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OSCAR MAURICIO ALDANA ARDILA

ECOLOGIA TRÓFICA DO FLAMINGO-CHILENO *Phoenicopterus chilensis* (AVES: PHOENICOPTERIDAE) EM UMA LAGUNA DO EXTREMO SUL DO BRASIL

UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL

PORTO ALEGRE

2020

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Dissertação apresentada ao Programa de Pós-Graduação em Biologia Animal, Instituto de Biociências da Universidade Federal do Rio Grande do Sul, como requisito parcial à obtenção do título de Mestre em Biologia Animal.

Área de concentração: Biologia e comportamento animal

Orientador: Prof. Dr. Caio José Carlos

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“I met with these birds wherever there were lakes of brine. I saw them here wading about in search of food—probably for the worms which burrow in the mud; and these latter probably feed on infusoria or confervae. Thus we have a little living world within itself, adapted to these inland lakes of brine.”

Charles Darwin,

in The Voyage of the Beagle

APRESENTAÇÃO

A presente dissertação de mestrado é apresentada conforme Resolução Nº37/2018, deste Programa de Pós-Graduação em Biologia Animal (PPG-BAN) da Universidade Federal do Rio Grande do Sul, que institui procedimentos e normas para apresentação e avaliação da Dissertação de Mestrado e da Tese de Doutorado. O texto principal desta dissertação está estruturado sob a forma de um artigo científico, redigido em língua inglesa, visando à submissão ao *The Wilson Journal of Ornithology* (Qualis B2). O presente trabalho está de acordo com as "normas aos autores" do referido periódico, disponíveis no endereço eletrônico fornecido no item Referências Bibliográficas do capítulo introdutório e no Anexo 1. De acordo com o Artigo 43º do Regimento do PPG-BAN, o artigo, que compõe a parte central desta dissertação, está acompanhado de dois capítulos extras. O primeiro, a introdução geral, contém uma revisão sobre o problema abordado pelo presente trabalho, e traz os objetivos e os principais resultados obtidos no trabalho. O segundo, após o texto principal, apresenta as principais conclusões. Ambos capítulos introdutório e conclusivo estão redigidos em língua portuguesa.

RESUMO

Este estudo descreveu a dieta do Flamingo chileno *Phoenicopterus chilensis* em uma área contranupcial, o Parque nacional da Lagoa do Peixe. A dieta foi avaliada através de estruturas não digeridas presentes em 91 excrementos coletados nos locais de alimentação ao redor da lagoa. Foi possível identificar 268 presas que pertenciam a seis táxons (Calanoida, *Laeonereis acuta*, *Alitta succinea*, *Nereis* sp. Ostracoda e Diptera). As presas mais frequentes nas amostras de fezes do Flamingo chileno foram (Calanoida, *Laeonereis acuta*, *Alitta succinea* e *Nereis* sp.). Ademais, através da análise de amostras de sedimentos e água, foram caracterizadas as presas potenciais para o Flamingo chileno disponíveis na lagoa. Para as presas disponíveis que foram confirmadas nas amostras de fezes do Flamingo chileno, foram observadas altas abundancias entre a primavera, verão e o início do outono. Apesar de a análise microscópica das fezes ter sido eficaz, limitantes no método, como a subestimação das presas de corpos moles, reduziram o número de táxons identificados nas amostras de fezes. Portanto, recomenda-se o uso de metodologias complementares, como análise estável de isótopos e técnicas moleculares.

Palavras chave: Dieta, excrementos, presas, área contranupcial, Lagoa do Peixe.

ABSTRACT

This study described the diet of Chilean flamingo *Phoenicopterus chilensis* in a non-bree area, the Lagoa do Peixe lagoon. The diet was evaluated by the analyses of undigested structures present in 91 droppings collected in feeding sites around the lagoon environment. It was possible to identify 268 prey items that belonged to six taxa. (Calanoida, *Laeonereis acuta*, *Alitta succinea*, *Nereis* sp. Ostracoda and Diptera). The most frequent prey in the feces samples of Chilean flamingo was Calanoida, *Laeonereis acuta*, *Alitta succinea*, and *Nereis* sp. Besides, through the analyses of samples of benthos and water, was characterized the potentials prey available for the Chilean flamingo in the lagoon. To the available prey that was confirmed as prey items in the feces samples of Chilean flamingo was observed high abundances among the spring, summer, and the beginning of the autumn. Despite the microscopical feces analysis was effective, gaps in the method as the underestimation of soft-body prey reduced the number of identified taxa in the feces samples. Therefore, the use of complementary methodologies such as stable isotope analysis and molecular techniques is recommended.

Key words: Diet, droppings, non-breeding area, Lagoa do Peixe lagoon.

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INTRODUÇÃO GERAL

Os Flamingos formam uma clado de aves aquáticas que inclui seis espécies viventes nos gêneros *Phoenicopterus*, *Phoenicoparrus* e *Phoeniconaias*; *Phoenicopterus ruber, Phoenicopterus roseus, Phoenicopterus chilensis, Phoenicoparrus andinus, Phoenicoparrus jamesi* e *Phoeniconaias minor* (Torres et al. 2014). São aves de grande porte (*P. ruber, P. roseus* e *P. chilensis* são as espécies de maior porte; 132 cm de cumprimento e 3200 g de massa corpórea) (del Hoyo et al. 1992), com pescoço e pernas longas, plumagens de tons róseos ou avermelhados e um bico cujas mandíbulas são encurvadas na porção média possuindo estruturas especializadas (lamelas) para alimentação por filtração (Olson & Feduccia 1980).

Os Flamingos têm como habitat estuários e outras áreas costeiras, tais com lagoas rasas, salobras e salgadas e se distribuem em quase todos os continentes, exceto na Antártida e na Oceania (Allen 1956; del Hoyo et al. 1992). Essas aves apresentam comportamento gregário e vivem em colônias de reprodução que podem contar com mais de 20.000 indivíduos (Perdue et al. 2011). O Flamingo chileno, (*Phoenicopterus chilensis*) é restrito a América do Sul, distribuindo-se desde o centro do Peru até a Terra do Fogo no Chile e Argentina, ocorrendo também na região Sul do Brasil e no Uruguai (Branco et al. 2001). A espécie desloca-se sazonalmente, em busca de locais adequados para reprodução e alimentação (González-Villar 2007); no verão, se reproduz em lagos salgados nos Andes da América do Sul, enquanto, no inverno, muitos indivíduos se deslocam para zonas úmidas em altitudes mais baixas nas planícies centrais da Argentina, Chile e Peru, ou outros ambientes não afetados pela queda das temperaturas (Caziani et al. 2007).

Nos censos simultâneos realizados em áreas úmidas de Argentina, Bolívia, Chile e Peru em 2010 encontrou-se 283.000 aves e estimou-se a população global em 300.000 (Marconi et al. 2011). Apesar de ser a espécie de flamingo mais numeroso e distribuído da América do Sul (del Hoyo 2018), desde o 2004 é considerado na categoria "Quase Ameaçada" (sigla NT da lista vermelha da IUCN), porque há suspeitas de que passará por declínio populacional nas próximas três gerações, por causa de caça e perturbação de seu habitat (BirdLife International 2018).

No Brasil, O Flamingo chileno é um visitante migratório, vindo do Cone Sul do continente, sendo observado no Estado do Rio Grande do Sul (Branco et al. 2001) no Parque Nacional da Lagoa do Peixe (Sick 2001), localizado nos municípios de Tavares, e Mostardas, costa média do Rio Grande do Sul.

Os primeiros estudos sobre a ecologia trófica do Flamingo chileno iniciaram-se há 60 anos, quando Allen (1956) descreveu vários aspectos dos hábitos alimentares do Flamingo chileno, como as estruturas especializadas do bico envolvidas no processo de filtração do alimento, descrevendo inclusive, os seus comportamentos de forrageio e alimentação. Allen (1956) também compilou as informações da na literatura sobre o conteúdo estomacal de Flamingos chilenos coletados em diferentes áreas da América do Sul. Baseando-se nesses dados, o autor elaborou, não apenas uma lista das presas consumidas pelas aves, mas também comparou os resultados dos estudos com dados sobre as possíveis presas disponíveis no ambiente para o Flamingo chileno, concluindo que a sua dieta era composta principalmente por anelídeos, copépodes, algas, e lodo orgânico.

Jenkin (1957) também realizou uma revisão da literatura sobre a dieta do Flamingo chileno a traves da análise do conteúdo estomacal; porém, a maior contribuição da autora foi a análise de crânios de adultos de Flamingo chileno da coleção do Museu Britânico de História Natural, na qual fez uma descrição morfológica de todas as estruturas relacionadas com o processo de alimentação do flamingo: a estrutura do bico, a estrutura, variação e forma das lamelas, as estruturas da língua e o palato, e os órgãos sensoriais relacionados. Também através da observação de flamingos *in situ* e em cativeiro a autora analisou os movimentos do bico relacionados com o comportamento alimentar. Mascitti e Kravetz (2002), complementaram as observações da Jenkin, descrevendo morfologicamente o bico do Flamingo chileno e fazendo ênfase na capacidade de seleção de presas através das lamelas no bico dessa ave.

No ano 2014, Tobar et al. (2014) através da análise microscópica das fezes os autores consideraram que o Flamingo chileno, apresentou uma dieta exclusivamente carnívora, segundo os autores essa preferência alimentar é por causa das “as restrições morfoestruturais do bico do flamingo”. Finalmente, Polla et al. (2018) analisaram a dieta do Flamingo chileno em áreas de invernada em 11 lagos da planície central da Argentina. Nessa pesquisa, as fezes foram avaliadas por meio de métodos macro e microscópicos, complementados com analises de sequenciamento do gene 16S rRNA. Adicionalmente, também foi realizado uma caracterização dos recursos alimentares disponíveis na área estudada. Os resultados desta pesquisa mostraram que a dieta do Flamingo chileno foi de tipo onívora e composta principalmente por cianobactérias, Bacillariophyta, Copepoda, Cladocera e Rotifera. No Brasil, não há, ou não se conhece, nenhum trabalho sobre hábitos alimentares do Flamingo chileno em áreas contranupciais.

A Lagoa do Peixe apresenta uma importante produtividade primária das águas garantindo uma ampla quantidade de organismos disponíveis para a alimentação das aves aquáticas (Knak 1999). Dessa forma, o estudo da dieta do Flamingo chileno na Lagoa do Peixe, fornece uma grande oportunidade para aprimorar o conhecimento dos hábitos alimentares dessa espécie contribuindo assim com sua conservação. Nesse sentido, o presente estudo teve como objetivo descrever a dieta do Flamingo chileno em uma área contranupcial e identificar variações sazonais na dieta do flamingo e suas possíveis presas.

O Parque Nacional Lagoa do Peixe (31°29’ S, 50°46’ W) está localizado no litoral médio do estado do Rio Grande do Sul (Fepam 2018) a 230 quilômetros da capital do estado; Porto Alegre (Figura 1). Tem uma extensão de 34.400 ha e abrange os municípios de Tavares, Mostardas e

São José do Norte (Ministério do Meio Ambiente 2018), desde o ano 1993 foi reconhecido como um sitio Ramsar e também faz parte da Rede de Reservas de Aves Marinhas do Hemisfério Ocidental, além de ser incluído na Reserva da Biosfera da Mata Atlântica da UNESCO (da Silveira & Poerschke 2010).

O trabalho de campo foi realizado entre os meses de Outubro de 2018 e Setembro de 2019 na área da Lagoa do Peixe conhecida como o Canal da Barra. A dieta do Flamingo chileno foi avaliada através da análise de 91 excrementos fecais frescos coletados nos locais de alimentação no ambiente lagunar. Os excrementos foram coletados pela observação de aves se alimentando perto da costa da lagoa (Figura 2). As amostras fecais foram coletadas utilizando uma pipeta plástica de 10 ml e uma espátula metálica depois foram embaladas em sacos de papel filtro e mantidas a temperatura ambiente até ser analisadas. No laboratório, todas as amostras foram examinadas sob um microscópio estereoscópico, com ampliação de 80X.

