considered moderate and resistant to pollution increased as a function of landscape resistance due to land use intensification. The results of this thesis reveal the importance of anthropogenic pressures on headwaters streams at multiple spatial scales (from streams to hydrological units) using benthic organisms as bioindicators of water quality and ecological degradation by human activities.

Key-words: Cerrado, dispersal, biodiversity thresholds, benthic macroinvertebrates, metacommunity, landscape resistance, land use and cover.

Introdução geral

Ecossistemas aquáticos continentais ocupam menos de 1% da superfície terrestre e abrigam alta riqueza de espécies em diferentes grupos biológicos, tais como algas, plantas superiores, invertebrados (p. ex. moluscos, anelídeos e insetos) e vertebrados (p. ex. peixes e anfíbios) (Dudgeon et al., 2006). As populações humanas utilizam os recursos aquáticos para consumo doméstico, atividades industriais e agropecuárias, aquicultura, geração de energia, navegação e recreação (Malmqvist & Rundle, 2002). A intensificação dessas atividades, entretanto, tem gerado diversos impactos sobre estes ecossistemas incluindo superexploração de recursos hídricos (Vörösmarty et al., 2010), alterações nos fluxos hídrico e biogeoquímico (Sala et al., 2000; Woodward et al., 2012), invasão de espécies exóticas (Dudgeon et al., 2006) e mudanças nos usos e ocupação do solo (Allan, 2004; Foley et al., 2005). Os efeitos destas pressões antrópicas alteram a integridade de ecossistemas em diferentes escalas espaciais e, consequentemente, levam à perda de biodiversidade em escala global (Rockström et al., 2009; Steffen et al., 2015). Faz-se necessário, portanto, avaliar as condições ambientais de ecossistemas em diferentes escalas espaciais (Turner, 1989). Esta tese avaliou os efeitos de uso e ocupação do solo sobre os ecossistemas fluviais no cerrado, um bioma que tem sido severamente ameaçado pela perda de cobertura de vegetação natural (Strassburg et al., 2017).

Nesta introdução geral são apresentadas as bases conceituais que nortearam esta tese de doutorado. Os riachos não são apenas simples elementos que compõem a paisagem terrestre, mas são, sobretudo, paisagens em si, que abrigam comunidades biológicas únicas. Dessa forma, é possível aplicar os mesmos conceitos base em ecologia da paisagem para compreender como comunidades biológicas são estruturadas em função de processos ecológicos ocorrentes em múltiplas escalas espaciais. Um dos aspectos mais importantes em ecologia é que a interpretação de padrões e processos ecológicos é dependente de escalas (Odum & Barrett, 2007). Considerando as comunidades biológicas em riachos como exemplo, processos evolutivos podem explicar os padrões de riqueza de gêneros de insetos aquáticos, enquanto que condições ambientais locais (p. ex. nutrientes) devem explicar os padrões de abundância de organismos observados entre diferentes regiões biogeográficas (Heino et al., 2018). Assim, a importância de processos ecológicos para os padrões observados deve ser analisada a partir da delimitação de escalas apropriadas (Turner, 1989). Esta tese avaliou apenas a escala espacial. Além disso, outras abordagens comumente utilizadas na ecologia da paisagem foram também utilizadas nesta tese e são apresentadas ao longo desta introdução geral, como análises de gradientes (ver limiares ecológicos) e teoria de grafos (ver medidas de distância).

Nesta introdução de bases conceituais é apresentado o conceito de **hierarquia de ecossistemas fluviais** (Frissell et al., 1986) que descreve a importância de processos climáticos, geomorfológicos e ecológicos que ocorrem em diferentes escalas espaciais e que são responsáveis pelas condições abióticas e bióticas observadas em cada nível hierárquico. Assim, considerar que riachos são organizados de forma hierárquica na paisagem terrestre constitui umas das principais bases conceituais para compreender como o uso e ocupação do solo pelos humanos alteram condições ambientais em diferentes escalas espaciais e que, consequentemente, afetam a biota local (Allan, 2004).

Em seguida, é apresentado o conceito de comunidades biológicas (Stroud et al., 2015), com ênfase em **comunidades de macroinvertebrados bentônicos** em riachos. Os macroinvertebrados bentônicos são amplamente utilizados como bioindicadores de qualidade de água (Rosenberg & Resh, 1993; Bonada et al., 2006), e dentre eles, organismos pertencentes às ordens Ephemeroptera, Plecoptera e Trichoptera constituem assembleias biológicas formadas por organismos considerados sensíveis a pressões antrópicas sobre os ecossistemas aquáticos (Callisto et al., 2001). Além de desempenhar o papel de bioindicadores, os macroinvertebrados bentônicos apresentam diferentes estratégias de dispersão, sendo então amplamente utilizados em estudos de metacomunidades em riachos (Heino & Peckarsky, 2014; Heino et al., 2017). Nesta tese, os macroinvertebrados bentônicos foram utilizados como organismos modelos para avaliar o efeito de pressões antrópicas sobre condições ambientais locais, e sobre a paisagem terrestre devido ao efeito de limitação de dispersão.

O próximo conceito ecológico importante para esta tese é o de **limiares em comunidades biológicas** (King & Baker, 2014). Um limiar refere-se ao ponto em que se observa uma mudança abrupta na integridade de ecossistemas em função do aumento de pressões antrópicas, gerando assim, novas condições ambientais. A partir do ponto detectado como limiar, é esperada alteração na estrutura de comunidades biológicas, sendo observada perda de espécies sensíveis e predomínio de espécies tolerantes às novas condições ambientais. Diversos tipos de pressões antrópicas observadas em diferentes escalas espaciais têm gerado respostas limiares em comunidades biológicas, como uso e ocupação do solo em escala regional (Baker & King, 2010), supressão de vegetação em zonas ripárias (Rodrigues et al., 2016) e perda de habitat e diminuição da qualidade de água em escala local (Shimano & Juen, 2016).

Por fim, o conceito de **metacomunidade.** Uma metacomunidade é definida como um conjunto de comunidades locais ligadas por dispersão onde múltiplas espécies potencialmente interagem (Leibold et al., 2004). Esse conceito ressalta a importância de processos ecológicos que ocorrem em múltiplas escalas espaciais para estruturação de comunidades. O conceito de metacomunidade considera que em escala local as condições ambientais selecionam espécies que coexistem localmente, e em escala regional, que a limitação de dispersão aumenta à medida que a distância entre as comunidades aumenta. Em seguida são apresentados os *proxies* (isto é, variáveis que podem ser mensuradas em um ecossistema a fim de permitir inferências sobre um processo ecológico) comumente utilizados em estudos de metacomunidade. Primeiramente são apresentados os *proxies* de dispersão que descrevem as características intrínsecas de dispersão de macroinvertebrados bentônicos. Em seguida, são apresentados os *proxies* de distância ambiental e de distâncias físicas. A distância ambiental é utilizada para avaliar a importância de condições ambientais locais, e baseia-se na teoria de nicho ecológico. As distâncias físicas são utilizadas para avaliar a limitação de dispersão, e baseiam-se na teoria de grafos. Um grafo é definido como um conjunto de nós, denominados de vértices, que são conectados por ligações, denominadas de arestas (Urban et al., 2009). O conceito de metacomunidade tem importantes implicações para a conservação de biodiversidade. Esse conceito considera simultaneamente a importância de condições ambientais locais (com base na teoria de nicho ecológico) e processos ecológicos que ocorrem em escala regional (com base na teoria de teoria de grafos). Considerando que pressões antrópicas afetam os ecossistemas em múltiplas escalas espaciais, a ecologia de metacomunidade oferece bases conceituais para avaliar e monitorar o efeito de pressões antrópicas sobre os ecossistemas. Programas de biomonitoramento de ecossistemas aquáticos, por exemplo, devem considerar que pressões antrópicas alteram não somente as condições ambientais locais, mas também aumentam o isolamento entre habitats em boas condições ambientais (Heino, 2013).

Ecossistemas fluviais na ecologia da paisagem

A ecologia da paisagem é uma ciência interdisciplinar que combina a abordagem espacial da geografia com a abordagem funcional da ecologia (Forman & Godron, 1986). A ecologia da paisagem pode ser definida como a ciência que investiga a relação entre padrões espaciais e processos ecológicos, como causa e consequência da heterogeneidade espacial em diferentes escalas (Turner & Gardner,2015) O termo ecologia da paisagem foi proposto pelo biogeógrafo Carl Troll em 1939, ao utilizar fotografias aéreas para avaliar diferentes elementos da paisagem na Europa (Turner & Gardner 2015). No entanto, somente a partir da década de 1980 que a ecologia da paisagem recebeu maior atenção enquanto ciência, subsidiando a proposição de medidas de conservação de biodiversidade em grandes escalas (Sanderson & Harris, 2000).

Uma paisagem corresponde a uma área espacialmente heterogênea em pelo menos um dos fatores de interesse (Turner & Gardner, 2015). Dentro de uma paisagem terrestre podem ser observados diferentes elementos incluindo matriz, mancha, mosaico, e o corredor, representado pela zona ripária localizada nas margens do riacho (Figura 1). Os elementos de paisagem são formados por diversos processos ecológicos, evolutivos, geomorfológicos que ocorrem simultaneamente (Turner & Gardner, 2015). Tais processos são responsáveis pelos gradientes de heterogeneidade horizontal e vertical, bem como pela estrutura hierárquica de ecossistemas (Sanderson & Harris, 2000). Por exemplo, processos geomorfológicos (degelo de geleiras, erupções vulcânicas) e evolutivos (especiação) são responsáveis pelos gradientes de heterogeneidade horizontal, como os diferentes tipos de cobertura do solo e de vegetação terrestre (Naveh, 1991). Processos geomorfológicos (intemperismo de rochas) e ecológicos (p.ex. ciclos biogeoquímicos) são responsáveis, por exemplo, pela heterogeneidade vertical, como a estratificação do solo (Naveh, 1991). As atividades humanas têm alterado a paisagem tanto no que se refere ao gradiente horizontal quanto o vertical (Turner, 1989). Mudanças nos usos e cobertura do solo são responsáveis por perda de conectividade da paisagem terrestre (heterogeneidade horizontal) e alteração nos ciclos biogeoquímicos (heterogeneidade vertical). Esta tese avaliou o efeito do uso e cobertura do solo sobre comunidades bentônicas em riachos de cabeceira neotropicais ao longo de gradientes horizontais.

Os ecossistemas fluviais são analisados na ecologia da paisagem, considerando ao menos três perspectivas (Wiens, 2002). Na primeira, rios e riachos são vistos como simples elementos estruturais de uma paisagem e, portanto são equivalentes a qualquer outro elemento, tais como uma mancha formada por floresta, campos de cultivos ou mesmo um mosaico formado por diferentes tipos de vegetação (Figura 1). Na segunda, são vistos como partes funcionais da paisagem, onde são considerados os limites físicos entre os ecossistemas fluvial e terrestre, ao longo de perfis longitudinais e laterais, tais como o canal principal, a zona ripária e a área da planície de inundação. Dessa forma, processos ecológicos, tais como ciclagem de matéria orgânica, fluxo de energia, movimento de materiais e dispersão de organismos ocorre entre os compartimentos terrestres e aquáticos dentro de uma paisagem (Wiens, 2002; Allan & Castillo, 2007). Na terceira, os ecossistemas fluviais são considerados paisagens internamente heterogêneas, formadas por um mosaico de manchas de habitats, tais como áreas de remansos e corredeiras, com diferentes tipos de micro-habitats. Este padrão espacial de heterogeneidade observado em ecossistemas fluviais constitui uma paisagem própria, chamada por Wiens (2002) de *riverine landscape*. Nesta tese os riachos foram considerados como partes funcionais da paisagem a fim de avaliar a integração entre os ecossistemas terrestre e aquático (escala regional) e como paisagens internamente heterogêneas, com o intuito de se avaliar a importância de condições ambientais locais (escala local) para a estrutura de comunidades bentônicas.

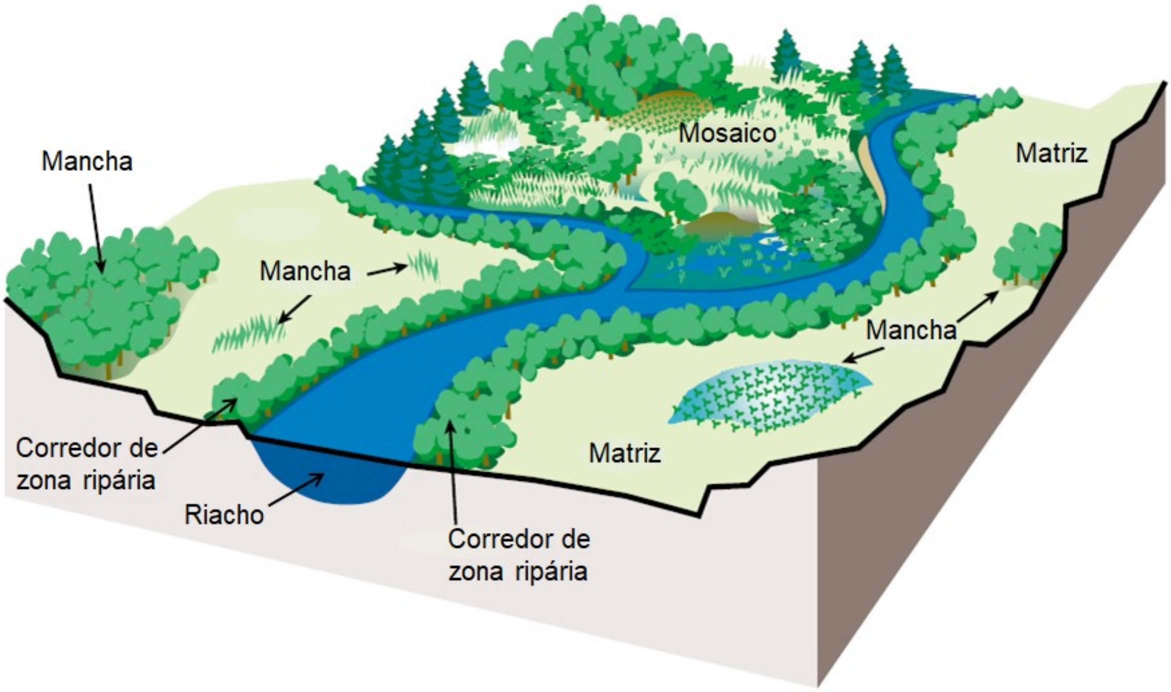

Figura 1. Representação esquemática de uma paisagem formada por manchas de vegetação de diferentes tipos (p. ex. florestas, gramíneas e áreas de cultivo), matriz, mosaico e corredor formado pela zona ripária localizada nas margens do riacho (Adaptada de FISRWG, 1998).

Um dos temas centrais em ecologia da paisagem relaciona padrões e processos ecológicos com a escala (Turner, 1989). *Escala* refere-se à dimensão (espacial ou temporal) em que um objeto ou processo é analisado (Turner & Gardner, 2015). A escala espacial é definida em função de dois componentes, o *grão*, que corresponde ao menor nível de resolução espacial, e a *extensão*, que representa o tamanho da área de estudo. O tamanho do grão corresponde à precisão da medida, denominada de *resolução*. Um grão em alta resolução espacial permite um maior detalhamento de elementos da paisagem. Por outro lado, um grão em baixa resolução espacial, possibilita a avalição de elementos da paisagem de forma menos detalhada. Não há uma escala espacial melhor ou pior, e sim, uma escala espacial adequada para investigar que características da paisagem se alteram de acordo com a escala espacial analisada (Levin, 1992). A escala espacial deve ser delimitada em função da capacidade do organismo em distinguir diferentes elementos em uma paisagem (Wiens, 1989). Por exemplo, organismos diferem em seus *traits*, como tamanho corporal e capacidade de dispersão, sendo esperado que organismos de maior tamanho se dispersem por maiores extensões, comparados àqueles de menor tamanho corporal (Wiens, 2002). Espera-se que medidas de escala espacial obtidas em baixa resolução sejam mais adequadas para avaliar a influencia da paisagem para os padrões de distribuição de organismos de grande tamanho corporal e alto potencial de dispersão, enquanto que aquelas obtidas em alta resolução espacial sejam mais apropriadas para organismos de menor tamanho corporal e baixo potencial de dispersão (Turner, 1989; Levin, 1992). No capítulo 1, as escalas local (trecho de riacho) e regional (bacia de drenagem) foram mapeadas em alta resolução espacial, a fim de selecionar estressores de origem antrópica sem correlação significativa com a variabilidade ambiental natural. No capítulo 2, as unidades hidrológicas (escala regional) foram mapeadas em baixa resolução espacial para avaliar a resistência da paisagem ao movimento de dispersão de macroinvertebrados bentônicos devido à intensificação nos usos do solo em grandes extensões espaciais.

Hierarquia de ecossistemas fluviais

Riachos estão inseridos na paisagem terrestre e são diretamente influenciados por processos climáticos, geomorfológicos e ecológicos observados em diferentes escalas espaciais (Wiens, 2002). Por exemplo, em escala regional, o clima e a geologia determinam a matriz do uso e cobertura do solo e a composição da zona ripária. Em consequência, detritos foliares provenientes da zona ripária e o intemperismo de rochas que compõem a matriz do uso e cobertura do solo determinam a composição do substrato observado em escala local (Allan & Castillo, 2007). Dessa forma, os riachos são ecossistemas organizados de forma hierárquica e espacialmente aninhada. O conceito de hierarquia foi proposto por Neill et al. (1989) para descrever paisagens enquanto ecossistemas complexos organizados em múltiplas escalas espacial e temporal. Uma propriedade importante de sistemas hierárquicos é a restrição, ou seja, níveis superiores determinam a organização de níveis inferiores, mas o inverso não é verdadeiro. Por exemplo, a composição do substrato do leito não determina a composição da zona ripária, ou a matriz do uso e cobertura do solo, e estes por sua vez não determinam o clima ou a geologia. Baseado no conceito de hierarquia, Frissell et al. (1986)

descreveram os diferentes níveis de organização de riachos (Figura 2). Em ecossistemas fluviais, o maior nível hierárquico corresponde à bacia hidrográfica, seguido por segmento, trecho, habitat e micro-habitat, que corresponde, portanto ao menor nível hierárquico.

Bacias hidrográficas podem cobrir extensões espaciais extremamente grandes, o que pode inviabilizar o desenvolvimento de estudos ecológicos de curto e médio prazo. Estudos de avaliação de condições ecológicas em escala regional podem ser conduzidos em menores extensões espaciais, como as unidades hidrológicas. Uma unidade hidrológica representa uma área de drenagem pré-estabelecida dentro de uma bacia hidrográfica (Seaber et al., 1987). Esta tese analisou a escala espacial local (trechos de riachos no capítulo 1 e 2) e regional (bacia de drenagem de cada riacho no capítulo 1, e unidades hidrológicas no capítulo 2).

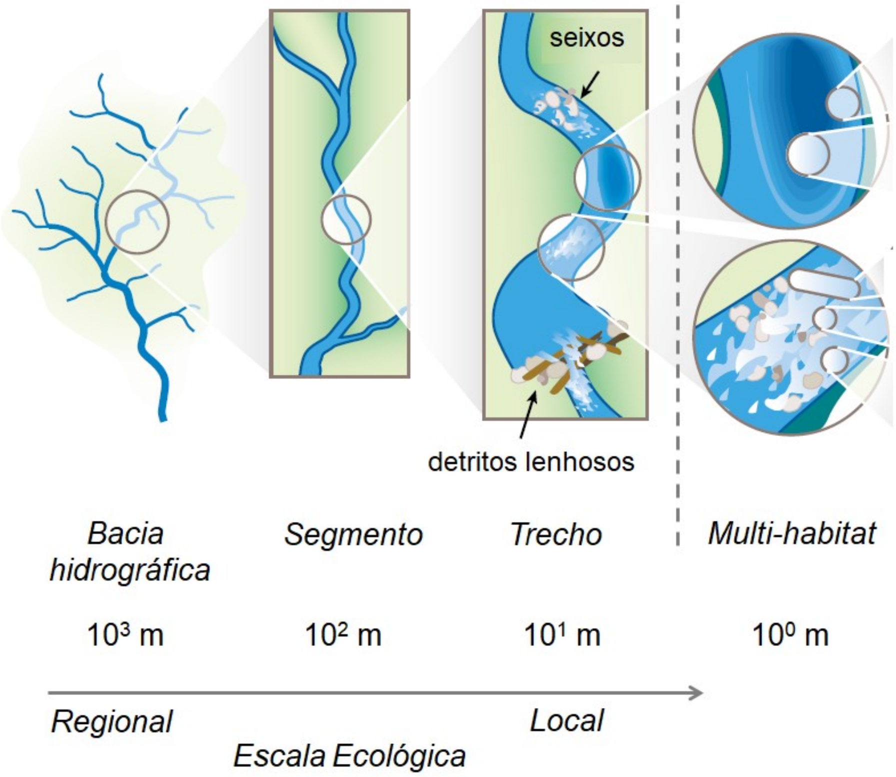

Figura 2. Esquema ilustrando a organização hierárquica de ecossistemas fluviais. Os diferentes micro-habitats existentes (areia, cascalho, detritos foliares) não estão representados nesta figura (Adaptada de FISRWG, 1998).

Uma bacia hidrográfica inclui toda a área da rede de drenagem. As condições ambientais de uma bacia hidrográfica são determinadas por fatores climáticos, geológicos, topográficos e biogeográficos. Tais fatores são responsáveis pelo clima, o tipo de solo, a biota regional (isto é, o conjunto de todas as espécies que ali ocorrem), e os tipos de uso e cobertura do solo. O seguinte nível hierárquico corresponde aos segmentos de riachos, que são diretamente influenciados pela topografia e geologia, que determinam a inclinação do segmento e sua posição na rede de drenagem. Um segmento pode ser formado por um único riacho, tendo como ponto de origem a sua nascente, ou também pela união de dois ou mais riachos. Strahler (1957) propôs um sistema de classificação quantitativa de ecossistemas fluviais, também conhecido como “ordem de Strahler” (Figura 3). Segundo este sistema, um segmento de primeira ordem é formado por um único riacho, um segmento de segunda ordem, pela confluência de dois segmentos de primeira ordem, um segmento de terceira, pela confluência de dois segmentos de segunda ordem e assim sucessivamente.

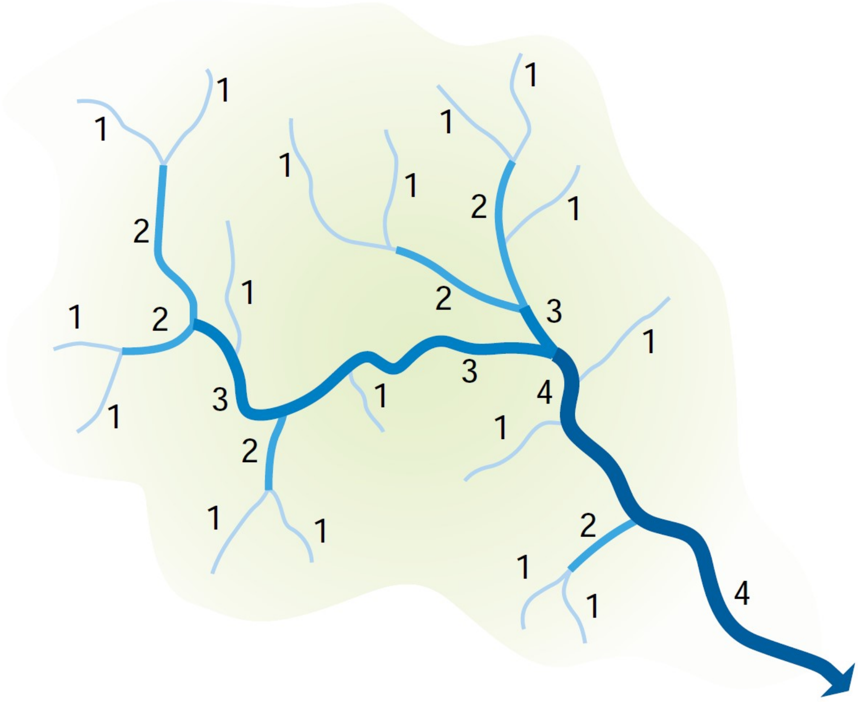

Figura 3. Representação esquemática de segmentos de riachos em uma rede de drenagem segundo o sistema de classificação de Strahler (1957) (Adaptada de FISRWG, 1998).

Comunidades biológicas

Sistemas biológicos também estão organizados de forma hierárquica. O organismo é a unidade fundamental dos níveis hierárquicos na ecologia, seguido pelos conceitos de população, comunidade, ecossistema, biomas e a biosfera, que corresponde ao maior nível hierárquico (Odum & Barrett, 2007). Comunidades biológicas podem ser definidas como um grupo de populações de espécies que interagem e ocorrem juntas no espaço (Stroud et al., 2015). Macroinvertebrados bentônicos é o termo utilizado para designar organismos invertebrados, visíveis a olho nu (> 1,0 mm) que habitam o fundo de ecossistemas aquáticos por parte, ou durante todo o seu ciclo de vida (Rosenberg & Resh, 1993; Esteves et al., 2011). A comunidade de macroinvertebrados bentônicos é composta por organismos pertencentes a diferentes grupos taxonômicos, tais como insetos, moluscos, crustáceos e anelídeos (Ruppert et al., 2005). Estudos em nível de comunidades biológicas podem focar em um grupo filogeneticamente mais próximo, sendo denominado como uma assembleia biológica. Uma assembleia pode ser definida como grupos de populações de espécies taxonomicamente relacionadas e que ocorrem juntas no espaço (Stroud et al., 2015).

Macroinvertebrados bentônicos são amplamente utilizados como bioindicadores de qualidade de água em programas de avaliação de condições ambientais de ecossistemas aquáticos (Bonada et al., 2006). Segundo Rosenberg & Resh (1993), os macroinvertebrados bentônicos oferecem vantagens como bioindicadores de pressões antrópicas em ecossistemas aquáticos pelas seguintes razões: (i) são ubíquos, e, portanto, podem ser afetados pelo efeito de pressões antrópicas sobre os ecossistemas aquáticos; (ii) apresentam alta riqueza de táxons com diferentes níveis de sensibilidade ao estresse; (iii) são relativamente sésseis, o que permite analisar o efeito de estresse em escala espacial; (iv) apresentam ciclo de vida relativamente longo nos ecossistemas aquáticos, o que permite avaliar o efeito de estresse ao longo do tempo. De uma maneira geral, os táxons de macroinvertebrados bentônicos podem ser classificados como sensíveis, tolerantes e resistentes a alterações de origem antrópica (Callisto et al., 2001). A figura 4 ilustra as mudanças na estrutura de comunidades de macroinvertebrados ao longo de um gradiente de condições ambientais. Em sítios de referência é esperada alta riqueza de grupos sensíveis com predomínio de organismos pertencentes às ordens Ephemeroptera, Plecoptera e Trichoptera. Em sítios em condições intermediárias é esperada alta riqueza de grupos tolerantes, com predomínio de organismos pertencentes às ordens Odonata, Heteroptera, Megaloptera e Coleoptera. Em sítios impactados, há perda de organismos sensíveis e tolerantes, enquanto que aqueles considerados resistentes predominam, incluindo aqueles pertencentes à classe Oligochaeta, à ordem Diptera, e ao filo Mollusca. Esta tese teve como foco a comunidade de macroinvertebrados bentônicos em riachos de cabeceira. O capítulo 1 avaliou os efeitos de pressões antrópicas com base nas respostas limiares de assembleias de Ephemeroptera (Arthropoda, Insecta). O capítulo 2 avaliou a importância de seleção de habitat e de dispersão para os padrões de metacomunidades de macroinvertebrados bentônicos.

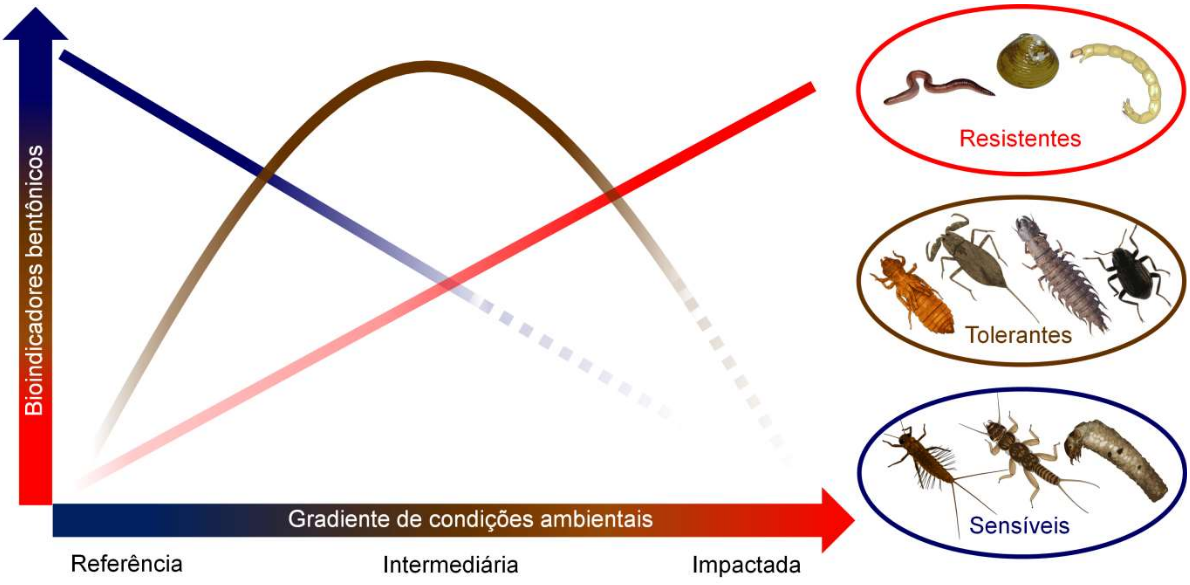

Figura 4. Mudanças esperadas na comunidade de macroinvertebrados ao longo de um gradiente de condições ambientais (azul: macroinvertebrados sensíveis, marrom: tolerantes, vermelho: resistentes). Desenhos dos macroinvertebrados bentônicos de Pau Fortuño (Universidade de Barcelona), exceto Megaloptera (Cao & Liu, 2013).

Limiares em comunidades biológicas

Pressões antrópicas têm alterado as condições do ambiente físico em uma escala temporal excessivamente curta (Hendry et al., 2017). Considerando que as respostas adaptativas normalmente ocorrem em escalas evolutivas, em geral temporalmente longas, a tendência é que muitos organismos desapareçam por não conseguirem suportar as novas condições ambientais. Assim, novas condições ambientais são geradas pelo aumento de estressores antropogênicos que podem alterar severamente a estrutura de comunidades biológicas, sendo observadas respostas limiares (King & Baker, 2014). Nesta tese foi adotado o conceito de limiares ecológicos em comunidades definido por Baker & King (2010) como sendo o aumento, ou diminuição acentuada, na frequência e/ou abundância de espécies em algum ponto ao longo de um gradiente gerado pelo aumento de um estressor de origem antrópica. Neste ponto observa-se mudança rápida e abrupta na estrutura de comunidades quando comparadas a outros pontos no gradiente. Novos gradientes alteram a estrutura de comunidades devido ao efeito de pressões seletivas que favorecem as espécies nativas menos especializadas, mas com alta plasticidade fisiológica. Desta forma, os organismos adaptam-se às novas condições ambientais por plasticidade fisiológica. Nestas condições é facilitado também o estabelecimento de espécies não nativas adaptadas às novas condições ambientais (King & Baker, 2014). A figura 5 ilustra as respostas teóricas de uma dada ao longo de um gradiente ambiental natural e a um novo gradiente. Neste exemplo, o gradiente natural representa a declividade em um riacho (em azul), e o novo gradiente representa uma fonte de poluição difusa (em vermelho), tais como hidrocarbonetos policíclicos aromáticos como derivados de petróleo, metais pesados, salinização etc. A curva em azul representa o intervalo de frequência e/ou abundância esperados à medida em que a declividade em um riacho aumenta. A curva vermelha representa o novo gradiente, ou seja, uma nova dimensão sendo teoricamente independente (ou ortogonal) ao gradiente natural. Neste exemplo, o novo gradiente tem um efeito negativo sobre a espécie, mas dependendo da localização no gradiente natural, a espécie pode responder de forma diferente ao novo gradiente. O capítulo 1 desta tese avaliou as respostas limiares de assembleias de Ephemeroptera aos estressores de origem antrópica mensurados em escala local (parâmetros limnológicos da coluna d'água, habitats físicos, condições de zonas ripárias) e regional (percentual de urbanização em bacias de drenagem). Para detectar as respostas limiares foi utilizada a análise *Threshold Indicator Taxa ANalysis* (TITAN) proposta por Baker & King (2010).

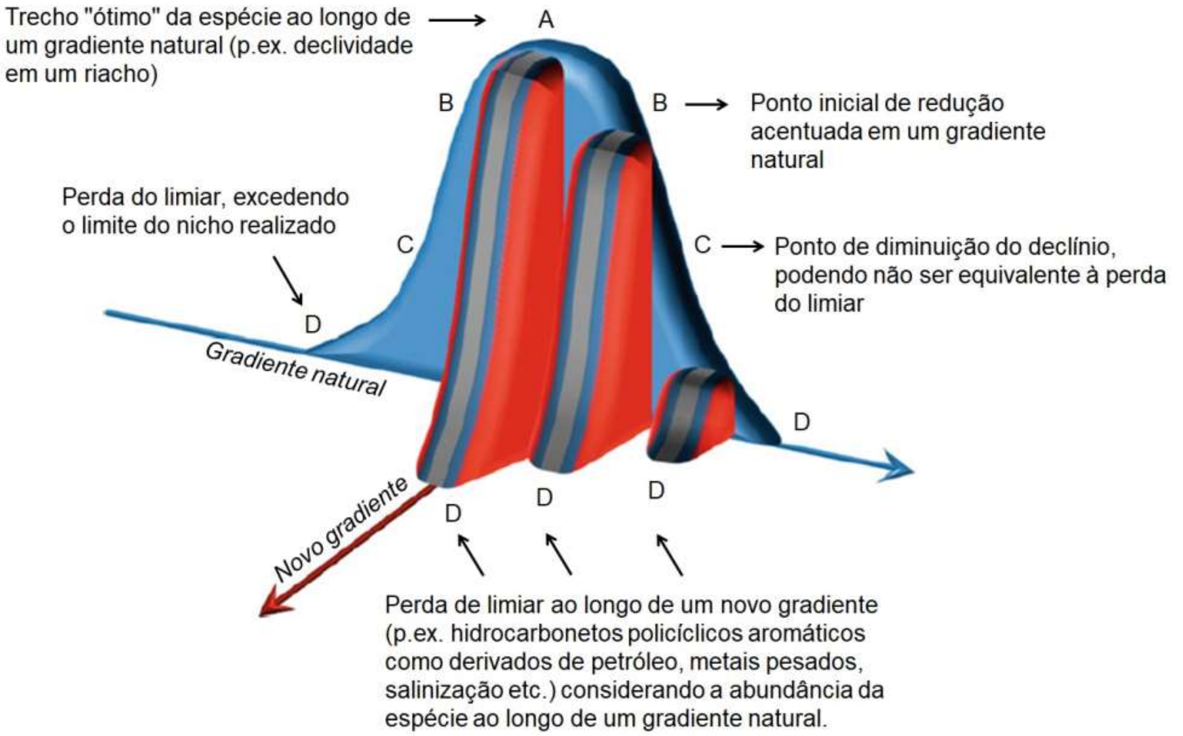

Figura 5. Diagrama conceitual ilustrando as respostas esperadas de uma única espécie para um gradiente natural e a um novo gradiente (Adaptada de King & Baker, 2014).

Metacomunidade

O estudo de ecologia de comunidades analisa padrões de diversidade de espécies para inferir a importância de processos ecológicos. Quatro processos ecológicos ocorrem simultaneamente: seleção, deriva, dispersão e especiação (Vellend, 2010). Seleção é um processo determinístico que considera que as espécies são diferentes em termos de aptidão (capacidade de gerar descendentes). Deriva se refere a um processo que altera de forma estocástica a abundância relativa de indivíduos de uma espécie. Dispersão é o movimento de indivíduos através do espaço, e a especiação é o processo de criação de novas espécies. Dentro desta estrutura teórica, o conceito de metacomunidade considera explicitamente a importância dos processos de seleção, deriva e dispersão para explicar as diferenças de composição entre comunidades. Uma metacomunidade é definida como um conjunto de comunidades locais ligadas por dispersão onde múltiplas espécies potencialmente interagem (Leibold et al., 2004). Estudos de metacomunidades buscam compreender ainda como processos ecológicos atuando em diferentes escalas espaciais estruturam comunidades locais e consequentemente, a biodiversidade. Em escala local observa-se a importância da seleção, através da heterogeneidade ambiental e interação entre espécies (Poff, 1997; Leibold et al., 2004), e em escala regional, a dispersão e a deriva (Hubbell, 2001; Logue et al., 2011). O conceito de metacomunidade ressalta, portanto, a importância de considerar a escala espacial de forma explícita a fim de compreender os padrões de distribuição e abundância de espécies. Um modelo espacialmente explícito assume que a disposição e/ou a distância entre habitats na paisagem influenciam o movimento e a interação de espécies (Leibold et al., 2004). Assim, estudos de metacomunidades são realizados no contexto de ecologia da paisagem.

Leibold et al. (2004) propuseram quatro modelos conceituais para explicar os padrões observados em metacomunidades: dinâmica de manchas, triagem de espécies, efeito de massa e efeito neutro. O modelo de dinâmica de manchas assume que os habitats são equivalentes em termos de condições e recursos e que, portanto, podem estar ocupados ou não. Assim, a composição de comunidades locais é direcionada por um balanço entre a capacidade de dispersão e a interação interespecífica por meio de competição. O modelo de triagem de espécies destaca a importância de gradientes de condições ambientais e de dispersão sobre a composição de comunidades locais. A heterogeneidade ambiental exerce um forte efeito de seleção sobre as espécies que ocorrem apenas em habitats ambientalmente adequados. A dispersão permite que as espécies acompanhem a heterogeneidade ambiental em busca de habitats adequados. No modelo de efeito de massa, as espécies alcançam máximo sucesso reprodutivo em habitats de alta qualidade. À medida que os recursos se tornam escassos, aumenta a competição entre as espécies. Como forma de diminuir o efeito da competição, observa-se aumento na frequência e abundância de espécies que se dispersam em direção a habitats de menor qualidade. Assim, habitats de alta qualidade são considerados fontes, enquanto que aqueles de menor qualidade são considerados drenos. Por fim, o modelo de efeito neutro assume que os habitats são ambientalmente equivalentes, e as espécies não diferem em termos de capacidade de dispersão e competição. Desse modo, as comunidades locais são estruturadas em função de processos estocásticos que ocorrem ao longo do tempo, sendo então responsáveis pelo ganho (imigração e especiação), e perda (emigração e extinção) de espécies (Hubbell, 2001).

O trabalho conceitual de Leibold et al. (2004), inspirou diversos estudos que buscaram quantificar a importância de processos ecológicos ocorrentes em escala local (seleção) e aqueles em escala regional (dispersão e deriva) para os padrões de metacomunidade. Desde então, um dos objetivos de estudos de metacomunidades tem sido descrevê-las com base em um dos quatro modelos propostos (Cottenie, 2005; Logue et al., 2011). No entanto, padrões em metacomunidades raramente são explicados por uma das quatro abordagens de forma independente. Winegardner et al. (2012) sugeriram que os modelos de dinâmica de manchas e de efeito de massa são casos especiais do modelo de triagem de espécies. Este raciocínio baseia-se na premissa de que os efeitos de dispersão sobre os padrões de metacomunidades atuam de formas diferentes em cada caso. No caso de dinâmica de manchas, a dissimilaridade entre as comunidades locais tende a aumentar devido à limitação de dispersão. Enquanto que no caso de efeito de massa, as comunidades tendem a se tornarem mais similares devido ao efeito de homogeneização de comunidades. Winegardner et al. (2012) sugerem que os quatro modelos sejam ordenados de forma a representar um gradiente que varia desde processos determinísticos até aqueles estocásticos: triagem de espécies, dinâmica de manchas, efeito de massa, e efeito neutro. Assim, mais do que simplesmente categorizar metacomunidades, esta organização ressalta que processos de seleção, dispersão e deriva varie gradativamente em importância relativa ao explicar os padrões observados em metacomunidades.

Riachos são ecossistemas modelos para investigar a importância de processos de seleção de habitat e dispersão por pelo menos três motivos. Primeiro, são os principais componentes de bacias hidrográficas em termos de extensão espacial (Benda et al., 2006). Segundo, exibem ampla variação de condições ambientais que atuam selecionando espécies que coexistem localmente (Frissell et al., 1986; Poff, 1997). Terceiro, a dispersão de organismos ocorre tanto dentro do riacho, sendo condicionada pela direção do fluxo (p. ex. peixes e imaturos de insetos), quanto através da paisagem terrestre (p. ex. insetos adultos alados) (Brown et al., 2011; Altermatt, 2013). Heino et al. (2015) conduziram uma extensiva revisão em estudos de metacomunidades em diferentes tipos de ecossistemas aquáticos. Os autores observaram que modelo de triagem de espécies foi o que melhor explicou a variação entre comunidades em riachos. Além disso, os autores argumentam que em diferentes extensões espaciais o processo de dispersão também exerce um forte efeito sobre os padrões de metacomunidades conforme mostrado na figura 6. A extensão espacial é utilizada para inferir a limitação de dispersão, uma vez que é esperado que a taxa de dispersão seja alta em locais próximos, e diminua à medida que a distancia aumenta. A menor extensão espacial é representada como a distância entre habitats dentro de um riacho (p. ex. entre corredeiras), entre riachos, entre bacias de drenagem, e a maior distância, entre regiões biogeográficas. Em pequenas extensões espaciais, as comunidades são homogeneizadas em função da alta taxa de dispersão, sendo observado um forte efeito de estruturação em função do espaço. Portanto, o modelo de efeito de massa explica a variação entre comunidades nesta extensão espacial. A taxa de dispersão é intermediária em extensões espaciais que compreendem desde a distância entre riachos até entre bacias de drenagens, o que permite aos organismos acompanharem a variabilidade ambiental dentro desta escala espacial. Em outras palavras, os organismos podem potencialmente se dispersar em busca de habitats com condições ambientais compatíveis com o nicho ecológico das espécies a que pertencem. Assim, a variação entre metacomunidades é explicada pelo modelo de triagem de espécies. A dispersão é extremamente limitada em grandes extensões espaciais, representada na figura como regiões biogeográficas, o que não permite que os organismos acompanhem a variabilidade ambiental. Dessa forma, a variação entre comunidades é explicada pela limitação de dispersão, sendo observado um forte efeito do espaço.

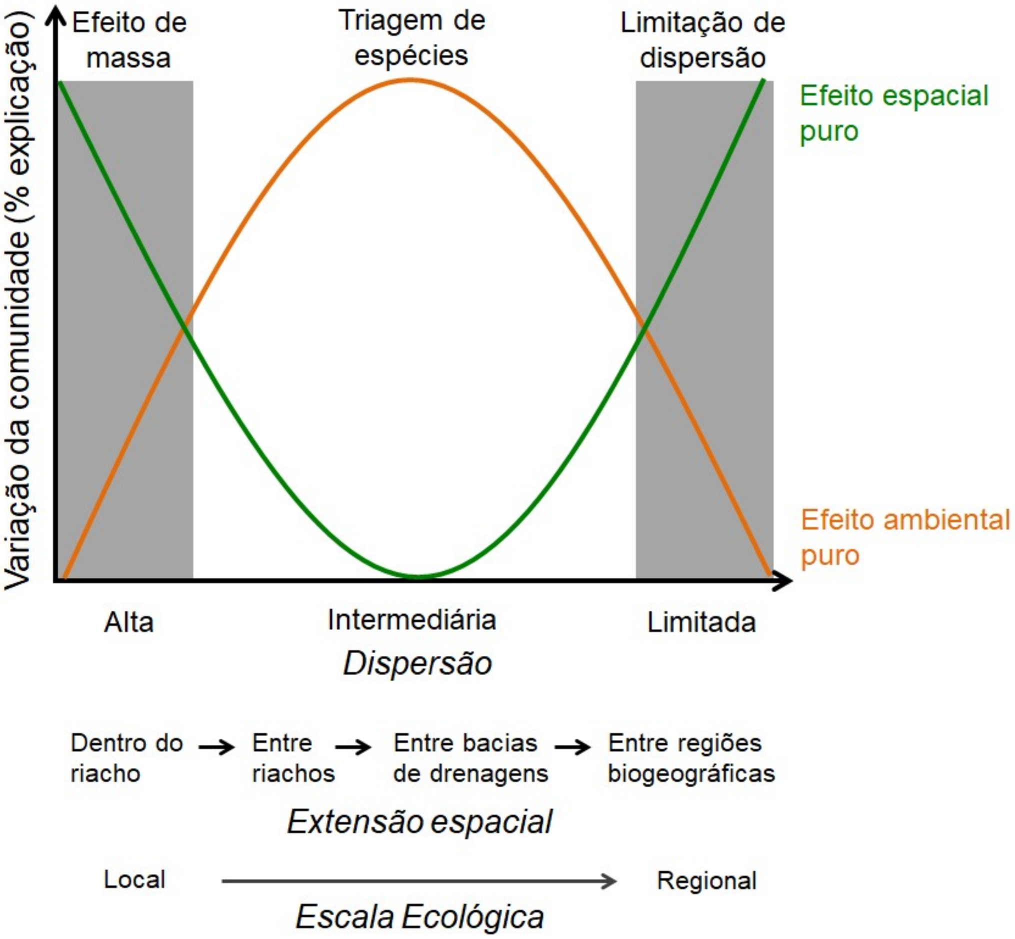

Figura 6. Representação esquemática ilustrando a importância do efeito ambiental e espacial em função da extensão espacial em explicar a variação na estrutura de comunidades em riachos (Adaptada de Heino et al., 2015).

A distinção entre uma comunidade local e uma metacomunidade não deve ser baseada somente na extensão espacial como um fator limitante da dispersão, mas deve considerar, sobretudo, a capacidade potencial de dispersão de organismos dentro de extensões espaciais (Brown et al., 2011; Tonkin et al., 2018). Por exemplo, peixes apresentam alta mobilidade dentro de um riacho, o que potencialmente favorece a exploração de diferentes habitats existentes. Entretanto, o movimento destes organismos ocorre principalmente dentro do canal do riacho, e em sua planície de inundação, quando esta se conecta ao canal principal pelo transbordamento do leito que ocorre em períodos de cheia (conceito de pulso de inundação, Junk et al., 1989). Dessa forma, o conjunto de espécies dentro de um riacho constitui uma comunidade, enquanto que comunidades de peixes em diferentes riachos dentro de uma bacia hidrográfica formam uma metacomunidade (Erös et al., 2017). A comunidade de macroinvertebrados bentônicos é formada por organismos que se dispersam dentro do canal, como os moluscos e oligoquetos, e pelos insetos, que se dispersam tanto pela deriva de imaturos (Brittain & Eikeland, 1988), como pelo voo ao longo de zonas ripárias (Bilton et al., 2001; Carlson et al., 2016). Desse modo, as comunidades locais estão conectadas por dispersão que ocorre no riacho, entre riachos e entre bacias de drenagem (Heino & Peckarsky, 2014; Heino et al., 2015). O conceito de metacomunidade foi abordado no capítulo 2 desta tese. Avaliou-se a importância de processos ecológicos ocorrentes em escala espacial local (heterogeneidade ambiental) e regional (dispersão) para explicar a dissimilaridade entre comunidades locais. Comunidades locais corresponderam ao conjunto de macroinvertebrados bentônicos amostrados em múltiplos habitats dentro de um trecho de riacho, e uma metacomunidade compreendeu o conjunto de comunidades locais de macroinvertebrados amostrados em riachos pertencentes a diferentes unidades hidrológicas.

Dispersão de organismos

Dispersão é definida como o movimento de organismos ou propágulos através do espaço com potencial consequência para o fluxo gênico (Ronce, 2007). O movimento de dispersão é considerado como um dos processos ecológicos mais importantes para a estrutura de populações e comunidades (Jacobson & Peres-Neto, 2010; Baguette et al., 2013). No entanto, a dispersão é um dos processos mais difíceis de ser mensurado de forma direta (Clobert et al., 2012), especialmente em comunidades de macroinvertebrados bentônicos (Bilton et al., 2001). Técnicas de marcação e recaptura são normalmente utilizadas para estimar a real distância percorrida por organismos entre o seu local de nascimento (ou aquele onde ocorre a captura e marcação), até o local de estabelecimento (ou aquele onde ocorre a recaptura) (Baguette et al., 2013). Macroinvertebrados em riachos são extremamente abundantes e diversos (Allan & Castillo, 2007) e a maioria deles apresenta um ciclo de vida adulta relativamente curta como os insetos da ordem Ephemeroptera (Domínguez et al., 2006). Devido às características intrínsecas dos macroinvertebrados bentônicos, é inviável a aplicação de técnicas de marcação e recaptura de um grande número de organismos em grandes extensões espaciais (Heino & Peckarsky, 2014). Dessa forma, estudos de metacomunidades combinam *proxies* de dispersão para avaliar a importância da movimentação em explicar os padrões de metacomunidades (Heino et al., 2017). Em ecologia, um *proxy* corresponde a qualquer variável que possa ser mensurada em um ecossistema a fim de permitir inferências sobre um processo ecológico (Stephens et al., 2015).

Traits são atributos biológicos, morfológicos, fisiológicos e fenológicos mensuráveis em um indivíduo (Violle et al., 2007). Existem vários tipos de *traits* que são comumente utilizados como *proxies* de dispersão: tamanho corporal, modo de dispersão (aquático passivo, aquático ativo, aéreo passivo, aéreo ativo), voltinismo (número de gerações por ano) e habilidade de dispersão (dispersores fracos, medianos e fortes) (Heino et al., 2017). Indivíduos de maior tamanho corporal possuem asas maiores, portanto são considerados bons voadores (Kärnä et al., 2015; Saito et al., 2015). Voadores e nadadores ativos apresentam maior habilidade de locomoção direcionada e, portanto, buscarão locais em melhores condições ambientais, enquanto que aqueles que se dispersam de forma passiva estarão sujeitos ao efeito de eventos estocásticos (correntes de vento ou fluxo hídrico) (Bonada et al., 2012; Kärnä et al., 2015). Quanto maior o número de gerações, maior será o número de descendentes potencialmente se dispersando (Saito et al., 2015; Sarremejane et al., 2017). Fortes dispersores podem voar a longas distâncias e, portanto, poderão acompanhar a variabilidade ambiental mesmo em grandes extensões espaciais (Cañedo-Argüelles et al., 2015; Heino et al., 2015). O capítulo 2 desta tese avaliou a habilidade de dispersão de macroinvertebrados bentônicos em riachos com base na informação de *traits* disponíveis na literatura. A habilidade de dispersão em ecossistemas aquáticos foi inferida por meio de um índice de propensão à deriva (Rader, 1997). A habilidade de dispersão aérea foi inferida por quatro categorias de dispersão: não-voadores (Mollusca, Oligochaeta, Hirudinea, Turbellaria), dispersores fracos (Ephemeroptera e Plecoptera), dispersores moderados (p. ex. Diptera e Trichoptera) e dispersores fortes (Odonata).

Medidas de distância

A primeira lei da geografia foi proposta por Tobler em 1970. De acordo com esta lei, todas as coisas estão relacionadas, mas coisas mais próximas estão mais relacionadas do que coisas mais distantes. Esta lei constitui um dos pressupostos base em ecologia para compreender o padrão de decaimento de similaridade entre comunidades em função do aumento da distância entre os habitats que elas ocupam. Segundo Nekola & White (1999), este padrão é devido a: i) condições ambientais locais variam ao longo de gradientes e, portanto selecionam espécies adaptadas às condições locais; ii) distância espacial e características da paisagem afetam a taxa de dispersão de organismos.

A distância ambiental está relacionada ao conceito de nicho ecológico multidimensional ou hipervolumétrico (Hutchinson, 1957). As dimensões do nicho correspondem aos limites de tolerância de condições (aquilo que não é consumido, como pH, temperatura da água), e recursos (aquilo que é consumido, como detritos foliares, presas) necessários ao desenvolvimento do organismo de uma dada espécie (Begon et al., 2007). O nicho fundamental se refere às condições e recursos do ambiente que possibilitam a existência da espécie indefinidamente (hipervolume máximo), enquanto que o nicho realizado considera que a existência da espécie pode estar condicionada por interações entre outras espécies, constituindo assim um espaço hipervolumétrico menor dentro do nicho fundamental (Odum & Barrett, 2007). A distância ambiental é calculada então com base em um conjunto de variáveis mensuradas em escala local que descrevem o nicho ecológico de uma espécie (Heino, 2013). As variáveis mais comumente utilizadas em estudos de metacomunidades em riachos são qualidade da água (pH, condutividade elétrica, nutrientes), composição de substratos (blocos, cascalho, areia, detritos foliares), e condições de zonas ripárias (composição e estrutura de cobertura de dossel) (Brown & Swan, 2010; Cañedo-Argüelles et al., 2015; Saito et al., 2015; Sarremejane et al., 2017). Poucos estudos de metacomunidades entretanto, têm sido conduzidos em riachos sob efeito de pressões antrópicas (Heino, 2013). Por exemplo, o uso do solo por humanos gera uma série de estressores que alteram as condições ambientais locais (aumento nas concentrações de nutrientes e sedimentos finos) (Allan, 2004). Em riachos sob efeito de pressões antrópicas é crucial selecionar variáveis ambientais que reflitam não apenas a variabilidade ambiental natural, mas também o efeito de estressores sobre a composição de comunidades locais (Feld et al., 2016). No capítulo 2 desta tese, a distância ambiental foi calculada com base em um conjunto de métricas previamente selecionadas como importantes preditores da riqueza local (número de táxons de macroinvertebrados bentônicos em um trecho de riacho).

A distância física entre os habitats é calculada com base na teoria de grafos (Urban et al., 2009; Heino et al., 2017). Um grafo é definido como um conjunto de nós, denominados de vértices, que são conectados por ligações, denominadas de arestas (Urban et al., 2009). Em ecologia, os nós de um grafo representam os habitats e as ligações representam o fluxo de dispersão entre os habitats (Urban et al., 2009). A teria de grafos é amplamente aplicada à ecologia da paisagem para analisar padrões de conectividade entre habitats através de rotas de dispersão, com o objetivo de identificar áreas prioritárias para a conservação de biodiversidade (Turner & Gardner, 2015).

Há uma série de medidas de distância calculadas com base na teoria de grafos que são utilizadas como *proxies* de dispersão, incluindo: distância de rede de drenagem, distância euclidiana e distância de custo (Heino et al. 2017). (Heino et al. 2017). Estas distâncias são metaforicamente conhecidas como: "como os peixes nadam" (rede de drenagem), "como os corvos voam" (euclidiana), e "como as raposas correm" (custo) (Kärnä et al., 2015). A distância de rede de drenagem pressupõe que os organismos se dispersam estritamente dentro do canal do rio, sendo dispersos em razão da força e direção do fluxo (Altermatt, 2013). Dentre eles, os peixes se dispersam de forma ativa, enquanto que os invertebrados, tais como moluscos e insetos imaturos se dispersam passivamente por deriva (isto é, são levados pelo fluxo) (Tonkin et al., 2018). No caso dos insetos adultos alados, a rede de drenagem também constitui uma importante rota de dispersão aérea. Tal fato está relacionado ao comportamento de oviposição das fêmeas que voam a montante para compensar a dispersão passiva por deriva (Bilton et al., 2001; Heino & Peckarsky, 2014). A distância euclidiana corresponde à distância mais curta em linha reta entre dois pontos, sendo facilmente calculada através de coordenadas geográficas (Heino et al., 2017). A distância euclidiana é a medida de distância mais comumente utilizada em estudos de metacomunidades (Soininen et al., 2007; Heino et al., 2015). No entanto, uma das limitações deste *proxy* é que organismos movendo-se na paisagem não necessariamente buscam o caminho mais curto, mas talvez o de menor custo (McRae, 2006; Zeller et al., 2012). A distância de custo considera que características da paisagem podem restringir o movimento de dispersão entre habitats (Heino et al., 2017). Distâncias de custo são calculadas com base em mapas de superfícies de custo, tais como variações na altitude (p. ex. morros e vales) e perda de conectividade terrestre entre habitats devido à fragmentação da paisagem (Jacobson & Peres-Neto, 2010; Baguette et al., 2013). Variações na altitude entre dois locais representam um custo à dispersão de insetos voadores, uma vez que será necessário maior gasto energético empregado em estruturas de vôo (Kärnä et al., 2015).

A fragmentação e perda de conectividade da paisagem terrestre diminui a probabilidade de dispersão em diversos grupos biológicos, como mamíferos e aves (Zeller et al., 2012; Baguette et al., 2013). Embora seja bem documentado que uso do solo por humanos altera a integridade de ecossistemas aquáticos, e em consequência a comunidade de macroinvertebrados bentônicos pouco se sabe se alterações na paisagem terrestre afetariam a dispersão de insetos adultos alados.

Espera-se que a perda de vegetação natural entre riachos diminua a probabilidade de dispersão de insetos adultos alados uma vez que os requerimentos fisiológicos desses organismos poderão ser afetados pelas condições adversas desses ambientes, como aumento da temperatura do ar, diminuição da umidade e exposição a predadores (Urban et al., 2006; Carlson et al., 2016). O capítulo 2 desta tese abordou *proxies* de dispersão com base em teoria de grafos. Foram calculadas medidas de distâncias baseadas na distância de rede de drenagem e na resistência da paisagem à dispersão (McRae, 2006), representada pela topografia. Além disso, esta tese propôs uma medida de resistência da paisagem à dispersão macroinvertebrados bentônicos que considera o uso e cobertura do solo. A distância de uso do solo foi calculada com base no conceito de hemerobia proposto pelo botânico alemão J. Jalas em 1955. O termo hemerobia provém das palavras gregas *hémeros* (cultivado, domesticado) e *bíos* (vida). O hemerobia foi primeiramente utilizado para mensurar os impactos antrópicos sobre a vegetação natural. Atualmente é considerada uma medida que integra os impactos antrópicos em nível de ecossistemas (Walz & Stein, 2014). Os graus de hemerobia variam em uma escala numérica onde o menor valor corresponde a paisagens minimamente impactadas, e o maior valor àquelas severamente impactadas. Nesta tese foi adotada a escala de hemerobia variando de 1 a 7 conforme descrito em Walz & Stein (2014).

Atividades humanas modificam a paisagem terrestre e por consequência, afetam os ecossistemas aquáticos. Mudanças no uso e ocupação do solo criam padrões de manchas que variam desde áreas com cobertura vegetal natural, até aquelas antropizadas (agricultura, pastagens, áreas urbanas). Em resposta, observam-se alterações na estrutura de comunidades biológicas presentes em ecossistemas sob influência de mudanças no uso e ocupação do solo. Ainda não está claro, entretanto, se comunidades de macroinvertebrados bentônicos apresentam respostas limiares aos estressores de origem antrópica, bem como se alterações na paisagem afetam a dispersão de organismos. O capítulo 1 desta tese aborda a influência de distúrbios de atividades humanas sobre os ecossistemas aquáticos e respostas limiares em assembleias de macroinvertebrados bentônicos a diversos estressores de origem antrópica. O capítulo 2 aborda os efeitos de condições ambientais locais e de características da sobre as respostas funcionais de comunidades de macroinvertebrados bentônicos.

Objetivo Geral

O objetivo geral desta tese foi avaliar pressões antrópicas em múltiplas escalas espaciais na estruturação de comunidades bentônicas em riachos de cabeceira na savana neotropical.

Objetivos específicos

Para alcançar o objetivo geral, esta tese foi dividida em dois capítulos:

Capítulo 1: Limiares ecológicos de Ephemeroptera como bioindicadores de distúrbios antrópicos em riachos no cerrado

(*Mayfly bioindicator thresholds for several anthropogenic disturbances in neotropical savanna streams)*

a) Selecionar estressores de origem antrópica sem correlação significativa com variabilidade ambiental natural.
b) Avaliar a importância destes efeitos com base nos limiares em assembleias de Ephemeroptera (Insecta) em resposta aos estressores selecionados.

Capítulo 2: integração de ambientes aquáticos e terrestres determinam os padrões de metacomunidade de macroinvertebrados em riachos no cerrado

(*Aquatic environment and terrestrial integration determines macroinvertebrate metacommunity patterns in neotropical streams)*

a) Classificar macroinvertebrados bentônicos em função de suas tolerâncias à poluição e habilidades de dispersão.
b) Calcular medidas de distância com base em teoria de grafos para avaliar a limitação de dispersão.
c) Avaliar a importância de seleção de habitat e de limitação de dispersão para a estrutura de metacomunidades de macroinvertebrados bentônicos.

Metodologia Geral

O bioma cerrado

O termo cerrado é comumente utilizado para caracterizar as savanas que ocorrem na porção central do Brasil (Wantzen et al., 2006). Este bioma apresenta duas estações bem definidas, uma seca, de abril a setembro, e outra úmida, de outubro a março. As temperaturas médias variam entre 22º a 27º graus, e a pluviosidade média anual é de 1.5000 mm (Klink & Machado, 2005). O cerrado é o segundo maior bioma brasileiro, cobrindo originalmente cerca de 20% do território nacional (~ 2 milhões de Km^2) (Wantzen et al., 2006). Este bioma apresenta elevada diversidade e endemismo de espécies animais e vegetais, e vem sendo severamente ameaçado por pressões antrópicas o que levou Myers et al. (2000) a classificá-lo como um dos *hotspots* globais de biodiversidade. Dentre as principais ameaças ao cerrado destacam-se a perda de vegetação natural pelo uso do fogo, plantio de gramíneas exóticas para formação de áreas de pastagens, e a expansão da agricultura em larga escala (Klink & Machado, 2005). Embora o solo do cerrado seja caracterizado por elevada acidez, altas concentrações de alumínio, e baixas concentrações de nutrientes, correções químicas por aplicações de fertilizante e calcário permitem cultivos de *commodities* em larga escala, tais como soja, algodão, milho e cana-de-açúcar (Strassburg et al., 2017). Todas essas atividades levam à intensificação nos usos e ocupação dos solos (Wantzen et al., 2006), fragmentação da paisagem (Carvalho et al., 2009) e perda de habitats (Strassburg et al., 2017), e que em conjunto afetam a biodiversidade terrestre de forma negativa (Myers et al., 2000; Newbold et al., 2015). Além disso, este bioma possui um alto potencial hídrico devido ao grande número de riachos de cabeceira drenando para importantes bacias hidrográficas, tais como as nascentes dos rios Paraguai e São Francisco (Machado et al., 2011). Assim, o cerrado é estratégico para construção de grandes empreendimentos hidrelétricos. Tais alterações modificam os cursos d'água e influenciam diretamente as rotas de dispersão de organismos aquáticos, tais como peixes (Pelicice & Agostinho, 2008). A intensificação nos usos e ocupação do solo no bioma cerrado também afeta a biodiversidade aquática devido à intensificação no processo de assoreamento e à entrada de fertilizantes e contaminantes nos cursos d' água (Wantzen et al., 2006), alterações nas condições de bacias de drenagens (escala regional) e nos habitats físicos (escala local) (Macedo et al., 2014a), e nas estruturas tróficas de comunidades de macroinvertebrados bentônicos (Castro et al., 2016) e peixes (Carvalho et al., 2017).

Área de Estudos

Foram amostrados 184 trechos de riachos localizados a montante de quatro empreendimentos hidrelétricos da CEMIG: Nova Ponte, Três Marias, Volta Grande e São Simão, compreendendo uma área total de 45.180 km^2 no bioma cerrado (Figura 7). Cada riacho foi amostrado apenas uma vez dentro de cada área (daqui em diante: unidade hidrológica, *sensu*

Seaber et al. [1987]; Ferreira et al. [2017]; Firmiano et al. [2017]; Silva et al. [2017]) durante a estação seca dos anos de 2010 a 2014. A escala local corresponde aos trechos de riachos, enquanto que a escala regional corresponde às unidades hidrológicas.

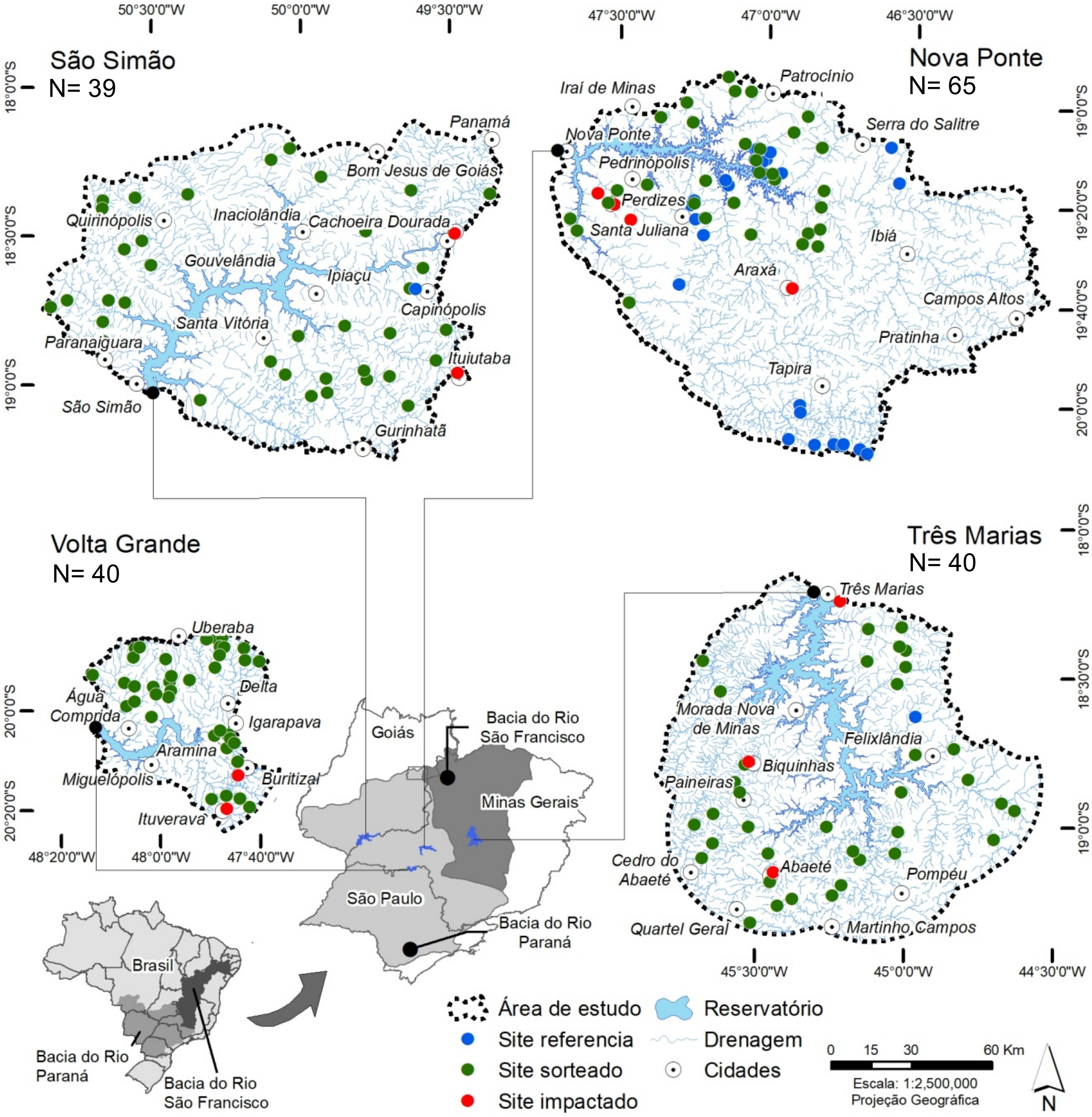

Figura 7. Mapa da área de estudos com os pontos amostrais nas unidades hidrológicas de São Simão, Nova Ponte e Volta Grande Três Marias.

Desenho amostral

Primeiramente foi estabelecida uma área potencial de amostragem dentro de um *buffer* de 35 km a partir dos limites de cada reservatório utilizando-se uma escala de 1:100.000 para mapeamento da área de drenagem (Macedo et al., 2014b). Os corpos d'água foram classificados de forma hierárquica como proposto por Strahler (1957). Os riachos a serem amostrados foram selecionados de acordo com um desenho probabilístico, sistemático e espacialmente balanceado (Olsen & Peck, 2008), garantindo assim uma amostragem representativa e uniformemente distribuída dentro de cada unidade hidrológica (Herlihy et al., 2000; Macedo et al., 2014b). Para o sorteio, apenas riachos de 1ª a 3ª ordens foram considerados. Estes riachos normalmente encontram-se em áreas de cabeceira, sendo também chamados de *wadeable streams*, isto é, trechos capazes de serem atravessados a pé por uma pessoa adulta mediana (Kaufmann et al., 1999). Após o sorteio as equipes foram a campo para realizar o reconhecimento de trechos de riachos para avaliar o acesso ao ponto de coleta, planejamento da logística de amostragens e validar os trechos selecionados (isto é, se os trechos selecionados atendiam o critério de *wadeable streams*) (Macedo et al., 2014b). Foram selecionados trechos de riachos em condição de referência e impactada com base no reconhecimento em campo a fim de que todo o gradiente ambiental existente em cada unidade hidrológica fosse representado (Figura 8). Em 2014 foram realizadas amostragens adicionais na unidade hidrológica de Nova Ponte com o intuito de identificar riachos exclusivamente em condições de referência. Para a seleção desses riachos adicionais foram observados os seguintes aspectos: inserção em unidade de conservação (Parque Nacional da Serra da Canastra), interpretação de imagens de satélite (Google Earth®) e reconhecimento em campo (Firmiano et al., 2017; Martins et al., 2017). Ao final foi amostrado um total de 184 trechos de riachos sendo 31 em condições de referência, 11 em condição impactada, e 142 sorteados. Os trechos de riachos foram distribuídos em cada unidade hidrológica da seguinte forma: Nova Ponte (N= 65); Três Marias (N= 40), Volta Grande (N= 40), São Simão (N= 39).

Figura 8. Exemplos de trechos de riachos amostrados ao longo de um gradiente de condições ambientais desde aqueles em condição de referência (esquerda), intermediária (meio), e impactadas por atividades humanas (direita).

Definição de trecho amostral

Para a determinação da extensão a ser amostrada, a largura molhada média de cada riacho foi multiplicada por 40 (Peck et al., 2006), sendo a extensão amostral mínima de 150 metros (Figura 8). Posteriormente, o trecho a ser amostrado foi dividido em 11 transectos equidistantes (nomeados de A - K) e dez sessões de mesma extensão (Figura 9). Após esta determinação, foi aplicado o protocolo de caracterização de habitat físico desenvolvido pelo US-EPA (Peck et al., 2006), que foi traduzido pela equipe da rede de colaborações e adaptado à realidade do cerrado mineiro (Callisto et al., 2014). Em cada transecto e ao longo das sessões, foram mensuradas várias características relacionadas à morfologia do canal (p. ex. profundidade, largura molhada, inclinação das margens, sinuosidade), à caracterização do substrato e do fluxo (p. ex. tamanho e composição do substrato, tipo e frequência de fluxo), estrutura da vegetação ripária (p. ex. sombreamento do leito e margens, densidade de extratos vegetais), e influência humana no canal e nas margens (p. ex. proximidade de estradas, presença de lixo, alterações no canal, atividades de agricultura e pastagem nas margens). Posteriormente foram calculadas métricas de habitats físicos conforme proposto por Kaufmann et al. (1999, 2008). Adicionalmente, foram mensurados os seguintes parâmetros limnológicos: temperatura da água (C°), condutividade elétrica (µS. cm-^{1}, turbidez (UNT) e pH, mensurados em campo utilizando uma sonda multiparâmetros YSI 6600. Foram coletadas amostras de água para determinação em laboratório das concentrações de fósforo total (µg.L^{-1}), nitrogênio total (mg.L^{-1}), oxigênio dissolvido (mg.L^{-1}) e alcalinidade total (µEq LCO$_2$$^{-1}$) de acordo com APHA (2005).

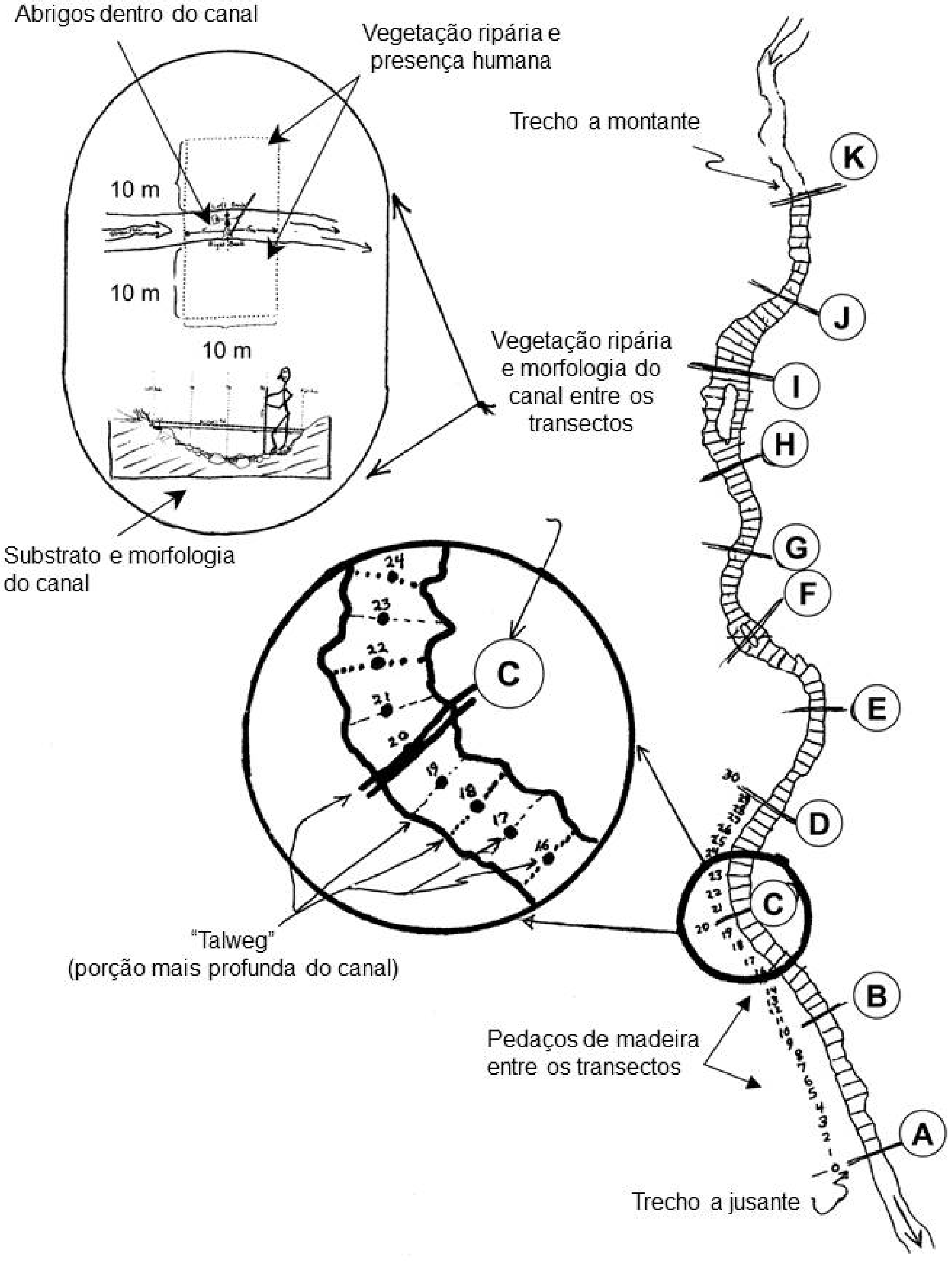

Figura 9. Representação esquemática de definição de trecho amostral para mensuração de características do habitats físicos e amostragem de comunidades de macroinvertebrados bentônicos (Adaptada de Kaufmann et al., 1999).

