



Noteworthy records of aquatic birds in the state of Querétaro, Mexico.

Rubén Pineda-López* and Alejandro Arellano-Sanaphre.

Laboratorio de Zoología, Facultad de Ciencias Naturales, Universidad Autónoma de Querétaro. Avenida de las Ciencias s/n, Colonia Juriquilla, Querétaro, 76230, México. E-mail: *rpineda62@hotmail.com.

Abstract

A systematic sampling of aquatic birds was conducted over a period of two years in the state of Querétaro, Mexico. Twenty nine species have been added to the official list of species for the state, nine of which have few records in the interior of the country: *Dendrocygna autumnalis*, *D. bicolor*, *Lophodytes cucullatus*, *Gavia immer*, *Pluvialis squatarola*, *Charadrius semipalmatus*, *Numenius phaeopus*, *Limosa haemastica*, and *Thalasseus maximus*.

Key words: avifauna, distribution, new records, wetlands.

Registros notables de aves acuáticas en el estado de Querétaro, México.

Resumen

Se realizó un muestreo sistemático durante dos años de las aves acuáticas del estado de Querétaro, México. Veintinueve especies se adicionan a la lista oficial de especies para el estado, nueve de las cuales tienen pocos registros en el interior del país: *Dendrocygna autumnalis*, *D. bicolor*, *Lophodytes cucullatus*, *Gavia immer*, *Pluvialis squatarola*, *Charadrius semipalmatus*, *Numenius phaeopus*, *Limosa haemastica* y *Thalasseus maximus*.

Palabras clave: avifauna, distribución, nuevos registros, humedales.

HUITZIL (2010) 11(2):49-59

Introduction

There have been few studies conducted of the aquatic birds of continental wetland habitats in Mexico (Barragán *et al.* 2002, Mellink and de la Riva 2005, SEMARNAT 2006). This is the case for Querétaro, where although the total list of birds for the state has increased considerably in the last 19 years, aquatic birds have received little attention and records are limited to occasional surveys in a few local reservoirs. Presently, 41 species of aquatic birds have been reported for the state (Navarro *et al.* 1991, 1993, Rojas-Soto *et al.* 2001, González 2001, González-García *et al.* 2004), belonging to the orders Anseriformes, Podicipediformes, Ciconiiformes, Suliformes, Pelecaniformes, Accipitriformes (Pandionidae), Gruiformes, Charadriiformes, Coraciiformes (Alcedinidae) and Passeriformes (*Cistothorus palustris* and *Geothlypis trichas*). However, unpublished records and geographic extrapolations of distribution maps (*e.g.*, Howell and Webb 1995) suggest that there are more species present in Querétaro. This paper is the result of a systematic study of the aquatic birds of 12 reservoirs in a semiarid region of the central state of Querétaro, Mexico, and includes new records and distribution confirmations.

Methods

Study area

The state of Querétaro is located in the center of Mexico. It is a small state (11,500 km²) with highly variable topography and at least 15 types of vegetation (Zamudio *et al.* 1992). The present study was carried out in 12 reservoirs (Figure 1, Appendix 1) located along the southern region of the state, between 20°49'09"-20°23'17"N and 99°50'13"-100°32'51"W, and characterized by a semiarid climate with summer rains, within the physiographic province of the Transvolcanic Belt (INEGI 1986).

All reservoirs studied show substantial fluctuations in water level and some of them dry out completely during the dry season (spring). All reservoirs are influenced by urban areas (Figure 1). The reservoirs El Centenario and Paso de Tablas are part of the San Juan River and are highly polluted by urban and industrial wastes from the cities of San Juan del Río and Tequisquiapan. The vegetation present in these reservoirs consists mainly of seasonal semiaquatic species dominated by *Polygonum mexicanum*, *P. punctatum*, *Echinocloa crusgavonis*, *E. crusgalli*, *E. holciformis*, and *E. ophismroides*. Permanent aquatic species are also found: *Eichhornia crassipes*, *Typha dominguensis*, and

Scirpus sp. During the rainy season, various terrestrial plant species were found along the banks, including *Iva*

ambrosifolia, *Chenopodium ambrosioides*, *Ambrosia psilostachya*, and *Amaranthus hybridus*.

