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*Original article*

# *Richness and abundance of the aquatic bird assemblage associated with mangroves in the Coloma-Las Canas sector*

*Riqueza y abundancia del ensamblaje de aves acuáticas asociadas a manglares del sector Coloma-Las Canas*

*Riqueza e abundância da assembléia de aves aquáticas associadas aos manguezais no setor Coloma-Las Canas*

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***ABSTRACT***

The present research was carried out during the years 2021 to 2023, in mangrove areas of a Sector of the Coloma-Las Canas, in order to determine the richness and abundance of the assembly of waterfowl associated with this plant formation. For this purpose, three linear transects of variable width were established, with a separation between them

of at least 100 m, where all the species of birds seen or heard were noted; for the analysis of diversity, the abundance range curves were analyzed, a cluster analysis was performed to analyze the similarity between areas, the Kruskal-Wallis mean comparison test was performed, to determine if there were differences between the values of richness and abundance of the birds detected between the areas and the years sampled. The species recorded were classified according to their residence, endemism, threat and trophic guild, species richness and abundance were estimated. A total of 536 individuals of 65 species of waterfowl were recorded, belonging to 14 orders, 26 families, of which 10 are endemic to Cuba and four to the Caribbean and the Antilles. The bird species detected were mostly migratory, grouped into 10 trophic groups, with shallow sounders, waders, aerial searchers and insectivores being the best represented. There were differences between the years studied, in relation to the richness and abundance of the species, with a decrease in 2022, after Hurricane Ian passed through the area.

**Keywords:** waterfowl, diversity, mangroves.

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***RESUMEN***

La presente investigación se realizó durante los años 2021 al 2023, en áreas de manglar de un Sector de la Coloma-Las Canas, con el fin de determinar la riqueza y abundancia del ensamblaje de aves acuáticas asociadas a esta formación vegetal. Para este fin se establecieron tres transectos lineales de ancho variable, con una separación entre ellos de 100 m como mínimo, donde fueron anotadas todas las especies de aves vistas o escuchadas; para el análisis de la diversidad se analizaron las curvas de rango abundancia, se realizó un análisis de conglomerados para analizar la similitud entre áreas, se realizó la prueba de comparación de medias Kruskal-Wallis, para determinar si existían diferencias entre los valores de riqueza y abundancia de las aves detectadas entre las áreas y los años muestreados Las especies registradas fueron clasificadas según su residencia, endemismo, amenaza y gremio trófico, se estimó la riqueza de especies y su abundancia. Se registraron un total de 536 individuos de 65 especies de aves acuáticas, pertenecientes a 14 órdenes, 26 familias, de los cuales 10 son endémicos de Cuba y cuatro del Caribe y las Antillas. Las especies de aves detectadas fueron mayormente migratorias, se agruparon en 10 grupos tróficos, siendo los sondeadores someros,

zancudas, buscadores aéreos y los insectívoros los mejores representados. Hubo diferencias entre los años estudiados, en relación a la riqueza y abundancia de las especies, con una disminución en el año 2022 tras el paso del huracán Ian por la zona.

**Palabras clave**: aves acuáticas, diversidad, manglar.

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***RESUMO***

Portanto, a presente pesquisa foi realizada durante os anos de 2021 a 2023, em áreas de manguezal de um Setor do Coloma-Las Canas, a fim de determinar a riqueza e abundância da assembléia de aves aquáticas associadas a esta formação vegetal. Para tanto, foram estabelecidos três transectos lineares de largura variável, com uma separação entre eles de pelo menos 100 m, onde foram anotadas todas as espécies de aves vistas ou ouvidas; para a análise da diversidade, foram analisadas as curvas de faixa de abundância, foi realizada uma análise de agrupamento para analisar a similaridade entre as áreas, foi realizado o teste de comparação de médias de Kruskal-Wallis, para determinar se havia diferenças entre os valores de riqueza e abundância das aves detectados entre as áreas e os anos amostrados. As espécies registradas foram classificadas de acordo com sua residência, endemismo, ameaça e guilda trófica, riqueza e abundância de espécies foram estimados. Foram registrados 536 indivíduos de 65 espécies de aves aquáticas, pertencentes a 14 ordens, 26 famílias, das quais 10 são endêmicas de Cuba e quatro do Caribe e das Antilhas. As espécies de aves detectadas foram em sua maioria migratórias, agrupadas em 10 grupos tróficos, sendo as sirenes rasas, limícolas, buscadoras aéreas e insetívoros as mais bem representadas. Houve diferenças entre os anos estudados, em relação à riqueza e abundância das espécies, com diminuição em 2022, após a passagem do furacão Ian pela área.