Caracterização de comunidades de macroinvertebrados bentônicos

Em cada um dos 11 transectos em cada riacho foram coletadas amostras de sedimento para a carateriзação de comunidades de macroinvertebrados bentônicos. A coleta foi realizada em forma de "zigue e zague" objetivando amostrar de forma aleatória a maioria dos habitats existentes. As amostras de sedimento foram coletadas com o auxílio de um amostrador do tipo *kick net* (30 cm de abertura e 500 µm de malha, área de 0,09 m^2), sendo então posteriormente agrupadas para formar uma única amostra de cada riacho (aproximadamente 1 m^2 de área). As amostras foram acondicionadas em sacos plásticos, etiquetadas e fixadas em campo com solução de formol 10% e encaminhadas ao Laboratório de Ecologia de Bentos do ICB/UFMG, onde foram lavadas sobre peneira de 500 µm e armazenadas em potes plásticos etiquetados e preservadas em álcool a 70%. Posteriormente as amostras foram triadas em bandejas transiluminadas e os organismos identificados em microscópio esterescópico (32x) em nível de famílias, exceto Bivalvia, Hirudinea, Nematoda e Oligochaeta (Merritt & Cummins, 1996; Fernández & Domínguez, 2001; Costa et al., 2006; Mugnai et al., 2010). Organismos pertencentes às ordens Ephemeroptera, Plecoptera e Trichoptera foram identificados até o nível de gênero em lupa (aumento de 80x) utilizando chaves taxonômicas disponíveis (Pes et al., 2005; Domínguez et al., 2006; Salles, 2006). Todos os indivíduos foram depositados na Coleção de Referência de Macroinvertebrados Bentônicos do ICB/ Universidade Federal de Minas Gerais (Figura 10).

Figura 10. Etapas de amostragens e processamento de amostras em laboratório: aplicação do protocolo de caracterização de habitat físico (a-b), mensuração de parâmetros limnológicos (c), coleta de amostras de sedimento para caracterização de comunidades de macroinvertebrados bentônicos (d), lavagem (e), triagem (f), identificação (g), depósito na Coleção de Referência (h).

Capítulo 1

Mayfly bioindicator thresholds for several anthropogenic disturbances in neotropical savanna streams

Firmiano K. R., Ligeiro R., Macedo D. R., Juen L., Hughes R. M., Callisto M. 2017. Ecological Indicators. 74: 276 - 284. DOI: 10.1016/j.ecolind.2016.11.033

Ecological Indicators 74 (2017) 276–284

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Original Articles

Mayfly bioindicator thresholds for several anthropogenic disturbances in neotropical savanna streams

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ARTICLE INFO

Article history:
Received 2 February 2016
Received in revised form
18 November 2016
Accepted 22 November 2016

Keywords:
Land use change
Anthropogenic disturbance assessment
Headwater streams
Cerrado
TITAN

ABSTRACT

Anthropogenic disturbances are widely recognized as major threats to terrestrial and aquatic biodiversity worldwide, including areas located in non-forest ecosystems. Headwater streams in the neotropical savanna are severely threatened by large-scale landscape changes that degrade local habitat characteristics and lead to biodiversity loss. The objective of our study was to evaluate Ephemeroptera assemblages as bioindicators of catchment land use and cover, local streambed and riparian vegetation conditions, and instream water quality. To do so, we sampled mayfly nymphs in 184 stream sites across a broad disturbance gradient in four hydrologic units of the Brazilian neotropical savanna. We selected seven metrics without significant co-variation with natural variability: % catchment urban, riparian vegetation condition index (RCOND), human disturbances of the stream channel and riparian zone (W1_HALL), substrate mean embeddedness (XEMBED), dissolved oxygen (mg L^{-1}), pH, and total phosphorus (mg L^{-1}). We ran threshold indicator taxa analysis (TITAN) for each disturbance metric to detect change points in mayfly genera responses (whether sensitive or tolerant) and assemblage turnover pattern. TITAN showed that 20 of the 39 genera found were robust bioindicators (based on purity and reliability values >0.95), sixteen of them being sensitive to increased disturbance. The most sensitive genera were *Tricorythopsis* (Leptohyphidae) and *Camelobaetidius* (Baetidae), showing decreased abundance to most disturbance metrics. We found a turnover pattern of mayfly genera in response to W1_HALL in a narrow variation range. For total phosphorus, the benchmark value defined in Brazilian Federal Legislation is higher than the turnover threshold of several mayfly genera. This indicates that we will lose many sensitive genera even within the limits imposed by national environmental legislation. The indicator taxa approach, based on multiple taxa rather than univariate metrics or single indicator species, demonstrates the value of quantitative ecological information for conserving and managing freshwater ecosystems globally.

1. Introduction

Freshwater ecosystems in good ecological status are indispensable for providing high-quality water supplies for humans and for biodiversity maintenance and conservation (Vörösmarty et al., 2010). Rivers and streams achieve those conditions only if their channels, upstream reaches, riparian vegetation and catchments are in good ecological status (Dudgeon et al., 2006). Increased human developments have largely modified the natural condition of freshwater ecosystems, leading to reduced ecological function and biodiversity (Steffen et al., 2015). Such human-induced ecosystem changes are observed at multiple spatial scales (global, regional, local), constituting a complex and interconnected feedback system (Rockström et al., 2009). For instance, land uses affect geomorphological processes, causing many impacts to stream channels such as channel incision (Beschta et al., 2013), bottom siltation, decreased substrate and flow diversities (Allan, 2004), diminished litter input from riparian vegetation (Boyero et al.,

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http://dx.doi.org/10.1016/j.ecolind.2016.11.033
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2016), and degraded water quality (Taylor et al., 2014; Woodward et al., 2012).

Headwater streams are the smaller riverine sections (Strahler, 1957), comprising around 80% of the cumulative stream length in watersheds (Benda et al., 2005). Considering their contribution to river basins and their high degree of exposure to anthropogenic disturbances, it is important to protect them (Dudgeon et al., 2006). Varying levels of anthropogenic disturbances generate disturbance gradients, yielding streams ranging from nearly pristine to severely disturbed (Davies and Jackson, 2006). The local stream biota are a result of natural environmental drivers (Feld et al., 2016), but a wide range of anthropogenic disturbances also influence their structure (Stoddard et al., 2006). To develop reliable bioindicators, it is necessary to separate the effects of natural variability from anthropogenic disturbance on assemblage structure (Chen et al., 2014; Hughes and Peck, 2008).

Assemblage turnover is observed in response to disturbance gradients, wherein the abundance and/or frequency of taxa increase or decrease abruptly at some threshold point of the gradient (King and Baker, 2014). Baker and King (2010) proposed the threshold indicator taxa analysis (TITAN), which detects points of change in environmental gradients where assemblage response becomes most evident. This allows direct inference from the data and concrete actions to minimize impacts or propose rehabilitation strategies (King et al., 2011). Different studies have demonstrated threshold responses of stream assemblages to various anthropogenic disturbances, considering them as direct cause-and-effect relationships. For instance, assemblage composition change has been related to sedimentation (Burdon et al., 2013), urbanization (King et al., 2011), and natural vegetation suppression (Rodrigues et al., 2016). However, it is necessary to demonstrate how different anthropogenic disturbances alter stream biota by selecting disturbance metrics that are weakly related to natural variability (Shimano and Juen, 2016; Stoddard et al., 2008).

Much attention has been given to conserving and restoring tropical forests, but not much attention has been given to neotropical savannas (Overbeck et al., 2015; Veldman et al., 2015). The Brazilian neotropical savanna is the source of several important large rivers in South America (Wantzen et al., 2006), and their headwaters encompass high levels of biodiversity (Agostinho et al., 2005). However, agriculture, livestock grazing and urbanization are major threats to the biological integrity of this biome (Carvalho et al., 2009; Macedo et al., 2014; Silva et al., 2006). Likewise, hydropower dams and water supply reservoirs create major barriers to dispersal of native species (Agostinho et al., 2005).

Biological assessments are recommended for developing effective stream and catchment conservation and management (Hughes et al., 1986; Stoddard et al., 2008). Benthic macroinvertebrates have been widely recognized for their ability to detect impacts on freshwater ecosystems because of their sensitivity to multiple anthropogenic disturbances (Bonada et al., 2006). When natural environments are altered, sensitive taxa are lost and those that are tolerant prevail, producing assemblage turnover (Davies and Jackson, 2006; King and Baker, 2014). Mayfly nymphs are considered good bioindicators because they are highly diverse, abundant in streams in good ecological condition (Bauernfeind and Moog, 2000; Dedieu et al., 2015), represent multiple trophic levels (Brittain, 1982), and are relatively easy to identify to genus (Domínguez et al., 2006).

Our objective in this study was to evaluate the effects of anthropogenic disturbances on neotropical savanna streams based on thresholds of mayfly assemblage responses. Specifically, we sought to find disturbance metrics that most altered mayfly assemblages. The stream sites represented multiple land use and cover types, streambed and riparian vegetation condition levels, and instream water quality covering a wide disturbance gradient. We classified the mayfly genera by their sensitivity or tolerance based on their threshold responses for each disturbance metric as well as the overall assemblage turnover. Such information can contribute to the conservation of stream integrity and watershed management by identifying critical disturbance thresholds based on reliable bioindicators, as well as for determining priorities for biodiversity conservation and ecosystem restoration.

2. Material and methods

2.1. Study area

We conducted our study in 184 wadeable stream sites (1st-3rd order sensu Strahler, 1957; defined at a 1:100,000 scale), averaging 3.4 m (±1.9) wide, and 35.5 cm (±17.1) deep in the states of Minas Gerais, Goiás, and São Paulo, southeastern Brazil. The sites were located in four hydrologic units (Seaber et al., 1987) of the upper São Francisco and Paraná River Basins (Fig. 1), comprising a total geographic area of 45,180 km^2. Nova Ponte, Três Marias, Volta Grande, and São Simão hydrologic units were defined as the contributing drainage areas within 35 km upstream of each of four major hydropower reservoirs. The Nova Ponte hydrologic unit also included a set of 25 handpicked reference sites. The sites were far enough upstream of the reservoirs to be unaffected by variable water levels in the reservoirs.

We sampled in September from 2010 to 2013, one year for each aforementioned hydrologic unit, ensuring that samples were standardized by the low flow season. Dry season sampling facilitates data collection and reduces the effect of freshets, thereby clarifying the effects of the disturbance gradient on mayfly assemblages (Hughes and Peck, 2008). We believe that rainfall differences between the sampling years did not prevent the comparability of data because the average annual precipitation in the four hydrological units were comparable (2010: 958 mm, 2011: 968 mm, 2012: 1155 mm, 2013: 1171 mm) and within the normal climatological average for the neotropical savanna (ANA, 2016). In each hydrologic unit, small and medium-size cities (up to 80,000 inhabitants) occurred and the main land uses were irrigated agriculture (soy, coffee, corn, and sugarcane) and livestock grazing (hereafter pasture) (Ligeiro et al., 2013; Macedo et al., 2014).

2.2. Survey design

Selection of sites employed a spatially balanced probabilistic survey (Stevens and Olsen, 2004), used by the U.S. Environmental Protection Agency (US-EPA) in its regional and national biomonitoring programs (Olsen and Peck, 2008). To ensure that the disturbance gradient would be well represented, in each hydrological unit we also handpicked least- and most- disturbed sites to sample. Other studies have demonstrated the effectiveness of spatially balanced methods together with targeted sampling for strengthening disturbance gradients (Bryce et al., 2010; Ligeiro et al., 2013; Smucker et al., 2013). Least-disturbed sites included 25 sites located in Serra da Canastra National Park and Serra do Salitre region in the Paraná River Basin (Nova Ponte hydrologic unit), considered *a priori* as least-disturbed sites (Hughes et al., 1986; Stoddard et al., 2006). We assumed their good ecological condition based on the effectiveness of national parks in protecting ecosystems, Google Earth® images of the area showing landscape conditions, and field reconnaissance. Most-disturbed sites included a set of 23 urban sites ranging from 0.2% to 85% of catchment urban land use.

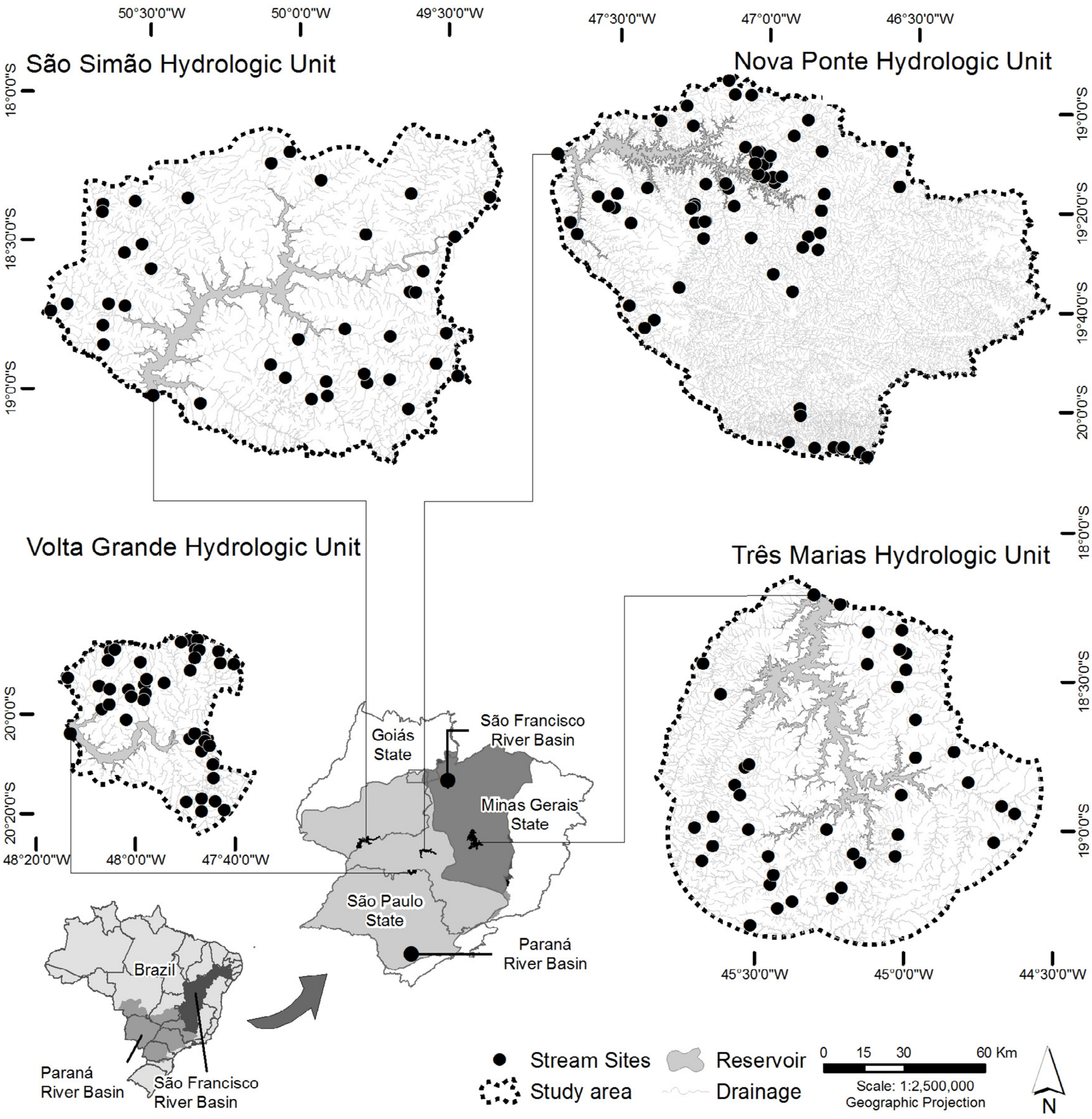

Fig. 1. Locations of hydrologic units and stream sites sampled in the Brazilian neotropical savanna.

2.3. *Natural environmental variables*

We extracted the average annual rainfall and temperature (~50 years climate baseline) from the worldclim dataset (Hijmans et al., 2005). Catchment area and catchment elevation and slope (range and average) were measured by DEM of Shuttle Radar Topographic Mission (1 arc-sec; USGS, 2005).

2.4. *Catchment scale anthropogenic disturbance metrics*

We assessed the land use and cover of the catchments of each stream site by interpreting satellite images. This method consisted of combined interpretation of September Landsat TM sensor multispectral imagery (R4G3B2 false color band combination) and fine resolution images from Google Earth® (0.6–5 m spatial resolution; Google, 2014). This method allows one to distinguish leaf structure showed in the multispectral Landsat response from the shape and texture of targets in fine resolution images (Macedo et al., 2014). We identified four natural vegetation cover phytophysiognomies (woodland savanna, parkland savanna, grassy-wood savanna and wetland palm swamp) and four anthropogenic land uses (pasture, agriculture, urban and *Eucalyptus* afforestation), and calculated the percentage of each cover type in each catchment. To further characterize anthropogenic influences we calculated household and population densities using 2010 Brazilian Census data (IBGE, 2016). Road density was calculated by Open Street Map data (OSM Foundation, 2016).

2.5. *Local scale anthropogenic disturbance and water quality metrics*

To determine the size of the site to be sampled, we multiplied the average wetted width of each site by 40, with a minimum longitudinal site length of 150 m. In each site we placed 11 equidistant cross sectional transects. In the field, we visually assessed anthropogenic pressures in the stream channel and riparian zone following a protocol developed by the US-EPA (Peck et al., 2006). We used: (1) mean substrate embeddedness (XEMBED) (Kaufmann et al., 1999), and (2) log-transformed relative bed stability (LRBS) as indicators of sediment input to the stream bed (Kaufmann et al., 2008); (3) W1_HALL (Kaufmann et al., 1999), which is a metric calculated from the sum of eleven types of disturbance in the stream margin (revetments, buildings, pavement, roads, pipes, trash, lawn, row crop, pasture, mines, and logging), distance weighted from the channel; (4) riparian woody cover (XCMGW); and (5) a composite riparian condition index (RCOND), which summarizes anthropogenic effects on riparian vegetation cover and structure (Kaufmann et al., 2008). The RCOND score decreases with increased W1_HALL, and increases with increased riparian vegetation complexity. We used an Integrated Disturbance Index (IDI) that combines local (W1_HALL) and catchment (percentage of different land use) disturbance (Ligeiro et al., 2013). Increased XEMBED, LRBS, W1_HALL and IDI scores suggest an increase in the intensity of anthropogenic disturbance in the sites, whereas increased XCMGW and RCOND suggest a decrease in anthropogenic disturbance.

We took one water sample per site for measurements of electrical conductivity ($\mu S\ cm^{-1}$), pH, and total dissolved solids ($mg\ L^{-1}$) with a multi-probe. Dissolved oxygen ($mg\ L^{-1}$), turbidity (NTU), and total phosphorus ($mg\ L^{-1}$) were measured in the laboratory following Standard Methods (APHA, 2005).

2.6. Mayfly assemblage sampling and taxonomic identification

We sampled mayfly nymphs in all 184 stream sites with a D-net (30 cm wide mouth, 500 μm mesh, and 0.09 m^2 area), taking one subsample per transect (Peck et al., 2006). The sampling was performed in six equidistant cross sectional transects, following a systematic zigzag pattern along transects to represent the predominant habitats at each site. We grouped all six subsamples into a single pooled sample for each site, fixing the samples in the field with 10% formalin. In the laboratory, samples were washed in a 500 μm sieve and then stored in 70% alcohol.

We identified mayfly nymphs under a stereomicroscope (80×) to genus using taxonomic keys and consulting taxonomists when necessary (Domínguez et al., 2006; Salles and Lima, 2014). All specimens were deposited in the reference collection of benthic macroinvertebrates of the Instituto de Ciências Biológicas, Universidade Federal de Minas Gerais.

2.7. Data analyses

2.7.1. Screening metrics

We conducted an ordinary least square regression on all metrics related to natural variability and all anthropogenic disturbance metrics. Our objective was to select disturbance metrics without significant co-variation with natural variability, excluding all disturbance metrics with $r^2 > 0.10$ (Chen et al., 2014). The metrics retained were submitted to a correlation matrix and metrics at $r_{Pearson} > |0.50|$ were excluded to avoid multicollinearity (Zar, 1999). Distribution frequencies of all metrics are shown in the Supplementary material (SM1).

2.7.2. Identification of threshold responses

We performed TITAN to detect change points in the genera responses to each final disturbance metric. TITAN combines change point (King and Richardson, 2003) and indicator value (Dufrêne and Legendre, 1997) analyses to detect abrupt change in the abundance and frequency of taxa along environmental gradients (Baker and King, 2010). TITAN also measures purity and reliability properties based on the bootstrap technique (500 resamples with replacement) to confirm the thresholds for each taxa and assemblage. Purity corresponds to the proportion of change points (if z− or z+) along the resampling that agree with the observed value. Reliability corresponds to the proportion of the resampling that reports an indicator value with significant p-values (Baker and King, 2010). After indicator taxa have been identified, TITAN supplies an assemblage-level threshold, reflecting the magnitude of assemblage changes as an indicator of coincident change point in the entire assemblage structure [sum(Z)]. Following the recommendations of Baker and King (2010), we excluded taxa occurring at fewer than three sites and with fewer than five individuals, resulting in 176 stream sites analyzed. We performed TITAN analysis in R version 3.3.1. (R Development Core Team, 2016), using the TITAN2 package (Baker and King, 2010).

3. Results

We collected 26,167 nymphs belonging to 39 genera and seven families. The most abundant genera were *Americabaetis* (18%) (Baetidae), *Traverhyphes* (14%) (Leptohyphidae), *Thraulodes* (10%), *Farrodes* (9%) (Leptophlebiidae), and *Caenis* (5%) (Caenidae). Those five represented 56% of all individuals collected, and occurred in 72%, 65%, 35%, 65% and 47% of the sites respectively. Sixteen genera were considered rare, and together accounted for less than 1% of all individuals collected.

3.1. Correlation between anthropogenic disturbance and natural variability metrics

Several disturbance variables were correlated with natural variability. Agriculture, *Eucalyptus*, natural native vegetation, and pasture were correlated with at least two natural variability metrics ($r^2 = 0.11$-0.35; $p < 0.001$) (Table 1). Population density was correlated with a natural variability metric ($r^2 = 0.12$; $p < 0.001$). LRBS was correlated with several natural variability metrics ($r^2 = 0.12$–0.51; $p < 0.001$) as was IDI ($r^2 = 0.16$–0.19; $p < 0.001$). Conductivity ($r^2 = 0.11$; $p < 0.001$) and total dissolved solids ($r^2 = 0.14$; $p < 0.001$) were correlated with natural variability metrics also. Nine disturbance metrics were not correlated with natural variability metrics: % catchment urban, household density, road density, RCOND, XEMBED, W1_HALL, dissolved oxygen, pH, and total phosphorus (Table 1). We selected% catchment urban, RCOND, XEMBED, W1_HALL, dissolved oxygen, pH, and total phosphorus as disturbance metrics to be used in the TITAN (Table 2). We selected% catchment urban versus household density or road density because it is more comprehensive.

3.2. TITAN versus anthropogenic disturbance metrics

TITAN detected 20 (52%) of 39 genera as robust bioindicators (purity and reliability ≥ 0.95) (Fig. 2). Sixteen genera were considered sensitive to at least one disturbance metric. The most sensitive genera were *Tricorythopsis* (Leptohyphidae) and *Camelobaetidius* (Baetidae), showing decreased abundance and frequency to several disturbance metrics. *Aturbina*, *Callibaetis*, *Waltzoyphius*, *Zelusia* (Baetidae), and *Caenis* (Caenidae) were considered tolerant to at least one disturbance metric. TITAN results for all genera are shown in Supplementary material (SM2).

Regarding catchment and physical habitat disturbance, none of the genera were tolerant to increased urbanization. Only *Caenis* was sensitive (z−) to increased% of urban area, starting to disappear from sites with >0% catchment urban (Fig. 2a). Two genera showed positive associations with increased riparian zone integrity, being observed in increased abundance and frequency in sites with RCOND values ranging from 8 (*Zelusia*) to 13 (*Askola*) (Fig. 2b). Six genera were sensitive, whereas three genera were tolerant, to riparian disturbance (W1_HALL) (Fig. 2c). We detected a clear turnover pattern, wherein two genera decreased while three other genera increased in abundances along an interval ranging from (Z−) = 0.5 and (Z+) = 2.4 W1_HALL values. Eleven genera were sensitive to increased fine sediments across a wide range of XEMBED values (Fig. 2d). The most sensitive genus to XEMBED started to decrease in abundance at an XEMBED of 6%, and the least sensitive started to decrease in abundance at an XEMBED of 87%.

Among water quality variables, we detected a turnover pattern wherein five genera showed positive associations with increased

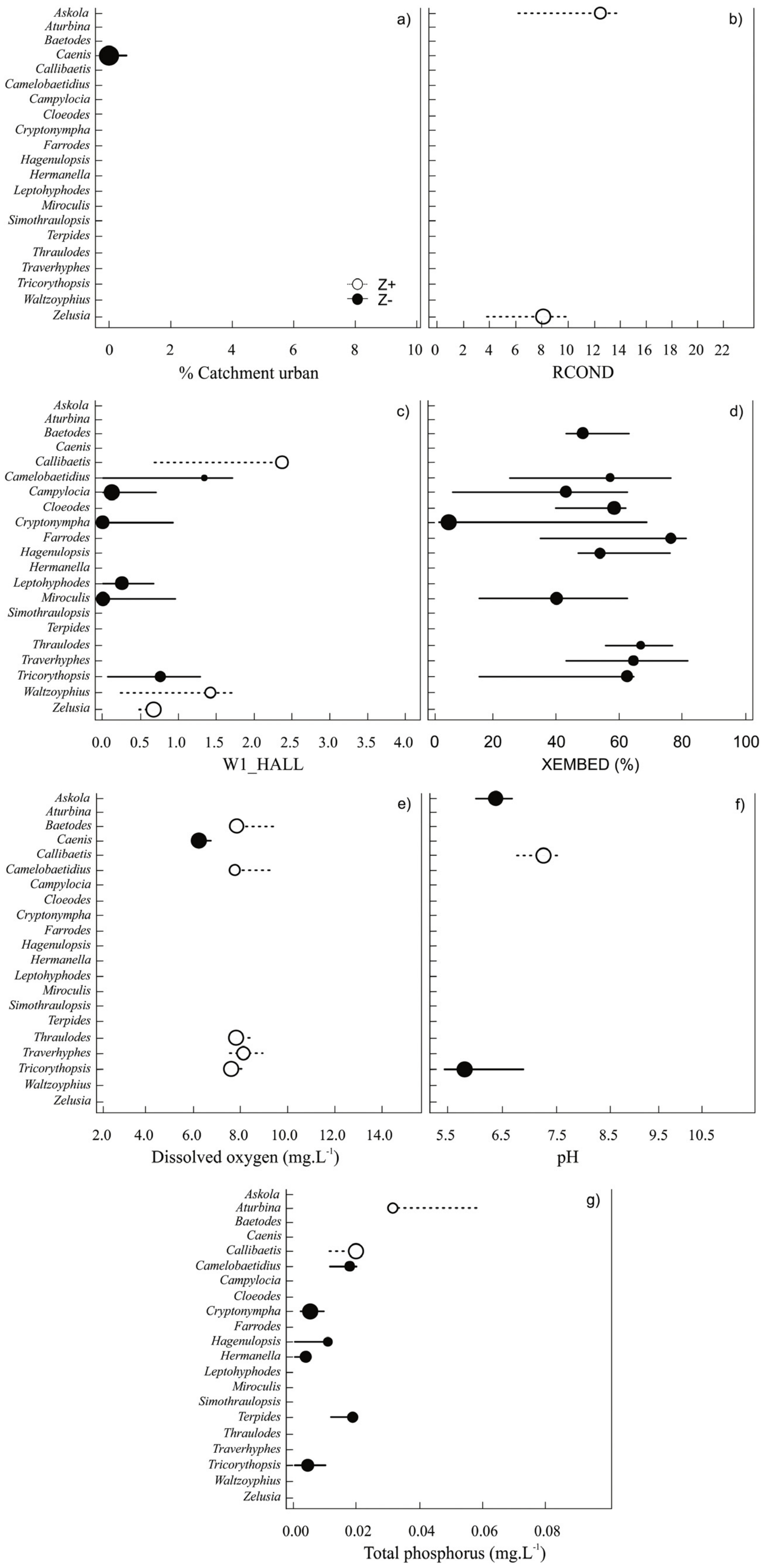

Fig. 2. Robust indicator taxa identified by TITAN in response to anthropogenic disturbance gradients, shown as declining (z −), or increasing genera (z +). Lines (solid or dashed) represent 95% confidence intervals of observed change points (open or black circles).

Table 1
Linear regression coefficient (r^2) among anthropogenic disturbance and natural variability metrics.

Type of descriptor	Metric code	Altitude	Annual rainfall average	Annual temperature average	Catchment area	Catchment elevation average	Catchment elevation range	Catchment slope average	Catchment slope range
Land use and cover	Agriculture (%)	0.12[***]	0.12[***]	0.10[***]	0.01	0.11[***]	0.11[***]	0.23[***]	0.03[**]
	Eucalyptus (%)	0.01	0.36[***]	0.01	0.17[***]	0.02	0.15[***]	0.04[**]	0.00
	Natural (%)	0.32[***]	0.00	0.25[***]	0.02	0.32[***]	0.00	0.35[***]	0.00
	Pasture (%)	0.01	0.17[***]	0.01	0.05[***]	0.01	0.17[***]	0.02	0.05[***]
	Urban (%)	0.01	0.00	0.01	0.00	0.02	0.01	0.01	0.00
Urbanization	Household density	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00
	Population density	0.02	0.00	0.00	0.12[***]	0.01	0.01	0.03[*]	0.00
	Road density	0.01	0.00	0.01	0.00	0.01	0.00	0.02	0.01
Local	LRBS	0.49[***]	0.12[***]	0.43[***]	0.03[*]	0.51[***]	0.03[*]	0.16[***]	0.00
	RCOND	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	XCMGW	0.11[***]	0.10[***]	0.10[***]	0.03[*]	0.10[***]	0.02[*]	0.02	0.00
	XEMBED (%)	0.03[**]	0.00	0.03[**]	0.00	0.05[**]	0.00	0.02	0.00
	W1_HALL	0.06[***]	0.02[*]	0.06[***]	0.00	0.06[***]	0.00	0.02	0.00
Integrated	IDI	0.19[***]	0.00	0.16[***]	0.00	0.19[***]	0.00	0.19[***]	0.02
Water quality	Conductivity	0.10[***]	0.04[**]	0.11[***]	0.02	0.11[***]	0.01	0.03[**]	0.00
	Dissolved oxygen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	pH	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00
	Total dissolved solids	0.14[***]	0.09[***]	0.14[***]	0.08[***]	0.14[***]	0.01	0.02[*]	0.02
	Total phosphorus	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00
	Turbidity	0.03[**]	0.00	0.03[**]	0.00	0.03[*]	0.00	0.02	0.00

[*] $P < 0.05$.
[**] $p < 0.01$.
[***] $p < 0.001$.

Table 2
Correlations among selected anthropogenic disturbance metrics.

Metric code	% catchment urban	Household density	Road density	RCOND	XEMBED (%)	W1_HALL	Dissolved oxygen	pH	Total phosphorus	Turbidity
% catchment urban	–	0.90[*]	0.98[*]	−0.01	0.12	0.46[*]	0	−0.01	−0.01	−0.01
Household density	0.90[*]	–	0.86[*]	0.02	0.11	0.48[*]	0	−0.01	−0.01	0
Road density	0.98[*]	0.86[*]	–	0	0.12	0.46[*]	0.01	−0.02	0	0.01
RCOND	−0.01	0.02	0	–	0.11	0.14	−0.01	0.09	0.04	−0.06
XEMBED (%)	0.12	0.11	0.12	0.11	–	0.1	−0.15[*]	−0.01	0.06	0.20[*]
W1_HALL	0.46[*]	0.48[*]	0.46[*]	0.14	0.1	–	−0.06	−0.03	−0.05	0.02
Dissolved oxygen	0	0	0.01	−0.01	−0.15[*]	−0.06	–	−0.01	−0.23[*]	−0.18[*]
pH	−0.01	−0.01	−0.02	0.09	−0.01	−0.03	−0.01	–	−0.01	−0.01
Total phosphorus	−0.01	−0.01	0	0.04	0.06	−0.05	−0.23[*]	−-0.01	–	0.69[*]
Turbidity	−0.01	0	0.01	−0.06	0.20[*]	0.02	−0.18[*]	−0.01	0.69[*]	–

[*] $P < 0.05$.

dissolved oxygen ranging from 5 to 10.65 mg L^{-1}, whereas one genus started declining in abundance in sites with dissolved oxygen > 6.4 mg L^{-1} (Fig. 2e). We detected a turnover pattern for two genera that were sensitive to pH values of 5.8 and 6, whereas one genus persisted in pH up to 7.3, being considered tolerant (Fig. 2f). We observed a turnover pattern comprising a range of 0.001 to 0.02 mg L^{-1} of total phosphorus (Fig. 2g). Six genera were sensitive to increased total phosphorus concentrations ranging from 0.001 to 0.02 mg L^{-1}, whereas two genera were considered tolerant, increasing in abundance in sites ranging from 0.02 and 0.06 mg L^{-1} of total phosphorus. Finally, we observed a wide range of change points when we considered disturbance variables and the assemblage as a whole, based on loss of sensitive genera [Sum(Z−)], and increase in tolerant genera [Sum(Z+)] (Table 3).

Table 3
TITAN assemblage-level thresholds estimated from mayfly genera responses to anthropogenic disturbance metrics. Sum(z) associated with decrease (−) or increase (+) along the gradient; CP is the assemblage change point; 5%, 10%, 50%, 90% and 95% are bootstrap quantile intervals capturing true thresholds.

Metric code	Sum(z)	CP	5%	10%	50%	90%	95%
Urban	−	0.00	0.00	0.00	0.00	0.00	0.08
	+	7.18	0.00	0.00	3.53	7.57	8.57
RCOND	−	0.00	0.00	0.00	3.28	9.26	9.32
	+	1.75	1.51	1.75	8.65	12.46	12.77
W1_HALL	−	0.00	0.00	0.00	0.13	1.43	1.66
	+	1.34	0.39	0.43	1.08	2.53	2.61
XEMBED (%)	−	63.00	27.83	48.86	58.05	67.14	77.23
	+	11.38	11.38	11.38	70.76	92.58	92.91
Dissolved oxygen	−	6.40	5.60	5.90	6.35	6.50	7.25
	+	8.25	7.10	7.20	8.20	10.25	10.70
pH	−	6.34	5.43	5.80	6.37	6.86	7.50
	+	7.30	7.10	7.11	7.28	8.30	8.45
Total phosphorus	−	0.010	0.001	0.003	0.010	0.017	0.020
	+	0.020	0.002	0.003	0.015	0.058	0.059

4. Discussion

Tropical freshwater ecosystems harbor high biodiversity and their protection should be a priority considering the growing pressure of anthropogenic alterations (Dudgeon et al., 2006; Sala et al., 2000). This is particularly true of aquatic ecosystems in neotropical savannas (Rodrigues et al., 2016; Silva et al., 2006; Wantzen et al., 2006). Their high biodiversity can be properly evaluated only if ecological assessments use continuous disturbance gradients to represent the extent and severity of anthropogenic disturbances, rather than setting discrete disturbance categories (Davies and Jackson, 2006; Ligeiro et al., 2013). In our study, we confirmed the value of using a combination of streams selected *a priori* as minimally disturbed reference sites and highly disturbed urban sites, together with sites selected through a probabilistic survey design (Bryce et al., 2010; Smucker et al., 2013). Likewise, we confirmed the importance of using sensitive or relatively rare taxa when making those assessments, as did Pond et al. (2008) for temperate forest streams and Leitão et al. (2016) for Amazonian streams.

The scientific literature reports a broad range of land use effects on freshwater ecosystems as a result of human activities near watercourses (Sala et al., 2000). We could demonstrate the effects of land use pressures on stream biota directly only for urbanization, because the other types were significantly correlated with several natural environmental variables. This finding suggests a deterministic relationship, where some areas exhibit favorable natural conditions (like favorable climate and flat terrain) for food production and other commodities whereas sites in better ecological condition are more likely in rugged terrain. Such relationships have been demonstrated in other studies in the neotropical savanna (Carvalho et al., 2009; Silva et al., 2006) as well as in the western USA (Whittier et al., 2006), New Zealand (Burdon et al., 2013), and eastern Australia (Kath et al., 2014). Such correlations between natural environmental gradients, anthropogenic disturbances, and biological responses are why others have used regression analysis residuals to calibrate biological metrics against natural environmental gradients when developing multimetric indices in Bolivia (Moya et al., 2011), Brazil (Macedo et al., 2016; Pereira et al., 2016), China (Chen et al., 2014), and the USA (Mazor et al., 2016; Stoddard et al., 2008).

We selected disturbance metrics not correlated with natural variability to better separate disturbance effects from natural effects on freshwater ecosystems. Our results suggest that different anthropogenic disturbances may act independently in impairing stream sites, as demonstrated by other studies conducted in Mexico (Ávila-Gómez et al., 2015) and Bolivia (Moya et al., 2011). For instance, Macedo et al. (2014) showed a decrease in the macroinvertebrates richness due to alterations in the local conditions affected by influences of land use and cover composition at catchment scales. Besides catchment-scale anthropogenic disturbances, tropical ecosystems are also under more subtle effects, such as modifications in riparian zone structure (as indicated by RCOND and W1_HALL) (Sloan and Sayer, 2015). Similar patterns have been reported for riparian vegetation condition in the western USA (Paulsen et al., 2008). Alterations in water quality parameters can also reflect anthropogenic disturbances that represent serious threats to human water supply and biodiversity maintenance globally (Sala et al., 2000; Steffen et al., 2015; Woodward et al., 2012). For this reason water quality variables are used as normative parameters in Brazil (Brasil, 2005), and other nations, such as the USA (Clean Water Act), European Union (Water Framework Directive), and Australia (Sustainable Rivers Audit).

Assemblage turnover responses are usually related strictly to the gradient being evaluated as demonstrated by many studies, including the effect of deforestation in bat assemblages in Mexico (Ávila-Gómez et al., 2015), and the effect of groundwater in the decline of trees in New Zealand (Kath et al., 2014). In our study, we demonstrated the negative effects of anthropogenic disturbances on freshwater ecosystems based on the evaluation of several metrics, indicating the importance of measuring multiple disturbances, as confirmed by Shimano and Juen (2016) for Amazonian streams and Paulsen et al. (2008) for USA streams. We suggest that future studies also investigate response thresholds and turnover in response to different anthropogenic disturbance metrics. This is particularly important because, based on the range effects of each type of stressor, decision makers can target conservation actions and rehabilitation programs more efficiently (Steffen et al., 2015).

Our results corroborate the negative effects of urbanization and local anthropogenic disturbances (W1_HALL, RCOND, XEMBED) on assemblage structure, as observed with aquatic insects in New Zealand (Burdon et al., 2013); neotropical savanna (Rodrigues et al., 2016), and Amazonia (Dedieu et al., 2015; Shimano and Juen, 2016). We observed a wide variation in the response of each genus, corroborating the negative effects resulting from an increase of very low levels of urbanization in Mexico (Ávila-Gómez et al., 2015) and the USA (Hughes and Dunham, 2014; King et al., 2011). On the other hand, we observed a strong positive effect of increasing riparian vegetation integrity (RCOND) on the stream biota, as did Rodrigues et al. (2016) for adult damselflies in neotropical savanna, and Kaufmann et al. (2014) for fish and birds in northeastern USA lakes. Local anthropogenic disturbances can decrease habitat availability for many aquatic taxa (Allan, 2004). We demonstrated this from the turnover pattern in mayfly assemblages in response to a narrow range of change in the W1_HALL gradient. Maintaining and restoring the riparian zone is crucial to ensure stream habitat integrity. For this reason, riparian zones are regulated by the Brazilian Forest Code (Brasil, 2012), which limits riparian vegetation removal to protect stream biota (Sloan and Sayer, 2015). For that same reason, anthropogenic disturbances are restricted for 50–100 m in the riparian zones of USA Pacific Northwest forests, depending on whether streams support fish or not (Thomas and Raphael, 1993).

Intensive land use tends to increase streambed sedimentation, leading to loss of appropriate habitat for several aquatic organisms and causing many local extinctions (Bryce et al., 2010; Burdon et al., 2013). Our study corroborates the effectiveness of sedimentation metrics (e.g., mean embeddedness) as surrogates for intensity of land use. Researchers studying Ephemeroptera, Plecoptera, and Trichoptera assemblages in temperate regions found very low sedimentation thresholds (10% in Bryce et al., 2010; 20% in Burdon et al., 2013), whereas we found a Sum(z−) threshold of 63% XEMBED for the whole mayfly assemblage. Despite the wide range in response thresholds of individual taxa, we observed that mayflies as a whole assemblage do not have a positive association with increased sedimentation, which supports the use of individual target taxa to evaluate sedimentation thresholds. In our study, we observed that sensitive genera showed considerable diversity in gill morphology (e.g., filamentous: *Askola*; operculate: *Tricorythopisis*), mobility (e.g., swimmers: *Campylocia*; crawlers: *Camelobaetidius*), and feeding group (e.g., collector-gatherer: *Cloeodes*; scrapers: *Miroculis*). Specific morphological features associated with improved absorption of oxygen, such as presence of filamentous gills (Shimano and Juen, 2016), or small body-size genera are abundant in minimally disturbed sites (Dedieu et al., 2015). However, associations between traits and stressors need to be better investigated in neotropical savanna streams.

The threshold values for pH and dissolved oxygen demonstrated by mayfly genera agreed with the water quality thresholds established by Brazilian legislation. However, the total phosphorus criterion is 0.05 mg/L (Brasil, 2005). That value is higher than the threshold response of the whole mayfly assemblage [sumz(−) = 0.010 mg L^{-1}], and much higher than the individual response thresholds of the most sensitive genera (e.g., *Hagenulopsis, Hermanella*, and *Tricorythopsis*). The scientific literature shows biodiversity loss as a result of freshwater eutrophication (e.g., Baker and King, 2010; Taylor et al., 2014), calling attention to global eutrophication tendencies (Steffen et al., 2015; Stoddard et al., 2016; Woodward et al., 2012). Our results reveal that small streams can be particularly sensitive to nutrient enrichment, and the changing urban thresholds of the assemblages can be much lower than the value considered in legislation or regulations. Thus, we suggest that environmental legislation and regulations set benchmarks based on actual biological information such as we provided here.

We demonstrated how specific anthropogenic disturbances reduce ecological quality in headwater streams by using disturbance metrics not correlated with natural variability. Thus, we observed biodiversity loss and assemblage turnover responses to independent disturbance gradients. We highlight the applications of our results, including: (i) the use of biological thresholds when developing regulations for water quality and biological integrity; (ii) the use of the indicator taxa approach based on multiple taxa rather than using only univariate metrics such as taxonomic richness and abundance; and (iii) the necessity of dialog, based on high quality ecological data and scientific information, among decision makers, industrial leaders, and the scientific community to find common goals for managing and conserving ecosystems.

Acknowledgements

We acknowledge funding from Companhia Energetica de Minas-Gerais (CEMIG-Programa Peixe Vivo), Pesquisa e Desenvolvimento da Agência Nacional de Energia Elétrica (P&D ANEEL-CEMIG GT-487), Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), Conselho Nacional de Desenvolvimento Cientifico e Tecnológico (CNPq), and Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG). Colleagues from the Centro Federal de Educação Tecnológica de Minas Gerais, Pontifícia Universidade Católica de Minas Gerais, Universidade Federal de Lavras, and Universidade Federal de Minas Gerais helped with field work and sample processing. D. Pujoni helped with TITAN analyses, C.B.M. Alves helped with general logistics, and F.F. Salles trained the first author and confirmed genera identifications. K.R.F. received a scholarship from CNPq. M.C. was awarded a research productivity CNPq (no. 303380/2015-2), research project CNPq (no. 446155/2014-4), and Minas Gerais research grant FAPEMIG PPM-IX – 00525-15. L.J. received a research fellowship (CNPq no. 303252/2013-8). R.M.H. received a Fulbright Brasil grant. D.R.M. received a PRPq/UFMG research grant (ADRC – 05/2016). We also acknowledge two anonymous referees who greatly improved the content of this manuscript.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.ecolind.2016.11.033.

References

Ávila-Gómez, E.S., Moreno, C.E., García-Morales, R., Zuria, I., Sánchez-Rojas, G., Briones-Salas, M., 2015. Deforestation thresholds for phyllostomid bat populations in tropical landscapes in the Huasteca region, Mexico. Trop. Conserv. Sci. 8, 646–661.

ANA, Agência Nacional de Águas, 2016. Hidroweb: sistema de informações hidrológicas. Agencia Nacional de Águas, Brasilia, http://hidroweb.ana.gov.br (Accessed September 2016).

APHA, 2005. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington, DC.

Agostinho, A.A., Thomaz, S.M., Gomes, L.C., 2005. Conservation of the biodiversity of Brazil's inland waters. Conserv. Biol. 19, 646–652.

Allan, J.D., 2004. Landscapes and riverscapes: the influence of land use on stream ecosystems. Annu. Rev. Ecol. Evol. Syst. 35, 257–284.

Baker, M.E., King, R.S., 2010. A new method for detecting and interpreting biodiversity and ecological community thresholds. Methods Ecol. Evol. 1, 25–37.

Bauernfeind, E., Moog, O., 2000. Mayflies (Insecta: Ephemeroptera) and the assessment of ecological integrity: a methodological approach. Hydrobiologia 422/423, 71–83.

Benda, L., Hassan, M.A., Church, M., May, C.L., 2005. Geomorphology of steepland headwaters: the transition from hillslopes to channels. J. Am. Water Resour. Assoc. 41, 835–851.

Beschta, R.L., Donahue, D.L., DellaSala, D.A., Rhodes, J.J., Karr, J.R., O'Brien, M.H., Fleischner, T.L., Williams, C.D., 2013. Adapting to climate change on western public lands: addressing the ecological effects of domestic, wild, and feral ungulates. Environ. Manage. 51, 474–491.

Bonada, N., Prat, N., Resh, V.H., Statzner, B., 2006. Developments in aquatic insect biomonitoring: a comparative analysis of recent approaches. Annu. Rev. Entomol. 51, 495–523.

Boyero, L., Pearson, R.G., Hui, C., Gessner, M.O., Pérez, J., Alexandrou, M.A., Graça, M.A.S., Cardinale, B.J., Albariño, R.J., Arunachalam, M., Barmuta, L.A., Boulton, A.J., Bruder, A., Callisto, M., Chauvet, E., Death, R.G., Dudgeon, D., Encalada, A.C., Ferreira, V., Figueroa, R., Flecker, A.S., Gonçalves, J.F., Helson, J., Iwata, T., Jinggut, T., Mathooko, J., Mathuriau, C., M'Erimba, C., Moretti, M.S., Pringle, C.M., Ramírez, A., Ratnarajah, L., Rincon, J., Yule, C.M., 2016. Biotic and abiotic variables influencing plant litter breakdown in streams: a global study. Proc. R. Soc. B Biol. Sci. 283, 20152664.

Brasil, Conselho Nacional de Meio-Ambiente, 2005. Resolução n. 357 do Conselho Nacional de Meio-Ambiente, de 17 de março de 2005.

Brasil, 2012. Código Florestal. Lei Federal n. 12.651, de 25 de maio de 2012. http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm (Acessed September 2016).

Brittain, J.E., 1982. Biology of mayflies. Annu. Rev. Entomol. 27, 119–147.

Bryce, S.A., Lomnicky, G.A., Kaufmann, P.R., 2010. Protecting sediment-sensitive aquatic species in mountain streams through the application of biologically based streambed sediment criteria. J. North Am. Benthol. Soc. 29, 657–672.

Burdon, F.J., McIntosh, A.R., Harding, J.S., 2013. Habitat loss drives threshold response of benthic invertebrate communities to deposited sediment in agricultural streams. Ecol. Appl. 23, 1036–1047.

Carvalho, F.M.V., De Marco, P., Ferreira, L.G., 2009. The cerrado into-pieces: habitat fragmentation as a function of landscape use in the savannas of central Brazil. Biol. Conserv. 142, 1392–1403.

Chen, K., Hughes, R.M., Xu, S., Zhang, J., Cai, D., Wang, B., 2014. Evaluating performance of macroinvertebrate-based adjusted and unadjusted multi-metric indices (MMI) using multi-season and multi-year samples. Ecol. Indic. 36, 142–151.

Davies, S.P., Jackson, S.K., 2006. The biological condition gradient: a descriptive model for interpreting change in aquatic ecosystems. Ecol. Appl. 16, 1251–1266.

Dedieu, N., Rhone, M., Vigouroux, R., Céréghino, R., 2015. Assessing the impact of gold mining in headwater streams of eastern Amazonia using Ephemeroptera assemblages and biological traits. Ecol. Indic. 52, 332–340.

Domínguez, E., Molineri, C., Pescador, M., Hubbard, M.D., Nieto, C., 2006. Ephemeroptera of South America. Pensoft, Moscow.

Dudgeon, D., Arthington, A.H., Gessner, M.O., Kawabata, Z.-I., Knowler, D.J., Lévêque, C., Naiman, R.J., Prieur-Richard, A.-H., Soto, D., Stiassny, M.L.J., Sullivan, C.A., 2006. Freshwater biodiversity: importance, threats, status and conservation challenges. Biol. Rev. Camb. Philos. Soc. 81, 163–182.

Dufrêne, M., Legendre, P., 1997. Species assemblages and indicator species: the need for a flexible asymmetrical approach. Ecol. Monogr. 67, 345–366.

Feld, C.K., Birk, S., Eme, D., Gerisch, M., Hering, D., Kernan, M., Maileht, K., Mischke, U., Ott, I., Pletterbauer, F., Poikane, S., Salgado, J., Sayer, C.D., van Wichelen, J., Malard, F., 2016. Disentangling the effects of land use and geo-climatic factors on diversity in European freshwater ecosystems. Ecol. Indic. 60, 71–83.

Google, 2014. Google earth. Google, Inc., Mountain View, California.

Hijmans, R.J., Cameron, S.E., Parra, J.L., Jones, P.G., Jarvis, A., 2005. Very high resolution interpolated climate surfaces for global land areas. Int. J. Climatol. 25, 1965–1978.

Hughes, R.M., Dunham, S., 2014. Aquatic biota in urban areas. In: Yeakley, J.A., Maas-Hebner, K.G., Hughes, R.M. (Eds.), Wild Salmonids in the Urbanizing Pacific Northwest. Springer, New York, pp. 155–167.

Hughes, R.M., Peck, D.V., 2008. Acquiring data for large aquatic resource surveys: the art of compromise among science, logistics, and reality. J. North Am. Benthol. Soc. 27, 837–859.

Hughes, R.M., Larsen, D.P., Omernik, J.M., 1986. Regional reference sites: a method for assessing stream potentials. Environ. Manage. 10, 629–635.

IBGE, Instituto Brasileiro de Geografia e Estatística, 2016. Cadastro nacional de endereços para fins estatísticos, http://www.censo2010.ibge.gov.br/cnefe (Accessed September 2016).

Kath, J., Reardon-Smith, K., Le Brocque, A.F., Dyer, F.J., Dafny, E., Fritz, L., Batterham, M., 2014. Groundwater decline and tree change in floodplain landscapes: identifying non-linear threshold responses in canopy condition. Global. Ecol. Conserv. 2, 148–160.

Kaufmann, P.R., Levine, P., Robison, E.G., Seeliger, C., Peck, D.V., 1999. Quantifying Physical Habitat in Wadeable Streams. EPA/620/R-99/003. U.S. Environmental Protection Agency, Washington, DC.

Kaufmann, P.R., Faustini, J.M., Larsen, D.P., Shirazi, M.A., 2008. A roughness-corrected index of relative bed stability for regional stream surveys. Geomorphology 99, 150–170.

Kaufmann, P.R., Hughes, R.M., Whittier, T.R., Bryce, S.A., Paulsen, S.G., 2014. Relevance of lake physical habitat assessment indices to fish and riparian birds. Lake Reserv. Manage. 30, 177–191.

King, R.S., Baker, M.E., 2014. Use, misuse, and limitations of threshold indicator taxa analysis (TITAN) for natural resourse management. In: Guntenspergen, G.R. (Ed.), Application of Threshold Concepts in Natural Resource Decision Making. Springer-Verlag, New York, pp. 231–254.

King, R.S., Richardson, C.J., 2003. Integrating bioassessment and ecological risk assessment: an approach to developing numerical water-quality criteria. Environ. Manage. 31, 795–809.

King, R.S., Baker, M.E., Kazyak, P.F., Weller, D.E., 2011. How novel is too novel? Stream community thresholds at exceptionally low levels of catchment urbanization. Ecol. Appl. 21, 1659–1678.

Leitão, R.P., Zuanon, J., Villéger, S., Williams, S.E., Baraloto, C., Fortunel, C., Nendonça, F.P., Mouillot, D., 2016. Rare species contribute disproportionately to the functional structure of species assemblages. Proc. R. Soc. B 283, 20160084.

Ligeiro, R., Hughes, R.M., Kaufmann, P.R., Macedo, D.R., Firmiano, K.R., Ferreira, W.R., Oliveira, D., Melo, A.S., Callisto, M., 2013. Defining quantitative stream disturbance gradients and the additive role of habitat variation to explain macroinvertebrate taxa richness. Ecol. Indic. 25, 45–57.

Macedo, D.R., Hughes, R.M., Ligeiro, R., Ferreira, W.R., Castro, M.A., Junqueira, N.T., Oliveira, D.R., Firmiano, K.R., Kaufmann, P.R., Pompeu, P.S., Callisto, M., 2014. The relative influence of catchment and site variables on fish and macroinvertebrate richness in cerrado biome streams. Landsc. Ecol. 29, 1001–1016.

Macedo, D.R., Hughes, R.M., Ferreira, W.R., Firmiano, K.R., Silva, D.R.O., Ligeiro, R., Kaufmann, P.R., Callisto, M., 2016. Development of a benthic macroinvertebrate multimetric index (MMI) for neotropical savanna headwater streams. Ecol. Indic. 54, 132–141.

Mazor, R.D., Rehn, A.C., Ode, P.R., Engeln, M., Schiff, K.C., Stein, E.D., Gillett, D.J., Herbst, D.B., Hawkins, C.P., 2016. Bioassessment in complex environments: designing an index for consistent meaning in different settings. Freshw. Sci. 35, 249–271.

Moya, N., Hughes, R.M., Domínguez, E., Gibon, F.M., Goitia, E., Oberdorff, T., 2011. Macroinvertebrate-based multimetric predictive models for evaluating the human impact on biotic condition of Bolivian streams. Ecol. Indic. 11, 840–847.

OSM Foundation, Open Street Map, 2016. https://www.openstreetmap.org/#map=8/56.964/-10.024 (Accessed September 2016).

Olsen, A.R., Peck, D.V., 2008. Survey design and extent estimates for the Wadeable Streams Assessment. J. North Am. Benthol. Soc. 27, 822–836.

Overbeck, G.E., Vélez-Martin, E., Scarano, F.R., Lewinsohn, T.M., Fonseca, C.R., Meyer, S.T., Müller, S.C., Ceotto, P., Dadalt, L., Durigan, G., Ganade, G., Gossner, M.M., Guadagnin, D.L., Lorenzen, K., Jacobi, C.M., Weisser, W.W., Pillar, V.D., 2015. Conservation in Brazil needs to include non-forest ecosystems. Divers. Distrib. 21, 1455–1460.

Paulsen, S.G., Mayio, A., Peck, D.V., Stoddard, J.L., Tarquinio, E., Holdsworth, S.M., Van Sickle, J., Yuan, L.L., Hawkins, C.P., Herlihy, A., Kaufmann, P.R., Barbour, M.T., Larsen, D.P., Olsen, A.R., 2008. Condition of stream ecosystems in the US: an overview of the first national assessment. J. North Am. Benthol. Soc. 27, 812–821.

Peck, D.V., Herlihy, A.T., Hill, B.H., Hughes, R.M., Kaufmann, P.R., Klemm, D.J., Lazorchak, J.M., McCormik, F.H., Peterson, S.A., Ringold, P.L., Magee, T., Cappaert, M.R., 2006. Environmental Monitoring and Assessment Program – Surface Waters Western Pilot Study: Field Operations Manual for Wadeable Streams. – EPA 600/R-06/003. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC.

Pereira, P.S., Souza, N.F., Baptista, D.F., Oliveira, J.L.M., Buss, D.F., 2016. Incorporating natural variability in the bioassessment of stream condition in the Atlantic Forest biome, Brazil. Ecol. Indic. 69, 606–616.

Pond, G.J., Passmore, M.E., Borsuk, F.A., Reynolds, L., Rose, C.J., 2008. Downstream effects of mountaintop coal mining: comparing biological conditions using family- and genus-level macroinvertebrate bioassessment tools. J. Norrth Am. Benthol. Soc. 208, 717–737.

R Development Core Team, 2016. R: a Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria.

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F.S., Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., de Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., Foley, J.A., 2009. A safe operating space for humanity. Nature 461, 472–475.

Rodrigues, M.E., de Oliveira Roque, F., Quintero, J.M.O., de Castro Pena, J.C., de Sousa, D.C., De Marco Junior, P., 2016. Nonlinear responses in damselfly community along a gradient of habitat loss in a savanna landscape. Biol. Conserv. 194, 113–120.

Sala, O.E., Chapin III, F.S., Armesto, J.J., Berlow, E., Blomfield, J., Dirzo, R., Huber-Sanwald, E., Huenneke, L.F., Jackson, R.B., Kinzig, A., Leemans, R., Lodge, D.M., Mooney, H.A., Oesterheld, M., Poff, M.L., Sykes, M.T., Walker, B.H., Walker, M., Wall, D.H., 2000. Global biodiversity scenarios for the year 2100. Science 287, 1770–1774.

Salles, F.F., Lima, M.M., 2014. Chave interativa para identificação dos gêneros de Leptophlebiidae (Ephemeroptera) registrados para o Brasil, http://www.ephemeroptera.com.br (Accessed September 2016).

Seaber, P.R., Kapinos, F.P., Knapp, G.L., 1987. Hydrologic unit maps. U.S. Geological Survey Water-Supply Paper 2294. U.S. Geological Survey, Denver, Colorado. https://pubs.usgs.gov/wsp/wsp2294/pdf/wsp_2294_a.pdf (Accessed July 2016).

Shimano, Y., Juen, L., 2016. How oil palm cultivation is affecting mayfly assemblages in Amazon streams. Ann. Limnol. Int. J. Limnol. 52, 35–45.

Silva, J.F., Farinas, M.R., Felfili, J.M., Klink, C.A., 2006. Spatial heterogeneity, land use and conservation in the cerrado region of Brazil. J. Biogeogr. 33, 536–548.

Sloan, S., Sayer, J.A., 2015. Forest resources assessment of 2015 shows positive global trends but forest loss and degradation persist in poor tropical countries. For. Ecol. Manage. 352, 134–145.

Smucker, N.J., Becker, M., Detenbeck, N.E., Morrison, A.C., 2013. Using algal metrics and biomass to evaluate multiple ways of defining concentration-based nutrient criteria in streams and their ecological relevance. Ecol. Indic. 32, 51–61.

Steffen, W., Richardson, K., Rockstrom, J., Cornell, S.E., Fetzer, I., Bennett, E.M., Biggs, R., Carpenter, S.R., de Vries, W., de Wit, C.A., Folke, C., Gerten, D., Heinke, J., Mace, G.M., Persson, L.M., Ramanathan, V., Reyers, B., Sorlin, S., 2015. Planetary boundaries: guiding human development on a changing planet. Science 347, 1259855.

Stevens, D.L., Olsen, A.R., 2004. Spatially balanced sampling of natural resources. J. Am. Stat. Assoc. 99, 262–278.

Stoddard, J.L., Larsen, D.P., Hawkins, C.P., Johnson, R.K., Norris, R.H., 2006. Setting expectations for the ecological condition of streams: the concept of reference condition. Ecol. Appl. 16, 1267–1276.

Stoddard, J.L., Herlihy, A.T., Peck, D.V., Hughes, R.M., Whittier, T.R., Tarquinio, E., 2008. A process for creating multimetric indices for large-scale aquatic surveys. J. North Am. Benthol. Soc. 27, 878–891.

Stoddard, J.L., Van Sickle, J., Brahney, J., Paulsen, S., Peck, D.V., Mitchell, R., Pollard, A.L., 2016. Continental-scale increase in lake and stream phosphorus: are oligotrophic systems disappearing in the United States? Environ. Sci. Technol. 50, 3409–3415.

Strahler, A.N., 1957. Quantitative classification of watershed geomorphology. Trans. Am. Geophys. Union 38, 913–920.

Taylor, J.M., King, R.S., Pease, A.A., Winemiller, K.O., 2014. Nonlinear response of stream ecosystem structure to low-level phosphorus enrichment. Freshw. Biol. 59, 969–984.

Thomas, J.W., Raphael, M.G., 1993. Forest Ecosystem Management: An Ecological, Economic and Social Assessment. Report of the Forest Ecosystem Management Assessment Team (FEMAT), Portland, OR.

USGS, United States Geological Survey, 2005. Shuttle Radar Topography Mission. SRTM, Washington, DC, http://srtm.usgs.gov (Accessed September 2016).

Vörösmarty, C.J., McIntyre, P.B., Gessner, M.O., Dudgeon, D., Prusevich a Green, P., Glidden, S., Bunn, S.E., Sullivan, C., a Liermann, C.R., Davies, P.M., 2010. Global threats to human water security and river biodiversity. Nature 467, 555–561.

Veldman, J.W., Buisson, E., Durigan, G., Fernandes, G.W., Le Stradic, S., Mahy, G., Negreiros, D., Overbeck, G.E., Veldman, R.G., Zaloumis, N.P., Putz, F.E., Bond, W.J., 2015. Toward an old-growth concept for grasslands, savannas, and woodlands. Front. Ecol. Environ. 13, 154–162.

Wantzen, K.M., Siqueira, A., da Cunha, C.N., Pereira de Sá, M. de F., 2006. Stream-valley systems of the Brazilian Cerrado: impact assessment and conservation scheme. Aquat. Conserv. Mar. Freshw. Ecosyst. 16, 713–732.

Whittier, T.R., Stoddard, J.L., Hughes, R.M., Lomnicky, G., 2006. Associations among catchment- and site-scale disturbance indicators and biological assemblages at least- and most-disturbed stream and river sites in the western USA. In: Hughes, R.M., Wang, L., Seelbach, P.W. (Eds.), Landscape Influences on Stream Habitat and Biological Assemblages, vol. 48. American Fisheries Society Symposium, pp. 641–664.

Woodward, G., Gessner, M.O., Giller, P.S., Gulis, V., Hladyz, S., Lecerf, A., Malmqvist, B., McKie, B.G., Tiegs, S.D., Cariss, H., Dobson, M., Elosegi, A., Ferreira, V., Graca, M.A.S., Fleituch, T., Lacoursiere, J.O., Nistorescu, M., Pozo, J., Risnoveanu, G., Schindler, M., Vadineanu, A., Vought, L.B.-M., Chauvet, E., 2012. Continental-scale effects of nutrient pollution on stream ecosystem functioning. Science 336, 1438–1440.

Zar, J.H., 1999. Biostatistical Analysis. Prentice-Hall, New Jersey, USA.

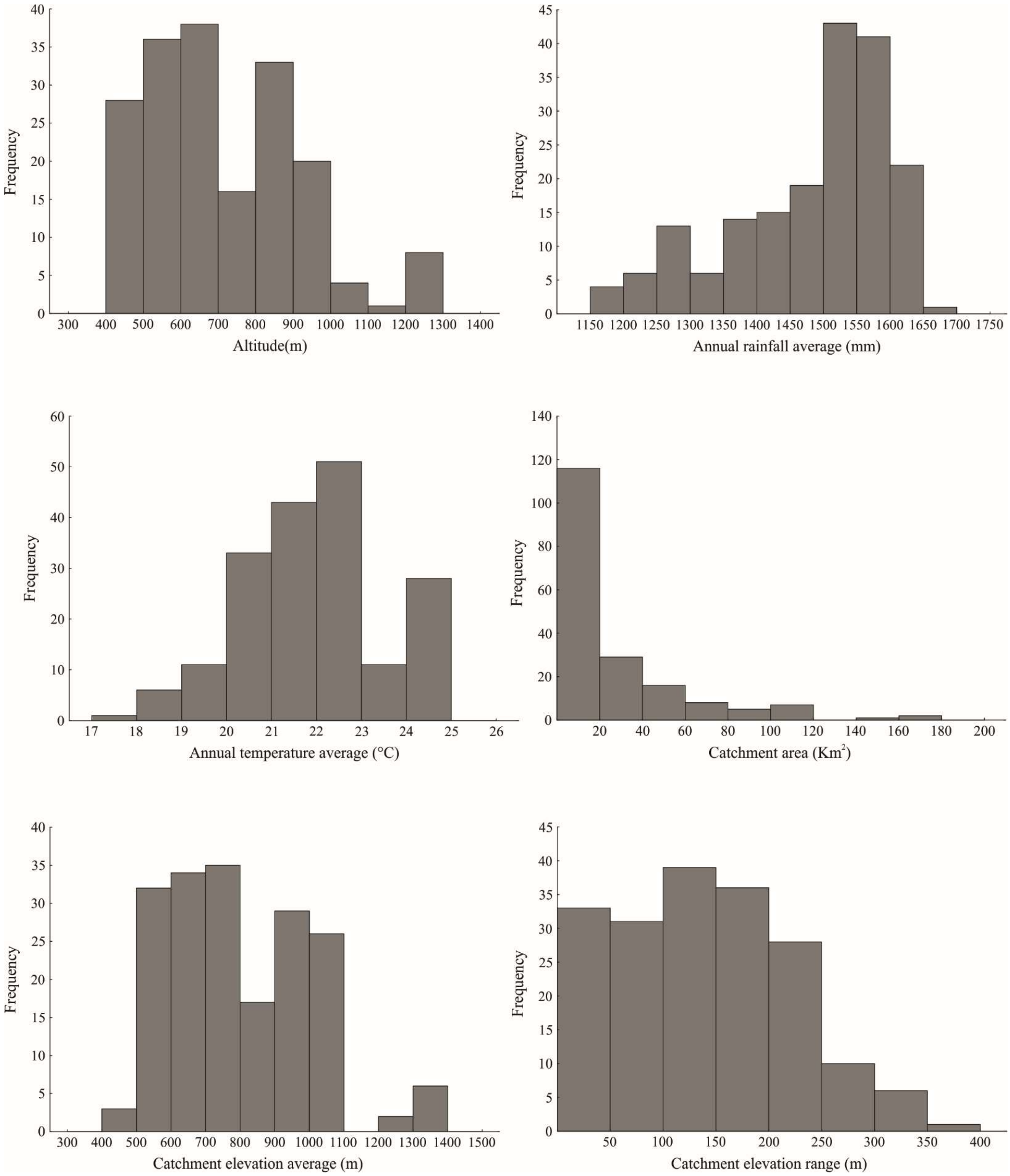

Figure SM1. Frequency histograms to natural variability, anthropogenic disturbance metrics, and water quality parameters across all 184 stream sites.

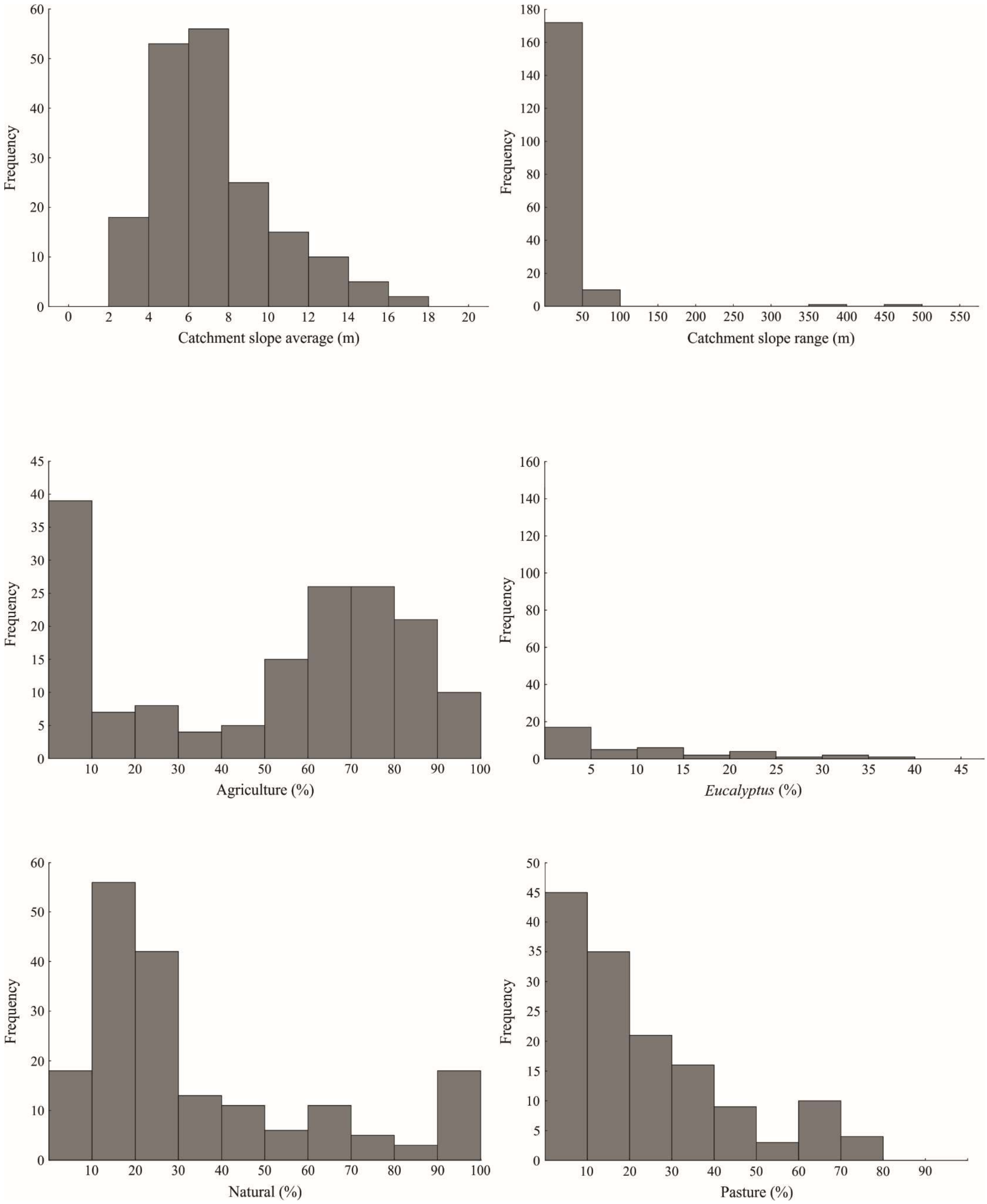

Figure SM1. Continuation. Frequency histograms to natural variability, anthropogenic disturbance metrics, and water quality parameters across all 184 stream sites.

