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DOUGLAS TICIANI

BARRAGENS EM SEQUÊNCIA: COMPOSIÇÃO E DISTRIBUIÇÃO DO ICTIOPLÂNCTON EM UM COMPLEXO ENERGÉTICO DE UM RIO NEOTROPICAL

CASCAVEL-PR
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Dissertação apresentado ao Programa de Pós-graduação *Stricto Sensu* em Conservação e Manejo de Recursos Naturais – Nível Mestrado, do Centro de Ciências Biológicas e da Saúde, da Universidade Estadual do Oeste do Paraná, como requisito parcial para a obtenção do título de Mestre em Ciências Ambientais.

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Dissertação apresentada ao Programa de Pós-Graduação em Conservação e Manejo de Recursos Naturais em cumprimento parcial aos requisitos para obtenção do título de Mestre em Conservação e Manejo de Recursos Naturais, área de concentração Ciências Ambientais, linha de pesquisa Biologia Comparada e Indicadores de Qualidade No Ambiente Aquático, APROVADO(A) pela seguinte banca examinadora:

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BARRAGENS EM SEQUÊNCIA: COMPOSIÇÃO E DISTRIBUIÇÃO DO ICTIOPLÂNCTON EM UM COMPLEXO ENERGÉTICO DE UM RIO NEOTROPICAL

RESUMO

Hidrelétricas que desviam o rio, além de fragmentar os ambientes aquáticos, reduzem drasticamente as descargas de fluxo hídrico nos Trechos de Vazão Reduzida (TVRs). O objetivo desse estudo foi avaliar a influência da formação de TVR's e das variáveis ambientais na composição e a distribuição espacial de ovos e larvas, em um complexo de barragens em sequência, que operam com soleira livre e sistema de desvio do rio e soleira livre. Foram realizadas amostragens quinzenais noturnas entre outubro/2016 e janeiro/2017, em quatro pontos na área de influência do Complexo Energético Rio das Antas, ecorregião Lagoa dos Patos. O ictioplâncton foi coletado com redes cônico-cilindricas, em três secções do rio e por uma armadilha luminosa por ponto. Os ovos foram quantificados, enquanto as larvas foram identificadas através da técnica de sequência regressiva de desenvolvimento, enquadradas em períodos larval (larval vitelino, pré-flexão, flexão e pós-flexão) e juvenil. Foram coletados 5.681 ovos, 2.124 larvas e 43 juvenis, pertencentes a 25 grupos taxonômicos. Espécies de pequeno porte, sedentárias e sem cuidado parental (pequenos caracídeos) foram as maiores contribuintes para a abundância e densidade totais. Foram identificadas significativas diferenças espaciais nas densidades de ovos e larvas, bem como nos estágios de desenvolvimento ontogênico, influenciadas pela vazão,

temperatura, transparência, pH e trecho de rio livre. A maior densidade de larvas à montante e a maior riqueza de espécies a jusante do complexo, indicam interrupção nos processos naturais de deriva e dispersão de muitas espécies no sentido montante. Maiores vazões influenciaram positivamente a utilização dos TVRs como sítios de desova.

PALAVRAS-CHAVE

Hidrelétricas em sequência; sistema de desvio do rio; trecho de vazão reduzida; peixes; ovos e larvas; rios de planalto.

DAMS CASCADE: COMPOSITION AND DISTRIBUTION OF ICHTHYOPLANKTON IN AN ENERGY COMPLEX OF A NEOTROPICAL RIVER

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Short running title: Composition and distribution of ichthyoplankton in dams cascade.

ABSTRACT

Run of River hydroelectric systems, beyond fragments aquatic environments, drastically reduced as flow discharges in the Reduced Flow Stretch (RDS). The objective of this study was to evaluate the influence of TVR formation and environmental variables on composition and spatial distribution of eggs and larvae, in dams cascade operating with free threshold and under the Run of River system. Fortnightly

nocturnal samplings were carried out between October/2016 and January/2017, in four points of influence area of the Rio das Antas Energy Complex, Patos Lagoon ecoregion. The ichthyoplankton was collected with conical-cylindrical networks, in three sections of the river and by a light trap per point. The eggs were quantified, while larvae were identified using the sequence regression development technique, framed in larval periods (larval yolk, pre-flexion, flexion and post-flexion) and juvenile. Were collected 5,681 eggs, 2,124 larvae and 43 juveniles, belonging to 25 taxonomic groups. Small species, sedentary and without parental care (small characids) had the highest total abundance and density. Significant spatial differences were identified in egg and larval densities, as well in the stages of ontogenic development, influenced by flow, temperature, pH and dam-free river stretch. The higher density of upstream larvae and the greater species richness downstream of the complex, indicate disruption in the natural processes of drift and the displacement of many species in the upstream direction. Higher flow rates positively influenced the use of RDS as spawning sites.

KEY WORDS

Dams cascade; Run of River System; reduced flow stretch; fish; eggs and larvae; plateau rivers.

1. Introdução

O represamento dos ecossistemas aquáticos pela instalação de complexos hidrelétricos ocasiona alterações nos processos físicos, químicos e biológicos, com mudanças em seus padrões longitudinais e a consequente descontinuidade serial (Ward & Stanford, 1983). Entre estas mudanças, destacam-se as alterações nos padrões de conectividade ecológica (e.g. restrição da migração, deriva e dispersão gênica) (Crook et al., 2015; Pringle, Freeman & Freeman, 2000) e a regulação dos regimes de fluxo hídrico (Agostinho, Bonecker & Luiz Carlos Gomes, 2009; Finer & Jenkins, 2012; McManamay, Peoples, Orth, Dolloff & Matthews, 2015). Modificações nesses aspectos são capazes de provocar a extirpação completa de organismos sensíveis (Konrad et al., 2011) e afetar as trajetórias evolutivas de populações e espécies (Allendorf, Luikart & Aitken, 2013), principalmente da fauna de peixes (Agostinho, Gomes, Santos, Ortega, & Pelicice, 2016). Para algumas espécies desse grupo, as condições de fluxo hídrico são reconhecidas por sinalizarem o desencadeamento do ciclo de vida (Gogola et al., 2010; Junk et al., 1989; Reynalte-Tataje, Agostinho, et al., 2012). Assim, os represamentos de sistemas fluviais têm contribuído para o declínio das espécies de peixes (Orsi & Britton, 2014), devido a fragmentação e limitação das áreas de desova e do desenvolvimento larval (Gogola, Sanches, Gubiani & Silva, 2013; Liermann, Nilsson, Robertson & Ng, 2012; Silva, Dias & Bialetzki, 2017).

As consequências da interrupção de corpos hídricos sobre a fauna de peixes são potencializadas quando os represamentos formam uma cascata de barramentos (Agostinho et al., 2016; Miranda, Habrat & Miyazono, 2008; Pelicice, Pompeu & Agostinho, 2015). Nesse contexto, a posição da atividade impactante ao longo do contínuo lótico (Santos et al., 2017; Ward & Stanford, 1983;) e o tipo

de sistema hidrelétrico (Ticiani & Delariva, em preparação), determinam a direção e a magnitude das alterações longitudinais dos processos ecológicos. Como exemplo, temos os sistemas hidrelétricos que desviam a água, tratados por Roberts (1995) como “ruinas do rio”, em função de seus potenciais impactos. Nesses sistemas, ocorre a transposição de grande parte do volume da água junto ao barramento para um determinado local a jusante (Anderson, Moggridge, Shucksmith & Warren, 2017; Silve & Pompeu, 2008). Essa técnica resulta na formação de um Trecho de Vazão Reduzida (TVR), secção formada pelo leito original entre o barramento, a montante, e a restituição da água ao curso original do rio, a jusante (Kubecka, Matena & Hartvich, 1997). Os TVRs são, em muitos casos, os únicos remanescentes lóticos que atuam como suporte para a manutenção de muitas espécies de peixes (Reynalte-Tataje, Hermes-Silva, Weiss & Zaniboni-Filho, 2008).

Centrais hidrelétricas dotadas com sistemas de desvio do rio possuem componentes de engenharia adaptáveis as condições geomorfológicas do local e por isso são muito utilizadas em regiões montanhosas de planalto, com elevada declividade (Anderson, Moggridge, Warren & Shucksmith, 2015). Esses sistemas são considerados menos prejudiciais ao ambiente (Paish, 2002), com a alegação de que reduzem drasticamente o risco da passagem de peixes pelas turbinas, além de facilitarem a instalação de dispositivos de transposição (Geman, 2017). Contudo, a redução das descargas de fluxo hídrico a jusante dos barramentos é muito acentuada (Singh & Agarwal, 2017), e muitas vezes insuficiente para abastecer simultaneamente a geração de energia e manter a integridade das comunidades de peixes nos TVRs (Anderson et al., 2017; Kubecka et al., 1997; Ovidio, Capra & Philippart, 2008). Além disso, barramentos do tipo soleira livre, ou

seja, que não possuem dispositivos de controle de vazão (comportas), fornecem condições hidrológicas altamente instáveis às secções de jusante. Dessa forma, no cenário atual de políticas de incentivo e flexibilização à implantação de empreendimentos hidrelétricos (Pelicice et al., 2017), é necessária uma revisão na compreensão atual dos impactos de tais sistemas sobre a biota (Anderson et al., 2015).

Nesse contexto, o estudo do ictioplâncton possibilita avaliar a influência da regulação de fluxo hídrico sobre o processo de efetivação da reprodução da fauna de peixes (Sanches et al., 2006), pois fornece informações relevantes acerca dos locais e épocas de desova (Nakatani et al., 2001). Devido a sua capacidade de resposta, vários estudos utilizam essa ferramenta no diagnostico dos efeitos de represamentos em cascata sobre a ictiofauna (e.g. Dudley & Platania, 2007; Frantine-Silva, Sofia, Orsi & Almeida, 2015; Reynalte-Tataje, Agostinho, et al., 2012). Destaca-se, principalmente, o diagnóstico da importância da descarga d'água pelo reservatório a montante no atendimento a demanda de recrutamento a jusante (Gogola et al., 2010; Reynalte-Tataje, Agostinho & Bialetzki, 2013), onde as desovas são mais restritas (Reynalte-Tataje, Agostinho, et al.). Nesse aspecto, cabe ressaltar que não existem diagnoses publicadas dos impactos sobre ovos e larvas de peixes em sistemas de desvio de rio dotados de TVRs.

Considerando a importância de trechos lóticos ininterruptos (Sanches et al., 2006; Dudley & Platania, 2007) e dos volumes de descarga a jusante dos barramentos (Gogola et al., 2010; Reynalte-Tataje et al., 2013) para a efetivação dos processos reprodutivos dos peixes, o presente estudo testou duas hipóteses: 1) a riqueza e a densidade do ictioplâncton sejam maiores a montante e a jusante do complexo energético; 2) a regulação do fluxo hídrico restrinja a desova e o

desenvolvimento larval de peixes nos TVRs. Assim, o objetivo deste trabalho foi avaliar o ictioplâncton em barragens de soleira livre em sequência que operam com sistema de desvio do rio, em relação: (i) a composição e (ii) distribuição espacial de ovos e larvas, bem como (iii) a influência das variáveis ambientais sobre a densidade de ovos e larvas de peixes. Como expectativa, espera-se que ocorra maior sucesso na efetivação das desovas a montante da cascata de reservatórios, devido ao caráter de fluxo hídrico inalterado e a menor fragmentação, em comparação aos TVRs.