Os organismos foram identificados no nível taxonômico mais baixo possível, com base na literatura especializada (Rozbaczylo 1980; Montú and Goeden 1986; Buckup and Bond-Buckup 1999; Thomé et al. 2004; Dominguez and Fernandez 2009).

Foram identificados 268 itens presas as quais foram classificadas em seis táxons, duas foram descritas no nível da espécie (*Laeonereis acuta*, *Alitta succinea*), uma no nível de gênero (*Nereis*), duas ordens (Calanoida e Diptera) e uma classe (Ostracoda). As principais presas nas amostras de fezes do Flamingo chileno foram Calanoida, *Laeonereis acuta*, Alitta *succinea* e *Nereis* sp. Nas amostras de sedimentos e água de presas disponíveis na Lagoa do Peixe que foram presas confirmadas nas fezes do Flamingo chileno, foram observados os maiores picos de abundância entre a primavera, o verão e o início do outono. Em relação à variabilidade dos itens de presas encontrados na dieta de Flamingo chileno na Lagoa do Peixe. Observou-se que enquanto as presas Calanoida, *L. acuta* e *A. succine*a estiveram presentes ao longo dos meses nas amostras de fezes, a ausência de presas como *Nereis* sp., Ostracoda e Insecta em maio ou Ostracoda e Insecta em junho, permitiram variações na composição e abundância relativa de presas nas amostras de fezes de Flamingo chileno.

Na análise dos excrementos fecais coletados nos locais de alimentação no ambiente lagunar do Flamingo chileno, também foram encontrados 291 restos de microplásticos, os quais pertencem à categoria de plásticos do usuário (restos não industriais de objetos de plástico) Gil-Delgado et al. (2017) de quatro tipos: fragmentos (50.1%), fibras (30.9%), flocos (7.2%), e miçangas (11%).

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https://www.editorialmanager.com/wilsonjo/default.aspx

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Feeding Ecology of the *Phoenicopterus chilensis* (PHOENICOPTERIFORMES: PHOENICOPTERIDAE) in a coastal wetland of Southern Brazil

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Abstract

This study described the diet of Chilean flamingo Phoenicopterus chilensis in a non-breeding area, the Lagoa do Peixe lagoon. The diet was evaluated through the analyses of undigested structures present in 91 droppings collected in feeding sites around the lagoon environment. It was possible to identify 268 prey items that belonged to six taxa. (Calanoida, *Laeonereis acuta*, *Alitta succinea*, *Nereis* sp. Diptera and Ostracoda). The most frequent prey in the feces samples of Chilean flamingo was Calanoida, *Laeonereis acuta*, *Alitta succinea*, and *Nereis* sp. Besides, through the analyses of samples of benthos and water, was characterized the potentials prey available for the Chilean flamingo in the lagoon. To the available prey that was confirmed as prey items in the feces samples of Chilean flamingo was observed high abundances among the spring, summer, and the beginning of the autumn. Despite the microscopical feces analysis was effective, gaps in the method as the underestimation of soft-body prey reduced the number of identified taxa in the feces samples. Therefore, the use of complementary methodologies such as stable isotope analysis and molecular techniques is recommended.

Key words: Diet, droppings, prey, non-breeding area, Lagoa do Peixe lagoon.

Resumo

Este estudo descreveu a dieta do Flamingo chileno *Phoenicopterus chilensis* em uma área contranupcial, o Parque nacional da Lagoa do Peixe. A dieta foi avaliada através de estruturas não digeridas presentes em 91 excrementos coletados nos locais de alimentação ao redor da lagoa. Foi possível identificar 268 presas que pertenciam a seis táxons (Calanoida, *Laeonereis acuta*, *Alitta succinea*, *Nereis* sp. Ostracoda e Diptera). As presas mais frequentes nas amostras de fezes do Flamingo chileno foram (Calanoida, *Laeonereis acuta*, *Alitta succinea* e *Nereis* sp.). Ademais, através da análise de amostras de sedimentos e água, foram caracterizadas as presas potenciais para o Flamingo chileno disponíveis na lagoa. Para as presas disponíveis que foram confirmadas nas amostras de fezes do Flamingo chileno, foram observadas altas abundancias entre a primavera, verão e o início do outono. Apesar de a análise microscópica das fezes ter sido eficaz, limitantes no método, como a subestimação das presas de corpos moles, reduziram o número de táxons identificados nas amostras de fezes. Portanto, recomenda-se o uso de metodologias complementares, como análise estável de isótopos e técnicas moleculares.

Palavras chave: Dieta, excrementos, presas, área contranupcial, Lagoa do Peixe.

Introduction

Flamingos (Phoenicopteriformes) are long-lived, gregarious wading birds easily recognized by their brightly colored plumage, long legs and neck, and uniquely shaped bill (Olson and Feduccia 1980) adapted for filtering small particles (Mascitti and Kravetz 2002). There are currently six extant, valid species of flamingos (Torres et al. 2014) found in the Americas, Africa, Asia, and Europe (Gill and Donsker 2020; Tobar et al. 2014). Flamingos inhabit shallow, freshwater and hypersaline lagoons, and lakes, sometimes with more than twice the salinity of seawater. (del Hoyo et al. 2019).

The Chilean Flamingo (*Phoenicopterus chilensis*) occurs in salt and freshwater lakes, estuaries, and marine coasts from Peru to Tierra del Fuego in Argentina, and from Chile to Uruguay, and southern Brazil (Polla et al. 2018). It breeds during summer in the Andes Mountains and migrates in winter to lower altitudes unaffected by the fall of temperatures in the central plains of Argentina, Bolivia, and Peru and south Brazil (Caziani et al. 2007).

Coordinated surveys in Argentina, Bolivia, Chile, and Peru in 2010 found 283,000 individuals and estimated the total population at 300,000 (Marconi et al. 2011). Despite being the most numerous and widespread flamingo species in South America (del Hoyo et al. 2019), the species has been listed as "Near Threatened" on the IUCN red list, because it is suspected that it will undergo a moderately rapid population decline over the next three generations owing to egg-harvesting, disturbance, and the degradation of its habitat (BirdLife International 2018).

The diet of the Chilean Flamingo was firstly studied by Allen (1956), and Jenkin (1957), who through a compilation of bibliographic data of stomach contents of individuals collected in Argentina and Chile, found that annelids, mollusks, gastropods, crustaceans, insects, and algae composed the main prey. Jenkin also performed a morphological description of the Chilean flamingo beak and lamellae, suggesting the importance of these structures in the feeding of this bird. Mascitti and Kravetz (2002) expand Jenkin's observations on the morphology of the Chilean flamingo beak, and provided evidence about the selection of different sizes of prey through the lamellae.

Others research addressed the Chilean flamingo food habits and ethology (Gallardo and Rodríguez 1992; Rocha 1994), the habitat selection for foraging (Mascitti and Castañera 2006), the availability and diversity of its diet (Tobar et al. 2014), the seasonal variation diet (Tobar et al. 2017), and the most recent, a study of diet and feeding selectivity of the Chilean flamingo (Polla et al. 2018). All these studies have been carried in or near the breeding areas in Argentina, Bolivia and Chile. No such studies has been carried out in the species' contranupcial area in Brazil.

Stomach contents and emetics have been widely used sources of dietary information in birds and vertebrates (Ralph et at. 1985; Rosenberg and Cooper 1990). However, although the upgrade of the emetic techniques has reducing the bird mortality (Poulin et al. 2002; Duraes and Marini 2003), this technique seems not be innocuous as some have suggested (Carlisle and Holberton 2006). Secondly sacrificing birds to analyses stomach contents is an undesirable option, when the species has some kind of threat or endangered (Ralph et at. 1985). Fecal analysis is one the most used method to collect samples for determining diet composition in birds (Moreby and Stoate 2010). It is a non-invasive technique and the samples can be collected from any bird alive by observing depositions in the field (Ralph et at. 1985; Moreby and Stoate 2010). Furthermore, according to Moreby and Stoate (2010), during the samples collection, this method probably places the least stress on the bird. Nevertheless, there are exists some limitations that can induce biased related to detectability of soft-bodied insects without hard parts in feces (Carlisle and Holberton 2006). Besides, the identification of prey items from fecal samples can consume time because of the many small fragments per sample (Moreby and Stoate 2010).

In Brazil, the Chilean flamingo is seen in large flocks in the Lagoa do Peixe National Park, specifically in a coastal lagoon with the same name; the Lagoa do Peixe lagoon (Sick 2001). According to the estimative of Belton (1984) and Resende and Leeuwenberg (1987), the population of the Chilean flamingo throughout the years fluctuates between 15 and over 350 individuals.

The Lagoa do Peixe lagoon has high primary productivity, ensuring a wide range of microorganisms, crustaceans, and fishes available to feed aquatic birds (Knak 1999). Thus, the study of the Chilean flamingo diet in Lagoa do Peixe provides a great opportunity to improve the knowledge of its diet and the availability of its food resources, and hopes to contribute to the conservation of this bird and its habitat in Brazil. This study aims to describe the diet of the Chilean flamingo in a non-breeding area and identify seasonal variations in the flamingo diet and its potential prey.

Methods

Study area

The Lagoa do Peixe National Park (31°29'S, 50°46'W) is a 34,440-ha federal protected area situated on coastal plain of Rio Grande do Sul, south Brazil (Carraro et al. 1974). It includes representative ecosystems from the region such as dunes, sandbanks, fresh waters lagoons, beaches, and salt marshes (Loebmann and Vieira 2005). The park has been recognized as a Ramsar Site in 1993 and is part of the Western Hemisphere Shorebird Reserve Network, besides being included within UNESCO's Mata Atlântica Biosphere Reserve (da Silveira & Poerschke 2010) (Figure 1).

The Lagoa do Peixe is a shallow lagoon (mean depth of 30 cm) and an average width of 1 km, with an extension of about 35 km (Arejano 2006, Sbruzzi 2015). The climate in the region is classified as a humid subtropical, without the presence of a dry season, having mean temperatures between 23° and 26° C in summer and 14° and 17°C in winter (Nimer 1979; Schossler et al. 2017).

Communication between the lagoon and the sea occurs during winter and spring months and remains until summer, when the North and Northeast winds transport and close the lagoon drainage area with sandy sediment (Sbruzzi 2015). One of the most important characteristics of Lagoa do Peixe lagoon is the seasonal variations in the water flow, which related to the direction and intensity of the winds responsible for the variability and mobility of the environment in short periods of time (Knak 1999).

Sampling methodology

Chilean flamingo Diet

Fieldwork were carried out between the months of October 2018 and September 2019. The diet of the Chilean flamingo was evaluated through the analysis of 91 fresh fecal droppings collected at the feeding sites in the lagoon environment. Droppings were collected by observing birds feeding near to the lagoon shoreline (Figure 2). Samples were collected using a plastic 10 ml pipette and a metallic spatula and in dry paper bags. In the laboratory, dropping were examined under a stereoscopic microscope 80X magnification. The organisms were identified at the lowest possible taxonomic level, based on the literature (Rozbaczylo 1980; Montú and Goeden 1986; Buckup and Bond-Buckup 1999; Thomé et al. 2004; Dominguez and Fernandez 2009).