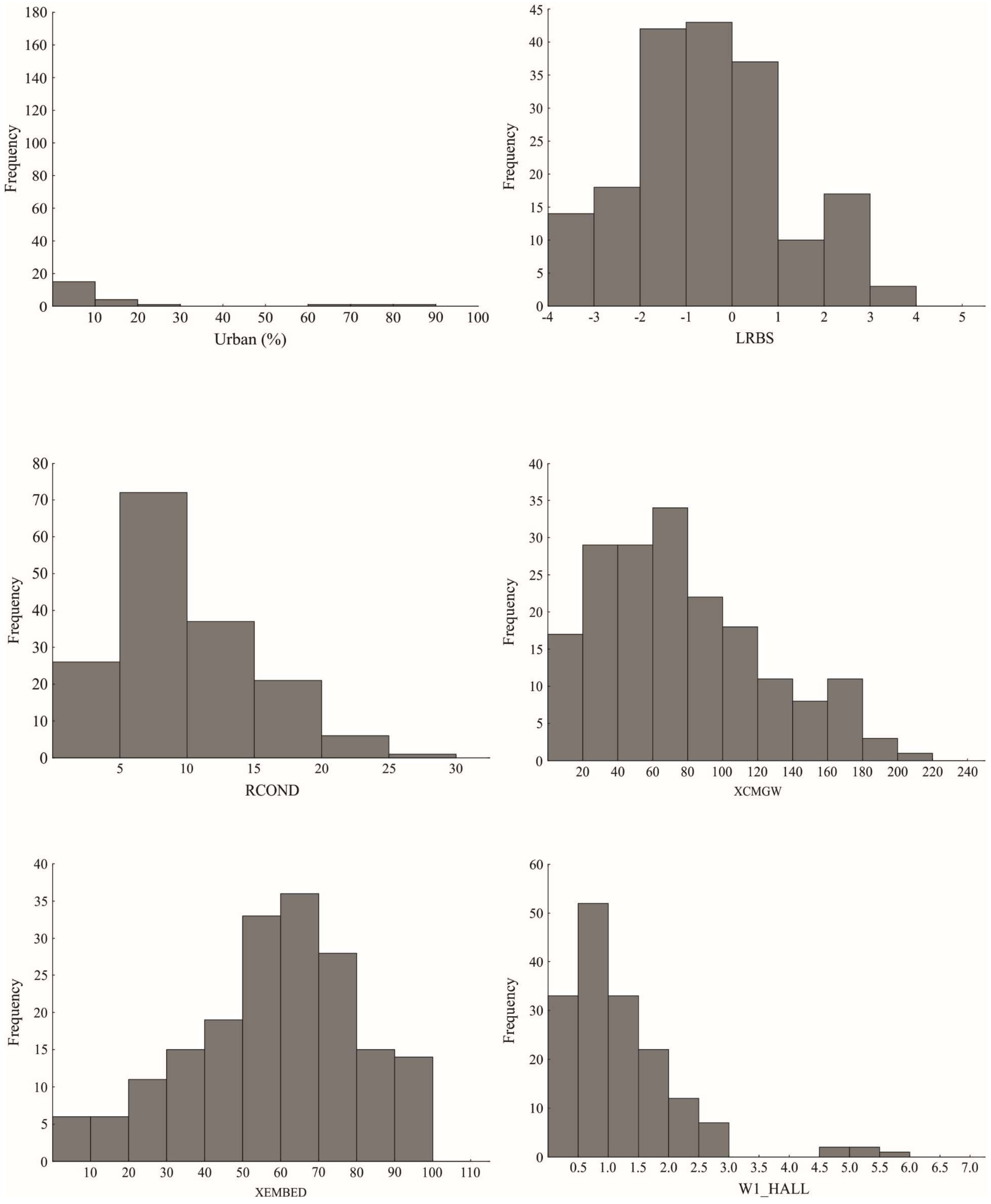

Figure SM1. Continuation. Frequency histograms to natural variability, anthropogenic disturbance metrics, and water quality parameters across all 184 stream sites.

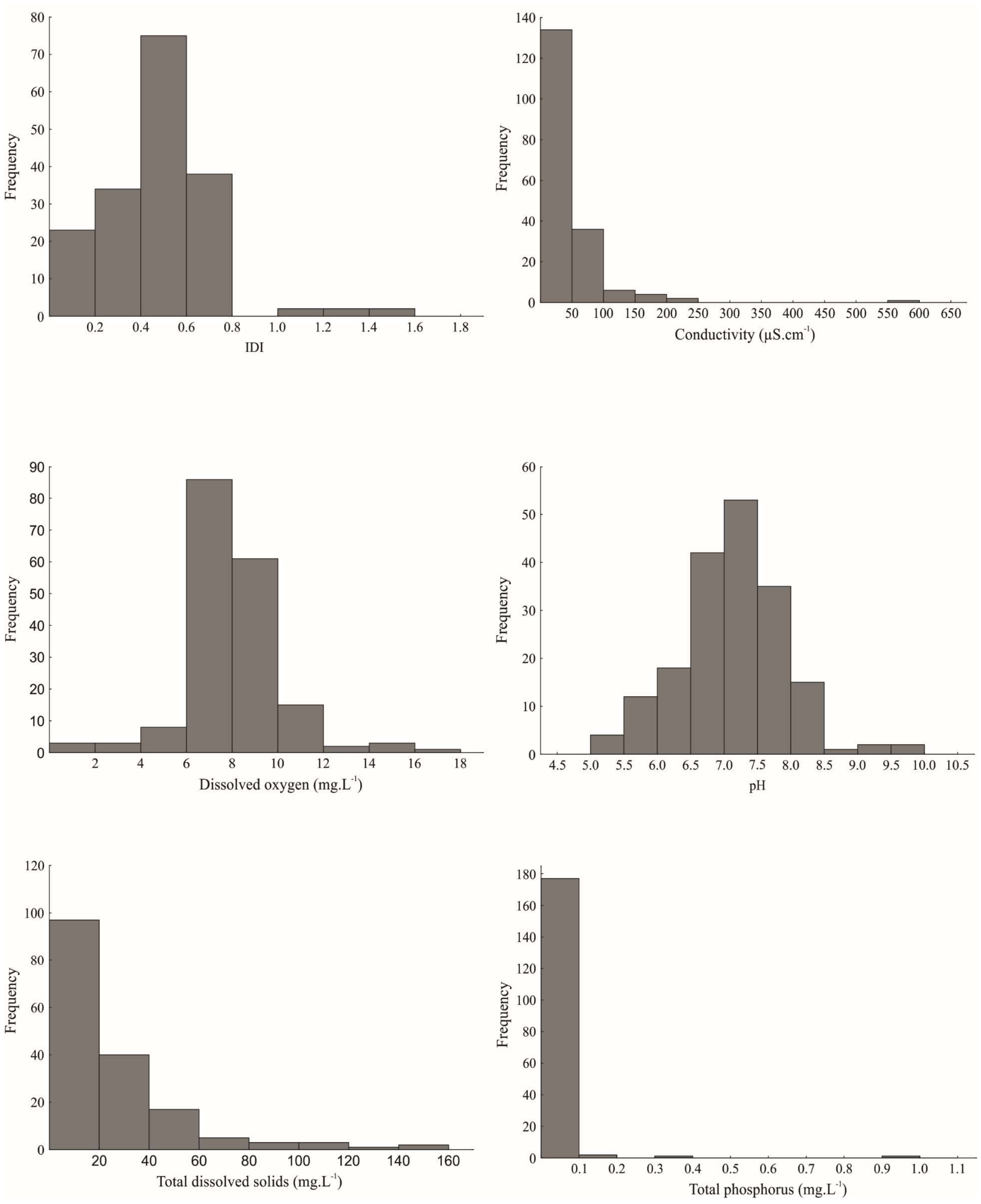

Figure SM1. Continuation. Frequency histograms to natural variability, anthropogenic disturbance metrics, and water quality parameters across all 184 stream sites.

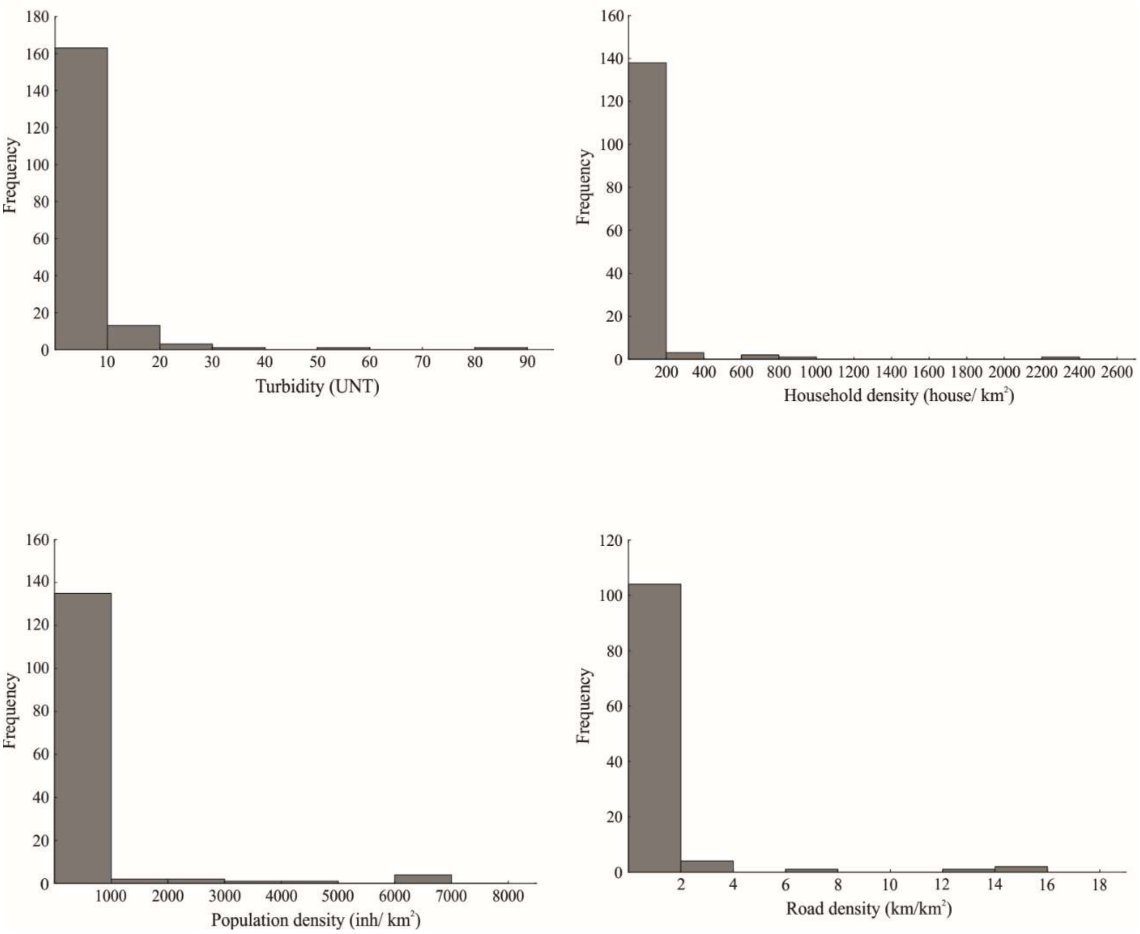

Figure SM1. Continuation. Frequency histograms to natural variability, anthropogenic disturbance metrics, and water quality parameters across all 184 stream sites.

Table SM2A. Results of TITAN for all genera for % catchment urban gradient. Change point (CP), frequency of observation (freq), association with decrease (-) or increase (+) along the gradient, indicator value (IndVal), z score (Z), 5%, 10%, 50%, 90% and 95%: bootstrap quantile intervals capture the true thresholds, purity (Pur) and reliability (rel).

Genera	CP	Freq.	Ass.	IndVal	Z	5%	10%	50%	90%	95%	Pur.	Rel.
Americabaetis	0.00	133	-	50.31	0.64	0.00	0.00	0.00	4.53	8.86	0.42	0.52
Apobaetis	0.00	49	-	24.51	2.45	0.00	0.00	0.00	0.00	5.39	0.68	0.58
Askola	0.00	11	-	7.24	0.65	0.00	0.00	0.00	0.00	0.00	0.70	0.42
Asthenopus	0.00	5	-	9.85	4.40	0.00	0.00	0.00	0.00	0.00	0.68	0.29
Aturbina	5.93	45	+	41.93	3.04	0.00	0.00	4.71	5.96	7.14	0.76	0.78
Baetodes	8.57	52	+	37.68	1.52	0.00	0.00	1.92	10.03	10.03	0.67	0.53
Caenis	0.00	87	-	52.73	3.47	0.00	0.00	0.00	0.10	0.56	0.99	1.00
Callibaetis	0.18	62	-	28.54	1.98	0.00	0.00	0.00	0.16	0.65	0.88	0.76
Camelobaetidius	8.57	31	+	27.86	0.89	0.00	0.00	0.00	10.03	10.03	0.56	0.63
Campsurus	0.00	4	+	5.07	2.35	0.00	0.00	0.00	0.08	0.08	0.66	0.40
Campylocia	0.00	19	-	12.26	1.19	0.00	0.00	0.00	0.00	0.00	0.78	0.52
Cloeodes	0.00	69	-	42.06	2.24	0.00	0.00	0.00	0.10	0.20	0.94	0.91
Cryptonympha	7.39	41	+	23.72	2.38	0.00	0.00	0.00	8.36	8.58	0.65	0.67
Farrodes	0.00	120	-	55.00	0.42	0.00	0.00	0.00	10.03	10.62	0.46	0.60
Hagenulopsis	0.00	42	-	21.28	2.37	0.00	0.00	0.00	5.86	5.93	0.45	0.58
Hermanella	0.00	8	-	9.81	3.62	0.00	0.00	0.00	0.00	0.00	0.68	0.37
Hydrosmilodon	8.57	19	+	21.34	2.53	0.00	0.00	0.00	7.57	8.57	0.68	0.70
Latineosus	0.00	9	-	11.32	3.88	0.00	0.00	0.00	0.00	0.00	0.68	0.39
Leptohyphes	7.18	34	+	53.43	5.73	0.00	0.00	1.86	7.18	7.36	0.87	0.85
Leptohyphodes	0.00	5	+	4.17	1.10	0.00	0.00	0.00	0.00	0.00	0.34	0.30
Massartella	0.00	13	-	10.83	3.08	0.00	0.00	0.00	0.00	0.00	0.71	0.45
Miroculis	0.00	63	-	43.63	1.46	0.00	0.00	0.00	4.53	5.86	0.74	0.54
Paracloeodes	0.00	67	+	32.21	2.52	0.00	0.00	0.00	4.65	5.93	0.42	0.52
Paramaka	0.00	4	-	8.07	1.57	0.00	0.00	0.00	0.00	0.00	0.63	0.25
Rivudiva	0.00	9	-	12.41	2.00	0.00	0.00	0.00	0.00	3.61	0.54	0.41
Simothraulopsis	0.00	10	-	8.00	2.06	0.00	0.00	0.00	0.00	0.00	0.71	0.39
Terpides	3.57	27	+	35.25	4.34	0.00	0.00	2.37	5.93	5.93	0.92	0.90
Thraulodes	7.18	64	+	46.44	1.76	0.00	0.00	0.00	7.36	8.36	0.65	0.70
Traverhyphes	0.00	120	-	49.57	1.25	0.00	0.00	0.00	10.03	10.62	0.70	0.61
Tricorythodes	0.00	59	+	25.70	0.94	0.00	0.00	0.00	3.57	5.86	0.64	0.64
Tricorythopsis	0.00	58	-	35.87	2.78	0.00	0.00	0.00	0.00	0.08	0.86	0.74
Ulmeritoides	1.54	57	+	29.25	1.07	0.00	0.00	0.00	3.64	5.86	0.67	0.63
Waltzoyphius	7.39	64	-	33.40	2.59	0.00	0.00	0.00	3.98	7.15	0.54	0.50
Zelusia	0.00	74	-	36.39	2.98	0.00	0.00	0.00	1.54	3.41	0.39	0.58

Table SM2B. Results of TITAN for all genera for RCOND gradient. Change point (CP), frequency of observation (freq), association with decrease (-) or increase (+) along the gradient, indicator value (IndVal), z score (Z), 5%, 10%, 50%, 90% and 95%: bootstrap quantile intervals capture the true thresholds, purity (Pur) and reliability (rel).

Genera	CP	Freq.	Ass.	IndVal	Z	5%	10%	50%	90%	95%	Pur.	Rel.
Americabaetis	13.90	133	-	70.39	1.54	0.00	0.00	4.93	12.91	13.22	0.64	0.57
Apobaetis	1.09	49	+	26.75	2.17	1.16	1.51	3.23	9.14	12.46	0.52	0.94
Askola	12.91	11	+	24.71	4.52	6.19	6.22	11.31	12.91	13.83	1.00	0.96
Asthenopus	6.73	5	-	4.39	1.45	2.42	2.42	3.90	6.95	7.10	0.88	0.51
Aturbina	12.46	45	+	26.79	1.86	1.16	1.39	8.26	12.46	12.46	0.86	0.87
Baetodes	12.04	52	+	22.53	0.88	0.00	2.01	7.26	10.10	11.59	0.55	0.64
Caenis	0.00	87	+	46.02	1.98	1.53	1.59	6.55	12.77	12.91	0.68	0.91
Callibaetis	9.26	62	-	37.97	4.71	1.59	3.29	9.07	9.26	9.30	0.92	1.00
Camelobaetidius	11.03	31	+	16.94	1.22	1.68	1.75	6.04	9.88	10.37	0.54	0.62
Campsurus	13.90	4	+	18.71	3.22	2.76	2.84	3.41	14.60	14.96	0.46	0.79
Campylocia	0.44	19	-	18.69	3.93	0.00	0.00	0.00	5.88	10.31	0.92	0.91
Cloeodes	13.90	69	-	35.49	2.83	1.75	2.65	6.44	9.34	9.75	0.91	0.93
Cryptonympha	0.00	41	-	76.64	7.78	0.00	0.00	1.48	7.77	11.43	0.68	0.92
Farrodes	13.90	120	-	66.81	1.60	0.00	1.09	9.26	13.22	13.90	0.47	0.65
Hagenulopsis	13.90	42	+	20.69	0.91	0.00	0.00	5.28	11.47	12.32	0.51	0.81
Hermanella	0.00	8	-	17.70	2.23	0.00	0.00	2.01	7.54	7.72	0.62	0.71
Hydrosmilodon	3.32	19	-	15.32	2.41	2.01	2.19	3.46	6.19	9.22	0.94	0.87
Latineosus	3.42	9	+	7.44	1.75	3.28	3.30	4.04	7.68	8.34	0.81	0.64
Leptohyphes	0.00	34	+	19.29	1.10	1.09	2.01	4.35	9.50	9.87	0.68	0.52
Leptohyphodes	13.90	5	+	36.97	7.75	0.00	6.19	11.62	13.90	13.90	0.91	0.86
Massartella	12.91	13	+	8.67	1.35	2.93	3.03	7.96	12.77	12.91	0.82	0.65
Miroculis	11.47	63	+	29.36	1.81	0.00	0.00	7.43	11.56	12.46	0.75	0.86
Paracloeodes	12.46	67	+	34.10	2.06	1.75	1.80	4.17	12.46	12.46	0.77	0.89
Paramaka	8.52	4	+	4.10	1.22	1.83	1.85	8.08	9.02	9.72	0.63	0.61
Rivudiva	11.70	9	+	17.34	4.10	3.86	3.93	11.51	13.96	14.93	0.84	0.72
Simothraulopsis	2.04	10	-	6.57	1.09	2.42	2.71	3.71	9.27	9.73	0.66	0.58
Terpides	0.00	27	+	14.93	1.67	0.00	2.04	7.77	9.91	10.61	0.56	0.65
Thraulodes	13.90	64	+	32.28	1.67	1.59	1.69	5.70	9.23	10.02	0.46	0.77
Traverhyphes	0.00	120	+	64.08	2.17	0.00	1.73	9.08	13.62	14.60	0.72	0.68
Tricorythodes	0.00	59	+	33.82	2.02	0.00	0.72	3.63	11.27	11.68	0.87	0.82
Tricorythopsis	0.00	58	-	63.26	3.65	0.00	0.00	1.31	10.93	11.31	0.60	0.92
Ulmeritoides	0.00	57	+	35.40	2.20	0.86	1.48	7.68	11.79	12.46	0.86	0.77
Waltzoyphius	0.00	64	+	37.87	1.29	0.00	1.51	3.29	9.92	10.93	0.69	0.60
Zelusia	7.90	74	+	50.09	5.95	3.80	4.64	7.90	8.89	9.86	1.00	1.00

Table SM2C. Results of TITAN for all genera for W1_HALL gradient. Change point (CP), frequency of observation (freq), association with decrease (-) or increase (+) along the gradient, indicator value (IndVal), z score (Z), 5%, 10%, 50%, 90% and 95%: bootstrap quantile intervals capture the true thresholds, purity (Pur) and reliability (rel).

Genera	CP	Freq.	Ass.	IndVal	Z	5%	10%	50%	90%	95%	Pur.	Rel.
Americabaetis	2.56	133	-	70.29	1.55	0.00	0.00	1.72	2.38	2.46	0.72	0.69
Apobaetis	1.40	49	+	25.56	2.42	0.13	0.48	0.90	1.44	1.91	0.92	0.89
Askola	0.00	11	-	27.69	5.61	0.00	0.00	0.13	1.71	1.77	0.70	0.88
Asthenopus	2.56	5	+	19.32	3.25	0.00	0.00	1.74	2.61	2.67	0.67	0.82
Aturbina	0.48	45	+	26.55	2.97	0.41	0.44	0.50	2.33	2.56	0.83	0.93
Baetodes	0.00	52	-	25.84	1.80	0.17	0.25	1.22	1.71	1.73	0.75	0.72
Caenis	0.00	87	-	48.18	1.42	0.00	0.13	1.21	2.34	2.45	0.34	0.66
Callibaetis	2.37	62	+	59.90	4.48	0.67	1.14	1.34	2.37	2.41	0.98	0.98
Camelobaetidius	0.00	31	-	19.58	3.08	0.00	0.00	1.00	1.28	1.71	0.97	0.97
Campsurus	1.40	4	+	2.96	0.48	0.16	0.16	0.81	1.41	1.46	0.53	0.38
Campylocia	0.00	19	-	29.65	7.89	0.00	0.00	0.14	0.69	0.70	1.00	0.99
Cloeodes	0.00	69	-	52.24	2.76	0.00	0.00	0.71	1.73	1.76	0.84	0.77
Cryptonympha	0.00	41	-	47.00	6.40	0.00	0.00	0.00	0.08	0.92	0.98	0.98
Farrodes	0.00	120	-	45.66	1.19	0.00	0.00	1.24	2.27	2.37	0.64	0.79
Hagenulopsis	2.37	42	-	22.66	2.43	0.00	0.40	0.96	1.44	1.49	0.96	0.86
Hermanella	0.00	8	-	12.78	4.48	0.00	0.00	0.03	2.06	2.55	0.89	0.91
Hydrosmilodon	0.80	19	+	14.60	1.92	0.00	0.00	0.86	2.52	2.60	0.80	0.91
Latineosus	0.00	9	-	10.28	1.43	0.00	0.00	0.67	1.00	1.69	0.85	0.63
Leptohyphes	0.67	34	+	23.00	3.13	0.49	0.58	0.67	0.98	1.29	0.90	0.93
Leptohyphodes	0.00	5	-	11.61	6.43	0.00	0.00	0.20	0.39	0.67	1.00	0.96
Massartella	1.66	13	-	9.15	1.42	0.14	0.23	0.69	1.66	1.69	0.86	0.65
Miroculis	0.00	63	-	62.82	7.04	0.00	0.00	0.13	0.89	0.96	1.00	0.99
Paracloeodes	0.00	67	-	69.98	4.53	0.00	0.00	1.44	1.76	1.77	0.84	0.89
Paramaka	0.00	4	-	9.11	4.43	0.00	0.00	0.00	0.74	1.02	0.92	0.71
Rivudiva	0.00	9	-	35.26	5.66	0.00	0.00	0.80	0.98	1.37	0.55	0.76
Simothraulopsis	2.56	10	+	10.65	3.58	0.10	0.10	1.38	2.58	2.64	0.70	0.95
Terpides	0.00	27	+	14.80	1.45	0.03	0.29	0.67	2.10	2.15	0.60	0.61
Thraulodes	0.00	64	-	30.72	2.12	0.16	0.23	1.27	2.33	2.37	0.77	0.77
Traverhyphes	0.85	120	-	53.52	2.48	0.08	0.49	0.83	1.57	1.73	0.93	0.88
Tricorythodes	1.91	59	-	31.00	1.80	0.33	0.36	0.79	1.75	1.77	0.45	0.92
Tricorythopsis	0.33	58	-	40.19	5.41	0.06	0.12	0.74	1.26	1.28	1.00	1.00
Ulmeritoides	0.00	57	-	25.96	1.42	0.00	0.00	0.61	1.49	2.33	0.60	0.67
Waltzoyphius	1.42	64	+	40.67	3.96	0.23	0.25	1.26	1.52	1.73	1.00	1.00
Zelusia	0.67	74	+	45.12	5.40	0.47	0.50	0.67	0.72	0.76	1.00	1.00

Table SM2D. Results of TITAN for all genera for XEMBED gradient. Change point (CP), frequency of observation (freq), association with decrease (-) or increase (+) along the gradient, indicator value (IndVal), z score (Z), 5%, 10%, 50%, 90% and 95%: bootstrap quantile intervals capture the true thresholds, purity (Pur) and reliability (rel).

Genera	CP	Freq.	Ass.	IndVal	Z	5%	10%	50%	90%	95%	Pur.	Rel.
Americabaetis	94.45	133	-	59.34	3.27	10.34	30.82	54.36	94.27	94.45	0.95	0.91
Apobaetis	11.38	49	-	26.65	0.93	26.14	36.61	77.91	89.71	92.91	0.61	0.46
Askola	6.33	11	+	7.01	1.44	6.33	6.33	57.69	94.57	96.82	0.67	0.71
Asthenopus	81.82	5	+	7.00	2.68	32.89	53.17	80.37	81.82	82.45	0.74	0.56
Aturbina	11.38	45	-	24.58	0.50	13.38	15.77	53.15	89.34	90.98	0.48	0.60
Baetodes	49.13	52	-	39.66	5.22	43.55	47.73	56.82	63.09	63.64	1.00	1.00
Caenis	96.97	87	-	34.73	1.65	32.48	34.82	54.64	86.82	89.52	0.67	0.74
Callibaetis	13.74	62	+	36.13	1.37	16.05	22.63	69.45	93.21	97.71	0.64	0.84
Camelobaetidius	55.73	31	-	22.68	3.87	25.83	26.55	55.82	70.87	76.97	0.99	0.98
Campsurus	96.97	4	+	9.49	5.57	36.42	76.53	83.89	96.19	96.97	0.93	0.92
Campylocia	6.33	19	-	20.09	5.48	7.67	16.06	35.44	63.00	63.09	1.00	1.00
Cloeodes	57.74	69	-	48.88	6.04	40.36	40.89	55.59	58.69	62.55	1.00	1.00
Cryptonympha	6.33	41	-	76.76	7.41	3.33	5.00	13.74	51.56	69.21	1.00	1.00
Farrodes	81.55	120	-	62.34	5.05	35.41	46.52	76.97	81.55	81.64	1.00	1.00
Hagenulopsis	54.36	42	-	28.40	5.17	47.45	51.52	58.59	66.93	76.64	1.00	0.99
Hermanella	6.33	8	-	7.78	2.60	3.33	5.00	51.55	62.09	62.84	0.98	0.84
Hydrosmilodon	55.73	19	-	14.29	1.97	40.35	41.07	55.73	71.98	72.18	0.80	0.82
Latineosus	13.38	9	-	6.87	1.32	13.38	13.38	47.45	71.45	72.37	0.74	0.54
Leptohyphes	81.55	34	-	21.51	2.66	34.41	45.36	64.27	77.91	81.64	0.92	0.94
Leptohyphodes	6.33	5	-	38.45	7.13	6.33	6.33	11.38	59.15	63.00	0.85	0.78
Massartella	26.14	13	-	7.55	1.01	28.17	34.41	57.66	72.41	76.33	0.76	0.58
Miroculis	16.14	63	-	45.40	5.62	16.06	16.14	36.71	54.55	63.00	1.00	1.00
Paracloeodes	6.33	67	-	36.53	2.99	7.65	13.74	73.16	78.00	79.10	0.96	0.94
Paramaka	62.78	4	-	4.12	1.67	40.90	49.13	55.82	63.00	63.09	0.93	0.43
Rivudiva	55.14	9	+	8.65	3.20	53.09	53.82	55.14	68.32	75.28	0.99	0.87
Simothraulopsis	19.73	10	+	9.69	1.81	19.73	19.73	61.36	81.82	82.20	0.42	0.82
Terpides	82.82	27	-	17.53	1.41	16.61	22.84	40.23	74.73	81.46	0.58	0.67
Thraulodes	76.64	64	-	38.87	4.02	56.18	59.15	66.93	76.73	77.28	1.00	1.00
Traverhyphes	86.82	120	-	61.26	4.44	43.73	53.78	66.01	77.57	82.18	1.00	1.00
Tricorythodes	13.38	59	+	33.62	2.60	36.42	36.69	43.55	70.85	72.37	0.87	0.95
Tricorythopsis	18.95	58	-	38.24	5.32	16.14	17.58	62.91	64.48	65.00	1.00	1.00
Ulmeritoides	11.38	57	-	30.33	1.56	22.00	36.30	67.36	84.04	87.27	0.61	0.69
Waltzoyphius	11.38	64	+	31.45	1.66	18.34	34.82	63.64	89.34	92.91	0.88	0.76
Zelusia	11.38	74	-	36.23	1.98	13.36	13.38	36.60	75.00	76.73	0.47	0.61

Table SM2E. Results of TITAN for all genera for dissolved oxygen (mg.L^{-1}) gradient. Change point (CP), frequency of observation (freq), association with decrease (-) or increase (+) along the gradient, indicator value (IndVal), z score (Z), 5%, 10%, 50%, 90% and 95%: bootstrap quantile intervals capture the true thresholds, purity (Pur) and reliability (rel).

Genera	CP	freq.	Ass.	IndVal	Z	5%	10%	50%	90%	95%	Pur.	Rel.
Americabaetis	4.00	133	+	77.78	2.12	4.30	4.70	6.15	6.75	8.40	0.55	0.27
Apobaetis	5.95	49	-	52.00	5.49	4.65	5.70	5.95	8.30	10.25	0.87	0.98
Askola	6.40	11	-	11.68	1.92	6.30	6.40	7.20	9.15	9.20	0.79	0.73
Asthenopus	4.00	5	-	10.43	3.71	2.80	3.55	6.50	10.20	10.55	0.64	0.90
Aturbina	5.95	45	-	26.33	1.47	4.14	4.65	6.35	9.31	10.10	0.65	0.71
Baetodes	10.65	52	+	31.73	3.67	7.35	7.60	7.80	10.65	10.78	0.98	0.97
Caenis	6.40	87	-	63.23	5.09	6.10	6.25	6.60	7.30	7.41	0.98	0.99
Callibaetis	6.10	62	-	67.98	7.54	5.95	6.10	6.35	8.81	9.75	0.86	1.00
Camelobaetidius	10.65	31	+	18.58	2.91	7.15	7.20	8.00	10.65	10.70	0.98	0.95
Campsurus	4.65	4	-	8.14	4.46	4.65	4.90	7.00	10.15	10.25	0.84	0.88
Campylocia	10.70	19	+	11.22	1.91	6.40	7.40	7.60	9.75	9.90	0.76	0.76
Cloeodes	5.75	69	-	45.89	3.00	5.75	5.75	7.10	9.75	10.10	0.55	0.89
Cryptonympha	9.45	41	-	24.49	1.88	6.60	6.70	8.70	9.50	9.60	0.56	0.77
Farrodes	4.00	120	-	50.96	1.35	5.30	6.00	7.60	10.10	10.15	0.40	0.76
Hagenulopsis	6.15	42	+	21.24	2.56	6.90	7.25	7.75	9.45	10.00	0.77	0.86
Hermanella	10.65	8	+	10.75	2.64	7.30	7.50	10.40	11.01	11.50	0.56	0.87
Hydrosmilodon	8.25	19	+	13.12	1.39	4.25	5.05	8.30	10.40	10.65	0.79	0.72
Latineosus	10.10	9	+	8.29	1.43	5.60	5.70	8.30	10.05	10.10	0.75	0.63
Leptohyphes	11.60	34	+	20.26	2.10	6.85	7.39	8.25	11.61	11.85	0.94	0.89
Leptohyphodes	8.00	5	-	5.32	2.45	6.40	6.60	7.80	8.10	8.10	0.96	0.68
Massartella	6.40	13	-	24.67	6.54	6.20	6.25	6.50	8.01	9.25	0.89	0.96
Miroculis	4.00	63	-	49.45	1.82	3.80	4.00	6.70	9.20	9.90	0.64	0.73
Paracloeodes	4.00	67	+	29.94	1.96	6.25	6.40	8.20	8.72	9.90	0.82	0.79
Paramaka	10.65	4	+	7.34	2.02	7.30	7.65	10.25	10.65	10.70	0.74	0.42
Rivudiva	5.60	9	+	7.89	0.81	5.60	5.60	8.25	10.20	11.00	0.63	0.68
Simothraulopsis	4.65	10	-	20.18	5.81	3.80	4.65	6.20	7.91	9.00	0.89	0.92
Terpides	13.10	27	-	14.83	1.94	6.95	7.00	8.40	13.10	15.15	0.46	0.85
Thraulodes	5.05	64	+	35.32	3.75	7.60	7.70	8.00	8.70	8.95	0.99	0.97
Traverhyphes	9.35	120	+	57.13	3.36	7.15	7.20	8.40	9.90	9.90	0.98	0.97
Tricorythodes	7.10	59	+	32.55	2.31	4.70	6.80	7.20	10.10	10.20	0.89	0.89
Tricorythopsis	7.00	58	+	34.04	3.89	6.90	6.95	7.30	8.40	8.50	0.96	1.00
Ulmeritoides	6.40	57	-	44.18	3.99	4.65	5.75	6.50	8.30	9.81	0.94	0.91
Waltzoyphius	13.10	64	-	52.47	3.52	4.65	4.65	7.50	14.80	15.15	0.57	0.92
Zelusia	13.10	74	-	36.40	2.57	7.55	8.00	8.60	15.15	15.15	0.58	0.96

Table SM2F. Results of TITAN for all genera for pH gradient. Change point (CP), frequency of observation (freq), association with decrease (-) or increase (+) along the gradient, indicator value (IndVal), z score (Z), 5%, 10%, 50%, 90% and 95%: bootstrap quantile intervals capture the true thresholds, purity (Pur) and reliability (rel).

Genera	CP	freq.	Ass.	IndVal	Z	5%	10%	50%	90%	95%	Pur.	Rel.
Americabaetis	5.55	133	+	76.63	2.06	5.54	5.55	6.67	7.93	8.25	0.51	0.88
Apobaetis	6.34	49	-	22.46	1.16	6.06	6.31	7.20	7.80	7.96	0.44	0.66
Askola	6.06	11	-	20.27	6.43	6.01	6.06	6.31	6.63	6.68	0.99	0.99
Asthenopus	7.20	5	+	5.56	2.66	7.11	7.12	7.29	7.70	8.05	0.98	0.71
Aturbina	8.60	45	-	23.07	2.18	6.51	7.10	7.50	7.60	7.65	0.60	0.87
Baetodes	7.80	52	-	31.76	2.31	6.31	6.50	7.43	7.86	7.87	0.95	0.91
Caenis	8.60	87	+	32.59	0.81	5.62	6.25	7.10	8.10	8.35	0.64	0.77
Callibaetis	7.27	62	+	39.30	6.17	6.77	7.10	7.28	7.50	7.60	1.00	1.00
Camelobaetidius	6.06	31	-	19.14	0.98	6.56	6.60	7.41	8.01	8.10	0.62	0.50
Campsurus	7.30	4	+	5.06	2.87	7.26	7.26	7.30	7.50	7.50	0.98	0.66
Campylocia	5.64	19	-	29.50	4.93	5.32	5.44	5.82	6.87	7.98	0.90	0.93
Cloeodes	8.60	69	+	34.08	2.26	7.10	7.11	7.57	8.03	8.30	0.90	0.83
Cryptonympha	8.25	41	-	21.80	1.74	5.74	5.80	7.36	7.60	7.62	0.86	0.77
Farrodes	5.55	120	-	49.25	2.27	5.64	6.17	7.60	7.69	8.08	0.78	0.83
Hagenulopsis	5.74	42	-	28.17	3.62	5.42	5.70	6.52	7.57	7.86	0.87	0.94
Hermanella	6.46	8	-	5.79	1.22	6.46	6.47	6.86	7.69	8.04	0.71	0.61
Hydrosmilodon	8.45	19	+	19.16	1.65	6.59	6.80	8.35	8.60	8.80	0.93	0.77
Latineosus	6.43	9	-	5.33	0.81	6.61	6.78	7.26	8.10	8.30	0.57	0.38
Leptohyphes	6.18	34	-	19.10	1.56	5.82	6.15	6.80	7.60	8.51	0.74	0.71
Leptohyphodes	6.06	5	-	11.50	3.72	5.82	5.90	6.20	8.00	8.01	0.77	0.76
Massartella	8.50	13	+	16.91	3.30	5.80	5.84	6.84	8.41	8.50	0.49	0.97
Miroculis	5.55	63	-	35.05	1.21	5.55	5.70	6.85	7.80	8.01	0.82	0.82
Paracloeodes	5.64	67	+	32.63	1.15	6.25	6.43	6.94	8.35	8.35	0.61	0.84
Paramaka	6.14	4	-	3.68	0.20	6.14	6.16	7.03	7.67	7.69	0.65	0.46
Rivudiva	6.83	9	-	7.92	2.88	6.70	6.80	6.88	7.41	7.65	0.86	0.83
Simothraulopsis	8.50	10	+	9.27	3.35	6.50	7.26	7.30	7.60	8.45	0.93	0.88
Terpides	6.06	27	+	13.22	1.21	6.50	6.51	7.23	7.63	8.03	0.52	0.78
Thraulodes	8.50	64	-	25.80	0.73	5.45	5.57	6.78	8.30	8.45	0.66	0.61
Traverhyphes	8.25	120	+	66.94	3.21	5.82	5.85	7.93	8.30	8.30	0.58	0.99
Tricorythodes	5.55	59	+	32.97	1.52	6.06	6.07	7.26	7.69	8.30	0.64	0.73
Tricorythopsis	5.80	58	-	69.54	6.77	5.44	5.64	5.80	6.39	6.90	0.98	0.99
Ulmeritoides	8.60	57	-	24.62	1.05	5.58	5.80	7.11	7.81	8.40	0.66	0.67
Waltzoyphius	8.50	64	+	30.86	1.81	5.58	5.62	7.22	8.36	8.50	0.61	0.86
Zelusia	5.64	74	-	33.39	1.92	5.61	5.64	7.50	7.70	8.35	0.85	0.84

Table SM2G. Results of TITAN for all genera for total phosphorus (mg.L^{-1}) gradient. Change point (CP), frequency of observation (freq), association with decrease (-) or increase (+) along the gradient, indicator value (IndVal), z score (Z), 5%, 10%, 50%, 90% and 95%: bootstrap quantile intervals capture the true thresholds, purity (Pur) and reliability (rel).

Genera	CP	freq.	Ass.	IndVal	Z	5%	10%	50%	90%	95%	Pur.	Rel.
Americabaetis	0.059	133	-	64.25	0.91	0.001	0.001	0.002	0.024	0.031	0.36	0.79
Apobaetis	0.001	49	+	28.59	2.39	0.001	0.001	0.006	0.027	0.052	0.80	0.77
Askola	0.001	11	-	14.57	1.91	0.001	0.001	0.001	0.019	0.020	0.65	0.67
Asthenopus	0.026	5	+	8.84	3.11	0.001	0.001	0.018	0.026	0.030	0.79	0.73
Aturbina	0.059	45	+	26.35	3.53	0.002	0.002	0.005	0.052	0.059	0.99	0.98
Baetodes	0.001	52	-	22.97	0.61	0.002	0.003	0.027	0.045	0.060	0.64	0.44
Caenis	0.001	87	+	41.78	2.25	0.001	0.002	0.007	0.027	0.035	0.84	0.74
Callibaetis	0.020	62	+	41.65	5.33	0.003	0.006	0.011	0.020	0.020	1.00	1.00
Camelobaetidius	0.016	31	-	21.80	3.11	0.003	0.004	0.009	0.017	0.020	0.99	0.99
Campsurus	0.020	4	+	10.53	6.85	0.017	0.018	0.020	0.020	0.020	0.98	0.89
Campylocia	0.001	19	-	32.56	6.39	0.001	0.001	0.001	0.008	0.020	0.97	0.92
Cloeodes	0.001	69	+	31.10	1.35	0.001	0.001	0.015	0.068	0.093	0.79	0.69
Cryptonympha	0.009	41	-	30.93	4.88	0.001	0.001	0.008	0.011	0.016	1.00	1.00
Farrodes	0.001	120	+	49.34	1.30	0.001	0.001	0.008	0.023	0.025	0.43	0.65
Hagenulopsis	0.001	42	-	27.81	2.72	0.001	0.001	0.017	0.023	0.023	0.99	0.98
Hermanella	0.001	8	-	9.30	3.51	0.001	0.001	0.007	0.009	0.009	1.00	0.97
Hydrosmilodon	0.009	19	-	13.56	1.56	0.001	0.003	0.009	0.022	0.032	0.82	0.71
Latineosus	0.002	9	+	6.43	0.88	0.003	0.004	0.009	0.025	0.027	0.30	0.59
Leptohyphes	0.020	34	-	22.31	2.27	0.002	0.002	0.011	0.020	0.021	0.97	0.93
Leptohyphodes	0.001	5	-	20.69	5.93	0.001	0.001	0.001	0.009	0.010	0.82	0.63
Massartella	0.008	13	+	9.82	2.42	0.004	0.006	0.008	0.019	0.020	0.96	0.79
Miroculis	0.001	63	-	42.56	2.17	0.001	0.003	0.011	0.059	0.102	0.80	0.85
Paracloeodes	0.001	67	-	32.17	2.09	0.001	0.002	0.007	0.022	0.022	0.87	0.83
Paramaka	0.008	4	-	4.55	2.25	0.002	0.002	0.008	0.009	0.009	0.88	0.47
Rivudiva	0.003	9	-	12.52	6.01	0.001	0.003	0.004	0.009	0.010	0.99	0.93
Simothraulopsis	0.059	10	+	36.53	5.36	0.001	0.015	0.020	0.059	0.059	0.91	0.90
Terpides	0.017	27	-	19.51	3.24	0.004	0.004	0.016	0.018	0.018	0.98	0.98
Thraulodes	0.033	64	-	37.14	1.12	0.001	0.001	0.006	0.026	0.032	0.62	0.71
Traverhyphes	0.035	120	-	63.35	1.95	0.001	0.001	0.022	0.036	0.038	0.56	0.70
Tricorythodes	0.001	59	-	34.61	3.25	0.002	0.002	0.012	0.018	0.019	0.87	0.99
Tricorythopsis	0.001	58	-	33.08	3.87	0.001	0.001	0.009	0.020	0.021	1.00	1.00
Ulmeritoides	0.001	57	+	25.30	1.17	0.001	0.002	0.009	0.077	0.102	0.78	0.75
Waltzoyphius	0.059	64	+	49.65	2.42	0.002	0.005	0.011	0.059	0.061	0.90	0.89
Zelusia	0.059	74	-	35.34	1.85	0.001	0.002	0.018	0.059	0.061	0.40	0.88

Capítulo 2

Aquatic environment and terrestrial integration determines macroinvertebrate metacommunity patterns in neotropical streams

Aquatic environment and terrestrial integration determines macroinvertebrate metacommunity patterns in neotropical streams

Running title: Metacommunity patterns in neotropical streams

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Abstract:

Aim: Land use intensification affects both terrestrial and aquatic ecosystems at multiple spatial scales with well documented impacts to biodiversity. These changes can affect key ecological processes to shape regional freshwater biodiversity such as the freshwater organisms' movement through the landscape. At local scale, land use intensification results in habitat degradation leading to biological changes with a replacement of sensitive species by opportunistic, resistant taxa. Rivers and streams are interesting models to understand how local (stream sites) and regional (terrestrial landscape) factors shape regional biodiversity. Here, we used a wide variety of spatial, environmental and landscape resistance distances to explore their relative role in structuring macroinvertebrate metacommunities.

Location: 183 Brazilian headwater stream sites in the neotropical savanna.

Methods: We used multiple regression models to identify which local, network and landscape aspects are relevant to explain macroinvertebrate community dissimilarity varying dispersal ability and pollution tolerance. As predictors, we calculated five distance metrics: environmental distance describing the dissimilarity in local physical and chemical conditions, the network distance accounting for distances across the drainage system, and three distances measuring unweighted (null) and weighted landscape resistance (topographic and land use). We simultaneously classified stream macroinvertebrates according to their aerial and aquatic dispersal and water pollution tolerance, as these traits could result in different metacommunity patterns.

Results: The local environment and the land use resistance distances were the most important factors explaining community dissimilarity. Weak dispersers were mainly affected by environmental and land use distances, irrespectively of their pollution tolerance. Moderate dispersers showed different patterns depending on their pollution tolerance, whilst strong dispersers were affected by network, topographic and land use distances.

Main conclusion: Land use intensification may alter community structure not only by disturbing the aquatic environment and riparian vegetation quality but also through increased landscape resistance for flying dispersers during their aerial dispersal movements. This result reinforces the importance of considering the whole stream catchment to preserve stream health and biodiversity, and advocates for a more integrative connection between terrestrial and aquatic ecology.

Key-words: benthic macroinvertebrates, Cerrado, connectivity, cost distance, dispersal, distance-decay relationships, Euclidean distance, pollution sensitivity, river network.

1. Introduction

Healthy freshwater ecosystems provide multiple benefits to human well-being such as clean water, food and recreation, while maintaining aquatic biodiversity (Vörösmarty et al., 2010). However, the freshwater biodiversity is highly threatened by anthropogenic pressures and stressors resulting of global changes (e.g. hydrological and climate changes, land use, and invasion species) (Dudgeon et al., 2006; Larsen, Muehlbauer, & Marti, 2016). Human populations tend to disproportionality lives near to freshwater ecosystems what modifies greatly the surrounding landscape, and consequently compromises the integrity of those ecosystems (Sala et al., 2000). Land use intensification (hereafter land use) affects both terrestrial and aquatic ecosystems at multiple spatial scales with well documented impacts to biodiversity (Allan, 2004; Newbold et al., 2015). At large landscape scales, it replaces natural vegetation by human land uses such as agriculture, hydropower dams, livestock farms, and urbanization (Foley et al., 2005). These changes can affect key ecological processes to shape regional freshwater biodiversity such as the freshwater organisms' movement through the landscape (Carlson, Mckie, Sandin, & Johnson, 2016; Larsen et al., 2016). Locally, land use intensification results in habitat degradation (e.g. nutrient increase and siltation) leading to biological changes with a replacement of sensitive species by opportunistic, resistant taxa (Castro, Dolédec, & Callisto, 2018; Heino, 2013; Siqueira, Lacerda, & Saito, 2015). Thus, is key for looking for integration between freshwater and terrestrial ecosystems conservation where preserving healthy and unmodified terrestrial landscapes might also benefit aquatic biodiversity (Adams et al., 2014; Larsen et al., 2016).

Rivers and streams are environmentally heterogeneous ecosystems organized into hierarchical dendritic networks embedded into the landscape (Frissel, Liss, Warren, & Hurley, 1986). More specifically, headwater streams occupy large landscape extensions, comprising more than 60 percent of cumulative length of the drainage network (Benda, Hassan, Church, & May, 2005). These features make them interesting models to understand how ecological processes occurring on aquatic and terrestrial ecosystems shape regional biodiversity within a metacommunity framework (Brown et al., 2011). Metacommunity refers to a set of local communities connected by dispersal of multiple potentially interacting species (Leibold et al., 2004). Ecological processes occurring at local scale (abiotic factors and biotic interactions) select species, while those ones occurring at regional scale can add (dispersal) or remove (stochastic events) species from a local community shaping the regional biodiversity what over time (Vellend, 2010). Although the species sorting (i.e. species are filtered by environmental conditions, occurring only in suitable habitats) is typically reported as the most important mechanism assembling stream metacommunities, it explains only a portion of the community variance (Heino et al., 2015). It is therefore necessary to explore the stream metacommunities considering the landscape features and the ability of organisms to persist locally, and their multiple dispersal strategies (Brown et al., 2011; Cañedo-Argüelles et al., 2015; Heino et al., 2017; Kärnä et al., 2015). A set of studies have investigating the importance of local factors and dispersal along network drainage, and more recently to elevation gradients as landscape resistance (Cañedo-Argülles et al., 2015; Kärnä et al., 2015; Sarremejane et al., 2017; Tonkin et al., 2017). Other studies have found the land use reducing the flying capacity of organisms to disperse along the riparian corridors (Carlson et al., 2016; Smith, Venugopal, Baker, & Lamp, 2015; Urban, Skelly, Burchsted, Price, & Lowry, 2006; but see Petersen, Masters, Hildrew, & Ormerod, 2004). Studies investigating if land use at large landscape scales would affect the stream macroinvertebrates dispersal, however are lacking. This gap can be fulfill by the application of landscape metrics such as those based on hemerobiotic approach.

The hemeroby concept was originally proposed by Jalas (1955) to measuring the degrees of anthropogenic pressures on terrestrial vegetation. Later it was considered as unified measure of all anthropogenic pressures on ecosystem (Sukopp, 1976). Since then, the degrees of heremoby have been widely applied as landscape indicators (Fu, Hu, Chen, Honnay, & Gulinck, 2006; Hill, Roy, Thompson, 2002; Walz & Stein, 2014). Some studies conducted in Europe have employed the degrees of hemeroby to calculating landscape metrics aiming evaluating the effects of land use on terrestrial insects, (Cotes, Campos, Garc, Pascual, & Ruano, 2011), birds (Battisti & Fanelli, 2016), and mammals communities (Battisti, Fanelli, Mariani, & Capizzi, 2017). As far as we known, no study conducted in freshwater ecosystems applied the degrees of hemeroby to evaluate if human alterations on landscape would affect the movements of macroinvertebrates througt overland. The land use tends to remove the natural vetegation creating open landscapes. It is reasonable hypothetize that wind flow would is an important dispersal vector on those landscapes (Heino et al., 2017). Other studies, however have demonstrated that human land uses tends to maintaining winged adult insects close to stream course (Petersen, et al., 2004; Carlson et al., 2016; Urban et al., 2006). Thus, is not clear yet how land use observed at large landscape scales could affetc macroinvertebrate community dissimilarity between streams.

Here, we used a wide variety of spatial, environmental and landscape resistance distances to explore their relative role in structuring macroinvertebrate metacommunities (Table 1). Stream macroinvertebrates are adequate models to explore metacommunity patterns due to their diversity and contrasting environment tolerance (Bonada, Prat, Resh, & Statzner, 2006; Hawkes, 1998; Smith et al., 2015; Tachet, Richoux, Bounard, & Usseglio-Polatera, 2002), and dispersal abilities (from strictly aquatic taxa, such as mollusks, to winged-taxa able to fly over hundreds of kilometers) (Bilton, Freeland, & Okamura, 2001; Poff et al., 2006; Petersen et al., 2004).

Table 1. Hypotheses and predictions according to traits related to pollution tolerance (sensitive, tolerant, tesistant) and dispersal (weak, moderate, strong) to each distance measure.

Distance	Hypothesis	Prediction by traits
Environmental	Species are filtered by environmental conditions, occurring only in suitable habitats.	sensitive > tolerant > resistant
Network	Aquatic forms disperse by downstream drift. Aerial forms disperse by upstream flight.	weak < moderate < strong weak > moderate > strong
Null	Dispersal limitation as distance increasing.	weak < moderate > strong
Topographic	Elevation acts as barrier to dispersal.	weak < moderate < strong
Land use	Dispersal decreases in landscapes altered by land use.	weak < moderate < strong

2. Material and methods

2.1. Study area

The study area is located in the Brazilian neotropical savanna, a biodiversity hotspot (Myers, Mittermeier, Mittermeier, Fonseca, & Kent, 2000) with intense land use, mainly related with agriculture expansion (Silva, Farinas, Felfili, & Klink, 2006). The Brazilian neotropical savanna presents a dry season from April to September, and a wet season from October to March, with air temperatures ranging from 22º to 27º and average annual rainfall of 1,500 mm (Klink & Machado, 2005). Although soil exhibit high acidity, high aluminum concentrations, and low nutrient concentrations, large-scale agriculture and grazing activities are established due to chemical mitigation (Strassburg et al., 2017).

Our data set comprises primary data related to local communities of stream macroinvertebrates and local environmental conditions (water quality and physical habitat variables) collected in 183 neotropical headwater streams sites (1^{st} to 3^{rd} orders; Strahler, 1957) (Appendix S1: table S1). Sites were located in four hydrologic units (hereafter: HU; *sensu* Seaber, Kapinos, & Knapp, 1987) (Três Marias HU: n = 40; Volta Grande HU: n = 40, São Simão HU: n = 39, Nova Ponte HU: n = 64) covering a gradient of land use represented by degrees of hemeroby (Figure 1). The stream site elevation range in each HU were comparable (Três Marias HU: 231 m; Volta Grande HU: 258 m, São Simão HU: 296 m, Nova Ponte HU: 428 m). In each HU a spatially balanced probabilistic survey (Stevens & Olsen, 2004) combined with handpicked least- and most- disturbed sites procedure was done to ensure that the regional variability would be well-represented (Silva, Herlihy, Hughes, & Callisto, 2017).

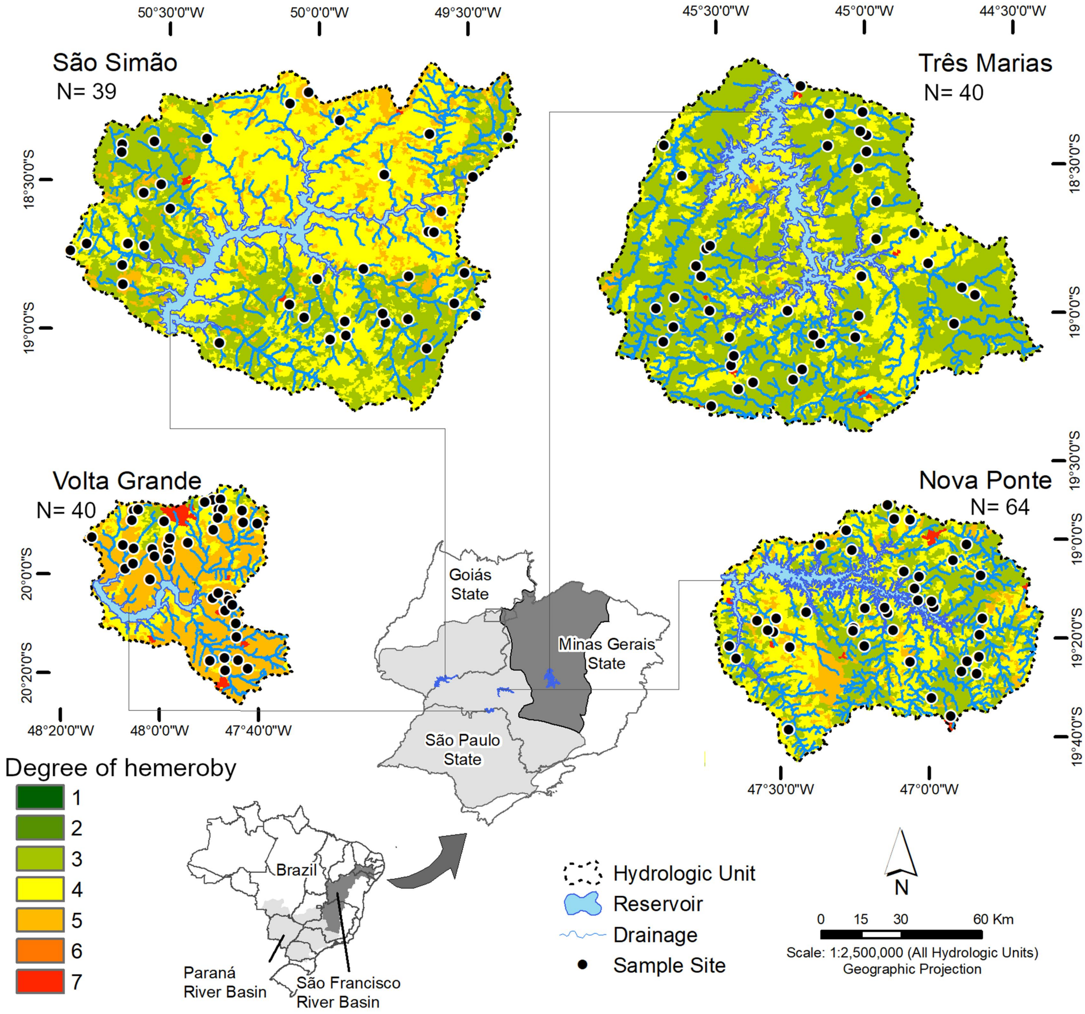

Figure 1. Stream site locations in the four hydrologic units in the neotropical savanna (N = 183). The colors green, yellow, orange to red represent the assignment of Brazilian land use and land cover map based on IBGE (2015) to degree of hemeroby described in Walz & Stein (2014): (1) *almost no human impacts*: naturally discovered areas; (2) *weak human impacts*: forest, palm swamps; (3) *moderate human impacts*: forest with significant agriculture areas, *Eucalyptus* afforestation, grassland; (4) *moderate-strong human impacts*: grassland with significant agriculture areas, pasture, agriculture with significant forest areas, reservoirs; (5) *strong human impacts*: intensive agriculture areas; (6) *very strong human impacts*: not identified in the study area; (7) *excessively strong human impacts*: urban areas (For more information, see Appendix S1, Table S7).

2.2. Sampling sites

The sampling was conducted in September from 2010 to 2013, one year for each aforementioned HU, collecting one sample per site during the low flow season (Paulsen et al., 2008). Macroinvertebrates were collected using a D-net in a multi-habitat composite sample representing all micro-habitats. Samples were fixed in the field with 10 % formalin, and brought to laboratory, where macroinvertebrates were sorted and identified at family (except to non-insect taxa: Bivalvia, Decapoda, Nematoda, and Oligochaeta) and genus (Ephemeroptera, Plecoptera and Trichoptera, EPT) levels.

In each site, electrical conductivity (µS cm^{-1}), pH and total dissolved solids (mg L^{-1}) were measured using a YSI multi-probe. Dissolved oxygen (mg L^{-1}), turbidity (nephelometric turbidity unit - NTU), and total phosphorus and nitrogen (mg L^{-1}) were measured in the laboratory following Standard Methods (APHA, 2005). Physical habitat structure was assessed following standardized field protocols (Kaufmann, Levine, Robison, Seelige, & Peck, 1999; Peck et al., 2006) and included information on channel morphology, riparian structure, flow type, substrate type, describing both natural variability as anthropogenic stressors. The metrics related to physical habitat structure were calculated following (Kaufmann, Larsen, & Faustini, 2009; Kaufmann, Levine, Robison, Seeliger, & Peck, 1999). A previously selected set of metrics were used after removing redundant metrics, and disentangling natural variability through correlation and principal component analysis, and ordinary least square regression (Ferreira et al., 2014; Firmiano et al., 2017). Further data acquisition details can be found elsewhere (Silva et al., 2017; Castro et al., 2018).

2.3. Ecological and biological trait data

To characterize the pollution tolerance and dispersal ability of each taxa, we compiled ecological and biological traits related to organic pollution tolerance, drift propensity and flight ability based on literature, existing databases and knowledge from different experts (see Appendix S2 – Data sources). Following this procedure, we classified a total of six non-insect taxa, 88 families (comprising all insect taxa), and 82 genera (belonging to 21 EPT families) (Appendix S1, Tables S4 and S5). We used the scores of the Biological Monitoring Working Party (BMWP; Hawkes, 1998) for neotropical regions (Brazil: Junqueira & Campos, 1998, and Ecuador: Acosta, Ríos, Rieradevall, & Prat, 2009). The BMWP scores range from 1 to 10, wherein high scores indicate high sensitivity to organic pollution and low scores indicate high tolerance. We used the drift propensity index proposed by Rader (1997) as a surrogate of downstream dispersal of aquatic forms. This index is based upon several organism characteristics describing propensity to intentional drift, abundance or benthic exposure, among others. The index ranging from 1, indicating weak drift propensity up to 80, indicating strong drift propensity. We placed each macroinvertebrate taxa into one of four categories representing maximum distance that a flying insect could potentially reach by directional flight: non-flying, weak, moderate, and strong dispersers. No insects taxa comprised non-flying organisms (e.g. Mollusca, and Crustacea), weak dispersers comprised insects taxa able to fly up to 1 km (e.g. Ephemeroptera and Plecoptera), moderate to those ones ranging from > 1 to 20 km (e.g. Coleoptera and Trichoptera), and strong dispersers to those ones over 20 km (e.g. some

Hemiptera and Odonata). We derived those categories since that no standardized information of direct measurements exists for all macroinvertebrates (i.e. using mark-recapture, molecular or isotopic techniques; Heino et al., 2017; Heino & Peckarsky, 2014). For EPT taxa at genus level, we assigned the family-level biological group.

2.4. Environmental, network and landscape resistance distance matrices

We calculated five distance metrics (Figure 2): one was related with the local environmental conditions (environmental distance), one was related with the network drainage (network distance), and three were related with the landscape resistance to dispersal (topographic, land use and null distances). Our pre-analysis identified mean wetted channel width (m), (a variable related to natural variability), riparian vegetation condition index (RCOND) (evidence of streamside human activities and the cover and structure of riparian vegetation) (Kaufmann, Faustini, Larsen, & Shirazi, 2008; Kaufmann et al., 1999), and increase of fine sediments on streambed (lsubd-mm: $\log_{10}$[geometric mean diameter]) (Kaufmann et al., 2009) as the most important abiotic variables related to stream site family and genus richness (See Appendix S1, Exploratory analysis: Selecting environmental variables, and Table S6). Based on those variables, we calculated the environmental distance using Euclidean distance on standardized values. Our network distance refers to the least distance between sites along the stream network, which was extracted from 1:100,000 scale digital maps of the Brazilian Geographical and Statistical Institute (Macedo et al., 2014), using the Network Analyst extension in ARCGIS 10.5 (Johnston, Hoef, Krivoruchko, & Lucas, 2001). We calculated topographic, land use and null distances using cost surface analysis. Topographic distance assumes that the terrain configuration affects the dispersal of macroinvertebrates, with concave areas facilitating dispersal due to a greater availability of water bodies and wet areas (Cañedo-Argüelles et al., 2015). We hypothesized that pixels with low elevation values would facilitate, while those one with high elevation values would decrease the dispersal probability. We extracted the elevation data from Shuttle Radar Topographic Mission – SRTM (USGS, 2005). Land use distance assumes that dispersal probability would decrease with certain land uses (e.g. Carlson et al., 2016; Urban et al., 2006). We calculated the land use distance based on degrees of hemeroby described in Walz & Stein (2014) to assign a resistance value to each pixel (Figure 1; Appendix 1S, Table S7). The degrees of hemeroby varies from 1 to 7, representing from almost no human impacts such as bare rocks (1), to excessively strong human impacts such as very urbanized areas (7). We estimated the human impacts from the Brazilian land use and land cover map (IBGE, 2015). The null distance assumes that the landscape is homogeneous and does not influence dispersal. We calculated the null distance as surrogate of Euclidean distance considering all weighted pixel value = 1 (Tucker, Allendorf, Truex, & Schwartz, 2017). This procedure allowed us to avoid comparisons among highly correlated distances (Pearson's correlation > 70) (See Appendix S1, Table S8). A fisher metapopulation (*Pekania pennanti)* study derived a null resistance model as surrogate of

Euclidean distance that improved the model's performance to evaluate the importance of landscape heterogeneity determining to sex-biased dispersal (Tucker et al., 2017). We weighed all raster files as described above, from pixel map 250 m and then we considered it as input in the CIRCUITSCAPE programing (McRae, 2006). CIRCUITSCAPE is based on the electronic circuit theory to estimate effective resistance landscape. The resistance pairwise values refer to sum of resistances of individual pixels considering all possible pathways connecting between communities.

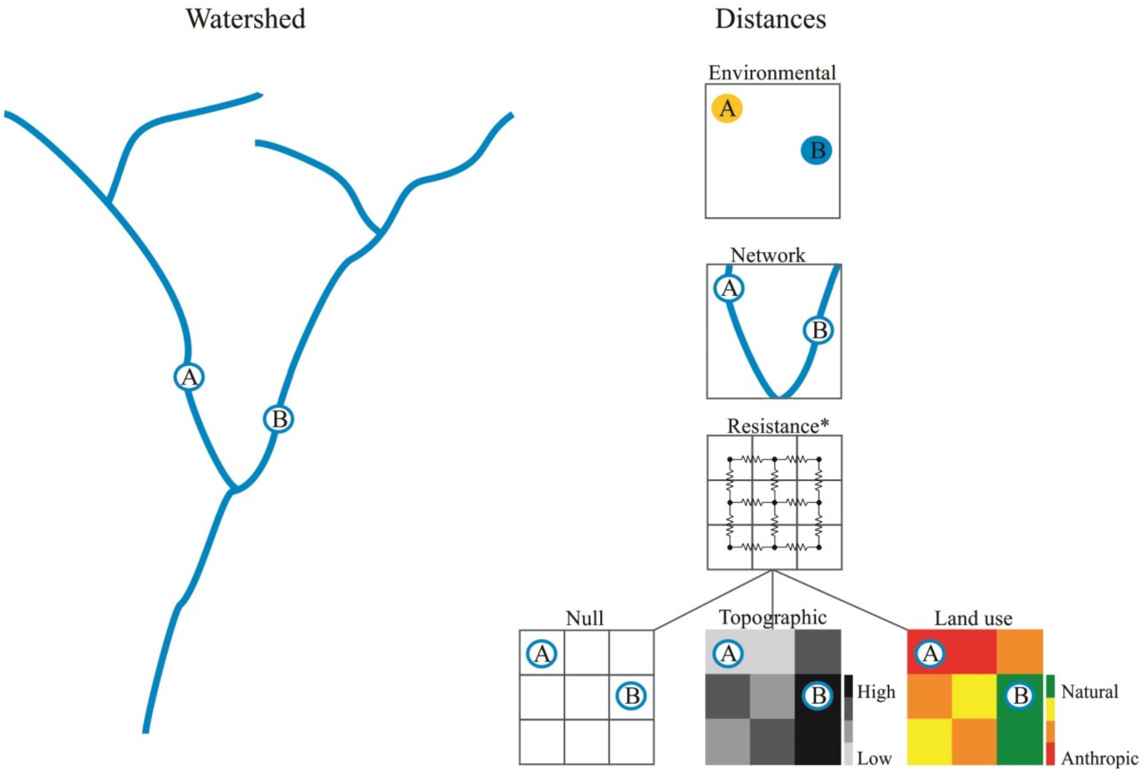

Figure 2. Details of the five distance metrics used in this study. For simplicity only one pairwise comparison is shown (distances between sites A and B, boxes on right side). *Environmental distance:* dissimilarity between two sites was based on a set of local water quality and physical habitat variables. *Network distance:* least-cost path between each pair of sites along the network drainage. Only one pathway exists between a given pair of sites. For the resistance distances, raster grids were converted to electrical networks (represented by Resistance* box) where each pixel represents a cell (illustrated by black dots), with a given resistance value, and adjacent pixels are connected by resistors (McRae, Shah, & Mohapatra, 2013). *Null resistance distance*: distance between sites calculated as a minimum resistance value for all pixels (unweighted, pixel = 1). *Topographic distance:* pairwise resistances considering that the elevation gradients would affect the dispersal (elevation-weighted distance). The high resistance is represented by high elevation (dark gray pixel), and low resistance by flat terrain (light gray pixel). *Land use distance*: pairwise resistances considering the land use configuration would act as barriers to dispersal, such as urbanized areas or human altered open areas (land-use-weighted distance). The

different colors of the pixels indicate different degrees of land use, ranging from weak human impact to strong human impact when moving from green, yellow, orange and red pixels.

2.5. Statistical analysis

We simultaneously evaluated how macroinvertebrates pollution tolerance and dispersal ability would affect the metacommunity patterns based on traits compilation described before. We produced a taxon-x-taxon dissimilarity matrix based on a modified Gower index (Pavoine, Vallet, Dufour, Gachet, & Daniel, 2009), which can handle heterogeneous traits to produce a dendrogram using a Ward's clustering method. Before conduct the clustering analysis, we log transformed the drift propensity index.

We constructed abundance data matrices for each macroinvertebrate groups related to pollution tolerance and dispersal ability separately and deleted rare taxa (abundance less than 3%) to avoid potential bias in the metacommunity patterns due to the excessive number of zeros in the composition matrix (Valente-Neto, Durães, Siqueira, & Roque, 2018). We square-root-transformed abundance values before computing the Bray-Curtis dissimilarity among each pair of sites.

We considered each HU as an independent metacommunity because their drainage systems were located in different freshwater ecoregions (Abell et al., 2008), with no continental connectivity among them through the river network (i.e. it was not possible to calculate the network distance between all pair of sites).

We used multiple regression models for distance matrices (MRM) (Lichstein, 2007) to evaluate the significance and importance of each distance in explaining community dissimilarity. MRM is similar to a multiple regression but, in this case, the predictors are distance or dissimilarity matrices, and the coefficient significance was assessed by permutation tests (1000 permutations).

We also performed variance partition analysis to quantify their relative contribution to each model's explained variance. All statistical analysis were carried out using the R software (R Core Team, 2017) with the "MRM" function in the 'Ecodist' (Goslee & Urban, 2007) and 'hier.part' packages (Walsh & Nally, 2013).

3. Results

3.1. Macroinvertebrate clustering based on pollution tolerance and dispersal ability traits

Our hierarchical clustering analysis identified five macroinvertebrate groups that yielded the most coherent aggregation for the studied taxa (Figure 3) (See also Appendix S1: Tables

S2-S5, Figure S1). Macroinvertebrates considered as *sensitive to pollution and weak dispersers* included taxa with low flight ability and drift propensity (mainly Ephemeroptera and all Plecoptera). *Sensitive to pollution and moderate dispersers* included aerial forms with moderate flight ability and aquatic forms with high drift propensity (mainly Trichoptera). *Tolerant to pollution and strong dispersers* included aerial forms with very high flight ability but aquatic forms with low drift propensity (Odonata and large Heteroptera). *Resistant to pollution and moderate dispersers* included aerial forms with moderate flight ability and aquatic forms with low drift propensity (mainly Diptera, some Coleoptera and small Hemiptera). *Resistant to pollution and weak dispersers* included aquatic obligate taxa and taxa with low flight ability and low drift propensity (Oligochaeta, Mollusca and some Ephemeroptera).

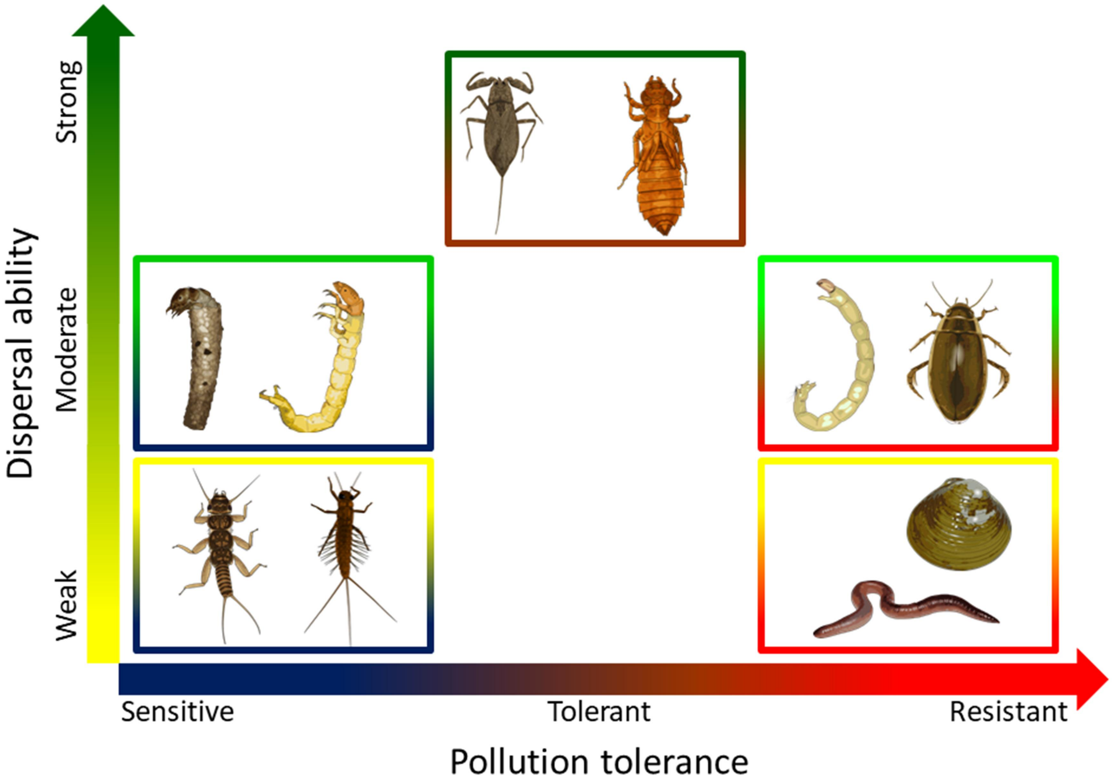

Figure 3. Plot showing the macroinvertebrate taxa along axes of pollution tolerance, and dispersal ability. For clarity, only some taxa are illustrated in each group. Macroinvetebrate drawings courtesy of Pau Fortuño.

3.2. Contribution of environmental, network and landscape resistance distances to biological dissimilarity

For all groups we found at least one distance being significantly linked (pseudo-p < 0.05) with taxonomic dissimilarity (Table 2, Appendix S1: Figure S2). Environmental and land use distances explained large variation on community dissimilarity of four of five macroinvertebrate groups related to traits of pollution tolerance and dispersal ability simultaneously. In addition, the network distance was important to macroinvertebrate taxa sensitive to pollution and with moderate dispersal ability and those tolerant to pollution and with strong dispersal ability.

Table 2. Results of the multiple regression models (MRM) relating biological dissimilarity for each group of macroinvertebrates considering traits of pollution tolerance and dispersal ability simultaneously to environmental (ENV), network (NET), null (NULL), topographic (TOP), and land use (LAND) distances. The intercepts, slopes, significance, *F*-values and R^2 of the MRM are also shown for each group. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

					Resistance distances				
Pollution tolerance	Dispersal ability	Intercept	ENV	NET	NULL	TOP	LAND	F	R^2
Sensitive	Weak	0.789**	0.036***	0.003	-0.009	0.018	0.055*	78.574	0.085
Sensitive	Moderate	0.808	0.026***	0.028**	-0.041	0.001	0.062***	64.327	0.070
Tolerant	Strong	0.583	0.012	0.034*	-0.088*	0.029	0.062*	63.529	0.069
Resistant	Moderate	0.481	0.027***	0.006	-0.02	0.001	0.023	47.225	0.052
Resistant	Weak	0.634	0.028***	-0.003	-0.021	0.014	0.036*	56.785	0.062

3.3. Relative contribution of each distance to each model overall explained variance

Overall, environmental and land use distances were the most explanatory distances explaining community dissimilarity (Figure 4), while the null distance showed a poor explanatory capacity (4% – 12%). Environmental distance was the most important distance for macroinvertebrate taxa resistant to pollution and ranging from moderate (76%) to weak dispersers (56%), and also those ones sensitive to pollution and weak dispersers (40%). Topographic distance was the most explanatory distance for macroinvertebrate taxa tolerant to pollution and strong dispersers (34%), along with network (25%) and land use distance (24 %). Land use (45%), environmental (26%), and network (17%) were the most important distances explaining the macroinvertebrate taxa dissimilarities with sensitive to pollution and moderate dispersers.