2. Materiais e Métodos

2.1. Área de estudo

O estudo foi realizado no Complexo Energético Rio das Antas (CERAN), implantado na bacia hidrográfica do sistema Taquari-Antas (26.428 km^2), localizado na região serrana do estado do Rio Grande do Sul/Brasil (Figura 1). Importante contribuinte do rio Jacuí, esse sistema apresenta declividade média elevada e é caracterizado por regimes pluviométricos torrenciais, escoamentos superficiais rápidos e bruscas variações de descargas (FEPAM, 2009). Esse cenário é comumente observado nos rios que compõem a densa rede de drenagem da ecoregião Lagoa dos Patos, composta, de maneira geral, por rios de planalto, com elevada declividade e rápidos em seus trechos superiores, e meândricos e planos nas regiões inferiores (FEOW, 2015). Devido a elevada declividade, a área de influência do Complexo CERAN não possui tributários que possam caracterizar rotas migratórias alternativas, com exceção do rio da Prata, o qual é barrado por hidrelétrica cerca de dez km a montante de sua foz.

O Complexo Energético CERAN é composto pelas Usinas Hidrelétricas (UHE's) Castro Alves (130 Megawatts (MW)), Monte Claro (130 MW) e 14 de Julho (100 MW). Apesar da formação de reservatórios de armazenamento, todos os barramentos que compõe o Complexo CERAN apresentam soleira livre, ou seja, não possuem dispositivo de controle de vazão. Esses empreendimentos utilizam a técnica de desvio do rio, resultando na formação de secções denominadas Trecho de Vazão Reduzida (TVR). Essas características, geralmente observadas em Pequenas Centrais Hidrelétricas (PCH's), não interferem no enquadramento legal das hidrelétricas do Complexo CERAN, classificadas como UHE's devido ao fato da potência máxima instalada exceder 30 MW (ANEEL, 2015).

As usinas Castro Alves (UHE CA) e 14 de Julho (UHE 14) contam com vazão mínima remanescente de 17,0 e 28,2 m³/s, respectivamente. Ambas iniciaram a operação comercial em 2008 e possuem área alagada de cinco (5) km², enquanto a UHE Monte Claro (UHE MC), que iniciou suas atividades em 2004, possui área alagada de 1,4 km² e vazão remanescente de 28,6 m³/s. Em sua totalidade, a área diretamente influenciada pelo complexo compreende aproximadamente 100 km de extensão longitudinal, entre o trecho de transição, a montante do reservatório da UHE Castro Alves, e a Alça de Vazão Reduzida, a jusante do barramento da UHE 14 de Julho. Este intervalo localiza-se a aproximadamente 200 km a montante da confluência do rio Taquari com o rio Jacuí (Scopel, Teixeira & Binotto, 2005), trecho no qual não são registradas atualmente barreiras físicas intransponíveis a ictiofauna.

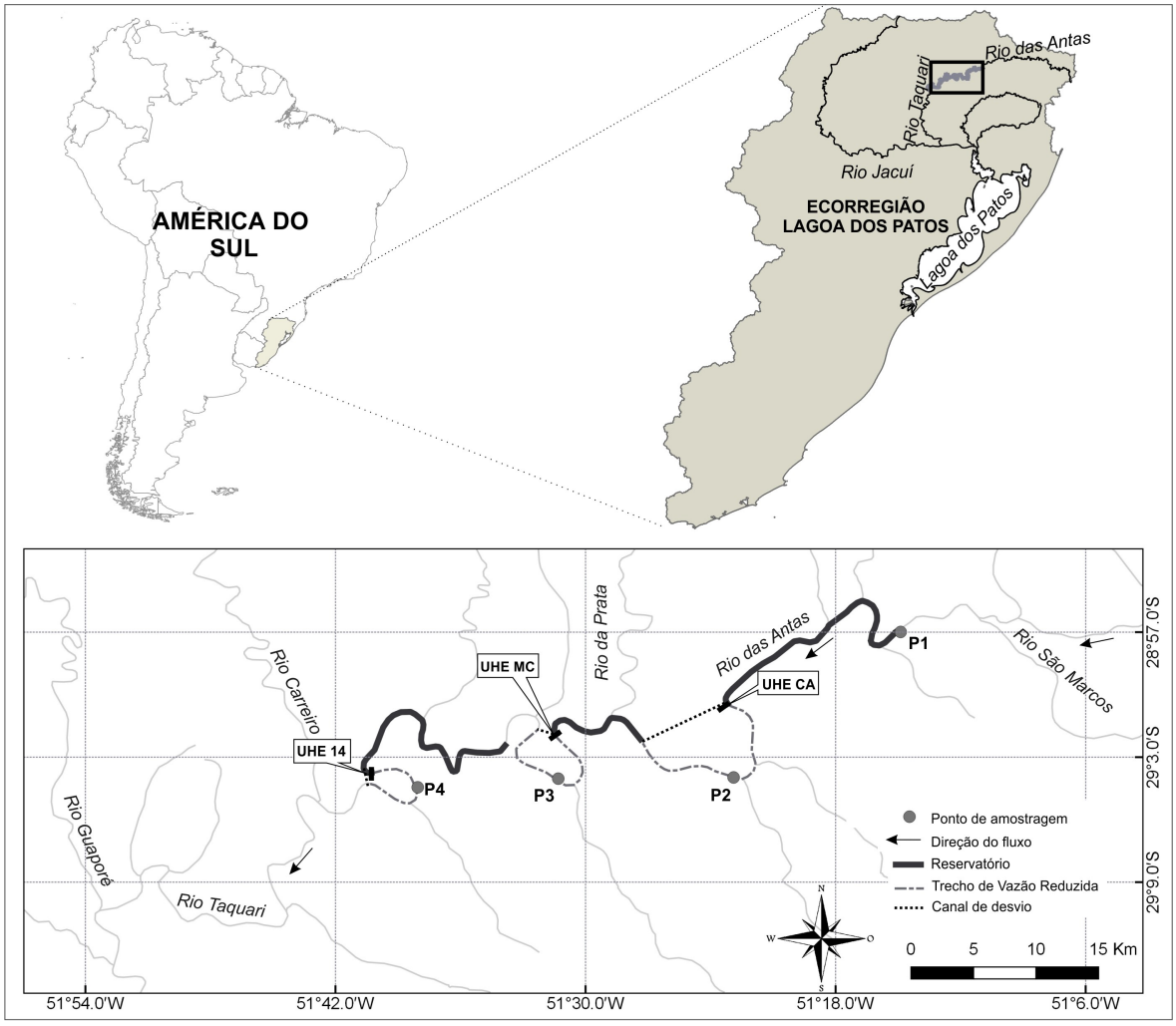

Figura 1. Distribuição da rede amostral do ictioplâncton no Complexo Energético Rio das Antas, Rio Grande do Sul, Brasil no contexto da ecorregião Lagoa dos Patos, América do Sul. P – Ponto amostral. Hidrelétricas: UHE 14 – Usina Hidrelétrica 14 de Julho; UHE MC - Usina Hidrelétrica Monte Claro; UHE CA - Usina Hidrelétrica Castro Alves.

2.2. Amostragem

Quatro pontos amostrais foram estabelecidos no Complexo Energético CERAN (Figura 1), sendo que três abrangem remanescentes lóticos, dispostos ao longo dos TVRs de cada hidrelétrica (pontos P2, P3 e P4). Além disso, avaliou-se também a secção de transição da UHE Castro Alves, a montante do complexo (ponto P1).

As amostragens ocorreram quinzenais entre outubro de 2016 e janeiro de 2017, período considerado de maior potencial reprodutivo para a fauna de peixes da região (Luz-Agostinho, Latini, Abujanra, Gomes & Agostinho, 2010), abrangendo ainda o período de defeso no estado do Rio Grande do Sul (Brasil, 2008).

As amostras foram obtidas com redes de plâncton cônico-cilíndricas, malha de 500 µm e diâmetro de 36 cm, equipadas com fluxômetro para obtenção do volume de água filtrada (Bialetzki, Nakatani, Sanches, Baumgartner & Gomes, 2005; Nakatani et al., 2001). Cada rede foi exposta por um período de 10 minutos, em quatro horários pré-definidos: 21:00, 01:00, 05:00 e 09:00 horas. Em cada horário, amostras foram obtidas por meio de arrastos horizontais na superfície, em locais com menor velocidade de fluxo hídrico, bem como por redes estacionárias no centro e na margem com maior fluxo em seções transversais ao curso d'água, amarradas a um cabo esticado entre as duas margens (Reynalte-Tataje et al., 2013). Ao todo, foram realizadas oito incursões, totalizando 96 réplicas em cada ponto amostral.

Com o objetivo de complementar os resultados de composição de espécies, em cada ponto foi instalada uma armadilha luminosa na margem de menor fluxo hídrico ao anoitecer (21:00h) e retirada antes do amanhecer (05:00h).

O modelo de armadilha utilizada seguiu Ávila-Simas, Reynalte-Tataje & Zaniboni-Filho (2014), adaptada de Reynalte-Tataje, Garcia, Nunes, Lopes & Zaniboni-Filho (2012).

O material biológico foi fixado em formol a 4%, tamponado com carbonato de cálcio, etiquetado e armazenado para posterior identificação laboratorial. Os procedimentos amostrais especificados seguiram projeto de monitoramento aprovado pelo órgão ambiental vigente (Fundação Estadual de Proteção Ambiental Henrique Luiz Roessler), conforme as seguintes licenças de operação e captura: 1353/2015-DL (UHE CA) e 02844/2016-DL (UHE MC) e 1264/2015-DL (UHE 14).

A influência das variáveis ambientais locais sobre a composição e distribuição do ictioplâncton foi avaliada através dos seguintes parâmetros, obtidos *in loco* e simultaneamente às coletas: temperatura (ºC) da água e oxigênio dissolvido (mg/L), aferidos com oxímetro YSI 55, transparência (m), aferida na amostragem diurna (9:00h) com Disco de Secchi, pH com pHmetro Hanna HI 8424 e condutividade ($\mu S/cm^{-1}$) com medidor AK50. Adicionalmente, foi mensurada a distância de rio livre de barramentos (km), através do software Google Earth Pro (Google, 2017), buscando-se detectar a influência da fragmentação longitudinal. Para isso, considerou-se o trecho de deriva da linha central do canal (Dudley & Platania, 2007) a montante de cada ponto amostral. Além disso, foram elencados os valores de vazão (m^3/s), através de dados fornecidos pela Companhia Energética Rio das Antas (CERAN), gestora do complexo.

2.3. Análises laboratoriais

Em laboratório, os ovos e larvas foram separados do restante do material sob estereomicroscópio com ampliação de 10X, utilizando placa do tipo Bogorov. Após a triagem, os ovos foram apenas quantificados, enquanto as larvas foram contabilizadas e identificadas empregando-se a técnica de sequência regressiva de desenvolvimento, a qual utiliza a forma do corpo, presença de barbilhões, sequência de formação das nadadeiras, a posição relativa da abertura anal em relação ao corpo, número de vértebras/miômeros e raios das nadadeiras (Ahlstrom & Moser, 1976; Nakatani et al., 2001). A identificação das larvas foi baseada ainda em literatura referente a composição da ictiofauna regional (Becker et al., 2013; Luz-Agostinho et al., 2010;). Após a identificação, as larvas foram enquadradas de acordo com o seu grau de desenvolvimento (Ahlstrom, Butler & Sumida (1976), modificado por Nakatani et al.) em períodos larval (estágios de larval vitelino, pré-flexão, flexão e pós-flexão) e juvenil. Exemplares testemunhos (Vouchers) serão depositados no Museu do Nupélia (Núcleo de Pesquisas em Limnologia, Ictiologia e Aquicultura), na Universidade Estadual de Maringá.