**Palavras-chave**: aves aquáticas, diversidade, manguezal

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## *INTRODUCTION*

Waterfowl are one of the most characteristic groups of wetlands, exploiting the numerous trophic resources that wetlands provide, since they are consumers of aquatic vertebrates and invertebrates (Charalambidou and Santamaría 2005, Gatto *et al*. 2008) cited by García *et al*. (2022). They play an important role in the functioning of the ecosystem, since they intervene in processes such as energy flow and nutrient recycling (Mugica *et al*. 2006). They are a key component in the functioning of wetlands due to their position in trophic webs, energetic importance in ecosystems and high response capacity to environmental changes (Kushlan and Hancock, 2005), cited by Rodríguez *et al*. (2021).

According to Denis *et al*. (2006), there are several threats that can affect the natural populations of aquatic birds, being the loss of natural habitats caused directly or indirectly by human activities, the main cause of the decline in biodiversity. On the other hand, Villarreal *et al*. (2006) propose that the study of birds provides a fast, reliable and replicable method to evaluate the conservation status of terrestrial and aquatic habitats. In this sense, in the Coloma-Las Canas Sector no studies have been reported that characterize the assemblages of birds associated with the different ecosystems that compose it, which allow them to be taken into account in their management plans, particularly in mangrove ecosystems. For these reasons, this research had the following objective: to determine the richness and abundance of the assemblage of aquatic birds associated with mangrove areas of the Coloma-Las Canas Sector.

## *MATERIALS AND METHODS*

### *Characteristics of the study area*

This study was carried out in different mangrove areas of a Sector of La Coloma-Las Canas, located in the coastal region of the town of La Coloma and Playa las Canas, in the southwestern portion of the province of Pinar del Río in the municipality of the same name.

*Waterfowl Count*

To record birds in the area, linear transects of variable width were conducted as suggested by Acosta *et al.* (2013). Three transects were established (Table 1), depending on the characteristics of each site, separated by a minimum distance of 100 m from each other, to avoid counting the same individuals between sampling units. The characteristics of each sampling unit are described below.

*Transects*

*Laguna de las mujeres (TLM)*

This transect has a distance of 800 m, covers a freshwater lagoon with swamp vegetation, where species that predominate are *Typha domingensis*, *Rhizophora mangle* and *Avicennia germinans*, and mangroves with patches of ferns. It should be taken into account that the lagoon underwent transformations after the passage of Hurricane Ian, modifying its structure and opening up the vegetation, currently having more bodies of water.

*Carretera a playa las canas (TCPC)*

This transect is 800 m long and covers an area of coastal forest with abundant invasive species such as *Casuarina equisetifolia* and *Dichrostachys cinerea*. It also has native species such as *Bucida buceras*, *Chrysobalanus icaco, Rhizophora mangle* and *Avicennia germinans*.

*Camino de la playa (TCP)*

This transect covers a distance of 800 m, covering mangrove forest vegetation to the north and sandy coastal vegetation to the south.

***Table 1*** *- Geographic location (coordinates) of the sampling units*

| Place | Latitude | Longitude |
|---|---|---|
| Laguna de las mujeres | 22° 14 ′ 29.70 ″ | 83° 34 ′ 35.35 ″ |
| Carretera a playa las canas | 22° 15 ′ 14.00 ″ | 83° 35 ′ 06.29 ″ |
| Camino de la playa | 22° 13 ′ 34.49 ″ | 83° 35 ′ 16.13 ″ |

In each transect, all bird species seen or heard were recorded during the month of October, from 2021 to 2023. In all cases, sampling was carried out under normal weather conditions, during the first 4 hours of dawn, when aquatic bird activity is highest. Although the primary target is aquatic birds, non-aquatic birds using the wetland during sampling should also be recorded (Acosta *et al.* 2013).

*Data analysis*

The recorded species were classified according to their residence status using the categories partially migratory, winter resident and transient, summer resident and permanent resident; endemism and threat criteria, as proposed by Navarro (2023). In addition, they were classified according to the trophic guild using the criteria of Kirkconnell *et al. (1992)* and González *et al*. (2019).