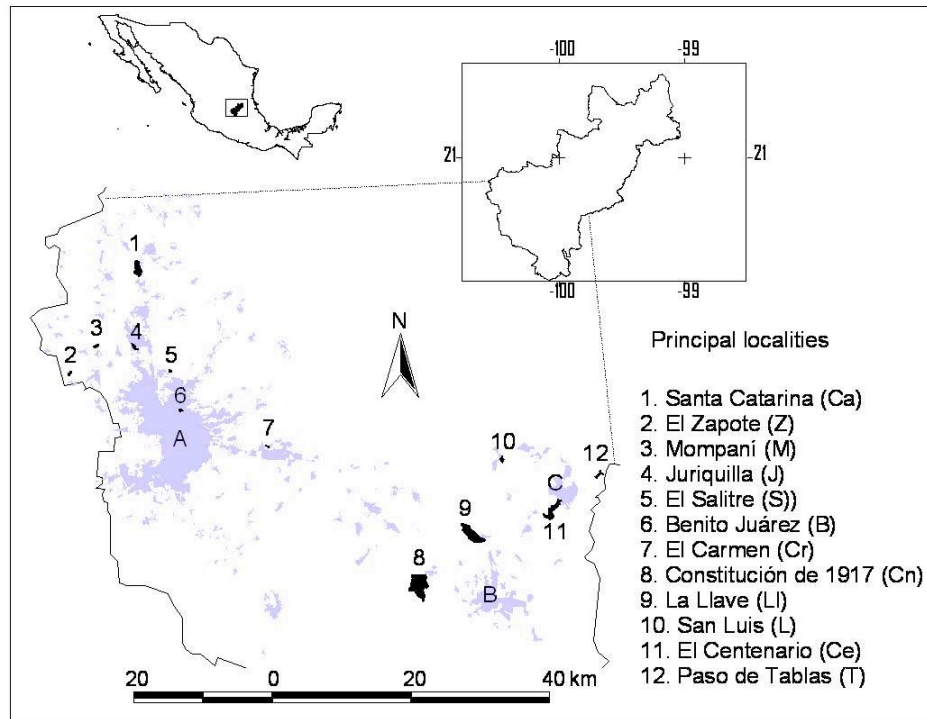


Figure 1. Location of Querétaro, study area and sampled reservoirs. Urbanized areas are shown in purple. Large cities are: (A) Querétaro, (B) San Juan del Río, and (C) Tequisquiapan.

Data collection

Sampling was carried out once a month at nine reservoirs during 2 years (October 2004 to September 2005 and August 2006 to June 2007). During the second year, three additional reservoirs were sampled (see Appendix 1). For sampling, we used a transect along the longest axis of each reservoir. Sampling time varied between 45 and 90 minutes, depending on the size of the reservoir. Observations were made using 10 x 50 mm binoculars and a Canon EOS1 camera with a SIGMA 270-500 mm lens, which allowed the creation of a species image database.

The taxonomic sequence and nomenclature of the species used in this study follow the list of the American Ornithologists' Union (AOU 2010). References to the National Collection of Birds (CNAV)

and the Ornithological Collection of the Museum of Zoology, Faculty of Sciences (MZFC), were obtained by the Global Biodiversity Information Facility portal (GBIF 2010). These references were used to cite the nearest record of some species.

Results

In this study, we observed 69 bird species (Appendix 2), of which 29 species represents new records for the state of Querétaro (Figure 2). In addition, two previously recorded species were confirmed. The new records (N) and confirmations (C) for the state are as follows (the number of observed individuals is in parentheses and abbreviations for specific locations are referred in Figure 1):