2.4. Análise de dados

A classificação taxonômica foi baseada em Nelson (2006) para todas as ordens e as famílias de Siluriformes; Reis, Kullander & Ferraris-Jr (2003) para as demais famílias, exceto Characidae, que seguiu Mirande (2009). Larvas que não puderam ser identificadas pelo menos ao grupo de ordem foram classificadas como "não identificadas" (larvas recém-eclodidas), enquanto aquelas que em algum aspecto físico estavam danificadas foram classificadas como "não

identificáveis". De modo a identificar padrões na composição da fauna de peixes em cada ponto amostral, as larvas identificadas pelo menos ao táxon de gênero foram classificadas de acordo com a estratégia reprodutiva dos parentais, indicando se realizam algum tipo de migração e se apresentam cuidado parental, seguindo Balon (1975), Vazzoler (1996) e Luz-Agostinho et al. (2010).

Para as análises exploratórias, a abundância dos organismos capturados nas réplicas foi padronizada para indivíduos/10m³ de volume filtrado. A densidade foi padronizada de acordo com Tanaka (1973), modificada por Nakatani et al. (2001). Adicionalmente, foi calculada a frequência de ocorrência de cada grupo taxonômico (incluindo as larvas capturadas na armadilha luminosa), em cada ponto amostral. A abundância total (nº) a frequência de ocorrência (%) foram utilizadas somente para compor a tabela de composição, enquanto a densidade (ind./m³) foi empregada nas análises de significância e exploratórias.

Diferenças espaciais (pontos amostrais como fatores) nas densidades de ovos e larvas foram testadas através da Análise de Variância (ANOVA one-way). Devido à grande presença de valores zero, as premissas de normalidade e homocedasticidade foram testadas sobre os resíduos (Hammer, Harper & Ryan, 2001). Em casos onde diferenças significativas foram observadas, o teste de Tukey foi aplicado para detectar quais pontos amostrais diferiram. Os mesmos procedimentos foram adotados para testar diferenças entre as densidades dos estágios de desenvolvimento das larvas em cada ponto amostral. Adicionalmente, ANOVA bifatorial (two-way) foi utilizada para testar a interação desses fatores (estágios de desenvolvimento e pontos amostrais como fatores independentes).

Para verificar a influência das características locais sobre o grau de desenvolvimento do ictioplâncton, as variáveis ambientais foram sumarizadas

pela Análise de Componentes Principais (PCA), com base na matriz de correlação (Hammer et al., 2001). Os valores dos componentes significativos da PCA, obtidos através do critério de Broken Stick (Jackson, 1993), foram correlacionados com as densidades totais de ovos e larvas, bem como com os estágios de desenvolvimento em cada ponto amostral, através da correlação de Spearman. Variáveis ambientais com coeficientes estruturais >0.40 foram consideradas biologicamente importantes (Hair, Anderson, Tatham & Grablowski, 1984).

Para detectar a influência do gradiente ambiental na distribuição espacial das espécies, utilizou-se a Análise de Correspondência Canônica (CCA) (Legendre & Legendre, 1998), na qual consideramos as densidades dos grupos taxonômicos como a variável resposta às condições locais (Hammer et al., 2001). Para essa análise, tanto a matriz de dados bióticos (densidades de larvas) quanto abióticos foi composta pelos valores médios das réplicas obtidos em cada ponto, nas diferentes coletas, exceto transparência da água (aferida apenas no período diurno) e trecho de rio livre, cujo valor é único e invariável em cada ponto. O teste de permutação de Monte Carlo (999 permutações) foi utilizado para testar a significância do modelo. Todas as análises foram realizadas no software Statistica® 7.0 (STATSOFT, 2007), considerando-se o intervalo de confiança de $p<0,05$.

3. Resultados

3.1. Composição taxonômica

Foram coletados 5.681 ovos, 2.124 larvas e 43 juvenis na área de influência do Complexo CERAN. Os ovos foram capturados exclusivamente nas amostragens com redes de plâncton. As armadilhas luminosas (amostragem não

255 padronizada) contribuíram respectivamente com 6,4 e 11,6% do total de larvas e
256 juvenis capturados.

257 As larvas e juvenis representaram quatro ordens, sendo Characiformes e
258 Siluriformes as mais abundantes. Foi possível também a identificação de 12
259 táxons quanto a espécie, nove a gênero e quatro apenas até família (Tabela 1). A
260 composição taxonômica foi dominada por espécies de pequeno porte (60,0%),
261 principalmente dos gêneros *Astyanax* e *Bryconamericus*, responsáveis ainda
262 pelas maiores contribuições em abundância e densidade total de larvas (Tabela
263 1). Esse cenário reflete a ocorrência em maior número de táxons sedentários
264 (76,0%) e sem cuidado parental (60,0%).

265 Tabela 1. Grupos taxonômicos, estratégia reprodutiva (ER), abundância (ATL) e densidade total de larvas (DTL), bem como
266 frequência de ocorrência de cada táxon e respectivo grau de desenvolvimento inicial dos peixes registrados no Complexo
267 Energético Rio das Antas, durante o período de outubro de 2016 a janeiro de 2017. P – Ponto amostral. ER: M – Migradora; S –
268 Sedentária; G – Guardadora; NG – Não Guardadora. Estágios de desenvolvimento: LV – Larval vitelino; PF – Pré-flexão; FL –
269 Flexão; FP – Pós-flexão; JU – Juvenil. X indica captura na armadilha luminosa. Escalas de frequência de ocorrência: Larvas =
270 0.01–1.00; 1.01–5.00; 5.01–26.00 (%); Jovens = 0.01–10.00; 10.01–21.00 (%).

Táxon	ER	ATL (n)	DTL (ind/m³)	P1					P2					P3					P4				
				LV	PF	FL	FP	JU	LV	PF	FL	FP	JU	LV	PF	FL	FP	JU	LV	PF	FL	FP	JU
ATHERINIFORMES																							
Atherinopsidae																							
Odontesthes spp.	S;G	27	0.93												X					X			
CHARACIFORMES																							
Characidae																							
Astyanax spp. 1	S;NG	186	50.88							X	X				X	X				X	X		
Astyanax spp. 2	S;NG	6	1.27				X																
Astyanax spp. 3	S;NG	845	271.48							X						X							
Astyanax spp. 4	S;NG	1																		X			
Astyanax spp. 5	S;NG	5	1.68																				
Bryconamericus iheringii (Boulenger, 1887)	S;NG	366	111.18		X		X			X		X		X	X	X	X		X	X	X	X	
Bryconamericus spp.	S;NG	19	4.65		X					X										X			
Charax stenopterus (Cope, 1894)	S;NG	1	0.36																				
Cyanocharax alburnus (Hensel, 1870)	S;NG	3	1.01										X										X
Diapoma speculiferum Cope, 1894	S;NG	-	-										X										
Oligosarcus jenynsii (Gunther, 1964)	S;NG	1	0.13																				
Characidae morfotipo 1		1	0.47																				
Crenuchidae																							
Characidium orientale Buckup e Reis, 1997	S;NG	39	9.36																	X			
Erythrinidae																							
Hoplias aff. *malabaricus* (Bloch, 1794)	S;G	16	3.69			X														X	X		
PERCIFORMES																							
Cichlidae																							
Crenicichla punctata Hensel, 1870	S;G	1	0.57																				
SILURIFORMES																							
Auchenipteridae																							
Glanidium sp.	S;G	7	3.65																				

271 Tabela 1. Continuação...

Táxon	ER	ATL (n)	DTL (ind/m³)	P1					P2					P3					P4				
				LV	PF	FL	FP	JU	LV	PF	FL	FP	JU	LV	PF	FL	FP	JU	LV	PF	FL	FP	JU
Heptapteridae																							
Rhamdia quelen (Quoy e Gaimard, 1824)	S;NG	15	4.27																				
Heptapteridae morfotipo 1		60	20.97																				
Heptapteridae morfotipo 2		2	0.51																				
Loricariidae																							
Hypostomus spp.	S;G	-	-																				
Loricariichthys anus (Valenciennes, 1836)	S;G	2	0.27																				
Rineloricaria strigilata (Hensel, 1868)	S;G	-	-																				
Pimelodidae																							
Pimelodus pintado	M;NG	202	99.60																				
Pimelodidae morfotipo 1	M;NG	133	46.40																				
Não identificadas		4	1.30																				
Não identificáveis		182	53.80	X										X					X				
Total		2124	688.44																				

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3.2. Distribuição espacial

Foram identificadas diferenças espaciais significativas nas densidades de ovos e larvas. As densidades médias de ovos foram mais acentuadas no P3, em comparação a P1 (p=0,007) e P2 (p=<0,001) (Figura 2A). Enquanto as densidades médias de larvas foram mais elevadas no P1, em comparação aos TVRs P2 e P4 (p = 0,036 e p=0,035, respectivamente) (Figura 2B).

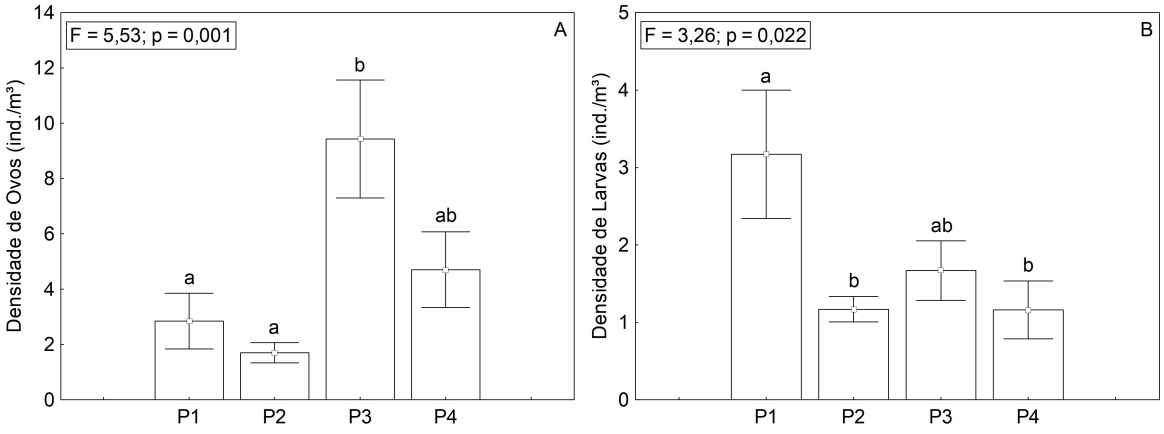

Figura 2. Densidade de ovos (A) e larvas (B) de peixes nos distintos pontos amostrais da área de influência do Complexo Energético Rio das Antas, entre outubro de 2016 e janeiro de 2017. Valores na extremidade superior esquerda representam os resultados da ANOVA. Quadrados – médias; barras – erro padrão; letras diferentes indicam densidades médias significativamente distintas.

Foram observadas diferenças entre os estágios de desenvolvimento larval em todos os pontos (Figura 3). No P1 e P2, as densidades das larvas em pré-flexão foram significativamente maiores do que os demais estágios (larval-vitelino p=0,001 e p=0,001, respectivamente; flexão e pós-flexão p=<0,001, para ambos os estágios e pontos). No P3, as densidades de indivíduos em larval-vitelino diferiram daqueles em flexão (p=0,002) e pós-flexão (p=0,003). No P4, as densidades foram similares, diferindo significativamente somente entre os indivíduos nos estágios de pré e pós-flexão (p=0,032). Foi identificada interação

entre os pontos amostrais e os estágios larvais (F=4,40, df=9, p=<0,001), indicando que o fator espacial é determinante para o grau de desenvolvimento ontogênico (Figura 4).