Chilean flamingo ´s trophic resources availability

Benthos Potential Prey

The available food resources and the variation of their availability through time were investigated by the monthly sampling benthic macroinvertebrates at the feeding sites of the Chilean Flamingo in the Lagoa do Peixe. The feeding sites were in the intertidal zone of the lagoon, and were chosen based on observation of the bioturbation left by the Chilean flamingo during foraging. The bioturbation, or feeding ring, is produced by the flamingo's feet when stirring up the benthos as it swivels on its axis using its body as a pivot (Tobar et al. 2014). At the same time, the flamingo submerges its head in the water allowing its beak to filter the sediment suspension for prey items (Lee and Mayorga-Dussarrat 2016).

Four transections distant from each other by 250 meters were selected (Figure 3a). At each point, six sediment samples were taken from the first 9 cm in depth, with the help of a 10 cm diameter PVC corer; therefore, twenty-four monthly sediment samples were taken at the four collect points. The collected samples were directly introduced into labeled plastic bags, and then the samples were fixed in a 4% formaldehyde solution and preserved in 70% alcohol (INAG IP 2008). In the laboratory, the samples were washed with ordinary water using a 1 mm diameter mesh sieve (Fedrizzi 2008). Then, was performed a washed material triage, and later the organisms extracted from this material were preserved in 70% alcohol.

The invertebrates were identified to lowest taxonomic level possible with a stereoscopic microscope 80X magnification. Identification were based on the criteria available in the literature (Rozbaczylo 1980; Buckup and Bond-Buckup 1999; Thomé et al. 2004 and Dominguez and Fernandez 2009).

Zooplankton Potential Prey

A monthly plankton sample was taken at three points, each in the middle of the four sediment collection transect. (Figure 3b). Using a conical plankton net (net mouth area 0.3 m diameter by 1.0 m in length), with a mesh size of 50μm, 80 l. of water were filtered for each collection point. In the laboratory, the samples of zooplankton were concentrated in a known volume of 50 ml and from these; three sub-samples of 5 ml were taken, according to the Aoki recommendations (2010). Each of the sub-samples was analyzed using the method proposed by Villafañe and Reid (1995) in which the Sedgwick-Rafter camera was replaced by a microscope slide of 26 x 76 mm, and with a 50 µl single channel pipette a 0.05 ml portion was deposited on the slide.

The identification analysis was carried with a stereoscopic 80X and optical microscope 100X, and the organisms were identified at the lowest taxonomic level possible, according to criteria in literature (Montú and Goeden 1986; Buckup and Bond-Buckup). All organisms were preserved in 70% alcohol and 4% formalin.

Zooplankton abundance (org/m^3) was calculated by dividing the number of individuals present in the sample by the volume of filtered water (Lopes et al. 1998).

Statistical analysis

The relative frequency of occurrence (FN %), and the frequency of occurrence (FO) of the prey items in Chilean flamingo feces was calculated. The relative frequency of occurrence (FN %), represents the percentage of a given prey concerning the total number of prey consumed (N), and the Frequency of occurrence (FO) represents the percentage of individuals in which a certain prey is present in the diet (O).

To verify monthly variation in the frequencies of occurrences in prey items in the Chilean flamingo diet, Pearson's chi-squared test Q^2 was used, and if it was significant, Bonferroni simultaneous confidence intervals (BSCI) were performed.

To verify if there was difference in the abundance of macroinvertebrates available for Chilean flamingo through months, the Kruskal-Wallis non-parametric test was applied, because data do not fit normal distribution. If a statistically difference was found, then the data was further examined by using Dunn's multiple comparison test. To verify if there was a difference in the abundance of available macroinvertebrates that were the most frequent prey in the feces samples of the Chilean flamingo, an ANOVA analysis was performed. If a statistically difference was found, then the data was examined by using Tukey's honest significance test. All analyses were performed using the software BioEstat version 5.0 (Ayres et al. 2007).

Results

Dietary analysis

Through undigested structures present in 91 droppings, it was possible to identify 268 prey items in six taxa (Table 1). The most abundant prey from feces of the Chilean flamingo were Calanoida (N=86), *Laeonereis acuta* (N=66), and *Alitta succinea* (N=38). Regarding the frequency of occurrence, Calanoida (FO = 94.50) and the polychaete *L. acuta* (FO =72.52), *A. succinea* (FO = 41.75), and *Nereis* sp. (FO =32.96) were the most frequent in the flamingo feces (Table 1). Significant differences were recorded in the monthly frequency of occurrence of the

Chilean flamingo consumed preys (Figure 4) (X^2 = 391.931, df. = 50, P < 0.0001). According to the Bonferroni simultaneous confidence intervals, the prey items Calanoida and *L. acuta* were consumed above the expected level by chance when compared to the other prey items.

Potential prey availability

Benthos

In the benthic samplings at the feeding sites used by the Chilean flamingo in Lagoa do Peixe lagoon, 2316 individuals in ten taxa were identified (Table 2). The most abundant animals were the polychaetes *Laeonereis acuta* (N= 690), *Heteromastus similis* (N= 395), and *Nereis* sp. (N= 280) (Table 2). In the polychaete *L. acuta* high values of abundance in the environment were observed in October and November. To *H. similis*, peaks of abundances were observed in October and March, and to *A. succinea* was observed high abundances in October, November, and June. Diptera (N=75) and Ostracoda (N=59) were the less abundant potentials prey available in the Lagoa do Peixe Lagoon. The high values of abundance for Diptera were in December and April, meanwhile for Ostracoda were in November, December, and January (in fact were the only months with records for Ostracoda). Significant differences were recorded in the abundance of benthic macroinvertebrates during the study months (Kruskal-Wallis test H^4 = 47.6912 df. = 10, P < 0.0001). By evaluating the *p*-values of comparisons pair to pair from Dunn's test, was observed in *L. acuta* significant differences in its monthly abundances when compared with prey as *A. succinea*, Ostracoda, and Diptera, these differences specially in July and August, determined this statistical result. Also, significant differences were found in the monthly abundances of available prey that were frequent in the feces samples of Chilean Flamingo (*L. acuta*, *A. succinea*, and *Nereis* sp.) (F = 51.3254, df = 2, P = < 0.0001). The values for *A. succinea* in December, July, August, and September, determined this result.

Zooplankton

Six taxa of copepod were identified in the water samples; of these, four were identified at the species level: *Centropages furcatus*, *Centropages velificatus*, *Acartia tonsa*, and *Penilia avirostris* (Table 3). The most abundant copepod in the water samples was *Penilia avirostris* and the morphotypes Calanoida I and Calanoida II. In Penilia avirostris ta was observed higher values of abundance from December to March. For Calanoida I and Calanoida II, it was observed high abundance peaks in January and March. No significant differences were recorded in the abundance of zooplankton during the study (Kruskal-Wallis test $H^4 = 3.6565$, df. = 8, P = 0.8867). No significant differences were found in the monthly abundances of available prey Calanoida, that were the most frequent prey in the feces samples of Chilean Flamingo (F = 0.0004, df = 2, P = < 0.981).

The abundance of Chilean flamingos

During the 12 months of field work 486 individuals of Chilean flamingo were counted, of them 39 was a juvenile individuals. The abundance of Chilean flamingo in the study area was highly variable among months (Table 4). In August (141) and September (168) 2018, the abundance of Chilean flamingos was considerably higher than other months.

Discussion

The diet of the Chilean Flamingo in the Lagoa do Peixe lagoon was composed of Calanoida, three species of polychaetes, Ostracoda, and Diptera. The most frequent prey in the feces samples was Calanoida, *L. acuta*, *A. succinea*, and *Nereis* sp. Similar results regarding the prey composition and the frequency of occurrence of prey were found in other studies with Chilean flamingos (Hurlbert 1982; Gallardo and Rodríguez 1992; Tobar et al 2014; Tobar et al. 2017; Polla et al. 2018). Furthermore, this result is also similar to those found for Andean flamingo

(*Phoenicoparrus andinus*), (Rocha 1994), the Greater flamingo (*Phoenicopterus roseus*), and the Caribbean flamingo (*Phoenicopterus ruber*), (Brown and King 2005).

Tobar et al. (2017), through optical microscopic analyses in feces samples of Chilean flamingo, collected in in a non-breeding area in a coastal wetland in southern Chile, found that bird's diet was composed of 18 prey items, the foraminifers (FO %=29.3), polychaetes (FO %= 29.1), and copepods (FO %= 14.8) being the most frequent prey in the feces samples. On the other hand, Polla et al. (2018), by molecular (16S rRNA gene amplification) and microscopic examination of feces samples of the Chilean flamingo in a non-breeding area in the central region of Argentina, found that its diet was composed of 75 taxa, mostly by Cyanobacteria (49%), Copepoda, and Cladocera (30%), and algae (21%).

Gallardo and Rodríguez (1992), through the feces analysis of Chilean flamingo, Andean flamingo, and James flamingo, in Salar de Surire, a breeding area for Chilean flamingo, found that these birds feeds mainly on lagoons favorable to the development of microinvertebrates such as nematodes and copepods. Besides, Rocha (1994), observed insect and small crustaceans larvae in the stomach contents of Andean flamingo in Eduardo Avaroa National Reserve, the only place in South America where the three species are known to breed together (Maier and Kelly 1994).

Calanoida was the most frequent prey item in the feces samples of Chilean flamingo in Lagoa do Peixe lagoon. In addition, regarding to the prey available in the water samples, the taxa Calanoida was one of the most abundant prey. High peaks of abundance for morphotypes Calanoida I and Calanoida II was observed through the months, especially in December, January and March. Knak (1998), by the water samples analysis in the Lagoa do Peixe lagoon, found that variation in the abundance of zooplankton are related to high salinities values in water. According to Knak (1999), during the summer and autumn, the salinity in the lagoon is increased, especially in summer reaching hypersaline conditions due to the strong evaporation caused by the low depths that occur at this time. Consequently, the high frequencies of Calanoida in the feces samples of Chilean flamingo was expected.

However, the prey item Calanoida was at least one of six potential prey found in the water samples. Two explanations might explain the absence of the other available prey. First, according to Hurlbert (1982), the copepods use their swimming capabilities as escape behavior to avoid being predated by the Chilean flamingo, and probably, due to the greater mobility of prey as (e.g. small planktonic crustaceans), the Chilean and Caribbean flamingos walk rapidly and purposefully when it is feeding (Bildstein et al 1991; del Hoyo et al. 2019). Second, in spite that copepods have various morphological characters for their taxonomic identification (e.g. swimming legs, antennules, body segments, and telson), find these fragments mixed with other prey portions in a feces samples could be difficult (Moreby and Stoate 2010).

The consumption at least one species of polychaetes in Chilean flamingo was recorded by Tobar et al (2015). In the present study, it was found three species of polychaetes (*L. acuta*, *A. succinea*, and *Nereis* sp.), all of them with high frequencies of occurrence in the feces samples. Additionally, *L. acuta* and *Nereis* sp. were among the most abundant prey available in the samples of macroinvertebrates The Nereididae are species with cosmopolitan behavior, especially in tropical and temperate estuaries (Pardo and Dauer 2003), and when water temperatures increase, their abundances also do it (Pamplin et al. 2007; Weis et al. 2017). Therefore, the high abundances values for *L. acuta* in October and November and *Nereis* sp. in December, January and March were expected.

The polychaete *Heteromastus similis* was more abundant than *Nereis* sp. in benthic samples. However, it was not observed in Chilean flamingo feces. Two reasons may be suggested this absence. First, according, to Lee & Mayorga-Dussarrat (2016), soft-bodied organisms (e.g. *H.*

similis) and those with hard structures (e.g. *L. acuta*, *Nereis* sp.), are digested at different rates in the stomachs of vertebrates. Second, the method used for feces analysis have limitations as underestimation of soft-bodied fauna in the diet (Scholz et al. 1991; Lee & Mayorga-Dussarrat 2016), as explained above. Consequently, the presence of *H. similis* would not be detected.