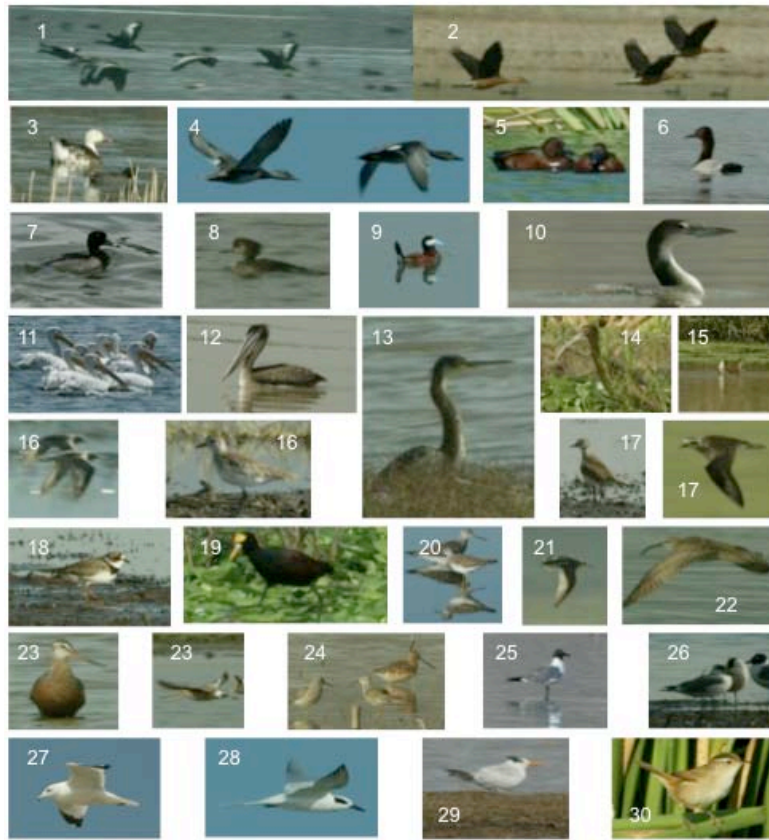


Figure 2. Photographic records of the species reported (except for *Ixobrychus exilis*): (1) *Dendrocygna autumnalis*, (2) *D. bicolor*, (3) *Chen caerulescens*, (4) *Anas strepera*, (5) *A. cyanoptera*, (6) *Aythya valisineria*, (7) *A. collaris*, (8) *Lophodytes cucullatus*, (9) *Oxyura jamaicensis*, (10) *Gavia immer*, (11) *Pelecanus erythrorhynchos*, (12) *P. occidentalis*, (13) *Egretta tricolor*, (14) *Plegadis chihi*, (15) *Porzana carolina*, (16) *Pluvialis squatarola*, (17) *P. dominica*, (18) *Charadrius semipalmatus*, (19) *Jacana spinosa*, (20) *Tringa flavipes*, (21) *Bartramia longicauda*, (22) *Numenius phaeopus*, (23) *Limosa haemastica*, (24) *Calidris himantopus*, (25) *Leucophaeus atricilla*, (26) *L. pipixcan*, (27) *Larus delawarensis*, (28) *Sterna forsteri*, (29) *Thalasseus maximus*, (30) *Cistothorus palustris*.

Dendrocygna autumnalis (Black-bellied Whistling-Duck) (N). This species was recorded irregularly during the second year of sampling, on 30 August 2006 (L)(2), 20 December 2006 (L)(2) and 11 January 2007 (Ce)(7). This is a rare visitor in the interior of Mexico, where there are few prior records (Howell and Webb 1995, Forcey 2002, Colón 2004, Forcey and Aragón 2009). The occasional record of the species in the interior of Mexico suggests a pattern of natural wandering, as has been suggested previously for the species in the United States (Halliwell 2000).

Dendrocygna bicolor (Fulvous Whistling-Duck) (N). This species was observed on 17 November 2006 (L)(8) and 14 May 2007 (Ce)(9). This species often wanders after breeding in the United States (Hohman and Lee 2001). Likewise, it is considered a sporadic visitor in the interior of Mexico (Howell and Webb 1995), where there are few records (Wilson and Ceballos-Lascuráin 1993, Forcey 2002, Colón 2004, Urbina-Torres *et al.*

2009). As for the previous species, the occasional records of this species suggest a pattern of natural wandering in this region.

Chen caerulescens (Snow Goose) (N). This species was observed from late October to early June (L)(1). The area of non-reproductive distribution of this species is found near the state of Querétaro and in adjacent areas of Guanajuato, although occasionally the species has been observed in Belize and Honduras (Howell and Webb 1995).

Anas strepera (Gadwall) (N). This species was observed on the outskirts of Amealco on 2 February 2005 (5) and 2 March 2005 (17). It was absent in the reservoirs sampled during the first year of surveys, whereas 93 individuals appeared during the second year, from late October to mid-April (Ca, Ce, Cn, L, Ll, M, and T). The highest numbers were observed on 9 January (20)(M) and 11 January 2007 (20)(L). This species is found from

October to May in most parts of the country (Howell and Webb 1995).

Anas cyanoptera (Cinnamon Teal) (N). This species was recorded from late October to early April (S, J, B, Ca, Ll, Ce, T, Cr, L, and Cn), mainly during the second year, with a maximum of records in the winter, on 13 February 2007 (141)(B). Although Howell and Webb (1995) suggest that the species is a resident in the southern portion of the state, we did not observe this species during the summer months.

Aythya valisineria (Canvasback) (N). This species appeared from September to December (M, B, Ca, T, L, and Cn). Generally, there were only one to three individuals sighted, except in Santa Catarina, where approximately 60 individuals were observed in an area of dense vegetation on 15 November 2006. Howell and Webb (1995) considered this species to be a non-reproductive visitor in central and northern Mexico, from November to April. However, the reductions of wetlands during the dry season have seemingly limited its presence, as this is a species of deep bays, lakes, and ponds (Mowbray 2002).