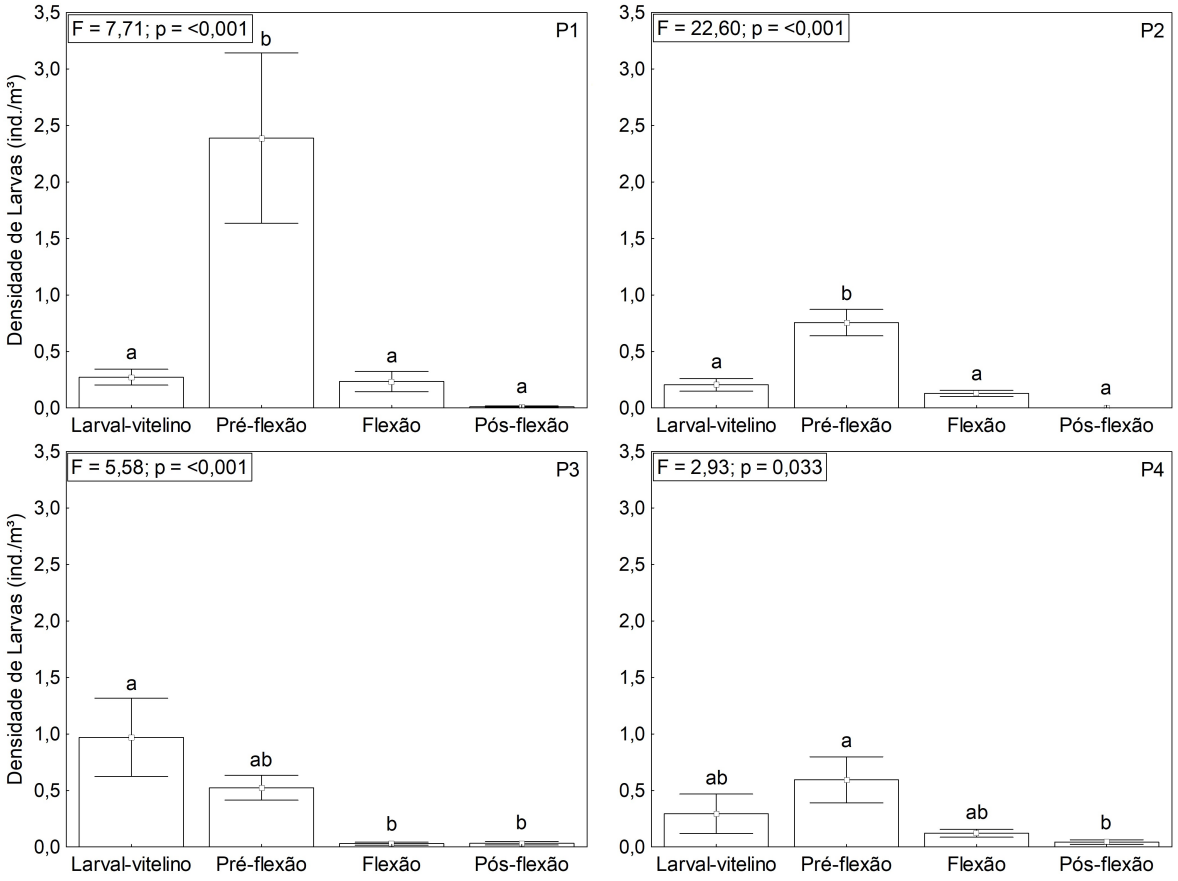

Figura 3. Densidade de larvas de peixes em diferentes estágios de desenvolvimento ontogênico em cada ponto amostral do Complexo Energético Rio das Antas, entre outubro de 2016 e janeiro de 2017. Valores na extremidade superior esquerda representam os resultados da ANOVA. Quadrados – médias; barras – erro padrão; letras diferentes indicam densidades médias significativamente distintas.

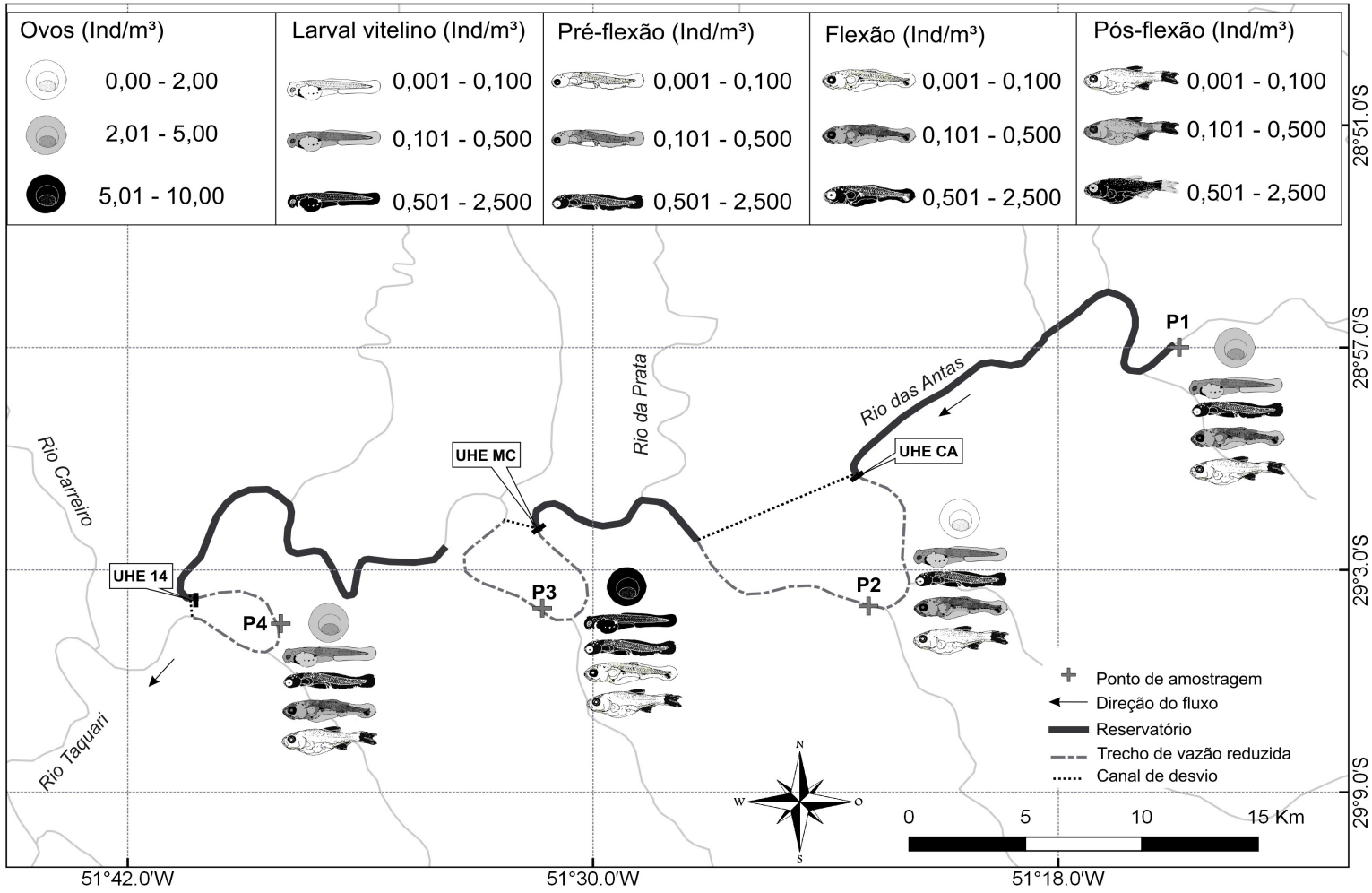

Figura 4. Distribuição espacial da densidade média de ovos e dos diferentes estágios de desenvolvimento ontogênico de larvas em cada ponto amostral do Complexo Energético Rio das Antas, entre outubro de 2016 e janeiro de 2017. Hidrelétricas: UHE 14 – Usina Hidrelétrica 14 de Julho; UHE MC - Usina Hidrelétrica Monte Claro; UHE CA - Usina Hidrelétrica Castro Alves.

3.3. Influência das variáveis ambientais

As variáveis ambientais mostraram-se similares em todos os pontos, com exceção dos valores de trecho de rio livre de barramentos e da vazão que foram maiores no P1 e P3, respectivamente (Tabela 2).

Os dois primeiros eixos da Análise de Componentes Principais (PCA) foram significativos para representar as condições locais. O eixo 1 (explicando 32,9%), representado principalmente pela vazão, temperatura e transparência (Tabela 2), esteve altamente correlacionado com a captura de ovos em cada ponto (Tabela 3). O eixo 2 (22,9%), por sua vez representado pelo pH, transparência e temperatura (Tabela 2), foi associado a ocorrência de larvas em fases iniciais (Tabela 3). Correlações significativas das densidades totais de ovos e larvas com ambos os eixos da PCA, indicam que as variáveis ambientais supracitadas influenciaram a ocorrência e distribuição do ictioplâncton.

Tabela 2. Média, desvio padrão (±) e coeficientes de estrutura da PCA relativas as variáveis ambientais em cada ponto amostral no Complexo Energético Rio das Antas, no período de outubro de 2016 e janeiro de 2017. Valores em negrito representam coeficientes de estrutura biologicamente importantes (>0,40).

Variáveis Ambientais	**Média e Desvio Padrão**				**Coeficientes**	
	P1	**P2**	**P3**	**P4**	**PCA1**	**PCA2**
Rio livre de barramentos (km)	125,10	10,20	8,82	4,92	0,02	0,07
Temperatura da água (ºC)	22,34±3,00	22,24±2,95	22,67±3,12	22,83±2,79	**0,68**	**-0,56**
Oxigênio dissolvido (mg/L)	7,93±1,75	8,20±1,91	7,94±1,76	8,32±1,85	**-0,64**	0,18
Condutividade (µS/cm^{-1})	22,34±6,05	30,75±10,77	30,20±9,10	27,63±11,12	**0,48**	0,33
Transparência (m)	1,13±0,46	1,01±0,42	1,00±0,55	0,88±0,41	**0,65**	**0,63**
Vazão (m³/s)	93,81±158,98	72,39±87,29	396,17±1008,21	75,98±72,72	**-0,83**	-0,20
pH	7,66±0,43	7,69±0,32	7,56±0,65	7,68±0,37	-0,29	**0,84**

Tabela 3. Correlação dos componentes significativos da PCA com as densidades dos diferentes estágios de desenvolvimento do ictioplâncton no Complexo Energético Rio das Antas, entre outubro de 2016 e janeiro de 2017. Valores em negrito indicam correlações significativas.