Hurlbert (1982) and Rodriguez (2005), reports in the diet of Chilean flamingo insect larvae and amphipods as Artemia, and according to Brown and King (2005), the Greater flamingo and the Caribbean flamingo feed of a variety of items including Artemia and insects. Although the Chilean flamingo diet in Lagoa do Peixe lagoon was mainly composed of copepods and polychaetes, prey items as Diptera and Ostracoda were found in its feces samples. Concerning this prey in the macroinvertebrates samples, the abundance peaks of Diptera observed between summer and the beginning of autumn, are related to the oviposition increase activity in Diptera organisms (e.g. *Chironomus* sp.), when the water temperatures are over 22 ° C (Canteiro 2008). On the other hand, the Ostracoda peaks abundance were observed only in summer, where temperatures fluctuate between 23 ° and 26 ° C (Schossler et al. 2017) and where according to Montú and Goeden (1986) a several crustaceans species increase their reproduction rates.

For the six prey taxa identified in the feces samples of Chilean flamingo, were observed high peaks of abundances in its availability in the lagoon environment (benthos and water samples), those abundances peaks, despite were in different months all were recorded between spring, summer and the beginning of the autumn (in the South region of Brazil (Sartori 2003)). Variation in the availability of food resources in the Lagoa do Peixe Lagoon are related to one of the most remarkable characteristics of this lagoon, the variability of its environment in short periods (Knak 1999). These variations are associated with the precipitation regime (Schossler et al 2017), the accelerated modification of the landscape due to the speed and wind direction (Knak 1999), and the communication between the lagoon and the sea, that occurs during the winter and spring and remains to the end of the summer (Sbruzzi 2015).

In the Lagoa do Peixe lagoon, Belton (1984), reported the presence (in different years) of Chilean flamingo, he listed 239 individuals in the spring of 1972, 190 in the autumn, 15 individuals in the summer of 1974, and 40 in the winter of 1981. According to Resende and Leeuwenberg (1987), the Chilean flamingo occurs throughout the year in Lagoa do Peixe, with highest abundances in autumn and winter, and between spring and summer. The records of Resende and Leeuwenberg (1987) and Belton (1984), could indicate that despite the Chilean flamingo occurs during the year in the Lagoa do Peixe, and an important factor for these movements could be the food availability (Johnson 1998).

Lagoa do Peixe National Park is considered an extremely important wintering area for most of the birds on the migratory route between North America and Patagonia, and other resident birds (Resende and Lewemberg 1987). This area provide food and rest for birds to recover their energy spent on migration and to continue their routes (Zwarts 1990; Fedrizzi 2008). Fedrizzi (2008) reported that shorebirds from the Northern Hemisphere observed in high abundances in summer in the Lagoa do Peixe uses the lagoon as a feeding point during their wintering period, and found that in these areas exists a synchronized cycle linking recruitment periods of some potential prey and high abundances of shorebirds.

Based on the results , it is concluded that the diet of the Chilean flamingo diet in the Lagoa do Peixe Lagoon, a non-breeding area, was carnivorous, mainly composed of Calanoida, *Laeonereis acuta* and *Alitta succinea*, and with variations in the frequencies of prey over the months. Compared to other non-breeding, such as Caulín Bay in southern Chile and Pampa de las Lagunas in central Argentina, the diet of the Chilean flamingo in Lagoa do Peixe was similar regarding the prey composition, but with a lower number of prey taxa in the feces samples.

Only six prey taxa of sixteen present in the environment were observed in the feces samples of Chilean flamingo. These lower values in the feces samples are related to the feces analysis method used. The methodology has important limitations as the underestimation of soft-bodied prey (e.g. *H. similis*, *P. avirostris,* and Calanoida). Therefore, the use of complementary methodologies such as stable isotope analysis and molecular techniques is recommended.

The Lagoa do Peixe lagoon is the only non-breeding area where the Chilean flamingo is seen all year round in Brazil, and their high abundances in spring and summer seasons, confirm the importance of the lagoon in the life cycle for this bird. Consequently, it is expected that this study, also to providing new ecological data of the species, will contribute to the conservation of the Chilean flamingo and The Lagoa do Peixe lagoon.

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Table 1. Identified prey and residual portions found in Chilean flamingo feces samples, collected in the lagoon environment of Lagoa do Peixe National Park, between October 2018 and September 2019.

		Feces: 91	
Identified prey	**Residual portions**	**N**	**FO**
Family Nereididae *Laeonereis acuta*	Pair jaws	66	72.52
Alitta succinea	Pair jaws	38	41.75
Nereis sp.	Pair jaws	30	32.96
Order Calanoida			
Calanoida Undetermined	Fragments of body	86	94.50
Order Diptera			
Diptera Undetermined	Body fragments and segments of larvae	23	25.27
Class Ostracoda			
Ostracoda Undetermined	Fragments of, antennae claw and segments of cephalothorax	25	27.47
		268	
Other items			
Plastic debris	Fragments, fibres, beads and flakes	291	100
Vegetal	Remains of seeds and other vegetal items	31	31.9
TOTAL		590	

Contribution expressed in absolute numbers (N), and frequency of occurrence (FO).

Table 2. Benthic macroinvertebrates individuals collected in the lagoon environment of Lagoa do Peixe National Park between October 2018 and September 2019.

	OCT			NOV			DEC			JAN			MAR			APR			MAY			JUN			JUL			AGO			SET			
Taxa	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	TOTAL
Family Nereididae																																		
Laeonereis acuta	93	3.88	2.3	96	4.00	2.7	51	2.13	2.0	65	3.61	3.03	75	3.13	2.99	60	2.50	3.97	41	1.71	3.17	72	3.00	2.71	54	2.25	1.85	34	1.42	2.82	49	2.04	2.35	690
Alitta succinea	52	2.17	4.2	23	0.96	1.4	0	0.00	0.0	14	0.78	2.83	20	0.83	3.32	6	0.25	1.41	13	0.54	4.95	29	1.21	1.24	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	157
Family Capitellidae																																		
Heteromastus similis	67	2.79	3.6	41	1.71	1.8	31	1.29	3.5	43	2.39	2.16	62	2.58	3.12	46	1.92	1.99	31	1.29	1.45	3	0.13	0.71	4	0.17	1.00	17	0.71	1.14	50	2.08	3.19	395
Nereis sp.	18	0.75	1.4	34	1.42	1.5	64	2.67	2.3	43	2.39	2.73	46	1.92	2.36	6	0.25	0.00	7	0.29	0.00	2	0.08	0.00	2	0.08	0.00	0	0.00	0.00	58	2.42	2.62	280
Family Opheliidae																																		
Euzonus furciferus	23	0.96	2.2	6	0.25	1.0	47	1.96	2.7	32	1.78	5.51	23	0.96	1.52	13	0.54	3.51	3	0.13	0.00	0	0.00	0.00	3	0.13	0.00	1	0.04	0.00	0	0.00	0.00	151
Family Nephtyidae																																		
Nephtys fluviatilis	26	1.08	2.1	36	1.50	3.1	0	0.00	0.0	4	0.22	1.53	18	0.75	4.58	5	0.21	0.00	0	0.00	0.00	2	0.08	0.00	7	0.29	0.50	0	0.00	0.00	36	1.50	2.65	134
Family Solecurtidae																																		
Tagelus plebeius	8	0.33	0.8	38	1.58	2.4	9	0.38	2.1	21	1.17	2.17	0	0.00	0.00	0	0.00	0.00	4	0.17	0.00	8	0.33	0.00	12	0.50	3.00	16	0.67	2.16	55	2.29	3.75	171
Family Cochliopidae																																		
Heleobia australis	27	1.13	1.9	19	0.79	2.5	37	1.54	4.1	31	1.72	2.44	0	0.00	0.00	13	0.54	3.06	41	1.71	2.07	6	0.25	1.41	0	0.00	0.00	0	0.00	0.00	30	1.25	2.98	204
Order Ostracoda																																		
Ostracoda Undet.	0	0.00	0.0	15	0.63	6.4	26	1.08	0.0	18	1.00	1.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	59
Class Insecta																																		
Diptera Undet.	0	0.00	0.0	13	0.54	0.7	15	0.75	0.4	11	0.61	0.98	0	0.75	1.27	18	0.00	0.00	4	0.17	0.00	0	0.00	0.00	0	0.00	0.00	8	0.33	2.08	6	0.25	0.00	75
Undetermined	35	1.46	1.9	65	2.71	2.4	66	2.75	2.1	0	0.00	0.00	48	2.00	2.93	18	0.75	1.67	44	1.83	3.09	13	0.54	0.00	28	1.17	2.10	18	0.75	2.08	40	1.67	3.55	375

Contribution expressed in absolute numbers (N), mean (MEAN) and standard deviation (SD).

Table 3. Zooplankton in water samples collected in the lagoon environment of Lagoa do Peixe National Park between October 2018 and September 2019.

	OCT			NOV			DEC			JAN			MAR			APR			MAY			JUN			JUL			AUG			SEP			
Taxa	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	TOTAL
Family Centropagidae																																		
Centropages furcatus	12	3.9	1.5	12	4.1	1.3	14	4.8	0.4	16	5.2	0.9	22	7.2	1.2	13	4.3	3.8	20	6.5	1.3	0	0	0	0	0	0	5.84	1.95	1	15	5	1.3	129
Centropages velificatus	6.4	2.1	1.8	7	2.3	1	15	5.1	1.2	21	7	1.8	17	5.7	3.2	23	7.8	2.3	12	4	3.5	4.7	1.6	1.5	0	0	0	10.4	3.47	0.6	13	4.2	1.3	130
Family Acartiidae																																		
Acartia tonsa	13	4.3	2	13	4.2	0.9	22	7.4	1.1	15	5	2.3	17	5.6	4.8	14	4.5	2.2	16	5.4	1.5	10	3.3	2	4.8	1.6	1.6	9.84	3.28	1.1	9.8	3.3	1.3	144
Order Calanoida																																		
Calanoida I	9.2	3.1	1.3	8.8	2.9	0.8	18	6.1	2.2	35	12	6.3	26	8.6	4.8	16	5.2	1.4	20	6.6	1.3	0	0	0	0	0	0	8.72	2.91	1.9	14	4.8	1.4	156
Calanoida II	11	3.8	1.6	7.8	2.6	0.5	21	7.1	1.2	23	7.7	2.3	19	6.4	3.1	16	5.4	1.8	14	4.5	0.8	13	4.3	1.5	6.8	2.3	0.8	12.5	4.16	1.5	12	3.9	1	156
Family Sididae																																		
Penilia avirostris	12	4.1	1	16	5.3	0.6	33	11	3.6	37	12	6.6	38	13	4.5	13	4.3	1.9	13	4.3	1.7	2.2	0.7	1.2	1.52	0.5	0.9	3.52	1.17	1.1	16	5.4	1	185
Order Ctenopoda																																		
Cladocera I	8.2	2.7	1.2	11	3.8	0.8	16	5.4	0.6	12	4	2.1	20	6.6	2.9	14	4.8	1.9	11	3.5	1.1	9.8	3.3	1.1	11.7	3.9	1.7	10.7	3.57	1.7	11	3.8	1.8	136
Cladocera II	9.8	3.3	1.1	12	3.9	1.3	14	4.6	1.9	9.7	3.2	1.9	21	7	1.6	12	3.9	1.9	10	3.5	2.1	3.8	1.3	2.2	8.48	2.8	0.3	8.72	2.91	2.7	15	5	2	124
Undetermined	7.4	2.5	1.2	13	4.5	1.8	14	4.5	0.6	12	3.9	1	18	6.1	2.2	17	5.7	1.7	11	3.8	1.4	0	0	0	0	0	0	9.28	3.09	1	13	4.2	1.7	114

Contribution expressed in org/m^3 (N), Mean (MEAN) and standard deviation (SD).