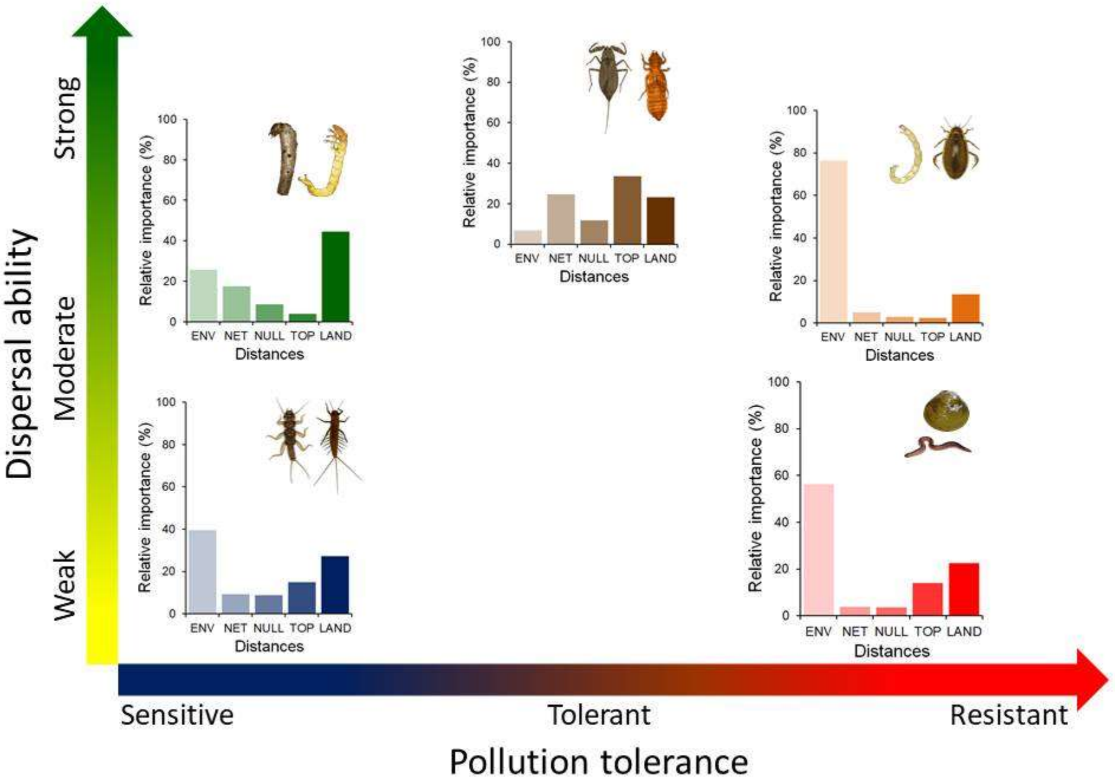

Figure 4. Relative contribution to overall explained variance to environmental (ENV), network (NET), null (NULL), topographic (TOP), and land use (LAND) distances shown for each group of macroinvertebrates considering traits of pollution tolerance and dispersal ability simultaneously.

4. Discussion

We used a wide variety of spatial, environmental and landscape resistance distances to explore their relative role in structuring stream macroinvertebrate metacommunities. For did this we classified all macroinvertebrate taxa according their pollution tolerance and dispersal traits. we demonstrated how land use intensification affected environmental filtering and dispersal limitation, key ecological processes to shaping regional biodiversity.

Importance of local environmental conditions

As we expected the environmental distance explained the dissimilarity patterns of macroinvertebrate taxa sensitive to pollution, and also to those ones resistant (in the end of pollution tolerance gradient), however it was not related to any tolerant taxa. All sensitive and resistant taxa displayed dispersal ability ranging from weak to moderate disperses, while all tolerant taxa were strong dispersers. We corroborated other studies showing the importance of species sorting explaining the community composition variation (Brown & Swan, 2010; Cañedo-

Argüelles et al., 2015; Heino et al., 2015; Kärnä et al., 2015; Sarremejane et al., 2017). Our study area covered a very wide range of environmental and habitat conditions being reflecting both natural variability as anthropogenic stressors effects (Castro et al., 2018; Firmiano et al., 2017; Silva et al., 2017). It suggests that environmental conditions modulated by effects of anthropogenic stressors acted as local habitat filters driving sensitive and resistant taxa (Smith et al., 2015), and due to with limited dispersal ability they are under more effect of environmental filtering (Heino, 2013). Instead, the community dissimilarity of tolerant taxa not showed significant environmental response probably because they can to track environmental gradient along the large landscape scales (Bonada, Dolédec, & Statzner, 2012; Leibold et al., 2004). In this way, features on landscape levels exert more effect on community dissimilarity of strong dispersers as demonstrated in this study as well as in other studies (De Marco et al., 2015; Urban et al., 2006).

Effects of land use intensification and network drainage

The land use distance was negatively correlated with community dissimilarity of majority of macroinvertebrate taxa (except to those ones tolerant to pollution and moderate dispersers) corroborating our hypothesis. In fact, some studies have shown that land use between streams determining community variation (Smith et al., 2015; Urban et al., 2006). An applausive reason for this is land use tends to increase the strength of stochastic events influencing the organisms' dispersal movements regardless their dispersal ability (Carlson et al., 2016). Open areas imposes ecological and physiological restrictions to winged adult insects dispersal far away from stream course such as predator exposure, high air temperature and low humidity, discouraging the organisms dispersal far away from stream course (Trichoptera and Chironomidae: Carlson et al. [2016]; Odonata Zygoptera sub-order: De Marco et al. [2015]). We applied the degrees of hemeroby, a simple and easy replicable concept which has already been used to measuring the land use intensification on terrestrial organisms (Battisti & Fanelli, 2016; Battisti et al., 2017; Cotes et al., 2011). We shows that the hemeroby was helpful to measuring the land use effects on organisms that depending on both terrestrial and freshwater ecosystems to complete their life circle. Thus, our finding suggests that successful conservation planning aiming to maintaining regional biodiversity of stream macroinvertebrates need looking forward terrestrial and freshwater ecosystems integration (Adams et al., 2014; Larsen et al., 2016).

The network distance explained the community dissimilarity of macroinvertebrate taxa ranging from moderate to strong dispersers, but not to weak dispersers as we expected. The stream network has been recognized as a preferential dispersal route for winged adults of aquatic insects (Brown & Swan, 2010; Petersen et al., 2004). This could be related to female adults follow the stream course to search upstream oviposition sites, and compensate larval drift downstream (Bilton et al., 2000; Rader, 1997). Our results are in concordance with others studies conducting in streams surrounding by human land uses. Adults of Trichoptera (sensitive to pollution and moderate disperser) and Odonata belonging Zigoptera sub-order (tolerant to pollution and strong disperser) were mainly catch in riparian zone close to streambed (Carlson et al., 2016; De Marco et al., 2015). This finds demonstrate the importance of riparian vegetation acting as buffering zone to overland organisms' movement along stream course.

Other distances

We found no evidence of significant community dissimilarity along the null distance, contradicting our initial expectation. We applied it in here as a surrogate of Euclidean distance aiming avoids multicoliniarity with other distances (Tucker et al., 2017). Considering this approach, this is rather surprising, as the Euclidean distance has been shown to be significantly related with macroinvertebrate community dissimilarity in arid (Cañedo-Argüelles et al., 2015), neotropical (Saito, Soininen, Fonseca-Gessner, & Siqueira, 2015) and Himalayan streams (Tonkin et al., 2017). However, our results align with other studies conducted along large geographical scales demonstrating that the Euclidean (in our case, null distance) is a purely spatial distance and, when compared with other factors that are spatially correlated, it can be a poor predictor of community dissimilarity (Bonada et al., 2012; Heino et al., 2017; Soininen, McDonald, & Hillebrand, 2007; Smith et al., 2015). Thus, the importance of other spatial distances in our study (i.e. network distance and land use resistance) could have lowered the importance of the null distance.

Also contradicting our expectation, the topographic distance was not related to dissimilarity to any macroinvertabrate dispersal ability group in the MRM models. However, when we analyzed the explained variance of each distance separately, it was best explaining the dissimilarity of strong dispersers. Other studies conducted in landscape without significant land use, demonstrated that topography was important for metacommunity patterns (Cañedo-Argüelles et al., 2015; Kärnä et al., 2015; Sarremejane et al., 2017; Tonkin et al., 2017). In another hand, our study area was located in a landscape without large topographical variation, allowing intensive land use activities, such as large-scale mechanized agriculture (Klink & Machado, 2005; Strassburg et al., 2017). Thus, our results suggest that in human altered landscapes, the effects of topography can be of low importance for stream community variation.

Our study has two limitations. First, we could not incorporate the sensitivity of adult insects in the degradation of the terrestrial ecosystems due to lack of information. Future studies can investigate if other adult aquatic insects exhibit traits allowing testing hypotheses relating physiological demand and terrestrial environment, expanding in this way, the bioindicador potential of other macroinvertebrates as for Odonata (De Marco Jr. et al., 2015). Second, our MRM results had low power explanation (R^2) requiring a caution interpreting the results. However, when analyzing the contribution of each distance explaining the community variation independently, the major conclusion that environmental filtering and dispersal limitation due to land use affecting stream macroinvertebrates was not changed as was observed in other studies (Smith et al., 2015; Urban et al., 2006).

5. Conclusions

In the present study conducted in neotropical headwater streams under a land use intensification gradient we demonstrated that aquatic environment and terrestrial connectivity explained macroinvertebrates community variation. Additionally, the network drainage also had some contribution but be more restricted to moderate and strong dispersers. This findings highlight that land uses alters terrestrial landscape and consequently the local environmental conditions, affecting in this way the stream community in multiple ways. These changes in community composition could be detected because the macroinvertebrates differed in terms of pollution tolerance and dispersal ability traits. This result reinforces the importance of considering the whole stream catchment to preserve stream health and biodiversity, and advocates for a more integrative connection between terrestrial and aquatic ecology.

Acknowledgments

We acknowledge funding from Companhia Energética de Minas Gerais (CEMIG-Programa Peixe Vivo), Pesquisa e Desenvolvimento da Agência Nacional de Energia Elétrica (P&D ANEEL-CEMIG GT-487 and GT-599). This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001, Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), and Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG). This project is also part of the outcome of the MECODISPER project (CTM2017-89295-P) funded by the Spanish "Ministerio de Economía, Industria y Competitividad – Agencia Estatal de Investigación" and cofunded by the ERDF (European Regional Development Fund). KRF received a Ph.D. scholarship from CNPq (142191/2015-9) and CAPES "Programa de doutorado sanduíche no exterior" (PDSE-88881.131740/2016-01). DRM received a UFMG research grant (PRPq-ADRC-05/2016) and CNPq research project grant 402907/2016-7. CG-C was supported by a "Juan de la Cierva" research contract (MINECO, FJCI-2015-25785). MC was awarded National Council for Scientific & Technological Development (CNPq) research productivity grants 303380/2015-2 and by Fundação de Amparo à Pesquisa do Estado de Minas Gerais grant (PPM 00104-18). We thank R. Acosta for reviewing BMWP information, A. Millán, J.A. Carbonell for reviewing Coleoptera and Hemiptera traits information, P.E.C. Peixoto for reviewing Odonata trait information.

6. References

Abell, R., Thieme, M. L., Revenga, C., Bryer, M., Kottelat, M., Bogutskaya, N., … Petry, P. (2008). Freshwater ecoregions of the world: A new map of biogeographic units for freshwater biodiversity conservation. *BioScience, 58,* 403-414.

Acosta, R., Ríos, B., Rieradevall, M., & Prat, N. (2009). Propuesta de un protocolo de evaluación de la calidad ecológica de ríos andinos (C.E.R.A.) y su aplicación a dos cuencas en Ecuador y Perú. *Limnetica, 28,* 35–64.

Adams, V. M., Alvarez-Romero, J. G., Carwardine, J., Cattarino, L., Hermoso, V., Kennard, M. J., ... Noss, R. (2014). Planning across freshwater and terrestrial realms: cobenefits and tradeoffs between conservation actions. *Conservation Letters, 7,* 425–440.

Allan, J. D. (2004). Landscapes and riverscapes: the influence of land use on stream ecosystems. *Annual Review of Ecology, Evolution, and Systematics, 35,* 257–284.

APHA. (2005). *Association, Standard Methods for the Examination of Water and Wastewater.* Washington, DC: American Public Health.

Battisti, C., & Fanelli, G. (2016). Applying indicators of disturbance from plant ecology to vertebrates: The hemeroby of bird species. *Ecological Indicators, 61,* 799–805.

Battisti, C., Fanelli, G., Mariani, L., & Capizzi, D. (2017). Assessing disturbance-sensitivity and generalism in mammals: Corroborating a hump-shaped relationship using a hemerobiotic approach. *Ecological Indicators, 76,* 178–183.

Benda, L., Hassan, M.A., Church, M., & May, C.L. (2006). Geomorpholoy of steepland headwaters: the transition from hillslopes to channels. *Journal of the American Water Resources Association, 4767*, 835–851.

Bilton, D. T., Freeland, J. R., & Okamura, B. (2001). Dispersal in Freshwater Invertebrates. *Annual Review of Ecology and Systematics, 32,* 159–181.

Bonada, N., Dolédec, S., & Statzner, B. (2012). Spatial autocorrelation patterns of stream invertebrates: Exogenous and endogenous factors. *Journal of Biogeography, 39,* 56–68.

Bonada, N., Prat, N., Resh, V. H., & Statzner, B. (2006). Developments in aquatic insect biomonitoring: a comparative analysis of recent approaches. *Annual Review of Entomology, 51,* 495–523.

Brown, B. L. & Swan, C. M. (2010). Dendritic network structure constrains metacommunity properties in riverine ecosystems. *Journal of Animal Ecology, 79,* 571–580.

Brown, B. L., Swan, C. M., Auerbach, D. A., Grant, E. H. C., Hitt, N. P., Maloney, K. O., … Hitt, N. P. (2011). Metacommunity theory as a multispecies, multiscale framework for studying the influence of river network structure on riverine communities and ecosystems. *Journal of the North American Benthological Society, 30,* 310–327.

Cañedo-Argüelles, M., Boersma, K. S., Bogan, M. T., Olden, J. D., Phillipsen, I., Schriever, T. A., & Lytle, D. A. (2015). Dispersal strength determines meta-community structure in a dendritic riverine network. *Journal of Biogeography, 42,* 778–790.

Carlson, P. E., Mckie, B. G., Sandin, L., & Johnson, R. K. (2016). Strong land-use effects on the dispersal patterns of adult stream insects: Implications for transfers of aquatic subsidies to terrestrial consumers. *Freshwater Biology, 61,* 848–861.

Castro, D., Dolédec, S., & Callisto, M. (2018). Land cover disturbance homogenizes aquatic insect functional structure in neotropical savanna streams. *Ecological Indicators, 84*, 573–582.

Cotes, B., Campos, M., Garc, P.A., Pascual, F., & Ruano, F. (2011). Testing the suitability of insect orders as indicators for olive farming systems. *Agricultural and Forest Entomology, 13,* 357–364.

De Marco Jr., P., Batista, J. D., & Cabette, H. S. R. (2015). Community Assembly of Adult Odonates in Tropical Streams: An Ecophysiological Hypothesis. *PLOS ONE, 10,* e0123023.

Dudgeon, D., Arthington, A. H., Gessner, M. O., Kawabata, Z.-I., Knowler, D. J., Lévêque, C., … Sullivan, C. A. (2006). Freshwater biodiversity: importance, threats, status and conservation challenges. *Biological reviews of the Cambridge Philosophical Society, 81,* 163–182.

Ferreira, W. R., Ligeiro, R., Macedo, D. R., Hughes, R. M., Kaufmann, P. R., Oliveira, L. G., & Callisto, M. (2014). Importance of environmental factors for the richness and distribution of benthic macroinvertebrates in tropical headwater streams. *Freshwater Science, 33,* 860–871.

Firmiano, K. R., Ligeiro, R., Macedo, D. R., Juen, L., Hughes, R. M., & Callisto, M. (2017). Mayfly bioindicator thresholds for several anthropogenic disturbances in neotropical savanna streams. *Ecological Indicators, 74,* 276–284.

Foley, J. A., Defries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., … Snyder, P. K. (2005). Global consequences of land use. *Science, 309,* 570–4.

Frissell, C. A., Liss, W. J., Warren, C. E., & Hurley, M. D. (1986). A Hierarchical framework for strearn habitat classification: viewing streams in a watershed context. *Environmental management, 10,* 199–214.

Fu, B.J., Hu, C.X., Chen, L.D., Honnay, O., & Gulinck, H. (2006). Evaluating change in agricultural landscape pattern between 1980 and 2000 in the Loess hilly region of Ansai County, China. *Agriculture, Ecosystems and Environment, 114,* 387–396.

Goslee, S. C. & Urban, D. L. (2007). The ecodist package for dissimilarity-based analysis of ecological data. *Journal of Statistical Software, 22,* 1–19.

Hawkes, H. A. (1998). Technical note origin and development of the biological monitoring working party score system. *Water Research, 32,* 964–968.

Heino, J. (2013). The importance of metacommunity ecology for environmental assessment research in the freshwater realm. *Biological Reviews, 88,* 166–178.

Heino, J., Alahuhta, J., Ala-Hulkko, T., Antikainen, H., Bini, L. M., Bonada, N., ... Soininen, J. (2017). Integrating dispersal proxies in ecological and environmental research in the freshwater realm. *Environmental Reviews, 25,* 334–349.

Heino, J., Melo, A. S., Siqueira, T., Soininen, J., Valanko, S., & Bini, L. M. (2015). Metacommunity organisation, spatial extent and dispersal in aquatic systems: patterns, processes and prospects. *Freshwater Biology, 60,* 845–869.

Heino, J. & Peckarsky, B. L. (2014). Integrating behavioral, population and large-scale approaches for understanding stream insect communities. *Current Opinion in Insect Science, 2,* 7–13.

Hill, M.O., Roy, D.B., & Thompson, K. (2002). Hemeroby, urbanity and ruderality: bioindicators of disturbance and human impact. *Journal of Applied Ecology, 39*, 708–720.

Jalas, J. (1955). Hemerobe und hemerochore Pflanzenarten. Ein terminologischerReformversuch, [Hemerobic and hemerochoric and plant species. An attempt ofa terminological reform]. *Acta Societatis pro Fauna et Flora Fennica, 72,* 1–15.

Johnston, K., Hoef, J., Krivoruchko, K., & Lucas, N. (2001). *Using ArcGIS Geostatistical Analyst*. Redlands, California.

Junqueira, V. & Campos, S. (1998). Adaptation of the “BMWP” method for water quality evaluation to Rio das Velhas watershed (Minas Gerais, Brazil). *Acta Limnologica Brasiliensia, 10,* 125–135.

Kärnä, O. M., Grönroos, M., Antikainen, H., Hjort, J., Ilmonen, J., Paasivirta, L., & Heino, J. (2015). Inferring the effects of potential dispersal routes on the metacommunity structure of stream insects: As the crow flies, as the fish swims or as the fox runs? *Journal of Animal Ecology, 84,* 1342–1353.

Kaufmann, P. R., Faustini, J. M., Larsen, D. P., & Shirazi, M. A. (2008). A roughness-corrected index of relative bed stability for regional stream surveys. *Geomorphology, 99,* 150–170.

Kaufmann, P. R., Larsen, D. P., & Faustini, J. M. (2009). Bed stability and sedimentation associated with human disturbances in Pacific Northwest streams. *Journal of the American Water Resources Association, 45,* 434–459.

Kaufmann, P. R., Levine, P., Robison, E. G., Seeliger, C., & Peck, D. V. (1999). *Quantifying physical habitat in wadeable streams. EPA/620/R-99/003.* Washington, DC: U.S. Environmental Protection Agency.

Larsen, S., Muehlbauer, J.D., & Marti, E. (2016). Resource subsidies between stream and terrestrial ecosystems under global change. *Global change biology, 22,* 2489–2504.

Klink, C. A. & Machado, R. B. (2005). Conservation of the Brazilian Cerrado. *Conservation Biology, 19,* 707–713.

Leibold, M. A., Holyoak, M., Mouquet, N., Amarasekare, P., Chase, J. M., Hoopes, M. F., … Gonzalez, A. (2004). The metacommunity concept: a framework for multi-scale community ecology. *Ecology Letters, 7,* 601–613.

Lichstein, J. W. (2007). Multiple regression on distance matrices: A multivariate spatial analysis tool. *Plant Ecology,* 188, 117–131.

Macedo, D.R., Hughes, R.M., Ligeiro, R., Ferreira, W.R., Castro, M.A., Junqueira, N.T., ... Callisto, M. (2014). The relative influence of catchment and site variables on fish and macroinvertebrate richness in cerrado biome streams. *Landscape Ecology, 29,* 1001–1016.

McRae, B. H. (2006). Isolation By Resistance. *Evolution, 60,* 1551.

McRae, B. H., Shah, V. B., & Mohapatra, T. K. (2013). *Circuitscape 4 User Guide.* The Nature Conservancy. http://www.circuitscape.org.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., Fonseca, G. A. B., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature, 403,* 853–858.

Newbold, T., Hudson, L. N., Hill, S. L. L., Contu, S., Lysenko, I., Senior, R. A., … Purvis, A. (2015). Global effects of land use on local terrestrial biodiversity. *Nature, 520,* 45–50.

Paulsen, S. G., Mayio, A., Peck, D. V, Stoddard, J. L., Tarquinio, E., Holdsworth, S. M., … Olsen, A. R. (2008). Condition of stream ecosystems in the US: an overview of the first national assessment. *Journal of the North American Benthological Society, 27,* 812–821.

Pavoine, S., Vallet, J., Dufour, A.-B., Gachet, S., & Daniel, H. (2009). On the challenge of treating various types of variables: application for improving the measurement of functional diversity. *Oikos, 118,* 391–402.

Peck, D. V., Herlihy, A. T., Hill, B. H., Hughes, R. M., Kaufmann, P. R., Klemm, D. J., … Cappaert, M. R. (2006). *Environmental Monitoring and Assessment Program – surface waters western pilot study: field operations manual for wadeable streams. EPA 600/R-06/003.* Washington, DC: U.S. Environmental Protection Agency, Office of Research and Development.

Petersen, I., Masters, Z., Hildrew, A. G., & Ormerod, S. J. (2004). Dispersal of adult aquatic insects in catchments of differing land use. *Journal of Applied Ecology, 41*, 934–950.

Poff, N. L., Olden, J. D., Vieira, N. K. M., Finn, D. S., Simmons, M. P., & Kondratieff, B. C. (2006). Functional trait niches of North American lotic insects: traits-based ecological applications in light of phylogenetic relationships. *Journal of the North American Benthological Society, 25,* 730–755.

R Core Team. (2017) *R: A language and environment for statistical computing.* Viena, Austria: R Foundation for Statistical Computing.

Rader, R. B. (1997). A functional classification of the drift: traits that influence invertebrate availability to salmonids. *Canadian Journal of Fisheries and Aquatic Sciences, 54,* 1211–1234.

Saito, V. S., Soininen, J., Fonseca-Gessner, A. A., & Siqueira, T. (2015). Dispersal traits drive the phylogenetic distance decay of similarity in Neotropical stream metacommunities. *Journal of Biogeography, 42,* 2101–2111.

Sala, O.E., Chapin III, F.S., Armesto, J.J., Berlow, E., Blomfield, J., Dirzo, R., … Wall, D.H. (2000). Global biodiversity scenarios for the year 2100. *Science, 287,* 1770–1774.

Sarremejane, R., Cañedo-Argüelles, M., Prat, N., Mykrä, H., Muotka, T., & Bonada, N. (2017). Do metacommunities vary through time? Intermittent rivers as model systems. *Journal of Biogeography, 44,* 2752–2763.

Seaber, P. R., Kapinos, F. P., & Knapp, G. L. (1987). *Hydrologic unit maps.* Denver, Corvallis: U. S. Geological Survey Water Supply-paper, 2294.

Silva, D. R. O., Herlihy, A. T., Hughes, R. M., & Callisto, M. (2017). An improved macroinvertebrate multimetric index for the assessment of wadeable streams in the neotropical savanna. *Ecological Indicators, 81,* 514–525.

Silva, J. F., Farinas, M. R., Felfili, J. M., & Klink, C. A. (2006). Spatial heterogeneity, land use and conservation in the cerrado region of Brazil. *Journal of Biogeography, 33,* 536–548.

Siqueira, T., Lacerda, C. G.-L. T., & Saito, V. S. (2015). How does landscape modification induce biological homogenization in tropical stream metacommunities? *Biotropica, 47,* 509–516.

Smith, R. F., Venugopal, P. D., Baker, M. E., & Lamp, W. O. (2015). Habitat filtering and adult dispersal determine the taxonomic composition of stream insects in an urbanizing landscape. *Freshwater Biology, 60,* 1740–1754.

Soininen, J., McDonald, R., & Hillebrand, H. (2007). The distance decay of similarity in ecological communities. *Ecography, 30,* 3–12.

Stevens, D. L. & Olsen, A. R. (2004). Spatially balanced sampling of natural resources. *Journal of the American Statistical Association, 99,* 262–278.

Strahler, A. N. (1957). Quantitative analysis of watershed geomorphology. *Transactions, American Geophysical Union, 38,* 913–920.

Strassburg, B. B. N., Brooks, T., Feltran-Barbieri, R., Iribarrem, A., Crouzeilles, R., Loyola, R., … Balmford, A. (2017). Moment of truth for the Cerrado hotspot. *Nature Ecology and Evolution, 1,* 1–3.

Sukopp, H. (1976). Dynamik und Konstanz in der Flora der Bundesrepublik Deutsch-land, [Dynamics and stability in Flora of the Federal Republic of Germany]. *Schriftenreihe für Vegetationskunde, 10,* 9–26.

Tachet, H., Richoux, P., Bournaud, M., & Usseglio-Polatera, P. (2002). *Invertébrés d'Eau Douce.* (2nd ed.). Paris: CNRS.

Tonkin, J. D., Shah, R. D. T., Shah, D. N., Hoppeler, F., Jähnig, S. C., & Pauls, S. U. (2017). Metacommunity structuring in Himalayan streams over large elevational gradients: the role of dispersal routes and niche characteristics. *Journal of Biogeography, 44,* 62–74.

Tucker, J. M., Allendorf, F. W., Truex, R. L., & Schwartz, M. K. (2017). Sex-biased dispersal and spatial heterogeneity affect landscape resistance to gene flow in fisher. *Ecosphere, 8,* e01839.

Urban, M. C., Skelly, D. K., Burchsted, D., Price, W., & Lowry, S. (2006). Stream communities across a rural – urban landscape gradient. *Diversity and Distributions, 12,* 337–350.

USGS (2005). Shuttle Radar Topography Mission – SRTM.

Valente-Neto, F., Durães, L., Siqueira, T., & Roque, F. O. (2018). Metacommunity detectives: Confronting models based on niche and stochastic assembly scenarios with empirical data from a tropical stream network. *Freshwater Biology, 63,* 86–99.

Vellend, M. (2010). Conceptual synthesis in community ecology. *The Quarterly Review of Biology*, *85,* 183–206.

Vörösmarty, C. J., McIntyre, P. B., Gessner, M. O., Dudgeon, D., Prusevich, A., Green, P., … Davies, P. M. (2010). Global threats to human water security and river biodiversity. *Nature,* *467,* 555–561.

Walsh, C. & Nally, R. M. (2013). hier.part: Hierarchical partitioning. R package version 1.0-4. https://CRAN.R-project.org/package=hier.part.

Walz, U. & Stein, C. (2014). Indicators of hemeroby for the monitoring of landscapes in Germany. *Journal for Nature Conservation, 22,* 279–289.

Supporting information

Appendix S1: Supporting results

Appendix S2: Data sources

Biosketch

Kele R. Firmiano is a freshwater ecologist interested in how anthropogenic pressures affect biodiversity in Neotropical freshwater ecosystems, using aquatic macroinvertebrates as biological models. This study is the result of a research partnership between Brazil and Spain initiated during her PhD research visit at the University of Barcelona.

Author contributions: K.R.F., D.R.M. and M.C. elaborated of the research design, collected and processed the data. D.R.M. calculated network and landscape resistance distances. K.R.F., M.C-A., C.G-C. and N.B. conducted the statistical analysis. All authors wrote the paper.

Supporting information - Appendix S1

Aquatic environment and terrestrial integration determines macroinvertebrate metacommunity patterns in neotropical streams

Kele R. Firmiano, Miguel Cañedo-Argüelles, Cayetano Gutiérrez-Cánovas, Diego R. Macedo, Núria Bonada & Marcos Callisto

Table S1. Environmental variables submitted to exploratory analyses as selection criteria to calculate the environmental distance. Mean, standard deviation (SD) is showed.

		Hydrologic units							
Variable group and name	Code	Nova Ponte		São Simão		Três Marias		Volta Grande	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Riparian									
Riparian human disturbance index	W1_HALL	0.84	1.1	1.35	1.02	1.11	0.78	1.22	0.83
Composite riparian vegetation index	RCOND	5.85	4.72	5.98	3.38	5.01	3.19	6.39	3.45
Mean mid-channel canopy density (%)	xcdenmid	67.69	28.29	75.52	24.24	73.03	24.51	77.16	17.88
SD mid-channel canopy density (%)	vcdenmid	20.4	17.6	13.89	9.2	14.16	8.48	13.86	9.01
Riparian vegetation cover (%)	xcmg	174.59	85.07	97.73	46.06	94.28	42.65	99.8	52.59
Channel morphology									
Mean depth of cross-section (cm)	xdepth_s	20.9	13.3	25.27	11.85	27.77	11.53	26.76	11.23
Mean wetted width (m)	xwidth	2.7	1.42	3.93	2.07	3.72	2.3	3.65	1.58
Mean bankfull width (m)	xbkf_w	5.11	1.99	6.92	3.18	6.5	3.57	6	2.66
Mean residual depth (cm)	rp100	14.64	10.18	17.15	8.59	27.8	11.37	17.48	6.06
Reach mean water surface slope (%)	xslope	2.02	2.71	0.81	0.55	0.6	0.58	0.82	1.2
Channel sinuosity (m/m)	sinu	0.98	0.28	1.23	0.08	1.24	0.06	1.21	0.07
Bed substrate									
Mean embeddness (channel and margin) (%)	xembed	53.68	25.41	58.38	19.64	58.38	24.49	64.9	14.4
SD of embeddedness in channel + margin (%)	vembed	30.57	10.76	35.83	6.87	35.63	11.07	35.76	9.4
log$_{10}$ (relative bed stability)	lrbs	-0.15	0.9	-1.44	0.97	-1.17	1.62	-1.38	1.12
Size (log$_{10}$[geometric mean diameter]) (mm)	lsub_dmm	0.77	1.33	0.29	0.97	0.23	1.84	0.18	1.23
Cobble (areal proportion with diameter 64-250 mm)	p_cb	0.08	0.1	0.08	0.1	0.09	0.13	0.1	0.12
Flow type									
Glide (proportion of reach)	p_gl	0.64	0.25	0.67	0.21	0.38	0.3	0.61	0.28
Pools (proportion glide + pool)	p_pool	0.05	0.12	0.05	0.13	0.52	0.37	0.05	0.12
Slow-water habitat (proportion glide + pool)	p_slow	0.7	0.25	0.71	0.2	0.89	0.12	0.66	0.28
Shelter									
Coarse litter (areal proportion)	p_bf	0.08	0.09	0.11	0.11	0.11	0.16	0.08	0.11
Large woody debris in channel (pieces/m^2)	clw_msq	0.01	0.02	0.03	0.04	0.03	0.04	0.06	0.09
Brush and small debris (areal % cover)	pct_xfc_brs	5.35	6.49	11.56	10.6	7.01	9.38	10.82	10.35
Undercut banks (areal % cover)	pct_xcf_ucb	7.73	7.09	5.96	6.9	3.65	5.21	6.2	6.82
Anthropogenic in stream cover (areal % cover)	pct_xfc_ant	2.29	8.05	8.08	19.77	6.71	11.68	1.68	4.77

Table S1 continuation. Environmental variables submitted to exploratory analyses as selection criteria to calculate the environmental distance. Mean, standard deviation (SD) is showed.

Variable group and name	Code	Hydrologic units Nova Ponte		São Simão		Três Marias		Volta Grande	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Water quality									
Dissolved O_2 (mg/L)	DO	7.81	1.37	7.82	1.13	7.67	2.82	8.62	2.87
pH	pH	6.79	0.82	6.9	0.53	7.67	0.48	7.47	0.78
Material in suspension (UNT)	Turbidity	4.05	4.81	6.74	4.09	8.22	14.37	5.97	4.48
Total Nitrogen (mg/L)	N-total	0.08	0.03	0.1	0.02	0.24	0.97	0.11	0.03
Conductivity (µS/cm)	Cond.	15.16	15.1	65.62	47.27	76.05	91.12	43.25	28.96
Total dissolved solids (mg/L)	TDS	7.83	8.03	36.73	29.28	41.14	33.03	24.31	21
Water temperature	T°C	19.45	1.54	20.19	1.67	17.26	1.78	20.59	1.41
Total Phosphorus (mg/L)	P-total	0.01	0.02	0.01	0.05	0.04	0.15	0.02	0.02

Table S2. Correlations between each Principal Coordinate Analysis (PCoA) axis and pollution tolerance (BMWP) and dispersal traits (flight ability and drift propensity). Explained variance by each axis is also shown.

Trait	PCoA 1 51%	PCoA 2 31%	PCoA 3 16%
BMWP	0.54	0.82	0.10
Flight ability	0.93	-0.29	0.16
Drift propensity	0.18	0.16	-0.94

Table S3. Mean trait values for macroinvertebrate groups according to hierarchical clustering.

Trait	Sensitive and weak	Sensitive and moderate	Tolerant and strong	Tolerant and resistant	Tolerant and weak
BMWP	10	8	6.5	4	4
Flight ability	1	2	3	2	0
Drift propensity	18.75	48	14.5	21.5	13

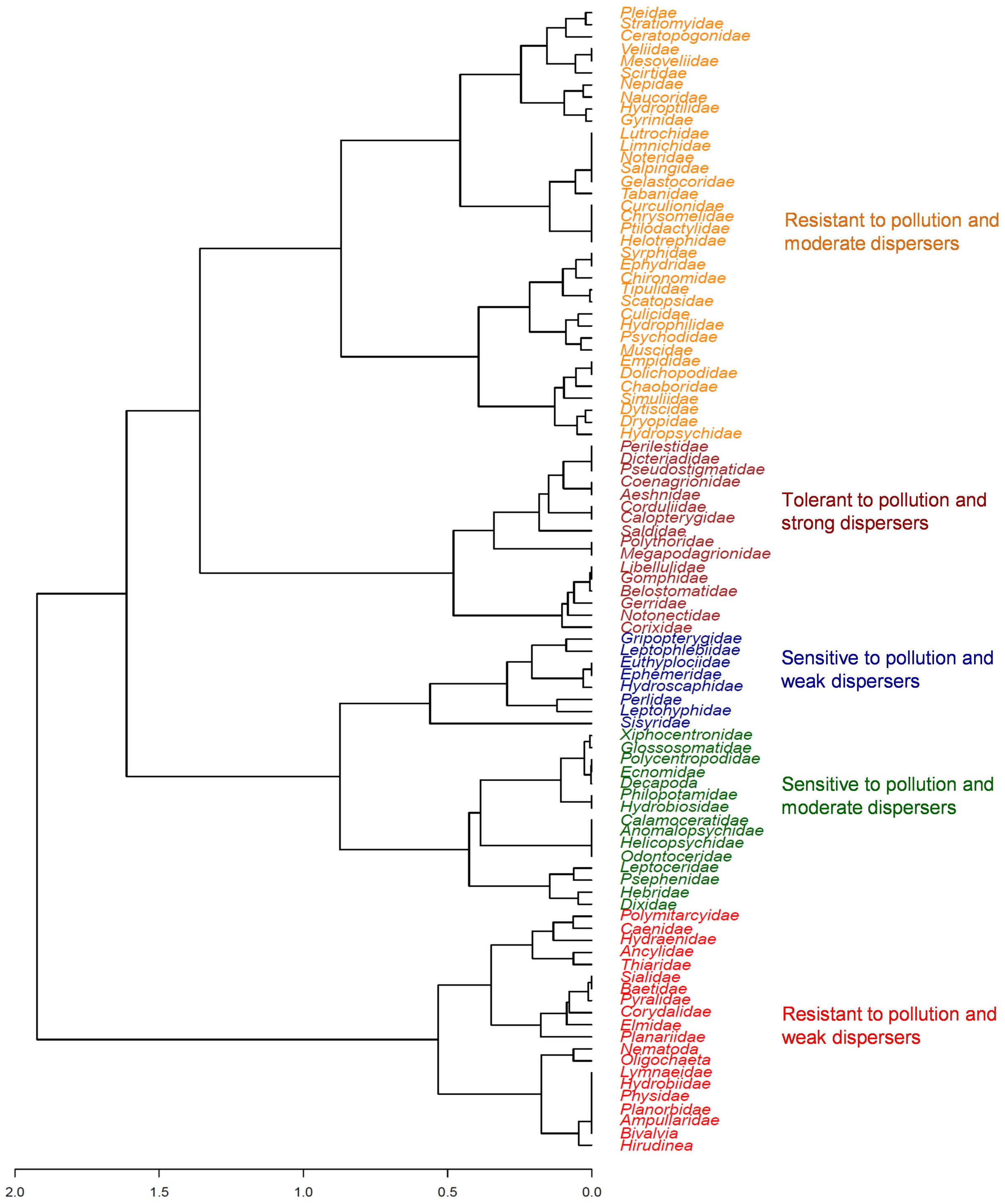

Figure S1. Dendrogram showing the hierarchical clustering of macroinvertebrate taxa based on traits related to pollution tolerance (BMWP scores), and dispersal ability (flight ability, and drift propensity index). Resistant to pollution and moderate dispersers (orange); tolerant to pollution and strong dispersers (brown); sensitive to pollution and weak dispersers (blue); sensitive to pollution and moderate dispersers (green); Resistant to pollution and weak dispersers (red).

Table S4. Traits of Neotropical stream macroinvertebrate taxa related to pollution tolerance (BMWP score); flight ability: 0 (not flying), 1 (weak: up to 1 km), 2 (moderate: > 1 km up to 20 km), 3 (strong: > 20 km); drift propensity; and results of clustering analysis based on combined traits.

Order/ Phylum	Taxa	BMWP	aerial dispersal	drift propensity	Clustering
Annelida	Hirudinea	3	0	10	Resistant and weak
	Oligochaeta	1	0	10	Resistant and weak
Coleoptera	Elmidae	4	1	34	Resistant and weak
	Hydraenidae	5	1	5	Resistant and weak
	Chrysomelidae	5	2	5	Resistant and moderate
	Curculionidae	5	2	5	Resistant and moderate
	Dryopidae	5	2	34	Resistant and moderate
	Dytiscidae	5	2	40	Resistant and moderate
	Gyrinidae	6	2	25	Resistant and moderate
	Hydrophilidae	3	2	20	Resistant and moderate
	Limnichidae	4	2	5	Resistant and moderate
	Lutrochidae	4	2	5	Resistant and moderate
	Noteridae	4	2	5	Resistant and moderate
	Ptilodactylidae	5	2	5	Resistant and moderate
	Salpingidae	4	2	5	Resistant and moderate
	Scirtidae	5	2	14.5	Resistant and moderate
	Hydroscaphidae	10	1	14.5	Sensitive and weak
	Psephenidae	8	2	14.5	Sensitive and moderate
Crustacea	Decapoda	7	2	45	Sensitive and moderate
Diptera	Ceratopogonidae	3	2	11.5	Resistant and moderate
	Chaoboridae	4	2	70.5	Resistant and moderate
	Chironomidae	2	2	70.5	Resistant and moderate
	Culicidae	3	2	28.5	Resistant and moderate
	Dolichopodidae	4	2	49.2	Resistant and moderate
	Empididae	4	2	49.2	Resistant and moderate
	Ephydridae	2	2	49.2	Resistant and moderate
	Muscidae	2	2	21.5	Resistant and moderate
	Psychodidae	2	2	28.5	Resistant and moderate
	Scatopsidae	3	2	49.2	Resistant and moderate
	Simuliidae	5	2	79.5	Resistant and moderate
	Stratiomyidae	4	2	17.5	Resistant and moderate
	Syrphidae	2	2	49.2	Resistant and moderate
	Tabanidae	4	2	7	Resistant and moderate
	Tipulidae	3	2	51.6	Resistant and moderate
	Dixidae	8	2	7	Sensitive and moderate

Table S4 continuation. Traits of Neotropical stream macroinvertebrate taxa related to pollution tolerance (BMWP score); flight ability: 0 (not flying), 1 (weak: up to 1 km), 2 (moderate: > 1 km up to 20 km), 3 (strong: > 20 km); drift propensity; and results of clustering analysis based on combined traits.

Order/ Phylum	Taxa	BMWP	aerial dispersal	drift propensity	Clustering
Gastropoda	Hydrobiidae	3	0	13	Resistant and weak
	Lymnaeidae	3	0	13	Resistant and weak
	Physidae	3	0	13	Resistant and weak
	Planorbidae	3	0	13	Resistant and weak
	Thiaridae	7	0	13	Resistant and weak
Hemiptera	Gelastocoridae	4	2	5	Resistant and moderate
	Helotrephidae	5	2	NA	Resistant and moderate
	Mesoveliidae	5	2	10	Resistant and moderate
	Naucoridae	5	2	25	Resistant and moderate
	Nepidae	5	2	20	Resistant and moderate
	Pleidae	4	2	15	Resistant and moderate
	Veliidae	5	2	10	Resistant and moderate
	Hebridae	8	2	10	Sensitive and moderate
	Belostomatidae	5	3	15	Tolerant and strong
	Corixidae	5	3	25	Tolerant and strong
	Gerridae	5	3	10	Tolerant and strong
	Notonectidae	4	3	15	Tolerant and strong
	Saldidae	7	3	5	Tolerant and strong
Lepidoptera	Pyralidae	4	1	21.5	Resistant and weak
Megaloptera	Corydalidae	5	1	20	Resistant and weak
	Sialidae	4	1	20	Resistant and weak
Mollusca	Ampullaridae	3	0	13	Resistant and weak
	Ancylidae	6	0	13	Resistant and weak
	Bivalvia	3	0	13	Resistant and weak
Nematoda	Nematoda	2	0	10	Resistant and weak
Neuroptera	Sisyridae	8	0	1	Sensitive and weak
Odonata	Aeshnidae	6	3	14.5	Tolerant and strong
	Calopterygidae	8	3	14.5	Tolerant and strong
	Coenagrionidae	6	3	14.5	Tolerant and strong
	Corduliidae	8	3	14.5	Tolerant and strong
	Dicteriadidae	7	3	14.5	Tolerant and strong
	Gomphidae	5	3	14.5	Tolerant and strong
	Libellulidae	5	3	14.5	Tolerant and strong
	Megapodagrionidae	10	3	14.5	Tolerant and strong
	Perilestidae	7	3	14.5	Tolerant and strong
	Polythoridae	10	3	14.5	Tolerant and strong
	Pseudostigmatidae	7	3	14.5	Tolerant and strong
Turbellaria	Planariidae	5	0	42	Resistant and weak

Table S5. Traits of Neotropical stream Ephemeroptera, Plecoptera, and Trichoptera genera related to pollution tolerance (BMWP score); flight ability: 0 (not flying), 1 (weak: up to 1 km), 2 (moderate: > 1 km up to 20 km), 3 (strong: > 20 km); drift propensity; and results of clustering analysis based on combined traits.

Order	Family	Genus	BMWP	aerial dispersal	drift propensity	Clustering
Ephemeroptera	Baetidae	*Americabaetis*	4	1	20	Resistant and weak
		Apobaetis	4	1	20	Resistant and weak
		Aturbina	4	1	20	Resistant and weak
		Baetodes	4	1	20	Resistant and weak
		Callibaetis	4	1	20	Resistant and weak
		Camelobaetidius	4	1	20	Resistant and weak
		Cloeodes	4	1	20	Resistant and weak
		Cryptonympha	4	1	20	Resistant and weak
		Guajirolus	4	1	20	Resistant and weak
		Paracloeodes	4	1	20	Resistant and weak
		Rivudiva	4	1	20	Resistant and weak
		Spiritiops	4	1	20	Resistant and weak
		Varipes	4	1	20	Resistant and weak
		Waltzoyphius	4	1	20	Resistant and weak
		Zelusia	4	1	20	Resistant and weak
	Caenidae	*Caenis*	5	1	11.5	Resistant and weak
		Latineosus	5	1	11.5	Resistant and weak
	Ephemeridae	*Hexagenia*	10	1	12	Sensitive and weak
	Euthyplociidae	*Campylocia*	10	1	12	Sensitive and weak
	Leptohyphidae	*Leptohyphes*	7	1	23	Sensitive and weak
		Leptohyphodes	7	1	23	Sensitive and weak
		Traverhyphes	7	1	23	Sensitive and weak
		Tricorythodes	7	1	23	Sensitive and weak
		Tricorythopsis	7	1	23	Sensitive and weak
	Leptophlebiidae	*Askola*	10	1	25.5	Sensitive and weak
		Farrodes	10	1	25.5	Sensitive and weak
		Hagenulopsis	10	1	25.5	Sensitive and weak
		Hermanella	10	1	25.5	Sensitive and weak
		Hydrosmilodon	10	1	25.5	Sensitive and weak
		Hylister	10	1	25.5	Sensitive and weak
		Massartella	10	1	25.5	Sensitive and weak
		Miroculis	10	1	25.5	Sensitive and weak
		Needhamella	10	1	25.5	Sensitive and weak
		Paramaka	10	1	25.5	Sensitive and weak
		Simothraulopsis	10	1	25.5	Sensitive and weak
		Terpides	10	1	25.5	Sensitive and weak
		Thraulodes	10	1	25.5	Sensitive and weak
		Tikuna	10	1	25.5	Sensitive and weak
		Ulmeritoides	10	1	25.5	Sensitive and weak
	Polymitarcyidae	*Asthenopus*	6	1	12	Resistant and weak
		Campsurus	6	1	12	Resistant and weak
Plecoptera	Gripopterygidae	*Grypopteryx*	10	1	50.4	Sensitive and weak
		Paragrypopteryx	10	1	50.4	Sensitive and weak
		Tupiperla	10	1	50.4	Sensitive and weak
	Perlidae	*Anacroneuria*	8	1	50.4	Sensitive and weak
		Kempnya	8	1	50.4	Sensitive and weak
		Macrogynoplax	8	1	50.4	Sensitive and weak

Table S5 continuation. Traits of Neotropical stream Ephemeroptera, Plecoptera, and Trichoptera genera related to pollution tolerance (BMWP score); flight ability: 0 (not flying), 1 (weak: up to 1 km), 2 (moderate: > 1 km up to 20 km), 3 (strong: > 20 km); drift propensity; and results of clustering analysis based on combined traits.

Order	Family	Genus	BMWP	aerial dispersal	drift propensity	Clustering
Trichoptera	Calamoceratidae	*Phylloicus*	10	2	49.2	Sensitive and moderate
	Ecnomidae	*Austrotinodes*	7	2	44.4	Sensitive and moderate
	Glossosomatidae	*Itaura*	7	2	49.2	Sensitive and moderate
		Mortoniella	7	2	49.2	Sensitive and moderate
		Protoptila	7	2	49.2	Sensitive and moderate
	Helicopsychidae	*Helicopsyche*	10	2	49.2	Sensitive and moderate
	Hydrobiosidae	*Atopsyche*	8	2	48	Sensitive and moderate
	Hydropsychidae	*Leptonema*	10	2	49.2	Sensitive and moderate
		Macronema	10	2	49.2	Sensitive and moderate
		Macrostemun	10	2	49.2	Sensitive and moderate
		Smicridea	10	2	49.2	Sensitive and moderate
	Hydroptilidae	*Alisotrichia*	6	2	29	Resistant and moderate
		Anchitrichia	6	2	29	Resistant and moderate
		Hydroptila	6	2	29	Resistant and moderate
		Metrichia	6	2	29	Resistant and moderate
		Neotrichia	6	2	29	Resistant and moderate
		Ochrotrichia	6	2	29	Resistant and moderate
		Oxyetira	6	2	29	Resistant and moderate
		Taraxitrichia	6	2	29	Resistant and moderate
		Zumatrichia	6	2	29	Resistant and moderate
	Leptoceridae	*Atanatolia*	8	2	23.5	Sensitive and moderate
		Grumichella	8	2	23.5	Sensitive and moderate
		Nectopsyche	8	2	23.5	Sensitive and moderate
		Notalina	8	2	23.5	Sensitive and moderate
		Oecetis	8	2	23.5	Sensitive and moderate
		Triplectides	8	2	23.5	Sensitive and moderate
	Odontoceridae	*Barypenthus*	10	2	49.2	Sensitive and moderate
		Marilia	10	2	49.2	Sensitive and moderate
	Philopotamidae	*Chimarra*	8	2	48	Sensitive and moderate
		Wormaldia	8	2	48	Sensitive and moderate
	Polycentropodidae	*Cyrnelus*	7	2	44.4	Sensitive and moderate
		Nyctiophylax	7	2	44.4	Sensitive and moderate
		Polycentropus	7	2	44.4	Sensitive and moderate
		Polyplectropus	7	2	44.4	Sensitive and moderate
	Xiphocentronidae	*Xiphocentron*	7	2	51.6	Sensitive and moderate

Exploratory analysis: selecting environmental variables

We first checked the presence of outliers by visualizing variable distributions. When necessary, local environmental variables were log- or square-root transformed to reduce distribution skewness and improve linearity. Second, we investigated the hierarchy of local environmental variables. We used Boosted Regression Trees (BRT) to rank the importance of local environmental variables for local family and genus richness. BRT is a nonparametric regression technique able to handle heterogeneous predictors, nonlinear relationships and missing values. After BRT and expert knowledge, we retained an uncorrelated ($r_{Pearson} < 0.70$) set of four local environmental variables to next steps: lsub_dmm, RCOND, xwidth, and vcdenmid. Finally, we used general linear models to investigate the additive effects of local environmental variables to family and genera richness. Our models showed that lsub_dmm and RCOND were significantly correlated to family richness, while lsub_dmm and xwidth were significantly correlated genus richness (Table S6). Consequently, we selected lsub_dmm, RCOND and xwidth as the most important environmental variables.

Table S6. Results of the models relating family and genus richness to local environmental variables using a multi-model inference approach. ns: no significant.

		Coefficients	Standard Error	*t* value	*P* value
Familly	Intercept	22.06	3.06	7.22	> 0.001
	lsubd_mm	0.97	0.43	2.27	> 0.05
	RCOND	1.51	0.61	2.47	> 0.05
	xwidth	0.98	1.26	0.78	ns
	vcdenmid	-0.70	0.71	-0.98	ns
Geuns	Intercept	4.12	3.12	1.32	ns
	lsubd_mm	1.55	0.44	3.57	> 0.001
	RCOND	1.05	0.62	1.69	ns
	xwidth	7.01	1.28	5.47	> 0.001
	vcdenmid	-1.00	0.73	-1.38	ns

Table S7. Assignment of Brazilian land use and land cover map of the IBGE (2015) to degrees of hemeroby according to Walz & Stein (2014).

Degree of hemeroby	Status	Walz & Stein, 2014	Brazilian land use and land cover map (IBGE, 2015)
1. Ahemerobic	– Almost no human impacts	Bare rocks	Discovered areas
2. Oligohemerobic	– Weak human impacts	Inland marshes Mixed forest (PNV)	Forest Palm swamps
3. Mesohemerobic	– Moderate human impacts	Mixed forest (not PNV) Natural grassland Moors and heathland Transitional woodland-shrub Sparsely vegetated areas Burnt areas	Forest with significant agriculture areas Rupestrian *Eucalyptus* aforestation Grassland
4. β-Euhemerobic	– Moderate-strong human impacts	Green urban areas Pastures Land principally occupied by agriculture, with significant areas on natural vegetation Water courses Water bodies	Grassland with significant agriculture areas Pastures Agriculture with significant forest areas Water bodies (included reservoirs)
5. α-Euhemerobic	– Strong human impacts	Sports and leisure facilities Fruit trees and berry plantations Non-irrigated arable land Complex cultivation patterns	Intensive agriculture areas
6. Polyhemerobic	– Very strong human	Discontinuous urban fabrics Mineral extraction Dump sites Construction sites	No identified
7. Metahemerobic	– Excessively strong human impacts – Biocoenosis destroyed	Continuous urban fabric Industrial or commercial units Road and rail networks and associate land Airports	Urban areas

Table S8. Pearson pairwise correlation coefficients among all distance metrics calculated for 183 stream sites. ENV, environmental distance; EUC, Euclidean distance; NULL, null distance; TOP, topographic distance; LAND, land use distance; NET, network distance.

Distance	ENV	EUC	NULL	TOP	LAND
EUC	0.19				
NULL	0.15	0.92			
TOP	0.26	0.47	0.44		
LAND	-0.05	0.40	0.51	0.01	
NET	0.24	0.75	0.69	0.66	0.23

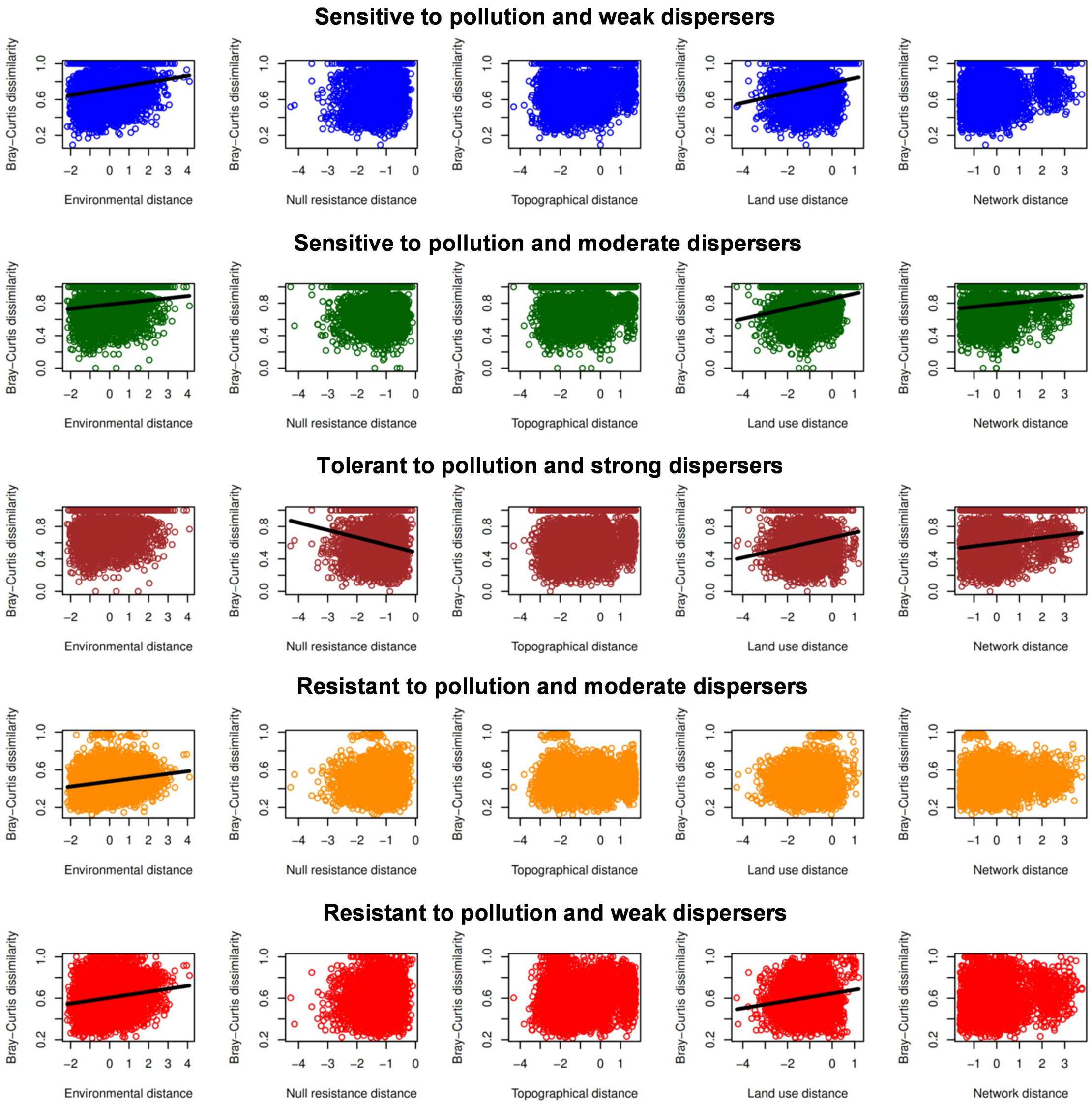

Figure S2. Relationships between community dissimilarity and distances for each macroinvertebrate group related to pollution tolerance and dispersal ability. Significant fitted values are shown using solid black lines.

References

Oksanen, A. J., Blanchet, F. G., Kindt, R., Legendre, P., Minchin, P. R., O'Hara, R. B., . . . Wagner, H. (2015). Vegan: Community Ecology Package. R package version 2.2-1. Retrieved from http://vegan. r-forge.r-project.org.

Gelman, A. & Su Y-S. Andrew Gelman and Yu-Sung Su (2018). arm: Data Analysis Using Regression and Multilevel/Hierarchical Models. R package version 1.10-1.Retrieved from https://CRAN.R-project.org/package=arm.

Ridgeway, G., 2015. Gbm: Generalized Boosted Regression Models. R Package Version 2.1.1. Retrieved from http://CRAN.R-project.org/package=gbm.

Hijmans,R.H., Phillips, S., Leathwick, J., Elith, J. (2017). dismo: Species Distribution Modeling. R package version 1.1-4. Retrieved from https://CRAN.R-project.org/package=dismo.

Supporting information - Appendix 2

Aquatic environment and terrestrial integration determines macroinvertebrate metacommunity patterns in neotropical streams

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Traits data source

Briers, R.A., Gee, J.H.R., Cariss, H.M., & Geoghegan, R. (2004). Inter-population dispersal by adult stoneflies detected by stable isotope enrichment. *Freshwater Biology, 49,* 425–431.

Callisto, M., Moretti, M., & Goulart, M. (2001). Macroinvertebrados Bentônicos como Ferramenta para Avaliar a Saúde de Riachos. *Revista Brasileira de Recursos Hídricos, 6,* 71–82.

Koetsier, P. & Bryan, C.F. (1995). Effects of abiotic factors on macroinvertebrate drift in the lower Mississippi River, Louisiana. *American Midland Naturalist, 134,* 63-74.

Kovats, Z., Ciborowski, J.J.H., & Corkum, L. (1996). Inland dispersal of adult aquatic insects. *Freshwater Biology, 36*, 265–276.

Lancaster, J., & Downes, B.J. (2013). Dispersal in the terrestrial environment. In Lancaster, J., & Downes, B.J., *Aquatic Entomology* (First ed., pp 137-152). Oxford: Oxford University Press.

Sappington, T.W. & Burks, C.S. (2014). Patterns of Flight Behavior and Capacity of Unmated Navel Orangeworm (Lepidoptera: Pyralidae) Adults Related to Age, Gender, and Wing Size. *Environmental Entomology, 43,* 696–705.

Schäfer, M.L., Lundkvist, E., Landin, J., Persson, T.Z., & Lundström, J.O. (2006). Influence of landscape structure on mosquitoes (Diptera: Culicidae) and dytiscids (Coleoptera: Dytiscidae) at five spatial scales in swedish wetlands. *Wetlands, 26,* 57–68.

Secretaria do Meio Ambiente e Recursos Hídricos do Estado do Paraná. Avaliação da Qualidade da Água Através dos Macroinvertebrados Bentônicos - Índice BMWP. http://www.meioambiente.pr.gov.br/modules/conteudo/conteudo.php?conteudo=91 (accessed October 2017).

Silva, K.W. dos S., Everton, N. dos S., & Melo, M.A.D. de (2016). Aplicação dos índices biológicos Biological Monitoring Working Party e Average Score per Taxon para avaliar a qualidade de água do rio Ouricuri no Município de Capanema, Estado do Pará, Brasil. *Revista Pan-Amazônica de Saúde, 7,* 13–22.

Wikelski, M., Moskowitz, D., Adelman, J.S., Cochran, J., Wilcove, D.S., & May, M.L. (2006). Simple rules guide dragonfly migration. *Biology Letters, 2,* 325–329.

Vieira, N. K. M., Poff, N. L., Carlisle, D. M., Moulton, S. R., Koski, M. L. & Kondratieff, B. C. (2006) A database of lotic invertebrate traits for North America. U.S. Geological Survey Data Series 187. http://pubs.usgs.gov/ds/ds187/ (accessed October 2017).

Conclusões

Esta tese avaliou os efeitos de pressões antrópicas observados em múltiplas escalas espaciais na estrutura de comunidades bentônicas em riachos de cabeceira na savana neotropical. No capítulo 1 foram avaliadas as respostas de um grupo de bioindicadores ao aumento de pressões antrópicas em ecossistemas aquáticos. No capítulo 2 foi avaliada a importância de condições ambientais e de dispersão para os padrões de metacomunidades.

Foi encontrado que a maioria dos gêneros de Ephemeroptera respondeu de forma negativa aos limiares detectados em função do aumento do percentual de áreas urbanas, alterações na zona ripária, aumento no assoreamento, e em função da diminuição de qualidade de água. Foi observado que a concentração de fósforo total estabelecida pela legislação ambiental brasileira é maior do que os valores limiares detectados para os gêneros sensíveis ao aumento deste estressor. As principais contribuições do capítulo 1 para a compreensão do efeito de estressores antropogênicos nos ecossistemas aquáticos são: (ii) a dissociação entre variabilidade ambiental e estressores permite selecionar os principais estressores afetando a estrutura de comunidades biológicas; (ii) as respostas limiares aos estressores selecionados podem variar independentemente em função da sensibilidade das espécies a cada tipo de impacto.

Foi evidenciado que os processos ecológicos que explicaram os padrões de metacomunidades foram seleção de habitat e limitação de dispersão. Além disso, foi também constatada que a importância destes processos varia em função da habilidade de dispersão e tolerância à poluição dos organismos. A seleção de habitat explicou o aumento da dissimilaridade de todos os macroinvertebrados considerados dispersores fracos e moderados, independentemente de sua tolerância à poluição. A distância da rede de drenagem explicou o aumento da dissimilaridade de macroinvertebrados classificados como dispersores moderados e sensíveis à poluição, e daqueles considerados dispersores fortes e tolerantes à poluição. A dissimilaridade de todos os grupos, exceto aqueles considerados dispersores moderados e resistentes à poluição aumentou em função da resistência da paisagem devido à intensificação nos usos do solo. As principais contribuições do capítulo 2 para a ecologia de metacomunidade são: (i) os padrões em metacomunidades são melhores compreendidos pela combinação de *traits* relacionados à dispersão e à tolerância à poluição; (ii) a utilização de diferentes medidas distâncias demonstra que a importância da dispersão em explicar a variação entre comunidades tem sido subestimada quando comparada às condições ambientais locais; (iii) a intensificação nos usos do solo em escala regional afeta organismos que dependem tanto de ecossistemas aquáticos quanto terrestres para completa seu ciclo de vida.

A principal conclusão desta tese de doutorado é que os efeitos de pressões antrópicas em múltiplas escalas espaciais afetam negativamente a estrutura e composição de comunidades de macroinvertebrados bentônicos em riachos neotropicais.

Perspectivas futuras

Os resultados desta tese evidenciam a importância de avaliar os efeitos de pressões antrópicas em múltiplas escalas espaciais na estruturação de comunidades bentônicas. Com base nestes resultados sugiro que pesquisas futuras busquem:

1. Ampliar a abordagem de limiares em comunidades para outros táxons de bioindicadores bentônicos. A detecção de respostas limiares tem potencial de fornecer valores de referência aplicados em programas de biomonitoramento. Muitos ecossistemas aquáticos estão sob efeito de pressões antrópicas intensas e frequentes, por exemplo, aqueles localizados em áreas densamente urbanizadas. As comunidades de macroinvertebrados presentes em tais ecossistemas são compostas principalmente por táxons tolerantes e resistentes, mas que não foram analisados nesta tese.

2. Construir uma base de dados de *traits* de dispersão com base em informações de táxons ocorrentes exclusivamente em região tropical. O número de estudos ecológicos nos trópicos com enfoque funcional tem crescido. A grande maioria deles, entretanto, se baseia em informações provenientes de regiões temperadas. Tais regiões diferem em muitos aspectos de regiões tropicais (p.ex. sazonalidade) o que gera padrões de biodiversidade divergentes entre regiões tropicais e temperadas. Estudos futuros podem analisar como aspectos fisiológicos (p.ex. tolerâncias térmicas), morfológicos (p.ex. aerodinâmica de voo) e populacionais (p.ex. nº de indivíduos por ano) influenciam a dispersão de organismos em nos trópicos.

3. Investigar a efetividade de *traits* observados em insetos adultos alados como potenciais indicadores de pressões antrópicas na paisagem terrestre. Adultos de Odonata, por exemplo, diferem em tolerâncias à incidência solar. Podem ser realizadas coletas de insetos adultos em paisagens em diferentes condições do ambiente terrestre juntamente com a mensuração de variáveis ambientais que afetam os requerimentos fisiológicos (p.ex. temperatura e umidade do ar, incidência solar).

4. Avaliar o efeito de pressões antrópicas sobre os padrões de metacomunidade em escala temporal. A maioria dos estudos de metacomunidade é conduzida em diferentes escalas espaciais, mas a escala temporal tem sido negligenciada. Estudos em escala temporal podem investigar como condições atípicas observadas entre diferentes períodos (p.ex. seca extrema) influenciam os processos de seleção de habitat e de dispersão.

5. Avaliar de forma experimental a contribuição da dispersão e seleção de habitats para os padrões de metacomunidades. Experimentos conduzidos em mesocosmos podem simular diversas situações (p.ex. perda de conectividade fluvial devido à diminuição de fluxo). Os resultados de tais experimentos podem ser úteis em prever como as comunidades aquáticas

responderão à alterações em função de mudanças globais, tais como as alterações climáticas.

Referências

Allan, J. D., 2004. Landscapes and riverscapes: the influence of land use on stream ecosystems. Annual Review of Ecology, Evolution, and Systematics 35: 257–284.

Allan, J. D. & M. M. Castillo, 2007. Stream Ecology. Springer Netherlands, Dordrecht, 436 pp.

Altermatt, F., 2013. Diversity in riverine metacommunities: a network perspective. Aquatic Ecology 47: 365–377.

APHA, 2005. Standard Methods for the Examination of Water and Wastewater. American Public Health Association Washington, DC.

Baguette, M., S. Blanchet, D. Legrand, V. M. Stevens & C. Turlure, 2013. Individual dispersal, landscape connectivity and ecological networks. Biological Reviews 88: 310–326.

Baker, M. E. & R. S. King, 2010. A new method for detecting and interpreting biodiversity and ecological community thresholds. Methods in Ecology and Evolution 1: 25–37.

Begon, M., C. R. Townsend & J. L. Harper, 2007. Ecologia: de Indivíduos a Ecossistemas. Artmed, Porto Alegre, 752 pp.

Benda, L., M. A. Hassan, M. Church & C. L. May, 2006. Geomorpholoy of steepland headwaters: the transition from hillslopes to channels. Journal of the American Water Resources Association 4767: 835–851.

Bilton, D. T., J. R. Freeland & B. Okamura, 2001. Dispersal in freshwater invertebrates. Annual Review of Ecology and Systematics 32: 159–181.

Bonada, N., S. Dolédec & B. Statzner, 2012. Spatial autocorrelation patterns of stream invertebrates: exogenous and endogenous factors. Journal of Biogeography 39: 56–68.

Bonada, N., N. Prat, V. H. Resh & B. Statzner, 2006. Developments in aquatic insect biomonitoring: a comparative analysis of recent approaches. Annual Review of Entomology 51: 495–523.

Brittain, J. E. & T. J. Eikeland, 1988. Invertebrate drift - a review. Hydrobiologia 166: 77–93.

Brown, B. L. & C. M. Swan, 2010. Dendritic network structure constrains metacommunity properties in riverine ecosystems. Journal of Animal Ecology 79: 571–580.

Brown, B. L., C. M. Swan, D. A. Auerbach, E. H. C. Grant, N. P. Hitt, K. O. Maloney, C. Patrick, E. H. C. Grant & N. P. Hitt, 2011. Metacommunity theory as a multispecies, multiscale framework for studying the influence of river network structure on riverine communities and ecosystems. Journal of the North American Benthological Society 30: 310–327.

Callisto, M., R. M. Hughes, J. M. Lopes & M. A. Castro, 2014. Ecological Conditions in Hydropower Basins. Belo Horizonte, CEMIG - Companhia Energética de Minhas Gerais, 216 pp.

Callisto, M., M. Moretti & M. Goulart, 2001. Macroinvertebrados bentônicos como ferramenta para avaliar a saúde de riachos. Revista Brasileira de Recursos Hídricos 6: 71–82.

Cañedo-Argüelles, M., K. S. Boersma, M. T. Bogan, J. D. Olden, I. Phillipsen, T. A. Schriever & D. A. Lytle, 2015. Dispersal strength determines meta-community structure in a dendritic riverine network. Journal of Biogeography 42: 778–790.

Cao, C. & X. Liu, 2013. Description of the final-instar larva and pupa of *Acanthacorydalis orientalis* (McLachlan, 1899) (Megaloptera: Corydalidae) with some life history notes. Zootaxa 3691: 145–152.

Carlson, P. E., B. G. Mckie, L. Sandin & R. K. Johnson, 2016. Strong land-use effects on the dispersal patterns of adult stream insects: Implications for transfers of aquatic subsidies to terrestrial consumers. Freshwater Biology 61: 848–861.

Carvalho, D. R., D. M. P. Castro, M. Callisto, M. Z. Moreira, & P. S. Pompeu, 2017. The trophic structure of fish communities from streams in the Brazilian Cerrado under different land uses: an approach using stable isotopes. Hydrobiologia 795: 199–217.

Carvalho, F. M. V., P. De Marco, & L. G. Ferreira, 2009. The Cerrado into-pieces: Habitat fragmentation as a function of landscape use in the savannas of central Brazil. Biological Conservation 142: 1392–1403.

Castro, D. M. P., D. R. De Carvalho, P. D. S. Pompeu, M. Z. Moreira, G. B. Nardoto, & M. Callisto, 2016. Land use influences niche size and the assimilation of resources by benthic macroinvertebrates in tropical headwater streams. PLoS ONE 11: 1–19.

Clobert, J., M. Baguette, T. G. Benton & J. M. Bullock, 2012. Dispersal in Ecology and Evolution. Oxford University Press, Oxford, 462 pp.

Costa, C., S. Ide & C. E. Simonka, 2006. Insetos Imaturos. Metamorfose e Identificação. Holos, Ribeirão Preto, 249 pp.

Cottenie, K., 2005. Integrating environmental and spatial processes in ecological community dynamics. Ecology Letters 8: 1175–1182.

Domínguez, E., C. Molineri, M. Pescador, M. D. Hubbard & C. Nieto, 2006. Ephemeroptera of South America. Pensoft, Moscow, 646 pp.

Dudgeon, D., A. H. Arthington, M. O. Gessner, Z.-I. Kawabata, D. J. Knowler, C. Lévêque, R. J. Naiman, A.-H. Prieur-Richard, D. Soto, M. L. J. Stiassny & C. a Sullivan, 2006. Freshwater biodiversity: importance, threats, status and conservation challenges. Biological reviews of the Cambridge Philosophical Society 81: 163–182.

Erös, T., P. Takács, A. Specziár, D. Schmera & P. Sály, 2017. Effect of landscape context on fish metacommunity structuring in stream networks. Freshwater Biology 62: 215–228.

Esteves, F. de A., J. J. F. Leal & M. Callisto, 2011. Comunidade Bentônica. In: Esteves, F. de A. (ed.), Fundamentos de Limnologia. Interciência, Rio de Janeiro: 581–607.

Feld, C. K., P. Segurado, & C. Gutiérrez-Cánovas, 2016. Analysing the impact of multiple stressors in aquatic biomonitoring data: A ‘cookbook’ with applications in R. Science of The Total Environment 573: 1320–1339,

Fernández, H. R., & E. Domínguez, 2001. Guía para la determinación de los artrópodos bentónicos sudamericanos. Universidad Nacional de Tucumán. Tucúman, 39 pp.

Ferreira, W. R., L. U. Hepp, R. Ligeiro, D. R. Macedo, R. M. Hughes, P. R. Kaufmann & M. Callisto, 2017. Partitioning taxonomic diversity of aquatic insect assemblages and functional feeding groups in neotropical savanna headwater streams. Ecological Indicators 72: 365–373.

Firmiano, K. R., R. Ligeiro, D. R. Macedo, L. Juen, R. M. Hughes & M. Callisto, 2017. Mayfly bioindicator thresholds for several anthropogenic disturbances in neotropical savanna streams. Ecological Indicators 74: 276–284.

FISRWG, 1998. Stream Corridor Restoration: Principles, Processes, and Practices. By the Federal Interagency Stream Restoration Working Group (FISRWG) (15 Federal agencies of the US gov’t). GPO Item No. 0120-A; SubDocs No. A 57.6/2:EN3/PT.653, Washington, 637 pp.