Aythya collaris (Ring-necked Duck) (N). This species was observed from mid-October to mid-March (M, Ca, Ll, Ce, L, and Cn), with a maximum number (1200) in El Centenario on 12 February 2007. This species occurs from October to April in central and northern Mexico (Howell and Webb 1995).

Lophodytes cucullatus (Hooded Merganser) (N). A juvenile appeared on 14 November 2006 (Cr). Howell and Webb (1995) mapped occasional sightings of this species in Mexico during the non-reproductive season, including a record for Distrito Federal, where the species has been collected previously (CNAV 0302, 0303), as well as in the State of Mexico (CNAV 0304).

Oxyura jamaicensis (Ruddy Duck) (N). This species was recorded year-round (M, S, J, B, Ca, Ll, Ce, T, Cr, and L), which confirms its status as resident in the area of study indicated by Howell and Webb (1995). The highest numbers were observed in Santa Catarina on 12 January 2007 (1380) and in El Centenario on 27 February 2005 (1190) and 18 November 2006 (1350), suggesting the arrival of wintering birds from the north.

Gavia immer (Common Loon) (N). Two juveniles (see Sibley 2003) were observed on 6 January, 22 January, and 7 February 2007 (Cn). Apparently these same individuals died in March when becoming entangled in nets used by local fishermen. We were unable to recover the specimens. This species has previously been sighted in central Mexico (Ramírez-Bastida *et al.* 1994, Howell and Webb 1995, Contreras-Balderas and Ruiz-Campos 2007, Romero-Águila *et al.* 2007). Our records give support to the suggestion by Romero-Águila *et al.* (2007) that this species may be

more frequent on the Mexican Plateau than previously supposed.

Pelecanus erythrorhynchos (American White Pelican) (N). This species was recorded from mid-September to early June (J, Ca, Ll, Ce, and Cn), with the highest numbers observed in February 2005 in El Centenario (852). During the second sampling period there were no sightings of this species in El Centenario, probably because high fish mortality due to a cyanobacteria bloom in the reservoir during the summer of 2005. Howell and Webb (1995) consider this species as a nomadic non-reproductive visitor from September to April on the coast and most of the interior of Mexico. The closest records are from Yuriria Lagoon (Babb 2000) and San Miguel de Allende reservoir in Guanajuato (GBIF 2010).

Pelecanus occidentalis (Brown Pelican) (C). We observed an immature at Constitución de 1917 on 6 and 11 January 2007 and 2 immatures at Santa Catarina on 23 April 2007. This species appears occasionally in the interior of the country (Wilson and Ceballos-Lascuráin 1993, Howell and Webb 1995, Urbina-Torres *et al.* 2009) and already has been recorded in the borders of the state by Rojas-Soto *et al.* (2001) and González-García *et al.* (2004).

Ixobrychus exilis (Least Bittern) (N). One individual was observed in the secondary vegetation along the wall in the reservoir Benito Juárez on 13 November 2004. This species is considered a resident near the western part of the state (Howell and Webb 1995).

Egretta tricolor (Tricolored Heron) (N). We observed an immature at Constitución de 1917 on 13 September 2006 and 7 February 2007. In central Mexico, this species is a non-reproductive visitor in several localities (Howell and Webb 1995), and was observed in November at the De Silva reservoir, Guanajuato (GBIF 2010).

Plegadis chihi (White-faced Ibis) (N). This species was observed throughout the year (M, S, Ca, Ce, Cr, Ll, and Cn), principally in Santa Catarina, La Llave, and El Centenario, with irregular numbers of up to 460 individuals at Santa Catarina on 8 February 2007. This species is a resident of other central and western highlands of Mexico (Howell and Webb 1995). The closest record for the White-faced Ibis is near Yuriria Lagoon, Guanajuato (MZFC 3273).

Porzana carolina (Sora) (N). This species was present from early September to mid-November (M, J, Ca, and Cr), with the greatest number (4) on 21 September 2006 (M). This species was always associated with aquatic vegetation, which together with its secretive habits suggest that it may not have been detected at several reservoirs and during different months. This species has commonly been observed from August to

May in most parts of the country (Howell and Webb 1995) and was reported by González-García *et al.* (2004) for El Epazote, an area of the state of Hidalgo near Querétaro.

Pluvialis squatarola (Black-bellied Plover) (N). Adults in non-breeding plumage were observed on 5 April (1) and 6 April (2) 2007 at La Llave. Howell and Webb (1995) note that this species appears occasionally in the interior of Mexico as a non-reproductive visitor, and they mapped sightings in Guanajuato and San Luis Potosí, close (or in?) Querétaro.