Table 4. Abundance of Chilean flamingos in the lagoon environment of Lagoa do Peixe National Park between October 2018 and September 2019.

Date	# Ind	Juvenile	Adult
Oct/2018	12	3	9
Nov/2018	15	4	11
Dec/2018	39	2	37
Jan/2019	15	2	13
Mar/2019	17	0	17
Apr/2019	13	4	9
May/2019	20	2	18
Jun/2019	42	5	37
Jul/2019	0	0	0
Aug/2019	141	9	132
Sep/2019	168	4	164
Oct/2019	4	4	0
Total	**486**	**39**	**447**

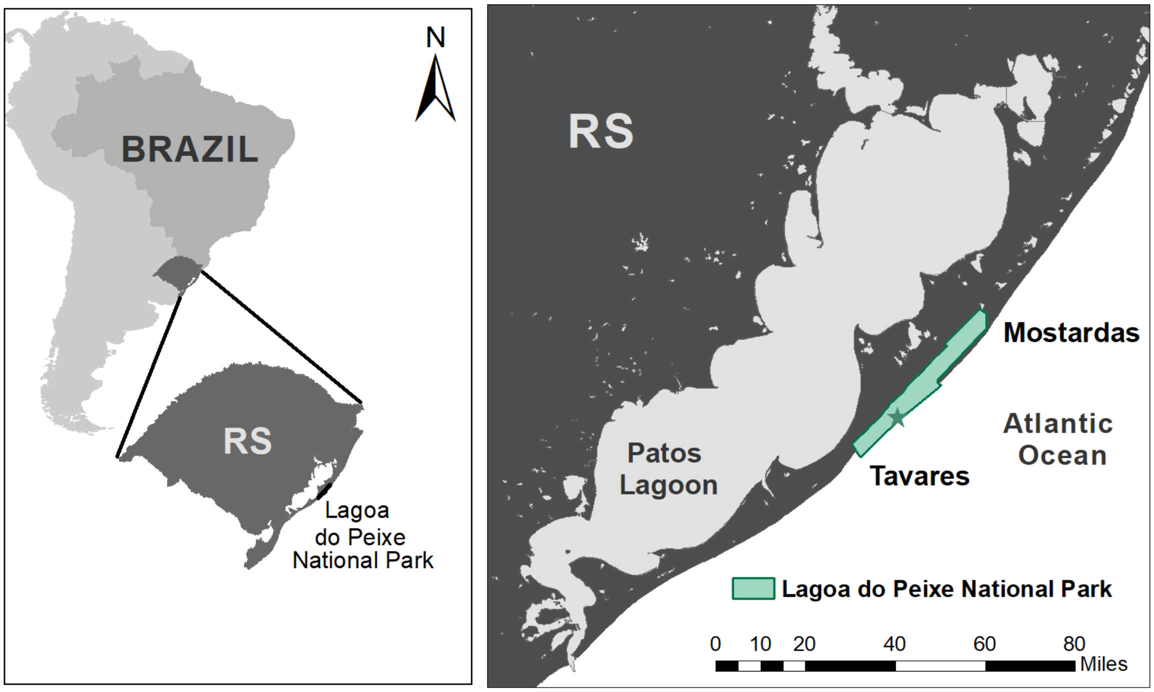

Figure 1. Study area Map: Map of South America showing the location of Lagoa do Peixe National Park(left), and a detail of the sampled lagoon marked with green star (right).

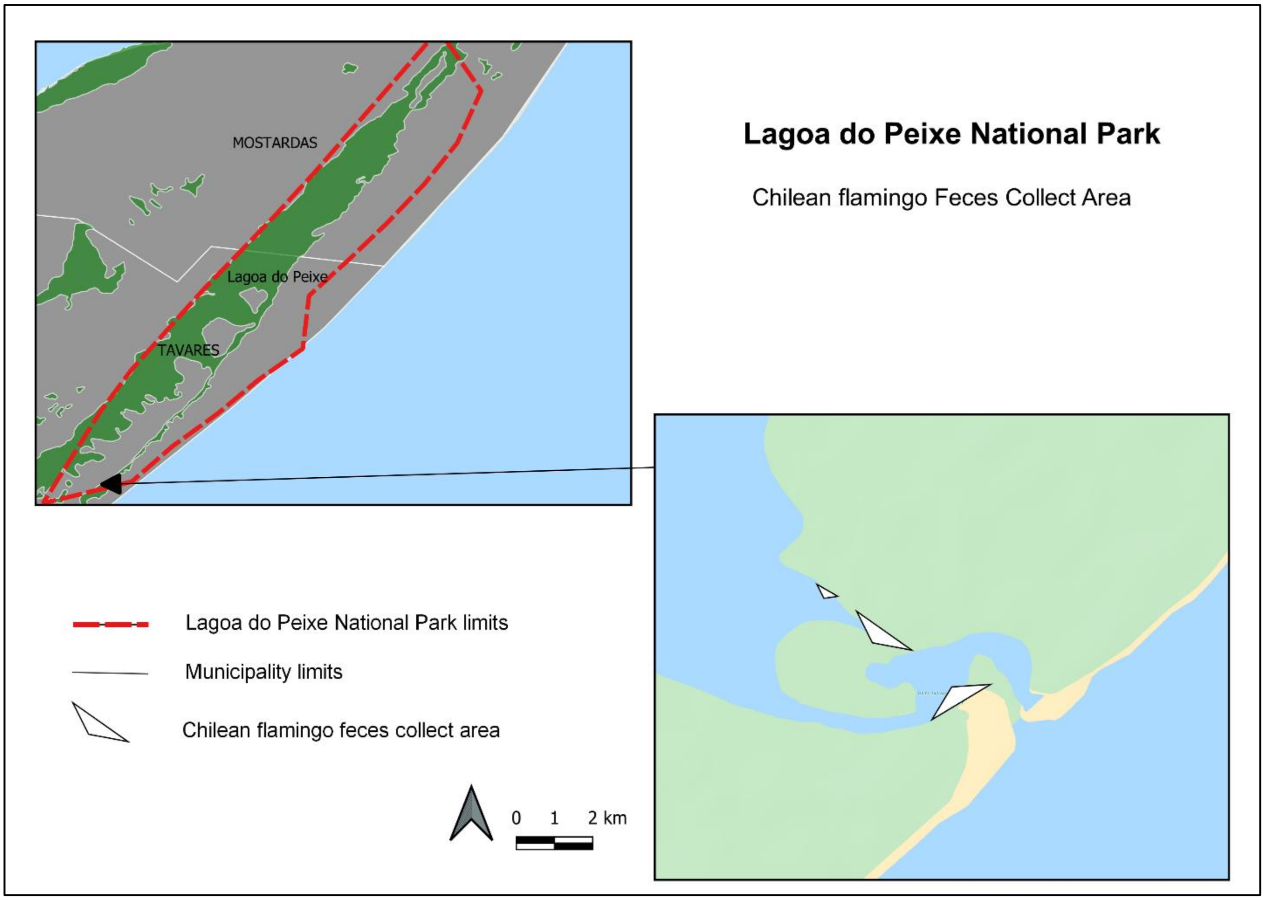

Figure 2. Chilean flamingo Feces Collect Area: Areas where the droppings was collected are highlighted in red.

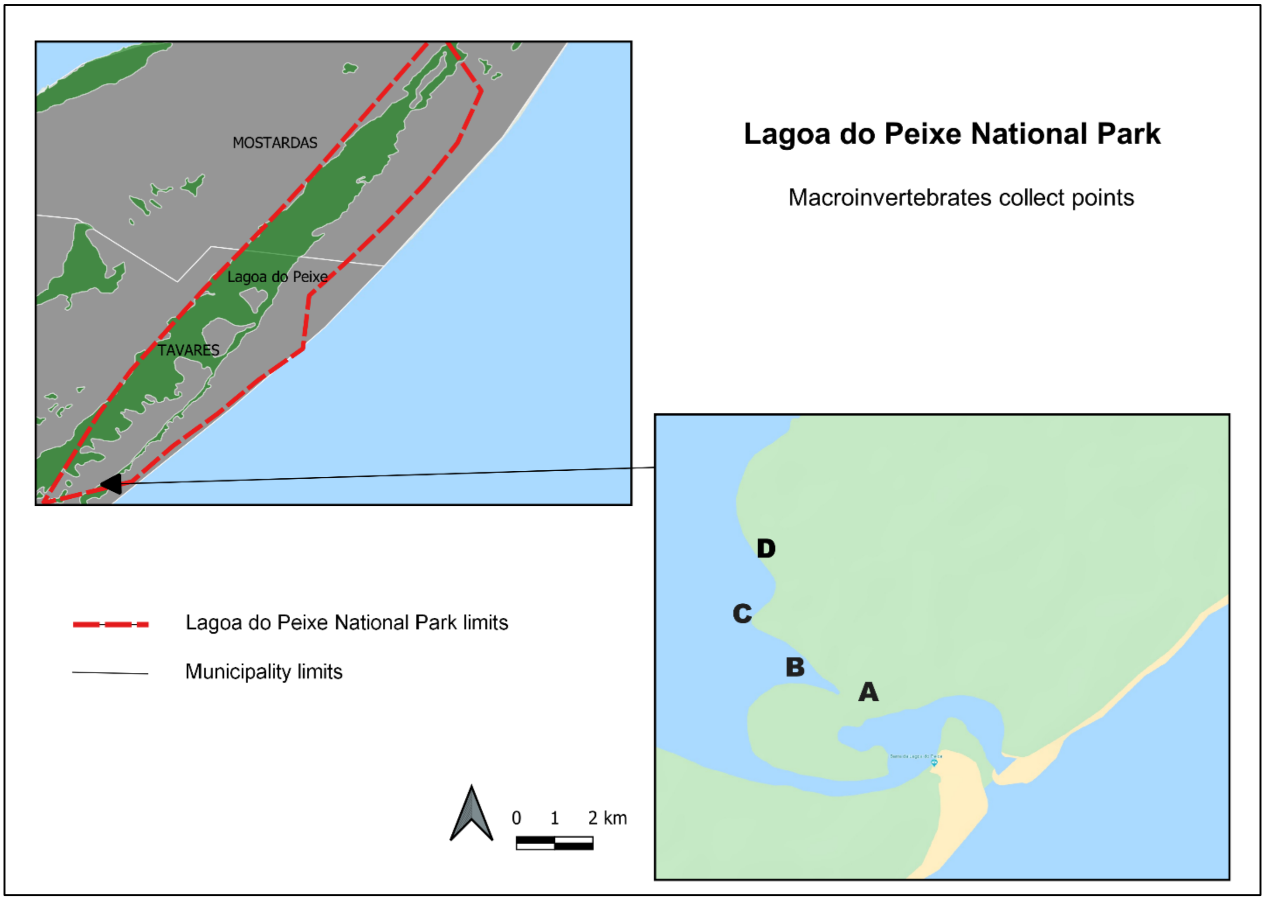

Figure 3a. Macroinvertebrates Collect Points.