For the study of diversity, the interpretation of the relative abundance graph, also known as the dominance-diversity graph, range-abundance graph or "Whittaker curves", proposed by (Feinsinger, 2004) for its simplicity and effectiveness compared to diversity indices, was used.

To assess the similarity in species composition between areas, a cluster analysis was performed using PC-ORD software, Version 4.17 (McCune and Mefford, 1999) using the quantitative Sorensen distance measure (Bray-Curtis).

## *RESULTS AND DISCUSSION*

A total of 536 individuals of 65 species of aquatic birds were recorded, belonging to 14 orders and 26 families, of which 10 are endemic to Cuba and four to the Caribbean and the Antilles (Table 2). The best represented orders were Charadriiformes, Passeriformes and Pelecaniformes, with 18, 14 and 11 species respectively. The families with the greatest species richness were Ardeidae and Scolopacidae, with 10 and 9 species respectively, thus coinciding with what has been described for other wetlands in the southern region of Cuba by Aguilar *et al*. (2020) and with the results obtained by Rodríguez *et al*. (2021).

Most of the recorded species were migratory, with 14 residents and/or winter transients and 14 with partially migratory populations (Table 2). 28 trophic guilds were detected, of which the best represented in number of species were shallow probers, waders and aerial searchers, coinciding with the results of González *et al*. (2019).

***Table 2. -*** *List of aquatic bird species detected in mangrove areas of a Sector of La Coloma-Las Canas*

| Order/Family/Species | Trophic guilds | Residence |
|---|---|---|
| **PHOENICOPTERIFORMES** | | |
| **Phoenicopteridae** | | |
| *Phoenicopterus ruber* | F | P.M |
| **COLUMBIFORMES** | | |
| **Columbidae** | | |
| *Streptopelia decaocto* | FG | YR |
| *Columbina passerina* | GS | YR |
| *Zenaida Asiatica* | GS | YR |
| *Zenaida macroura* | GS | YR |
| **CUCULIFORMES** | | |
| **Cuculidae** | | |
| *Crotophaga ani* | IFPE | YR |
| *Coccyzus americanus* | IFPE | T-SR |
| *Coccyzus merlini* | DIPV | YR |
| **APODIFORM** | | |
| **Trochilidae** | | |
| *Chlorostilbon ricordii* | NIVC | YR |
| **CHARADRIIFORMES** | | |
| **Recurvirostridae** | | |
| *Himantopus mexicanus* | H.H | P.M |
| **Charadriidae** | | |
| *Pluvialis squatarola* | H.H | T-WR |
| *Charadrius vociferus* | H.H | P.M |
| *Charadrius semipalmatus* | H.H | T-WR |
| *Charadrius wilsonia* | H.H | T-PM |
| **Scolopacidae** | | |

| | | |
|---|---|---|
| *Arenaria interpres* | H.H | T-PM |
| *Calidris alba* | H.H | T-WR |
| *Calidris minutilla* | H.H | T-WR |
| *Calidris mauri* | H.H | T-WR |
| *Limnodromus griseus* | H.H | T-WR |
| *Tringa flavipes* | H.H | T-WR |
| *Tringa melanoleuca* | H.H | T-PM |
| Tringa semipalmata | H.H | P.M |
| *Solitary Tringa* | H.H | T-WR |
| **Laridae** | | |
| *Leucophaeus atricilla* | CAS | T-PM |
| *Thalasseus maximus* | BA | T-PM |
| *Thalasseus sandvicensis* | BA | T-PM |
| *Hydroprogne caspia* | BA | T-PM |
| **SULFIFORMES** | | |
| **Fregatidae** | | |
| *Fregata magnificens* | BA | YR |
| **Anhingidae** | | |
| *Anhinga anhinga* | B | YR |
| Phalacrocoracidae | | |
| *Phalacrocorax auritus* | B | P.M |
| **PELECANIFORMES** | | |
| **Ardeidae** | | |
| *Ardea Herodias* | Z | P.M |
| *Ardea alba* | Z | T-PM |
| *Egretta thula* | Z | T-PM |
| *Egretta caerulea* | Z | T-PM |
| *Egretta tricolor* | Z | T-PM |
| *Egretta rufescens* | Z | T-PM |
| *Bubulcus ibis* | Z | P.M |
| *Butorides virescens* | Z | P.M |
| *Nycticorax nycticorax* | Z | T-PM |
| *Nyctanassa violacea* | Z | P.M |
| Threskiornithidae | | |
| *Eudocimus albus* | SP | T-PM |