Foley, J. A., R. Defries, G. P. Asner, C. Barford, G. Bonan, S. R. Carpenter, F. S. Chapin, M. T. Coe, G. C. Daily, H. K. Gibbs, J. H. Helkowski, T. Holloway, E. A. Howard, C. J. Kucharik, C. Monfreda, J. A. Patz, I. C. Prentice, N. Ramankutty & P. K. Snyder, 2005. Global consequences of land use. Science 309: 570–574.

Forman, R. T. T. & M. Godron, 1986. Landscape Ecology. John Wiley & Sons, New York, 619 pp.

Frissell, C. A., W. J. Liss, C. E. Warren & M. D. Hurley, 1986. A Hierarchical framework for stream habitat classification: viewing streams in a watershed context. Environmental Management 10: 199–214.

Heino, J., 2013. The importance of metacommunity ecology for environmental assessment research in the freshwater realm. Biological Reviews 88: 166–178.

Heino, J., J. Alahuhta, T. Ala-Hulkko, H. Antikainen, L. M. Bini, N. Bonada, T. Datry, T. Erős, J. Hjort, O. Kotavaara, A. S. Melo & J. Soininen, 2017. Integrating dispersal proxies in ecological and environmental research in the freshwater realm. Environmental Reviews 25: 334–349.

Heino, J., A. S. Melo, J. Jyrk, D. Katharine, P. Victor, S. Saito, K. T. Tolonen, L. Mauricio, B. Victor, L. Landeiro, T. Sanna, F. Silva, V. Pajunen, J. Soininen & T. Siqueira, 2018. Subtropical streams harbour higher genus richness and lower abundance of insects compared to boreal streams, but scale matters. Journal of Biogeography 36: 1–11.

Heino, J., A. S. Melo, T. Siqueira, J. Soininen, S. Valanko & L. M. Bini, 2015. Metacommunity organisation, spatial extent and dispersal in aquatic systems: patterns, processes and prospects. Freshwater Biology 60: 845–869.

Heino, J. & B. L. Peckarsky, 2014. Integrating behavioral, population and large-scale approaches for understanding stream insect communities. Current Opinion in Insect Science 2: 7–13.

Hendry, A. P., K. M. Gotanda & E. I. Svensson, 2017. Human influences on evolution, and the ecological and societal consequences. Phylosophical Transactions Royal Society B 372: 20160028.

Herlihy, A. T., D. P. Larsen, S. G. Paulsen, N. S. Urquhart & B. J. Rosenbaum, 2000. Designing a spatially balanced, randomized site selection process for regional stream surveys: the EMAP Mid-Atlantic pilot study. Environmental Monitoring and Assessment 63: 95–113.

Hubbell, S. P., 2001. The Unified Theory of Biodiversity and Biogeography. Princeton University Press, Princeton, 374 pp.

Hutchinson, G. E., 1957. Concluding remarks. Cold Spring Harbor Symposia on Quantitative Biology 22: 415–427.

Jacobson, B. & P. R. Peres-Neto, 2010. Quantifying and disentangling dispersal in metacommunities: how close have we come? How far is there to go? Landscape Ecology 25: 495–507.

Junk, W. J., P. B. Bayley & R. E. Sparks, 1989. The flood pulse concept in river-floodplain systems. Canadian Special Publication of Fisheries and Aquatic Sciences 106: 110–127.

Kärnä, O. M., M. Grönroos, H. Antikainen, J. Hjort, J. Ilmonen, L. Paasivirta & J. Heino, 2015. Inferring the effects of potential dispersal routes on the metacommunity structure of stream insects: as the crow flies, as the fish swims or as the fox runs? Journal of Animal Ecology 84: 1342–1353.

Kaufmann, P. R., J. M. Faustini, D. P. Larsen & M. A. Shirazi, 2008. A roughness-corrected index of relative bed stability for regional stream surveys. Geomorphology 99: 150–170.

Kaufmann, P. R., P. Levine, E. G. Robison, C. Seeliger & D. V. Peck, 1999. Quantifying Physical Habitat in Wadeable Streams. EPA/620/R-99/003. U.S. Environmental Protection Agency, Washington, 149 pp.

King, R. S. & M. E. Baker, 2014. Use, Misuse, and Limitations of Threshold Indicator Taxa Analysis (TITAN) for Natural Resource Management In Guntenspergen, G. R. (ed), Application of Threshold Concepts in Natural Resource Decision Making. Springer, New York: 231–254.

Klink, C. A., & R. B. Machado, 2005. Conservation of the Brazilian Cerrado. Conservation Biology 19: 707–713.

Leibold, M. A., M. Holyoak, N. Mouquet, P. Amarasekare, J. M. Chase, M. F. Hoopes, R. D. Holt, J. B. Shurin, R. Law, D. Tilman, M. Loreau & A. Gonzalez, 2004. The metacommunity concept: a framework for multi-scale community ecology. Ecology Letters 7: 601–613.

Logue, J. B., N. Mouquet, H. Peter & H. Hillebrand, 2011. Empirical approaches to metacommunities: A review and comparison with theory. Trends in Ecology and Evolution 26: 482–491.

Macedo, D. R., R. M. Hughes, R. Ligeiro, W. R. Ferreira, M. A. Castro, N. T. Junqueira, D. R. Oliveira, K. R. Firmiano, P. R. Kaufmann, P. S. Pompeu, & M. Callisto, 2014a. The relative influence of catchment and site variables on fish and macroinvertebrate richness in cerrado biome streams. Landscape Ecology 29: 1001–1016.

Macedo, D. R., P. S. Pompeu, L. Morais, M. A. Castro, C. B. M. Alves, J. S. França, B. O. Sanches, J. U. M. Agra & M. Callisto, 2014b. Sampling Site Selection, Land Use and Cover, Field Reconnaissance, and Sampling In Callisto, M., R. M. Hughes, J. M. Lopes & M. A. Castro (eds), Ecological Conditions in Hydropower Basins. Serie Peixe Vivo 3. Companhia Energética de Minas Gerais, Belo Horizonte: 61–83.

Machado, N., E. Venticinque, & J. Penha, 2011. Effect of environmental quality and mesohabitat structure on a Biotic integrity index based on fish assemblages of cerrado streams from Rio Cuiabá basin, Brazil. Brazilian Journal of Biology 71: 577–586.

Malmqvist, B. & S. Rundle, 2002. Threats to the running water ecosystems of the world. Environmental Conservation 29: 134–153.

Martins, I., R. Ligeiro, R. M. Hughes, D. R. Macedo & M. Callisto, 2017. Regionalization is key to establish reference conditions for neotropical savanna streams. Marine and Freshwater Research 69: 82–94.

McRae, B. H., 2006. Isolation By Resistance. Evolution 60: 1551-1561.

Merritt, R. W., & K. W. Cummins 1996. An Introduction to the Aquatic Insects of North America. Hunt publishing company, Kendal, 1158 pp.

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

Mugnai, R., J. L. Nessimian & D. F. Baptista, 2010. Manual de Identificação de Macroinvertebrados do Estado do Rio de Janeiro. Tecnical Books, Rio de Janeiro, 174 pp.

Naveh, Z., 1991. Some remarks on recent developments in landscape ecology as a transdisciplinary ecological and geographical science. Landscape Ecology 5: 65-73.

Neill, R. V. O., A. R. Johnson & A. W. King, 1989. A hierarchical framework for the analysis of scale. Landscape Ecology 3: 193–205.

Nekola, J. C. & P. S. White, 1999. The distance decay of similarity in biogeography and ecology. Journal of Biogeography 26: 867–878.

Newbold, T., L. N. Hudson, S. L. L. Hill, S. Contu, I. Lysenko, R. A. Senior, L. Börger, D. J. Bennett, A. Choimes, B. Collen, J. Day, A. De Palma, S. Díaz, S. Echeverria-Londoño, M. J. Edgar, A. Feldman, M. Garon, M. L. K. Harrison, T. Alhusseini, D. J. Ingram, Y. Itescu, J. Kattge, V. Kemp, L. Kirkpatrick, M. Kleyer, D. L. P. Correia, C. D. Martin, S. Meiri, M. Novosolov, Y. Pan, H. R. P. Phillips, D. W. Purves, A. Robinson, J. Simpson, S. L. Tuck, E. Weiher, H. J. White, R. M. Ewers, G. M. Mace, J. P. W. Scharlemann, & A. Purvis, 2015. Global effects of land use on local terrestrial biodiversity. Nature 520: 45–50.

Odum, E. P., & G. W. Barrett, 2007. Fundamentos de Ecologia. Thomson Learning, São Paulo, 612 pp.

Olsen, A. R. & D. V. Peck, 2008. Survey design and extent estimates for the Wadeable Streams Assessment. Journal of the North American Benthological Society 27: 822–836.

Peck, D. V., A. T. Herlihy, B. H. Hill, R. M. Hughes, P. R. Kaufmann, D. J. Klemm, J. M. Lazorchak, F. H. McCormik, S. A. Peterson, P. L. Ringold, T. Magee & M. R. Cappaert, 2006. Environmental Monitoring and Assessment Program – Surface waters western pilot study: Field Operations Manual for Wadeable Streams. EPA 600/R-06/003. U.S. Environmental Protection Agency, Washington, 275 pp.

Pelicice, F. M., & A. A. Agostinho, 2008. Fish-passage facilities as ecological traps in large neotropical rivers. Conservation Biology 22: 180–188.

Pes, A. M. O., N. Hamada & J. L. Nessimian, 2005. Chaves de identificação de larvas para famílias e gêneros de Trichoptera (Insecta) da Amazônia Central, Brasil. Revista Brasileira de Entomologia 49: 181–204.

Poff, N., 1997. Landscape filters and species traits: towards mechanistic understanding and prediction in stream ecology. Journal of the North American Benthological Society 16: 391–409.

Rader, R. B., 1997. A functional classification of the drift: traits that influence invertebrate availability to salmonids. Canadian Journal of Fisheries and Aquatic Sciences 54: 1211–1234.

Rockström, J., W. Steffen, K. Noone, Å. Persson, F. S. Chapin, E. F. Lambin, T. M. Lenton, M. Scheffer, C. Folke, H. J. Schellnhuber, B. Nykvist, C. A. de Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sörlin, P. K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R. W. Corell, V. J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen & J. A. Foley, 2009. A safe operating space for humanity. Nature 461: 472–475.

Rodrigues, M. E., F. de Oliveira Roque, J. M. O. Quintero, J. C. de Castro Pena, D. C. de Sousa & P. de Marco Junior, 2016. Nonlinear responses in damselfly community along a gradient of habitat loss in a savanna landscape. Biological Conservation 194: 113–120.

Ronce, O., 2007. How does it feel to be Like a rolling stone? Ten questions about dispersal evolution. Annual Review of Ecology, Evolution, and Systematics 38: 231–253.

Rosenberg, D. M. & V. H. Resh, 1993. Freshwater Biomonitoring and Benthic Macroinvertebrates. Chapman and Hall, New York, 488 pp.

Ruppert, E. E., R. S. Fox, & R. D. Barnes, 2005. Zoologia dos Invertebrados: Uma Abordagem Funcional-Evolutiva. Roca, São Paulo, 1145 pp.

Saito, V. S., J. Soininen, A. A. Fonseca-Gessner & T. Siqueira, 2015. Dispersal traits drive the phylogenetic distance decay of similarity in neotropical stream metacommunities. Journal of Biogeography 42: 2101–2111.

Sala, O. E., F. S. Chapin III, J. J. Armesto, E. Berlow, J. Blomfield, R. Dirzo, E. Huber-Sanwald, L. F. Huenneke, R. B. Jackson, A. Kinzig, R. Leemans, D. M. Lodge, H. A. Mooney, M. Oesterheld, M. L. Poff, M. T. Sykes, B. H. Walker, M. Walker & D. H. Wall, 2000. Global biodiversity scenarios for the year 2100. Science 287: 1770–1774.

Salles, F. F., 2006. A ordem Ephemeroptera no Brasil (Insecta): taxonomia e diversidade. Tese de doutorado. Universidade Federal de Viçosa. Viçosa, 276 pp.

Sanderson, J. & L. D. Harris, 2000. Landscape Ecology: a Top Down Approach. CRC Press LLC, Florida, 246 pp.

Sarremejane, R., H. Mykrä, N. Bonada, J. Aroviita & T. Muotka, 2017. Habitat connectivity and dispersal ability drive the assembly mechanisms of macroinvertebrate communities in river networks. Freshwater Biology 62: 1073–1082.

Seaber, P. R., F. P. Kapinos & G. L. Knapp, 1987. Hydrologic unit maps. U. S. Geological Survey Water-Supply Paper. U. S. Government Printing Office, Denver, 66 pp.

Shimano, Y. & L. Juen, 2016. How oil palm cultivation is affecting mayfly assemblages in Amazon streams. Annales de Limnologie - International Journal of Limnology 52: 35–45.

Silva, D. R. O., A. T. Herlihy, R. M. Hughes & M. Callisto, 2017. An improved macroinvertebrate multimetric index for the assessment of wadeable streams in the neotropical savanna. Ecological Indicators 81: 514–525.

Soininen, J., R. McDonald & H. Hillebrand, 2007. The distance decay of similarity in ecological communities. Ecography 30: 3–12.

Steffen, W., K. Richardson, J. Rockstrom, S. E. Cornell, I. Fetzer, E. M. Bennett, R. Biggs, S. R. Carpenter, W. de Vries, C. A. de Wit, C. Folke, D. Gerten, J. Heinke, G. M. Mace, L. M. Persson, V. Ramanathan, B. Reyers & S. Sorlin, 2015. Planetary boundaries: guiding human development on a changing planet. Science 347: 1259855.

Stephens, P. A., N. Pettorelli, J. Barlow, M. J. Whittingham & M. W. Cadotte, 2015. Management by proxy? The use of indices in applied ecology. Journal of Applied Ecology 52: 1–6.

Strahler, A. N., 1957. Quantitative analysis of watershed geomorphology. Transactions, American Geophysical Union 38: 913–920.

Strassburg, B. B. N., T. Brooks, R. Feltran-Barbieri, A. Iribarrem, R. Crouzeilles, R. Loyola, A. E. Latawiec, F. J. B. Oliveira Filho, C. A. M. De Scaramuzza, F. R. Scarano, B. Soares-Filho, & A. Balmford, 2017. Moment of truth for the Cerrado hotspot. Nature Ecology and Evolution Macmillan Publishers Limited 1: 1–3.

Stroud, J. T., M. R. Bush, M. C. Ladd, R. J. Nowicki, A. A. Shantz & J. Sweatman, 2015. Is a community still a community? Reviewing definitions of key terms in community ecology. Ecology and Evolution 5: 4757–4765.

Tobler, W. R., 1970. A Computer Movie Simulation Urban Growth in Detroit Region. Economic Geography 46: 234–240.

Tonkin, J. D., J. D. Olden, F. Altermatt, D. S. Finn, J. Heino, S. U. Pauls & D. A. Lytle, 2018. The role of dispersal in river network metacommunities: patterns, processes, and pathways. Freshwater Biology 23: 141–163.

Turner, M. G., 1989. Landscape ecology: the effect of pattern on process. Annual Review of Ecology and Systematics 20: 171–197.

Turner, M. G. & R. H. Gardner, 2015. Landscape Ecology in Theory and Pratice: Patterns and Process. Springer, New York, 482.

Urban, D. L., E. S. Minor, E. A. Treml & R. S. Schick, 2009. Graph models of habitat mosaics. Ecology Letters 12: 260–273.

Levin, S. A., 1992. The problem of pattern and scale in ecology: The Robert H . MacArthur award lecture. Ecology 73: 1943–1967.

Vellend, M., 2010. Conceptual synthesis in community ecology. The Quartelry Review of Biology 85: 183–206.

Violle, C., M.-L. Navas, D. Vile, E. Kazakou, C. Fortunel, I. Hummel & E. Garnier, 2007. Let the concept of trait be functional! Oikos 116: 882–892.

Vörösmarty, C. J., P. B. McIntyre, M. O. Gessner, D. Dudgeon, A. Prusevich, P. Green, S. Glidden, S. E. Bunn, C. A. Sullivan, C. R. Liermann & P. M. Davies, 2010. Global threats to human water security and river biodiversity. Nature 467: 555–561.

Walz, U., & C. Stein, 2014. Indicators of hemeroby for the monitoring of landscapes in Germany. Journal for Nature Conservation. 22: 279–289.

Wantzen, K. M., A. Siqueira, C. N. da Cunha, & M. de F.P. de Sá, 2006. Stream-valley systems of the Brazilian Cerrado: impact assessment and conservation scheme. Aquatic Conservation: Marine and Freshwater Ecosystems 16: 713–732.

Wiens, J. A., 1989. Spatial scaling in ecology. Functional Ecology 3: 385–307.

Wiens, J. A., 2002. Riverine landscapes: taking landscape ecology into the water. Freshwater Biology 47: 501–515.

Winegardner, A., A. K. Winegardner, B. K. Jones, I. S. Y. Ng, T. Siqueira & K. Cottenie, 2012. The terminology of metacommunity ecology. Trends in Ecology & Evolution 27: 253–254.

Woodward, G., M. O. Gessner, P. S. Giller, V. Gulis, S. Hladyz, A. Lecerf, B. Malmqvist, B. G. McKie, S. D. Tiegs, H. Cariss, M. Dobson, A. Elosegi, V. Ferreira, M. A. S. Graca, T. Fleituch, J. O. Lacoursiere, M. Nistorescu, J. Pozo, G. Risnoveanu, M. Schindler, A. Vadineanu, L. B.-M. Vought & E. Chauvet, 2012. Continental-scale effects of nutrient pollution on stream ecosystem functioning. Science 336: 1438–1440.

Zeller, K. A., K. McGarigal & A. R. Whiteley 2012. Estimating landscape resistance to movement: a review. Landscape Ecology 27: 777–797.

Anexos da tese

Anexo 1: Tabela com métricas abióticas analisadas em escalas de bacia de drenagem (“catchment scale”) e de trecho de riacho (“site scale”).

Anexo 2: Coordenadas geográficas (pseudo-mercator) de cada trecho de riacho.

Anexo 3: Tabelas com métricas abióticas em cada trecho de riacho.

Anexo 4: Tabelas com a abundância de táxons em cada trecho de riacho.

Anexo 5: Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Nota: os anexos estão disponíveis na versão em PDF.

Anexo 1. Tabela com métricas abióticas analisadas em escalas de bacia de drenagem (‘catchment scale”) e de trecho de riacho (“site scale”).

Scale	Type		Code	Metric name
Catchment	Climate		Annual rainfall average (mm)	Rainfall
			Annual temperature average (°C)	Temperature
	Catchment features		Altitude (m)	Altitude
			Basin elevation average (m)	Basin_elev_avg
			Basin elevation range (m)	Basin_elev_range
			Basin slope average (m)	Basin_slope_avg
			Basin slope range (m)	Basin_slope_range
			Catchment area (km^2)	Catchment_area
	Land use and cover		woodland (%)	Woodland
			Parkland (%)	Parkland
			Grassy wood (%)	Grassy_woody
			Palm swamp (%)	Palm_swamp
			Urban (%)	Urban
			Pasture (%)	Pasture
			Agriculture (%)	Agriculture
			Eucalyptus (%)	Eucalyptus
			Sum of natural cover (%)	Natural_sum
	Urbanization		Road density (km/km^2)	road_dens
			Population density (inhabitant/km^2)	pop_dens
			Household density (houses/km^2)	house_dens
	Impact index		Integrated Disturbance Index	IDI
			Catchment Disturbance Index	CDI
Site	Physical habitat	Channel morphology	Mean depth of cross-section (cm)	xdepth_s
			Mean wetted width (m)	xwidth
			Mean bankfull width (m)	xbkf_w
			Mean residual depht (cm)	rp100
			Reach mean water surface slope (%)	xslope
			Channel sinuosity (m/m)	sinu
		Bed substrate	Mean embeddness (channel and margin) (%)	xembed
			SD of embeddedness in channel + margin (%)	vembed
			log10 (relative bed stability)	lrbs
			Size (log10[geometric mean diameter]) (mm)	lsub_dmm
			Cobble (aeral proportion with diameter 64-250 mm)	p_cb
		Riparian	Mean mid-channel canopy density (%)	xcdenmid
			Standard deviation mid-channel canopy density (%)	vcdenmid
			Riparian vegetation cover (%)	xcmg
		Flow type	Glide (proportion of reach)	p_gl
			Pools (proportion glide + pool)	p_pool
			Slow-water habitat (proportion glide + pool)	p_slow
		Shelther	Corse litter (areal proportion)	p_bf
			Large woody debris in channel (pieces/ m^2)	clw_msq
			Brush and small debris (areal % cover)	pct_xfc_brs
			Undercut banks (areal % cover)	pct_xcf_ucb
			Anthropogenic fish cover (areal % cover)	pct_xfc_ant
	Impact indexes		Riparian human disturbance index	W1_HALL
			Composite riparian condition index	RCOND

Anexo 1 continuação. Tabela com métricas abióticas analisadas em escalas de bacia de drenagem (‘catchment scale”) e de trecho de riacho (“site scale”).

Scale	Type	Code	Metric name
Site	Water quality	Dissolved O2 (mg/L^{-1})	DO
		pH	pH
		Material in suspension (NTU)	Turbidity
		Total N (mg/L^{-1})	N-total
		Eletrical condictivity ($\mu S/cm^{-1}$)	Cond.
		Total dissolved solids (mg/L^{-1})	TDS
		Water temperature (°C)	T° C
		Total P (mg/L^{-1})	P-total

Anexo 2. Coordenadas geográficas (pseudo-mercator) de cada trecho de riacho.

Stream	XN	YN
np00008	-5292425.77	-2191103.155
np00012	-5256156.686	-2197289.095
np00016	-5231073.413	-2179756.909
np00028	-5256068.097	-2182407.552
np00047	-5219795.665	-2207513.515
np00052	-5304098.484	-2202266.281
np00054	-5237765.466	-2174212.248
np00055	-5217843.638	-2156990.942
np00075	-5235806.151	-2169792.672
np00092	-5260559.162	-2191395.829
np00095	-5211962.484	-2186357.928
np00096	-5241390.367	-2167890.776
np00097	-5262993.688	-2151548.003
np00100	-5236062.379	-2179200.037
np00108	-5245482.678	-2191019.034
np00110	-5284615.447	-2230632.869
np00112	-5247825.539	-2141550.323
np00128	-5272763.039	-2157351.714
np00132	-5230235.998	-2181848.484
np00139	-5239032.137	-2147195.935
np00144	-5260714.629	-2159240.703
np00187	-5213329.468	-2201634.741
np00192	-5289152.071	-2186340.308
np00203	-5212727.988	-2169410.032
np00228	-5306755.773	-2197489.642
np00240	-5278005.971	-2183970.316
np00251	-5214100.217	-2208390.467
np00287	-5212948.228	-2192922.615
np00368	-5245003.457	-2146949.543
np00375	-5222965.236	-2163384.439
np00443	-5217826.453	-2203409.214
np00511	-5238956.45	-2203578.808
np01524	-5296415.351	-2187213.789
np02991	-5230936.793	-2218142.01
np05612	-5284041.637	-2197788.989
np07308	-5248662.971	-2182152.431
np09612	-5247645.843	-2184061.618
np09757	-5224006.343	-2224988.882
np12892	-5260215.329	-2190167.555
np15048	-5290277.952	-2191935.558
rca02	-5215403	-2287374
rca08	-5256913	-2204074
rca22	-5198497	-2289162
rca23	-5195775	-2290908
rca29	-5275364	-2236379
rca30	-5225090	-2285046
rca31	-5259813	-2197862
rca44	-5265944	-2223661
rca47	-5278967	-2239487
rca49	-5234500	-2179828
rca52	-5233338	-2174326
rca53	-5227761	-2179633
rca57	-5204930	-2287704
rca58	-5204530	-2287059

Anexo 2 continuação. Coordenadas geográficas (pseudo-mercator) de cada trecho de riacho.

Stream	XN	YN
rca59	-5207990	-2287054
rca60	-5208144	-2287087
rca62	-5220853	-2271583
rca64	-5220668	-2274446
rca65	-5183681	-2183637
rca66	-5261588	-2192207
rca67	-5256521	-2197228
rca68	-5234967	-2175172
rca69	-5237371	-2170468
rca70	-5236639	-2178407
rca90	-5231958	-2171368
ss0001	-5659094.389	-2124221.076
ss0002	-5515157.433	-2145193.955
ss0008	-5495044.601	-2079551.345
ss0010	-5603288.782	-2160962.577
ss0014	-5637588.606	-2121497.59
ss0028	-5541379.095	-2094285.62
ss0029	-5549126.462	-2131714.569
ss0031	-5631492.225	-2101505.887
ss0033	-5555716.208	-2158091.466
ss0035	-5639296.82	-2137661.156
ss0037	-5532310.187	-2134460.599
ss0038	-5571472.442	-2150875.647
ss0044	-5524367.663	-2078213.248
ss0051	-5569751.366	-2061764.733
ss0053	-5532424.513	-2151622.4
ss0057	-5556095.767	-2152442.365
ss0059	-5627459.445	-2081248.277
ss0073	-5524772.763	-2116908.17
ss0078	-5652950.437	-2121606.409
ss0094	-5639594.344	-2130107.635
ss0105	-5566612.339	-2135756.318
ss0126	-5631318.701	-2122482.534
ss0129	-5561747.076	-2159235.538
ss0133	-5525438.083	-2163278.487
ss0144	-5558142.298	-2072888.367
ss0149	-5541029.872	-2152985.357
ss0150	-5576996.816	-2145713.484
ss0157	-5511352.824	-2133205.541
ss0175	-5621549.295	-2107707.535
ss0191	-5639509.93	-2082251.806
ss0199	-5576777.126	-2066223.941
ss0213	-5541995.797	-2149358.657
ss0351	-5625083.716	-2098036.221
ss0408	-5519968.534	-2108761.447
ss0411	-5607934.676	-2079929.36
ss0447	-5639767.16	-2085368.159
ss1000	-5522800.339	-2117122.621
ss4173	-5507053.257	-2150245.386
ss4330	-5508137.364	-2095184.852
tm0003	-5004750.107	-2126022.654
tm0007	-4972389.523	-2145334.853
tm0009	-5072222.944	-2136948.405
tm0027	-5008322.297	-2091517.139

Anexo 2 continuação. Coordenadas geográficas (pseudo-mercator) de cada trecho de riacho.

Stream	XN	YN
tm0028	-5087172.019	-2153537.617
tm0033	-5050820.427	-2182975.411
tm0040	-5084544.188	-2166847.426
tm0043	-5008248.455	-2084999.355
tm0058	-5028051.141	-2164074.176
tm0072	-5084165.549	-2088968.113
tm0082	-5059776.417	-2165142.853
tm0088	-5077451.902	-2101089.82
tm0090	-5032386.647	-2177727.163
tm0091	-5011467.842	-2098093.731
tm0106	-5025504.991	-2167613.682
tm0119	-4990319.557	-2123819.776
tm0126	-5010063.19	-2140962.549
tm0133	-5035764.758	-2181756.496
tm0134	-5011199.771	-2156475.391
tm0137	-5068464.747	-2129998.714
tm0159	-5009753.262	-2075816.963
tm0171	-5022241.142	-2076486.148
tm0178	-5037971.233	-2154479.13
tm0183	-4985081.139	-2135848.669
tm0187	-5022756.795	-2089235.919
tm0193	-5066443.542	-2192409.008
tm0209	-5056364.444	-2185712.292
tm0214	-5012400.678	-2164986.171
tm0220	-5080251.062	-2149398.791
tm0279	-4975396.637	-2159684.931
tm0283	-5010552.725	-2083445.622
tm0290	-5059074.702	-2176288.943
tm0296	-5080568.193	-2160999.766
tm0381	-5067101.495	-2154459.65
tm0391	-4967615.811	-2148333.222
tm0437	-5070297.099	-2140772.385
tm1865	-5066888.215	-2128753.251
tm3195	-5032925.298	-2065596.1
tm3962	-5004644.381	-2111140.683
tm6757	-5057918.993	-2172402.235
vg0002	-5326257.74	-2244702.268
vg0004	-5318625.348	-2287935.145
vg0016	-5340011.089	-2261589.381
vg0018	-5312304.015	-2248157.639
vg0021	-5346830.039	-2275568.606
vg0022	-5306570.541	-2253297.229
vg0034	-5323167.807	-2243889.352
vg0037	-5345010.14	-2266345.703
vg0044	-5341554.262	-2252390.287
vg0048	-5356906.82	-2261993.088
vg0080	-5346035.741	-2263544.872
vg0109	-5322994.726	-2255847.627
vg0112	-5353010.15	-2263342.846
vg0121	-5332598.845	-2260879.815
vg0124	-5351154.395	-2247650.839
vg0126	-5313692.863	-2307859.443
vg0128	-5368684.045	-2258778.703
vg0162	-5321330.68	-2250966.87

Anexo 2 continuação. Coordenadas geográficas (pseudo-mercator) de cada trecho de riacho.

Stream	XN	YN
vg0177	-5356052.856	-2271249.77
vg0191	-5323158.261	-2282967.364
vg0206	-5314517.536	-2293293.908
vg0210	-5320237.8	-2243732.521
vg0247	-5310177.433	-2311374.287
vg0252	-5339643.963	-2265206.209
vg0255	-5317948	-2282473.857
vg0277	-5340318.703	-2267512.465
vg0306	-5321099.363	-2247593.527
vg0320	-5352834.545	-2248198.652
vg0380	-5353615.37	-2251879.19
vg0387	-5324336.386	-2308151.743
vg0418	-5319545.544	-2247685.465
vg0433	-5353178.63	-2269348.715
vg0444	-5339265.223	-2259219.24
vg0447	-5321194.504	-2280954.409
vg0450	-5311716.721	-2252843.499
vg0511	-5317389.815	-2284069.711
vg0515	-5318759.144	-2306905.231
vg0558	-5314344.58	-2298670.47
vg0575	-5315792.509	-2285832.765
vg1257	-5318669.597	-2312079.527

Anexo 3. Tabelas com métricas abióticas em cada trecho de riacho.

	Climate		Catchment features						
Stream	Rainfall	Temperature	Altitude	Basin_elev_avg	Basin_elev_range	Basin_slope_avg	Basin_slope_range	Catchment_area
np00008	1558.50	20.21	920	1012.28	106.00	5.63	21.79	7.71
np00012	1619.71	19.97	871	1011.62	226.00	14.01	29.64	4.19
np00016	1566.46	20.74	835	997.77	345.00	14.44	56.74	32.72
np00028	1568.37	20.63	846	934.74	208.00	8.32	25.50	15.04
np00047	1611.00	20.45	900	960.54	84.00	7.71	15.24	1.73
np00052	1552.43	20.70	856	954.11	131.00	6.62	19.53	6.01
np00054	1557.09	20.84	845	989.04	355.00	10.95	45.71	50.74
np00055	1529.25	21.15	947	1024.34	123.00	6.26	15.52	10.41
np00075	1544.67	21.00	855	944.61	176.00	11.11	30.83	5.31
np00092	1608.33	19.97	940	1030.61	190.00	17.16	40.83	1.69
np00095	1547.20	21.10	897	924.71	84.00	5.90	12.60	3.22
np00096	1519.30	21.33	817	895.96	108.00	6.20	24.13	17.32
np00097	1516.50	20.74	865	1014.02	203.00	8.50	26.88	7.33
np00100	1564.70	20.78	823	972.03	307.00	8.92	30.22	8.64
np00108	1590.00	20.60	860	924.23	79.00	6.10	14.49	3.40
np00110	1621.57	20.14	893	1007.63	147.00	7.66	17.95	6.79
np00112	1494.22	21.37	877	943.79	104.00	6.03	15.14	7.28
np00128	1504.00	20.77	841	949.57	206.00	11.72	35.53	2.82
np00132	1556.50	21.05	854	905.49	140.00	7.74	20.87	1.38
np00139	1497.32	21.47	863	942.17	117.00	5.34	18.44	15.40
np00144	1503.00	21.13	826	910.63	204.00	11.36	25.45	3.65
np00187	1585.29	20.70	891	933.67	98.00	7.12	19.06	6.37
np00192	1555.00	20.26	910	1007.22	110.00	3.44	15.53	23.58
np00203	1531.21	21.18	888	1004.53	201.00	11.56	37.33	15.48
np00228	1537.40	20.62	870	961.00	116.00	6.84	17.29	4.58
np00240	1570.50	20.05	960	1029.03	84.00	7.30	19.64	1.54
np00251	1602.00	20.47	909	971.97	94.00	8.64	19.37	3.15
np00287	1561.85	21.01	833	899.57	132.00	7.55	21.02	16.96
np00368	1496.11	21.39	967	940.11	117.00	5.22	16.07	7.37
np00375	1537.33	21.03	948	1004.08	104.00	10.99	31.61	2.32
np00443	1601.11	20.52	887	951.22	111.00	7.75	21.87	13.40
np00511	1631.77	20.30	868	919.92	142.00	7.50	26.27	28.72
np01524	1550.67	20.23	914	1019.94	94.00	3.16	15.78	7.92
np02991	1657.43	20.10	895	947.69	116.00	8.18	20.78	5.90

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Climate		Catchment features					
Stream	Rainfall	Temperature	Altitude	Basin_elev_avg	Basin_elev_range	Basin_slope_avg	Basin_slope_range	Catchment_area
np05612	1594.68	20.02	954	1035.86	119.00	4.27	18.17	29.60
np07308	1567.50	20.75	839	906.89	85.00	9.00	21.11	1.39
np09612	1565.75	20.83	860	912.57	93.00	6.99	13.41	2.92
np09757	1618.31	19.98	952	1036.58	171.00	8.95	21.31	10.81
np12892	1599.67	20.14	904	980.29	209.00	12.34	34.44	6.90
np15048	1569.81	20.20	931	1011.11	128.00	5.13	17.95	27.80
rca02	1542.00	19.50	1203	1067.60	58.00	11.06	9.22	0.14
rca08	1634.33	19.77	917	1054.87	243.00	12.65	35.00	5.07
rca22	1600.33	18.13	1218	1321.28	134.00	6.41	16.49	3.85
rca23	1603.25	18.13	1240	1309.66	173.00	8.02	19.40	3.29
rca29	1646.00	19.53	1031	1088.85	98.00	3.96	14.54	6.78
rca30	1579.00	19.10	1243	1243.79	41.00	12.35	22.28	0.13
rca31	1632.67	19.70	1033	1081.63	99.00	8.74	18.32	3.07
rca44	1634.00	19.90	995	1031.63	64.00	9.06	13.51	0.32
rca47	1629.11	19.93	916	1019.72	171.00	8.92	28.38	6.70
rca49	1533.00	21.40	836	886.32	125.00	13.55	35.15	0.77
rca52	1559.23	20.77	900	1017.83	282.00	9.10	46.43	21.76
rca53	1573.00	20.62	876	1012.16	271.00	15.02	43.94	5.46
rca57	1611.83	18.02	1245	1332.56	178.00	7.69	24.51	5.53
rca58	1601.25	18.20	1210	1312.39	143.00	7.15	18.65	3.74
rca59	1615.82	17.97	1220	1320.87	193.00	6.86	20.64	11.02
rca60	1611.86	18.23	1215	1279.83	145.00	7.97	21.24	6.67
rca62	1536.75	21.13	1199	939.27	190.00	9.56	28.36	14.69
rca64	1531.50	21.18	1039	1002.58	212.00	11.26	31.66	16.26
rca65	1600.69	18.09	1048	1312.41	162.00	6.73	18.35	12.41
rca66	1623.00	19.60	997	1071.25	123.00	12.72	27.06	0.72
rca67	1603.00	20.30	903	975.70	155.00	13.26	17.98	0.78
rca68	1565.50	20.73	927	1025.44	285.00	12.26	43.78	6.52
rca69	1565.50	20.73	851	1025.59	285.00	12.32	43.78	6.52
rca70	1547.00	21.07	840	904.38	190.00	13.14	33.45	2.49
rca90	1562.00	20.80	916	979.81	114.00	10.57	26.54	2.29
ss0001	1589.25	22.95	705	736.22	69.00	3.68	7.11	3.32
ss0002	1386.39	23.93	484	577.85	222.00	4.14	33.33	32.69
ss0008	1299.43	23.44	601	687.70	135.00	6.13	18.75	6.05

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Climate		Catchment features						
Stream	Rainfall	Temperature	Altitude	Basin_elev_avg	Basin_elev_range	Basin_slope_avg	Basin_slope_range	Catchment_area
ss0010	1453.91	24.21	434	484.31	114.00	3.25	10.59	38.27
ss0014	1526.09	24.12	478	534.15	91.00	3.10	10.51	8.97
ss0028	1437.43	24.20	471	557.27	203.00	4.65	17.04	17.53
ss0029	1444.48	24.35	409	522.01	226.00	3.79	13.64	70.17
ss0031	1548.00	23.97	541	579.59	186.00	8.53	43.40	2.13
ss0033	1458.64	24.35	462	516.10	178.00	5.98	45.52	18.06
ss0035	1533.58	23.70	479	587.74	293.00	6.75	47.03	108.45
ss0037	1442.24	24.08	491	567.25	251.00	4.70	48.72	31.60
ss0038	1492.36	24.06	489	555.94	190.00	6.72	36.57	27.97
ss0044	1369.68	24.22	458	559.52	229.00	4.35	19.22	68.32
ss0051	1459.93	24.20	502	571.24	136.00	3.73	15.62	12.84
ss0053	1438.75	24.05	512	558.78	83.00	4.04	8.44	4.02
ss0057	1466.25	24.33	496	528.31	174.00	7.18	46.10	3.44
ss0059	1548.00	24.18	521	565.81	191.00	6.33	47.90	4.77
ss0073	1418.56	24.04	453	572.75	225.00	4.34	25.60	79.90
ss0078	1567.77	23.33	491	659.95	273.00	9.65	52.40	18.29
ss0094	1518.50	24.02	490	533.44	107.00	3.55	16.29	9.99
ss0105	1468.35	24.48	410	491.73	130.00	4.13	11.50	19.35
ss0126	1540.10	23.87	424	578.70	325.00	6.35	41.11	23.50
ss0129	1476.60	24.11	468	551.42	246.00	9.09	52.19	70.71
ss0133	1390.02	24.06	475	544.55	247.00	5.62	57.13	43.32
ss0144	1430.85	24.38	446	532.37	200.00	4.04	15.44	17.53
ss0149	1451.26	24.16	485	548.38	182.00	4.67	43.16	43.25
ss0150	1492.29	24.10	478	550.41	209.00	6.64	49.99	25.31
ss0157	1394.00	23.80	579	617.21	59.00	3.81	7.23	2.44
ss0175	1535.11	24.06	506	563.45	204.00	5.67	35.42	7.74
ss0191	1584.39	23.69	531	632.44	313.00	9.09	48.94	18.28
ss0199	1435.86	24.68	411	477.87	220.00	3.35	25.44	40.77
ss0213	1453.28	24.25	457	535.06	144.00	3.97	11.10	46.16
ss0351	1539.18	24.08	450	558.38	291.00	7.15	48.89	44.59
ss0408	1357.27	24.41	438	514.02	151.00	6.52	29.41	18.21
ss0411	1559.34	23.81	499	626.72	336.00	7.25	74.85	93.53
ss0447	1567.34	23.93	521	597.19	272.00	6.89	49.56	49.07
ss1000	1419.86	24.15	460	560.99	178.00	4.75	15.57	11.96

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Climate		Catchment features					
Stream	Rainfall	Temperature	Altitude	Basin_elev_avg	Basin_elev_range	Basin_slope_avg	Basin_slope_range	Catchment_area
ss4173	1333.00	24.20	513	530.62	43.00	8.10	14.86	0.37
ss4330	1260.59	24.38	431	514.30	236.00	6.19	28.93	36.24
tm0003	1184.67	22.68	590	672.02	78.70	5.46	50.52	87.90
tm0007	1198.30	21.97	623	698.52	45.39	6.30	27.36	105.06
tm0009	1355.00	22.59	647	759.90	52.36	11.56	37.78	17.27
tm0027	1261.70	21.75	765	838.55	13.86	4.47	13.92	7.50
tm0028	1412.44	22.18	666	761.12	41.29	16.72	48.96	7.48
tm0033	1364.00	22.60	659	704.72	9.32	8.46	16.47	1.57
tm0040	1449.00	21.50	815	930.02	39.89	10.39	19.53	0.45
tm0043	1264.63	21.74	784	815.50	18.21	4.15	12.36	7.37
tm0058	1267.57	22.60	639	622.89	15.69	7.20	18.51	5.55
tm0072	1386.17	22.37	734	783.35	17.21	8.80	475.30	9.10
tm0082	1363.56	22.94	584	611.60	19.66	5.51	18.45	44.81
tm0088	1376.25	22.10	770	791.92	15.23	8.53	35.31	3.16
tm0090	1303.25	22.50	648	721.60	27.22	6.77	16.93	5.13
tm0091	1253.38	21.69	709	839.01	47.71	7.98	30.23	103.59
tm0106	1262.00	22.63	645	692.29	18.82	7.53	18.85	1.87
tm0119	1184.57	22.50	600	680.64	64.05	4.59	47.34	72.54
tm0126	1204.16	22.67	591	636.90	25.74	4.84	13.34	38.00
tm0133	1319.13	22.67	614	646.54	16.35	6.09	16.92	11.93
tm0134	1222.00	22.50	669	675.79	15.12	6.10	8.76	1.10
tm0137	1338.82	22.74	611	712.72	69.30	10.50	44.34	62.05
tm0159	1257.57	21.74	729	827.53	34.38	6.00	20.70	164.97
tm0171	1258.63	21.98	675	794.44	43.18	5.80	25.31	162.23
tm0178	1277.03	22.93	586	614.73	22.98	4.84	16.02	30.16
tm0183	1186.00	22.44	616	678.79	43.86	3.40	37.45	53.83
tm0187	1265.56	22.01	742	796.71	19.35	4.22	13.25	24.98
tm0193	1402.26	22.53	621	673.05	23.19	6.24	396.25	109.18
tm0209	1386.62	22.54	637	642.13	18.35	5.74	18.46	53.29
tm0214	1229.57	22.57	636	680.00	29.64	4.77	15.33	44.48
tm0220	1415.25	21.98	671	813.19	36.92	14.24	52.18	10.92
tm0279	1201.77	21.84	642	754.23	39.61	5.95	25.03	157.22
tm0283	1262.06	21.72	753	834.13	23.95	4.44	14.14	55.32
tm0290	1381.17	22.74	606	630.16	16.84	5.04	16.41	22.98
tm0296	1435.47	21.84	682	871.57	68.93	14.81	47.73	24.59

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Climate		Catchment features					
Stream	Rainfall	Temperature	Altitude	Basin_elev_avg	Basin_elev_range	Basin_slope_avg	Basin_slope_range	Catchment_area
tm0381	1364.26	22.75	587	688.66	79.65	10.44	55.99	106.80
tm0391	1200.05	21.88	652	717.39	41.53	6.29	27.36	71.36
tm0437	1349.97	22.76	594	703.82	50.45	9.78	36.89	30.17
tm1865	1336.04	22.76	608	707.65	70.36	10.15	44.34	65.88
tm3195	1284.00	22.15	739	775.07	11.59	3.67	9.73	3.39
tm3962	1205.96	22.37	599	735.84	70.20	11.85	49.20	20.46
tm6757	1373.50	22.83	608	609.45	14.80	4.84	9.99	3.63
vg0002	1587.75	21.80	769	808.52	74.00	4.63	10.59	2.64
vg0004	1529.52	21.84	593	707.67	231.00	7.96	30.92	16.36
vg0016	1541.77	22.40	602	725.14	200.00	4.72	21.71	87.85
vg0018	1586.40	21.58	737	812.81	120.00	4.66	10.62	3.28
vg0021	1443.00	22.93	527	594.04	135.00	5.48	15.59	7.01
vg0022	1585.00	21.37	701	795.55	158.00	8.70	22.22	3.06
vg0034	1586.13	21.85	736	802.63	108.00	6.16	15.73	5.06
vg0037	1496.50	22.65	585	658.07	123.00	4.27	16.18	11.20
vg0044	1550.50	22.28	709	755.38	91.00	4.05	16.40	6.86
vg0048	1472.47	22.85	581	637.60	97.00	3.84	15.78	12.04
vg0080	1510.81	22.55	593	686.30	174.00	4.17	28.30	25.46
vg0109	1557.19	22.32	625	706.57	161.00	5.29	18.52	20.93
vg0112	1511.28	22.58	576	692.60	229.00	4.62	18.44	52.74
vg0121	1530.00	22.54	598	676.51	121.00	5.51	13.88	8.52
vg0124	1543.03	22.35	683	749.48	115.00	3.85	15.54	25.58
vg0126	1535.14	21.24	674	780.85	177.00	6.43	29.99	6.67
vg0128	1457.83	22.93	584	639.33	100.00	6.23	18.32	4.86
vg0162	1571.96	22.15	651	748.26	171.00	5.09	24.22	20.68
vg0177	1432.91	23.09	511	575.99	138.00	6.59	19.84	7.57
vg0191	1518.70	22.21	536	645.11	203.00	6.17	25.84	38.06
vg0206	1542.88	21.38	631	757.40	246.00	12.74	53.18	5.28
vg0210	1591.25	21.59	713	815.69	203.00	7.15	28.13	24.74
vg0247	1535.50	21.15	685	787.33	173.00	6.85	17.76	8.24
vg0252	1535.37	22.45	560	712.00	195.00	5.17	21.96	110.95
vg0255	1532.00	21.93	573	660.04	152.00	8.85	24.89	19.37
vg0277	1532.37	22.48	536	706.44	193.00	5.29	21.67	116.43
vg0306	1586.20	21.74	669	802.23	243.00	7.31	29.78	50.56

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Climate		Catchment features					
Stream	Rainfall	Temperature	Altitude	Basin_elev_avg	Basin_elev_range	Basin_slope_avg	Basin_slope_range	Catchment_area
vg0320	1524.00	22.42	700	747.03	108.00	3.85	14.51	4.10
vg0380	1530.47	22.44	627	722.80	91.00	4.23	11.63	47.69
vg0387	1493.33	22.27	545	629.39	176.00	5.00	16.45	22.35
vg0418	1581.33	21.86	688	786.64	174.00	6.90	18.77	8.42
vg0433	1477.15	22.79	531	618.27	197.00	5.17	24.06	85.40
vg0444	1544.35	22.39	599	731.25	205.00	4.43	21.44	80.09
vg0447	1527.28	22.17	536	633.50	187.00	7.97	22.87	35.47
vg0450	1587.88	21.53	669	813.28	316.00	6.93	29.94	49.68
vg0511	1533.13	21.85	603	700.57	167.00	7.48	23.08	13.55
vg0515	1518.18	21.72	555	705.70	239.00	8.62	34.33	26.57
vg0558	1556.13	20.93	612	845.24	267.00	5.36	61.32	12.15
vg0575	1537.30	21.69	626	722.79	182.00	6.71	21.61	8.50
vg1257	1498.57	22.20	588	629.53	134.00	3.21	12.34	5.18

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Land use and cover									Urbanization			Impact index	
Stream	Woodland	Parkland	Grassy_woody	Palm_swamp	Urban	Pasture	Agriculture	Eucalyptus	Natural_sum	road_dens	pop_dens	house_dens	IDI	CDI
np00008	8.89	0.00	4.99	2.15	0.00	3.99	79.99	0.00	16.02	0.57	13.00	4.80	0.56	163.97
np00012	30.06	0.00	57.52	0.00	0.00	11.40	1.02	0.00	87.58	0.00	0.00	0.00	0.34	13.44
np00016	11.89	81.18	0.00	0.00	0.00	2.39	4.54	0.00	93.07	0.00	2.00	0.09	0.04	11.46
np00028	17.72	0.00	13.11	0.00	0.00	15.32	53.84	0.00	30.84	0.25	40.00	8.58	0.43	123.00
np00047	27.72	0.00	8.24	0.00	0.00	38.60	25.44	0.00	35.96	0.00	0.00	0.00	0.30	89.47
np00052	8.26	0.00	21.51	0.00	0.00	15.55	54.68	0.00	29.77	0.09	0.00	0.00	0.44	124.90
np00054	10.56	56.83	0.00	0.00	0.00	12.69	19.91	0.00	67.40	0.00	17.00	1.20	0.22	52.52
np00055	9.38	0.00	0.00	0.00	0.00	0.00	90.62	0.00	9.38	0.00	20.00	6.24	0.61	181.24
np00075	5.84	88.31	0.00	0.00	0.00	0.00	5.85	0.00	94.15	0.00	0.00	0.00	0.14	11.70
np00092	21.33	0.00	0.00	2.10	0.00	70.80	5.78	0.00	23.42	0.60	0.00	0.00	0.44	82.36
np00095	12.69	0.00	0.00	0.00	0.00	2.48	84.83	0.00	12.69	0.61	1.00	0.31	0.60	172.14
np00096	12.68	0.00	0.85	0.00	0.00	5.08	81.39	0.00	13.53	0.00	19.00	3.81	0.56	167.86
np00097	19.31	0.00	2.50	0.00	0.00	31.98	46.21	0.00	21.80	0.62	9.00	4.50	0.54	124.41
np00100	9.03	68.61	0.00	0.00	0.00	0.00	22.37	0.00	77.63	0.00	1.00	0.35	0.16	44.74
np00108	24.34	0.00	0.00	0.00	0.00	0.00	75.66	0.00	24.34	0.00	0.00	0.00	0.52	151.33
np00110	23.35	0.00	3.66	0.00	0.00	14.75	58.24	0.00	27.01	0.59	4.00	1.91	0.44	131.23
np00112	14.19	0.00	0.00	0.00	0.00	22.74	63.07	0.00	14.19	0.39	1.00	0.27	0.52	148.87
np00128	25.23	0.00	21.77	1.10	0.00	30.19	21.71	0.00	48.10	0.00	2.00	2.84	0.59	73.61
np00132	18.65	25.10	0.00	0.00	0.00	0.00	56.26	0.00	43.74	0.00	1.00	2.90	0.40	112.52
np00139	14.51	0.00	0.00	0.42	0.00	0.00	85.07	0.00	14.93	0.39	9.00	1.95	0.61	170.14
np00144	14.24	0.00	34.99	0.00	0.00	6.35	44.42	0.00	49.23	0.00	0.00	0.00	0.39	95.19
np00187	9.35	0.00	27.80	0.00	0.00	1.36	61.49	0.00	37.15	0.49	3.00	1.26	0.41	124.35
np00192	4.54	0.00	13.03	1.34	0.00	1.46	79.64	0.00	18.90	0.21	6.00	0.85	0.55	160.74
np00203	20.20	16.59	24.59	0.00	0.00	28.23	10.40	0.00	61.37	0.00	14.00	3.17	0.22	49.03
np00228	16.97	0.00	8.79	0.00	0.00	3.00	71.24	0.00	25.76	1.65	19.00	12.45	0.65	145.47
np00240	11.27	0.00	0.00	0.00	0.00	34.72	54.01	0.00	11.27	0.00	0.00	0.00	0.60	142.75
np00251	19.13	0.00	10.34	0.00	0.00	8.83	61.70	0.00	29.47	0.11	1.00	0.63	0.45	132.23
np00287	13.28	0.00	14.15	0.00	0.00	15.80	56.78	0.00	27.42	0.39	5.00	0.88	0.50	129.36
np00368	7.92	0.00	1.86	0.00	0.00	0.00	90.22	0.00	9.78	0.29	7.00	3.53	0.79	180.45
np00375	17.37	45.61	2.08	0.00	0.00	32.77	2.16	0.00	65.06	0.00	5.00	6.47	0.28	37.10
np00443	13.87	0.00	24.60	0.00	0.00	0.00	61.53	0.00	38.47	0.21	2.00	0.67	0.41	123.06
np00511	11.33	0.00	8.01	0.00	0.00	3.13	77.53	0.00	19.34	0.00	0.00	0.00	0.56	158.20
np01524	7.08	0.00	0.00	0.00	0.00	0.00	92.92	0.00	7.08	0.27	3.00	1.39	0.75	185.83
np02991	14.49	0.00	11.86	0.00	3.53	0.00	70.12	0.00	26.35	1.17	10.00	4.58	0.52	154.36

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Land use and cover									Urbanization			Impact index	
Stream	Woodland	Parkland	Grassy_woody	Palm_swamp	Urban	Pasture	Agriculture	Eucalyptus	Natural_sum	road_dens	pop_dens	house_dens	IDI	CDI
np05612	5.32	0.00	9.72	4.40	0.00	4.29	76.27	0.00	19.44	0.09	7.00	0.84	0.58	156.83
np07308	33.21	0.00	57.56	0.00	0.00	8.46	0.78	0.00	90.76	0.00	0.00	0.00	0.04	10.02
np09612	14.77	0.00	5.19	0.00	0.00	18.31	61.73	0.00	19.96	0.00	0.00	0.00	0.47	141.76
np09757	10.01	0.00	6.41	3.31	29.76	19.60	30.91	0.00	19.74	6.04	3018.00	920.91	1.26	200.43
np12892	27.09	0.00	0.00	3.22	0.00	68.27	1.42	0.00	30.31	0.33	2.00	1.30	0.56	71.11
np15048	6.63	0.00	9.00	5.01	2.60	13.51	63.26	0.00	20.63	0.61	924.00	110.14	1.29	150.42
rca02	0.57	99.43	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00
rca08	50.39	20.84	5.68	0.00	0.00	16.26	6.83	0.00	76.91	0.25	4.00	1.58	0.10	29.92
rca22	1.89	98.11	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.70	0.00	0.00	0.00	0.00
rca23	3.50	96.50	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.29	0.00	0.00	0.00	0.00
rca29	19.39	0.00	3.97	0.00	0.00	6.49	70.15	0.00	23.36	0.00	0.44	0.15	0.49	146.80
rca30	2.33	23.34	0.00	0.00	0.00	23.69	50.64	0.00	25.67	0.00	0.00	0.00	0.44	124.97
rca31	28.04	37.79	0.00	0.00	0.00	2.89	31.27	0.00	65.84	0.00	2.00	2.93	0.23	65.44
rca44	23.63	0.00	0.00	0.00	0.00	76.37	0.00	0.00	23.63	0.00	0.00	0.00	0.26	76.37
rca47	32.07	0.00	2.37	0.00	0.00	13.33	52.23	0.00	34.44	0.12	0.60	0.15	0.41	117.79
rca49	6.39	75.54	0.00	0.00	0.00	0.00	18.07	0.00	81.93	0.00	1.00	3.90	0.18	36.14
rca52	5.43	93.01	0.00	0.00	0.00	0.00	1.56	0.00	98.44	0.00	11.00	1.93	0.07	3.11
rca53	15.14	77.39	0.00	0.00	0.00	4.50	2.97	0.00	92.53	0.00	0.00	0.00	0.14	10.44
rca57	1.05	98.95	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.35	0.00	0.00	0.00	0.00
rca58	2.89	97.11	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.67	0.00	0.00	0.00	0.00
rca59	0.66	99.34	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.51	0.00	0.00	0.00	0.00
rca60	0.59	99.41	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.82	1.00	0.60	0.00	0.00
rca62	4.71	95.29	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	8.00	1.97	0.00	0.00
rca64	8.40	38.71	52.90	0.00	0.00	0.00	0.00	0.00	100.00	0.00	15.00	3.32	0.07	0.00
rca65	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.58	0.00	0.00	0.03	0.00
rca66	13.78	0.00	5.93	0.00	0.00	66.63	13.66	0.00	19.71	0.00	0.00	0.00	0.33	93.95
rca67	28.53	44.51	0.00	0.00	0.00	25.88	1.08	0.00	73.03	0.00	0.00	0.00	0.12	28.05
rca68	9.81	89.04	0.00	0.00	0.00	0.00	1.16	0.00	98.84	0.00	0.00	0.00	0.01	2.31
rca69	6.84	58.29	0.00	0.00	0.00	13.84	21.03	0.00	65.13	0.00	0.00	0.00	0.19	55.90
rca70	13.58	52.65	32.32	0.00	0.00	0.00	1.44	0.00	98.56	0.00	0.00	0.00	0.01	2.88
rca90	10.29	36.16	0.00	0.00	0.00	26.55	27.00	0.00	46.46	0.00	0.00	0.00	0.33	80.54
ss0001	5.92	0.00	0.00	0.00	0.00	0.00	94.08	0.00	5.92	0.00	3.00	3.01	0.66	188.15
ss0002	15.27	0.00	2.45	0.00	0.00	13.29	65.82	3.17	17.72	0.00	10.00	0.89	0.51	148.10
ss0008	14.09	0.00	3.38	0.00	0.00	1.93	80.60	0.00	17.47	0.55	3.00	0.99	0.70	163.13

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Land use and cover									Urbanization			Impact index	
Stream	Woodland	Parkland	Grassy_woody	Palm_swamp	Urban	Pasture	Agriculture	Eucalyptus	Natural_sum	road_dens	pop_dens	house_dens	IDI	CDI
ss0010	5.39	0.00	0.00	5.85	0.00	12.39	76.36	0.00	11.24	0.40	11.00	0.86	0.60	165.12
ss0014	2.18	0.00	0.00	3.78	0.00	24.75	69.29	0.00	5.96	0.00	1.00	0.22	0.59	163.32
ss0028	7.29	0.00	0.00	3.21	0.00	0.00	88.14	1.36	10.49	0.00	9.00	1.25	0.62	177.65
ss0029	6.62	0.00	0.00	2.66	0.00	0.00	90.73	0.00	9.27	1.01	64.00	2.35	0.72	181.45
ss0031	17.56	5.38	0.00	11.33	0.00	3.71	62.03	0.00	34.26	0.39	0.00	0.00	0.57	127.76
ss0033	11.85	13.00	0.92	0.31	0.00	49.87	21.21	2.86	26.07	0.06	8.00	1.33	0.44	95.14
ss0035	24.34	0.00	1.11	2.20	0.00	20.74	50.25	1.37	27.65	0.00	18.00	0.44	0.45	122.60
ss0037	10.98	0.00	2.59	3.05	0.00	7.48	75.89	0.00	16.63	0.22	13.00	1.30	0.56	159.27
ss0038	21.44	0.00	1.60	2.47	0.00	2.93	66.27	5.29	25.50	0.00	22.00	2.22	0.52	140.77
ss0044	9.05	0.00	0.31	3.16	0.00	2.11	85.38	0.00	12.51	0.21	41.00	1.70	0.60	172.87
ss0051	12.32	0.00	1.86	1.16	0.00	1.89	82.77	0.00	15.34	0.00	8.00	2.10	0.58	167.43
ss0053	10.52	0.00	0.00	0.00	0.00	0.00	89.48	0.00	10.52	0.86	2.00	0.75	0.62	178.96
ss0057	18.18	0.11	0.00	0.00	0.00	61.35	20.36	0.00	18.29	1.42	2.00	1.74	0.44	102.07
ss0059	13.81	2.27	8.70	5.22	0.00	2.35	67.66	0.00	30.00	0.00	0.00	0.00	0.56	137.66
ss0073	10.95	0.00	0.53	0.08	4.57	0.00	83.87	0.00	11.56	1.86	4712.00	180.61	0.75	186.03
ss0078	24.89	0.00	0.00	1.48	0.00	10.66	61.74	1.23	26.37	0.00	0.00	0.00	0.51	135.37
ss0094	8.78	0.00	0.00	0.00	0.00	8.90	82.32	0.00	8.78	0.00	0.00	0.00	0.64	173.54
ss0105	8.19	0.00	3.64	2.69	0.00	0.00	85.48	0.00	14.52	0.08	6.00	1.34	0.70	170.96
ss0126	19.48	0.00	0.00	0.20	0.00	13.77	66.54	0.00	19.69	0.00	6.00	0.72	0.67	146.85
ss0129	12.14	0.00	0.65	2.08	0.00	7.20	72.12	5.81	14.87	0.16	14.00	0.55	0.54	157.24
ss0133	13.68	3.27	4.49	0.00	0.00	16.31	60.63	1.62	21.44	0.24	18.00	1.08	0.46	139.19
ss0144	6.45	0.00	4.03	2.60	0.00	0.00	86.93	0.00	13.07	0.00	5.00	0.97	0.67	173.85
ss0149	13.55	0.58	0.00	3.97	0.00	26.76	55.14	0.00	18.10	0.19	17.00	1.32	0.50	137.04
ss0150	10.56	0.00	2.33	8.49	0.00	13.17	62.39	3.07	21.38	0.00	16.00	1.66	0.71	141.01
ss0157	8.00	0.00	0.00	0.00	0.00	0.00	92.00	0.00	8.00	0.67	4.00	5.33	0.64	184.01
ss0175	22.72	2.55	0.00	4.18	0.00	2.78	67.78	0.00	29.44	0.00	7.00	1.94	0.48	138.33
ss0191	25.08	2.75	0.00	4.56	0.00	11.25	56.36	0.00	32.40	0.08	17.00	2.08	0.44	123.96
ss0199	14.54	0.00	0.54	6.72	0.00	1.06	77.15	0.00	21.80	0.00	3.00	0.27	0.54	155.35
ss0213	7.00	0.00	1.72	5.17	0.00	52.10	32.58	1.42	13.89	0.46	24.00	1.32	0.44	118.69
ss0351	16.11	1.65	1.61	2.29	0.00	16.33	62.01	0.00	21.66	0.07	19.00	1.28	0.47	140.34
ss0408	20.12	0.00	1.24	1.35	0.00	0.76	76.53	0.00	22.70	1.79	13.00	2.58	0.55	153.83
ss0411	25.82	1.00	0.00	1.21	0.00	8.44	63.54	0.00	28.03	0.06	3.00	0.10	0.47	135.51
ss0447	16.23	1.03	0.00	4.87	0.00	9.69	67.00	1.18	22.13	0.03	31.00	1.55	0.48	144.87
ss1000	14.00	0.00	0.69	0.29	0.00	0.00	85.02	0.00	14.98	0.22	4.00	0.67	0.61	170.03

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Land use and cover									Urbanization			Impact index	
Stream	Woodland	Parkland	Grassy_woody	Palm_swamp	Urban	Pasture	Agriculture	Eucalyptus	Natural_sum	road_dens	pop_dens	house_dens	IDI	CDI
ss4173	0.00	0.00	15.48	0.00	84.52	0.00	0.00	0.00	15.48	14.56	271.00	2232.43	1.48	338.10
ss4330	19.53	0.00	0.00	0.67	2.46	4.90	72.44	0.00	20.20	0.56	589.00	48.57	1.14	159.63
tm0003	9.20	4.92	6.56	1.70	0.00	61.10	3.83	12.69	22.38	0.15	69.00	2.35	0.38	81.44
tm0007	8.93	27.59	7.10	0.00	0.00	34.85	1.21	20.32	43.63	0.02	19.00	0.54	0.31	57.58
tm0009	48.87	9.86	10.07	0.00	0.00	31.21	0.00	0.00	68.79	0.00	15.00	2.49	0.29	31.21
tm0027	8.16	0.74	19.01	1.72	0.00	35.21	0.34	34.82	29.64	0.00	2.00	0.53	0.29	70.71
tm0028	56.19	24.81	0.00	0.00	0.00	19.00	0.00	0.00	81.00	0.00	1.00	0.40	0.34	19.00
tm0033	11.23	20.69	18.63	0.00	0.00	41.12	0.00	8.33	50.55	0.00	0.00	0.00	0.38	49.45
tm0040	16.18	4.71	11.00	0.00	0.00	68.11	0.00	0.00	31.89	0.00	1.00	6.67	0.36	68.11
tm0043	5.68	9.80	29.57	0.00	0.00	28.40	8.91	17.63	45.06	0.00	0.00	0.00	0.45	63.85
tm0058	7.31	24.24	6.69	0.00	0.00	59.94	0.00	1.82	38.24	0.00	0.00	0.00	0.52	61.76
tm0072	24.13	23.77	3.55	0.00	0.00	45.42	3.12	0.00	51.45	0.12	1.00	0.33	0.17	51.67
tm0082	12.30	3.39	5.81	2.97	0.16	72.23	1.70	1.44	24.47	0.46	116.00	8.39	0.30	77.72
tm0088	4.72	74.71	0.00	0.00	0.00	20.57	0.00	0.00	79.43	0.00	0.00	0.00	0.15	20.57
tm0090	21.33	21.48	6.70	0.00	0.00	44.63	1.60	4.27	49.51	0.16	3.00	2.53	0.21	52.09
tm0091	16.32	20.07	11.97	0.00	0.00	49.71	0.94	0.98	48.37	0.00	29.00	0.77	0.24	52.57
tm0106	9.32	30.73	11.24	0.00	0.00	38.43	0.00	10.28	51.29	0.00	1.00	1.07	0.17	48.71
tm0119	10.98	6.64	7.94	0.74	0.00	60.05	1.53	12.13	26.29	0.17	58.00	2.30	0.33	75.24
tm0126	8.34	17.43	24.69	0.00	0.00	7.64	4.74	37.17	50.46	0.09	4.00	0.37	0.18	54.28
tm0133	10.06	4.24	10.30	0.71	0.00	63.49	2.72	8.50	25.29	0.07	9.00	2.10	0.31	77.42
tm0134	2.36	93.76	0.00	0.00	0.00	3.89	0.00	0.00	96.11	0.00	0.00	0.00	0.01	3.89
tm0137	37.37	18.54	5.50	0.15	0.00	37.54	0.65	0.26	61.56	0.08	51.00	2.19	0.37	39.09
tm0159	8.37	31.50	8.47	0.89	0.00	16.32	1.74	32.70	49.24	0.01	7.00	0.15	0.39	52.50
tm0171	7.82	34.23	18.82	0.79	0.00	24.24	1.59	12.51	61.66	0.07	63.00	1.07	0.13	39.93
tm0178	15.26	2.18	11.57	0.00	0.00	64.33	2.11	4.55	29.01	0.24	14.00	1.16	0.27	73.09
tm0183	4.92	3.60	12.32	2.41	0.00	48.42	5.42	22.91	23.25	0.18	37.00	2.08	0.27	82.17
tm0187	8.63	10.43	27.25	0.00	0.00	46.24	7.44	0.00	46.32	0.24	14.00	1.20	0.24	61.12
tm0193	7.66	0.64	1.33	4.59	0.00	69.90	1.06	14.83	14.21	0.08	79.00	2.09	0.41	86.84
tm0209	17.70	1.05	1.39	4.32	0.00	38.45	14.50	22.59	24.46	0.04	35.00	1.80	0.30	90.04
tm0214	7.07	7.78	8.52	0.54	0.00	48.85	16.69	10.55	23.91	0.06	14.00	1.03	0.49	92.78
tm0220	43.55	20.33	5.48	0.00	0.00	30.64	0.00	0.00	69.36	0.00	0.00	0.00	0.14	30.64
tm0279	8.88	13.60	8.68	1.65	0.00	38.70	13.45	15.04	32.81	0.07	183.00	4.01	0.40	80.64
tm0283	6.70	19.98	31.49	1.50	0.00	17.38	2.51	20.44	59.67	0.00	9.00	0.31	0.14	42.84
tm0290	10.34	0.00	6.66	6.16	0.00	72.08	4.75	0.00	23.17	0.44	31.00	4.00	0.56	81.58
tm0296	29.60	29.64	11.94	0.00	0.00	28.83	0.00	0.00	71.17	0.00	5.00	0.49	0.30	28.83

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Land use and cover									Urbanization			Impact index	
Stream	Woodland	Parkland	Grassy_woody	Palm_swamp	Urban	Pasture	Agriculture	Eucalyptus	Natural_sum	road_dens	pop_dens	house_dens	IDI	CDI
tm0381	28.04	8.10	10.23	1.55	0.00	50.87	0.96	0.25	47.92	0.05	91.00	2.90	0.19	53.05
tm0391	9.91	24.05	3.35	0.00	0.00	32.92	0.68	29.09	37.31	0.01	8.00	0.36	0.22	63.37
tm0437	21.50	6.96	2.47	1.85	0.00	63.74	3.49	0.00	32.78	0.01	28.00	2.45	0.38	70.71
tm1865	35.73	18.49	5.43	0.89	0.00	37.99	1.24	0.24	60.53	0.09	58.00	2.38	0.56	40.71
tm3195	1.55	0.00	36.11	18.96	14.36	23.99	5.04	0.00	56.62	1.33	56.00	58.41	0.50	91.50
tm3962	24.87	32.97	4.13	0.00	0.00	32.06	5.97	0.00	61.97	0.00	12.00	1.56	0.39	44.00
tm6757	10.86	0.00	0.00	0.00	68.53	20.61	0.00	0.00	10.86	13.51	2174.66	737.19	1.11	294.73
vg0002	19.23	0.00	0.00	0.00	0.00	0.00	80.77	0.00	19.23	0.36	1.00	1.52	0.70	161.54
vg0004	12.88	0.00	1.84	0.00	0.00	17.79	67.48	0.00	14.72	0.26	10.00	1.83	0.53	152.76
vg0016	10.02	0.00	1.94	0.11	9.57	28.36	50.00	0.00	12.07	2.20	6916.00	241.12	0.73	166.63
vg0018	9.09	0.00	0.00	0.00	0.00	0.00	90.91	0.00	9.09	0.29	1.00	0.91	0.62	181.82
vg0021	18.57	0.00	0.00	0.00	0.00	1.43	80.00	0.00	18.57	0.00	0.00	0.00	0.54	161.43
vg0022	9.68	0.00	0.00	0.00	0.00	0.00	90.32	0.00	9.68	0.00	0.00	0.00	0.61	180.65
vg0034	10.00	0.00	0.00	0.00	0.00	0.00	90.00	0.00	10.00	0.47	1.00	0.20	0.79	180.00
vg0037	6.31	0.00	2.70	0.00	0.00	11.71	79.28	0.00	9.01	0.28	3.00	0.71	0.59	170.27
vg0044	10.14	0.00	0.00	0.00	4.35	47.83	37.68	0.00	10.14	1.15	12.00	5.69	0.55	140.58
vg0048	8.20	0.00	1.64	0.00	0.00	11.48	78.69	0.00	9.84	0.20	2.00	0.33	0.72	168.85
vg0080	9.02	0.00	1.57	0.78	0.00	7.06	81.57	0.00	11.37	0.28	35.00	3.02	0.68	170.20
vg0109	11.00	0.00	1.91	0.00	0.00	3.35	83.73	0.00	12.92	0.00	7.00	1.86	0.59	170.81
vg0112	10.82	0.00	1.33	0.57	3.61	12.90	70.78	0.00	12.71	0.36	162.00	9.10	0.62	168.88
vg0121	4.71	0.00	0.00	0.00	0.00	28.24	67.06	0.00	4.71	0.61	7.00	2.23	0.57	162.35
vg0124	10.55	0.00	4.69	0.00	13.28	26.95	44.53	0.00	15.23	2.06	366.00	43.39	0.59	169.14
vg0126	18.18	0.00	0.00	0.00	0.00	12.12	69.70	0.00	18.18	0.00	3.00	1.65	0.51	151.52
vg0128	18.37	0.00	0.00	0.00	0.00	6.12	67.35	8.16	18.37	0.00	2.00	0.82	0.59	148.98
vg0162	12.14	0.00	0.00	0.00	1.94	2.43	83.50	0.00	12.14	0.48	33.00	4.21	0.65	177.18
vg0177	6.67	0.00	0.00	2.67	0.00	5.33	85.33	0.00	9.33	0.00	4.00	1.72	0.72	176.00
vg0191	9.16	0.00	1.57	0.26	4.71	10.47	73.82	0.00	10.99	1.59	1468.00	120.91	0.63	176.96
vg0206	22.64	0.00	3.77	0.00	0.00	13.21	60.38	0.00	26.42	0.00	6.00	4.17	0.49	133.96
vg0210	29.44	0.00	0.40	0.00	0.00	18.15	52.02	0.00	29.84	0.23	22.00	2.43	0.51	122.18
vg0247	8.54	0.00	0.00	0.00	0.00	0.00	91.46	0.00	8.54	0.75	4.00	1.58	0.71	182.93
vg0252	9.73	0.00	2.88	0.09	7.57	24.32	55.41	0.00	12.70	1.91	6940.00	191.59	0.57	165.41
vg0255	11.98	0.00	3.65	0.00	0.00	10.42	73.96	0.00	15.63	0.36	23.00	3.10	0.54	158.33
vg0277	9.79	0.00	2.83	0.09	7.21	23.26	56.82	0.00	12.70	1.85	6946.00	182.71	0.64	165.75
vg0306	24.31	0.00	0.40	0.00	0.00	12.25	63.04	0.00	24.70	0.40	39.00	2.04	0.50	138.34

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

				Land use and cover							Urbanization		Impact index	
Stream	Woodland	Parkland	Grassy_woody	Palm_swamp	Urban	Pasture	Agriculture	Eucalyptus	Natural_sum	road_dens	pop_dens	house_dens	IDI	CDI
vg0320	9.52	0.00	0.00	4.76	0.00	14.29	71.43	0.00	14.29	0.33	15.00	11.22	0.56	157.14
vg0380	13.66	0.00	3.78	0.42	7.14	25.21	49.79	0.00	17.86	1.25	399.00	25.29	0.52	153.36
vg0387	3.14	0.00	0.00	4.93	0.00	1.35	90.58	0.00	8.07	0.27	12.00	1.12	0.62	182.51
vg0418	14.29	0.00	0.00	0.00	0.00	0.00	85.71	0.00	14.29	0.11	6.00	1.66	0.59	171.43
vg0433	9.35	0.00	2.34	0.17	0.00	3.51	84.64	0.00	11.85	0.10	55.00	1.70	0.60	172.79
vg0444	9.50	0.00	1.63	0.13	10.50	27.63	50.63	0.00	11.25	2.38	6910.00	264.24	0.62	170.88
vg0447	11.30	0.00	2.26	0.00	1.13	6.78	78.53	0.00	13.56	0.88	208.00	18.04	0.58	168.36
vg0450	19.35	0.00	0.81	0.00	0.20	9.07	70.56	0.00	20.16	0.58	42.00	2.29	0.56	151.01
vg0511	13.33	0.00	2.96	0.00	0.00	8.89	74.81	0.00	16.30	0.50	17.00	3.03	0.53	158.52
vg0515	17.42	0.00	3.79	0.00	0.00	16.29	62.50	0.00	21.21	0.00	15.00	2.11	0.50	141.29
vg0558	8.26	0.00	0.00	0.83	10.74	9.09	71.07	0.00	9.09	3.45	1157.00	278.52	0.65	194.21
vg0575	13.10	0.00	3.57	0.00	0.00	8.33	75.00	0.00	16.67	0.67	14.00	4.00	0.63	158.33
vg1257	0.00	0.00	0.00	0.00	75.00	0.00	25.00	0.00	0.00	15.83	2322.39	787.64	1.49	350.00