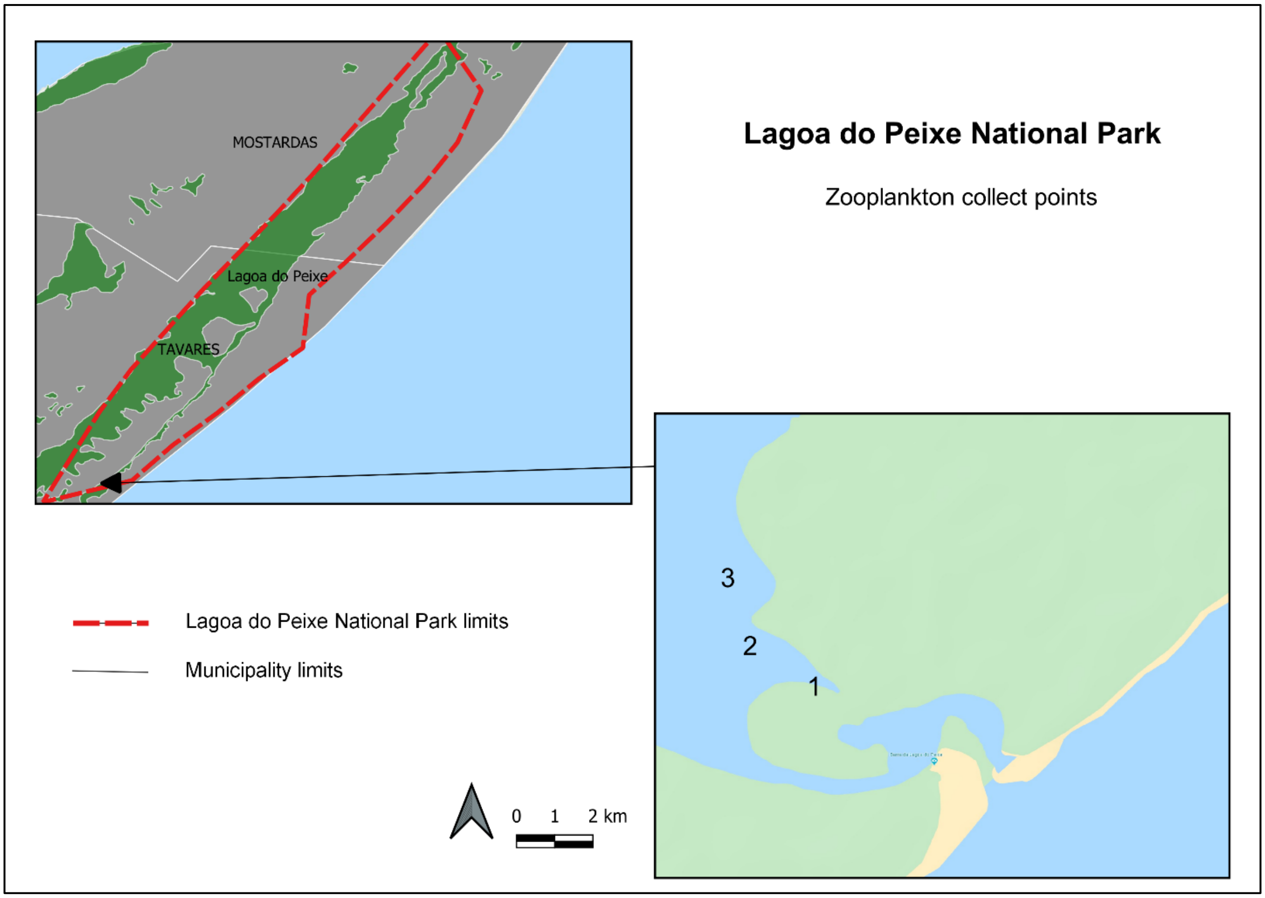

Figure 3b. Zooplankton Collect Points.

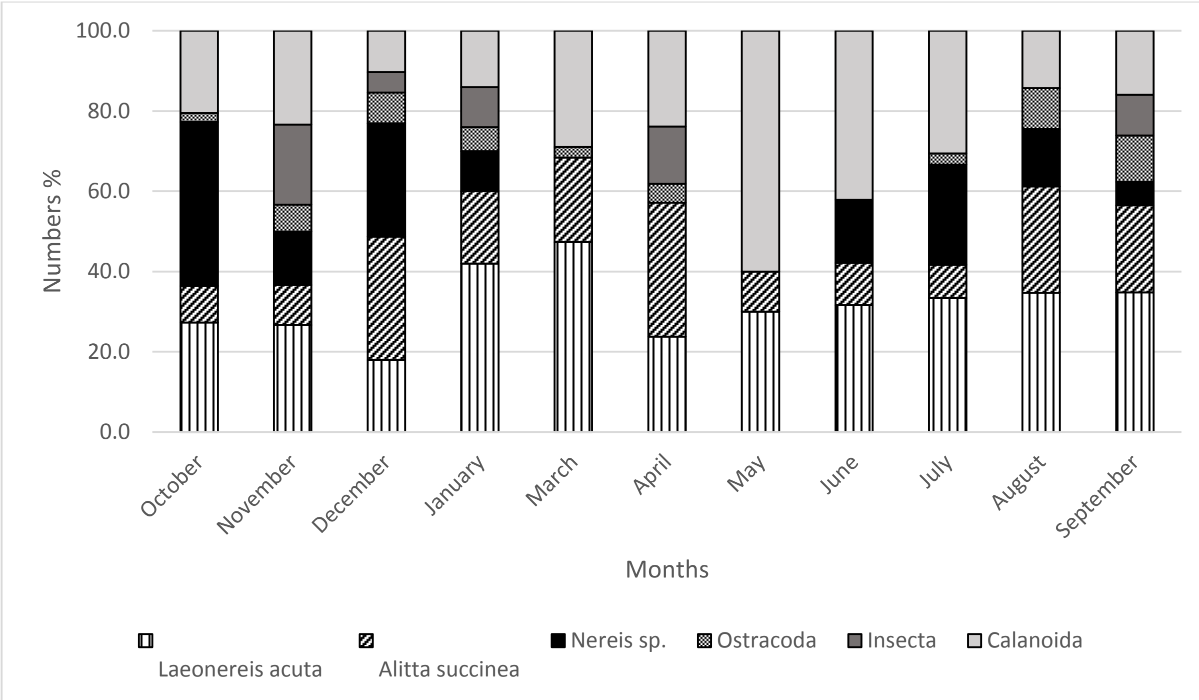

Figure 4. Frequency of occurrence of the prey found in Chilean flamingo feces samples collected in the lagoon environment of Lagoa do Peixe National Park between October 2018 and September 2019. Contribution expressed in relative frequency (FN %).

Conclusões Gerais

Com base nos resultados observados, conclui-se que a dieta da dieta do Flamingo chileno na Lagoa do Peixe, uma área não reprodutiva, foi carnívora, composta principalmente por Calanoida, Laeonereis acuta e Alitta succinea, e com variações nas frequências das presas ao longo dos meses de estudo. Comparado a outras áreas não reprodutivas como a Baía de Caulín, sul do Chile e Pampa de las Lagunas, no centro da Argentina, a dieta do Flamingo chileno em Lagoa do Peixe foi semelhante em relação à composição das presas, mas com menor número de táxons presa nas amostras das fezes.

Apenas seis dos 16 táxons presentes nas amostras de sedimentos e água foram observados nas amostras de fezes do Flamingo chileno. O número reduzido de táxons presa identificados nas fezes está relacionado ao método de análise utilizado. A metodologia de análise microscópica de fezes tem limitações importantes como a subestimação de presas de corpo mole (e.g. H. similis, P. avirostris e Calanoida). Portanto, recomenda-se seu uso conjunto de metodologias complementares, como análise de isótopos estáveis e técnicas moleculares de identificação.

Além das 268 porções residuais das presas nas fezes do Flamingo chileno, também foram encontrados 291 restos de microplásticos, compostos principalmente por fragmentos (50.1%) e fibras (30.9%). É importante mencionar que os restos de plásticos estiveram presentes em todas as 91 amostras de excrementos de Flamingo chileno coletados no ambiente lagunar da Lagoa do Peixe. Apesar da crescente literatura sobre contaminação por plásticos nos oceanos, ainda é limitada as informações disponíveis para corpos de água lênticos e ainda mais escassa a presença de plásticos na dieta do Flamingo chileno. Por conseguinte se faz necessário a implementação de metodologias como o as análises de conteúdo estomacal que permitam detectar, quantificar, classificar e rastrear os plásticos ingeridos pelas aves.

A lagoa do Peixe é a única área contranupcial em que o Flamingo chileno é visto o ano todo no Brasil, confirmando a importância da lagoa no ciclo de vida desta ave. Consequentemente, espera-se que este estudo, além de fornecer novos dados ecológicos da espécie, contribua para a conservação do Flamingo chileno e da lagoa da Lagoa do Peixe.

ANEXO 1. Normas de submissão (author guidelines) do periódico *The Wilson Journal of Ornithology*.

The Wilson Journal of Ornithology

Guidelines for Authors (Revised 1 July 2019)

Submission

For initial submission, upload the manuscript to PeerTrack in Editorial Manager (http://www.editorialmanager.com/wilsonjo) or via the direct link provided on the Wilson Journal of Ornithology (WJO) web page. You will be required to create a PeerTrack account. Assemble the main manuscript document, tables, and appendices in a single file. In addition, upload the cover letter, figures, and supplemental materials (if included) as separate files.

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Multi-authored submissions. All authors should have contributed in a significant manner to designing and performing the research, writing, reading, and approving the manuscript prior to submission.

International submissions. Authors whose native language is not English should ensure that colleagues fluent in English or an ESL copyeditor have critically reviewed their manuscript before submission.

General instructions

Carefully read and follow these instructions before submitting your manuscript. Papers that do not conform to these guidelines may be returned. The accepted style guide is the Council of Science Editors Scientific Style and Format, 8th edition.

Prepare manuscripts in Microsoft Word with standard margins (1 inch or 2.5 cm), with no additional formatting. Double-space all text, including literature cited, figure captions, and table titles. Use Times New Roman, 12-pt font size. Include page and line numbers on all manuscript pages. The published length of the manuscript in the journal is estimated as the total number of manuscript pages, including figures and tables, divided by 2.75.

Write in active voice whenever possible. Use US English spelling and punctuation. Use italics instead of underlining (e.g., scientific names, lower-level headings, and standard statistical symbols). Use Roman typeface (not bold) throughout the manuscript; an exception is in a table where boldfacing may be used to highlight certain values or elements.

Leave only a single space between sentences.

Use a serial comma (also called Oxford comma) in the next to last item in a list (e.g., red, white, and blue).

Common and scientific bird names. Use the AOS Check-list of North American Birds (http://www.checklist.aou.org) for common and scientific names of bird species that occur in North America, including Mexico, the Caribbean, and Central America south through Panama. For South American species, use names from the most current version of the AOS Species Lists of Birds for South American Countries and Territories (http://www.museum.lsu.edu/~Remsen/SACCCountryLists.htm). For species outside the Americas, use the preferred nomenclature of the corresponding country and the Cornell University Laboratory of Ornithology's Clements Checklist of Birds of the World (http://www.birds.cornell.edu/clementschecklist/). Use subspecific identification and list taxonomic authorities only when relevant. Give the scientific name in the title, at first mention of a species in the abstract, and at first mention in the body of the paper, with common name only thereafter. Capitalize common names of birds as specified in the checklist, except when referred to as a group (e.g., Hermit Thrush, Wood and Swainson's thrushes, thrushes). The common names of other organisms are lower case except for proper names (e.g., ponderosa pine, Douglas- fir, Couch's spadefoot).

Figures and tables. Figures and tables should supplement, not duplicate, material in the text, and except in rare instances, references to figures and tables should be parenthetical to the text, not used as the subject (i.e., cited only in parentheses to support text). Cite each figure and table in the text in numerical order. Use "Fig." rather than Figure to cite figures in the text (e.g., Fig. 5 or Fig. 3–7). To cite figures or tables from another work, write figure or table in lower case (e.g., figure 2 in Smith 1980; table 5 in Jones 1987).

Abbreviations. Use s (second), min (minute), h (hour), yr (year); report temperature as °C (e.g., 100 °C). In text, do not abbreviate day of the week or month; months should be abbreviated as 3 letters (Jan, Feb, etc.) in parentheses, figures, and tables. Define and write out acronyms and abbreviations the first time they appear in text; abbreviate thereafter: "Second-year (SY) birds. We found SY birds in large numbers."