Pluvialis dominica (American Golden-Plover) (N). An immature was observed at Constitución de 1917 on 7 February 2007 and two non-breeding adults were observed at La Llave on 5 and 19 April 2007. The birds were found in low areas of the reservoir surrounded by vegetation, which is its normal habitat during migration and the non-reproductive season (Johnson and Connors 1996). In Mexico, it is a migratory species mainly observed during the spring, from mid-February through May (Howell and Webb 1995). The closest record is for northeastern Hidalgo (Valencia-Herverth *et al.* 2008).

Charadrius semipalmatus (Semipalmated Plover) (N). This species was observed on 11 January 2007 (Cn)(1), 18 April 2007 (Cn)(4), 10 April 2007 (Ll)(5) and 11 May 2007 (Cn)(1). This species occasionally spends the non-reproductive season in the interior of the continent (Nol and Blanken, 1999). In Mexico, this species has been recorded occasionally on the Mexican Plateau from September to May, and has been recorded in the state of Guanajuato, near Querétaro (Howell and Webb 1995).

Jacana spinosa (Northern Jacana) (N). One adult was observed throughout the year, except at the beginning of the summer in La Llave. One or two immature specimens appeared in other reservoirs, on 23 December 2004 (2)(Ce), 27 February 2005 (2)(Ce) and 9 February 2007 (1)(M). This species was observed associated with water hyacinth (*Eichhornia crassipes*), except in Mompaní, where it walked and fed along areas without vegetation. Howell and Webb (1995) mapped it as resident in areas bordering the state, and it has been observed at San Miguel de Allende, Guanajuato (GBIF 2010).

Tringa flavipes (Lesser Yellowlegs) (N). This species was reported from mid-August until mid-May (M, S, J, Ca, Ll, Ce, T and L), mainly at La Llave on 19 August 2006 (19). This latter reservoir had the preferred habitat of the species, including shallows and muddy beaches with areas of vegetation (Tibbitts and Moskoff 1999). It is a non-reproductive visitor in Mexico, from July to May (Howell and Webb 1995) and has been observed in San Miguel de Allende, Guanajuato (GBIF 2010).

Bartramia longicauda (Upland Sandpiper) (N). One or two individuals were observed on banks with low vegetation on 30 August 2006 (2)(Ce), 1 September 2006 (2)(Ca) and 11 de September 2007 (1)(Ce). In central Mexico, it is a migratory species from late July to mid-October and from March to mid-May (Howell and Webb 1995). This species has been reported in Zacatecas and Guanajuato (Friedmann *et al.* 1950).

Numenius phaeopus (Whimbrel) (N). A solitary individual was recorded at Santa Catarina on 28 April 2005. In the interior of Mexico, there are only isolated records from Zacatecas, Tamaulipas (Howell and Webb 1995) and Coahuila (CNAV 13275).

Limosa haemastica (Hudsonian Godwit) (N). Adults with partial breeding plumage were observed at La Llave on 11 May (2 females, 1 male) and 17 May (3 females, 2 males) 2007. This species migrates through the Great Plains of the United States in spring (Elphick and Klima 2002), with migration peak in May. In the interior region of Mexico, the species has been sighted in Mexico City (Howell and Webb 1995) and Hidalgo (Ortiz-Pulido *et al.* in press).

Calidris himantopus (Stilt Sandpiper) (N). Ten individuals in partial breeding plumage were observed at Santa Catarina on 23 April 2007. This is a non-reproductive resident species in the Transvolcanic Belt, where it is uncommon from October to March (Howell and Webb 1995). Based on the date of observation, this species is apparently a transient migrant for the study area.

Leucophaeus atricilla (Laughing Gull) (N). One to three individuals appeared towards early September to mid-May (Ca, Ce, and Cn), mainly at the Constitución de 1917 reservoir. In the southern Mexican Plateau, this is a rare non-reproductive visitor (Howell and Webb 1995). Friedmann *et al.* (1950) recorded this species in San Luis Potosí.

Leucophaeus pipixcan (Franklin's Gull) (N). One or three individuals were observed on 15 and 16 November 2006 (1)(Cn and Ca), 18 April 2007 (3)(Cn) and 24 April 2007 (1)(Cn). This species is a transient migrant throughout most of Mexico, being absent only from northwestern and Baja California (Howell and Webb 1995), and has been recorded by González-García *et al.* (2004) from the Tula River in Hidalgo, close to Querétaro.