Ponto Amostral	Estádio de desenvolvimento	PCA1		PCA2	
		p	r	p	r
P1	Larval-vitelino	**0,006**	**0,281**	0,017	0,244
	Pré-flexão	0,862	-0,018	**<0,001**	**0,490**
	Flexão	0,590	-0,056	**<0,001**	**0,397**
	Pós-flexão	0,925	0,010	0,156	-0,146
	Ovos	**0,001**	**0,343**	0,102	-0,168
	Larvas	0,811	0,025	**<0,001**	**0,490**
P2	Larval-vitelino	0,121	0,159	**0,001**	**0,326**
	Pré-flexão	0,097	0,170	**<0,001**	**0,466**
	Flexão	0,130	0,156	0,305	0,106
	Pós-flexão	0,117	-0,161	0,872	0,017
	Ovos	**0,005**	**-0,285**	**0,043**	**-0,207**
	Larvas	0,051	0,200	**<0,001**	**0,524**
P3	Larval-vitelino	0,672	0,044	**0,001**	**0,320**
	Pré-flexão	**0,002**	**0,306**	**0,001**	**0,346**
	Flexão	0,448	-0,078	**0,007**	**0,272**
	Pós-flexão	0,594	0,055	0,052	-0,199
	Ovos	**0,022**	**0,233**	0,060	0,192
	Larvas	0,148	0,149	**<0,001**	**0,419**
P4	Larval-vitelino	0,711	0,038	**<0,001**	**0,352**
	Pré-flexão	**<0,001**	**0,408**	**0,003**	**0,301**
	Flexão	**0,012**	**0,256**	0,662	-0,045
	Pós-flexão	0,073	0,184	0,488	0,072
	Ovos	**0,030**	**-0,222**	0,310	-0,105
	Larvas	**0,001**	**0,341**	**0,040**	**0,210**
Total	Larval-vitelino	**0,003**	**0,150**	**<0,001**	**0,304**
	Pré-flexão	**<0,001**	**0,205**	**<0,001**	**0,403**
	Flexão	0,219	0,063	**<0,001**	**0,179**
	Pós-flexão	0,302	0,053	0,112	-0,081
	Ovos	0,157	0,072	0,116	-0,080
	Larvas	**<0,001**	**0,203**	**<0,001**	**0,418**

A influência das variáveis ambientais na composição taxonômica das larvas foi representada pelo modelo gerado na análise de correspondência (CCA) (Figura 5), que explicou 35,9% da ordenação dos dados e mostrou-se significativo ($p<0,024$). Dentre os eixos da CCA, os dois primeiros foram estatisticamente significativos na representação do modelo, explicando 38,5% ($p=<0,001$) e 24,6% ($p=0,004$), respectivamente. O primeiro eixo expressou gradiente positivo de transparência, pH e trecho de rio livre de barramentos e esteve correlacionado, principalmente, com Heptapteridae morfotipo 1 e Characidae morfotipo 1. O gradiente negativo do eixo 1 foi representado principalmente por espécies

predominantes do P4, como *Crenicichla punctata* e *Glanidium* sp. O segundo eixo, por sua vez, expressou gradiente positivo de temperatura, correlacionado principalmente com táxons da família Characidae.

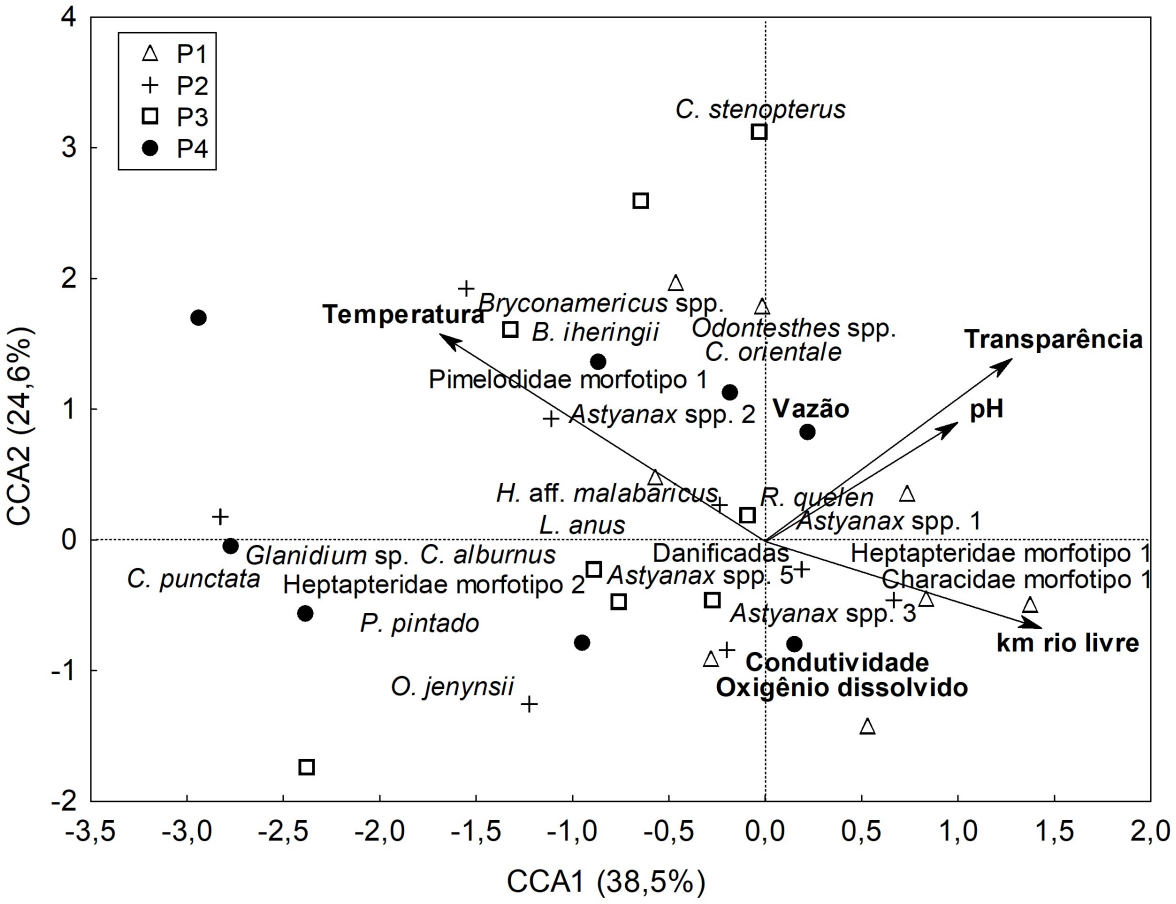

Figura 5. Análise de Correspondência Canônica (CCA) com a distribuição espacial das variáveis ambientais e a composição taxonômica das larvas capturadas no Complexo Energético Rio das Antas, entre março de 2015 a janeiro de 2017.

4. Discussão

A cascata de barramentos interrompeu os processos naturais de deriva de ovos e larvas de peixes, corroborando com as predições iniciais. Essa constatação é denotada pela elevada densidade de larvas à montante do complexo. Além disso, a maior riqueza de espécies a jusante indica que a fragmentação decorrente da cascata de barramentos, impossibilita que muitas espécies avancem no sentido montante. Em relação aos TVRs, constatou-se que maiores vazões influenciam positivamente a utilização destes como sítios de desova. Contudo, é importante destacar que a efetivação nas desovas esteve associada a espécies sedentárias, especialmente dos gêneros *Astyanax* e *Bryconamericus*, tendo em vista as elevadas densidades de organismos desses grupos em estágios iniciais. Ademais, apesar de não existir um gradiente ambiental evidente, algumas variáveis ambientais (vazão, temperatura, transparência, pH e trecho de rio livre de barramentos) influenciaram diretamente a ocorrência, composição e distribuição do ictioplânton na área de estudo.

A bacia hidrográfica Taquari-Antas possui documentada a ocorrência de 119 espécies (incluindo não nativas), sendo que destas apenas seis são consideradas migradoras (Becker et al., 2013). Para a área de influência direta do Complexo CERAN, a riqueza documentada é de 70 espécies (Luz-Agostinho et al., 2010), sendo que destas, 35,7% tiveram atividade reprodutiva detectada no presente estudo, destacando-se *Pimelodus pintado* como a única considerada migradora. Entretanto, essa espécie não possui grandes exigências espaciais na efetivação das desovas, com registros de reprodução em todos os pontos de coleta (Luz-Agostinho et al., 2010). De modo geral, a composição taxonômica do ictioplâncton compartilha espécies com demandas reprodutivas generalistas (e.g.

pequenos caracídeos, especialmente do gênero *Astyanax*) entre os distintos ambientes. Nesse aspecto, a comunidade de peixes adultos registrada na área de estudo corrobora com esse panorama (Ticiani & Delariva, em preparação) e segue o cenário característico de cursos hídricos neotropicais represados (Agostinho, Gomes & Pelicice, 2007; Agostinho et al., 2016).

O sucesso na efetivação das desovas a montante do P1, constatado pelo predomínio de larvas em pré-flexão, possivelmente esteja relacionado a ausência de barramentos no trecho superior do rio das Antas. Em reservatórios em sequência, as secções de montante favorecem deslocamentos migratórios devido a inexistência de barreiras físicas acima (Santos et al., 2017). Nesse estudo, Heptapteridae morfotipo 1 e Characidae morfotipo 1 foram os grupos taxonômicos mais influenciados pela variável trecho de rio livre, sugerindo que sejam residentes e/ou dependam dos trechos imediatamente acima do complexo para a reprodução.

Ainda sob o contexto da fragmentação, a inexistência de barreiras físicas intransponíveis a jusante do P4, em todo percurso até a foz do rio Jacuí, possibilita que um maior número de espécies alcance esse local para a efetivação das desovas, fornecendo uma característica exclusiva a esse TVR. Adicionalmente, a descarga de fluxo hídrico liberada pelo reservatório a montante (UHE 14 de Julho) parece atuar na manutenção das condições fluviais a jusante da cascata de reservatórios. Esse cenário contribuiu para o aumento da riqueza e abundância de espécies (Miranda & Dembkowski, 2015) e explica ainda o registro de táxons exclusivos (*Crenicichla punctata* e *Rineloricaria strigilata*) ou com ocorrência predominante no local (*e.g. Odontesthes* spp., *Characidium orientale*). Entretanto, essas constatações não constituem o mesmo padrão verificado a

jusante de grandes empreendimentos, como por exemplo, a UHE Itá, no rio Uruguai, cujas condições similares de trecho livre de barramentos não refletiram maior riqueza e densidade (Hermes-Silva et al, Reynalte-Tataje & Zaniboni-Filho, 2009).

O baixo número de espécies registradas nos TVRs (exceto P4) possivelmente está relacionado às características físicas desses ambientes, além da fragmentaçao. É esperado que os TVRs comportem menos espécies, com predomínio daquelas de menor tamanho, devido ao baixo volume de água (Singh & Agarwal, 2017). Nesses locais, a redução drástica no fluxo hídrico dificulta a manutenção das funções ecossistêmicas originais (Baumgartner et al., 2014; Brambilla, Fontes & Medeiros, 2017; Poff et al., 1997) e cria ambientes tipicos de riachos, insipientes para a sobrevivência de espécies com requisitos fluviais (Agarwal, Singh & Singh, 2011), as quais acabam migrando para secções menos alteradas (Ticiani & Delariva, em preparação). Adicionalmente, apesar da reconhecida importância dos tributários na manutenção dos estoques de peixes em ambientes represados (Frantine-Silva et al., 2015; Hermes-Silva et al, 2009; Reynalte-Tataje, Agostinho, et al., 2012), a elevada declividade do relevo e as pequenas dimensões dos afluentes das áreas intermediárias da cascata de barramentos aqui avaliada não proporcionam sua utilização como rota alternativa para a ictiofauna local.

A influência da vazão remanescente nas desovas, apontada na correlação com os escores da PCA, é ressaltada no TVR P3, o qual recebe descarga 60,2% maior em comparação ao P2, proporcionando condições satisfatórias para desovas de espécies de pequeno porte. Essas espécies, mesmo as sedentárias (e.g. gêneros *Astyanax* e *Bryconamericus*), apresentam algum grau de

dependência dos remanescentes lóticos a montante dos reservatórios para completarem seu ciclo reprodutivo (Agostinho, Pelicice & Gomes, 2008). Entretanto, é importante salientar que além da menor vazão remanescente do barramento a montante, em comparação aos demais, a limitação das desovas no TVR P2 pode estar associada a presença de barreira física natural a montante do local, conhecida como "Cachoeirão". Embora não existam indícios de que essa queda d'água seja intransponível, possivelmente já ocasionava a interrupção de deslocamentos migratórios de algumas espécies para o techo superior do rio das Antas, anteriormente a implantação do Complexo CERAN (Becker et al., 2013; Luz-Agostinho et al., 2010).