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Channel morphology						Bed substrate					Riparian		
Stream	xdepth_s	xwidth	xbkf_w	rp100	xslope	sinu	xembed	vembed	lrbs	lsubd_mm	p_cb	xcdenmid	vcdenmid	xcmg
np00008	42.60	2.28	3.90	39.46	0.67	1.05	78.36	20.71	-0.23	-0.44	0.02	95.59	8.60	118.07
np00012	15.18	3.98	6.13	8.49	0.91	1.32	25.55	29.65	0.59	0.95	0.11	89.44	9.48	60.68
np00016	76.25	4.20	5.25	58.10	0.91	1.21	13.82	17.27	1.21	2.21	0.03	57.49	17.81	69.43
np00028	16.22	3.31	4.91	12.90	1.86	1.28	72.91	33.98	0.32	0.71	0.17	98.13	1.75	126.59
np00047	11.40	1.81	3.51	6.87	1.42	1.19	74.91	36.86	-0.29	-0.55	0.12	99.60	1.33	156.36
np00052	16.27	2.48	5.36	9.93	0.82	1.30	66.00	35.47	0.02	0.04	0.01	90.78	9.49	120.45
np00054	12.16	0.82	1.95	4.56	4.77	1.18	74.18	38.14	-0.59	-1.42	0.00	100.00	0.00	270.00
np00055	20.33	1.93	3.26	14.87	0.89	1.24	54.73	41.31	0.10	0.19	0.00	99.47	1.36	101.82
np00075	25.62	4.32	12.23	30.10	0.49	1.15	39.64	38.25	0.92	1.39	0.10	72.06	15.37	131.48
np00092	6.25	1.53	3.79	2.08	0.55	1.15	97.27	11.46	-0.24	-0.30	0.00	80.88	13.00	88.98
np00095	32.60	1.28	2.13	15.93	2.30	1.17	79.82	37.14	-0.79	-1.68	0.00	100.00	0.00	172.39
np00096	18.18	2.50	4.45	15.36	0.61	1.19	59.09	40.38	0.15	0.25	0.03	68.85	23.36	90.45
np00097	11.89	3.14	5.59	11.14	1.36	1.23	55.82	39.88	0.48	0.96	0.23	90.91	4.69	125.91
np00100	25.47	2.89	4.36	20.43	0.54	1.21	51.64	35.00	0.32	0.50	0.15	72.86	32.37	101.93
np00108	10.27	2.11	4.69	4.36	2.01	1.26	81.64	19.89	0.03	0.06	0.09	98.40	1.80	145.80
np00110	24.38	2.19	2.65	12.10	1.83	1.20	37.09	34.73	0.63	1.31	0.42	99.47	0.74	150.91
np00112	12.62	2.76	3.72	10.16	0.58	1.07	76.55	38.69	-0.83	-1.31	0.00	92.51	2.75	129.09
np00128	26.60	1.53	3.39	24.54	0.37	1.15	100.00	0.00	-1.44	-2.08	0.00	29.14	27.92	59.09
np00132	15.71	1.82	4.69	10.79	1.28	1.04	40.56	24.50	0.65	1.27	0.07	99.47	1.19	109.55
np00139	16.15	2.43	4.50	11.86	0.37	1.16	58.73	38.97	0.09	0.12	0.00	90.91	7.38	150.23
np00144	26.67	3.40	6.37	30.52	0.47	1.26	55.82	34.46	0.48	0.73	0.01	85.29	6.61	118.98
np00187	11.20	2.22	4.66	6.91	0.32	1.29	41.09	39.52	0.32	0.42	0.02	97.33	4.04	154.77
np00192	24.24	1.92	2.91	14.22	0.53	1.01	51.64	37.90	0.20	0.33	0.07	98.13	2.47	78.07
np00203	19.93	3.69	7.35	18.13	0.54	1.19	56.00	29.48	0.91	1.52	0.15	95.72	5.03	186.93
np00228	15.89	2.16	3.20	11.13	2.01	1.16	28.18	33.17	0.66	1.39	0.02	95.05	4.23	238.30
np00240	11.38	1.72	7.68	8.92	0.65	1.08	72.08	32.42	-1.06	-1.62	0.00	88.50	11.23	73.75
np00251	13.82	3.18	4.32	9.49	1.67	1.23	36.00	39.46	0.56	1.06	0.17	95.05	3.37	146.25
np00287	18.56	1.33	4.16	12.10	1.43	1.06	87.27	20.32	-0.41	-0.76	0.00	99.73	0.59	84.32
np00368	16.75	2.64	4.82	6.06	1.26	1.13	73.00	36.62	-0.01	-0.02	0.01	95.59	3.29	159.89
np00375	35.47	5.78	9.51	38.54	0.49	1.23	41.07	41.57	0.56	1.01	0.04	81.42	13.99	115.91
np00443	15.69	2.62	3.61	11.02	0.31	1.28	86.36	28.05	-0.44	-0.57	0.06	94.25	4.08	108.52
np00511	16.87	4.57	7.52	13.48	0.52	1.31	60.91	35.03	0.27	0.40	0.03	68.72	8.80	97.61
np01524	17.80	1.88	4.49	7.95	2.27	1.25	58.55	29.15	0.61	1.37	0.16	99.60	0.95	112.73
np02991	17.36	2.52	5.06	8.71	1.01	1.25	75.82	23.62	0.32	0.58	0.10	86.23	12.36	119.43

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

			Channel morphology						Bed substrate				Riparian	
Stream	xdepth_s	xwidth	xbkf_w	rp100	xslope	sinu	xembed	vembed	lrbs	lsubd_mm	p_cb	xcdenmid	vcdenmid	xcmg
np05612	31.42	2.04	2.98	24.13	0.33	1.15	72.18	37.99	-0.48	-0.65	0.01	85.03	20.74	132.16
np07308	12.20	1.86	5.49	8.33	1.30	1.22	62.91	39.27	0.30	0.56	0.11	94.65	3.17	180.23
np09612	10.55	3.88	4.04	3.89	1.70	0.90	59.22	31.93	0.31	0.63	0.08	94.12	4.00	224.77
np09757	10.73	2.28	3.74	2.66	0.75	1.29	33.33	57.74	-0.02	-0.04	0.00	48.53	27.01	64.55
np12892	24.93	1.44	4.25	19.21	1.30	1.21	72.18	39.43	-0.11	-0.21	0.13	27.58	35.07	55.34
np15048	47.84	1.12	2.34	27.44	0.99	1.29	78.36	37.99	-0.69	-1.22	0.02	37.70	30.53	127.95
rca02	39.73	4.09	9.83	24.63	6.16	0.65	1.67	3.79	1.03	3.60	0.00	3.21	7.61	132.92
rca08	14.94	1.74	3.42	12.25	4.48	0.61	77.22	38.62	-3.12	-0.48	0.00	46.93	44.96	346.67
rca22	33.80	6.80	8.50	20.66	1.40	0.68	27.67	27.25	0.23	2.22	0.11	6.55	14.61	224.17
rca23	22.23	2.05	6.33	14.06	6.28	0.62	57.67	31.91	-2.05	0.54	0.09	50.80	48.65	327.29
rca29	15.83	2.82	4.42	14.70	3.34	0.62	9.67	26.59	0.82	3.08	0.02	49.33	47.31	306.46
rca30	58.83	6.59	8.00	38.33	3.28	0.63	13.67	22.63	0.40	3.03	0.02	37.30	37.12	110.63
rca31	13.56	2.88	7.50	7.77	1.62	0.66	75.00	36.18	-1.71	0.46	0.18	51.74	49.55	320.63
rca44	6.94	0.84	3.22	6.63	1.84	0.70	83.89	26.60	-2.21	0.06	0.15	51.07	48.96	281.88
rca47	13.61	2.24	5.42	6.61	1.76	0.61	36.11	28.10	-0.37	1.87	0.21	48.40	46.46	214.58
rca49	24.87	3.06	4.33	18.72	0.80	0.62	52.67	37.41	-0.52	1.27	0.00	42.65	40.87	305.00
rca52	11.83	7.52	7.93	4.75	0.40	0.63	62.83	30.16	-0.31	1.21	0.20	39.57	37.97	317.08
rca53	9.97	3.29	7.17	6.11	2.22	0.59	30.50	31.33	-0.39	2.18	0.40	37.57	36.06	322.08
rca57	64.37	3.26	4.50	18.89	0.44	0.61	5.00	7.77	1.60	3.40	0.05	39.57	38.64	275.00
rca58	17.47	1.69	7.17	13.48	4.64	0.63	5.00	9.00	0.88	3.45	0.04	27.81	30.55	160.21
rca59	21.17	4.66	6.92	8.56	7.20	0.68	0.67	2.54	0.84	3.70	0.02	8.42	10.44	153.33
rca60	12.55	4.26	7.83	13.26	17.80	0.66	0.00	0.00	0.28	3.75	0.00	0.00	0.00	116.46
rca62	16.38	0.66	4.83	15.82	17.32	0.66	7.67	17.55	-1.04	2.07	0.00	46.26	44.78	94.58
rca64	17.23	1.05	2.42	16.37	11.16	0.59	26.17	33.57	-0.71	2.75	0.02	46.66	45.45	231.25
rca65	4.06	1.16	5.00	3.03	1.36	0.67	87.78	22.38	-2.44	-0.20	0.00	51.74	49.54	276.25
rca66	11.33	1.61	6.67	8.45	1.28	0.65	80.56	21.00	-1.08	1.18	0.09	50.40	48.36	305.42
rca67	9.17	2.06	6.17	13.23	1.44	0.62	71.11	31.79	-1.30	0.82	0.18	49.20	47.12	299.38
rca68	14.44	1.73	3.67	19.46	1.98	0.66	42.22	42.78	-0.13	2.19	0.03	40.78	40.03	240.63
rca69	18.60	2.77	4.73	8.19	1.86	0.59	53.50	31.60	-0.86	1.34	0.42	39.17	37.66	283.33
rca70	22.44	1.83	3.58	22.29	2.68	0.62	22.78	38.01	-0.17	2.06	0.03	45.05	43.21	315.83
rca90	19.30	4.81	6.50	7.01	0.12	0.70	64.00	40.48	-0.68	0.41	0.00	27.94	27.69	269.38
ss0001	27.67	1.56	2.69	14.90	1.39	1.29	67.82	38.60	-1.55	0.21	0.09	96.66	2.19	137.84
ss0002	26.80	5.01	8.37	19.04	0.58	1.37	13.09	29.24	0.23	2.23	0.06	96.79	4.78	101.14
ss0008	12.95	2.21	8.67	8.64	2.64	1.17	40.55	41.16	-0.82	1.62	0.11	57.22	21.63	39.66

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

			Channel morphology						Bed substrate				Riparian	
Stream	xdepth_s	xwidth	xbkf_w	rp100	xslope	sinu	xembed	vembed	lrbs	lsubd_mm	p_cb	xcdenmid	vcdenmid	xcmg
ss0010	64.47	3.40	6.08	35.22	0.23	1.18	77.91	38.53	-2.41	-1.19	0.00	33.02	25.14	78.30
ss0014	27.53	1.99	5.16	20.27	1.59	1.16	20.00	40.37	-1.53	0.54	0.16	95.19	3.95	103.52
ss0028	16.98	2.94	6.25	19.15	1.34	1.18	51.27	33.72	-1.75	0.24	0.14	94.79	12.15	116.25
ss0029	44.02	4.78	4.81	27.68	0.19	1.02	48.00	41.34	-0.82	0.19	0.03	60.83	40.38	56.48
ss0031	16.80	2.18	5.77	13.03	1.12	1.28	67.27	34.34	-3.59	-1.84	0.00	90.78	9.30	63.07
ss0033	12.58	2.11	3.61	3.81	0.28	1.29	84.45	23.37	-1.68	-0.20	0.00	0.80	1.90	87.50
ss0035	39.38	6.82	9.81	31.84	0.40	1.18	55.55	37.76	-0.37	1.30	0.19	86.36	8.06	144.66
ss0037	16.20	5.43	8.82	10.73	0.05	1.33	63.09	38.91	-1.12	-0.28	0.00	88.50	9.48	77.50
ss0038	28.29	2.49	5.95	25.00	0.29	1.23	67.45	41.78	-1.72	-0.25	0.02	83.16	9.65	77.27
ss0044	23.60	3.43	4.57	17.34	0.46	1.11	52.91	34.78	-1.07	0.52	0.04	93.85	10.94	149.43
ss0051	28.62	1.54	3.27	17.14	0.59	1.32	45.82	32.64	-1.79	-0.33	0.00	96.52	3.91	183.64
ss0053	9.33	2.36	7.63	3.70	1.46	1.24	82.55	34.22	-3.22	-1.16	0.01	91.58	11.88	41.82
ss0057	50.05	2.95	4.95	38.58	0.82	1.21	74.73	37.96	-3.57	-1.79	0.01	94.25	5.56	21.36
ss0059	9.56	1.50	4.18	4.86	1.35	1.24	84.18	28.46	-2.63	-0.38	0.00	89.71	8.92	67.73
ss0073	33.13	4.53	6.47	20.11	0.18	1.22	44.55	42.11	-0.92	0.34	0.04	75.40	19.97	62.73
ss0078	17.05	5.05	7.92	8.29	0.61	1.22	76.73	34.64	-1.62	0.15	0.05	38.10	25.73	72.84
ss0094	20.36	3.33	5.52	11.14	1.28	1.24	58.64	33.73	-1.42	0.70	0.14	93.58	7.33	185.57
ss0105	22.75	3.25	6.09	18.23	0.85	1.22	78.00	32.40	-2.07	-0.01	0.09	96.12	3.43	31.14
ss0126	15.98	4.69	9.52	13.95	0.29	1.19	95.09	16.43	-1.94	-0.46	0.00	60.96	24.51	56.36
ss0129	22.13	3.47	5.70	17.47	0.40	1.13	97.82	11.50	-2.00	-0.53	0.00	75.67	18.06	99.09
ss0133	27.53	9.64	18.71	18.49	1.10	1.13	70.64	44.60	-1.25	0.75	0.02	24.20	20.99	134.32
ss0144	11.69	2.41	5.79	9.53	0.59	1.32	22.36	37.02	1.37	2.89	0.00	73.13	20.80	72.73
ss0149	31.58	4.78	6.70	26.82	0.56	1.21	68.91	43.33	-2.38	-0.80	0.04	58.29	16.01	146.82
ss0150	39.75	3.20	7.09	21.86	1.11	1.21	61.64	35.11	-1.63	0.43	0.16	83.16	25.85	28.41
ss0157	17.29	1.81	4.09	16.05	1.31	1.21	30.00	33.50	-2.35	-0.32	0.00	93.32	4.80	101.70
ss0175	13.18	4.59	8.68	8.59	1.88	1.36	40.00	34.96	-0.84	1.31	0.34	91.04	13.79	152.95
ss0191	23.35	3.71	6.18	14.42	0.58	1.25	72.18	35.47	-1.24	0.45	0.18	72.86	20.62	108.41
ss0199	24.05	3.43	5.43	17.17	0.61	1.31	49.64	38.44	-1.14	0.60	0.12	79.68	16.96	128.75
ss0213	48.13	5.24	9.17	38.65	1.08	1.30	50.91	37.82	-0.54	1.44	0.27	65.11	25.00	72.61
ss0351	18.60	7.03	12.04	11.34	0.36	1.29	62.73	33.47	-0.95	0.55	0.10	46.79	15.42	103.98
ss0408	19.16	1.89	3.05	14.90	0.42	1.26	36.73	41.85	-1.32	0.22	0.03	98.66	2.32	68.64
ss0411	17.85	8.60	11.59	7.48	0.30	1.28	51.45	39.97	-0.70	0.80	0.17	77.14	24.79	122.05
ss0447	19.49	6.97	9.76	11.88	0.35	1.24	55.64	47.29	-0.07	1.44	0.00	90.37	5.93	213.98
ss1000	27.11	1.20	1.87	17.40	0.85	1.11	34.82	38.50	-1.43	0.32	0.00	99.33	1.37	59.32

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Channel morphology						Bed substrate					Riparian		
Stream	xdepth_s	xwidth	xbkf_w	rp100	xslope	sinu	xembed	vembed	lrbs	lsubd_mm	p_cb	xcdenmid	vcdenmid	xcmg
ss4173	35.05	8.29	12.83	20.74	1.40	1.27	56.82	42.32	-1.88	0.27	0.32	21.39	27.97	77.16
ss4330	25.55	3.40	4.92	13.44	0.85	1.35	64.73	35.76	-0.35	1.39	0.30	81.15	10.42	164.66
tm0003	19.15	1.95	3.85	16.51	0.27	1.25	44.18	42.24	-1.44	-0.16	0.00	93.98	4.85	69.89
tm0007	57.38	4.08	5.75	50.51	0.01	1.22	72.55	45.07	-1.79	-1.85	0.00	75.80	8.38	279.32
tm0009	15.75	2.54	9.60	22.55	0.29	1.22	61.27	35.85	-0.67	0.70	0.00	65.91	11.06	75.34
tm0027	14.51	2.63	4.85	14.86	1.56	1.19	49.45	45.76	-0.49	1.37	0.44	88.24	10.27	71.70
tm0028	12.76	4.96	9.29	20.48	0.27	1.29	34.00	36.19	-0.28	1.10	0.17	84.89	9.76	97.27
tm0033	14.78	1.95	3.98	20.11	0.86	1.21	19.45	31.65	0.15	2.03	0.09	94.52	10.61	101.25
tm0040	8.47	1.47	4.06	8.66	2.38	1.26	50.36	41.85	-0.47	1.74	0.40	84.49	8.76	116.36
tm0043	27.62	3.57	7.03	27.88	0.18	1.20	61.09	42.59	0.39	1.48	0.05	79.81	21.56	62.16
tm0058	20.56	4.11	8.95	19.33	0.32	1.34	30.91	46.64	1.02	2.48	0.00	75.67	18.54	65.45
tm0072	26.56	4.04	8.38	38.87	0.21	1.24	30.96	36.64	0.08	1.24	0.11	71.79	8.52	92.50
tm0082	27.02	2.99	4.36	22.51	0.09	1.14	79.80	16.10	-2.78	-2.11	0.00	83.02	27.82	54.66
tm0088	19.80	3.57	7.49	20.81	0.95	1.28	21.63	39.28	0.43	2.35	0.02	68.58	24.92	81.82
tm0090	29.69	2.30	2.86	29.46	0.79	1.24	26.11	33.73	1.00	2.63	0.41	97.73	4.76	75.23
tm0091	30.60	6.67	12.68	35.06	0.24	1.24	71.78	36.45	-0.17	1.13	0.19	53.48	15.98	56.25
tm0106	28.22	2.43	6.04	34.08	0.27	1.15	81.82	38.92	-3.53	-2.02	0.00	99.60	0.69	96.93
tm0119	21.15	1.93	5.10	21.44	0.09	1.20	62.55	38.02	-2.81	-2.04	0.01	95.72	10.01	97.73
tm0126	20.58	1.45	2.39	18.65	0.30	1.24	57.82	44.17	-1.43	-0.45	0.05	94.25	8.64	97.61
tm0133	40.27	2.57	4.32	46.14	0.30	1.13	90.91	29.01	-3.56	-2.11	0.00	83.02	20.32	100.91
tm0134	24.13	2.33	3.62	25.06	1.87	1.18	40.18	43.69	-1.16	1.03	0.29	94.39	5.65	91.93
tm0137	53.76	2.60	4.67	49.35	0.04	1.32	83.09	34.47	-2.56	-2.11	0.00	87.70	7.68	58.07
tm0159	47.78	10.04	13.30	40.25	0.14	1.39	70.58	40.20	0.16	1.14	0.07	43.18	18.43	129.89
tm0171	35.35	9.40	13.99	28.94	1.73	1.34	54.73	38.68	0.33	2.36	0.03	16.58	14.65	83.64
tm0178	18.45	4.34	7.29	19.67	0.20	1.34	47.45	40.33	-0.38	0.96	0.19	82.89	10.28	99.77
tm0183	29.93	2.99	4.33	23.53	0.69	1.15	64.73	41.31	-1.19	0.27	0.26	96.52	4.62	118.98
tm0187	26.96	4.78	5.80	33.69	0.78	1.20	45.09	49.32	-0.34	1.14	0.00	92.91	10.84	79.32
tm0193	36.40	2.49	2.82	32.50	0.14	1.21	96.36	7.78	-3.12	-2.11	0.00	76.07	14.66	142.95
tm0209	48.28	2.55	3.10	41.58	0.39	1.17	97.60	10.98	-3.50	-2.11	0.00	89.04	29.61	203.18
tm0214	37.40	2.07	3.35	34.78	0.11	1.24	91.64	20.80	-2.77	-1.82	0.02	75.00	27.84	15.68
tm0220	20.44	4.18	9.61	18.90	1.63	1.31	26.55	34.15	0.02	2.11	0.05	65.24	14.55	77.73
tm0279	36.07	9.16	11.16	38.96	0.68	1.24	18.45	35.58	0.81	2.58	0.07	53.88	23.31	126.93
tm0283	20.62	5.33	12.80	12.70	1.19	1.24	22.91	40.63	1.16	3.02	0.10	35.96	24.35	94.77
tm0290	48.87	1.67	2.38	50.03	0.17	1.15	100.00	0.00	-3.00	-2.11	0.00	26.20	41.77	115.34
tm0296	21.47	7.72	12.63	23.57	0.51	1.35	34.82	34.68	-0.02	1.71	0.34	72.99	16.37	68.52

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Channel morphology						Bed substrate						Riparian		
Stream	xdepth_s	xwidth	xbkf_w	rp100	xslope	sinu	xembed	vembed	lrbs	lsubd_mm	p_cb	xcdenmid	vcdenmid	xcmg
tm0381	13.53	0.92	1.48	7.43	1.21	1.18	61.82	49.03	-3.80	-2.11	0.00	96.39	3.44	114.89
tm0391	16.73	7.13	12.60	10.14	0.68	1.26	51.82	49.97	1.98	3.56	0.06	53.48	20.95	69.55
tm0437	26.29	1.46	2.68	26.22	0.47	1.14	94.18	20.88	-3.15	-1.77	0.00	9.36	12.04	105.68
tm1865	31.29	2.69	6.07	34.52	0.23	1.29	81.82	37.02	-3.30	-1.87	0.00	79.68	11.00	43.41
tm3195	20.93	1.90	4.09	23.83	1.37	1.27	87.27	33.63	-3.19	-1.29	0.00	8.69	8.43	90.45
tm3962	32.95	5.98	8.15	44.39	0.24	1.20	39.25	42.87	-0.46	0.71	0.15	85.03	14.09	70.11
tm6757	28.27	2.03	3.06	24.20	0.27	1.26	78.36	39.15	-2.79	-1.63	0.00	89.44	6.27	78.18
vg0002	12.20	1.00	0.94	10.87	0.77	1.25	94.55	5.03	-3.30	-2.11	0.00	88.77	8.76	38.98
vg0004	34.82	4.73	5.96	23.31	0.57	1.24	44.91	42.81	-1.29	0.19	0.04	61.36	7.87	120.23
vg0016	43.95	5.51	6.61	29.56	0.07	1.28	81.45	32.38	-1.59	-0.79	0.01	78.34	12.36	26.82
vg0018	8.07	2.82	6.07	14.19	0.73	1.24	63.45	44.61	-0.73	0.93	0.10	90.64	7.33	82.05
vg0021	25.42	1.87	2.98	13.49	0.46	1.10	89.27	28.73	-3.07	-1.61	0.00	91.71	6.49	174.89
vg0022	14.02	1.96	4.31	9.81	1.47	1.23	40.73	40.32	-0.24	1.59	0.12	73.93	13.69	101.48
vg0034	25.09	3.20	4.04	14.81	0.50	1.19	64.91	36.96	-0.30	0.87	0.17	92.11	7.15	109.32
vg0037	24.38	1.84	2.54	18.02	0.39	0.92	96.25	13.34	-2.74	-1.64	0.00	64.04	41.45	95.00
vg0044	19.51	2.90	4.58	15.88	0.53	1.20	65.45	37.51	-1.85	-0.23	0.00	87.43	11.55	74.66
vg0048	48.02	1.83	3.52	27.31	0.84	1.23	68.40	33.22	-2.45	-0.78	0.20	60.83	30.72	24.09
vg0080	27.87	4.97	6.87	25.33	0.62	1.30	37.27	39.32	-0.29	1.35	0.15	88.24	10.06	65.45
vg0109	37.29	2.85	3.96	20.14	0.17	1.29	56.36	34.39	-1.22	-0.12	0.00	77.94	9.39	141.36
vg0112	53.16	3.93	5.25	24.34	0.13	1.24	66.36	41.34	-1.56	-0.50	0.10	94.12	7.14	112.27
vg0121	23.02	2.96	5.29	12.89	0.41	1.19	74.73	37.26	-1.41	0.24	0.01	62.83	17.21	102.05
vg0124	24.36	5.30	10.34	14.17	0.66	1.25	54.36	45.74	0.15	1.98	0.10	77.01	9.69	68.75
vg0126	15.56	3.42	3.86	10.73	0.34	1.17	63.27	41.90	-1.68	-0.42	0.06	95.32	3.47	98.75
vg0128	15.84	1.57	6.37	11.76	0.68	1.24	69.45	45.31	-2.85	-1.00	0.00	93.05	8.06	177.39
vg0162	30.07	2.53	3.86	16.85	0.51	1.31	68.18	32.09	-1.85	-0.15	0.02	96.79	2.62	98.98
vg0177	16.73	1.45	2.78	9.32	1.02	1.16	63.09	38.54	-3.80	-1.91	0.00	89.97	16.37	252.50
vg0191	31.93	4.16	7.15	17.57	0.40	1.21	67.64	43.03	-2.22	-0.59	0.04	86.50	16.32	105.34
vg0206	10.09	1.56	11.51	4.30	0.39	1.10	76.11	35.10	-1.51	0.22	0.20	85.70	9.69	72.27
vg0210	16.80	4.09	8.00	19.30	0.41	1.27	57.64	22.27	-0.17	1.31	0.19	35.29	17.94	46.48
vg0247	23.31	1.56	2.09	15.00	0.92	1.19	58.18	42.99	-2.54	-0.80	0.00	70.32	9.16	109.55
vg0252	37.16	5.30	6.66	23.60	0.10	1.14	59.91	32.32	-0.60	0.42	0.03	83.42	13.38	35.91
vg0255	24.91	3.96	5.22	10.92	0.45	1.19	63.09	40.04	-1.56	-0.03	0.02	65.51	10.45	82.27
vg0277	26.82	6.85	7.51	22.00	0.11	1.28	66.01	32.59	-1.33	-0.26	0.02	72.89	7.68	24.43
vg0306	34.69	5.49	10.65	25.89	0.45	1.18	66.82	24.71	0.15	1.71	0.40	75.00	22.56	79.66

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Channel morphology					Bed substrate					Riparian		
Stream	xdepth_s	xwidth	xbkf_w	rp100	xslope	sinu	xembed	vembed	lrbs	lsubd_mm	p_cb	xcdenmid	vcdenmid	xcmg
vg0320	36.51	6.54	6.64	23.24	4.58	1.18	48.80	43.74	-0.68	1.92	0.23	70.86	15.01	139.89
vg0380	26.16	4.43	7.01	15.41	0.31	1.25	63.64	42.09	-1.84	-0.45	0.00	88.37	6.04	118.18
vg0387	37.24	2.95	3.78	17.34	0.83	1.12	67.05	44.39	-1.75	-0.07	0.00	77.81	20.60	246.48
vg0418	22.15	2.27	5.05	17.14	1.25	1.14	54.36	39.80	-1.73	0.30	0.30	94.12	6.58	108.75
vg0433	59.45	4.70	8.15	31.89	0.22	1.27	63.64	37.53	-2.14	-0.82	0.02	97.46	3.78	137.50
vg0444	27.84	7.31	11.87	13.98	0.95	1.20	42.91	41.88	-0.78	1.09	0.30	34.76	30.40	120.91
vg0447	33.05	4.12	6.37	20.42	0.26	1.31	96.67	15.71	-2.73	-1.23	0.00	70.99	22.26	47.95
vg0450	21.04	6.13	11.44	23.58	0.26	1.28	94.36	18.54	2.02	3.33	0.00	47.19	32.97	58.64
vg0511	22.55	3.07	4.45	12.92	0.22	1.21	62.00	41.56	-1.47	-0.38	0.06	96.39	5.32	142.05
vg0515	14.86	4.16	5.89	13.59	6.86	1.25	47.45	44.76	-0.56	2.18	0.19	85.96	15.20	87.73
vg0558	15.20	3.78	10.55	12.58	1.56	1.26	59.64	34.48	0.32	2.45	0.48	78.88	7.45	152.50
vg0575	24.29	3.48	5.04	13.26	0.67	1.31	53.27	38.54	-0.77	0.81	0.25	84.09	18.84	92.39
vg1257	24.82	3.67	4.84	22.61	0.79	1.20	64.26	43.72	-1.41	0.15	0.28	20.32	31.37	18.30

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Flow type				Shelther				Impact index	
Stream	p_gl	p_pool	p_slow	p_bf	clw_msq	pct_xfc_brs	pct_xcf_ucb	pct_xfc_ant	W1_HALL	RCOND
np00008	0.47	0.25	0.72	0.12	0.01	3.64	20.68	12.50	0.64	10.63
np00012	0.50	0.10	0.60	0.10	0.01	4.09	0.45	0.91	1.70	4.31
np00016	0.77	0.10	0.87	0.02	0.01	4.55	5.91	0.00	0.09	6.41
np00028	0.65	0.04	0.69	0.01	0.05	7.73	1.36	1.36	0.61	8.69
np00047	0.87	0.10	0.97	0.26	0.00	9.77	5.68	0.00	0.10	11.69
np00052	0.50	0.00	0.50	0.07	0.02	12.50	0.00	0.00	0.64	7.26
np00054	0.89	0.08	0.97	0.33	0.00	25.00	1.82	0.00	0.67	19.27
np00055	0.96	0.03	0.99	0.08	0.04	10.00	13.64	0.00	0.48	10.37
np00075	0.62	0.22	0.84	0.14	0.00	4.09	5.00	0.45	0.67	10.95
np00092	0.96	0.00	0.96	0.17	0.04	3.18	0.91	0.45	1.73	6.59
np00095	0.83	0.00	0.83	0.11	0.10	20.68	0.91	0.00	0.89	8.48
np00096	0.80	0.00	0.80	0.00	0.05	16.59	15.00	0.00	0.23	7.26
np00097	0.37	0.17	0.55	0.16	0.04	5.91	6.82	0.00	1.77	10.56
np00100	0.74	0.00	0.74	0.00	0.02	4.09	0.45	18.41	0.27	3.93
np00108	0.43	0.00	0.43	0.20	0.03	9.55	10.45	6.36	0.73	10.88
np00110	0.38	0.00	0.38	0.12	0.00	3.18	5.45	0.00	0.40	9.72
np00112	0.91	0.05	0.96	0.21	0.00	6.82	6.82	0.00	0.85	13.22
np00128	0.92	0.06	0.98	0.00	0.01	3.18	0.00	37.73	2.70	0.00
np00132	0.78	0.05	0.83	0.11	0.01	3.64	14.09	3.64	0.68	8.15
np00139	1.00	0.00	1.00	0.22	0.01	11.59	5.00	0.00	1.09	11.22
np00144	0.18	0.73	0.91	0.10	0.02	6.36	3.18	2.73	1.16	6.18
np00187	0.90	0.00	0.90	0.14	0.01	8.18	5.00	0.00	0.00	9.19
np00192	0.31	0.00	0.31	0.00	0.02	5.00	26.82	0.00	0.67	3.28
np00203	0.88	0.09	0.97	0.05	0.01	5.00	7.27	0.00	0.70	11.35
np00228	0.65	0.00	0.65	0.13	0.03	5.45	8.64	0.00	2.13	9.64
np00240	0.71	0.27	0.98	0.33	0.03	18.86	0.00	0.00	1.83	6.76
np00251	0.37	0.09	0.45	0.02	0.08	16.59	0.45	0.00	0.42	11.63
np00287	0.72	0.28	1.00	0.17	0.03	10.45	8.64	5.45	1.24	8.95
np00368	0.81	0.00	0.81	0.25	0.09	15.23	15.91	1.82	2.58	6.03
np00375	0.72	0.13	0.85	0.11	0.01	2.73	1.36	0.00	1.25	8.91
np00443	0.55	0.00	0.55	0.06	0.01	4.55	7.73	0.45	0.00	6.66
np00511	0.42	0.00	0.42	0.05	0.03	13.64	4.09	0.00	0.96	4.97
np01524	0.80	0.08	0.88	0.14	0.03	17.05	19.55	0.91	2.09	8.87
np02991	0.90	0.00	0.90	0.12	0.01	2.73	21.36	3.18	0.50	11.10

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

		Flow type				Shelther			Impact index	
Stream	p_gl	p_pool	p_slow	p_bf	clw_msq	pct_xfc_brs	pct_xcf_ucb	pct_xfc_ant	W1_HALL	RCOND
np05612	0.32	0.00	0.32	0.04	0.03	2.73	8.64	0.45	1.27	1.48
np07308	0.83	0.00	0.83	0.24	0.02	17.73	1.36	0.00	0.11	10.61
np09612	0.93	0.00	0.93	0.10	0.02	18.86	3.18	0.00	0.20	14.57
np09757	0.39	0.49	0.89	0.00	0.00	0.00	0.00	0.00	5.33	0.00
np12892	0.21	0.00	0.21	0.03	0.01	1.36	1.36	49.55	2.52	1.66
np15048	0.10	0.00	0.10	0.00	0.00	0.00	0.45	0.00	5.96	2.23
rca02	0.35	0.00	0.35	0.00	0.00	0.00	5.91	0.00	0.00	0.00
rca08	1.00	0.00	1.00	0.00	0.00	0.00	11.82	0.00	0.00	6.65
rca22	0.61	0.04	0.65	0.02	0.00	0.00	5.45	0.00	0.00	7.77
rca23	1.00	0.00	1.00	0.07	0.00	0.00	1.36	0.00	0.00	11.59
rca29	0.20	0.00	0.20	0.00	0.00	0.00	9.32	0.00	0.33	0.00
rca30	0.67	0.00	0.67	0.00	0.00	0.00	11.14	0.00	0.67	0.00
rca31	0.53	0.00	0.53	0.00	0.00	0.00	14.09	0.00	0.33	0.00
rca44	0.58	0.00	0.58	0.06	0.00	0.00	4.09	0.00	0.17	0.00
rca47	0.43	0.00	0.43	0.00	0.00	0.00	5.91	0.00	0.61	0.00
rca49	0.87	0.00	0.87	0.07	0.00	0.00	15.91	0.00	0.67	0.00
rca52	0.88	0.00	0.88	0.16	0.00	0.00	2.73	0.00	0.33	3.70
rca53	0.23	0.00	0.23	0.00	0.00	0.00	10.23	0.00	0.67	0.00
rca57	1.00	0.00	1.00	0.00	0.00	0.00	25.45	0.00	0.00	6.24
rca58	0.40	0.00	0.40	0.00	0.00	0.00	8.18	0.00	0.00	0.00
rca59	0.64	0.00	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00
rca60	0.08	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
rca62	1.00	0.00	1.00	0.16	0.00	0.00	14.77	0.00	0.00	0.00
rca64	0.56	0.00	0.56	0.00	0.00	0.00	31.14	0.00	0.33	6.26
rca65	0.72	0.00	0.72	0.00	0.00	0.00	0.45	0.00	0.17	4.63
rca66	0.65	0.00	0.65	0.06	0.00	0.00	9.32	0.00	0.44	3.63
rca67	0.62	0.00	0.62	0.03	0.00	0.00	5.45	0.00	0.39	0.00
rca68	0.32	0.00	0.32	0.12	0.00	0.00	9.55	0.00	0.00	0.00
rca69	0.35	0.00	0.35	0.00	0.00	0.00	5.00	0.00	0.06	0.00
rca70	0.50	0.00	0.50	0.03	0.00	0.00	7.73	0.00	0.00	0.00
rca90	1.00	0.00	1.00	0.04	0.00	0.00	14.09	0.00	0.94	0.00
ss0001	0.36	0.00	0.36	0.10	0.13	52.05	12.95	0.00	1.00	12.31
ss0002	0.59	0.00	0.59	0.01	0.01	4.55	2.27	1.36	0.67	8.19
ss0008	0.47	0.20	0.67	0.24	0.02	3.18	9.32	4.09	2.20	2.71

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Flow type				Shelther				Impact index	
Stream	p_gl	p_pool	p_slow	p_bf	clw_msq	pct_xfc_brs	pct_xcf_ucb	pct_xfc_ant	W1_HALL	RCOND
ss0010	0.57	0.00	0.57	0.00	0.02	15.23	1.36	87.50	1.25	1.85
ss0014	0.37	0.00	0.37	0.04	0.02	7.27	15.00	0.00	1.08	4.59
ss0028	0.71	0.00	0.71	0.22	0.02	6.82	0.91	5.45	0.83	9.61
ss0029	1.00	0.00	1.00	0.07	0.04	7.27	21.36	4.09	1.92	3.51
ss0031	0.99	0.00	0.99	0.22	0.01	3.64	0.00	13.41	1.92	3.87
ss0033	0.57	0.00	0.57	0.00	0.00	0.00	0.00	18.41	1.50	0.00
ss0035	0.43	0.00	0.43	0.07	0.01	3.64	20.23	0.00	0.95	7.67
ss0037	0.90	0.00	0.90	0.21	0.00	2.73	1.82	0.91	0.96	5.17
ss0038	0.95	0.05	1.00	0.16	0.02	29.09	19.77	0.00	1.13	6.19
ss0044	0.85	0.00	0.85	0.11	0.03	12.27	2.27	0.00	0.83	8.01
ss0051	0.77	0.02	0.79	0.16	0.16	37.95	6.82	0.45	0.86	9.75
ss0053	0.89	0.02	0.91	0.20	0.01	1.36	0.45	0.00	0.92	3.99
ss0057	0.44	0.50	0.94	0.12	0.01	6.36	0.91	2.73	1.40	1.65
ss0059	0.87	0.00	0.87	0.17	0.13	21.82	10.00	0.00	1.60	3.78
ss0073	0.81	0.00	0.81	0.07	0.01	15.23	3.64	5.91	2.08	5.43
ss0078	0.85	0.00	0.85	0.01	0.01	2.27	0.45	2.27	1.21	2.16
ss0094	0.23	0.00	0.23	0.09	0.04	12.27	0.45	0.00	1.33	11.76
ss0105	0.77	0.00	0.77	0.06	0.01	16.59	1.36	0.00	2.04	2.23
ss0126	0.97	0.00	0.97	0.10	0.02	11.82	3.18	1.82	2.30	3.11
ss0129	1.00	0.00	1.00	0.05	0.07	11.82	9.55	3.18	0.61	7.06
ss0133	0.87	0.02	0.89	0.01	0.00	0.91	2.27	29.55	0.00	6.24
ss0144	0.54	0.31	0.85	0.16	0.08	13.86	22.05	2.27	1.67	2.84
ss0149	0.80	0.00	0.80	0.00	0.02	12.95	0.45	2.73	1.05	9.34
ss0150	0.65	0.07	0.72	0.06	0.01	14.32	8.64	0.45	2.64	1.31
ss0157	0.25	0.57	0.82	0.38	0.01	15.23	1.36	0.00	0.99	9.26
ss0175	0.59	0.00	0.59	0.20	0.02	4.55	1.36	1.36	0.67	9.08
ss0191	0.59	0.00	0.59	0.07	0.03	12.95	0.91	0.00	0.82	6.21
ss0199	0.79	0.00	0.79	0.55	0.01	30.45	17.73	0.00	0.79	9.38
ss0213	0.67	0.00	0.67	0.05	0.01	6.82	15.91	0.00	0.95	4.81
ss0351	0.54	0.00	0.54	0.08	0.00	10.45	0.00	0.91	0.00	8.56
ss0408	0.83	0.00	0.83	0.02	0.07	14.09	0.45	4.09	1.00	5.78
ss0411	0.65	0.00	0.65	0.07	0.00	6.36	2.27	1.36	0.67	7.68
ss0447	0.48	0.00	0.48	0.07	0.01	8.64	3.18	0.00	0.00	15.28
ss1000	0.33	0.00	0.33	0.03	0.09	12.27	7.27	2.27	1.09	4.92

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Flow type			Shelther					Impact index	
Stream	p_gl	p_pool	p_slow	p_bf	clw_msq	pct_xfc_brs	pct_xcf_ucb	pct_xfc_ant	W1_HALL	RCOND
ss4173	0.63	0.00	0.63	0.00	0.01	1.36	0.00	87.05	4.76	1.96
ss4330	0.58	0.00	0.58	0.13	0.02	0.45	4.55	31.59	5.05	5.80
tm0003	0.76	0.00	0.76	0.26	0.06	8.64	0.91	4.09	1.30	3.30
tm0007	0.50	0.30	0.80	0.19	0.10	40.68	1.82	0.00	1.21	14.63
tm0009	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	1.34	3.86
tm0027	0.17	0.83	1.00	0.04	0.00	0.00	0.00	15.91	0.80	4.98
tm0028	0.73	0.10	0.83	0.08	0.00	5.91	1.36	35.23	1.65	5.27
tm0033	0.49	0.45	0.94	0.00	0.01	4.09	10.00	3.18	1.73	3.62
tm0040	0.16	0.79	0.95	0.00	0.00	0.00	0.00	0.00	1.41	3.04
tm0043	0.80	0.03	0.83	0.01	0.04	3.64	3.64	1.36	1.97	2.68
tm0058	0.00	1.00	1.00	0.20	0.00	0.00	0.00	5.00	2.38	3.23
tm0072	0.18	0.61	0.79	0.01	0.00	0.91	15.23	0.00	0.12	6.70
tm0082	0.00	1.00	1.00	0.89	0.04	12.95	0.45	0.00	0.74	2.73
tm0088	0.00	1.00	1.00	0.02	0.01	1.82	1.82	32.27	0.69	3.28
tm0090	0.11	0.83	0.93	0.00	0.00	0.00	2.73	0.00	0.55	5.42
tm0091	0.59	0.00	0.59	0.02	0.00	2.73	0.45	31.36	0.80	3.02
tm0106	0.04	0.96	1.00	0.12	0.06	24.32	27.27	0.91	0.17	6.48
tm0119	0.71	0.21	0.93	0.35	0.02	7.73	0.00	0.00	1.08	3.80
tm0126	0.00	1.00	1.00	0.29	0.13	12.05	2.73	0.00	0.07	7.14
tm0133	0.40	0.57	0.97	0.06	0.11	27.95	5.00	0.91	0.88	4.12
tm0134	0.01	0.91	0.93	0.11	0.01	0.00	9.77	5.00	0.00	9.74
tm0137	0.00	1.00	1.00	0.00	0.05	28.64	0.45	0.00	1.76	6.41
tm0159	0.91	0.00	0.91	0.10	0.01	5.91	6.82	23.64	1.74	5.93
tm0171	0.39	0.16	0.55	0.00	0.00	0.00	5.91	13.64	0.00	1.80
tm0178	0.86	0.00	0.86	0.06	0.02	6.82	8.18	2.73	0.56	4.09
tm0183	0.16	0.71	0.87	0.12	0.03	6.82	10.00	0.00	0.00	7.68
tm0187	0.27	0.41	0.68	0.10	0.00	4.09	5.00	0.00	0.62	4.47
tm0193	0.88	0.05	0.93	0.04	0.08	13.18	7.05	0.45	1.46	7.37
tm0209	0.03	0.97	1.00	0.40	0.05	8.18	5.00	0.00	0.15	16.22
tm0214	0.69	0.31	1.00	0.12	0.01	10.45	0.91	0.00	1.88	0.87
tm0220	0.38	0.27	0.65	0.06	0.00	1.82	0.00	0.00	0.47	4.25
tm0279	0.78	0.00	0.78	0.03	0.01	1.36	2.73	1.36	1.45	3.03
tm0283	0.65	0.12	0.77	0.00	0.00	0.00	0.45	5.23	0.00	7.75
tm0290	0.41	0.57	0.98	0.00	0.00	0.00	2.27	2.27	2.45	1.49
tm0296	0.49	0.30	0.79	0.08	0.01	5.45	1.36	0.45	1.41	3.23

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Flow type			Shelther					Impact index	
Stream	p_gl	p_pool	p_slow	p_bf	clw_msq	pct_xfc_brs	pct_xcf_ucb	pct_xfc_ant	W1_HALL	RCOND
tm0381	0.62	0.33	0.95	0.17	0.09	6.36	1.36	6.14	0.41	5.76
tm0391	0.39	0.60	0.99	0.00	0.00	0.00	0.91	0.00	0.39	7.78
tm0437	0.50	0.33	0.83	0.00	0.00	0.45	0.00	45.00	1.49	2.06
tm1865	0.03	0.97	1.00	0.14	0.13	22.73	0.00	0.91	2.71	2.41
tm3195	0.15	0.79	0.94	0.00	0.00	0.00	0.00	28.18	1.97	0.00
tm3962	0.11	0.89	1.00	0.13	0.00	0.00	0.00	0.00	1.80	6.46
tm6757	0.75	0.22	0.97	0.09	0.00	4.55	4.55	3.18	2.62	4.47
vg0002	0.67	0.28	0.95	0.57	0.08	3.64	0.00	0.00	2.27	2.43
vg0004	0.70	0.04	0.74	0.19	0.01	10.91	5.00	5.68	0.77	9.97
vg0016	0.85	0.00	0.85	0.06	0.02	10.00	3.18	0.00	2.36	1.46
vg0018	0.63	0.00	0.63	0.14	0.19	5.91	0.45	0.00	0.67	6.52
vg0021	0.91	0.00	0.91	0.07	0.04	28.41	30.91	0.00	0.40	13.65
vg0022	0.33	0.00	0.33	0.26	0.04	2.27	2.73	0.00	0.30	9.26
vg0034	0.23	0.67	0.91	0.07	0.08	23.18	0.00	5.23	2.55	9.25
vg0037	0.07	0.00	0.07	0.01	0.27	23.64	2.27	0.00	0.83	6.05
vg0044	0.93	0.00	0.93	0.28	0.02	8.18	7.27	0.00	1.43	4.21
vg0048	0.47	0.00	0.47	0.00	0.13	8.18	0.45	2.73	2.26	1.69
vg0080	0.16	0.00	0.16	0.06	0.01	7.27	14.32	0.45	1.89	4.65
vg0109	0.97	0.00	0.97	0.19	0.01	6.82	17.50	0.00	0.83	10.76
vg0112	0.47	0.00	0.47	0.09	0.06	22.50	3.64	0.00	1.28	4.45
vg0121	0.73	0.00	0.73	0.00	0.37	23.64	15.68	0.00	0.86	10.06
vg0124	0.47	0.07	0.54	0.00	0.02	9.55	10.00	0.00	0.86	5.49
vg0126	0.48	0.00	0.48	0.14	0.03	9.09	5.00	9.32	0.23	8.19
vg0128	0.96	0.02	0.98	0.01	0.10	11.14	0.45	0.00	1.64	5.15
vg0162	0.95	0.01	0.96	0.05	0.16	25.00	5.91	0.00	1.33	6.00
vg0177	0.82	0.01	0.83	0.00	0.28	41.82	0.00	0.91	2.11	11.26
vg0191	0.69	0.00	0.69	0.09	0.02	11.82	6.36	0.45	1.05	11.27
vg0206	0.70	0.30	1.00	0.00	0.03	5.45	1.36	2.27	1.05	5.93
vg0210	1.00	0.00	1.00	0.06	0.01	1.82	0.45	0.00	1.54	2.01
vg0247	0.74	0.00	0.74	0.15	0.00	0.45	0.00	0.00	1.83	3.26
vg0252	0.78	0.00	0.78	0.11	0.03	8.18	9.32	0.00	0.74	5.10
vg0255	0.86	0.00	0.86	0.01	0.00	1.82	0.45	0.45	0.49	7.40
vg0277	0.82	0.00	0.82	0.10	0.02	4.09	3.64	0.00	1.64	1.53
vg0306	0.26	0.00	0.26	0.05	0.01	4.55	8.64	0.00	0.98	5.61

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Flow type			Shelther					Impact index	
Stream	p_gl	p_pool	p_slow	p_bf	clw_msq	pct_xfc_brs	pct_xcf_ucb	pct_xfc_ant	W1_HALL	RCOND
vg0320	0.00	0.12	0.12	0.00	0.01	2.27	5.91	0.00	1.04	9.77
vg0380	0.75	0.00	0.75	0.08	0.00	12.27	5.00	0.00	0.48	12.60
vg0387	0.80	0.01	0.81	0.00	0.23	40.68	14.32	0.00	0.64	10.90
vg0418	0.55	0.19	0.74	0.09	0.02	5.00	16.14	0.00	0.80	10.12
vg0433	0.96	0.00	0.96	0.01	0.03	20.91	13.64	0.00	0.83	5.82
vg0444	0.40	0.00	0.40	0.05	0.00	4.55	3.18	0.00	1.19	2.01
vg0447	0.76	0.00	0.76	0.00	0.03	1.82	19.32	0.00	0.80	3.33
vg0450	0.57	0.07	0.64	0.02	0.00	0.91	0.45	9.32	1.24	2.91
vg0511	0.11	0.00	0.11	0.09	0.03	14.09	1.82	0.00	0.14	8.81
vg0515	0.37	0.11	0.48	0.00	0.01	2.27	9.32	0.00	0.86	6.17
vg0558	0.51	0.00	0.51	0.08	0.01	5.45	3.18	0.00	0.20	7.37
vg0575	0.21	0.00	0.21	0.12	0.01	3.18	0.91	2.73	1.75	2.60
vg1257	0.79	0.09	0.88	0.01	0.00	0.00	0.00	27.73	4.62	0.70

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Water quality							
Stream	DO	pH	Turbidity	N-total	Cond.	TDS	T° C	P-total
np00008	6.58	5.99	4.17	0.08	6.25	0.00	19.00	0.01
np00012	8.40	6.80	14.99	0.08	24.00	10.70	19.10	0.02
np00016	8.14	6.31	1.41	0.13	9.06	0.00	19.00	0.01
np00028	8.49	7.80	2.65	0.11	25.00	19.00	19.04	0.01
np00047	7.45	6.48	20.40	0.09	15.99	10.90	22.70	0.18
np00052	7.62	8.20	1.53	0.10	22.00	16.00	21.00	0.00
np00054	7.19	6.00	2.41	0.08	8.50	6.20	19.10	0.02
np00055	8.49	6.38	4.22	0.10	12.57	0.63	18.00	0.02
np00075	7.97	6.49	3.79	0.11	18.03	6.49	19.50	0.02
np00092	7.88	6.90	3.07	0.08	46.00	17.90	20.00	0.01
np00095	8.57	7.98	1.55	0.09	17.00	13.00	16.44	0.00
np00096	8.57	6.90	31.70	0.11	27.00	20.00	19.40	0.01
np00097	7.53	6.70	4.28	0.11	42.00	25.60	20.70	0.01
np00100	9.01	7.92	4.94	0.11	21.00	15.00	19.42	0.01
np00108	6.67	6.51	6.45	0.13	13.47	3.54	19.00	0.02
np00110	8.14	6.31	2.72	0.10	14.10	10.10	26.20	0.01
np00112	6.23	6.30	7.14	0.09	6.70	4.90	19.10	0.01
np00128	6.67	7.60	4.58	0.08	29.00	16.15	20.20	0.01
np00132	7.97	6.50	2.38	0.09	15.66	2.31	19.00	0.01
np00139	7.71	6.51	2.49	0.10	13.79	10.05	19.20	0.03
np00144	7.53	6.56	1.88	0.07	40.00	15.31	16.70	0.02
np00187	7.62	8.30	3.20	0.08	29.00	21.00	19.00	0.01
np00192	7.97	7.63	9.36	0.12	28.00	16.00	19.30	0.05
np00203	9.44	5.80	1.30	0.08	28.00	4.71	17.00	0.01
np00228	8.49	5.84	3.81	0.08	7.92	5.76	19.40	0.01
np00240	8.14	5.90	3.44	0.11	16.00	24.80	19.70	0.02
np00251	8.14	6.50	4.13	0.10	14.00	17.95	18.90	0.02
np00287	6.06	6.80	2.06	0.08	62.50	27.50	19.00	0.00
np00368	8.40	7.26	1.84	0.12	14.80	10.50	21.20	0.00
np00375	8.83	7.32	1.53	0.11	20.00	14.00	21.20	0.01
np00443	7.19	7.94	3.49	0.09	23.00	16.00	20.09	0.02
np00511	7.45	6.63	2.31	0.01	17.00	8.14	17.50	0.00
np01524	9.35	6.60	2.29	0.07	23.00	0.00	17.00	0.01
np02991	9.01	7.67	3.90	0.12	11.80	10.29	19.30	0.02

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Water quality							
Stream	DO	pH	Turbidity	N-total	Cond.	TDS	T° C	P-total
np05612	9.53	7.67	4.00	0.09	11.80	8.60	19.30	0.00
np07308	6.41	5.80	1.58	0.10	18.00	11.82	19.10	0.01
np09612	7.97	6.80	2.95	0.07	11.00	17.95	19.40	0.01
np09757	8.23	6.26	2.82	0.09	81.13	5.30	17.80	0.02
np12892	6.41	7.28	2.16	0.11	37.00	27.00	18.67	0.00
np15048	7.01	5.68	9.27	0.09	13.40	9.90	18.60	0.01
rca02	6.70	6.79	0.27	0.06	1.36	0.00	19.30	0.00
rca08	3.30	7.11	10.74	0.06	7.25	3.72	19.90	0.01
rca22	9.20	6.58	0.71	0.06	1.66	0.00	17.70	0.01
rca23	7.00	5.68	2.78	0.05	4.47	0.00	16.70	0.00
rca29	9.60	5.30	2.89	0.05	0.41	0.21	21.80	0.00
rca30	7.60	6.84	0.43	0.05	2.61	0.00	20.30	0.01
rca31	9.00	6.52	3.01	0.06	1.47	0.74	21.00	0.01
rca44	8.10	7.92	5.56	0.06	4.27	2.14	21.30	0.00
rca47	12.20	5.80	5.30	0.05	2.55	1.31	20.20	0.00
rca49	7.60	5.16	2.46	0.06	0.65	0.28	20.10	0.00
rca52	8.60	5.22	1.40	0.04	2.53	1.24	18.20	0.00
rca53	8.20	7.33	3.44	0.03	0.55	0.27	17.00	0.00
rca57	7.60	8.01	0.26	0.04	2.57	0.00	18.40	0.00
rca58	7.60	7.12	0.27	0.04	3.47	0.00	19.20	0.00
rca59	7.70	7.43	0.13	0.08	1.85	0.00	19.20	0.00
rca60	9.20	6.90	0.10	0.04	1.19	0.00	18.20	0.00
rca62	1.80	7.43	0.96	0.08	6.28	0.00	18.70	0.01
rca64	8.60	6.47	4.16	0.07	12.18	0.00	19.40	0.01
rca65	7.60	8.40	2.72	0.03	2.66	1.21	21.30	0.00
rca66	7.10	7.39	1.69	0.04	4.41	2.28	19.80	0.00
rca67	8.20	7.60	1.13	0.04	4.39	2.31	20.80	0.00
rca68	7.60	5.60	2.42	0.04	2.38	1.51	20.10	0.00
rca69	7.40	6.60	5.52	0.02	0.71	0.35	19.90	0.00
rca70	7.80	5.34	2.37	0.07	3.27	1.43	19.80	0.00
rca90	9.10	7.94	4.08	0.03	1.77	0.94	21.20	0.00
ss0001	7.30	7.80	2.10	0.08	8.40	0.00	21.50	0.01
ss0002	8.30	7.26	3.90	0.08	78.90	46.20	20.00	0.00
ss0008	7.20	7.41	6.83	0.10	67.40	36.90	19.00	0.00

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

				Water quality				
Stream	DO	pH	Turbidity	N-total	Cond.	TDS	T° C	P-total
ss0010	7.60	6.54	4.14	0.08	36.00	18.60	19.00	0.00
ss0014	7.80	6.20	1.47	0.10	13.50	4.60	20.90	0.00
ss0028	7.30	5.56	4.97	0.09	39.80	19.40	21.00	0.00
ss0029	10.10	7.80	11.90	0.08	69.90	39.50	22.00	0.00
ss0031	7.20	5.54	9.86	0.12	18.70	5.10	21.00	0.01
ss0033	8.20	7.67	15.41	0.09	184.90	109.90	25.00	0.00
ss0035	7.30	6.80	6.85	0.11	39.60	18.70	21.60	0.00
ss0037	5.50	6.68	6.19	0.10	96.50	55.60	21.40	0.01
ss0038	7.70	6.87	12.41	0.11	116.20	66.50	19.00	0.00
ss0044	7.30	6.36	4.98	0.09	41.60	19.30	19.00	0.00
ss0051	7.00	7.26	7.73	0.09	39.70	18.30	19.00	0.00
ss0053	8.90	6.82	2.96	0.08	77.90	13.40	19.40	0.00
ss0057	6.70	7.11	3.78	0.11	233.00	145.00	20.00	0.00
ss0059	7.20	6.81	8.70	0.11	60.40	32.10	18.00	0.01
ss0073	6.30	6.78	4.46	0.21	95.10	56.40	21.50	0.02
ss0078	8.50	6.63	5.33	0.08	50.90	26.70	18.00	0.00
ss0094	8.30	6.60	2.45	0.08	24.40	9.40	24.50	0.00
ss0105	10.70	6.72	9.30	0.07	30.20	13.20	20.00	0.00
ss0126	7.60	6.86	7.73	0.11	33.50	15.90	17.00	0.00
ss0129	8.00	7.59	8.48	0.10	172.30	104.20	19.00	0.00
ss0133	10.20	7.66	3.76	0.10	94.00	53.80	19.00	0.00
ss0144	8.10	7.31	5.65	0.11	40.30	19.90	18.00	0.00
ss0149	8.80	7.60	20.90	0.08	58.00	29.50	20.00	0.01
ss0150	6.80	6.85	8.10	0.09	9.60	55.20	20.00	0.00
ss0157	7.30	6.57	4.70	0.09	76.90	35.30	20.00	0.34
ss0175	7.80	6.12	2.13	0.07	44.20	22.30	20.00	0.00
ss0191	7.50	6.77	6.08	0.13	45.60	22.60	18.50	0.00
ss0199	7.89	6.70	3.71	0.11	43.60	22.30	21.40	0.00
ss0213	8.30	6.65	7.26	0.11	55.30	28.80	21.90	0.00
ss0351	7.30	6.60	3.19	0.11	70.10	38.30	22.60	0.00
ss0408	6.80	7.02	14.19	0.09	29.50	43.30	20.00	0.00
ss0411	7.20	6.44	4.95	0.10	67.80	39.10	18.00	0.01
ss0447	11.10	7.03	3.98	0.10	45.80	24.00	20.00	0.00
ss1000	7.00	7.54	4.54	0.11	75.00	42.20	20.00	0.00

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Water quality							
Stream	DO	pH	Turbidity	N-total	Cond.	TDS	T° C	P-total
ss4173	7.60	7.30	12.93	0.15	131.60	60.30	20.00	0.00
ss4330	7.20	7.10	4.78	0.09	42.90	20.80	21.40	0.00
tm0003	8.30	7.50	15.31	0.06	34.00	22.00	16.33	0.01
tm0007	7.10	7.30	9.45	0.09	43.00	28.00	17.10	0.01
tm0009	6.60	7.40	1.56	0.06	108.00	71.00	15.20	0.02
tm0027	8.90	8.70	2.31	0.08	33.00	20.00	15.50	0.00
tm0028	10.60	8.50	2.04	0.08	128.00	83.00	14.90	0.03
tm0033	7.60	7.80	9.92	6.30	53.00	34.00	15.50	0.01
tm0040	5.70	7.60	3.68	0.08	60.00	39.00	15.60	0.02
tm0043	10.40	8.50	9.77	0.10	34.00	22.00	16.00	0.00
tm0058	5.10	7.60	3.04	0.07	36.00	27.00	18.40	0.02
tm0072	10.10	8.10	1.86	0.06	199.00	130.00	15.30	0.02
tm0082	6.90	7.50	3.88	0.07	135.00	88.00	16.20	0.02
tm0088	10.20	7.50	4.76	0.08	71.00	52.00	19.26	0.03
tm0090	9.90	7.40	4.48	0.07	30.00	19.00	16.80	0.02
tm0091	10.00	8.50	4.23	0.05	79.00	51.00	19.40	0.03
tm0106	2.30	7.20	3.05	0.06	39.00	30.00	16.20	0.02
tm0119	7.30	7.20	15.36	0.07	67.00	44.00	19.30	0.03
tm0126	0.80	7.50	6.72	0.13	63.00	41.00	16.60	0.06
tm0133	7.60	8.00	1.33	0.08	15.00	11.00	17.03	0.04
tm0134	9.00	7.60	2.41	0.10	44.00	29.00	18.00	0.00
tm0137	6.30	7.70	9.58	0.06	153.00	99.00	14.70	0.00
tm0159	10.10	8.30	1.49	0.06	42.00	27.00	19.00	0.01
tm0171	10.70	7.70	1.74	0.08	41.00	29.00	21.20	0.01
tm0178	8.40	7.20	2.45	0.08	136.00	101.00	18.72	0.03
tm0183	5.80	6.40	3.41	0.09	22.00	17.00	16.20	0.00
tm0187	9.30	6.80	4.22	0.06	22.00	17.00	17.40	0.02
tm0193	9.60	7.80	5.90	0.08	20.00	13.00	16.90	0.03
tm0209	6.90	7.30	4.45	0.06	26.00	17.00	16.30	0.03
tm0214	5.00	8.00	54.40	0.07	72.00	47.00	16.30	0.04
tm0220	9.90	8.30	1.60	0.14	219.00	142.00	16.50	0.02
tm0279	10.90	7.70	3.22	0.08	75.00	57.00	17.60	0.02
tm0283	11.70	8.10	3.66	0.11	30.00	20.00	18.70	0.00
tm0290	6.80	7.50	5.91	0.08	28.00	18.00	15.00	0.02
tm0296	10.30	7.80	4.07	0.07	50.00	37.00	18.40	0.02

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

	Water quality							
Stream	DO	pH	Turbidity	N-total	Cond.	TDS	T° C	P-total
tm0381	7.40	6.90	1.57	0.04	7.00	6.00	14.23	0.02
tm0391	9.00	8.30	10.02	0.08	39.00	25.00	19.60	0.03
tm0437	4.30	7.50	8.54	0.06	72.00	46.00	18.45	0.02
tm1865	1.80	7.30	7.49	0.06	90.00	69.00	16.90	0.03
tm3195	11.50	7.70	6.17	0.07	21.00	14.00	22.20	0.01
tm3962	5.70	7.50	3.04	0.09	47.00	0.00	19.00	0.01
tm6757	0.80	7.70	80.80	0.40	559.00	3.63	18.34	1.00
vg0002	6.10	7.10	3.51	0.10	20.00	29.00	20.30	0.00
vg0004	7.89	7.12	3.98	0.13	74.00	18.00	21.50	0.02
vg0016	8.00	6.98	3.43	0.12	45.00	50.00	19.30	0.01
vg0018	8.30	7.60	5.89	0.08	25.00	28.00	19.40	0.01
vg0021	9.70	7.21	14.14	0.12	44.00	8.00	21.80	0.03
vg0022	16.30	6.49	10.00	0.13	44.00	37.00	18.70	0.08
vg0034	8.40	7.30	2.08	0.13	42.00	30.00	19.80	0.01
vg0037	14.70	6.96	3.36	0.11	25.00	2.00	22.60	0.02
vg0044	7.40	8.10	3.15	0.13	35.00	5.00	21.90	0.01
vg0048	7.90	7.20	21.90	0.13	15.00	11.00	21.40	0.03
vg0080	4.20	9.30	6.15	0.11	16.00	17.00	22.10	0.02
vg0109	7.90	7.10	6.85	0.08	32.00	4.00	21.70	0.01
vg0112	3.80	9.10	4.88	0.06	23.00	25.00	20.40	0.01
vg0121	8.40	6.15	3.94	0.22	30.00	17.95	20.50	0.00
vg0124	6.60	6.41	3.90	0.11	32.00	17.95	20.20	0.02
vg0126	6.70	9.60	5.42	0.11	18.00	20.00	20.20	0.01
vg0128	15.60	7.67	3.80	0.18	22.00	16.00	19.90	0.02
vg0162	15.60	7.44	6.88	0.09	23.00	17.00	19.40	0.00
vg0177	6.70	7.26	7.92	0.13	49.00	35.00	21.20	0.01
vg0191	8.10	7.02	5.55	0.18	78.00	19.00	21.30	0.04
vg0206	6.40	7.60	3.90	0.07	63.00	17.95	21.60	0.02
vg0210	8.20	8.05	1.29	0.06	56.00	17.95	19.60	0.01
vg0247	7.60	6.98	2.35	0.12	35.00	5.00	21.80	0.02
vg0252	9.20	7.09	3.50	0.08	52.00	17.95	19.90	0.01
vg0255	7.90	7.26	10.82	0.09	37.00	26.00	20.70	0.02
vg0277	10.40	7.50	3.46	0.13	44.00	49.00	19.70	0.00
vg0306	7.80	7.24	3.19	0.13	38.00	17.95	19.10	0.00

Anexo 3 continuação. Tabelas com métricas abióticas em cada trecho de riacho.