Larus delawarensis (Ring-billed Gull) (N). This species appeared from mid-November to mid-May (J, Ca, Ce, and Cn), with a maximum of 20 individuals on 18 April 2007 (Cn). This species remains in Mexico from October to May (Howell and Webb 1995). Friedmann *et al.* (1950) reported this species for adjacent states: San Luis Potosí, Guanajuato and Michoacán.

Sterna forsteri (Forster's Tern) (N). One to three individuals were observed irregularly from mid-

September to early June (Ca and Cn). This species is a non-reproductive visitor in central Mexico from August to May (Howell and Webb 1995).

Thalasseus maximus (Royal Tern) (N). On 2 March 2005, this tern was observed at the Constitución de 1917 reservoir. This species has been recorded occasionally in the interior of the United States (Buckley and Buckley 2002). In the interior of Mexico, it has only been recorded in Mexico City (Howell and Webb 1995).

Cistothorus palustris (Marsh Wren) (C). This species was recorded from late October to late April (J, Ca, Ll, Ce, L, and Cn). The individuals observed probably belonged to the group *paludicola*, which frequently remains from September to mid-May in the area (Howell and Webb 1995). González (2001) reported this species for northeastern Querétaro.

Discussion

This work increases by 71% the number of species of aquatic birds reported for Querétaro. With the new additions reported here, the state has a total of 376 recorded bird species (Navarro *et al.* 1991, 1993, Eitniear *et al.* 2000, Rojas-Soto *et al.* 2001, Gómez de Silva and Medellín 2002, González-García *et al.* 2004, Pineda-López *et al.* 2010). Of the 29 new records reported in this paper, 20 had been suggested as potentially present in the state or in nearby areas by Howell and Webb (1995). The remaining nine species are considered occasional or rare records for the Mexican Plateau and included: *Dendrocygna autumnalis*, *D. bicolor*, *Lophodytes cucullatus*, *Gavia immer*, *Pluvialis squatarola*, *Charadrius semipalmatus*, *Numenius phaeopus*, *Limosa haemastica* and *Thalasseus maximus*. These species may be more frequent than previously supposed on the Mexican Plateau, as suggested by Romero-Águila *et al.* (2007) in comments concerning *Gavia immer*.

Most (97%) of the new records were from large reservoirs (Cn, Ce, Ca, and Ll), which presented a greater number of species. However, half of the new records were also recorded from small reservoirs (10 – 40 ha), including three of the occasional records for the Mexican Plateau. There is an extensive system of small, basically uncharted wetlands in the Transvolcanic Belt and the Mexican Plateau (Ramírez-Bastida *et al.* 2008). We propose that these small reservoirs, larger than 10 ha, should be considered in the conservation of aquatic birds

for the region, as has been proposed by Ramírez-Bastida *et al.* (2008) for reservoirs larger than 25 ha.

The data presented here confirm the importance of artificial reservoirs and seasonal wetlands in the conservation of resident and migratory aquatic birds, as noted elsewhere for Mexico (Barragán *et al.* 2002) and other countries (*e.g.*, Masero 2003, Ma *et al.* 2004, Kingsford *et al.* 2004). Artificial reservoirs have a particular significance in Mexico, where they represent 70% of the sources of standing water (Hoz and de la Lanza 2002). These reservoirs are more frequent in semiarid areas of Mexico, where many natural lakes have disappeared (Navarro de León *et al.* 2005), such as the lake formerly found in the study area in what is now the city of Tequisquiapan (Balbontín 1867). For this reason, it is necessary to implement management strategies for these ecosystems that include the conservation of aquatic birds as a priority taxonomic group and as flag species for conservation of other biotic groups.

Future management strategies should also consider the reduction of pollution that can directly affect aquatic bird species, and promote a significant increase in vegetation, which is highly favorable to the diversity of aquatic birds (Weller 1999). More extensive studies are needed of the aquatic systems in the semiarid areas of the Transvolcanic Belt and the Mexican Plateau, which given the high number of species recorded from these systems, suggests that they are critical areas for the conservation of North American aquatic birds.

Acknowledgments

This study was undertaken with the partial support of the Teacher Improvement Program (PROMEP: UAQ-QRO-77) and the CONCYTEQ (Project: Evaluación ecológica de un sistema queretano de embalses en cascada). We would like to thank E. Díaz Pardo and C. López González for their help in some parts of the project, P. Balderas Aguilar for identification of the recorded plants, N. Hernández Camacho and S. Contreras Robledo for their help with field work, R. Jones and K. Acevedo Whitehouse for English corrections and especially A. Navarro Sigüenza, P. Ramírez Bastida, O. R. Rojas Soto, F. González García, C. Almazán Núñez and an anonymous reviewer for their valuable comments.