Em relação à influência das variáveis ambientais, os resultados encontrados no presente estudo seguem a tendência observada para reservatórios neotropicais, onde a vazão, temperatura e transparência da água são reconhecidos como os principais estímulos para a reprodução de peixes (Oldani, 1990; Reynalte-Tataje, Agostinho, et al., 2012; Sanches et al., 2006). No presente estudo, a temperatura mostrou-se determinante na composição taxonômica, em especial na ocorrência de pequenos caracídeos. Peixes jovens, bem como aqueles que exibem pequeno tamanho corporal, tem seu metabolismo acelerado em temperaturas mais elevadas (Fonds, Cronie, Vethaak & Van Der Puyl, 1992).

Especialmente nos TVR's, o aumento da temperatura decorre da diminuição do volume de água (Richter, Baumgartner, Powell & Braun, 1996). No mesmo sentido, o represamento de sistemas fluviais atua na retenção de matéria orgânica (Humphries & Lake, 2000), o que acarreta a elevação da transparência nos setores de jusante, favorecendo espécies piscívoras (Santos et al., 2017), as

quais influenciam na estrutura da comunidade (Pelicice et al., 2005; Piana, Gomes & Agostinho, 2006). Em contrapartida, a diminuição das cargas orgânicas restringe a formação de ácidos húmicos e a consequente acidificação da água (Esteves, 2011; Zacardi & Ponte, 2016), a qual promove alterações nos processos fisiológicos dos peixes, principalmente de indivíduos jovens, alterando, por exemplo, comportamentos natatórios e a formação do esqueleto (Esteves, 2011; Kitamura & Ikuta, 2000). Assim, os valores estáveis de pH registrados no presente estudo influenciaram positivamente o desenvolvimento das larvas.

Em conclusão, a cascata de barramentos interrompeu os processos de dispersão, como pode ser constatada pelo evidente sucesso reprodutivo a montante e maior riqueza a jusante, como previsto inicialmente. Além disso, os barramentos impedem que muitas espécies de peixe alcancem os trechos superiores do rio das Antas. Nas seções intermediárias do complexo, a efetivação das desovas esteve associada a táxons com demandas reprodutivas generalistas (Winemiller, 1989), com destaque aos pequenos caracídeos. A constatação da utilização dos Trechos de Vazão Reduzida para desovas denota a necessidade de descargas de fluxo hídrico mais acentuadas da barragem a montante, possibilitando que um número maior de espécies utilize esses remanescentes lóticos.

O cenário de alterações apontado no presente estudo nos remete ao questionamento da imagem sustentável atribuído aos sistemas hidrelétricos de desvio do rio (Paish, 2002), considerados, em muitos casos, menos impactantes que os grandes reservatórios (Abassi & Abassi, 2011; Latini & Pedlowski, 2016). No Brasil, as políticas públicas fomentam financeiramente e flexibilizam as normas de regularização ambientais para a implantação de pequenas

hidrelétricas (Pelicice et al., 2017), sem considerar as alterações oriundas após a formação da cascata de barramentos. No mesmo sentido, os estudos de viabilidade de hidrelétricas com sistema de desvio do rio devem preconizar a adoção de metodologias para determinação da vazão remanescente que considerem as comunidades aquáticas a jusante, como por exemplo, a técnica do perímetro molhado, baseado tanto em critérios hidráulicos, quanto na disponibilidade de habitat para ictiofauna.

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759

Author Guidelines - Ecology of Freshwater Fish

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Ecology of Freshwater Fish publishes original contributions on all aspects of fish ecology in freshwater environments, including lakes, reservoirs, rivers, and streams. Manuscripts involving ecologically-oriented studies of behaviour, conservation, development, genetics, life history, physiology, and host-parasite interactions are welcomed. Studies involving population ecology and community ecology are also of interest, as are evolutionary approaches including studies of population biology, evolutionary ecology, behavioural ecology, and historical ecology. Papers addressing the life stages of anadromous and catadromous species in estuaries and inshore coastal zones are considered if they contribute to the general understanding of freshwater fish ecology. Theoretical and modelling studies are suitable if they generate testable hypotheses, as are those with implications for fisheries. Manuscripts presenting analyses of published data are considered if they produce novel conclusions or syntheses. The journal publishes articles, fresh perspectives, and reviews and, occasionally, the proceedings of conferences and symposia.

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vii. Main text;
viii. References;
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xiii. Figure legends;
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Journal Article

Beers, S. R., & De Bellis, M. D. (2002). Neuropsychological function in children with maltreatment-related posttraumatic stress disorder. *The American Journal of Psychiatry*, 159, 483–486. doi:10.1176/appi.ajp.159.3.483

Book

Bradley-Johnson, S. (1994). *Psychoeducational assessment of students who are visually impaired or blind: Infancy through high school* (2nd ed.). Austin, TX: Pro-ed.

Internet Document

Norton, R. (2006, November 4). How to train a cat to operate a light switch [Video file]. Retrieved from http://www.youtube.com/watch?v=Vja83KLQXZs

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Tables should be self-contained and complement, but not duplicate, information contained in the text. They should be supplied as **editable files**, not pasted as images, each on a separate page at the end of the main text file. Indicate the approximate location desired in the text.

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However, two kinds of material are cited only in the text: references to classical works such as the Bible and the Qur'an, whose sections are standardized across editions, and references to personal communications (see sections 6.18 and 6.20). References in a meta-analysis are not cited in text unless they are also mentioned in the text (see section 6.26)

6.11 One Work by One Author

The author–date method of citation requires that the surname of the author (do not include suffixes such as *Jr.*) and the year of publication be inserted in the text at the appropriate point:

> Kessler (2003) found that among epidemiological samples
> Early onset results in a more persistent and severe course (Kessler, 2003).

If the name of the author appears as part of the narrative, as in the first example, cite only the year of publication in parentheses. Otherwise, place both the name and the year, separated by a comma, in parentheses (as in the second example). Even if the reference includes month and year, include only the year in the text citation. In the rare case in which both the year and the author are given as part of the textual discussion, do not add parenthetical information:

> In 2003, Kessler's study of epidemiological samples showed that

Within a paragraph, when the name of the author is part of the narrative (as in the first example above), you need not include the year in subsequent nonparenthetical references to a study as long as the study cannot be confused with other studies cited in the article. Do include the year in all parenthetical citations:

> Among epidemiological samples, Kessler (2003) found that early onset social anxiety disorder results in a more potent and severe course. Kessler also found. . . . The study also showed that there was a high rate of comorbidity with alcohol abuse or dependence and major depression (Kessler, 2003).

However, when both the name and the year are in parentheses (as in the second example above), include the year in subsequent citations within the paragraph:

Early onset results in a more persistent and severe course (Kessler, 2003). Kessler (2003) also found. . . .

6.12 One Work by Multiple Authors

When a work has two authors, cite both names every time the reference occurs in text. When a work has three, four, or five authors, cite all authors the first time the reference occurs; in subsequent citations, include only the surname of the first author followed by *et al.* (not italicized and with a period after *al*) and the year if it is the first citation of the reference within a paragraph.

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Exception: If two references of more than three surnames with the same year shorten to the same form (e.g., both Ireys, Chernoff, DeVet, & Kim, 2001, and Ireys, Chernoff, Stein, DeVet, & Silver, 2001, shorten to Ireys et al., 2001), cite the surnames of the first authors and of as many of the subsequent authors as necessary to distinguish the two references, followed by a comma and *et al.*

Ireys, Chernoff, DeVet, et al. (2001) and Ireys, Chernoff, Stein, et al. (2001)

Precede the final name in a multiple-author citation in running text by the word *and*. In parenthetical material, in tables and captions, and in the reference list, join the names by an ampersand (&):

as Kurtines and Szapocznik (2003) demonstrated

as has been shown (Jöreskog & Sörbom, 2007)

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Kosslyn, Koenig, Barrett, Cave, Tang, and Gabrieli (1996)

Kosslyn, Koenig, Gabrieli, Tang, Marsolek, and Daly (1996)

In text you would cite them, respectively, as

Kosslyn, Koenig, Barrett, et al. (1996) and Kosslyn, Koenig, Gabrieli, et al. (1996)

Early onset results in a more persistent and severe course (Kessler, 2003). Kessler (2003) also found. . . .

6.12 One Work by Multiple Authors

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Ireys, Chernoff, DeVet, et al. (2001) and Ireys, Chernoff, Stein, et al. (2001)

Precede the final name in a multiple-author citation in running text by the word *and*. In parenthetical material, in tables and captions, and in the reference list, join the names by an ampersand (&):

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Kosslyn, Koenig, Gabrieli, Tang, Marsolek, and Daly (1996)

In text you would cite them, respectively, as

Kosslyn, Koenig, Barrett, et al. (1996) and Kosslyn, Koenig, Gabrieli, et al. (1996)

Basic Citation Styles

Type of citation	First citation in text	Subsequent citations in text	Parenthetical format, first citation in text	Parenthetical format, subsequent citations in text
One work by one author	Walker (2007)	Walker (2007)	(Walker, 2007)	(Walker, 2007)
One work by two authors	Walker and Allen (2004)	Walker and Allen (2004)	(Walker & Allen, 2004)	(Walker & Allen, 2004)
One work by three authors	Bradley, Ramirez, and Soo (1999)	Bradley et al. (1999)	(Bradley, Ramirez, & Soo, 1999)	(Bradley et al., 1999)
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When a work's author is designated as "Anonymous," cite in text the word *Anonymous* followed by a comma and the date:

(Anonymous, 1998)

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Order the citations of two or more works within the same parentheses alphabetically in the same order in which they appear in the reference list (including citations that would otherwise shorten to *et al.*).

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> Past research (Gogel, 1990, 2006, in press)

Identify works by the same author (or by the same two or more authors in the same order) with the same publication date by the suffixes *a, b, c,* and so forth, after the year; repeat the year. The suffixes are assigned in the reference list, where these kinds of references are ordered alphabetically by title (of the article, chapter, or complete work).

> Several studies (Derryberry & Reed, 2005a, 2005b, in press-a; Rothbart, 2003a, 2003b)

List two or more works by different authors who are cited within the same parentheses in alphabetical order by the first author's surname. Separate the citations with semicolons.

> Several studies (Miller, 1999; Shafranske & Mahoney, 1998)

Exception: You may separate a major citation from other citations within parentheses by inserting a phrase, such as *see also*, before the first of the remaining citations, which should be in alphabetical order:

> (Minor, 2001; see also Adams, 1999; Storandt, 2007)

6.17 Secondary Sources

Use secondary sources sparingly, for instance, when the original work is out of print, unavailable through usual sources, or not available in English. Give the secondary source in the reference list; in text, name the original work and give a citation for the secondary source. For example, if Allport's work is cited in Nicholson and you did not read Allport's work, list the Nicholson reference in the reference list. In the text, use the following citation:

> Allport's diary (as cited in Nicholson, 2003).

6.18 Classical Works

When a date of publication is inapplicable, such as for some very old works, cite the year of the translation you used, preceded by *trans.*, or the year of the version you used, followed by *version*. When you know the original date of publication, include it in the citation.

> (Aristotle, trans. 1931)
> James (1890/1983)

Reference list entries are not required for major classical works, such as ancient Greek and Roman works or classical religious works; simply identify in the first citation in the text the version you used. Parts of classical works (e.g., books, chapters, verses, lines, cantos) are numbered systematically across all editions, so use these numbers instead of page numbers when referring to specific parts of your source:

1 Cor. 13:1 (Revised Standard Version)
(Qur'an 5:3–4)

6.19 Citing Specific Parts of a Source

To cite a specific part of a source, indicate the page, chapter, figure, table, or equation at the appropriate point in text. Always give page numbers for quotations (see section 6.03). Note that *page,* but not *chapter,* is abbreviated in such text citations:

(Centers for Disease Control and Prevention, 2005, p. 10)
(Shimamura, 1989, Chapter 3)

For guidance on citing electronic sources that do not provide page numbers, see section 6.05.