| | | |
|---|---|---|
| **CATHARTIFORMES** | | |
| **Cathartidae** | | |
| *Cathartes aura* | C | P.M |
| **ACCIPITRIFORMES** | | |
| **Pandionidae** | | |
| *Pandion haliaetus* | AcP | P.M |
| **STRIGIFORMES** | | |
| **Tytonidae** | | |
| *Glaucidium siju* | DPN | YR |
| **CORACIIFORMES** | | |
| **Todidae** | | |
| *Todus multicolor* | IFPVC | YR |
| **Alcedinidae** | | |
| *Megaceryle alcyon* | BA | T-WR |
| **PICIFORMES** | | |
| **Picidae** | | |
| *Melanerpes superciliaris* | ITP | YR |
| *Xiphidiopicus percussus* | ITP | YR |
| *Colaptes auratus* | ISTP | YR |
| **FALCONIFORMES** | | |
| **Falconidae** | | |
| *Falco sparverius* | DA | YR |
| *Falco columbarius* | DA | T-WR |
| **PASSERIFORMES** | | |
| **Tyrannidae** | | |
| *Tyrannus caudifasciatus* | IP | YR |
| *Contopus caribaeus* | IP | YR |
| **Mimidae** | | |
| *Mimus polyglottos* | IFPE | YR |
| **Turdidae** | | |
| *Turdus plumbeus* | IFSR | YR |
| **Icteridae** | | |
| *Ptiloxena atroviolacea* | IFPE | YR |
| *Quiscalus niger* | IFFPE | YR |
| **Parulidae** | | |

| | | |
|---|---|---|
| *Parkesia noveboracensis* | ISAP | T-WR |
| *Setophaga ruticilla* | IPRP | WR |
| *Setophaga americana* | IFE | T-WR |
| *Setophaga petechia* | IFE | T-YR |
| *Setophaga palmarum* | ISFPE | T-WR |
| *Setophaga discolor* | ITFE | T-WR |
| **Thraupidae** | | |
| *Tiaris olivaceus* | GSF | YR |
| *Phonipara canora* | GSF | YR |

Trophic guilds: SS: shallow prober, SP: deep prober, BA: aerial searcher, B: diver, Z: wader, O: omnivore. B: Diver, AcP: Aquatic Prey, BA: Aerial Forager, C: Scavenger, CAS: Surface Aquatic Carnivore, DA: Aerial Predator, DIPV Predator of insects and small vertebrates, DPN: Nocturnal Perching Predator, F: Filter Feeder, FG: Frugivore-Granivore, GS: Ground Granivore, GSF: Ground and Foliage Granivore, IFE: Foliage Gleaning Insectivore, IFPE: Frugivorous Insectivore with Pecking and Gleaning, IFPVC: Perching Frugivorous Insectivore with Hanging Flight, IFPE: Frugivorous Insectivore with Pecking and Gleaning, IFSR: Ground Insectivore-Frugivore (Scrambler), IP: Perching Insectivore, IPRP: Perching Insectivore with Fluttering and Chasing, ISAP: Soil and water insectivore with pecking, ISFPE: Soil and foliage insectivore with pecking and gleaning, ISTP: Soil and trunk-boring insectivore, ITFE: Trunk and foliage insectivore by gleaning, ITP: Trunk-boring insectivore, NIVC: Nectarivore-insectivore with hovering flight, SP: Deep-bore, SS: Shallow-bore, Z: Wader. State of permanence, PM: partially migratory, T-PM: transient and partially migratory, T-WR: winter resident and transient, T-SR: summer resident and transient, YR: permanent resident.

Figure 1 presents the relative abundance range curves for the studied areas. The degree of inclination of these curves (slopes) relates to less favorable (very steep slope) or more favorable (gentle slope) conditions, allowing bird communities to accommodate fewer or more species equally, respectively (Magurran, 2004).