Literature cited

AOU (American Ornithologists' Union) (online). 2010. Check-list of North American Birds. <<http://www.aou.org/checklist/north/>> (accessed August 2010).

Babb, A.K. 2000. AICA 56 Laguna de Yuriria. Pp. 361. In: M. del C., Arizmendi and L. Márquez (eds.). Áreas de Importancia para la Conservación de las Aves en México (AICA's). Cipamex-Conabio-CCA-FMCN. México, DF.

- Balbontín, J.M. 1867. Estadística del estado de Querétaro en los años de 1854 y 1855. Impresor V.G. Torres. México DF.
<<http://openlibrary.org/a/OL6012792A/Juan-María-Balbontín>> (accessed August 2010).
- Barragán, S.J., E. López-López, and K.A. Babb. 2002. Spatial and temporal patterns of a waterfowl community in a reservoir system of the Central Plateau, Mexico. *Hidrobiología* 467:123-131.
- Buckley, P.A. and F.G. Buckley (online). 2002. Royal Tern (*Sterna maxima*). In: A. Poole (ed.). The Birds of North America Online. <<http://bna.birds.cornell.edu/bna/species/700/articles/introduction>> (accessed December 2009).
- Colón, Q.D. 2004. Presencia de patos pijije, alablanca (*Dendrocygna autumnalis*) y canelo (*Dendrocygna bicolor*), en Toluca, Estado de México. *Huitzil* 5:1-2.
- Contreras-Balderas, A.J. and G. Ruiz-Campos. 2007. Second unusual record of common loon, *Gavia immer*, for Coahuila Mexico, and its first report for the Cuatro Ciénegas basin. *The Southwestern Naturalist* 52:153-155.
- Eitniear, J.C., T.A. Aragón, V. González, R. Pedraza, and J.T. Baccus. 2000. New Galliformes for the Mexican state of Querétaro. *Cotinga* 13:10-13.
- Elphick, C.S. and J. Klima (online). 2002. Hudsonian Godwit (*Limosa haemastica*). In: A. Poole (ed.). The Birds of North America Online. <<http://bna.birds.cornell.edu/bna/species/629/articles/introduction>> (accessed December 2009).
- Forcey, M.J. 2002. Notes on the birds of central Oaxaca, Part I: Podicipedidae to Laridae. *Huitzil* 3:1-10.
- Forcey, M.J. and R. Aragón. 2009. Notes on Oaxacan birds. *Huitzil* 10:38-47.
- Friedmann, H., L. Griscom, and R.T. Moore. 1950. Distributional Check-list of the birds of Mexico. Part 1. Pacific Coast Avifauna 29:1-202.
- GBIF (Global Biodiversity Information Facility) (online). 2010. <<http://data.gbif.org/species/>> (accessed January 2010).
- Gómez de Silva, H. and A.R. Medellín. 2002. Are land bird assemblages functionally saturated? An empirical test in Mexico. *Oikos* 96:169-181.
- González, S.C. 2001. Avifauna de la Reserva de la Biosfera Sierra Gorda, Querétaro, México. Tesis de Licenciatura, ENEP Iztacala, Universidad Nacional Autónoma de México. Tlalnepantla, Estado de México.
- González-García, F., O.F. Puebla, M.S. Barrios, N. Fajardo, and H. Gómez de Silva. 2004. Información adicional sobre la avifauna de los estados de Hidalgo y Querétaro, México, incluyendo nuevos registros estatales. *Cotinga* 22:56-64.
- Halliwell, T. 2000. What's next in New Jersey. *Records of New Jersey birds* 26:58-67.
- Hohman, W.L. and S.A. Lee (online). 2001. Fulvous Whistling-Duck (*Dendrocygna bicolor*). In: A. Poole (ed.). The Birds of North America Online. <<http://bna.birds.cornell.edu/bna/species/562/articles/introduction>> (accessed December 2009).
- Howell, S.N.G. and S. Webb. 1995. A guide to the birds of Mexico and northern Central America. Oxford University Press. New York.
- Hoz, Z.E.E. and E.G. de la Lanza. 2002. Los jagüeyes, cuerpos de agua epicontinentales del noreste de México. Pp. 295-321. In: E.G. de la Lanza and J.L.C. García (eds.). Lagos y presas de México. AGT Editor. México, DF.
- INEGI (Instituto Nacional de Estadística Geografía e Informática). 1986. Síntesis Geográfica, Nomenclátor y Anexo Cartográfico del Estado de Querétaro. México, DF.
- Johnson, O.W. and P.G. Connors (online). 1996. American Golden-Plover (*Pluvialis dominica*). In: A. Poole (ed.). The Birds of North America Online <<http://bna.birds.cornell.edu/bna/species/201/articles/introduction>> (accessed December 2009).
- Kingsford, T.R., K.M. Jenkins y J.L. Porter. 2004. Imposed hydrological stability on lakes in arid Australia and effects on waterbirds. *Ecology* 85:2478-2492.
- Ma, Z., B. Li, B. Zhao, K. Ping, S. Tang, and J. Chen. 2004. Are artificial wetlands good alternatives to natural wetlands for waterbirds? A case study on Chongming Island, China. *Biodiversity and Conservation* 13:333-350.
- Masero, J.A. 2003. Assessing alternative anthropogenic habitats for conserving waterbirds: salinas as buffer areas against the impact of natural habitat loss for shorebirds. *Biodiversity and Conservation* 12:1157-1173.
- Mellink, E. and G. de la Riva. 2005. Non-breeding waterbirds at Laguna de Cuyutlán and its associated wetlands, Colima, México. *Journal of Field Ornithology* 76:158-167.
- Mowbray, T.B. (online). 2002. Canvasback (*Aythya valisineria*). In: A. Poole (ed.). The Birds of North America Online <<http://bna.birds.cornell.edu/bna/species/659/articles/introduction>> (accessed December 2009).
- Navarro, A., L. León, and B. Hernández. 1991. Notas sobre las aves de Querétaro, México. *Southwestern Naturalist* 36:360-363.
- Navarro, A., B. Hernández, and H. Benítez. 1993. Listados faunísticos de México: IV. Las aves del estado de Querétaro, México. Instituto de