See section 6.18 for citing parts of classical works.

6.20 Personal Communications

Personal communications may be private letters, memos, some electronic communications (e.g., e-mail or messages from nonarchived discussion groups or electronic bulletin boards), personal interviews, telephone conversations, and the like. Because they do not provide recoverable data, personal communications are not included in the reference list. Cite personal communications in text only. Give the initials as well as the surname of the communicator, and provide as exact a date as possible:

T. K. Lutes (personal communication, April 18, 2001)
(V.-G. Nguyen, personal communication, September 28, 1998)

Use your judgment in citing other electronic forms as personal communications; online networks currently provide a casual forum for communicating, and what you cite should have scholarly relevance.

Some forms of personal communication are recoverable, and these should be referenced as archival materials. See section 7.10 for templates, descriptions, and examples of archival sources in the reference list.

6.21 Citations in Parenthetical Material

In a citation that appears in parenthetical text, use commas, not brackets, to set off the date:

(see Table 3 of U.S. Department of Labor, 2007, for complete data)

Reference List

The reference list at the end of a journal article provides the information necessary to identify and retrieve each source. Choose references judiciously and include only the sources that you used in the research and preparation of the article. APA journals and other journals using APA Style generally require reference lists, not bibliographies.[1] APA requires that the reference list be double-spaced and that entries have a hanging indent. Because a reference list includes only references that document the article and provide recoverable data, do not include in the list personal communications, such as letters, memoranda, and informal electronic communications. Instead, cite personal communications only in text (see section 6.20 for format).

6.22 Construction of an Accurate and Complete Reference List

Because one purpose of listing references is to enable readers to retrieve and use the sources, reference data must be correct and complete. Each entry usually contains the following elements: author, year of publication, title, and publishing data—all the information necessary for unique identification and library search. The best way to ensure that information is accurate and complete is to check each reference carefully against the original publication. Give special attention to spelling of proper names and of words in foreign languages, including accents or other special marks, and to completeness of journal titles, years, volume and issue numbers, page numbers, and electronic retrieval data. Authors are responsible for all information in their reference lists. Accurately prepared references help establish your credibility as a careful researcher.

Abbreviations. Acceptable abbreviations in the reference list for parts of books and other publications include the following:

Abbreviation	Book or publication part
ed.	edition
Rev. ed.	Revised edition
2nd ed.	second edition
Ed. (Eds.)	Editor (Editors)
Trans.	Translator(s)
n.d.	no date
p. (pp.)	page (pages)
Vol.	Volume (as in Vol. 4)
Vols.	Volumes (as in Vols. 1–4)
No.	Number
Pt.	Part
Tech. Rep.	Technical Report
Suppl.	Supplement

Arabic numerals. Although some volume numbers of books and journals are given in Roman numerals, APA journals use Arabic numerals (e.g., Vol. 3, not Vol. III) because they use less space and are easier to comprehend than Roman numerals. A Roman numeral that is part of a title should remain Roman (e.g., *Attention and Performance XIII*).

[1]Note that a *reference list* cites works that specifically support a particular article. In contrast, a *bibliography* cites works for background or for further reading and may include descriptive notes.

6.23 Consistency

Consistency in reference style is important, especially in light of evolving technologies in database indexing, such as automatic indexing by database crawlers. These computer programs use algorithms to capture data from primary articles as well as from the article reference list. If reference elements are out of order or incomplete, the algorithm may not recognize them, lowering the likelihood that the reference will be captured for indexing. With this in mind, follow the general formats for placement of data and use the electronic reference guidelines detailed in this chapter to decide which data are necessary to allow readers to access the sources you used.

6.24 Using the Archival Copy or Version of Record

When using information and data retrieved online, check to see whether you are citing the appropriate version of your reference source. In-progress and final versions of the same work might coexist on the Internet, which can present challenges in determining which version is most current and most authoritative. In most cases, it is best to cite the archival version or version of record, which has been peer-reviewed and may provide additional links to online supplemental material. If the most current version available was an advance release version at the time that you originally cited it, recheck the source and update its publication status as close as possible to the publication date of your work (see section 6.32).

6.25 Order of References in the Reference List

The principles for arranging entries in a reference list are described next. You may also find it helpful to look at the reference list in Chapter 2 in the sample manuscript and at reference lists in journals that are published in APA Style.

Alphabetizing names. Arrange entries in alphabetical order by the surname of the first author followed by initials of the author's given name, and use the following rules for special cases:

- Alphabetize by the author's surname. This surname/given name formula is commonly used in Western countries but is less commonly used in many Eastern countries. If you are uncertain about the proper format for a name, check with the author for the preferred form or consult the author's previous publication for the commonly used form (e.g., Chen Zhe may publish under Zhe Chen in the United States).
- Alphabetize letter by letter. When alphabetizing surnames, remember that "nothing precedes something": Brown, J. R., precedes Browning, A. R., even though *i* precedes *j* in the alphabet.

Singh, Y., precedes Singh Siddhu, N.

López, M. E., precedes López de Molina, G.

Ibn Abdulaziz, T., precedes Ibn Nidal, A. K. M.

Girard, J.-B., precedes Girard-Perregaux, A. S.

Villafuerte, S. A., precedes Villa-Lobos, J.

Benjamin, A. S., precedes ben Yaakov, D.

- Alphabetize the prefixes M', Mc, and Mac literally, not as if they were all spelled *Mac*. Disregard the apostrophe: MacArthur precedes McAllister, and MacNeil precedes M'Carthy.
- Alphabetize entries with numerals chronologically (e.g., Macomber, J., II, precedes Macomber, J., III).

Order of several works by the same first author. When ordering several works by the same first author, give the author's name in the first and all subsequent references, and use the following rules to arrange the entries:

- One-author entries by the same author are arranged by year of publication, the earliest first:

  Upenieks, V. (2003).
  Upenieks, V. (2005).

- One-author entries precede multiple-author entries beginning with the same surname (even if the multiple-author work was published earlier):

  Alleyne, R. L. (2001).
  Alleyne, R. L., & Evans, A. J. (1999).

- References with the same first author and different second or third authors are arranged alphabetically by the surname of the second author or, if the second author is the same, the surname of the third author, and so on:

  Boockvar, K. S., & Burack, O. R. (2007).
  Boockvar, K. S., Carlson LaCorte, H., Giambanco, V., Friedman, B., & Siu, A. (2006).
  Hayward, D., Firsching, A., & Brown, J. (1999).
  Hayward, D., Firsching, A., & Smigel, J. (1999).

- References with the same authors in the same order are arranged by year of publication, the earliest first:

  Cabading, J. R., & Wright, K. (2000).
  Cabading, J. R., & Wright, K. (2001).

- References by the same author (or by the same two or more authors in the same order) with the same publication date are arranged alphabetically by title (excluding *A* or *The*).

Exception: If the references with the same authors published in the same year are identified as articles in a series (e.g., Part 1 and Part 2), order the references in the series order, not alphabetically by title.

Place lowercase letters—*a*, *b*, *c*, and so forth—immediately after the year, within the parentheses:

Baheti, J. R. (2001a). Control . . .
Baheti, J. R. (2001b). Roles of . . .

Order of several works by different first authors with the same surname. Arrange works by different authors with the same surname alphabetically by first initial:

Mathur, A. L., & Wallston, J. (1999).
Mathur, S. E., & Ahlers, R. J. (1998).

Note: Include initials with the surname of the first author in text citations (see section 6.14).

Order of works with group authors or with no authors. Occasionally, a work will have as its author an agency, association, or institution, or it will have no author at all.

Alphabetize group authors, such as associations or government agencies, by the first significant word of the name. Full official names should be used (e.g., American Psychological Association, not APA). A parent body precedes a subdivision (e.g., University of Michigan, Department of Psychology).

If, and only if, the work is signed "Anonymous," begin the entry with the word *Anonymous* spelled out, and alphabetize the entry as if Anonymous were a true name.

If there is no author, move the title to the author position, and alphabetize the entry by the first significant word of the title.

Treat legal references like references with no author; that is, alphabetize legal references by the first significant item in the entry (word or abbreviation). See Appendix 7.1 for the format of references for legal materials and ways to cite them in the text.

6.26 References Included in a Meta-Analysis

If the number of articles contributing studies to the meta-analysis is relatively small (e.g., about 50 or fewer), they should appear in the reference list with an asterisk included to identify them. If the number of articles in the meta-analysis exceeds 50, then the references to the articles should be placed in a list and submitted as an online supplemental archive. In this second case, if an article is mentioned in the text and is included in the meta-analysis, it should be cited both in the reference list and in the supplemental materials.

Add the following statement before the first reference entry: *References marked with an asterisk indicate studies included in the meta-analysis.* The in-text citations to studies selected for meta-analysis are not preceded by asterisks.

Bandura, A. J. (1977). *Social learning theory.* Englewood Cliffs, NJ: Prentice Hall.

*Bretschneider, J. G., & McCoy, N. L. (1968). Sexual interest and behavior in healthy 80- to 102-year-olds. *Archives of Sexual Behavior, 14,* 343–350.

Reference Components

In general, a reference should contain the author name, date of publication, title of the work, and publication data. The following sections (6.27–6.31) describe these components. Detailed notes on style accompany the description of each element, and example numbers given in parentheses correspond to examples in Chapter 7 in sections 7.1–7.11.

6.27 Author and Editor Information

Authors.

- Invert all authors' names; give surnames and initials for up to and including seven authors (e.g., Author, A. A., Author, B. B., & Author, C. C.). When authors number eight or more, include the first six authors' names, then insert three ellipses, and add the last author's name (see Chapter 7, Example 2). In text, follow the citation guidelines in section 6.12.
- If the reference list includes different authors with the same surname and first initial, the authors' full first names may be given in brackets:

  Janet, P. [Paul]. (1876). La notion de la personnalité [The notion of personality]. *Revue Scientifique, 10,* 574–575.

  Janet, P. [Pierre]. (1906). The pathogenesis of some impulsions. *Journal of Abnormal Psychology, 1,* 1–17.

  In text:

  (Paul Janet, 1876)

  (Pierre Janet, 1906)

- If an author's first name is hyphenated, retain the hyphen and include a period after each initial (Lamour, J.-B., for Jean-Baptiste Lamour).
- Use commas to separate authors, to separate surnames and initials, and to separate initials and suffixes (e.g., Jr. and III; see Chapter 7, Example 24); with two to seven authors, use an ampersand (&) before the last author.
- Spell out the full name of a group author (e.g., Royal Institute of Technology; National Institute of Mental Health; see Chapter 7, Examples 31, 32, 35, 68). In a reference to a work with a group author (e.g., study group, government agency, association, corporation), a period follows the author element.
- If authors are listed with the word *with,* include them in the reference in parentheses: Bulatao, E. (with Winford, C. A.). The text citation, however, refers to the primary author only.
- In a reference to a work with no author, move the title to the author position, before the date of publication (see Chapter 7, Examples 9, 30, 71). A period follows the title.

Editors.

- In a reference to an edited book, place the editors' names in the author position, and enclose the abbreviation *Ed.* or *Eds.* in parentheses after the last editor's name. The period follows the parenthetical abbreviation (Eds.).
- In a reference to a chapter in an edited book, invert the chapter authors' names as noted above but do not invert book editors' names.
- The name of the book editor should be preceded by the word *In.* Provide initials and surnames for all editors (for substantial reference works with a large editorial board, naming the lead editor followed by *et al.* is acceptable).