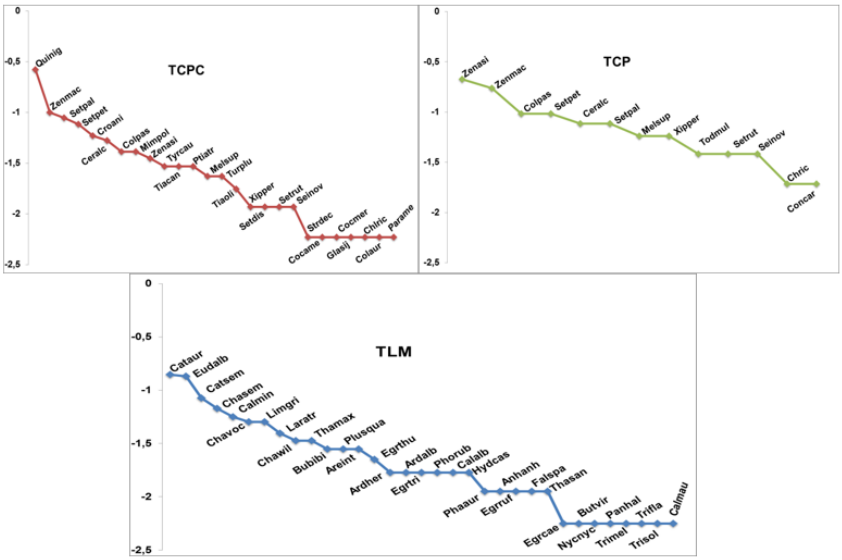


***Figure 1.*** *- Range abundance curves (Whittaker) of the species detected in each transect of the studied area*

Species acronyms: *Anhinga anhinga* (Anhanh), *Ardea alba* (Ardalb), *Ardea herodias* (Ardher), *Arenaria interpres* (Areint), *Bubulcus ibis* (Bubibi), *Butorides virescens* , (Butvir), *Calidris alba* (Calalb), *Calidris mauri* (Calmau), *Calidris minutilla* (Calmin), *Cathartes aura* (Cataur), *Catoptrophorus semipalmatus* (Catsem), *Megaceryle alcyon* (Megalc), *Charadrius semipalmatus* (Chasem), *Charadrius vociferus* (Chavoc), *Charadrius wilsonia* (Chawil), *Chlorostilbon ricordii* (Chlric), *Coccyzus americanus* (Cocame), *Coccyzus merlini* (Cocmer), *Colaptes auratus* (Colaur), *Columbina passerina* (Colpas), *Contopus caribaeus* (Concar), *Crotophaga ani* (Croani) , *Egretta caerulea* (Egrcae) , *Egretta rufescens* (Egrruf), *Egretta* thula (Egrthu) (Limgri), *Melanerpes superciliaris* (Melsup), *Mimus polyglottos* (Mimpol), *Nycticorax nycticorax* (Nycnyc), *Pandion haliaetus* (Panhal), *Parula Americana* (Parame), *Phalacrocorax auritus* (Phaaur), *Phoenicopterus ruber* (Phorub), *Pluvialis squatarola* (Plusqua), *Ptiloxena atroviolacea* (Ptiatr), *Quiscalus niger* (Quinig), *Seiurus noveboracensis* (Seinov), *Setophaga discolor* (Setdis), *Setophaga palmarum* (Setpal), *Setophaga petechia* (Setpet), *Setophaga ruticilla* (Setrut), *Streptopelia decaocto* (Strdec), *Thalasseus maximus* (Thamax), *Thalasseus sandvicensis* (Thasan), *Tiaris canorus* (Tiacan), *Tiaris olivaceus* (Tiaoli), *Todus multicolor* (Todmul), *Tringa flavipes* (Trifla), *Tringa melanoleuca* (Trimel), *Tringa solitaria* (Trisol), *Turdus plumbeus* (Turplu), *Tyrannus caudifasciatus* (Tyrcau), *Xiphidiopicus percussus* (Xipper), *Zenaida asiatica* (Zenasi), *Zenaida macroura* (Zenmac)

The Figure 1 shows that the curves representing the TLM and TCPC exhibit greater species richness (S) than the TCP. This may be related to the vegetation present in these areas and the availability of water, which provide resources such as food and shelter, enabling a greater presence and abundance of species. Regarding the last transect, the lower richness may have been due to the incidence of human activity there (illegal logging and dumping of solid and liquid waste), which damages the vegetation and poses a threat to the recovery of damaged sites and the survival of bird species.