				Water quality				
Stream	DO	pH	Turbidity	N-total	Cond.	TDS	T° C	P-total
vg0320	8.40	7.20	4.71	0.12	30.00	17.95	20.00	0.01
vg0380	8.60	7.26	3.17	0.13	50.00	10.00	20.50	0.01
vg0387	7.60	7.06	9.87	0.15	38.00	27.00	21.00	0.13
vg0418	9.10	7.40	1.63	0.12	65.00	15.00	19.50	0.01
vg0433	8.50	7.40	4.49	0.11	2.00	14.00	20.40	0.01
vg0444	8.40	7.31	2.86	0.11	58.00	13.00	19.80	0.01
vg0447	7.60	7.00	18.50	0.13	43.00	17.95	20.80	0.06
vg0450	8.60	6.82	3.47	0.08	40.00	17.95	18.90	0.00
vg0511	6.40	9.80	9.17	0.07	41.00	44.00	21.70	0.02
vg0515	8.60	7.50	4.20	0.11	55.00	17.95	20.70	0.01
vg0558	9.30	7.80	3.58	0.12	31.00	24.00	16.30	0.03
vg0575	14.00	8.30	14.39	0.09	69.00	69.00	23.20	0.01
vg1257	3.90	6.97	3.34	0.11	191.00	126.00	24.90	0.04

Anexo 4. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Aeshnidae	Ampullaridae	Ancylidae	Anomalopsychidae	Baetidae	Belostomatidae	Bivalvia	Caenidae	Calamoceratidae	Calopterygidae	Ceratopogonidae	Chaoboridae	Chironomidae	Chrysomelidae	Coenagrionidae	Corduliidae	Corixidae	Corydalidae	Culicidae	Curculionidae	Decapoda	Dicteriadidae	Dixidae	Dolichopodidae
np00008	0	0	0	0	56	0	1	2	0	0	1	0	296	0	0	0	0	0	0	0	0	0	0	0
np00012	0	0	0	0	162	1	1	1	2	0	29	0	905	0	9	0	0	4	0	0	0	0	0	0
np00016	0	0	0	0	56	0	0	66	1	0	15	0	1028	0	14	0	0	0	0	0	0	0	0	1
np00028	0	0	0	0	28	0	30	0	0	0	11	0	1209	0	6	0	0	2	0	0	0	0	0	0
np00047	0	0	0	0	0	0	11	0	0	0	3	0	343	0	1	0	0	0	11	90	0	0	0	0
np00052	0	0	0	0	121	0	0	0	1	0	3	0	525	0	0	0	0	0	0	0	0	0	0	0
np00054	0	0	0	0	15	0	0	0	2	1	6	0	248	0	2	1	0	0	3	1	0	0	0	0
np00055	0	0	0	0	13	0	0	0	0	0	0	0	237	0	2	0	0	0	0	0	0	1	0	0
np00075	2	0	0	0	176	2	2	2	2	9	11	0	1201	0	46	0	6	10	0	0	0	0	1	0
np00092	0	0	0	0	7	0	5	34	0	4	27	0	1759	0	14	0	0	0	0	0	0	0	0	0
np00095	0	0	0	0	3	0	17	21	29	0	7	0	688	0	1	0	0	0	1	0	0	0	0	0
np00096	0	0	0	0	34	0	1	2	0	0	12	0	644	0	0	0	0	2	0	0	0	0	0	0
np00097	0	0	0	0	34	0	2	0	0	2	0	0	300	0	3	0	0	3	0	0	0	0	0	0
np00100	0	0	0	0	118	0	0	97	2	2	2	0	413	0	10	0	0	7	1	0	0	1	0	0
np00108	0	0	0	0	41	0	0	0	7	3	31	0	1553	0	4	1	0	2	0	1	0	0	0	0
np00110	0	0	0	0	145	0	9	0	1	0	20	0	1447	0	0	0	0	1	1	0	0	0	0	0
np00112	0	0	0	0	553	0	0	191	2	0	12	0	1803	0	5	0	0	2	10	1	0	0	1	0
np00128	0	0	0	0	118	0	2	0	0	0	2	0	199	0	1	0	0	0	0	0	0	0	0	0
np00132	1	0	0	1	20	1	0	4	0	2	11	0	186	0	3	2	0	2	0	0	0	2	0	0
np00139	0	0	0	0	30	0	7	0	0	2	18	0	1406	0	4	0	0	1	0	0	0	0	0	0
np00144	2	0	0	0	227	0	1	52	0	0	5	0	953	0	2	0	0	0	0	0	0	0	1	0
np00187	0	0	0	0	20	0	0	1	0	0	9	0	217	0	0	0	0	0	0	0	0	2	0	0
np00192	0	0	0	0	26	0	2	0	0	0	4	0	147	0	0	1	0	1	0	0	0	0	0	0
np00203	0	0	0	0	35	0	0	2	0	0	3	0	1200	0	3	0	0	6	0	0	0	0	0	0
np00228	0	0	0	0	16	0	0	0	11	0	9	0	1060	0	2	0	0	1	0	0	0	0	0	0
np00240	0	0	0	0	0	0	0	1	6	0	4	0	1634	0	1	0	0	0	1	0	0	0	0	0
np00251	0	0	0	0	30	0	2	1	0	1	16	0	183	0	0	0	0	0	0	0	0	0	0	0
np00287	1	0	0	0	234	2	0	366	13	0	24	0	2065	0	5	0	0	1	2	0	0	0	0	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Aeshnidae	Ampullaridae	Ancylidae	Anomalopsychidae	Baetidae	Belostomatidae	Bivalvia	Caenidae	Calamoceratidae	Calopterygidae	Ceratopogonidae	Chaoboridae	Chironomidae	Chrysomelidae	Coenagrionidae	Corduliidae	Corixidae	Corydalidae	Culicidae	Curculionidae	Decapoda	Dicteriadidae	Dixidae	Dolichopodidae
np00368	0	0	0	0	8	0	0	0	0	1	5	0	301	0	4	0	0	0	0	0	0	2	0	0
np00375	0	0	0	0	124	0	0	5	1	0	17	0	707	0	8	0	0	1	0	0	0	0	0	0
np00443	0	0	0	0	7	0	0	0	0	0	6	0	650	0	0	0	0	0	0	0	0	0	0	0
np00511	0	0	0	0	170	0	18	0	1	2	12	0	1541	0	6	0	0	0	0	0	0	1	0	0
np01524	0	0	0	0	64	0	0	4	0	0	67	0	943	0	7	0	0	0	0	1	0	0	0	0
np02991	0	0	0	0	240	0	27	0	0	0	9	0	1026	0	12	0	0	0	0	0	0	1	0	0
np05612	0	0	0	0	1	0	0	0	0	0	3	0	256	0	0	0	0	0	0	0	0	0	0	0
np07308	1	0	0	0	32	0	0	8	13	0	27	0	1139	0	1	0	0	0	0	0	0	0	0	0
np09612	0	0	0	0	15	1	0	0	5	1	47	0	954	0	1	0	0	0	0	0	0	0	0	0
np09757	0	0	0	0	0	0	2	0	0	0	8	0	5108	0	1	0	0	0	0	0	0	0	0	0
np12892	0	0	0	0	157	0	6	0	0	0	29	0	3189	0	10	0	0	0	4	0	0	0	4	0
np15048	0	0	0	0	5	0	0	0	0	5	0	0	103	0	0	0	0	0	0	0	0	0	0	0
rca02	0	0	0	0	619	0	0	0	0	0	0	0	879	0	0	0	0	0	0	0	0	0	0	0
rca08	1	0	0	0	18	0	0	23	0	0	32	0	191	0	3	0	0	0	10	0	0	8	0	0
rca22	0	0	0	0	139	0	0	23	0	0	5	0	200	0	3	2	0	1	0	0	0	0	0	0
rca23	0	0	0	0	2	0	0	0	0	0	50	1	194	0	1	0	0	0	1	0	0	0	0	0
rca29	0	0	0	0	0	0	0	0	1	0	6	0	109	0	1	0	0	1	0	0	0	0	0	0
rca30	0	0	0	0	93	0	0	2	1	0	1	0	245	0	0	0	0	0	0	0	0	0	0	0
rca31	0	0	0	0	2	0	0	0	1	1	13	0	38	0	0	0	0	0	0	0	0	0	0	0
rca44	3	0	0	0	8	0	0	0	4	2	1	0	94	0	0	0	0	0	0	0	0	1	1	0
rca47	0	0	0	0	21	0	0	0	0	0	7	0	188	0	2	0	0	4	0	0	0	0	0	0
rca49	3	0	0	0	18	0	2	38	12	4	25	0	698	0	20	1	0	7	0	0	0	1	0	0
rca52	0	0	0	0	6	0	0	1	0	8	8	0	366	0	29	0	0	10	0	0	0	0	0	0
rca53	0	0	0	0	2	0	0	0	0	0	0	0	23	0	2	0	0	2	0	0	0	0	0	0
rca57	0	0	0	0	5	0	0	1	1	0	15	0	637	0	2	0	0	0	0	0	0	0	0	0
rca58	0	0	0	0	2	0	0	1	0	1	115	0	615	0	2	0	0	0	0	0	0	0	0	0
rca59	0	0	0	0	261	0	0	1	0	0	150	0	1060	0	7	0	3	0	0	0	0	0	0	0
rca60	0	0	0	0	157	0	0	0	0	0	23	0	771	0	0	0	0	0	0	0	0	0	0	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Aeshnidae	Ampullaridae	Ancylidae	Anomalopsychidae	Baetidae	Belostomatidae	Bivalvia	Caenidae	Calamoceratidae	Calopterygidae	Ceratopogonidae	Chaoboridae	Chironomidae	Chrysomelidae	Coenagrionidae	Corduliidae	Corixidae	Corydalidae	Culicidae	Curculionidae	Decapoda	Dicteriadidae	Dixidae	Dolichopodidae
rca62	3	0	0	0	0	0	0	0	0	0	95	2	1105	0	61	1	0	0	0	0	0	0	0	0
rca64	0	0	0	0	11	0	0	0	2	0	1	0	84	0	2	0	0	0	1	0	0	0	0	0
rca65	0	0	0	0	3	0	0	0	0	0	11	0	35	0	0	0	0	0	1	0	0	1	0	0
rca66	1	0	0	0	3	0	0	71	2	0	23	0	793	0	3	0	0	3	0	0	0	0	0	0
rca67	2	0	0	0	13	0	0	3	4	2	19	0	153	0	13	0	0	7	0	0	0	0	0	0
rca68	0	0	0	0	14	0	0	9	4	0	19	0	318	0	7	0	0	9	0	0	0	0	0	0
rca69	0	0	0	0	6	0	0	0	3	10	2	0	56	0	2	0	0	13	0	0	0	0	0	0
rca70	0	0	0	0	0	0	0	0	0	0	8	0	41	0	0	0	0	0	0	0	0	0	0	0
rca90	0	0	0	0	15	0	0	1	0	0	20	0	259	0	3	0	0	2	0	0	0	0	0	0
ss0001	0	0	0	0	15	0	0	0	1	2	0	0	48	0	0	0	0	0	0	1	0	0	0	0
ss0002	0	0	0	0	437	0	1	17	58	29	37	0	1331	0	20	0	0	0	0	0	0	0	0	0
ss0008	0	0	0	0	148	0	51	32	3	3	51	0	941	0	28	0	0	1	0	0	0	0	0	0
ss0010	0	0	0	0	21	0	0	0	0	0	2	0	110	0	1	0	0	0	0	0	0	0	0	0
ss0014	0	0	0	0	18	0	0	0	0	1	2	0	52	0	4	0	0	0	0	0	0	0	0	0
ss0028	0	0	0	0	73	0	1	12	5	6	13	0	779	0	36	0	0	1	1	0	0	0	0	0
ss0029	0	0	0	0	6	0	8	5	1	0	6	0	317	0	0	0	0	0	0	0	1	0	0	0
ss0031	0	0	0	0	257	2	10	8	0	16	22	0	1914	0	29	0	1	0	3	0	0	0	0	0
ss0033	0	0	0	0	31	0	1	3	0	1	17	0	876	0	0	0	0	0	0	0	0	0	1	0
ss0035	0	0	0	0	33	0	2	0	0	0	0	0	38	0	0	0	0	1	0	0	0	0	0	0
ss0037	0	0	0	0	243	0	334	17	10	0	25	0	442	0	0	0	0	0	0	0	0	0	0	0
ss0038	0	0	0	0	17	0	0	0	0	0	25	0	174	0	2	0	0	1	0	0	2	0	0	0
ss0044	0	0	0	0	99	0	21	7	1	2	22	0	546	0	5	0	0	0	0	0	0	0	0	0
ss0051	0	0	0	0	0	0	40	1	0	0	33	0	368	0	2	0	0	0	0	0	0	0	0	0
ss0053	0	0	0	0	78	0	3	1	6	6	6	0	286	0	10	0	0	0	1	0	0	0	0	0
ss0057	0	0	0	0	57	0	0	33	0	0	20	0	264	0	4	0	0	4	0	0	2	0	0	0
ss0059	0	0	0	0	21	0	1	0	0	1	3	0	110	0	1	0	0	0	0	0	0	0	0	0
ss0073	0	0	0	0	7	0	0	0	0	0	0	0	541	0	0	0	0	0	0	0	0	0	0	0
ss0078	0	0	0	0	449	0	3	1	2	28	16	0	277	0	6	0	0	2	0	0	0	0	0	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Aeshnidae	Ampullaridae	Ancylidae	Anomalopsychidae	Baetidae	Belostomatidae	Bivalvia	Caenidae	Calamoceratidae	Calopterygidae	Ceratopogonidae	Chaoboridae	Chironomidae	Chrysomelidae	Coenagrionidae	Corduliidae	Corixidae	Corydalidae	Culicidae	Curculionidae	Decapoda	Dicteriadidae	Dixidae	Dolichopodidae
ss0094	0	0	0	0	181	0	2	1	3	1	15	0	315	0	7	0	0	0	0	0	4	0	0	0
ss0105	0	0	0	0	6	0	2	0	0	0	4	0	82	0	0	0	0	0	0	0	0	0	0	0
ss0126	0	0	0	0	0	0	1	0	0	1	5	0	80	0	0	0	0	0	0	0	0	0	1	0
ss0129	0	0	0	0	29	0	0	17	0	0	4	0	109	0	1	0	0	0	0	0	1	0	0	0
ss0133	0	0	1	0	636	0	1	10	0	2	23	0	1332	0	2	0	0	0	0	0	0	0	0	0
ss0144	0	0	0	0	57	0	2	7	1	1	8	0	395	0	12	0	0	0	2	0	0	0	0	0
ss0149	0	0	0	0	63	0	0	0	0	5	2	0	125	0	0	0	0	0	0	0	0	0	0	0
ss0150	0	0	0	0	36	0	0	0	0	0	1	0	186	0	0	0	0	0	0	0	0	0	0	0
ss0157	0	0	0	0	28	0	0	28	69	0	38	0	3306	0	26	0	0	0	0	1	1	0	0	0
ss0175	0	0	0	0	493	0	0	1	8	6	13	0	763	0	3	0	0	8	0	2	1	0	0	0
ss0191	0	0	0	0	290	0	1	1	0	4	24	0	602	0	6	0	0	3	0	0	0	0	0	0
ss0199	0	17	0	0	24	0	5	2	1	0	3	0	198	0	2	0	0	0	0	0	0	0	0	0
ss0213	0	0	0	0	102	0	1	0	2	0	1	0	254	0	3	0	0	1	0	0	0	0	0	0
ss0351	0	0	0	0	117	0	0	2	3	1	10	0	370	0	11	0	0	1	0	0	0	0	1	0
ss0408	0	0	0	0	7	0	14	4	1	4	50	0	327	0	3	0	0	0	0	0	0	0	0	0
ss0411	0	0	0	0	663	0	17	20	2	2	16	0	928	0	10	0	0	2	0	0	2	0	0	0
ss0447	0	0	0	0	72	0	5	1	1	1	6	0	418	1	2	0	0	0	0	0	0	0	0	0
ss1000	0	0	0	0	94	0	3	0	0	4	3	0	699	0	7	0	0	0	0	0	0	0	0	0
ss4173	0	0	0	0	0	0	0	0	0	0	0	0	6278	0	0	0	0	0	0	248	0	0	0	0
ss4330	0	0	4	0	7	0	40	4	3	0	3	0	213	0	16	0	0	1	0	0	0	0	0	0
tm0003	0	0	0	0	75	0	1	0	0	1	7	0	705	0	14	0	0	0	1	0	0	0	0	0
tm0007	0	0	0	0	60	0	2	5	0	1	15	0	458	0	6	0	0	0	2	0	0	0	0	0
tm0009	0	0	0	0	178	0	0	7	0	0	52	0	1927	0	8	0	2	0	52	0	0	0	0	0
tm0027	1	0	0	0	34	0	2	1	0	25	4	0	88	0	5	0	0	1	0	0	0	0	0	0
tm0028	0	0	0	0	151	0	0	115	0	0	73	0	1070	0	0	0	0	0	0	0	0	0	0	4
tm0033	0	0	0	0	118	0	0	15	0	1	18	0	209	0	8	2	2	0	6	0	0	0	0	0
tm0040	0	0	4	0	603	0	1	65	0	0	34	0	693	0	4	3	0	0	0	0	0	0	0	0
tm0043	0	0	0	0	90	0	7	20	0	2	48	0	589	0	3	0	2	0	0	0	0	0	0	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Aeshnidae	Ampullaridae	Ancylidae	Anomalopsychidae	Baetidae	Belostomatidae	Bivalvia	Caenidae	Calamoceratidae	Calopterygidae	Ceratopogonidae	Chaoboridae	Chironomidae	Chrysomelidae	Coenagrionidae	Corduliidae	Corixidae	Corydalidae	Culicidae	Curculionidae	Decapoda	Dicteriadidae	Dixidae	Dolichopodidae
tm0058	0	0	0	0	649	0	0	202	1	0	121	2	1446	0	18	0	13	1	17	0	0	0	0	0
tm0072	0	0	0	0	33	0	4	53	1	1	27	0	309	0	8	0	3	2	0	0	0	0	0	1
tm0082	0	0	6	0	5	0	33	0	1	0	18	0	527	0	0	0	0	0	2	0	0	0	0	0
tm0088	0	0	0	0	240	0	0	56	0	0	73	8	2114	0	1	0	6	0	8	0	0	0	0	0
tm0090	0	0	0	0	284	0	1	11	0	1	22	0	324	0	26	0	14	2	9	0	0	0	0	0
tm0091	0	0	0	0	274	0	0	13	0	1	32	0	602	0	12	0	0	3	0	0	0	0	0	0
tm0106	0	0	0	0	34	0	0	17	0	0	16	3	204	0	0	0	0	0	6	0	0	0	0	0
tm0119	0	0	0	0	10	0	162	1	0	4	15	0	579	0	15	0	0	0	2	1	0	0	0	0
tm0126	0	0	0	0	98	0	26	4	0	0	33	0	425	0	4	0	0	0	22	1	0	0	0	0
tm0133	0	0	0	0	18	0	12	3	0	1	35	0	690	0	11	0	0	0	3	0	0	0	0	0
tm0134	0	0	0	0	27	0	0	8	24	0	36	0	1747	0	24	0	0	0	3	0	0	0	0	0
tm0137	0	0	49	0	49	0	80	153	0	0	11	3	482	0	4	0	3	0	5	0	0	0	0	0
tm0159	0	0	0	0	112	0	0	9	0	1	37	0	570	0	0	0	0	0	0	0	0	0	0	0
tm0171	0	0	0	0	216	0	39	1	0	0	36	0	599	0	3	0	11	1	0	0	0	0	0	1
tm0178	0	0	0	0	355	0	26	237	0	0	67	0	1281	1	0	0	0	0	0	0	0	0	0	0
tm0183	0	0	3	0	14	0	9	4	0	0	39	1	1248	0	19	0	0	1	4	0	0	0	0	0
tm0187	0	0	0	0	246	0	4	18	17	8	50	0	553	0	5	0	11	2	1	0	0	0	0	0
tm0193	0	0	0	20	0	22	1	0	1	1	0	881	0	5	0	0	0	0	0	0	0	0	0	0
tm0209	0	0	0	0	19	0	24	4	0	0	38	0	769	0	3	0	0	0	4	0	0	0	0	0
tm0214	0	0	0	0	9	0	0	0	0	0	118	0	300	0	3	0	0	0	3	0	0	0	0	0
tm0220	0	0	10	0	229	1	0	72	5	0	22	0	677	0	5	0	0	0	10	0	0	0	0	1
tm0279	0	0	1	0	124	0	32	0	0	0	6	0	788	0	5	0	0	0	0	0	0	0	0	0
tm0283	0	0	0	0	299	0	1	1	0	0	12	0	469	0	6	0	0	0	0	0	0	0	0	0
tm0290	0	0	0	0	35	2	0	1	0	0	12	0	181	0	4	0	0	0	21	0	0	0	0	0
tm0296	0	0	0	0	178	0	1	41	1	0	75	0	752	0	15	0	12	0	1	0	0	0	0	0
tm0381	0	0	0	0	0	0	20	0	0	0	5	0	328	0	0	0	0	0	2	0	0	0	0	0
tm0391	0	0	1	0	45	0	3	1	0	0	66	0	596	0	4	0	1	0	0	0	0	0	0	3
tm0437	0	0	1	0	1050	1	128	11	0	6	27	0	1056	0	15	0	3	0	0	0	0	0	0	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Aeshnidae	Ampullaridae	Ancylidae	Anomalopsychidae	Baetidae	Belostomatidae	Bivalvia	Caenidae	Calamoceratidae	Calopterygidae	Ceratopogonidae	Chaoboridae	Chironomidae	Chrysomelidae	Coenagrionidae	Corduliidae	Corixidae	Corydalidae	Culicidae	Curculionidae	Decapoda	Dicteriadidae	Dixidae	Dolichopodidae
tm1865	0	0	13	0	164	2	240	21	0	1	8	17	249	0	5	0	0	0	15	0	0	0	0	0
tm3195	1	0	0	0	6	0	641	1	0	0	5	0	763	0	4	0	0	0	1	1	0	0	0	0
tm3962	0	0	1	0	87	1	3	39	0	14	44	30	1277	0	11	0	18	0	20	0	0	0	0	0
tm6757	0	0	0	0	0	1	0	0	0	0	0	0	2751	0	0	0	0	0	37	0	0	0	0	0
vg0002	0	0	0	0	22	1	108	4	0	5	0	0	96	0	7	0	0	0	0	0	0	0	0	0
vg0004	0	0	3	0	662	2	3	9	9	7	22	0	1540	0	15	0	0	3	0	0	0	6	1	0
vg0016	0	0	0	0	59	0	1	1	1	3	6	0	655	0	3	0	0	1	0	0	0	0	0	0
vg0018	0	0	0	0	8	0	1	0	4	1	22	0	561	0	4	0	0	1	0	0	0	0	0	0
vg0021	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
vg0022	0	0	1	0	548	0	0	0	124	0	4	0	859	0	5	0	0	0	0	0	0	10	0	0
vg0034	0	0	0	0	52	0	39	75	34	3	5	0	1387	0	20	0	0	0	0	0	0	0	0	0
vg0037	0	0	0	0	0	0	1	0	0	0	1	0	43	0	0	0	0	0	0	0	0	0	0	0
vg0044	1	0	0	0	95	0	0	0	12	2	18	0	1071	0	16	0	0	0	1	0	3	0	0	0
vg0048	0	0	0	0	4	0	12	3	4	2	32	0	1104	0	0	0	0	1	0	0	0	0	0	0
vg0080	0	0	1	0	58	0	0	1	3	2	7	0	327	0	3	0	0	1	0	0	0	0	0	0
vg0109	0	0	0	0	100	0	54	0	3	2	3	0	1322	0	3	0	0	0	0	0	0	0	0	0
vg0112	0	0	0	0	25	0	4	0	0	1	0	0	224	0	2	0	0	0	0	0	0	0	0	0
vg0121	0	0	0	0	39	0	0	0	0	0	0	0	151	0	4	0	0	0	0	0	0	0	0	0
vg0124	0	0	0	0	169	0	0	0	0	3	2	0	391	0	8	0	0	0	0	0	0	0	0	0
vg0126	0	0	4	0	45	0	1	10	11	5	3	0	741	0	9	0	0	1	0	0	0	0	0	1
vg0128	0	0	0	0	226	0	4	0	0	3	37	0	617	0	11	0	0	0	2	0	0	0	0	0
vg0162	0	0	0	0	107	0	2	0	3	7	3	0	1469	0	12	0	0	3	0	1	0	0	0	0
vg0177	0	0	0	0	5	0	7	6	0	6	9	0	490	0	3	0	0	1	0	0	0	0	0	0
vg0191	0	0	24	0	100	0	430	0	0	0	7	0	2197	0	2	0	0	0	0	0	0	1	1	0
vg0206	0	0	0	0	120	0	10	99	92	12	4	0	1234	0	1	0	0	0	1	0	0	0	1	19
vg0210	0	0	0	0	341	0	0	22	2	2	12	0	285	0	2	0	0	0	0	0	0	0	0	0
vg0247	0	0	0	0	27	0	0	0	0	0	4	0	222	0	1	0	0	0	0	0	0	0	3	0
vg0252	0	0	0	0	18	0	1	0	0	0	3	0	276	0	0	0	0	0	0	0	0	0	0	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Aeshnidae	Ampullaridae	Ancylidae	Anomalopsychidae	Baetidae	Belostomatidae	Bivalvia	Caenidae	Calamoceratidae	Calopterygidae	Ceratopogonidae	Chaoboridae	Chironomidae	Chrysomelidae	Coenagrionidae	Corduliidae	Corixidae	Corydalidae	Culicidae	Curculionidae	Decapoda	Dicteriadidae	Dixidae	Dolichopodidae
vg0255	0	0	0	0	75	0	2	0	0	1	2	0	341	0	2	0	0	0	0	0	0	0	0	0
vg0277	0	0	0	0	162	0	1	2	7	7	5	0	392	0	0	0	0	0	0	0	0	1	0	0
vg0306	0	0	1	0	337	10	1	31	3	1	8	0	542	0	5	0	0	2	0	0	0	0	1	0
vg0320	0	0	0	0	35	0	0	0	0	1	0	0	113	0	1	0	0	0	0	0	0	0	0	0
vg0380	0	0	0	0	108	0	0	0	6	4	13	0	2554	0	10	0	0	0	0	1	0	0	0	0
vg0387	0	0	0	0	45	0	17	0	0	6	11	0	704	0	7	0	0	0	0	3	0	0	0	0
vg0418	0	0	0	0	136	0	9	7	5	2	13	0	1683	0	18	0	0	1	0	0	0	0	3	0
vg0433	0	0	0	0	51	0	0	0	1	1	3	0	262	0	1	0	0	0	0	0	0	1	0	0
vg0444	0	0	0	0	1077	0	0	1	0	31	6	0	1285	0	27	0	0	0	0	0	0	0	3	0
vg0447	0	0	0	0	32	0	6	0	0	0	1	0	160	0	0	0	0	0	0	0	0	0	0	0
vg0450	0	0	0	0	28	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0
vg0511	0	0	0	0	27	0	0	1	0	0	3	1	64	0	0	0	0	0	0	0	0	0	0	0
vg0515	0	0	0	0	169	0	0	0	6	3	4	0	750	0	3	0	0	1	0	0	0	0	0	0
vg0558	0	0	0	0	271	0	0	0	0	0	11	0	3183	0	0	0	0	0	0	0	0	0	0	0
vg0575	0	0	0	0	31	0	0	9	15	0	1	0	587	0	0	0	0	0	0	0	0	0	1	0
vg1257	0	0	0	0	0	0	0	0	0	0	9	0	1801	0	5	0	0	0	36	0	0	0	0	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Dryopidae	Dytiscidae	Ecnomidae	Elmidae	Empididae	Ephemeridae	Ephydridae	Euthyplociidae	Gelastocoridae	Gerridae	Glossosomatidae	Gomphidae	Gripopterygidae	Gyrinidae	Hebridae	Helicopsychidae	Helotrephidae	Hirudinea	Hydraenidae	Hydrobiidae	Hydrobiosidae	Hydrophilidae	Hydropsychidae	Hydroptilidae
np00008	4	0	1	41	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0	0
np00012	2	4	0	161	7	0	0	1	0	0	1	0	6	0	0	0	0	0	0	0	3	6	43	19
np00016	0	4	0	230	6	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	6	4	1	14
np00028	0	2	0	30	2	0	0	0	0	1	0	7	1	0	0	0	0	2	0	0	0	1	6	2
np00047	0	2	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	0
np00052	1	0	0	6	4	0	0	0	0	0	4	4	74	0	0	0	0	0	0	0	0	0	9	0
np00054	0	0	1	2	0	0	0	0	0	0	0	1	4	2	0	0	0	0	0	0	0	0	0	0
np00055	1	1	0	4	0	0	0	0	0	0	1	1	4	0	0	0	0	0	0	0	0	1	3	0
np00075	0	11	3	542	3	0	0	3	0	0	7	14	0	3	0	0	0	0	0	4	5	2	15	4
np00092	1	3	0	14	7	0	0	0	0	0	0	13	6	0	0	0	0	0	0	0	0	0	40	0
np00095	6	5	0	257	0	0	0	0	0	0	0	3	20	0	0	0	0	3	0	0	0	1	2	0
np00096	0	5	0	144	1	0	0	0	0	1	1	5	0	1	0	0	0	0	0	0	1	0	25	0
np00097	0	0	0	9	1	0	0	0	0	0	2	4	3	0	0	0	0	0	0	0	0	1	18	0
np00100	0	0	0	239	0	0	0	0	0	0	51	4	4	5	0	0	0	1	0	0	4	0	9	4
np00108	0	11	0	22	7	0	0	0	0	0	0	9	139	0	0	0	0	0	0	0	0	0	67	0
np00110	0	1	0	71	14	0	0	0	0	0	25	0	11	0	0	0	0	1	0	0	0	0	23	7
np00112	0	31	8	233	3	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	30	4
np00128	0	4	0	3	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0
np00132	0	0	0	55	1	0	0	0	0	0	0	8	116	0	0	0	0	0	0	0	0	0	3	0
np00139	13	0	0	453	11	0	0	0	0	0	0	7	0	1	0	0	0	11	0	0	0	0	19	0
np00144	0	19	0	26	0	0	0	0	0	4	0	12	4	1	0	0	1	0	0	0	0	0	0	0
np00187	0	0	0	26	2	0	0	0	0	0	2	0	5	0	0	0	0	0	0	0	0	0	4	0
np00192	7	0	0	129	2	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	10	0
np00203	0	5	0	89	31	0	0	0	0	0	9	8	7	0	0	0	0	0	0	0	0	4	13	2
np00228	0	4	0	82	11	0	0	0	0	0	0	3	14	4	0	0	0	0	0	0	0	1	14	1
np00240	2	6	0	3	0	0	0	0	0	1	0	4	0	0	0	0	0	0	0	0	0	1	5	0
np00251	0	0	0	17	22	0	0	3	0	0	0	1	45	0	0	0	1	0	0	0	0	0	2	8
np00287	2	20	0	97	4	0	0	0	0	0	0	26	120	1	0	0	0	1	0	0	0	3	58	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Dryopidae	Dytiscidae	Ecnomidae	Elmidae	Empididae	Ephemeridae	Ephydridae	Euthyplocidae	Gelastocoridae	Gerridae	Glossosomatidae	Gomphidae	Gripopterygidae	Gyrinidae	Hebridae	Helicopsychidae	Helotrephidae	Hirudinea	Hydraenidae	Hydrobidae	Hydrobiosidae	Hydrophilidae	Hydropsychidae	Hydroptilidae
np00368	0	0	2	24	0	0	0	0	0	0	0	2	1	0	0	0	0	2	0	0	0	0	0	0
np00375	0	7	1	175	18	0	0	0	0	0	17	4	1	1	0	0	0	0	0	0	5	28	16	1
np00443	0	6	0	93	4	0	0	0	0	0	19	1	2	0	0	0	0	0	0	0	0	0	2	1
np00511	3	4	0	805	28	0	0	0	0	0	183	5	0	2	0	0	0	0	0	0	0	7	14	13
np01524	1	1	0	530	8	0	0	0	0	0	14	3	0	2	0	0	0	0	0	0	0	0	12	0
np02991	2	2	2	326	19	0	0	0	0	0	27	4	0	3	0	0	0	0	0	0	24	0	13	2
np05612	0	0	1	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
np07308	0	9	0	111	8	0	0	14	0	0	0	1	21	0	0	0	0	0	0	0	0	0	27	0
np09612	0	0	0	28	4	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	5	20	1
np09757	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	162	0	0	0	57	1	0
np12892	0	6	0	6	38	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	50	128
np15048	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
rca02	0	0	0	136	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	21	0	1	7
rca08	0	1	0	8	0	0	0	0	0	1	0	4	0	0	0	1	0	34	0	0	0	1	0	0
rca22	0	1	1	67	0	0	0	4	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	11
rca23	1	1	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	5	0
rca29	1	0	0	3	1	0	0	0	0	0	0	3	4	0	0	0	0	0	0	0	0	0	15	0
rca30	0	0	0	280	5	0	0	6	0	0	0	0	1	1	0	1	0	0	0	0	0	1	1	17
rca31	0	3	0	9	1	0	0	0	0	0	2	8	0	0	0	1	0	0	0	0	0	0	0	0
rca44	0	1	1	27	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	1	1	0
rca47	1	0	0	110	0	0	0	0	0	0	14	6	4	0	0	0	0	0	0	0	0	0	39	0
rca49	0	0	7	313	4	0	0	7	0	0	1	0	10	0	0	0	0	1	0	0	0	1	93	9
rca52	1	2	1	67	2	0	0	12	0	0	5	1	0	0	0	0	0	2	0	0	1	0	38	9
rca53	0	0	0	54	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	11	3
rca57	0	3	0	43	0	0	0	8	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
rca58	0	0	0	46	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	14	14
rca59	1	2	0	448	5	0	0	0	0	0	0	1	32	0	0	0	0	0	0	0	0	0	87	47
rca60	0	0	0	120	12	0	0	0	0	0	0	0	7	0	0	1	0	0	0	0	2	0	18	47

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Dryopidae	Dytiscidae	Ecnomidae	Elmidae	Empididae	Ephemeridae	Ephydridae	Euthyplociidae	Gelastocoridae	Gerridae	Glossosomatidae	Gomphidae	Gripopterygidae	Gyrinidae	Hebridae	Helicopsychidae	Helotrephidae	Hirudinea	Hydraenidae	Hydrobiidae	Hydrobiosidae	Hydrophilidae	Hydropsychidae	Hydroptilidae
rca62	0	1	3	2	2	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	1	5	0
rca64	0	0	0	19	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	2
rca65	0	0	0	8	0	0	0	0	0	0	4	8	1	0	0	0	0	0	0	0	0	0	0	0
rca66	1	0	1	28	0	0	0	0	0	1	0	6	0	1	0	2	0	1	0	0	0	0	0	1
rca67	0	0	0	113	0	0	0	0	0	0	6	7	1	0	0	0	0	2	0	0	0	1	9	3
rca68	0	0	1	204	7	0	0	12	0	0	15	2	0	0	0	1	0	0	0	0	0	0	57	0
rca69	0	0	0	94	2	0	0	0	0	0	6	2	2	0	0	0	0	0	0	0	1	1	19	2
rca70	0	0	0	13	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	4	1
rca90	0	0	0	43	1	0	0	0	0	0	34	4	0	0	0	0	0	0	0	0	0	0	1	0
ss0001	0	0	0	43	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	11	0
ss0002	0	1	3	91	7	0	0	0	0	0	0	11	0	0	0	1	0	1	0	0	0	4	7	2
ss0008	0	1	1	166	1	0	0	0	0	0	4	20	0	0	0	2	0	0	0	0	0	1	36	5
ss0010	0	0	0	2	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	6	0
ss0014	0	0	0	58	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	10	0
ss0028	0	0	1	146	0	0	0	0	0	0	0	9	0	2	0	0	0	0	0	0	1	0	49	0
ss0029	0	0	3	29	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0	0
ss0031	0	1	0	14	1	0	0	0	0	0	0	21	0	2	0	0	0	2	0	0	0	1	135	2
ss0033	0	0	0	215	8	0	0	0	0	0	9	0	0	0	0	0	0	1	0	0	0	1	686	23
ss0035	0	0	0	11	2	0	0	0	0	0	11	2	0	0	0	0	0	0	0	0	0	0	3	0
ss0037	0	0	2	75	1	0	0	0	0	1	8	13	0	1	0	2	0	0	0	0	0	0	3	0
ss0038	0	0	0	5	1	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	13	0
ss0044	0	11	0	215	6	0	0	0	0	0	0	23	0	1	0	6	0	0	0	0	0	0	9	0
ss0051	0	0	2	63	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	12	0
ss0053	0	5	0	79	2	0	0	0	0	0	1	20	0	1	0	1	0	0	0	0	0	2	22	1
ss0057	0	0	0	206	0	0	0	0	0	0	0	11	0	0	0	18	0	0	0	0	0	0	97	0
ss0059	0	0	0	8	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
ss0073	0	0	0	1	0	0	0	0	0	0	22	1	0	0	0	0	0	0	0	0	0	2	125	3
ss0078	0	0	0	248	2	0	0	0	0	0	1	1	0	0	0	1	0	0	1	0	0	0	99	2

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Dryopidae	Dytiscidae	Ecnomidae	Elmidae	Empididae	Ephemeridae	Ephydridae	Euthyplociidae	Gelastocoridae	Gerridae	Glossosomatidae	Gomphidae	Gripopterygidae	Gyrinidae	Hebridae	Helicopsychidae	Helotrephidae	Hirudinea	Hydraenidae	Hydrobiidae	Hydrobiosidae	Hydrophilidae	Hydropsychidae	Hydroptilidae
ss0094	0	0	0	186	7	0	0	0	0	0	13	4	0	0	0	2	0	0	0	0	0	0	46	0
ss0105	0	0	0	16	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	17	0
ss0126	0	1	0	8	1	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
ss0129	0	0	0	13	3	0	0	0	0	1	0	5	0	0	0	0	0	0	0	0	0	0	2	0
ss0133	0	2	0	439	1	0	0	0	0	0	1	3	0	0	0	16	0	13	0	0	0	0	42	183
ss0144	0	1	0	32	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	1	0	0
ss0149	0	0	6	5	2	0	0	0	0	0	1	1	0	0	0	4	0	0	0	0	0	0	1	1
ss0150	0	0	1	69	2	0	0	0	0	0	0	2	0	0	0	9	0	0	0	0	0	0	14	0
ss0157	0	1	0	82	16	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	7	0
ss0175	0	0	0	350	9	0	0	0	0	0	7	2	0	0	0	3	0	0	0	0	0	0	148	0
ss0191	0	2	0	256	9	0	0	0	0	1	0	9	0	1	0	20	0	1	0	0	0	0	10	4
ss0199	0	1	0	20	1	0	0	0	0	0	0	6	0	1	0	9	0	3	0	0	0	0	6	0
ss0213	0	0	3	38	3	0	0	0	0	0	6	2	0	0	0	3	0	0	0	0	0	0	18	1
ss0351	0	0	1	188	15	0	0	0	0	2	4	4	0	0	0	7	0	0	0	0	0	0	45	4
ss0408	0	1	3	23	1	0	0	0	0	0	0	4	0	0	0	0	0	7	0	0	0	1	13	0
ss0411	0	0	0	116	1	0	0	0	0	0	6	14	0	2	0	24	0	0	0	0	4	0	38	35
ss0447	0	2	0	49	4	0	0	0	0	0	2	7	0	1	0	2	0	0	0	0	0	0	2	0
ss1000	0	0	1	190	4	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	28	0
ss4173	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	992	0	0	0	5	446	1
ss4330	0	0	4	98	1	0	0	0	0	0	1	3	0	0	0	24	0	69	0	88	0	0	20	1
tm0003	0	0	0	55	3	0	0	0	0	0	0	6	0	7	0	0	0	0	0	0	0	1	135	0
tm0007	0	1	0	23	0	4	0	0	0	0	0	12	0	1	0	0	0	0	0	0	0	1	5	0
tm0009	0	4	0	41	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	5
tm0027	0	0	0	12	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	4
tm0028	0	0	0	20	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	51
tm0033	0	0	1	49	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	1	0
tm0040	0	0	0	33	0	0	0	4	0	0	0	6	0	0	0	3	0	1	0	0	0	3	0	0
tm0043	0	3	0	26	0	0	0	1	0	1	0	13	0	0	0	10	0	0	0	0	2	0	0	2

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Dryopidae	Dytiscidae	Ecnomidae	Elmidae	Empididae	Ephemeridae	Ephydridae	Euthyplociidae	Gelastocoridae	Gerridae	Glossosomatidae	Gomphidae	Gripopterygidae	Gyrinidae	Hebridae	Helicopsychidae	Helotrephidae	Hirudinea	Hydraenidae	Hydrobidae	Hydrobiosidae	Hydrophilidae	Hydropsychidae	Hydroptilidae
tm0058	0	4	0	97	0	0	0	0	0	0	0	3	0	0	0	2	0	2	0	0	7	1	66	1
tm0072	0	0	0	104	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	1	91	5
tm0082	0	3	0	267	3	0	0	0	0	0	0	21	0	0	0	0	0	5	0	5	0	0	2	0
tm0088	0	9	0	70	0	0	0	0	0	1	0	1	0	0	1	12	0	0	0	0	0	1	0	6
tm0090	0	1	1	33	0	0	0	18	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	5
tm0091	0	15	0	137	9	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1	0	32	18
tm0106	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
tm0119	1	19	0	184	6	0	0	0	0	0	0	19	0	1	0	0	0	0	0	37	0	0	72	0
tm0126	0	1	0	60	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	6	0
tm0133	0	0	0	28	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
tm0134	0	3	0	56	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	8	0	0
tm0137	0	2	0	656	0	0	0	0	0	0	0	11	0	1	0	0	0	4	0	0	0	0	19	0
tm0159	0	2	0	104	1	0	0	2	0	1	1	3	0	0	0	0	0	0	0	0	0	0	0	34
tm0171	0	0	0	355	5	0	0	2	0	0	0	2	0	0	0	2	0	0	0	0	0	0	50	8
tm0178	0	0	0	258	7	0	0	0	0	1	5	6	0	0	0	0	0	0	0	0	20	0	16	33
tm0183	0	0	0	69	4	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	3	0	1	4
tm0187	0	9	2	124	5	0	0	2	0	0	1	24	0	0	0	4	0	0	0	0	3	0	11	10
tm0193	0	0	36	5	0	0	0	0	0	0	1	0	1	0	0	0	0	3	0	0	0	4	0	0
tm0209	0	0	0	11	1	0	0	0	0	0	0	2	0	0	0	0	0	5	0	0	0	0	0	0
tm0214	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	3	1	0
tm0220	0	1	1	205	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	56	4
tm0279	0	0	0	124	12	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	11
tm0283	0	0	0	11	2	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	11	0	33	0
tm0290	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	2
tm0296	2	0	2	217	3	0	0	2	0	2	2	2	0	2	0	4	0	2	0	0	0	0	44	74
tm0381	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	1	0	0
tm0391	0	2	0	18	0	0	0	0	0	0	0	6	0	0	0	0	0	1	0	0	0	1	14	4
tm0437	0	1	0	1048	11	0	0	0	0	0	0	7	0	0	0	0	0	12	0	0	0	0	70	12

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Dryopidae	Dytiscidae	Ecnomidae	Elmidae	Empididae	Ephemeridae	Ephydridae	Euthyplociidae	Gelastocoridae	Gerridae	Glossosomatidae	Gomphidae	Gripopterygidae	Gyrinidae	Hebridae	Helicopsychidae	Helotrephidae	Hirudinea	Hydraenidae	Hydrobiidae	Hydrobiosidae	Hydrophilidae	Hydropsychidae	Hydroptilidae
tm1865	0	0	0	958	0	0	0	0	0	1	0	11	0	0	0	0	0	14	0	0	0	1	10	3
tm3195	0	6	0	10	0	0	0	0	0	1	0	4	0	1	0	0	0	0	0	0	0	0	0	0
tm3962	0	22	0	96	0	0	0	0	0	0	0	1	0	0	0	0	0	12	0	0	0	1	2	1
tm6757	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
vg0002	0	0	0	19	1	0	0	0	0	0	0	4	0	0	0	0	0	16	0	0	0	3	1	0
vg0004	5	6	9	630	15	0	0	0	0	0	7	3	0	0	0	0	0	0	0	0	0	3	53	81
vg0016	1	5	0	336	8	0	0	0	0	0	0	2	0	1	0	19	0	0	0	0	0	1	6	0
vg0018	0	3	0	4	13	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	8	0
vg0021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
vg0022	1	0	0	89	7	0	0	0	0	3	10	3	0	0	0	0	0	0	0	0	0	4	15	0
vg0034	1	5	0	124	7	0	0	0	0	0	0	4	0	1	0	0	0	0	0	0	0	0	25	0
vg0037	0	0	0	24	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
vg0044	0	64	0	217	1	0	0	0	0	0	12	9	0	0	0	0	0	0	0	0	0	0	12	0
vg0048	0	0	0	166	3	0	0	0	0	1	0	1	0	2	0	0	0	0	0	0	0	0	111	2
vg0080	0	0	0	64	12	0	0	0	0	0	3	1	0	0	0	1	0	0	0	0	0	0	10	0
vg0109	3	5	0	169	6	0	0	0	0	0	0	3	0	2	0	0	0	0	0	0	0	0	3	0
vg0112	0	2	0	75	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	18	1
vg0121	10	3	0	34	4	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	66	0
vg0124	0	1	1	88	1	0	0	0	0	0	8	2	0	0	0	0	0	0	0	0	0	0	3	1
vg0126	0	0	1	14	24	0	0	0	0	0	0	4	0	0	0	1	0	6	0	0	0	0	112	0
vg0128	22	3	0	104	17	0	1	0	0	0	0	0	0	3	0	0	0	3	0	0	0	2	11	0
vg0162	2	7	0	170	13	0	0	0	0	0	1	1	0	3	0	0	0	0	0	0	3	0	10	1
vg0177	1	1	0	94	16	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3	2	120	11
vg0191	0	1	0	18	3	0	0	0	0	0	30	1	0	0	0	0	0	43	0	0	0	0	288	0
vg0206	2	0	0	91	4	0	0	0	0	0	6	1	0	1	0	0	0	0	0	0	0	0	104	0
vg0210	0	2	0	61	0	0	0	0	0	1	8	7	0	0	0	0	0	0	0	0	1	0	8	1
vg0247	2	0	0	140	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
vg0252	3	1	0	52	4	0	0	0	0	0	0	8	0	0	0	4	0	0	0	0	0	0	5	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Dryopidae	Dytiscidae	Ecnomidae	Elmidae	Empididae	Ephemeridae	Ephydridae	Euthyplociidae	Gelastocoridae	Gerridae	Glossosomatidae	Gomphidae	Gripopterygidae	Gyrinidae	Hebridae	Helicopsychidae	Helotrephidae	Hirudinea	Hydraenidae	Hydrobidae	Hydrobiosidae	Hydrophilidae	Hydropsychidae	Hydroptilidae
vg0255	1	0	0	46	5	0	0	0	0	0	11	1	0	1	0	0	0	0	0	0	0	0	2	0
vg0277	6	48	0	101	2	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
vg0306	2	0	0	563	5	0	0	0	0	0	131	0	0	0	0	0	0	0	0	0	3	0	20	0
vg0320	0	0	0	39	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	9	1
vg0380	0	14	0	257	5	0	0	0	0	0	3	47	0	2	0	0	0	0	0	0	1	0	2	0
vg0387	9	0	2	84	8	0	0	0	0	0	0	3	0	3	0	0	0	1	0	0	0	0	7	1
vg0418	0	10	0	395	31	0	0	0	0	0	41	3	0	0	0	0	0	0	0	0	26	1	26	0
vg0433	0	0	1	116	11	0	0	0	0	0	0	1	0	2	0	16	0	0	0	0	5	0	17	0
vg0444	1	0	1	625	26	0	0	0	0	0	43	5	0	0	0	3	0	7	0	0	0	0	114	2
vg0447	0	0	0	10	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0
vg0450	0	0	0	62	0	0	0	0	0	0	35	2	0	0	0	0	0	0	0	0	0	0	6	0
vg0511	0	0	0	18	2	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	6	0
vg0515	0	1	0	131	7	0	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0	21	2
vg0558	0	0	0	23	0	0	0	0	0	0	98	1	0	0	0	0	0	0	0	0	0	0	247	0
vg0575	1	0	0	70	8	0	0	0	0	0	6	2	0	0	0	0	0	0	0	0	0	0	5	1
vg1257	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	58	0	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Hydroscaphidae	Leptoceridae	Leptohyphidae	Leptophlebiidae	Libellulidae	Lymnaeidae	Limnichidae	Lutrochidae	Megapodagrionidae	Mesoveliidae	Muscidae	Naucoridae	Nematoda	Nepidae	Noteridae	Notonectidae	Odontoceridae	Oligochaeta	Ostracoda	Perilestidae	Perlidae	Philopotamidae	Physidae	Phoridae	Planariidae
np00008	0	0	2	1	1	0	0	2	0	0	0	0	1	0	0	0	12	19	0	0	10	0	0	0	0
np00012	0	0	450	42	4	0	0	0	2	0	0	27	0	0	0	0	1	34	0	0	15	0	0	0	3
np00016	0	0	109	211	6	0	0	0	4	0	0	16	1	0	0	0	3	21	0	0	1	0	0	0	1
np00028	0	2	25	20	3	0	0	0	0	0	0	0	0	0	0	0	1	16	0	0	8	0	0	0	1
np00047	0	0	0	0	19	0	0	0	0	0	0	2	0	0	0	0	0	83	0	0	0	0	0	0	0
np00052	0	2	49	0	2	0	0	0	0	0	0	2	0	0	0	0	3	0	0	0	1	0	0	0	0
np00054	0	7	15	24	7	0	0	0	0	0	1	0	1	0	0	0	1	11	0	2	2	0	0	0	0
np00055	1	0	25	1	0	0	0	0	0	0	0	0	1	0	0	0	13	0	0	0	0	0	0	0	0
np00075	0	16	177	264	11	0	0	0	3	0	1	38	0	0	0	0	12	15	0	5	40	0	0	0	1
np00092	0	3	4	9	20	0	0	0	0	0	3	6	0	0	0	0	4	13	0	0	2	0	0	0	0
np00095	0	86	26	25	0	0	0	11	2	0	0	5	0	0	0	0	12	15	0	0	0	0	0	0	0
np00096	0	5	83	112	0	0	0	0	0	0	1	5	0	0	0	0	4	29	0	0	23	0	0	0	0
np00097	0	0	86	25	8	0	0	0	1	0	0	0	1	0	0	0	1	296	0	0	0	1	0	0	2
np00100	0	14	276	304	10	0	0	0	0	0	0	15	0	0	0	0	7	4	0	3	9	0	0	0	0
np00108	0	3	13	1	4	0	0	3	3	0	1	2	0	0	0	0	4	41	0	0	2	0	0	0	0
np00110	0	1	57	3	0	0	0	1	0	0	10	1	2	0	0	0	0	114	0	0	8	2	0	0	1
np00112	0	17	143	418	1	0	0	3	2	0	6	2	0	0	0	1	5	331	0	0	23	1	0	0	0
np00128	0	0	0	0	11	0	0	0	0	0	0	1	0	0	0	0	1	17	0	0	0	0	0	0	1
np00132	0	10	146	59	3	0	0	0	6	0	1	2	0	0	0	0	5	16	0	1	3	0	0	0	0
np00139	0	0	8	10	2	0	0	4	0	0	0	15	0	0	0	0	1	74	0	0	1	0	0	0	5
np00144	0	2	25	86	6	0	0	0	0	0	0	52	0	1	0	0	6	2	0	7	0	0	0	0	0
np00187	0	0	60	1	1	0	0	0	0	0	1	1	0	0	0	0	5	0	0	0	0	0	0	0	0
np00192	0	0	1	0	0	0	0	11	0	0	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0
np00203	0	1	834	6	8	0	0	1	1	0	0	33	0	0	0	0	1	38	0	1	0	0	0	0	0
np00228	0	4	26	5	3	0	0	1	0	1	0	0	0	0	0	0	4	145	0	0	4	0	0	0	0
np00240	0	0	0	11	3	0	0	1	0	0	0	1	0	0	0	0	0	16	0	0	2	0	0	0	0
np00251	0	0	152	5	3	0	0	0	0	0	0	3	0	0	0	0	3	11	0	1	4	1	0	0	2
np00287	0	13	0	112	13	0	0	2	2	0	0	3	0	0	0	0	6	38	0	0	9	2	0	0	2

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Hydroscaphidae	Leptoceridae	Leptohyphidae	Leptophlebiidae	Libellulidae	Lymnaeidae	Limnichidae	Lutrochidae	Megapodagrionidae	Mesoveliidae	Muscidae	Naucoridae	Nematoda	Nepidae	Noteridae	Notonectidae	Odontoceridae	Oligochaeta	Ostracoda	Perilestidae	Perlidae	Philopotamidae	Physidae	Phoridae	Planariidae
np00368	0	4	78	4	1	0	0	11	0	0	0	1	0	0	0	0	3	174	0	0	2	0	0	0	0
np00375	0	1	153	322	1	0	0	0	1	0	0	4	0	0	0	0	0	24	0	0	8	0	0	0	0
np00443	0	0	100	8	1	0	0	1	0	0	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0
np00511	0	13	213	21	4	0	0	3	0	1	0	51	0	0	0	0	2	26	0	0	17	0	0	0	4
np01524	0	0	0	16	1	0	0	0	0	0	0	2	0	0	0	0	26	24	0	0	110	0	0	0	0
np02991	0	2	97	97	2	0	0	1	0	0	3	82	0	0	0	0	4	175	0	0	18	0	0	0	1
np05612	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	1	8	0	0	0	0	0	0	0
np07308	0	43	39	146	1	0	0	2	4	0	0	34	0	0	0	0	5	10	0	1	15	0	0	0	0
np09612	0	16	28	18	0	0	0	0	1	0	0	0	0	0	0	0	4	0	0	0	5	0	0	0	0
np09757	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	3727	0	0	0	0	0	0	22
np12892	0	0	0	7	4	0	0	0	0	0	0	0	3	0	1	0	13	806	0	0	1	0	0	0	0
np15048	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	126	0	0	0	0	0	0	3
rca02	0	31	0	22	0	0	0	1	0	0	0	1	0	0	0	0	0	12	0	0	0	0	0	0	0
rca08	0	8	80	93	5	0	0	1	0	0	0	0	1	0	0	0	0	145	0	0	4	0	0	0	0
rca22	0	11	14	69	0	0	0	1	0	0	0	1	0	0	4	0	0	5	0	1	0	0	0	0	0
rca23	0	1	0	15	0	0	0	0	0	0	0	0	1	0	0	3	0	44	0	0	7	0	0	0	0
rca29	0	0	10	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	2	0	0	0	0
rca30	0	30	25	39	0	0	0	0	0	0	1	1	0	0	0	0	5	8	0	0	0	0	0	0	0
rca31	0	0	1	5	2	0	0	0	0	0	0	2	0	0	0	0	2	4	0	0	3	0	0	0	0
rca44	0	4	0	11	6	0	0	0	0	0	0	0	0	0	0	0	16	22	0	0	18	0	0	0	0
rca47	0	0	44	12	4	0	0	0	0	0	0	1	0	0	0	0	29	8	0	0	55	0	0	0	0
rca49	0	8	120	51	12	0	0	1	6	0	0	0	0	0	0	0	12	15	0	3	13	0	0	0	0
rca52	0	8	137	211	11	0	0	0	6	0	0	6	0	0	0	0	70	18	0	0	36	0	0	0	1
rca53	0	0	13	23	0	0	0	0	0	0	0	1	0	0	0	0	5	6	0	0	4	4	0	0	0
rca57	2	16	1	22	9	0	0	0	0	0	0	0	1	0	0	0	6	111	0	0	0	0	0	0	0
rca58	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
rca59	0	42	63	147	15	0	0	0	0	0	0	0	7	0	0	0	0	149	0	0	13	0	0	0	14
rca60	0	337	21	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Hydroscaphidae	Leptoceridae	Leptohyphidae	Leptophlebiidae	Libellulidae	Lymnaeidae	Limnichidae	Lutrochidae	Megapodagrionidae	Mesoveliidae	Muscidae	Naucoridae	Nematoda	Nepidae	Noteridae	Notonectidae	Odontoceridae	Oligochaeta	Ostracoda	Perilestidae	Perlidae	Philopotamidae	Physidae	Phoridae	Planariidae
rca62	0	27	0	118	9	0	0	0	0	0	0	2	0	0	0	1	0	47	0	0	0	0	0	0	0
rca64	0	1	0	13	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0
rca65	0	0	12	1	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
rca66	0	13	42	22	22	0	0	2	0	0	0	0	0	0	0	0	8	58	0	0	3	0	0	0	1
rca67	0	17	45	43	11	0	0	0	0	0	1	0	0	0	0	0	3	34	0	4	13	0	0	0	0
rca68	0	2	94	64	2	0	0	0	0	0	0	0	0	0	0	0	3	24	0	0	19	0	0	0	0
rca69	0	2	26	12	1	0	0	0	0	0	0	1	0	0	0	0	10	1	0	0	8	0	0	0	0
rca70	0	0	3	0	0	0	0	0	1	0	0	0	0	0	0	0	5	16	0	0	3	0	0	0	0
rca90	0	1	27	10	3	0	0	0	0	0	0	17	1	0	0	0	3	10	0	0	1	0	0	0	0
ss0001	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	1	0	0	0
ss0002	0	38	135	253	18	0	0	0	2	0	0	14	2	0	0	0	1	45	0	0	0	0	0	0	0
ss0008	0	0	39	57	11	0	0	0	0	0	0	3	0	0	0	0	13	23	0	0	2	0	0	0	0
ss0010	0	0	2	3	2	0	0	0	0	0	0	2	0	0	0	0	0	25	0	0	0	0	0	0	0
ss0014	0	0	5	6	0	0	0	0	0	0	0	8	0	0	0	0	0	12	0	0	1	0	0	0	0
ss0028	0	7	203	89	10	0	0	4	0	0	0	7	4	0	0	0	1	173	0	0	1	2	0	0	0
ss0029	0	4	31	14	0	0	0	0	0	0	0	2	1	0	0	0	0	10	0	0	0	0	0	0	1
ss0031	0	0	0	132	28	0	0	0	0	0	0	0	0	0	0	0	4	349	0	0	0	0	0	0	0
ss0033	0	0	20	1	3	0	0	0	0	0	0	51	0	0	0	0	0	52	0	0	1	0	0	0	0
ss0035	0	0	3	27	1	0	0	1	0	0	0	3	0	0	0	0	0	0	0	0	0	1	0	0	0
ss0037	0	6	23	38	2	0	0	0	0	0	0	21	1	0	0	0	1	27	0	0	0	0	0	0	0
ss0038	0	0	4	57	0	0	0	1	0	0	0	1	0	0	0	0	0	14	0	0	0	0	0	0	0
ss0044	0	3	141	121	2	0	0	3	0	0	0	5	0	0	0	0	0	98	0	0	4	1	0	0	1
ss0051	0	2	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	64	0	0	0	0	0	0	0
ss0053	0	0	2	26	45	0	0	0	0	0	1	8	0	0	0	0	0	1	0	0	8	0	0	0	0
ss0057	0	1	5	160	5	0	0	2	0	0	0	3	0	0	0	1	0	328	0	0	9	34	0	0	1
ss0059	0	1	0	2	0	0	0	0	0	0	0	7	0	0	0	0	0	1	0	0	0	0	0	0	0
ss0073	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1020	0	0	0	0	0	0	0
ss0078	0	58	24	153	18	0	0	0	0	0	0	8	0	0	0	0	0	8	0	0	13	0	0	0	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Hydroscaphidae	Leptoceridae	Leptohyphidae	Leptophlebiidae	Libellulidae	Lymnaeidae	Limnichidae	Lutrochidae	Megapodagrionidae	Mesovelidae	Muscidae	Naucoridae	Nematoda	Nepidae	Noteridae	Notonectidae	Odontoceridae	Oligochaeta	Ostracoda	Perilestidae	Perlidae	Philopotamidae	Physidae	Phoridae	Planariidae
ss0094	0	3	62	173	0	0	0	0	4	0	2	15	0	0	0	0	0	25	0	0	17	0	0	0	0
ss0105	0	1	0	8	1	0	0	0	0	0	0	11	0	0	0	0	0	11	0	0	1	1	0	0	0
ss0126	0	0	1	1	1	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
ss0129	0	0	10	32	0	0	0	0	0	0	0	2	0	0	0	0	0	19	0	0	1	0	0	0	0
ss0133	0	7	57	76	13	0	0	0	0	0	0	18	0	0	0	2	2	201	0	0	0	2	0	0	0
ss0144	0	0	18	6	2	0	0	1	0	0	0	5	0	0	0	0	0	0	0	0	1	0	1	0	0
ss0149	0	1	2	0	2	0	0	0	0	0	0	1	1	0	0	0	0	4	0	0	0	0	0	0	0
ss0150	1	3	24	106	15	0	0	2	0	0	0	23	0	0	0	0	0	7	0	0	8	0	0	0	0
ss0157	0	9	9	44	12	0	0	0	9	0	4	2	1	0	0	1	2	18	0	0	2	0	0	0	0
ss0175	0	0	184	390	6	0	0	0	0	0	0	7	0	0	0	0	0	43	0	0	156	219	0	0	0
ss0191	0	1	79	154	17	0	0	1	0	0	0	19	0	0	0	0	0	23	0	0	14	10	0	0	0
ss0199	0	3	3	47	0	0	0	0	0	0	1	1	0	0	0	1	0	29	0	0	0	0	0	0	0
ss0213	0	2	39	54	3	0	0	1	0	0	0	1	0	0	0	0	0	8	0	0	5	0	0	0	0
ss0351	0	1	82	296	35	0	0	0	0	0	0	34	0	0	0	0	0	14	0	0	11	8	0	0	0
ss0408	0	0	12	0	4	0	0	0	0	0	0	1	2	0	0	0	0	148	0	0	0	0	0	0	29
ss0411	0	13	104	182	18	0	0	0	0	0	0	4	1	0	0	0	3	51	0	0	6	0	0	0	0
ss0447	0	1	19	29	5	0	0	0	1	0	0	4	0	0	0	0	0	7	0	0	0	0	0	0	0
ss1000	0	0	43	77	3	0	0	1	0	0	0	4	6	0	0	0	2	115	0	0	19	1	0	0	2
ss4173	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1805	0	0	0	0	0	0	0
ss4330	0	8	52	22	5	0	0	0	0	0	0	0	0	0	0	0	0	56	0	0	0	2	0	0	0
tm0003	0	2	156	401	3	0	0	11	0	0	1	0	0	0	0	0	0	27	0	0	1	3	0	0	0
tm0007	0	5	0	20	1	0	0	0	0	0	0	9	0	0	0	0	0	6	0	0	0	1	0	0	0
tm0009	0	0	12	10	14	1	0	0	0	0	0	8	0	0	0	0	12	32	0	0	0	0	0	0	0
tm0027	0	0	9	0	17	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0
tm0028	0	1	428	92	1	0	0	0	0	0	0	0	0	0	0	0	0	177	0	3	8	0	0	0	0
tm0033	0	4	0	66	6	0	0	0	0	2	0	0	0	0	0	0	4	13	0	0	1	0	0	0	0
tm0040	0	5	39	60	5	0	0	0	2	0	0	0	0	0	0	0	2	60	0	0	0	0	0	0	0
tm0043	0	7	14	59	9	0	0	0	4	0	0	0	0	0	0	0	2	19	0	0	1	0	0	0	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Hydroscaphidae	Leptoceridae	Leptohyphidae	Leptophlebiidae	Libellulidae	Lymnaeidae	Limnichidae	Lutrochidae	Megapodagrionidae	Mesoveliidae	Muscidae	Naucoridae	Nematoda	Nepidae	Noteridae	Notonectidae	Odontoceridae	Oligochaeta	Ostracoda	Perilestidae	Perlidae	Philopotamidae	Physidae	Phoridae	Planariidae
tm0058	0	2	65	361	23	0	0	0	0	0	0	2	0	0	0	0	5	46	0	0	10	26	0	0	33
tm0072	0	0	39	30	1	0	0	0	0	0	0	3	0	0	0	0	6	11	0	0	11	2	0	0	0
tm0082	0	0	12	10	3	0	0	0	0	0	0	0	0	0	3	0	0	33	0	0	0	0	1	0	0
tm0088	0	0	88	83	0	0	0	0	0	0	0	4	0	0	0	2	3	42	0	0	0	0	0	0	0
tm0090	0	2	1	174	7	0	0	0	3	0	0	2	0	0	0	0	5	1	0	1	22	0	0	0	0
tm0091	0	8	106	224	13	0	0	0	0	0	0	40	8	0	0	1	1	43	0	0	42	689	0	0	0
tm0106	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0	0	3	32	0	0	0	0	0	0	0
tm0119	0	11	1	7	3	0	0	8	0	0	0	7	3	0	0	0	0	15	0	0	5	0	5	0	0
tm0126	0	8	2	70	4	0	0	12	0	0	0	13	0	0	0	0	0	6	0	0	0	0	0	0	0
tm0133	0	5	1	5	11	0	0	0	1	0	0	5	0	0	0	0	4	16	0	0	0	0	0	0	0
tm0134	0	0	14	61	2	0	0	0	0	0	0	4	0	0	0	0	0	2	0	0	0	0	0	0	0
tm0137	0	5	21	39	3	0	0	7	0	0	1	2	0	0	0	4	0	49	0	0	0	0	0	0	0
tm0159	0	5	172	17	10	0	0	0	0	0	0	6	0	0	0	1	0	35	0	0	0	0	0	0	1
tm0171	0	0	199	118	16	0	0	2	0	0	0	5	0	0	0	0	1	179	0	0	15	39	0	0	12
tm0178	0	27	355	94	3	0	0	0	0	0	0	3	1	0	0	1	0	46	0	0	36	9	0	0	1
tm0183	0	7	79	19	25	0	0	0	0	0	0	0	0	0	0	1	0	54	0	0	0	0	0	0	0
tm0187	0	6	28	157	3	0	0	1	4	0	0	7	0	0	0	0	10	13	0	1	24	0	0	0	1
tm0193	3	25	4	7	0	0	2	0	0	0	6	0	0	0	0	2	259	0	0	0	0	0	0	0	0
tm0209	0	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	194	0	0	0	0	0	0	0
tm0214	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	76	0	0	0	0	0	0	0
tm0220	0	21	878	273	27	0	0	0	0	3	0	8	0	0	0	0	0	143	0	0	25	14	0	0	0
tm0279	0	1	82	16	1	0	0	0	0	0	0	1	0	0	0	0	0	237	0	0	6	0	0	0	0
tm0283	0	0	22	34	4	0	0	0	0	0	0	4	0	0	0	0	1	3	0	0	2	1	0	0	0
tm0290	0	0	0	0	17	0	0	0	0	0	0	1	1	0	0	0	0	3	0	0	0	0	0	0	0
tm0296	0	4	193	95	16	0	0	0	0	1	0	7	0	0	0	0	2	193	0	0	14	10	0	0	6
tm0381	0	2	0	0	3	0	0	0	0	0	0	0	0	0	1	0	0	45	0	0	0	0	0	0	0
tm0391	0	2	6	9	13	0	0	0	0	6	0	0	0	0	0	0	0	24	0	0	0	1	0	0	0
tm0437	0	0	33	40	10	0	0	0	0	0	0	12	0	0	0	0	0	227	0	0	2	0	0	0	7

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Hydroscaphidae	Leptoceridae	Leptohyphidae	Leptophlebiidae	Libellulidae	Lymnaeidae	Limnichidae	Lutrochidae	Megapodagrionidae	Mesoveliidae	Muscidae	Naucoridae	Nematoda	Nepidae	Noteridae	Notonectidae	Odontoceridae	Oligochaeta	Ostracoda	Perilestidae	Perlidae	Philopotamidae	Physidae	Phoridae	Planariidae
tm1865	0	7	38	20	5	0	0	5	0	0	0	5	0	0	0	0	8	215	0	0	0	0	1	0	10
tm3195	0	0	0	0	3	0	0	0	0	0	0	10	0	0	0	0	3	47	0	0	0	0	0	0	0
tm3962	0	9	7	10	21	0	0	0	0	0	0	2	0	0	0	0	1	240	0	0	0	0	1	0	0
tm6757	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	448	0	0	0	0	9	0	0
vg0002	0	0	0	0	3	0	0	0	0	0	0	13	0	0	0	0	1	365	0	0	0	0	0	0	0
vg0004	0	8	166	900	1	0	0	0	0	0	0	13	0	0	0	0	2	148	0	0	69	0	0	0	5
vg0016	0	4	33	114	1	0	0	0	0	0	0	13	0	0	0	0	0	100	0	0	0	0	0	0	4
vg0018	1	0	19	1	0	0	0	0	2	0	3	6	0	0	0	0	0	32	0	0	2	0	0	0	0
vg0021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
vg0022	0	1	27	34	2	0	0	0	0	0	0	11	0	0	0	0	0	11	0	0	1	0	0	0	2
vg0034	0	1	58	21	3	0	0	0	0	0	0	2	0	0	0	0	3	215	0	0	2	0	0	0	0
vg0037	0	0	0	1	0	0	0	0	0	0	0	5	0	0	0	0	0	20	0	0	0	0	0	0	0
vg0044	0	3	19	227	1	0	0	0	0	0	0	21	0	0	0	0	17	6	0	0	8	0	0	0	0
vg0048	0	5	1	0	1	0	0	0	0	0	1	1	1	0	0	0	1	41	0	0	38	0	0	0	0
vg0080	0	3	19	31	0	0	0	0	0	0	1	7	0	0	0	0	0	13	0	0	4	0	0	0	0
vg0109	0	0	29	10	1	0	0	5	1	0	0	23	0	0	0	0	0	144	0	0	7	0	0	0	0
vg0112	0	0	23	51	0	0	0	0	0	0	0	2	0	0	0	0	0	9	0	0	6	1	0	0	0
vg0121	0	1	7	45	0	0	0	0	0	0	0	11	0	0	0	0	0	5	0	0	2	0	0	0	3
vg0124	0	0	7	36	0	0	0	0	0	0	0	4	0	0	0	0	4	6	0	0	0	0	0	0	0
vg0126	0	5	7	2	4	0	0	0	0	0	0	1	0	0	0	0	0	23	0	0	1	0	0	0	0
vg0128	0	0	3	23	2	0	0	0	1	0	1	19	0	0	0	0	3	104	0	0	10	0	0	0	5
vg0162	0	0	35	23	1	0	0	1	2	0	0	10	0	0	0	0	3	126	0	0	13	0	0	0	0
vg0177	0	3	26	46	0	0	0	0	0	0	0	1	0	0	0	0	0	142	0	0	12	0	0	0	0
vg0191	0	0	1	50	0	0	0	0	0	0	0	1	0	0	0	0	0	5171	0	0	0	0	12	0	31
vg0206	0	1	112	45	3	0	0	0	0	0	0	32	0	0	0	0	36	18	0	0	4	0	0	0	0
vg0210	0	2	55	130	4	0	0	0	0	0	0	4	0	0	0	0	6	5	0	0	8	5	0	0	1
vg0247	0	1	23	0	0	0	1	0	0	0	0	0	0	0	0	0	2	232	0	0	11	0	0	0	0
vg0252	0	4	14	15	0	0	0	0	0	0	0	21	0	0	0	0	1	0	0	0	3	0	0	0	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Hydroscaphidae	Leptoceridae	Leptohyphidae	Leptophlebiidae	Libellulidae	Lymnaeidae	Limnichidae	Lutrochidae	Megapodagrionidae	Mesoveliidae	Muscidae	Naucoridae	Nematoda	Nepidae	Noteridae	Notonectidae	Odontoceridae	Oligochaeta	Ostracoda	Perilestidae	Perlidae	Philopotamidae	Physidae	Phoridae	Planariidae
vg0255	0	0	18	1	0	0	0	0	1	0	0	4	0	0	0	0	0	18	0	0	0	0	0	0	0
vg0277	0	1	28	60	0	0	0	1	0	0	0	6	0	0	0	0	0	4	0	0	0	0	0	0	0
vg0306	0	8	117	653	4	0	0	0	0	0	0	13	0	0	0	0	2	6	0	0	28	9	0	0	1
vg0320	0	0	1	18	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	1
vg0380	0	4	82	111	2	0	0	0	0	0	0	45	0	0	0	0	0	34	0	0	0	0	0	0	0
vg0387	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	368	0	0	0	0	0	0	2
vg0418	0	7	167	331	2	0	0	0	0	0	0	34	0	0	0	0	5	309	0	0	23	0	0	0	2
vg0433	0	2	30	26	0	0	0	0	0	0	0	16	0	0	0	0	0	30	0	0	26	0	0	0	1
vg0444	0	14	514	373	4	0	0	0	4	0	0	7	0	0	0	0	1	138	0	0	28	87	0	0	1
vg0447	0	0	1	3	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
vg0450	0	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
vg0511	0	0	7	4	0	0	0	0	0	0	0	14	0	0	0	0	0	13	0	0	0	0	0	0	0
vg0515	0	1	14	90	2	0	0	0	1	0	0	0	0	0	0	0	0	12	0	0	2	0	0	0	9
vg0558	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	12	0	0	8
vg0575	0	0	14	7	0	0	0	0	0	0	0	2	0	0	0	0	0	147	0	0	0	0	0	0	0
vg1257	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	4984	0	0	0	0	0	0	62

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Planorbidae	Pleidae	Polycentropodidae	Polymitarcyidae	Polythoridae	Psephenidae	Pseudostigmatidae	Psychodidae	Ptilodactylidae	Pyralidae	Saldidae	Salpingidae	Scatopsidae	Scirtidae	Sericostomatidae	Sialidae	Simuliidae	Sisyridae	Staphylinidae	Stratiomyidae	Syrphidae	Tabanidae	Thiaridae	Tipulidae	Veliidae	Xiphocentronidae
np00008	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	13	18	0	0	0	0	0	0	1	0	0
np00012	0	2	4	0	0	0	0	0	0	1	0	0	0	0	0	0	502	0	0	0	0	0	0	4	0	0
np00016	0	3	8	0	0	10	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	1	0	255	0	0
np00028	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	5	0	0	0	0	1	0	2	8	0
np00047	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0
np00052	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	1	0	0	1	0	6	3	0
np00054	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	3	5	0	1	0	0	0	0	7	6	0
np00055	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	3	4	0	0	0	0	0	0	0	0	0
np00075	0	11	22	0	0	12	0	0	0	2	0	0	0	0	0	2	30	0	0	0	0	5	0	115	2	0
np00092	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	12	0	0
np00095	0	13	0	0	0	0	0	0	0	1	0	0	0	0	0	0	6	0	1	0	0	0	0	2	0	0
np00096	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	1	0	0	4	0	10	1	0
np00097	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0
np00100	0	0	4	0	0	25	0	0	0	5	0	0	0	0	0	0	21	0	0	0	0	1	0	5	0	0
np00108	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	133	0	1	0	0	0	0	9	2	0
np00110	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	209	0	0	0	0	0	0	2	1	0
np00112	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	3	261	0	0	0	0	4	0	35	1	0
np00128	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0
np00132	0	0	1	0	0	25	0	0	0	1	0	0	0	0	0	0	36	0	0	0	0	3	0	1	0	0
np00139	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	41	0	0	0	0	0	0	0	3	0
np00144	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	4	0	2	1	0
np00187	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	7	0	0
np00192	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	14	0	1	0	0	1	0	1	0	0
np00203	0	0	4	0	0	2	0	0	0	0	0	0	0	1	0	0	334	0	0	0	0	0	0	5	0	0
np00228	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	139	0	1	0	0	0	0	8	1	0
np00240	0	0	0	0	0	0	0	1	0	2	0	0	0	7	0	0	6	0	0	0	0	0	0	32	0	0
np00251	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	78	0	0	0	0	1	0	5	0	0
np00287	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	40	0	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Planorbidae	Pleidae	Polycentropodidae	Polymitarcyidae	Polythoridae	Psephenidae	Pseudostigmatidae	Psychodidae	Ptilodactylidae	Pyralidae	Saldidae	Salpingidae	Scatopsidae	Scirtidae	Sericostomatidae	Sialidae	Simuliidae	Sisyridae	Staphylinidae	Stratiomyidae	Syrphidae	Tabanidae	Thiaridae	Tipulidae	Veliidae	Xiphocentronidae
np00368	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43	0	1	0	0	3	0	0	1	0
np00375	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	1	35	0	0	0	0	2	0	132	1	0
np00443	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	3	0	0
np00511	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	75	0	5	0	0	0	0	57	1	0
np01524	0	0	0	0	0	0	0	0	0	11	0	0	0	1	0	0	44	0	0	0	0	0	0	11	0	0
np02991	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	102	0	0	0	0	0	0	9	3	0
np05612	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0
np07308	0	4	0	0	0	0	0	0	1	1	0	0	0	0	0	0	59	0	0	0	0	0	0	14	0	0
np09612	0	0	0	0	0	7	0	0	1	0	0	0	0	0	0	0	19	0	0	0	0	0	0	14	4	0
np09757	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	67	0	0	0	0	0	0	5	0	0
np12892	0	0	0	0	0	0	0	0	0	7	0	0	0	1	0	0	4604	0	0	0	0	0	0	4	0	0
np15048	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	324	0	0	0	0	0	0	0	0	0
rca02	0	0	0	0	0	0	0	0	0	85	0	0	0	0	0	0	1860	0	1	0	0	0	0	0	0	1
rca08	0	18	0	0	0	1	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	12	1	0
rca22	0	1	5	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
rca23	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	90	0	0	0	0	1	0	16	1	0
rca29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
rca30	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0
rca31	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0
rca44	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	6	0	0
rca47	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	53	0	0	0	0	0	0	7	0	0
rca49	0	1	0	0	0	3	7	1	0	16	0	0	0	0	0	0	72	0	0	0	0	2	0	38	0	0
rca52	0	1	21	0	0	13	0	0	0	6	0	0	0	0	0	0	48	0	0	0	0	0	0	39	0	3
rca53	0	0	4	0	0	11	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	5	0	0
rca57	0	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
rca58	0	3	0	0	0	0	0	0	0	4	0	0	0	1	0	0	10	0	0	0	0	0	0	2	0	0
rca59	0	22	0	0	0	0	0	0	0	30	0	0	0	7	0	0	366	0	0	0	1	0	0	2	0	0
rca60	0	1	2	0	0	0	0	0	0	9	0	0	0	0	0	0	1364	0	0	0	0	0	0	0	0	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Planorbidae	Pleidae	Polycentropodidae	Polymitarcyidae	Polythoridae	Psephenidae	Pseudostigmatidae	Psychodidae	Ptilodactylidae	Pyralidae	Saldidae	Salpingidae	Scatopsidae	Scirtidae	Sericostomatidae	Sialidae	Simuliidae	Sisyridae	Staphylinidae	Stratiomyidae	Syrphidae	Tabanidae	Thiaridae	Tipulidae	Veliidae	Xiphocentronidae
rca62	0	2	0	0	0	0	0	0	0	48	0	0	0	0	0	0	6	0	0	0	0	0	0	79	0	0
rca64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	1	0	0	0	0	1	1	1
rca65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	112	3	0
rca66	0	1	1	0	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	33	1	0
rca67	0	4	2	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	10	1	0
rca68	0	1	4	0	0	64	0	0	0	6	0	0	0	0	0	0	21	0	2	0	0	0	0	6	0	0
rca69	0	1	0	0	0	13	0	0	3	2	0	0	0	0	0	0	16	0	0	0	0	0	0	2	0	0
rca70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0
rca90	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	37	0	0
ss0001	0	0	1	0	2	0	0	0	0	4	0	0	0	0	0	0	4	0	0	0	0	0	0	0	2	0
ss0002	0	0	6	0	0	0	0	0	0	5	0	0	0	0	0	0	1	0	0	0	0	0	2	5	3	0
ss0008	8	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	66	0	1	0	0	0	1	2	0	0
ss0010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
ss0014	0	0	7	0	0	0	0	0	0	2	0	0	0	0	0	0	9	0	0	0	0	0	0	2	0	0
ss0028	1	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	40	0	0	0	0	0	1	0	5	0
ss0029	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0
ss0031	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	1	0
ss0033	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	4	1	0
ss0035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	2	1	0
ss0037	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
ss0038	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	5	0	0
ss0044	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	0	0	0	0	38	1	0
ss0051	0	0	5	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ss0053	0	0	4	0	0	0	0	1	0	0	0	0	0	0	0	0	166	0	0	0	0	0	0	0	1	0
ss0057	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	94	0	0	0	0	1	0	0	0	0
ss0059	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	2	2	0
ss0073	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
ss0078	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	28	0	0	0	0	0	0	4	2	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Planorbidae	Pleidae	Polycentropodidae	Polymitarcyidae	Polythoridae	Psephenidae	Pseudostigmatidae	Psychodidae	Ptilodactylidae	Pyralidae	Saldidae	Salpingidae	Scatopsidae	Scirtidae	Sericostomatidae	Sialidae	Simuliidae	Sisyridae	Staphylinidae	Stratiomyidae	Syrphidae	Tabanidae	Thiaridae	Tipulidae	Veliidae	Xiphocentronidae
ss0094	0	0	23	0	0	2	0	0	1	4	0	0	0	4	0	0	23	0	0	0	0	0	0	10	2	0
ss0105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
ss0126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ss0129	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	2	1	0
ss0133	0	0	9	0	0	0	0	0	0	5	0	0	0	0	0	0	1	4	0	1	0	0	0	0	3	0
ss0144	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	7	0
ss0149	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	0	0	0	0	0	0	0	0	0
ss0150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	27	0	0
ss0157	0	0	11	0	0	0	0	0	0	1	0	0	0	1	0	0	163	0	0	1	0	0	0	1	0	0
ss0175	0	0	10	0	0	2	0	0	0	0	0	0	0	0	0	0	900	0	0	2	0	1	0	13	5	0
ss0191	0	0	0	0	0	11	0	2	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0	9	1	0
ss0199	1	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
ss0213	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	1	1	0
ss0351	0	0	1	0	0	35	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	2	7	0
ss0408	227	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	2	1	0
ss0411	0	0	1	0	0	3	0	0	0	7	0	0	0	0	0	0	258	0	0	0	0	0	0	0	2	0
ss0447	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	6	5	0
ss1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	215	0	1	0	0	0	2	0	1	0
ss4173	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
ss4330	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	1	0
tm0003	0	0	9	0	0	0	0	0	0	1	0	0	0	0	0	0	2621	0	0	0	0	0	0	24	3	0
tm0007	0	1	10	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	1	0	0
tm0009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
tm0027	1	0	4	0	0	0	0	0	0	1	0	0	0	0	0	0	11	0	0	0	0	0	0	0	3	0
tm0028	0	1	3	0	4	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	4	0	2	0	0
tm0033	0	0	5	0	19	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	1	3	0
tm0040	0	11	0	0	23	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	1	0
tm0043	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2820	0	0	0	0	3	0	1	1	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Planorbidae	Pleidae	Polycentropodidae	Polymitarcyidae	Polythoridae	Psephenidae	Pseudostigmatidae	Psychodidae	Ptilodactylidae	Pyralidae	Saldidae	Salpingidae	Scatopsidae	Scirtidae	Sericostomatidae	Sialidae	Simuliidae	Sisyridae	Staphylinidae	Stratiomyidae	Syrphidae	Tabanidae	Thiaridae	Tipulidae	Velidae	Xiphocentronidae
tm0058	0	0	3	0	2	1	0	0	0	0	0	0	0	0	0	0	387	0	0	0	0	0	0	14	6	0
tm0072	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	1	0	3	1	0
tm0082	3	4	1	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
tm0088	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0	0
tm0090	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0	0	0	1	0	3	0	0
tm0091	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	742	0	0	0	0	1	0	12	1	0
tm0106	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
tm0119	11	0	1	3	0	0	0	0	2	0	0	0	0	0	0	2	41	0	0	0	0	0	0	0	1	0
tm0126	0	0	30	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
tm0133	6	0	2	0	0	0	0	0	0	0	0	0	0	0	0	6	229	0	0	0	0	1	0	3	0	0
tm0134	0	0	1	0	11	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	9	0	0
tm0137	26	0	8	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
tm0159	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0
tm0171	0	3	0	1	0	0	0	0	0	11	0	0	0	0	0	0	140	0	0	0	0	0	0	5	0	0
tm0178	0	0	19	0	0	0	0	0	0	1	0	0	0	0	0	0	73	0	0	0	0	0	1	17	1	0
tm0183	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	282	0	0	0	0	0	0	0	1	0
tm0187	0	2	1	16	0	0	0	0	0	0	0	0	0	0	0	1	108	0	0	0	0	17	0	3	0	0
tm0193	3	6	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	11	0	0	0
tm0209	0	0	38	30	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
tm0214	19	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0
tm0220	0	12	7	0	9	4	0	0	0	1	0	0	0	1	0	0	277	0	0	0	0	2	0	2	1	0
tm0279	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	293	0	0	0	0	0	0	2	0	0
tm0283	0	1	1	0	0	0	0	0	0	6	0	0	0	0	0	0	347	0	0	0	0	0	0	1	0	0
tm0290	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	62	0	1	0	0	0	0	0	0	0
tm0296	0	0	10	16	4	4	0	0	0	3	0	0	0	0	0	0	127	0	0	1	0	0	0	0	0	0
tm0381	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	1	0	0
tm0391	0	0	3	0	0	0	0	0	0	7	0	0	0	0	0	0	51	0	0	0	0	0	0	3	1	0
tm0437	17	0	15	39	0	0	0	0	0	1	0	0	0	0	0	0	2153	0	0	0	0	0	8	1	0	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Planorbidae	Pleidae	Polycentropodidae	Polymitarcyidae	Polythoridae	Psephenidae	Pseudostigmatidae	Psychodidae	Ptilodactylidae	Pyralidae	Saldidae	Salpingidae	Scatopsidae	Scirtidae	Sericostomatidae	Sialidae	Simuliidae	Sisyridae	Staphylinidae	Stratiomyidae	Syrphidae	Tabanidae	Thiaridae	Tipulidae	Veliidae	Xiphocentronidae
tm1865	37	0	6	6	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	1	0	0	0
tm3195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
tm3962	0	0	24	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
tm6757	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
vg0002	2	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	4	0	2	0	0
vg0004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1435	0	0	0	0	0	0	2	8	0
vg0016	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	67	0	0	0	0	0	0	2	2	0
vg0018	0	0	3	0	0	0	0	1	1	0	0	0	0	12	0	0	220	0	0	0	0	1	0	8	0	0
vg0021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
vg0022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2738	0	1	0	0	0	0	1	8	0
vg0034	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	1	0	2	0	1	4	0
vg0037	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0
vg0044	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	20	5	0
vg0048	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	12	0	0	0	0	0	0	5	0	0
vg0080	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	267	0	1	0	0	0	0	0	0	0
vg0109	0	8	2	0	0	0	0	0	2	0	0	0	0	0	0	0	5	0	0	0	0	0	0	17	1	0
vg0112	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	12	0	0	0	0	0	0	7	6	0
vg0121	0	1	1	0	0	0	0	0	1	0	0	0	0	2	0	0	20	0	0	0	0	0	0	2	3	0
vg0124	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	2	0	0	0	0	0	0	0	7	0
vg0126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	193	0	0	0	0	1	0	0	8	0
vg0128	1	0	0	0	0	0	0	0	5	0	0	0	0	4	0	0	138	0	0	1	0	2	0	9	2	0
vg0162	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	68	0	0	0	0	9	0	9	2	0
vg0177	0	0	5	0	0	0	0	1	0	1	0	0	0	3	0	0	11	0	0	0	0	0	0	1	3	0
vg0191	20	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	4	1	0	0
vg0206	0	1	0	0	0	0	0	0	0	1	0	0	0	3	0	0	4	0	0	0	0	0	0	6	22	0
vg0210	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	8	0	16	0	0	0	0	2	3	0
vg0247	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61	0	1	0	0	0	0	4	0	0
vg0252	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56	0	0	0	0	0	0	0	0	0

Anexo 4 continuação. Tabelas com a abundância de táxons em cada trecho de riacho.