Numbers. Use numerals (e.g., 2, 6, 9, 18, 59) rather than words for cardinal numbers indicating amount or quantity, including numbers <10, unless the number is the first word of a sentence or is used in a nonquanitative sense ("this one is preferred" or "one reason for the change"). Because digits "1" and "0" are easily confused with letters "l" and "O," spell out unless connected to a unit of measure (1 yr; 0 mm), used as an assigned value (a mean value of 0; x = 0), or are part of a series of other numbers in the same sentence (0, 1, 8, 12, and 27 nest sites).

Use numerals to express all measurements and mathematical relationships, such as ratios and multiplication factors (2:1; 10× magnification; 3-fold, 8 years).

Use numerals for ordinal numbers 10 and above (e.g., 11th, 15th), but spell out single-digit ordinals (e.g., first, second) unless used in a series (we tested the 1st, 9th, and 15th replicates).

Spell out and hyphenate fractions (two-thirds). Decimal or percent form is preferred when possible.

Units of measure. Present all measurements in International System of Units (SI). Use a forward slash or the word per between units (e.g., 34 pairs/ha, 9% per year). Units of measurement include s, min, h, d, week, month, and yr. Use a comma every 3 digits to separate numbers >999 (1,000; 200,000). Do not present "naked" decimals (0.01 not .01); use the symbol for percent when presented with a value (50% not 50 percent); Round percentages to the nearest whole number unless there is a compelling reason not to do so. Identical units for a series of values can follow the final value in the list (3, 10, 55, and 60 cm).

Do not hyphenate values with units of measure, even if used as an adjective (5 g bird).

Use continental dating (e.g., 29 May 1992), the 24 h clock without a colon (e.g., 0800 h, 2315 h), and local standard time. Specify time as Standard Time (e.g., EST for Eastern Standard Time) at first reference to time of day. Present latitude and longitude with no spaces between elements.

Use single and double prime symbols rather than quotation marks (e.g., 28°07′52″N, 114°31′29″W).

Statistical Abbreviations. Italicize the following abbreviations: F, G, H, k, n, P, R, r2, t-test, U-test, w, Z, z. Use Roman type for the following abbreviations: AIC, AICc, ANOVA, CI, CV, df, K, SD, SE, $\chi2$. Carefully note that subscript or superscript typeface may differ from that of the abbreviation (e.g., Zmax, r2). Use lowercase n for sample size.

Reporting P values. Use uppercase P. If $P > 0.10$ then report to 2 decimal places (e.g., $P = 0.27$); if $0.001 \leq P \leq 0.100$, then report to 3 decimal places (e.g., $P = 0.057$); if $P < 0.001$, report as $P < 0.001$. Do not report P as $P < 0.05$ or $P > 0.05$ unless referring to a group of tests (e.g., all $P < 0.05$).

Genetics. All gene or amino acid sequences must be deposited in GenBank or an equivalent repository and the accession number(s) reported in the Methods.

Use the term “sex” rather than “gender” to refer to the male or female division of a species.

Manuscript preparation

Assemble manuscript for a Major Article in the following sequence: title page, abstract (one in English and one in a second language—see details under Abstract section that follows), text (includes introduction [not labeled], Methods, Results, and Discussion), acknowledgments (no e after g), literature cited, figure captions, figures, appendices (optional), and tables. Figures and supplemental materials are uploaded as separate files in PeerTrack; tables and appendices are included in the main manuscript file. Short Communications can be subdivided into sections (optional), including methods (only if needed), results, and discussion, but all must include an abstract. Include page and line numbers on all manuscript pages.

Title page (see examples that follow later). RRH: Author names • shortened title, max 50 characters, capitalize first word and proper nouns only) at top of page. Use initials and surname for single author; both surnames connected by “and” for co-authors; and surname et al. for multiauthors. The running head for Short Communications is RRH: Short Communications [no author names].

1 author: McSmith • Age effects on birds

2 authors: McSmith and Smith • Kites and eagles

≥3 authors: McSmith et al. • Sage-grouse Short Communication

Follow with full title in sentence case (capitalize only first word and proper nouns) for all papers, then follow by full names of all authors in regular type, standard capitalization.

David S. McSmith1 and Antony A. Jones2

David S. McSmith,1 Antony A. Jones,2* and Paul F. De Black2

Author affiliations should be footnoted with numbers and presented in the following sequence: the affiliation of each author (from first to last) at the time of the study, the current affiliation (if different from above) of each author (first to last), any special essential information (e.g., deceased), and the corresponding author and email address (*). Use two-letter postal codes (e.g., CO, SK) for US states and Canadian provinces. Spell out countries except USA and UK. Mailing addresses are not included. No periods after addresses.

1 US Environmental Protection Agency, Office of Research and Global Development, National Health and Environment Effects Research Laboratory, Atlantic Ecology Division, Newton, RI, USA

2 Environmental Resource Sciences, University of Nevada, Reno, NV, USA, and Department of Biological Sciences, Simon Fraser University, Burnaby, BC, Canada

*Corresponding author: pbwood@wvu.edu

Include both common and scientific names of the species studied in the title, e.g., American Robin (Turdus migratorius).

Abstract. Begin immediately following title page information (no page break). Heading should be left-flush, 12-pt bold type, regular Times New Roman font, followed by an em dash. Text begins immediately following the em dash. Do not include references, and limit abbreviations. Limit Abstract text in Major Articles to 300 words and Short Communications to 250 words.

All abstracts (plus title and key words) are published in English and one other language, including Spanish, Portuguese, French, or the author's native language. Because common names are not internationally standardized, use only scientific names of birds in foreign language abstracts. If you or your co-authors cannot provide a second language abstract, please indicate your choice of Spanish, Portuguese, or French (default is Spanish if no preference is given) and we will provide a translation. Translations into all other languages will be posted online.

ABSTRACT—Text

RESUMEN (Spanish)—Text RÉSUMÉ (French)—Text RESUMO (Portuguese)—Text

Key words. Following the Abstract, include 5 to 7 key words (lowercase except for proper nouns, separated by commas) in alphabetical order that summarize the results of the study. Include period after last key word. Do not repeat words used in the title.

Text. Omit heading for introduction. All paragraphs indented 0.5-inch, no lines or formatted spacing between paragraphs.

Heading levels. Up to 3 levels of headings may be used, all presented in sentence capitalization (capitalize first word and proper nouns only). First level: centered, 14-pt bold; text begins on next line, no indent (includes Methods, Results, Discussion, Acknowledgments, and Literature cited; no heading for Introduction). Second level: left-flush, 12-pt bold; text begins on next line, no indent. Third level (if needed): left-flush, 12-pt italics, not bold. Keep headings to a minimum.

Major Articles typically contain all first-level headings and often second and third. Short Communications may or may not use all major headings, depending on the topic and length of paper. Typical headings under Methods may include "Study area" and "Statistical analyses."

Acknowledgments. For individuals, use first and middle initials followed by last name; do not list professional titles and institutions for individuals. Accepted manuscripts may acknowledge peer reviewers (by name if known). Appropriate sources of funding, collection permit numbers, and other relevant information should be noted.

Literature cited. Each reference cited in text must be listed in the Literature Cited section and vice versa. Verify all entries against original sources, especially journal titles, volume and page numbers, DOI numbers, accents, diacritical marks, and spelling in languages other than English. Follow non-English titles with English translation in square brackets, and end reference with language of reference.

See detailed referencing guidelines in later section.

Figures, tables, appendices, and supplemental materials. Figures and tables should supplement, not duplicate, material in the text or appendices, and except in rare instances, in-text references to figures and tables should be parenthetical to the text (i.e., cited only in parentheses to support text). Use a consistent font and style throughout (e.g., 12-pt font, Times New Roman is preferred). Do not use boldface font for figure keys and axis labels. Capitalize first word of figure keys and axis labels; all other words are lower case except proper nouns. Handwritten symbols are not acceptable.

Figures. Type figure captions in paragraph form. Do not include symbols (lines, dots, triangles, etc.) in figure captions; either label them in a figure key or refer to them by name in the caption (e.g., open circles, dotted line). All subpanel letters should be lowercase (e.g., a, b) and cited with lowercase letters (e.g., Fig. 1a, Fig 2c–d). Upload figures into PeerTrack in separate hi-res (min 300 dpi) figure files.

Routine illustrations are black-and-white photographs, drawings, or graphs. Consult the Editor about color images for the frontispiece or in special cases. Copies of figures and plates must be high resolution (final figures must be at least 300 dpi). Drawings should be on good-quality paper and allow about 20% reduction. Do not submit originals larger than 8.5 × 11 inches, unless it is impractical to do otherwise. Illustrations should be prepared for 1- or 2-column width, keeping in mind dimensions of a page in WJO. When possible, try to group closely related illustrations as panels in a single figure. Figures should be submitted in JPG, TIFF, or GIF format.

Tables and appendices. Appendices and then tables follow the figure captions. Each appendix and table must have a title that is intelligible without recourse to the text. Kroodsma (2000; Auk 117:1081–1083) provides suggestions to improve table titles and figure captions. Tables and appendices should supplement, not duplicate, material in the text or figures, and except in rare instances, in-text references to tables and appendices should be parenthetical to the text (i.e., cited only in parentheses to support text). Indicate table footnotes by lowercase superscript letters, not numbers, which can be confused with exponents in tables. Note that appendices are copyedited for language and WJO style and are included in the printed journal, but supplemental information is not. Numbered tables and figures in the appendices should be denoted by a preceding letter A (e.g., Appendix Fig. A1.

Develop tables and appendices using a table formatting tool, not a tab-delimited format.

Do not use vertical lines in tables/appendices. Include horizontal lines above and below the box head, and at end of table/appendix. Use the same font type and size as in text.

Supplemental materials. Online publishing allows inclusion of information that may not fit into a printed paper with page limits or may be deemed redundant (tables of data included in a figure)

or otherwise inappropriate for the print version (extensive photographic evidence, videos, metadata, other potentially useful information not essential to the paper). These files are not included in the page/word counts of the manuscript and will be presented online as submitted by the authors (not copy edited for content, language, or WJO style). Authors should upload this information as a separate file entitled “Supplement” in PeerTrack. Supplemental figure and table numbers should be preceded by the letter S to indicate supplemental (Supplemental Table S1, Supplemental Fig. S4).

Examples

Materials suitable for inclusion in a supplement include but are not limited to:

- Methodological details useful for repeating the work but not essential to the conclusions drawn from the data.
- Maps or related location information helpful to understanding where the work was conducted but not essential to comprehending how the work was performed or understanding the results.

- Large data tables used for analyses but summarized as condensed tables, figures, or as a narrative explanation in the manuscript. Inclusion of actual data and code are encouraged to create a potentially valuable record that can be maintained for future access.

- Tables of statistical analyses summarized in the paper but that need not be viewed to understand data interpretations (e.g., lengthy tables of correlation coefficients or significance levels where differences are apparent from figures or the narrative is conclusive).

- Photographic evidence, videos, figures, or other graphics beyond those necessary as examples to explain the work in the main body of the paper.

- Additional references of interest not essential to integrate the work into current nowledge.

Mathematical equations

Present all equations in an editable format, not inserted as an image.

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If you have questions, contact the Editor at editor.wjo@gmail.com Effective 1 July 2019.