  Author, A. A. (2008). Title of chapter. In E. E. Editor (Ed.), *Title of book* (pp. xx–xx). Location: Publisher.

- For a book with no editor, simply include the word *In* before the book title.

6.28 Publication Date

- Give in parentheses the year the work was published (for unpublished or informally published works, give the year the work was produced).
- For magazines, newsletters, and newspapers, give the year and the exact date of the publication (month or month and day), separated by a comma and enclosed in parentheses (see Chapter 7, Examples 7–11). If the date is given as a season, give the year and the season, separated by a comma and enclosed in parentheses.
- For papers and posters presented at meetings, give the year and month of the meeting, separated by a comma and enclosed in parentheses.
- Write *in press* in parentheses for articles that have been accepted for publication but that have not yet been published (see Chapter 7, Example 6). Do not give a date until the article has actually been published. (To reference a paper that is still in progress, under review, or being revised, see Chapter 7, Example 59.)
- If no date is available, write *n.d.* in parentheses.
- For several volumes in a multivolume work or several letters from the same collection, express the date as a range of years from earliest to latest (see Chapter 7, Examples 23 and 65).
- For archival sources, indicate an estimated date that is reasonably certain but not stated on the document by using *ca.* (circa) and enclose the information in square brackets (see Chapter 7, Example 67).
- Finish the element with a period after the closing parenthesis.

6.29 Title

Article or chapter title. Capitalize only the first word of the title and of the subtitle, if any, and any proper nouns; do not italicize the title or place quotation marks around it. Finish the element with a period.

Mental and nervous diseases in the Russo-Japanese war: A historical analysis.

Periodical title: Journals, newsletters, magazines. Give the periodical title in full, in uppercase and lowercase letters. Italicize the name of the periodical.

Social Science Quarterly

Nonperiodical title: Books and reports.

- Capitalize only the first word of the title and of the subtitle, if any, and any proper nouns; italicize the title.
- Enclose additional information given on the publication for its identification and retrieval (e.g., edition, report number, volume number) in parentheses immediately after the title. Do not use a period between the title and the parenthetical information; do not italicize the parenthetical information.

Development of entry-level tests to select FBI special agents (Publication No. FR-PRD-94–06).

- If a volume is part of a larger, separately titled series or collection, treat the series and volume titles as a two-part title (see Chapter 7, Example 24).
- Finish the element with a period.

Nonroutine information in titles. If nonroutine information is important for identification and retrieval, provide it in brackets immediately after the title and any parenthetical information. Capitalize the first letter of the notation. Brackets indicate a description of form, not a title. Here are some of the more common notations that help identify works:

Notation
[Letter to the editor]
[Special issue]
[Special section]
[Monograph]
[Abstract]
[Audio podcast]
[Data file]
[Brochure]
[Motion picture]
[Lecture notes]
[CD]
[Computer software]
[Video webcast]
[Supplemental material]

6.30 Publication Information

Periodicals: Journals, newsletters, magazines.

- Give the volume number after the periodical title; italicize it. Do not use *Vol.* before the number.
- Include the journal issue number (if available) along with the volume number if the journal is paginated separately by issue (see Chapter 7, Examples 3, 7, 8). Give the issue number in parentheses immediately after the volume number; do not italicize it. Give inclusive page numbers on which the cited material appears.
- Finish the element with a period.

Social Science Quarterly, 84, 508–525.

- Periodical publisher names and locations are generally not included in references, in accordance with long practice.

Nonperiodicals: Books and reports

- Give the location (city and state or, if outside of the United States, city and country) where the publisher is located as noted on the title page for books; reports; brochures; and other separate, nonperiodical publications.

- If the publisher is a university and the name of the state or province is included in the name of the university, do not repeat the name in the publisher location.
- The names of U.S. states and territories are abbreviated in the reference list and in the Method section (suppliers' locations); use the official two-letter U.S. Postal Service abbreviations. To cite locations outside the United States, spell out the city and the country names. However, if you are publishing outside the United States or for an international readership, check your institution's or publisher's specific style guidelines for writing out or abbreviating state, province, territory, and country names.
- Use a colon after the location.
- Give the name of the publisher in as brief a form as is intelligible. Write out the names of associations, corporations, and university presses, but omit superfluous terms, such as *Publishers, Co.*, and *Inc.*, which are not required to identify the publisher. Retain the words *Books* and *Press*.
- If two or more publisher locations are given in the book, give the location listed first or, if specified, the location of the publisher's home office.
- When the author is also the publisher, use *Author* to indicate the publisher.
- Finish the element with a period.

New York, NY: McGraw-Hill.
Washington, DC: Author.
Newbury Park, CA: Sage.
Pretoria, South Africa: Unisa.

6.31 Electronic Sources and Locator Information

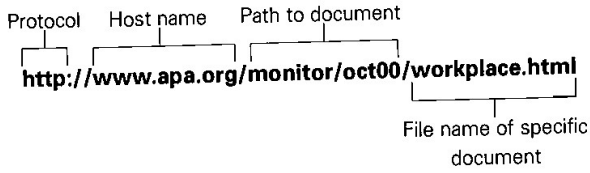
Since this manual was last updated, electronic journal publishing has gone from being the exception to the rule. Publishing in the online environment has greatly increased the efficiency of publication processes and has contributed to a more vibrant and timely sharing of research results. However, the electronic dissemination of information has also led to a number of new publishing models. Unedited articles can now be disseminated on the Internet in advance of publication. Links to supplementary material such as long data sets and videos can be embedded in electronic articles and made accessible with a simple click. Corrections that were formerly noted in a subsequent journal issue can now be made with no fanfare as a simple update to online files. All of these circumstances have called for new ways of tracking digital information.

In this new environment, some former models for referencing material no longer apply. It is not always clear how to distinguish the advance online version of an article from the final published version or how to determine which is the "version of record" (see section 6.24). Moreover, readers may be consulting the electronic version with supplemental material or the print version of the same article without supplemental material. In the ephemeral world of the web, article links are not always robust.

In general, we recommend that you include the same elements, in the same order, as you would for a reference to a fixed-media source and add as much electronic retrieval information as needed for others to locate the sources you cited. We discuss next some key elements of the electronic retrieval process, beginning with some general information about uniform resource locators (URLs) and digital object identifiers

(DOIs) and ending with formatting guidance for citing publication data from electronic sources.

Understanding a URL. The URL is used to map digital information on the Internet. The components of a URL are as follows:



Protocol indicates what method a web browser (or other type of Internet software) should use to exchange data with the file server on which the desired document resides. The protocols recognized by most browsers are hypertext transfer protocol (HTTP), hypertext transfer protocol secure (HTTPS), and file transfer protocol (FTP). In a URL, the protocol is followed by a colon and two forward slashes (e.g., http://).

Host or *domain name* identifies the server on which the files reside. On the web, it is often the address for an organization's home page (e.g., http://www.apa.org is the address for APA's home page). Although many domain names start with "www," not all do (e.g., http://journals.apa.org is the home page for APA's electronic journals, and http://members.apa.org is the entry page to the members-only portion of the APA site). The domain name is not case sensitive; for consistency and ease of reading, always type it in lowercase letters.

The domain name extension (in the preceding example, ".org") can help you determine the appropriateness of the source for your purpose. Different extensions are used depending on what entity hosts the site. For example, the extensions ".edu" and ".org" are for educational institutions and nonprofit organizations, respectively; ".gov" and ".mil" are used for government and military sites, respectively; and ".com" and ".biz" are used for commercial sites. Domain name extensions may also include a country code (e.g., ".ca" for Canada or ".nz" for New Zealand). The rest of the address indicates the directory path leading to the desired document.

All content on the Internet is prone to being moved, restructured, or deleted, resulting in broken hyperlinks and nonworking URLs in the reference list. In an attempt to resolve this problem, scholarly publishers have begun assigning a DOI to journal articles and other documents.

The DOI system. Developed by a group of international publishers, the DOI System provides a means of persistent identification for managing information on digital networks (see http://www.doi.org/). The DOI System is implemented through registration agencies such as CrossRef, which provides citation-linking services for the scientific publishing sector. According to their mission statement, CrossRef is dedicated "to enable easy identification and use of trustworthy electronic content by promoting the cooperative development and application of a sustainable infrastructure" (http://www.crossref.org/).

CrossRef's participants have developed a system that provides two critical functions. First, they assign each article a "unique identifier and underlying routing system" that functions as a clearinghouse to direct readers to content, regardless of where

the content resides (Kasdorf, 2003, p. 646). Second, they collaborate to use the DOI as an underlying linking mechanism "embedded" in the reference lists of electronic articles that allows click-through access to each reference. CrossRef currently has more than 2,600 participating publishers and scholarly societies.

The DOI as article identifier. A DOI is a unique alphanumeric string assigned by a registration agency (the International DOI Foundation) to identify content and provide a persistent link to its location on the Internet.

The publisher assigns a DOI when your article is published and made available electronically. All DOI numbers begin with a *10* and contain a prefix and a suffix separated by a slash. The prefix is a unique number of four or more digits assigned to organizations; the suffix is assigned by the publisher and was designed to be flexible with publisher identification standards. We recommend that when DOIs are available, you include them for both print and electronic sources.

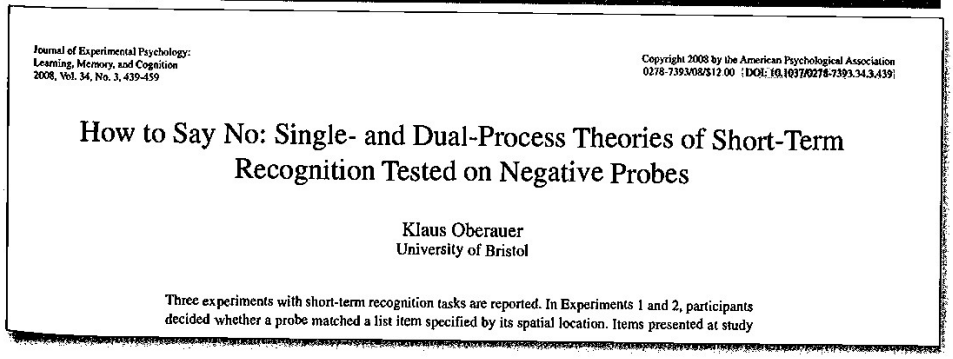
The DOI is typically located on the first page of the electronic journal article, near the copyright notice (see Figure 6.2). The DOI can also be found on the database landing page for the article (see Figure 6.3).

The linking function of DOIs. The DOIs in the reference list function as links to the content you are referencing. The DOI may be hidden under a button labeled *Article, CrossRef, PubMed,* or another full-text vendor name (see Figure 6.4). Readers can then click on the button to view the actual article or to view an abstract and an opportunity to purchase a copy of the item. If the link is not live or if the DOI is referenced in a print publication, the reader can simply enter the DOI into the *DOI resolver* search field provided by the registration agency CrossRef.org and be directed to the article or a link to purchase it (see Figure 6.5). Locating the article online with the DOI will give you electronic access to any online supplemental archives associated with the article (see section 2.13 regarding supplemental materials).

6.32 Providing Publication Data for Electronic Sources

- For electronic versions based on a print source (as in PDF), give inclusive page numbers for the article cited. Use *pp.* before the page numbers in references to newspapers. See Chapter 7, Examples 1–3.

Location of Digital Object Identifier (DOI) in Journal Article



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How to Say No: Single- and Dual-Process Theories of Short-Term Recognition Tested on Negative Probes

Klaus Oberauer
University of Bristol

Three experiments with short-term recognition tasks are reported. In Experiments 1 and 2, participants decided whether a probe matched a list item specified by its spatial location. Items presented at study