Stream	Planorbidae	Pleidae	Polycentropodidae	Polymitarcyidae	Polythoridae	Psephenidae	Pseudostigmatidae	Psychodidae	Ptilodactylidae	Pyralidae	Saldidae	Salpingidae	Scatopsidae	Scirtidae	Sericostomatidae	Sialidae	Simuliidae	Sisyridae	Staphylinidae	Stratiomyidae	Syrphidae	Tabanidae	Thiaridae	Tipulidae	Veliidae	Xiphocentronidae
vg0255	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	1	0
vg0277	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
vg0306	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	28	0	2	0	0	0	0	1	0	0
vg0320	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	301	0	0	0	0	0	0	0	0	0
vg0380	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	23	0	0
vg0387	2	0	1	0	0	0	0	0	0	0	0	0	0	7	0	0	54	0	0	0	0	0	0	1	1	0
vg0418	0	1	2	0	0	0	0	0	0	0	0	0	0	2	0	0	90	0	0	0	0	0	0	15	14	0
vg0433	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	119	0	0	1	0	0	0	5	0	0
vg0444	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	1102	0	0	0	0	2	0	3	0	0
vg0447	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
vg0450	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0
vg0511	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	4	0	0
vg0515	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	25	0	0	0	0	0	0	4	2	0
vg0558	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1877	0	46	0	0	1	0	0	0	0
vg0575	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	11	0	0	0	0	0	0	1	2	0
vg1257	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0

Anexo 5. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Alisotrichia*	*Americabaetis*	*Anacroneuria*	*Anastomoneura*	*Anchitrichia*	*Apobaetis*	*Askola*	*Asthenopus*	*Atanatolia*	*Atopsyche*	*Aturbina*	*Austrotinodes*	*Baetodes*	*Barypenthus*	*Caenis*	*Callibaetis*	*Camelobaetidius*	*Campsurus*	*Campylocia*	*Chimarra*	*Cloeodes*	*Cryptonympha*	*Cyrnelus*	*Farrodes*	*Grumicha*
np00008	0	15	10	0	0	0	0	0	0	0	0	1	0	9	2	0	0	0	0	0	0	0	0	1	0
np00012	1	92	12	0	0	0	0	0	0	2	0	0	49	1	1	3	2	0	0	0	1	0	0	36	0
np00016	0	20	1	0	0	0	0	0	0	6	0	0	0	0	64	1	3	0	1	0	14	0	0	15	0
np00028	0	0	8	0	0	14	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	5	0	0	0
np00047	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
np00052	0	95	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0
np00054	0	0	0	0	0	0	5	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0
np00055	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
np00075	0	45	36	0	0	2	0	0	0	8	5	3	18	0	3	3	5	0	3	0	15	2	0	14	0
np00092	0	4	1	0	0	0	1	0	0	0	0	0	0	0	33	0	0	0	0	0	0	0	0	1	0
np00095	0	0	0	0	0	0	6	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	2	0
np00096	0	5	23	0	0	14	0	0	0	1	0	0	0	4	1	0	0	0	0	0	0	0	0	5	0
np00097	0	8	0	0	0	0	0	0	0	0	0	0	24	0	0	0	1	0	0	1	0	0	0	16	0
np00100	0	60	14	0	0	0	0	0	0	4	1	0	0	2	97	6	0	0	0	0	1	24	0	17	0
np00108	0	22	2	0	0	0	0	0	0	0	1	0	7	0	0	0	0	0	0	0	3	0	0	0	0
np00110	0	65	7	0	0	0	0	0	0	0	0	0	48	0	0	0	3	0	0	2	7	0	0	3	0
np00112	0	395	20	0	0	0	4	0	0	0	5	8	0	2	191	6	0	0	2	1	1	0	0	210	0
np00128	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0
np00132	0	2	2	0	0	0	0	0	0	0	1	0	1	4	4	1	0	0	0	0	0	0	0	34	0
np00139	0	12	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0
np00144	0	23	0	0	0	0	0	0	0	0	56	0	16	1	40	5	0	0	0	0	6	0	0	8	0
np00187	0	17	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0
np00192	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
np00203	0	0	0	0	0	0	0	0	0	0	4	0	12	1	2	0	6	0	0	0	0	0	0	3	0
np00228	1	11	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0
np00240	0	0	0	0	0	0	10	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
np00251	0	26	1	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	3	1	0	0	0	1	0
np00287	0	9	7	0	0	0	0	0	0	0	0	0	0	0	368	155	0	0	0	2	5	0	0	75	0
np00368	0	0	2	0	0	0	0	0	0	0	1	2	0	3	0	0	0	0	0	0	0	0	0	2	0
np00375	0	34	11	0	1	7	1	0	0	5	0	1	8	0	5	42	0	0	0	0	8	1	0	1	0
np00443	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Alisotrichia*	*Americabaetis*	*Anacroneuria*	*Anastomoneura*	*Anchitrichia*	*Apobaetis*	*Askola*	*Asthenopus*	*Atanatolia*	*Atopsyche*	*Aturbina*	*Austrotinodes*	*Baetodes*	*Barypenthus*	*Caenis*	*Callibaetis*	*Camelobaetidius*	*Campsurus*	*Campylocia*	*Chimarra*	*Cloeodes*	*Cryptonympha*	*Cyrnelus*	*Farrodes*	*Grumicha*
np00511	0	125	16	0	0	2	0	0	0	0	6	0	0	2	0	0	0	0	0	0	0	7	0	7	0
np01524	0	1	107	0	0	0	6	0	0	0	0	0	0	0	4	0	0	0	0	0	0	29	0	4	0
np02991	0	150	18	0	0	0	0	0	0	24	0	2	0	0	0	0	0	0	0	0	0	14	0	62	0
np05612	0	0	0	0	0	0	2	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
np07308	0	14	12	0	0	0	11	0	0	0	2	0	0	4	7	0	0	0	14	0	0	0	0	13	0
np09612	0	5	5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
np09757	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
np12892	0	145	1	0	0	2	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0
np15048	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
rca02	0	554	0	0	0	0	0	0	0	21	0	0	0	0	0	0	0	0	0	0	25	26	0	21	0
rca08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	13	0	0	0	0	3	1	0	1	0
rca22	0	20	0	0	0	0	1	0	0	3	0	1	0	0	24	0	0	0	4	0	9	50	0	16	0
rca23	0	0	4	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
rca29	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
rca30	2	40	0	0	0	0	0	0	0	0	2	0	7	4	2	0	1	0	6	0	23	6	0	3	0
rca31	0	0	2	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
rca44	0	8	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	11	0
rca47	0	10	48	0	0	0	0	0	0	1	0	0	4	0	0	0	0	0	0	0	6	0	0	1	0
rca49	1	1	12	0	0	0	0	0	0	0	1	7	0	4	38	0	0	0	6	0	6	0	0	10	0
rca52	0	0	22	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	12	0	0	4	0	0	0
rca53	1	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	4	2	0	0	0	0
rca57	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	2	0	0	7	0	3	0	0	0	0
rca58	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	2	0	1	0
rca59	1	62	11	0	0	0	0	0	0	0	0	0	15	0	1	0	0	0	0	0	8	96	0	119	0
rca60	1	106	5	0	0	0	0	0	0	2	0	0	32	0	0	0	0	0	0	0	0	6	0	48	0
rca62	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	2	0
rca64	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
rca65	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
rca66	0	1	1	0	0	0	0	0	0	0	0	1	0	4	68	0	0	0	0	0	1	0	0	0	0
rca67	0	4	11	0	0	0	0	0	0	0	0	0	0	2	3	1	0	0	0	0	3	0	0	17	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Alisotrichia*	*Americabaetis*	*Anacroneuria*	*Anastomoneura*	*Anchitrichia*	*Apobaetis*	*Askola*	*Asthenopus*	*Atanatolia*	*Atopsyche*	*Aturbina*	*Austrotinodes*	*Baetodes*	*Barypenthus*	*Caenis*	*Callibaetis*	*Camelobaetidius*	*Campsurus*	*Campylocia*	*Chimarra*	*Cloeodes*	*Cryptonympha*	*Cyrnelus*	*Farrodes*	*Grumicha*
rca68	0	6	17	0	0	0	0	0	0	0	0	1	4	0	10	0	0	0	12	0	2	0	0	29	0
rca69	0	3	7	0	0	0	0	0	0	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0
rca70	1	0	1	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
rca90	0	4	0	0	0	1	0	0	0	0	0	0	0	2	1	0	6	0	0	0	0	2	0	1	0
ss0001	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	0	0	0
ss0002	0	72	0	0	0	3	0	0	0	0	58	3	0	0	12	1	2	0	0	0	18	7	0	17	0
ss0008	0	61	2	0	0	19	0	0	0	0	0	1	4	0	32	14	6	0	0	0	25	1	0	2	0
ss0010	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	3	0
ss0014	0	8	1	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	2	0	0	6	0
ss0028	0	30	1	0	0	6	0	0	0	1	0	1	0	0	12	0	0	0	0	2	0	2	0	86	0
ss0029	0	1	0	0	0	0	0	0	0	0	1	3	2	0	4	0	0	0	0	0	0	0	0	4	0
ss0031	0	10	0	0	0	2	0	0	0	0	0	0	0	0	8	6	3	0	0	0	1	0	0	3	0
ss0033	0	28	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
ss0035	0	2	0	0	0	0	0	0	0	0	0	0	4	0	0	1	15	0	0	1	3	1	0	12	0
ss0037	0	14	0	0	0	39	0	0	0	0	7	2	0	0	16	53	37	0	0	0	8	1	1	0	0
ss0038	0	8	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56	0
ss0044	0	21	5	0	0	12	0	0	0	0	1	0	0	0	7	0	0	0	0	1	3	5	0	30	0
ss0051	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0
ss0053	0	27	8	0	0	0	0	0	0	0	0	0	15	0	1	6	0	0	0	0	0	0	0	5	0
ss0057	0	35	9	0	0	0	0	0	0	0	2	0	4	0	33	0	0	0	0	32	15	0	0	77	0
ss0059	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
ss0073	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ss0078	0	214	14	0	0	19	0	0	0	0	0	0	9	0	1	0	32	0	0	0	4	5	0	143	0
ss0094	0	25	16	0	0	0	0	0	0	0	1	0	61	0	1	0	1	0	0	0	6	15	0	28	0
ss0105	0	3	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	7	0
ss0126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ss0129	0	17	1	0	0	2	0	0	0	0	1	0	0	0	17	0	0	0	0	0	0	0	0	30	0
ss0133	2	339	0	0	0	0	0	0	0	0	5	0	0	0	9	78	60	0	0	2	63	7	0	40	0
ss0144	0	9	1	0	0	9	0	0	0	0	0	0	3	0	7	2	9	0	0	0	1	8	0	5	0
ss0149	0	13	0	0	0	1	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	31	0	0	0
ss0150	0	10	8	0	0	1	0	0	0	0	0	1	14	0	0	0	1	0	0	0	0	7	0	55	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Alisotrichia*	*Americabaetis*	*Anacroneuria*	*Anastomoneura*	*Anchitrichia*	*Apobaetis*	*Askola*	*Asthenopus*	*Atanatolia*	*Atopsyche*	*Aturbina*	*Austrotinodes*	*Baetodes*	*Barypenthus*	*Caenis*	*Callibaetis*	*Camelobaetidius*	*Campsurus*	*Campylocia*	*Chimarra*	*Cloeodes*	*Cryptonympha*	*Cyrnelus*	*Farrodes*	*Grumicha*
ss0157	0	1	2	0	0	1	0	0	0	0	0	0	0	0	28	0	0	0	0	0	2	0	0	16	0
ss0175	0	44	144	0	0	0	0	0	0	0	6	0	341	0	1	5	8	0	0	182	43	0	0	46	0
ss0191	0	56	13	0	0	18	0	0	0	0	2	0	4	0	0	0	11	0	0	10	19	1	0	118	0
ss0199	0	3	0	0	0	5	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	7	0
ss0213	0	23	5	0	0	0	0	0	0	0	4	3	8	0	0	0	44	0	0	0	5	8	0	7	0
ss0351	0	41	11	0	0	0	0	0	0	0	1	1	0	0	1	2	41	0	0	7	1	0	0	107	0
ss0408	0	2	0	0	0	3	0	0	0	0	0	3	0	0	4	0	0	0	0	0	0	0	0	0	0
ss0411	0	368	6	0	0	3	0	0	0	3	50	0	2	0	10	9	77	0	0	0	41	0	0	14	0
ss0447	0	13	0	0	0	3	0	0	0	0	1	0	0	0	1	1	8	0	0	0	2	1	0	22	0
ss1000	0	22	17	0	0	0	0	0	0	0	0	1	61	0	0	0	0	0	0	1	0	0	0	34	0
ss4173	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ss4330	0	2	0	0	0	0	0	0	0	0	0	4	0	0	4	2	0	0	0	2	0	1	0	8	0
tm0003	0	23	1	0	0	2	0	0	0	0	16	0	0	0	1	0	0	0	0	3	0	0	0	81	0
tm0007	0	1	0	0	0	0	0	0	0	0	23	0	0	0	5	18	0	0	0	1	0	1	3	2	0
tm0009	0	2	0	0	0	0	0	0	0	0	0	0	0	0	5	135	0	0	0	0	23	0	0	4	0
tm0027	0	9	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	0	0	1	0	0	0	0	0
tm0028	0	43	7	0	0	0	0	0	0	0	0	0	0	0	112	15	0	0	0	0	16	0	0	35	0
tm0033	0	14	0	0	0	1	0	0	0	0	24	1	0	0	15	5	0	0	0	0	45	0	0	4	0
tm0040	0	1	0	0	0	2	8	0	0	0	11	0	0	0	66	57	0	0	4	0	476	1	0	1	0
tm0043	1	1	1	0	0	2	0	0	0	2	7	0	4	0	19	20	0	0	1	0	22	0	0	2	0
tm0058	0	440	7	0	0	4	0	0	0	7	1	0	15	0	190	148	0	0	0	26	11	0	0	141	0
tm0072	0	8	11	0	0	0	0	1	0	0	0	0	0	0	53	8	0	0	0	2	6	0	0	16	0
tm0082	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	9	0	0	0	0	0	1	0
tm0088	1	0	0	0	0	0	0	0	0	0	0	0	0	0	55	168	0	0	0	0	43	0	0	2	0
tm0090	0	30	22	0	0	3	4	0	0	0	32	1	0	0	8	85	0	0	17	0	77	0	0	102	0
tm0091	0	18	38	0	0	0	0	0	0	1	18	0	6	0	13	173	2	0	0	646	19	0	0	14	0
tm0106	0	1	0	0	0	5	0	0	0	0	0	0	0	0	17	23	0	0	0	0	5	0	0	0	0
tm0119	0	1	5	0	0	0	0	3	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	5	0
tm0126	0	0	0	0	0	6	0	0	0	0	51	0	0	0	4	8	0	2	0	0	0	0	0	41	0
tm0133	0	5	0	0	0	1	0	0	0	0	1	0	0	0	3	2	0	0	0	0	0	0	0	2	0
tm0134	0	1	0	0	0	0	4	0	0	0	6	0	0	0	7	4	0	0	1	0	5	0	0	2	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Alisotrichia*	*Americabaetis*	*Anacroneuria*	*Anastomoneura*	*Anchitrichia*	*Apobaetis*	*Askola*	*Asthenopus*	*Atanatolia*	*Atopsyche*	*Aturbina*	*Austrotinodes*	*Baetodes*	*Barypenthus*	*Caenis*	*Callibaetis*	*Camelobaetidius*	*Campsurus*	*Campylocia*	*Chimarra*	*Cloeodes*	*Cryptonympha*	*Cyrnelus*	*Farrodes*	*Grumicha*
tm0137	0	0	0	0	0	4	0	22	0	0	2	0	0	0	149	24	0	0	0	0	3	0	5	2	0
tm0159	0	0	0	0	0	0	0	0	0	0	28	1	0	0	1	60	0	0	2	0	0	0	0	3	0
tm0171	1	32	14	0	0	0	0	1	0	0	1	0	49	0	1	41	28	0	2	39	56	0	0	2	0
tm0178	0	105	35	0	0	2	0	0	0	20	3	0	60	0	220	55	0	0	0	8	74	1	0	34	0
tm0183	0	2	0	0	0	3	0	0	0	3	3	0	0	0	4	3	0	0	0	0	0	0	2	9	0
tm0187	0	38	24	0	0	2	0	16	0	3	14	2	0	0	18	40	12	0	2	0	44	17	0	61	0
tm0193	0	7	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
tm0209	0	0	0	0	0	1	0	0	0	0	2	0	0	0	5	4	0	30	0	0	0	0	0	0	0
tm0214	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0
tm0220	0	51	22	0	0	0	0	0	0	1	0	0	3	0	66	16	0	0	0	12	129	0	0	124	0
tm0279	0	31	6	0	0	11	0	0	0	0	1	0	28	0	0	26	2	0	0	0	5	7	0	4	0
tm0283	0	213	2	0	0	0	0	0	0	11	0	0	5	0	1	1	38	0	0	1	9	6	0	11	0
tm0290	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	35	0	0	0	0	0	0	0	0	0
tm0296	0	56	13	0	0	3	0	0	0	0	8	0	20	0	39	50	2	15	2	10	9	0	0	8	0
tm0381	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
tm0391	0	4	0	0	3	0	0	0	0	0	2	0	0	0	1	29	0	0	0	0	10	0	0	0	0
tm0437	0	620	2	0	0	28	0	6	0	0	72	0	0	0	12	39	0	32	0	0	0	0	12	31	0
tm1865	0	3	0	0	0	2	0	6	0	0	34	0	0	0	23	67	0	0	0	0	12	0	5	10	0
tm3195	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	0	0	0	1	0	0	0	0
tm3962	0	0	0	0	0	1	0	1	0	0	3	0	0	0	38	60	0	0	0	0	16	0	0	3	0
tm6757	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
vg0002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
vg0004	0	347	65	0	0	10	0	0	0	0	61	8	10	0	9	0	47	0	0	0	8	0	0	606	0
vg0016	0	30	0	0	0	1	0	0	0	0	10	0	1	0	1	0	0	0	0	0	0	1	0	50	0
vg0018	0	1	2	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
vg0021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
vg0022	6	37	1	0	0	0	0	0	0	0	1	0	387	0	0	0	0	0	0	0	1	0	0	25	0
vg0034	0	7	2	0	0	1	0	0	0	0	0	0	0	0	73	2	0	0	0	0	34	0	0	10	0
vg0037	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
vg0044	0	19	8	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0
vg0048	0	3	36	0	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	1	0	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Alisotrichia*	*Americabaetis*	*Anacroneuria*	*Anastomoneura*	*Anchitrichia*	*Apobaetis*	*Askola*	*Asthenopus*	*Atanatolia*	*Atopsyche*	*Aturbina*	*Austrotinodes*	*Baetodes*	*Barypenthus*	*Caenis*	*Callibaetis*	*Camelobaetidius*	*Campsurus*	*Campylocia*	*Chimarra*	*Cloeodes*	*Cryptonympha*	*Cyrnelus*	*Farrodes*	*Grumicha*
vg0080	0	14	4	0	0	2	0	0	0	0	0	0	12	0	1	0	0	0	0	0	1	2	0	21	0
vg0109	0	21	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	4	0
vg0112	1	3	6	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	32	0
vg0121	0	12	2	0	0	1	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	34	0
vg0124	0	24	0	0	0	7	0	0	0	0	20	0	1	0	0	4	1	0	0	0	6	12	0	4	0
vg0126	0	38	1	0	0	0	0	0	0	0	0	1	3	0	10	0	0	0	0	0	0	0	0	1	0
vg0128	0	121	10	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	15	0
vg0162	0	11	14	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0
vg0177	0	3	12	0	0	0	0	0	0	3	0	0	0	0	5	0	0	0	0	0	0	0	0	37	0
vg0191	0	96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	48	0
vg0206	0	72	4	0	0	1	0	0	0	0	1	0	1	0	90	0	0	0	0	0	28	0	0	1	0
vg0210	0	79	8	0	0	2	0	0	0	1	2	0	1	0	21	79	5	0	0	4	126	0	0	5	0
vg0247	0	11	11	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
vg0252	0	15	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	4	0
vg0255	0	47	0	0	0	1	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0
vg0277	0	58	0	0	0	2	0	0	0	0	43	0	0	0	0	0	0	0	0	0	0	0	0	35	0
vg0306	0	59	28	0	0	3	0	0	2	3	72	0	14	0	31	64	5	0	0	9	88	0	0	10	0
vg0320	0	1	1	0	0	0	0	0	0	1	0	0	28	0	0	0	0	0	0	0	0	2	0	13	0
vg0380	0	14	0	0	0	1	0	0	0	1	28	0	0	0	0	0	0	0	0	0	0	2	0	23	0
vg0387	0	7	0	0	0	0	0	0	0	0	0	2	30	0	0	0	0	0	0	0	0	0	0	0	0
vg0418	0	20	20	0	0	2	0	0	6	26	24	0	12	0	7	2	9	0	0	0	5	0	0	147	0
vg0433	0	1	26	0	0	0	0	0	0	4	0	1	1	0	0	0	0	0	0	0	0	0	0	25	0
vg0444	1	264	26	0	0	44	0	0	0	0	97	1	510	0	1	0	32	0	0	86	4	32	0	96	0
vg0447	0	26	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
vg0450	0	14	0	0	0	0	0	0	0	0	0	0	5	0	0	0	2	0	0	0	0	0	0	0	0
vg0511	0	24	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	4	0
vg0515	0	43	2	0	0	0	0	0	0	0	0	0	14	0	0	0	101	0	0	0	0	0	0	36	0
vg0558	0	58	0	0	0	0	0	0	0	0	0	0	205	0	0	0	0	0	0	9	0	0	0	0	0
vg0575	0	12	0	0	0	5	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	3	0
vg1257	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Grumichella*	*Grypopteryx*	*Guajirolus*	*Hagenulopsis*	*Helicopsyche*	*Hermanella*	*Hexagenia*	*Hydroptila*	*Hydrosmilodon*	*Hylister*	*Itaura*	*Kempnya*	*Latineosus*	*Leptohyphes*	*Leptohyphodes*	*Leptonema*	*Macrogynoplax*	*Macronema*	*Macrostemun*	*Marilia*	*Massartella*	*Metrichia*	*Miroculis*	*Mortoniella*	*Nectopsyche*
np00008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
np00012	0	0	0	0	0	0	0	6	0	0	1	0	0	1	0	9	0	0	3	0	0	0	0	0	0
np00016	0	0	0	19	0	0	0	6	0	0	0	0	0	0	0	1	0	0	0	3	0	1	13	0	0
np00028	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0
np00047	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
np00052	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	3	0	0	0	0	0
np00054	0	0	0	0	0	0	0	0	0	0	0	2	0	3	9	0	0	0	0	0	0	0	19	0	0
np00055	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	12	0	0	0	0	0
np00075	0	0	0	59	0	0	0	3	0	2	8	5	0	0	0	11	0	2	0	12	0	0	29	0	0
np00092	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	4	0	0	0	0	0
np00095	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	11	0	0	12	0	0
np00096	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	6	0	0	0	0	0	0	0	0	0
np00097	0	0	0	0	0	0	0	0	0	0	2	0	0	18	0	0	0	0	0	1	0	0	0	0	0
np00100	0	0	0	58	0	0	0	0	0	0	51	1	0	0	0	2	0	0	0	6	0	0	17	0	11
np00108	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	4	0	0	0	0	0
np00110	0	0	0	0	0	0	0	0	0	0	22	1	0	0	0	0	0	1	0	0	0	3	0	0	1
np00112	0	0	0	24	0	0	0	0	0	0	0	3	0	0	0	6	0	0	0	3	5	0	68	0	0
np00128	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
np00132	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	2	0	1	1	0	8	0	0
np00139	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	1	0	0	0	0	0
np00144	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1	0	13	0	0
np00187	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	4	0	0	0	0	0
np00192	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
np00203	0	0	0	0	0	0	0	3	0	0	5	0	0	0	0	14	0	0	0	0	1	0	0	0	0
np00228	0	9	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	3	0	0	2	0	0
np00240	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0
np00251	0	7	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	1	0	7	2	0	0
np00287	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	2	0	1	0	6	14	0	5	0	1
np00368	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
np00375	0	0	0	11	0	0	0	0	2	0	17	1	0	0	0	4	0	0	0	0	0	0	0	0	0
np00443	0	0	0	0	0	0	0	0	0	0	20	1	0	0	0	1	0	0	0	0	0	0	0	0	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Grumichella*	*Grypopteryx*	*Guajirolus*	*Hagenulopsis*	*Helicopsyche*	*Hermanella*	*Hexagenia*	*Hydroptila*	*Hydrosmilodon*	*Hylister*	*Itaura*	*Kempnya*	*Latineosus*	*Leptohyphes*	*Leptohyphodes*	*Leptonema*	*Macrogynoplax*	*Macronema*	*Macrostemun*	*Marilia*	*Massartella*	*Metrichia*	*Miroculis*	*Mortoniella*	*Nectopsyche*
np00511	0	0	0	0	0	0	0	13	0	0	119	0	0	0	0	0	0	0	0	0	0	0	0	1	3
np01524	0	0	0	2	0	0	0	0	0	0	13	0	0	0	0	6	0	1	0	27	0	0	0	0	0
np02991	0	0	0	0	0	0	0	2	0	0	27	0	0	3	0	1	0	0	0	3	0	0	0	0	0
np05612	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
np07308	0	0	0	8	0	0	0	0	0	0	0	2	0	0	7	2	0	0	1	1	23	0	26	0	0
np09612	0	0	0	0	0	0	0	0	0	0	0	1	0	0	8	8	0	1	0	3	0	0	0	0	0
np09757	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
np12892	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0
np15048	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
rca02	31	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0
rca08	0	0	0	0	1	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	1	0	1	0	0
rca22	1	0	0	8	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	9	42	0	8
rca23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
rca29	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
rca30	31	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	14	23	0	0
rca31	0	0	0	0	1	0	0	0	0	0	2	1	0	0	0	0	0	0	0	1	0	0	0	0	0
rca44	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	14	0	0	0	0	1
rca47	0	4	0	0	0	0	0	0	0	0	12	3	0	4	0	3	0	0	0	29	0	0	1	0	0
rca49	0	0	0	8	0	0	0	0	0	0	1	1	0	0	0	1	0	9	3	7	1	8	17	0	0
rca52	0	0	0	31	0	0	0	8	0	0	5	13	0	0	0	1	0	0	0	69	0	0	9	0	2
rca53	0	0	0	12	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	5	0	0	0	0	0
rca57	0	0	0	5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	12	0	0
rca58	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	8	0	0	0	2	0	0	0
rca59	40	0	0	0	0	20	0	7	0	0	0	0	0	0	0	13	0	0	1	0	0	12	0	0	3
rca60	336	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	0	0
rca62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	108	0	0
rca64	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
rca65	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
rca66	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
rca67	0	0	0	4	0	0	0	0	0	0	6	2	0	0	0	0	0	0	0	1	0	0	1	0	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Grumichella*	*Grypopteryx*	*Guajirolus*	*Hagenulopsis*	*Helicopsyche*	*Hermanella*	*Hexagenia*	*Hydroptila*	*Hydrosmilodon*	*Hylister*	*Itaura*	*Kempnya*	*Latineosus*	*Leptohyphes*	*Leptohyphodes*	*Leptonema*	*Macrogynoplax*	*Macronema*	*Macrostemun*	*Marilia*	*Massartella*	*Metrichia*	*Miroculis*	*Mortoniella*	*Nectopsyche*
rca68	0	0	0	15	1	0	0	0	0	0	15	2	0	0	0	1	0	5	25	3	0	0	1	0	0
rca69	0	0	0	7	0	0	0	0	2	0	6	1	0	0	0	0	0	0	2	8	0	2	0	0	0
rca70	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
rca90	0	0	0	1	0	0	0	0	0	0	32	1	0	0	0	0	0	0	0	1	0	0	0	0	0
ss0001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
ss0002	0	0	0	0	1	0	0	1	0	0	0	0	5	0	0	0	0	6	0	1	0	0	151	0	35
ss0008	0	0	0	13	2	0	0	4	0	0	2	0	0	2	0	0	0	33	0	11	0	0	15	0	0
ss0010	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
ss0014	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	1	0	0	0	0	2	0
ss0028	0	0	0	0	0	0	0	0	1	0	0	0	0	20	0	3	0	1	2	0	0	0	0	0	5
ss0029	0	0	0	5	1	0	0	0	0	0	0	0	1	4	0	0	0	0	0	0	0	0	1	0	3
ss0031	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	131	0	4	0	0	103	0	0
ss0033	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
ss0035	0	0	0	0	0	5	0	0	9	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0
ss0037	0	0	0	2	1	0	0	0	0	0	0	0	1	0	0	1	0	3	0	1	0	0	13	0	3
ss0038	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ss0044	0	0	0	46	6	0	0	0	7	0	0	0	0	7	0	0	0	5	0	0	0	0	8	0	1
ss0051	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	1
ss0053	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	2	0	15	0	0	0	0	14	0	0
ss0057	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	5	0	4	0	0	0	0	59	0	0
ss0059	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ss0073	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ss0078	0	0	0	0	1	0	0	1	0	0	0	0	0	11	0	5	0	0	0	0	0	0	0	0	57
ss0094	0	0	0	4	2	0	0	0	2	0	12	0	0	2	0	2	0	1	4	0	0	0	8	0	2
ss0105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ss0126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
ss0129	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
ss0133	0	0	0	0	14	13	0	160	2	0	0	0	1	0	0	0	0	6	0	2	0	0	16	0	5
ss0144	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ss0149	0	0	0	0	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
ss0150	0	0	0	0	9	2	0	0	16	0	0	0	0	12	0	1	0	0	0	0	0	0	0	0	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Grumichella*	*Grypopteryx*	*Guajirolus*	*Hagenulopsis*	*Helicopsyche*	*Hermanella*	*Hexagenia*	*Hydroptila*	*Hydrosmilodon*	*Hylister*	*Itaura*	*Kempnya*	*Latineosus*	*Leptohyphes*	*Leptohyphodes*	*Leptonema*	*Macrogynoplax*	*Macronema*	*Macrostemun*	*Marilia*	*Massartella*	*Metrichia*	*Miroculis*	*Mortoniella*	*Nectopsyche*
ss0157	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	18	0	1
ss0175	0	0	0	6	3	1	0	0	0	0	0	0	0	164	0	12	0	0	0	0	0	0	25	0	0
ss0191	0	0	0	0	23	4	0	3	0	0	0	0	1	26	0	0	0	0	0	0	0	0	7	0	0
ss0199	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	34	0	1
ss0213	0	0	0	3	3	3	0	0	19	0	0	0	0	28	0	0	0	1	0	0	0	1	0	0	3
ss0351	0	0	0	0	7	0	0	2	23	0	0	0	1	26	0	13	0	0	0	0	0	2	2	0	1
ss0408	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ss0411	0	0	1	0	25	62	0	5	1	0	2	0	10	14	0	0	0	14	0	3	0	29	9	0	11
ss0447	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1
ss1000	0	0	0	1	0	0	0	0	0	0	0	0	0	19	0	0	0	7	0	0	0	0	0	0	0
ss4173	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ss4330	0	0	0	1	24	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
tm0003	0	0	0	0	0	0	0	0	312	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
tm0007	0	0	0	0	0	0	4	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	14	0	0
tm0009	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0
tm0027	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
tm0028	0	1	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	1
tm0033	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	4	15	0	15	0	0
tm0040	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	16	0	21	0	4
tm0043	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	14	0	6
tm0058	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	4	0	5	0	0	36	0	0
tm0072	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	7	0	0	0	6	0	0	0	0	0
tm0082	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0
tm0088	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	12	0	0
tm0090	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	6	0	0	45	0	0
tm0091	0	0	0	0	0	10	0	6	20	0	0	0	0	6	0	5	0	0	0	1	0	0	1	0	7
tm0106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	0	0	0	0
tm0119	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	6	0	0	0	0	0	8
tm0126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	16	0	8
tm0133	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0
tm0134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Grumichella*	*Grypopteryx*	*Guajirolus*	*Hagenulopsis*	*Helicopsyche*	*Hermanella*	*Hexagenia*	*Hydroptila*	*Hydrosmilodon*	*Hylister*	*Itaura*	*Kempnya*	*Latineosus*	*Leptohyphes*	*Leptohyphodes*	*Leptonema*	*Macrogynoplax*	*Macronema*	*Macrostemun*	*Marilia*	*Massartella*	*Metrichia*	*Miroculis*	*Mortoniella*	*Nectopsyche*
tm0137	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0
tm0159	0	0	0	0	0	0	0	10	0	0	0	0	8	0	0	0	0	0	0	0	0	15	2	0	4
tm0171	0	0	0	0	2	16	0	2	12	0	0	0	0	0	0	2	0	0	0	1	0	2	0	0	0
tm0178	0	0	0	0	0	0	0	26	0	0	0	0	12	0	0	9	0	1	0	0	0	3	0	3	18
tm0183	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	4
tm0187	0	0	0	2	4	0	0	2	0	0	0	0	0	0	0	0	0	4	0	7	1	0	56	1	1
tm0193	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	2	0	0	2	0	2
tm0209	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
tm0214	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
tm0220	0	0	0	30	0	0	0	4	0	0	0	0	0	0	0	1	0	0	0	0	8	0	3	0	12
tm0279	0	0	0	0	0	0	2	9	1	0	0	0	0	0	0	7	0	0	0	0	0	0	1	0	0
tm0283	0	0	0	2	0	6	0	0	0	0	0	0	0	7	0	0	0	0	0	26	0	0	3	0	1
tm0290	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
tm0296	0	0	0	0	4	0	0	24	0	0	0	0	0	13	0	2	0	3	0	3	0	50	23	2	0
tm0381	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
tm0391	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0
tm0437	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	2	0	30	1	0	0	0	0	0	0
tm1865	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	7	0	0	0	0	1
tm3195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
tm3962	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	3
tm6757	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
vg0002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
vg0004	0	0	0	92	0	0	0	77	0	0	2	0	0	147	0	1	0	0	0	2	0	1	0	0	4
vg0016	0	0	0	3	17	0	0	0	36	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	3
vg0018	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	3	0	0	0	0	0	0	0
vg0021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
vg0022	0	0	0	2	0	0	0	0	0	0	9	0	0	7	0	0	0	0	0	0	0	4	0	0	0
vg0034	0	0	0	1	0	0	0	0	0	0	0	0	0	5	0	0	0	0	1	3	0	0	6	0	0
vg0037	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
vg0044	0	0	0	8	0	0	0	0	0	0	11	0	0	0	0	2	0	1	0	17	0	0	51	0	1
vg0048	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Grumichella*	*Grypopteryx*	*Guajirolus*	*Hagenulopsis*	*Helicopsyche*	*Hermanella*	*Hexagenia*	*Hydroptila*	*Hydrosmilodon*	*Hylister*	*Itaura*	*Kempnya*	*Latineosus*	*Leptohyphes*	*Leptohyphodes*	*Leptonema*	*Macrogynoplax*	*Macronema*	*Macrostemun*	*Marilia*	*Massartella*	*Metrichia*	*Miroculis*	*Mortoniella*	*Nectopsyche*
vg0080	0	0	0	2	1	0	0	0	4	0	2	0	0	5	0	3	0	0	0	0	0	0	0	0	1
vg0109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
vg0112	0	0	0	3	1	4	0	0	5	0	0	0	0	20	0	2	0	0	0	0	0	0	1	0	0
vg0121	0	0	0	7	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
vg0124	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	4	0	0	6	0	0
vg0126	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
vg0128	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	0	2	0	0
vg0162	0	0	0	0	0	0	0	0	0	0	1	0	0	16	0	1	0	1	0	3	0	0	1	0	0
vg0177	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0
vg0191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
vg0206	0	0	0	8	0	0	0	0	0	0	6	0	0	10	0	4	0	0	0	35	0	0	0	0	1
vg0210	0	0	0	3	0	0	0	0	0	0	5	0	0	12	0	0	0	0	0	6	0	1	0	0	1
vg0247	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	2	0	0	0	0	0
vg0252	0	0	0	0	3	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	1
vg0255	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
vg0277	0	0	0	1	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	1	0	1
vg0306	0	0	0	6	0	0	0	0	2	0	121	0	0	34	0	2	0	0	0	2	0	0	2	0	4
vg0320	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0
vg0380	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	32	0	1
vg0387	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0
vg0418	0	0	0	23	0	0	0	0	0	0	42	0	0	38	0	6	0	0	0	5	0	0	80	0	0
vg0433	0	0	0	0	14	0	0	0	1	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	1
vg0444	0	0	0	13	3	0	0	0	10	0	13	0	0	380	0	17	0	0	0	1	0	0	0	0	13
vg0447	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
vg0450	0	0	0	0	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	1	0	0	0	0	0
vg0511	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0
vg0515	0	0	0	8	0	0	0	0	4	0	21	0	0	7	0	0	0	0	0	0	0	1	1	0	0
vg0558	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	0
vg0575	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0
vg1257	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Needhamella*	*Neotrichia*	*Notalina*	*Nyctiophylax*	*Ochrotrichia*	*Oecetis*	*Oxyetira*	*Paracloeodes*	*Paragrypopteryx*	*Paramaka*	*Phylloicus*	*Polycentropus*	*Polyplectropus*	*Protoptila*	*Rivudiva*	*Simothraulopsis*	*Smicridea*	*Spiritiops*	*Taraxitrichia*	*Terpides*	*Thraulodes*	*Tikuna*	*Traverella*	*Traverhyphes*	*Tricorythodes*
np00008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
np00012	0	0	0	0	0	0	8	6	3	0	2	0	4	0	0	0	31	0	0	0	2	0	0	389	0
np00016	0	2	0	0	0	0	6	9	0	0	1	0	8	0	0	1	0	0	0	0	153	0	0	22	0
np00028	0	0	0	0	0	1	0	2	0	0	0	0	1	0	0	0	5	0	0	0	17	0	0	14	0
np00047	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
np00052	0	0	0	0	0	0	0	0	59	0	1	0	0	0	0	0	9	0	0	0	0	0	0	38	0
np00054	0	0	2	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
np00055	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
np00075	0	0	7	0	0	8	1	75	0	0	2	1	21	0	0	6	2	0	0	27	67	0	0	66	11
np00092	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	42	0	0	0	0	0	0	4	0
np00095	0	0	26	0	0	5	0	0	1	0	29	0	0	0	0	0	0	0	0	0	0	0	0	5	17
np00096	0	0	0	0	0	0	0	9	0	0	0	0	0	0	3	0	20	0	0	0	103	0	0	41	2
np00097	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	8	0	0	62	0
np00100	0	0	0	0	0	0	3	20	0	0	2	1	3	0	0	0	7	0	0	0	211	0	0	88	0
np00108	0	0	1	0	0	0	0	2	35	0	7	0	0	0	0	0	37	0	0	0	1	0	0	2	5
np00110	0	2	0	0	0	0	0	9	0	0	1	0	0	1	0	0	22	0	0	0	0	0	0	40	6
np00112	0	4	2	0	0	0	0	23	0	0	1	0	0	0	0	0	23	0	0	3	61	0	0	146	0
np00128	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
np00132	0	0	2	0	0	0	0	3	5	0	0	0	1	0	0	0	0	0	0	0	16	0	0	81	2
np00139	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	5	0
np00144	0	0	0	0	0	2	0	91	1	0	0	0	1	0	0	0	0	0	0	0	34	0	0	24	0
np00187	0	0	0	0	0	0	0	2	4	0	0	0	0	0	0	0	3	0	0	0	0	0	0	21	0
np00192	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0
np00203	0	0	0	0	0	1	0	1	0	0	0	1	2	2	0	0	0	0	0	0	1	0	0	637	0
np00228	0	0	1	0	0	0	0	3	2	0	11	0	0	0	0	0	13	0	0	0	0	0	0	25	1
np00240	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	4	0	0	0	0	0	0	0	0
np00251	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	2	0	0	0	0	0	0	122	0
np00287	0	0	0	0	0	4	0	34	7	0	17	0	0	0	0	0	56	0	0	0	0	0	0	0	0
np00368	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	68	1
np00375	0	0	1	0	0	0	0	17	0	0	1	0	0	0	0	0	11	0	0	0	303	0	0	23	0
np00443	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	58	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Needhamella*	*Neotrichia*	*Notalina*	*Nyctiophylax*	*Ochrotrichia*	*Oecetis*	*Oxyetira*	*Paracloeodes*	*Paragrypopteryx*	*Paramaka*	*Phylloicus*	*Polycentropus*	*Polyplectropus*	*Protoptila*	*Rivudiva*	*Simothraulopsis*	*Smicridea*	*Spiritiops*	*Taraxitrichia*	*Terpides*	*Thraulodes*	*Tikuna*	*Traverella*	*Traverhyphes*	*Tricorythodes*
np00511	0	0	1	0	0	9	0	12	0	0	1	0	0	64	1	0	14	0	0	0	3	0	0	91	1
np01524	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	4	0	0	0	0
np02991	0	0	0	0	0	2	0	26	0	0	0	0	0	0	0	0	13	0	0	0	30	0	0	68	0
np05612	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
np07308	0	0	1	0	0	0	0	0	3	0	13	0	0	0	0	0	25	0	0	0	0	0	0	21	0
np09612	0	1	0	0	0	0	0	0	4	0	5	0	0	0	0	0	10	0	0	0	0	0	0	27	0
np09757	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
np12892	0	0	0	0	0	0	128	1	0	0	0	0	0	0	0	0	49	0	0	1	0	0	0	0	0
np15048	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
rca02	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
rca08	0	0	6	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
rca22	0	0	1	0	0	0	1	38	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	2	1
rca23	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	5	0	0	0	0	0	0	0	0
rca29	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	14	0	0	0	0	0	0	1	0
rca30	0	1	0	0	0	0	0	8	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	3
rca31	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	5	0	0	1	0
rca44	0	0	1	0	0	1	0	0	0	0	4	1	0	0	0	0	1	0	0	0	0	0	0	0	0
rca47	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	36	0	0	0	6	0	0	38	0
rca49	0	0	5	0	0	0	0	0	0	0	12	0	0	0	0	0	77	0	0	0	0	0	0	85	0
rca52	0	0	2	0	0	2	0	2	0	0	0	2	17	0	0	0	37	0	0	0	159	0	0	22	0
rca53	0	2	0	0	0	0	0	0	0	0	0	0	4	0	0	0	11	0	0	0	9	0	0	2	0
rca57	0	0	16	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
rca58	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	1	0
rca59	0	7	0	0	0	0	17	13	30	0	0	0	0	0	0	0	71	0	0	0	0	0	0	1	0
rca60	0	1	0	0	0	0	21	0	7	0	0	0	2	0	0	0	19	0	0	0	0	0	0	1	0
rca62	0	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
rca64	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0
rca65	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
rca66	0	0	4	0	0	5	0	1	0	0	2	0	1	0	0	0	0	0	0	12	0	0	0	0	41
rca67	0	2	9	0	0	3	0	1	0	0	4	0	2	0	0	0	8	0	0	13	0	0	0	40	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Needhamella*	*Neotrichia*	*Notalina*	*Nyctiophylax*	*Ochrotrichia*	*Oecetis*	*Oxyetira*	*Paracloeodes*	*Paragrypopteryx*	*Paramaka*	*Phylloicus*	*Polycentropus*	*Polyplectropus*	*Protoptila*	*Rivudiva*	*Simothraulopsis*	*Smicridea*	*Spiritiops*	*Taraxitrichia*	*Terpides*	*Thraulodes*	*Tikuna*	*Traverella*	*Traverhyphes*	*Tricorythodes*
rca68	0	0	1	0	0	0	0	0	0	0	4	1	3	0	0	0	26	0	0	0	13	0	0	73	0
rca69	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	16	0	0	1	6	0	0	16	0
rca70	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	5	0	0	0	0	0	0	1	0
rca90	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	1	0	0	0	8	0	0	5	0
ss0001	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	11	0	0	0	0	0	0	0	0
ss0002	0	0	0	2	0	1	0	51	0	0	52	0	4	0	2	0	1	0	0	41	7	0	0	126	0
ss0008	0	0	0	0	0	0	0	0	0	0	3	0	2	2	0	0	3	0	0	11	7	0	0	35	1
ss0010	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	1	0
ss0014	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	9	0	0	0	0	0	0	0	2
ss0028	0	0	0	0	0	1	0	0	0	0	3	0	0	1	0	0	43	0	0	0	1	0	0	180	1
ss0029	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	26	0
ss0031	0	0	0	0	0	0	1	4	0	0	0	3	0	0	0	0	3	0	0	0	0	0	0	0	0
ss0033	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	686	0	0	0	0	0	0	11	8
ss0035	0	0	0	0	0	0	0	0	0	0	0	0	0	7	6	0	3	0	0	0	1	0	0	0	1
ss0037	0	0	0	0	0	3	0	48	0	0	10	0	0	8	15	0	0	0	0	1	18	0	0	17	5
ss0038	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	1	3
ss0044	0	0	0	0	0	2	0	12	0	0	1	0	0	0	0	0	4	0	0	10	0	0	0	49	79
ss0051	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
ss0053	0	0	0	0	0	0	0	3	0	0	7	0	4	0	18	0	6	0	0	6	0	0	0	2	0
ss0057	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	84	0	0	0	1	0	0	3	0
ss0059	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
ss0073	0	1	0	0	0	0	0	0	0	0	0	0	0	22	0	0	124	0	0	0	0	0	0	0	0
ss0078	0	1	0	0	0	0	0	123	0	0	2	0	0	1	2	0	93	0	0	0	0	0	0	9	0
ss0094	0	0	0	0	0	1	0	0	0	0	3	0	23	0	5	0	35	0	0	0	118	0	0	6	42
ss0105	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	17	0	0	0	1	0	0	0	0
ss0126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
ss0129	0	0	0	0	0	0	0	5	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	5	5
ss0133	0	0	0	3	0	2	21	59	0	0	0	0	6	1	6	0	35	0	0	1	0	0	0	17	33
ss0144	0	0	0	0	0	1	0	0	0	0	2	1	3	1	0	0	0	0	0	0	0	0	0	16	2
ss0149	0	0	0	0	0	0	0	4	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	1
ss0150	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	13	0	0	0	33	0	0	8	2

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Needhamella*	*Neotrichia*	*Notalina*	*Nyctiophylax*	*Ochrotrichia*	*Oecetis*	*Oxyetira*	*Paracloeodes*	*Paragrypopteryx*	*Paramaka*	*Phylloicus*	*Polycentropus*	*Polyplectropus*	*Protoptila*	*Rivudiva*	*Simothraulopsis*	*Smicridea*	*Spiritiops*	*Taraxitrichia*	*Terpides*	*Thraulodes*	*Tikuna*	*Traverella*	*Traverhyphes*	*Tricorythodes*
ss0157	0	0	0	3	0	5	0	0	0	0	66	7	1	0	0	0	7	0	0	0	0	0	0	9	0
ss0175	0	0	0	3	0	0	0	7	0	1	8	1	6	6	0	0	133	0	0	2	300	0	0	17	3
ss0191	0	0	0	0	0	1	0	39	0	0	0	0	0	1	14	0	7	0	0	0	12	0	0	7	42
ss0199	0	0	0	0	0	2	0	0	0	0	1	4	0	0	0	0	0	0	0	1	0	0	0	1	0
ss0213	0	0	0	0	0	0	0	1	0	0	2	0	1	6	0	0	15	0	0	0	20	0	0	3	3
ss0351	0	0	0	0	0	0	0	21	0	1	3	0	1	4	0	0	30	0	0	10	141	0	0	47	5
ss0408	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	13	0	0	0	0	0	0	12	0
ss0411	0	0	0	0	0	2	0	57	0	0	2	0	1	4	7	0	24	0	0	0	69	0	0	78	9
ss0447	0	0	0	0	0	0	0	8	0	0	1	0	0	2	6	0	2	0	0	0	2	0	0	3	14
ss1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	1	35	0	0	23	0
ss4173	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	439	0	0	0	0	0	0	0	0
ss4330	0	0	0	0	0	6	0	1	0	0	3	0	0	1	0	0	18	0	0	0	0	0	0	52	0
tm0003	0	0	0	0	0	1	0	1	0	0	0	9	0	0	0	0	133	0	0	0	0	0	0	2	149
tm0007	0	0	0	0	0	4	0	2	0	0	0	6	1	0	0	1	4	0	0	0	0	0	0	0	0
tm0009	0	0	0	0	0	0	6	2	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	12	0
tm0027	0	0	0	0	0	0	3	1	0	0	0	3	1	0	0	0	1	0	0	0	0	0	0	9	0
tm0028	0	0	0	0	0	0	4	27	0	0	0	1	2	0	0	0	1	0	0	0	24	0	0	401	0
tm0033	0	0	0	0	0	3	0	8	0	0	0	0	5	0	0	1	0	0	0	0	7	0	0	0	0
tm0040	0	0	0	0	0	0	0	32	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	38	0
tm0043	0	0	0	0	0	0	1	18	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	10	1
tm0058	0	0	0	0	0	2	2	7	0	0	1	0	3	0	0	0	55	0	0	0	135	0	0	66	0
tm0072	0	0	0	0	0	0	3	0	0	0	1	0	6	0	0	0	84	0	0	0	9	0	0	27	0
tm0082	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	11	1
tm0088	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	73	3
tm0090	0	0	0	0	0	0	3	19	0	0	0	0	13	0	0	2	0	0	0	0	0	0	0	0	0
tm0091	0	0	0	0	0	0	11	20	0	0	0	0	0	0	0	0	26	0	1	0	170	0	0	85	2
tm0106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
tm0119	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0
tm0126	0	0	0	0	0	1	0	3	0	0	0	24	6	0	0	7	0	0	0	0	1	0	0	1	1
tm0133	0	0	0	0	0	4	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1
tm0134	0	0	0	0	0	0	0	0	0	0	22	0	1	0	0	1	0	0	0	0	0	0	0	13	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Needhamella*	*Neotrichia*	*Notalina*	*Nyctiophylax*	*Ochrotrichia*	*Oecetis*	*Oxyetira*	*Paracloeodes*	*Paragrypopteryx*	*Paramaka*	*Phylloicus*	*Polycentropus*	*Polyplectropus*	*Protoptila*	*Rivudiva*	*Simothraulopsis*	*Smicridea*	*Spiritiops*	*Taraxitrichia*	*Terpides*	*Thraulodes*	*Tikuna*	*Traverella*	*Traverhyphes*	*Tricorythodes*
tm0137	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	3	0	0	0	0	0	0	0	21	0
tm0159	0	0	0	0	0	1	8	18	0	1	0	0	1	1	0	0	0	0	0	0	9	0	0	154	10
tm0171	1	0	0	0	0	0	2	0	0	5	0	0	0	0	0	2	47	0	0	0	69	0	0	180	7
tm0178	0	0	0	0	2	9	3	0	0	0	0	2	17	2	0	0	6	0	0	0	52	0	0	343	0
tm0183	0	0	0	0	0	4	2	0	0	0	0	6	0	0	0	2	1	0	0	0	0	0	0	75	0
tm0187	0	2	0	0	0	3	6	17	0	0	18	0	1	0	0	2	4	0	0	0	5	0	0	15	0
tm0193	0	0	0	0	0	0	0	0	0	0	0	4	2	0	0	0	1	0	0	0	0	0	0	24	0
tm0209	0	0	0	0	0	4	0	0	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0
tm0214	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
tm0220	0	0	0	0	0	0	0	0	0	0	0	1	7	0	0	0	55	0	0	0	92	0	0	869	0
tm0279	0	0	0	0	0	0	1	1	0	0	0	7	2	0	0	0	13	0	0	0	1	0	0	59	0
tm0283	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	8	8	0	0	4	0	0	12	0
tm0290	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
tm0296	0	0	0	0	0	4	2	6	0	0	1	0	10	0	0	7	38	0	0	0	50	0	0	171	6
tm0381	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
tm0391	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	14	0	0	0	0	0	0	2	4
tm0437	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	2	37	0	0	0	0	0	0	14	14
tm1865	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	5	1	0	0	0	2	0	0	35	1
tm3195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
tm3962	0	0	0	0	0	5	1	0	0	0	0	11	13	0	0	0	0	0	0	0	0	0	0	7	0
tm6757	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
vg0002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
vg0004	0	0	0	0	0	1	0	0	0	0	6	0	0	5	0	0	51	0	0	14	84	0	0	15	4
vg0016	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	6	0	0	1	2	0	0	17	5
vg0018	0	0	0	0	0	0	0	0	0	0	4	7	0	0	0	0	4	0	0	0	0	0	0	16	0
vg0021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
vg0022	0	0	0	0	0	1	0	0	0	0	123	0	0	0	0	0	15	0	0	1	2	0	0	20	0
vg0034	0	0	0	0	0	1	0	2	0	0	34	0	0	0	0	0	22	0	0	0	0	0	0	48	4
vg0037	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
vg0044	0	0	0	0	0	2	0	22	0	0	12	0	0	1	3	0	9	0	0	27	12	0	0	7	10
vg0048	0	0	0	0	0	3	0	0	0	0	4	0	1	0	0	0	107	0	0	0	0	0	0	1	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Needhamella*	*Neotrichia*	*Notalina*	*Nyctiophylax*	*Ochrotrichia*	*Oecetis*	*Oxyetira*	*Paracloeodes*	*Paragrypopteryx*	*Paramaka*	*Phylloicus*	*Polycentropus*	*Polyplectropus*	*Protoptila*	*Rivudiva*	*Simothraulopsis*	*Smicridea*	*Spiritiops*	*Taraxitrichia*	*Terpides*	*Thraulodes*	*Tikuna*	*Traverella*	*Traverhyphes*	*Tricorythodes*
vg0080	0	0	0	0	0	1	0	2	0	0	4	0	0	1	0	0	7	0	0	0	0	0	0	4	8
vg0109	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	2	0	0	0	0	0	0	9	20
vg0112	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	16	0	0	1	1	0	0	0	2
vg0121	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	65	0	0	3	0	0	0	2	4
vg0124	0	2	0	0	0	0	0	56	0	0	0	0	0	0	1	0	3	0	0	2	8	0	0	7	0
vg0126	0	0	0	0	0	5	0	0	0	0	12	0	0	0	0	0	114	0	0	0	0	0	0	7	0
vg0128	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	2
vg0162	0	1	0	0	0	0	0	11	0	0	3	0	0	0	0	0	8	0	0	1	1	0	0	2	12
vg0177	0	10	0	0	0	3	0	0	0	0	0	4	0	0	0	0	105	0	0	0	0	0	0	5	0
vg0191	0	0	0	0	0	0	0	0	0	0	0	1	0	31	0	0	280	0	0	0	0	0	0	1	0
vg0206	0	0	0	0	0	1	0	1	0	0	93	0	0	0	0	0	90	0	0	1	31	0	0	90	0
vg0210	0	0	0	0	0	0	0	23	0	0	2	0	0	1	0	0	7	0	0	1	112	0	0	35	7
vg0247	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	21	1
vg0252	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	5	0	0	0	6	0	0	3	1
vg0255	0	0	0	0	0	0	0	2	0	0	0	2	0	5	0	0	2	0	0	0	0	0	0	13	2
vg0277	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	9	3	0	0	12	11
vg0306	0	0	0	0	0	0	1	14	0	0	3	0	0	8	0	0	18	0	0	12	583	0	0	26	49
vg0320	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	7	0	0	0	3	0	0	0	1
vg0380	0	0	0	0	0	3	0	35	0	0	6	4	0	2	0	0	2	0	0	3	1	0	0	38	12
vg0387	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	4	0	0	0	0	0	0	0	0
vg0418	0	1	0	0	0	1	0	7	0	0	5	2	0	0	0	0	19	0	0	6	58	0	0	44	78
vg0433	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	4
vg0444	0	1	0	0	0	1	0	11	0	0	0	0	0	32	0	0	97	0	0	10	236	0	0	115	3
vg0447	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0
vg0450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	3
vg0511	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	7	0
vg0515	0	1	0	0	0	0	0	0	0	0	5	0	0	8	1	0	21	0	0	0	11	0	0	1	0
vg0558	0	0	0	0	0	0	0	0	0	0	0	0	0	98	0	0	210	0	0	0	0	0	0	0	0
vg0575	0	0	0	0	0	0	0	2	0	0	14	0	0	5	0	0	5	0	0	1	2	0	0	11	2
vg1257	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Tricorythopsis*	*Triplectides*	*Tupiperla*	*Ulmeritoides*	*Varipes*	*Waltzoyphius*	*Wormaldia*	*Xiphocentron*	*Zelusia*	*Zumatrichia*
np00008	1	0	0	0	0	41	0	0	0	0
np00012	73	0	5	0	0	0	0	0	0	0
np00016	88	0	0	2	0	2	0	0	0	0
np00028	11	1	1	2	0	1	0	0	2	0
np00047	0	0	0	0	0	0	0	0	0	0
np00052	0	1	9	0	0	0	0	0	0	0
np00054	0	2	4	0	0	1	0	0	13	0
np00055	19	0	1	0	0	4	0	0	1	0
np00075	74	0	0	59	0	1	0	0	0	0
np00092	0	2	5	6	0	0	0	0	0	0
np00095	1	54	18	0	0	0	0	0	1	0
np00096	24	5	0	1	0	0	0	0	0	0
np00097	0	0	2	0	0	1	0	0	0	0
np00100	183	3	4	0	0	4	0	0	0	0
np00108	6	2	101	0	0	0	0	0	4	0
np00110	9	0	6	0	0	0	0	0	2	0
np00112	4	13	0	20	0	2	0	0	45	0
np00128	0	0	0	0	0	92	0	0	1	0
np00132	57	10	106	0	0	6	0	0	6	0
np00139	2	0	0	3	0	5	0	0	8	0
np00144	0	0	3	18	0	0	0	0	6	0
np00187	35	0	1	0	0	0	0	0	0	0
np00192	1	0	0	0	0	0	0	0	0	0
np00203	219	1	7	0	0	0	0	0	0	0
np00228	0	3	2	0	0	2	0	0	0	0
np00240	0	0	0	1	0	0	0	0	0	0
np00251	28	0	15	0	0	1	0	0	1	0
np00287	0	8	113	13	0	1	0	0	25	0
np00368	9	4	1	1	0	4	0	0	1	0
np00375	136	0	1	0	0	0	0	0	1	0
np00443	42	0	0	2	0	0	0	0	3	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Tricorythopsis*	*Triplectides*	*Tupiperla*	*Ulmeritoides*	*Varipes*	*Waltzoyphius*	*Wormaldia*	*Xiphocentron*	*Zelusia*	*Zumatrichia*
np00511	88	1	0	9	4	1	0	0	1	0
np01524	0	0	0	0	0	34	0	0	1	0
np02991	7	0	0	4	0	14	0	0	1	0
np05612	0	0	0	0	0	0	0	0	0	0
np07308	10	42	25	59	0	0	0	0	13	0
np09612	7	17	11	0	0	0	0	0	9	0
np09757	0	0	0	0	0	0	0	0	0	0
np12892	0	0	0	6	0	4	0	0	0	0
np15048	0	0	0	0	0	0	0	0	0	0
rca02	0	0	0	0	0	0	0	1	0	0
rca08	0	0	0	169	0	0	0	0	0	0
rca22	11	1	0	0	0	0	0	0	0	0
rca23	0	0	0	0	0	0	0	0	2	0
rca29	8	0	2	0	0	0	0	0	0	0
rca30	21	0	0	0	0	0	0	0	2	0
rca31	0	0	0	0	0	0	0	0	0	0
rca44	0	0	0	0	0	0	0	0	0	0
rca47	0	0	0	0	0	0	0	0	0	0
rca49	34	1	10	11	0	7	0	0	2	0
rca52	108	2	0	0	0	0	0	3	0	0
rca53	11	0	0	0	0	0	0	0	0	0
rca57	0	0	0	0	0	0	0	0	0	0
rca58	0	0	0	0	0	0	0	0	0	0
rca59	61	0	1	0	0	0	0	0	0	0
rca60	19	0	0	0	0	0	0	0	0	0
rca62	0	0	0	0	0	0	0	0	0	0
rca64	0	1	0	2	0	0	0	1	0	0
rca65	11	0	0	0	0	0	0	0	0	0
rca66	0	3	0	8	0	0	0	0	0	0
rca67	4	6	1	14	0	2	0	0	0	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Tricorythopsis*	*Triplectides*	*Tupiperla*	*Ulmeritoides*	*Varipes*	*Waltzoyphius*	*Wormaldia*	*Xiphocentron*	*Zelusia*	*Zumatrichia*
rca68	22	1	0	0	0	0	0	0	1	0
rca69	8	2	2	0	0	1	0	0	0	0
rca70	1	0	0	0	0	0	0	0	0	0
rca90	22	1	0	0	0	0	0	0	0	0
ss0001	0	0	0	0	0	2	0	0	6	0
ss0002	3	0	0	11	0	19	0	0	111	0
ss0008	0	0	0	5	0	2	0	0	0	1
ss0010	0	0	0	0	0	5	0	0	0	0
ss0014	3	0	0	0	0	0	0	0	3	0
ss0028	1	0	0	1	0	2	0	0	31	0
ss0029	0	0	0	0	0	0	0	0	0	0
ss0031	0	0	0	18	0	141	0	0	68	0
ss0033	0	0	0	0	0	0	0	0	0	0
ss0035	1	0	0	0	0	0	0	0	0	0
ss0037	0	0	0	2	0	0	0	0	2	0
ss0038	0	0	0	0	0	0	0	0	7	0
ss0044	5	0	0	19	0	4	0	0	25	0
ss0051	0	0	0	2	0	0	0	0	0	0
ss0053	0	0	0	0	0	5	0	0	0	0
ss0057	0	0	0	21	0	0	0	0	0	0
ss0059	0	0	0	0	0	0	0	0	1	0
ss0073	0	0	0	0	0	0	0	0	0	0
ss0078	0	0	0	0	0	0	0	0	0	0
ss0094	3	0	0	7	0	0	0	0	45	0
ss0105	0	0	0	0	0	0	0	0	2	0
ss0126	0	0	0	0	0	0	0	0	0	0
ss0129	0	0	0	0	0	0	0	0	2	0
ss0133	6	0	0	1	0	0	0	0	2	0
ss0144	0	0	0	0	0	2	0	0	5	0
ss0149	0	0	0	0	0	0	0	0	0	0
ss0150	1	1	0	0	0	0	0	0	1	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Tricorythopsis*	*Triplectides*	*Tupiperla*	*Ulmeritoides*	*Varipes*	*Waltzoyphius*	*Wormaldia*	*Xiphocentron*	*Zelusia*	*Zumatrichia*
ss0157	0	3	0	6	0	2	0	0	13	0
ss0175	0	0	0	3	0	6	38	0	27	0
ss0191	2	0	0	5	0	6	1	0	62	0
ss0199	2	0	0	5	0	1	0	0	11	0
ss0213	5	0	0	1	0	0	0	0	1	0
ss0351	4	0	0	2	0	0	1	0	1	0
ss0408	0	0	0	0	0	1	0	0	0	0
ss0411	0	0	0	12	0	2	0	0	6	0
ss0447	1	0	0	2	0	1	0	0	22	0
ss1000	0	0	0	0	0	3	0	0	4	0
ss4173	0	0	0	0	0	0	0	0	0	1
ss4330	0	0	0	13	0	0	0	0	1	0
tm0003	0	0	0	0	0	17	0	0	3	0
tm0007	0	0	0	1	0	3	0	0	4	0
tm0009	0	0	0	1	0	0	0	0	0	0
tm0027	0	0	0	0	0	16	0	0	0	0
tm0028	0	0	0	7	0	0	0	0	0	0
tm0033	0	0	0	16	0	1	0	0	16	0
tm0040	0	0	0	5	0	0	0	0	8	0
tm0043	1	0	0	34	0	11	0	0	2	0
tm0058	0	0	0	35	0	2	0	0	0	0
tm0072	0	0	0	1	0	0	0	0	0	0
tm0082	0	0	0	6	0	0	0	0	1	0
tm0088	2	0	0	63	0	0	0	0	0	0
tm0090	0	0	0	4	0	0	0	0	4	0
tm0091	1	0	0	1	0	0	0	0	0	0
tm0106	0	0	0	6	0	0	0	0	0	0
tm0119	0	0	0	0	0	2	0	0	1	0
tm0126	0	0	0	0	0	7	0	0	11	0
tm0133	0	0	0	2	0	7	0	0	0	0
tm0134	0	0	0	11	0	0	0	0	2	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Tricorythopsis*	*Triplectides*	*Tupiperla*	*Ulmeritoides*	*Varipes*	*Waltzoyphius*	*Wormaldia*	*Xiphocentron*	*Zelusia*	*Zumatrichia*
tm0137	0	5	0	22	0	1	0	0	3	0
tm0159	4	0	0	0	0	1	0	0	0	0
tm0171	3	0	0	4	0	0	0	0	0	0
tm0178	0	0	0	4	0	0	1	0	0	0
tm0183	0	0	0	0	0	2	0	0	0	0
tm0187	11	1	0	18	0	7	0	0	0	0
tm0193	0	1	0	0	0	13	0	0	0	0
tm0209	0	0	0	0	0	12	0	0	0	0
tm0214	0	0	0	0	0	0	0	0	0	0
tm0220	0	2	0	4	0	0	0	0	0	0
tm0279	21	1	0	7	0	0	0	0	0	0
tm0283	2	0	0	0	0	0	0	0	0	0
tm0290	0	0	0	0	0	0	0	0	0	0
tm0296	0	0	0	2	0	0	0	0	1	0
tm0381	0	2	0	0	0	0	0	0	0	0
tm0391	0	0	0	2	0	0	0	0	0	0
tm0437	0	0	0	4	0	198	0	0	4	0
tm1865	0	6	0	0	0	35	0	0	5	0
tm3195	0	0	0	0	0	0	0	0	0	0
tm3962	0	0	0	7	0	4	0	0	2	0
tm6757	0	0	0	0	0	0	0	0	0	0
vg0002	0	0	0	0	0	22	0	0	0	0
vg0004	0	1	0	47	0	3	0	0	142	0
vg0016	0	0	0	8	0	0	0	0	8	0
vg0018	0	0	0	1	0	2	0	0	0	0
vg0021	0	0	0	0	0	0	0	0	0	0
vg0022	0	0	0	0	0	13	0	0	12	0
vg0034	0	0	0	3	0	2	0	0	1	0
vg0037	0	0	0	0	0	0	0	0	0	0
vg0044	0	0	0	83	0	16	0	0	27	0
vg0048	0	1	0	0	0	0	0	0	0	0

Anexo 5 continuação. Tabelas com a abundância de gêneros de Ephemeroptera, Plecoptera e Trichoptera em cada trecho de riacho.

Stream	*Tricorythopsis*	*Triplectides*	*Tupiperla*	*Ulmeritoides*	*Varipes*	*Waltzoyphius*	*Wormaldia*	*Xiphocentron*	*Zelusia*	*Zumatrichia*
vg0080	2	1	0	0	0	1	0	0	17	0
vg0109	0	0	0	2	0	10	0	0	56	0
vg0112	0	0	0	0	0	5	0	0	12	0
vg0121	0	0	0	0	0	1	0	0	13	0
vg0124	0	0	0	13	0	10	0	0	4	0
vg0126	0	0	0	0	0	0	0	0	0	0
vg0128	1	0	0	0	0	21	0	0	49	0
vg0162	0	0	0	3	0	9	0	0	53	0
vg0177	0	0	0	0	0	1	0	0	1	0
vg0191	0	0	0	0	0	1	0	0	0	0
vg0206	0	0	0	0	0	0	0	0	4	0
vg0210	0	0	0	3	0	0	0	0	1	0
vg0247	0	1	0	0	0	3	0	0	10	0
vg0252	3	2	0	0	0	0	0	0	0	0
vg0255	0	0	0	0	0	0	0	0	1	0
vg0277	2	0	0	5	0	7	0	0	28	0
vg0306	2	0	0	19	0	0	0	0	6	0
vg0320	0	0	0	0	0	0	0	0	1	0
vg0380	1	0	0	43	0	9	0	0	8	0
vg0387	0	0	0	0	0	0	0	0	1	0
vg0418	0	0	0	0	0	25	0	0	6	0
vg0433	5	0	0	0	0	1	0	0	38	0
vg0444	5	0	0	2	0	4	0	0	3	0
vg0447	1	0	0	0	0	1	0	0	0	0
vg0450	0	0	0	0	0	0	0	0	0	0
vg0511	0	0	0	0	0	0	0	0	0	0
vg0515	3	0	0	0	0	0	0	0	0	0
vg0558	0	0	0	0	0	0	3	0	0	0
vg0575	0	0	0	0	0	3	0	0	9	0
vg1257	0	0	0	0	0	0	0	0	0	0