Example of a single-author title page

RRH: R. H. Yahner • Bird communities in a managed landscape

Responses of bird communities to early successional habitat in a managed landscape

Richard H. Yahner1

1 School of Forest Resources, Pennsylvania State University, University Park, PA, USA; email: rhy@psu.edu

Example of a 2-author title page

RRH: Ryder and Rimmer • Yellow Warbler molt

Latitudinal variation in the definitive prebasic molt of Yellow Warblers (Setophaga petechia)

Thomas B. Ryder1,2 and Christopher C. Rimmer1*

1 Vermont Institute of Natural Science, Woodstock, VT, USA

2 Current address: Department of Biology, University of Missouri-St. Louis, St. Louis, MO, USA

* Corresponding author: crimmer@vinsweb.org

Example of a multiple-author title page

RRH: Jones et al. • Sparrow hybrid

A probable Grasshopper Sparrow (Ammodramus savannarum) × Savannah Sparrow (Passerculus sandwichensis) hybrid singing a Song Sparrow (Melospiza melodia) song

Andrea L. Jones,1,4* W. Gregory Shriver,2 Natalie L. Bulgin,2 Ronald Lockwood,3 and Peter D. Vickery1,4,5

1 Massachusetts Audubon Society, Lincoln, MA, USA

2 Department of Biology, McMaster University, ON, Canada

3 [for author with no current affiliation] E-mail: e-mail address

4 Department of Natural Resources Conservation, University of Massachusetts, Amherst, MA 01003, USA

5 Current address: Center for Ecological Research, Richmond, ME, USA

* Corresponding author: ajones@massaudubon.org

Example of a Short Communication

RRH: Short Communication

Genetic mating system of Australasian Gannets (Morus serrator)

Mark E. Hauber,1,2* Claire Daniel,1 Brent M. Stephenson,3 Craig D. Millar,1 and Stefanie M.H. Ismar1,4

1 School of Biological Sciences, University of Auckland, Auckland, New Zealand 2 Department of Animal Biology, School of Integrative Biology, University of Illinois, Urbana- Champaign, IL, USA

3 Eco-Vista Wildlife Photography, Havelock North, New Zealand

4 Experimental Ecology, GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany

*Corresponding author: markehauber@gmail.com

Literature cited

In-text citations

One author: Able (1989) or (Able 1989).

Two authors: Able and Baker (1989) or (Able and Baker 1989). Three or more authors: Able et al. (1989) or (Able et al. 1989).

Within parentheses, order multiple citations by date. Separate by commas unless list includes multiple years for same citation name: (Harris 1989, Able 1992, Charley 1996), (Charley 1980; Able 1983, 1990; Able and Baker 1984), (Lusk et al. 1988a, 1988b, 2005; Able 2000a, 2000b; Smith 2003, Jones 2011).

Quotations. When citing a direct quote, insert the page number of the quote after the year: (Smith 1983: p. 77).

Unpublished references. Unpublished citation information should be used sparingly. Must include name, employer or title, and date (if relevant), followed by type of communication, such as pers. obs., pers. comm., or unpubl. data. Unpublished citations are not listed in Literature Cited.

(A.B. Beatty, US Forest Service, 2006, pers. comm.) (C.D. Smith, State University, 2013, unpubl. data) (A.L. Baker, USGS, 2015, pers. observ.)

Do not use et al. (A.L. Baker et al., unpubl. data); cite as (A.L. Baker, unpubl. data).

If unpublished citation is by submitting authors, use initials only and omit agency/title: (ABB, 2006, pers. comm.)

(CDS, 2013, unpubl. data) (ALB, 2015, pers. observ.)

Accepted for publication but not yet published. If a manuscript has been accepted for publication but not yet published (formerly referred to as "in press"), follow author name with "forthcoming," year, and month (if known) of expected publication:

Year and month unknown: (Casey GD forthcoming) Year known: (Casey GD forthcoming 2017)

Year and month known: (Casey GD forthcoming 2017 Aug)

Reference list guidelines

General

References immediately follow Acknowledgments. Regular type (no bold, no underlines, no italics except scientific names), double space, hanging indents of 0.5 in (paragraph indentation option under Word format menu). Do not use spacing or tabs to create a hanging indent.

Journal titles and place names should be written out in full and not abbreviated. Do not use abbreviations for editor, number, technical coordinator, or version. Cite papers from Current Ornithology, Studies in Avian Biology, and International Ornithological Congresses as journal articles.

Published literature is listed alphabetically by first author or first word of official agency name, not agency acronym. Anonymous is not used.

First author surname is followed by initials (no comma) and no periods after initials. Subsequent author names are separated by commas, with no “and” between the final 2 authors.

Johnson DH, Krapu GL, Reinecke KJ, Jorde DG. 1985. An evaluation of condition indices for birds. Journal of Wildlife Management. 49:569–575.

References by a single author precede multi-authored works by the same first author, regardless of date, followed by multi-authored works alphabetically ordered by second author, then by date, regardless of number of authors. If a cited author has 2 or more works in same year, designate with consecutive lowercase letters (e.g., l99la, 199lb).

Smith AB. 1988.

Smith AB. 1996.

Smith AB, Adams CD, Williams GH. 2003. Smith AB, Adams CD, Jones EF. 2010.

Smith AB, Jones GH. 1999.

Smith AB, Williams LR, Jones GH. 2006a. Clutch size… Smith AB, Williams LR, Adams CD. 2006b. Nesting sites…

Cite in text as (Smith et al. 2006a, 2006b)

Surname prefixes such as de, la, van, van de, and von, are part of the surname and are alphabetized as such. Use lowercase if that is how the author spells the name; standardize throughout text and references.

Crumpton WG, Isenhart TM, Mitchell PD. 1992. de Hoyos C, Comin FA. 1999.

Edmondson WT. 1972. von Brink VR. 2002.

Surname titles follow initials, with no punctuation between.

Samuels B Jr, Rogers T III.

List all author names for first 5 authors, followed by et al. if authors number >5. For 6 authors, include the sixth rather than omit only one.

Alphabetize agency names by first word of agency name, not by acronym used in text citation. [APHA] American Public Health Association (alphabetize as American)

[OECD] Organisation for Economic and Co-operative Development (alphabetize as Organisation)

[USEPA] United States Environmental Protection Agency (alphabetize as United)

Separate volume from page range with a colon, no space, and present page numbers with an en dash, with no spaces: 5:32–39.

Examples

Birds of North America references (according to Cornell Lab of Ornithology website)

Whole resource

Rodewald P, editor. 2015. Birds of North America. Ithaca (NY): Cornell Laboratory of Ornithology. https://birdsna.org

Individual species account

Shane TG. 2000. Lark Bunting (Calamospiza melanocorys). In: Poole A, editor. Birds of North America. Ithaca (NY): Cornell Laboratory of Ornithology. https://birdsna.org/Species-Account/bna/species/larbun/

Books

Page range for book chapters or parts is required at end of reference (e.g., p. 32–48); total page number at end of full volume book citations is optional (e.g., 305 p.). Use country (only UK or USA are abbreviated) or 2-letter postal abbreviations for state or province in parentheses for publisher addresses, followed by publisher name.

Single volume

Bennett PM, Owens IPF. 2002. Evolutionary ecology of birds: Life histories, mating systems, and extinction. New York (NY): Oxford University Press.

Multiple volumes or editions

Zar JH. 1996. Biostatistical analysis. 3rd edition. Upper Saddle River (NJ): Prentice Hall.

Book chapter

Kear J. 1970. The adaptive radiation of parental care in waterfowl. In: Crook JH, editor. Social behavior in birds and mammals. London (UK): Academic Press; p. 357– 392.

Snow DW. 2001. Family Momotidae (motmots). In: del Hoyo J, Elliott A, Sargatal J, editors. Handbook of the birds of the world. Volume 6. Mousebirds to hornbills. Barcelona (Spain): Lynx Edicions; p. 264–285.

Journal article

List volume, issue number only if relevant (i.e., if each issue begins with page 1), and page range of article.

No space between colon and page number range (33:12–20). Spell out all journal names in full, followed by period.

General style: Author(s). Year. Journal title. Journal name. vol:pp–pp.

MacLean GL. 1976. Arid-zone ornithology in Africa and South America. Proceedings of the International Ornithological Congress. 16:468–480.

Payne RB, Payne LL. 1998. Brood parasitism by cowbirds: risks and the effects on reproductive success and survival in Indigo Buntings. Behavioral Ecology. 9:64– 73.

Remsen JV Jr, Robinson SK. 1990. A classification scheme for foraging behavior of birds in terrestrial habitats. Studies in Avian Biology. 13:144–160.

Thesis, dissertation

Davis SK. 1994. Cowbird parasitism, predation, and host selection in fragmented grassland of southwestern Manitoba [master's thesis]. Winnipeg (Canada): University of Manitoba.

Freeman S. 1991. Molecular systematics and morphological evolution in the blackbirds [dissertation]. Seattle (WA): University of Washington.

Government publication

Order location information from broadest (city/state/country) to narrowest (specific agency office). Alphabetize by agency name, not acronym.

Known author(s):

Burns RM, Honkala BH, technical coordinators. 1990. Silvics of North America. Volume

1. Conifers. Volume 2. Hardwoods. Washington (DC): USDA, Forest Service. Agriculture Handbook Number 654.

Huff MH, Betinger KA, Ferguson HL, Brown MJ, Altman B. 2000. A habitat-based point-count protocol for terrestrial birds, emphasizing Washington and Oregon. Portland (OR): USDA, Forest Service, Pacific Northwest Research Station.

General Technical Report PNW-501.

Agency as author:

[USFWS] United States Fish and Wildlife Service. 2003. Mexican Spotted Owl survey protocol. Albuquerque (NM): USDI, Fish and Wildlife Service, Southwest Regional Office.

[USGS] United States Geological Survey. 1962. Grand Canyon National Park and vicinity, Arizona. Reston (VA): USDI, Geological Survey.

Symposia and proceedings

Complete volume

Likens GE, editor. 1972. Nutrients and eutrophication. Special Symposium 1; 21 Mar 1972.

American Society of Limnology and Oceanography. Lawrence (KS): Allen Press.

Individual article from a proceedings or symposia

Edmondson WT. 1972. Nutrients and phytoplankton in Lake Washington. In: Likens GE, editor. Nutrients and eutrophication. Special Symposium 1; 21 Mar 1972. American Society of Limnology and Oceanography. Lawrence (KS): Allen Press; p. 172–193.

Internet sources

Use sparingly because web sites are often ephemeral

Sauer JR, Hines JE, Fallown J. 2003. North American Breeding Bird Survey, results and analysis 1966–2003. Version 2003.1. Laurel (MD): USGS, Patuxent Wildlife Research Center [cited 5 May 2004]. www.mbr-pwrc.usgs.gov/bbs/bbs.html

Forthcoming publications (formerly "in press")

Year unknown:

Miller MR, Fleskes JP, Takekawa JY, Orthmeyer DC, Casazza ML, Perry WM. Forthcoming. Spring migration of Northern Pintail from California's Central Valley wintering area tracked with satellite telemetry: routes, timing, and destinations. Canadian Journal of Zoology.

Year known:

DeCandido R, Bierregaard RO Jr, Martell MS, Bildstein KL. Forthcoming 2006.

Evidence of nighttime migration by Osprey (Pandion haliaetus) in eastern North America and Western Europe. Journal of Raptor Research. DOI if available

Year and volume number known:

Poling TD, Hayslette SE. Forthcoming 2006. Dietary overlap and foraging competition between Mourning Doves and Eurasian Collared-Doves. Journal of Wildlife Management. 70. DOI.

Non-English publications

End reference with original language of document. If title is non-English, follow with English translation in square brackets.

Hallström E, Johansson C, Jonsson C, Lenneryd K, Rosengren E, Villamor C. 2002.

Experimentell undersökning av gässens del i eventuell eutrophiering av Oppmannasjön [Experimental investigation of geese contribution to eutrophication of Lake Oppmannasjön]. Kristianstad (Sweden): Kristianstad University. Swedish.