The TCPC shows the numerical dominance of *Quiscalus niger*, which could be influenced by the social and sometimes gregarious behavior of the species, in addition to being a species that lives in mangroves and coastal areas, coinciding with Garrido and Kirkconnell (2002), García and Batista (2021) reported *Quiscalus mexicanus* among the most abundant species present in the mangrove on the Pixvae coast, Veraguas province, Republic of Panama.

While in the graph belonging to the TCP the dominant species was *Zenaida asiatica* which according to Garrido and Kirkconnell (2002) inhabits, among other places, mangrove swamps; in both areas the second most abundant species was *Zenaida macroura,* which according to the authors mentioned above, can be found in coastal areas.

In the graph showing the TLM, the most abundant species was *Cathartes aura,* followed by *Eudocimus albus.* This result could be due to the fact that both species were seen in flocks of several individuals. Furthermore, in the case of *C. aura,* it is a scavenger that also feeds on waste, according to Garrido and Kirkconnell (2002) and which plays a useful role as a supplementary garbage dump, being, according to its abundance, common in populated places, where it can be found in low, open areas, near the coasts and associated with urban areas, scenarios similar to that of this research.

As part of the analysis of species richness and abundance in the studied areas, the variation between the years 2021 and 2023 is shown in Figure 3. As can be seen, both the richness and abundance of species vary between the years studied, both indicators being higher in 2021, followed by 2023, with a decrease in 2022, which could be caused by the passage of hurricane Ian through the area in September of that year, which caused

changes in the structure of the forest (defoliation and tree fall) as shown in Figure 2, with the consequent impact on the fauna that inhabits it and specifically on birds.

***Figure 2.*** *- Impact of hurricane Ian on the vegetation of the studied area*

Regarding the effect of hurricanes on animals, Ackerman *et al*. (1991) stated that the main effect occurs after the hurricane passes due to the loss of flowers, fruits, and seeds. However, the immediate impact can cause mortality in migratory birds, eggs, or chicks in nests.

The distribution of birds is influenced by environmental variables (Orgeira, 1997) and anthropogenic factors (Maciel-Mata *et al.* 2015) cited by Hernández *et al*. (2020); according to these last authors, in the records derived from their research, environmental conditions such as storms or hurricanes could have forced individuals to move from their area, where possibly the force of the winds displaced them to other areas.

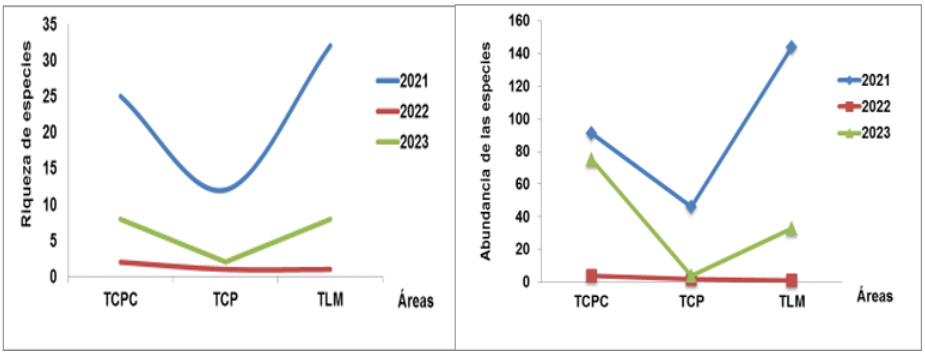


***Figure 3.*** *- Difference between years in species richness and abundance*

As can be seen in Figure 3, there is a recovery of both the richness and abundance of species in 2023, which could be due to the recovery of the areas. This may be related to what was proposed by Cumming *et al.* (2012) cited by Tobar *et al*. (2021) in that, since birds have high mobility, it allows them to use wetlands opportunistically, abandoning the habitat when conditions become unfavorable and recolonizing them when they become favorable.

## *CONCLUSIONS*

The assemblage of aquatic birds associated with mangroves in the Coloma-Las Canas sector is composed primarily of migratory birds, shallow-water probers, waders, and aerial searchers, with both species richness and abundance varying between the years studied. Both were highest in 2021, followed by 2023 and a decrease in 2022.

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The authors declare not to have any interest conflicts.

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The authors have participated in the writing of the work and analysis of the documents.