- Biología, Universidad Nacional Autónoma de México. México, DF.
- Navarro de León, I., J. Gárfias-Soliz, and J. Mahlknecht. 2005. Groundwater flow regime under natural conditions as inferred from past evidence and contemporary field observations in a semi-arid basin: Cuenca de la Independencia, Guanajuato, Mexico. *Journal of Arid Environments* 63:756-771.
- Nol, E. and M.S. Blanken (online). 1999. Semipalmated Plover (*Charadrius semipalmatus*). In: A. Poole (ed.). *The Birds of North America Online* <<http://bna.birds.cornell.edu/bna/species/444/articles/introduction>> (accessed December 2009).
- Ortiz-Pulido, R., J. Bravo-Cadena, V. Martínez-García, D. Reyes, M.E. Mendiola, G. Sánchez and M. Sánchez. In press. Listado de aves de la Reserva de la Biosfera Barranca de Metztitlán. *Revista Mexicana de Biodiversidad*.
- Pineda-López R., A.S. Arellano, R.C. Almazán-Núñez, C. López-González, and F. González-García. 2010. Nueva información para la avifauna del estado de Querétaro, México. *Acta Zoológica Mexicana* (n.s.) 26:47-57.
- Ramírez-Bastida, P., A. Desucré, A. Navarro, P.J. Romo, and H. Castro. 1994. Winter record of the Common Loon (*Gavia immer*) in the state of Hidalgo, México. *Southwestern Naturalist* 39:394-395.
- Ramírez-Bastida, P., A.G. Navarro-Sigüenza y A.T. Peterson. 2008. Aquatic bird distributions in Mexico: designing conservation approaches quantitatively. *Biodiversity and Conservation* 17:2525-2558.
- Romero-Águila, E., C. Posadas-Leal, and L. Chapa-Vargas. 2007. Primeros registros del Colimbo mayor (*Gavia immer*) en San Luis Potosí, México. *Huitzil* 8:11-13.
- Rojas-Soto, O.R., F.J. Sahagún-Sánchez, and A. Navarro. 2001. Additional information of the avifauna of Querétaro, Mexico. *Cotinga* 15:48-52.
- SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales). 2006. Proyecto para la conservación y manejo de las aves playeras y su hábitat en México. Dirección General de Vida Silvestre. México, DF.
- Sibley A.D. 2003. *The Sibley field guide to birds of western North America*. Chanticleer Press. New York.
- Tibbitts, T.L. and W. Moskoff (online). 1999. Lesser Yellowlegs (*Tringa flavipes*). In: A. Poole (ed.). *The Birds of North America Online* <<http://bna.birds.cornell.edu/bna/species/427/articles/introduction>> (accessed December 2009).
- Urbina-Torres, F., C.R. de Vivar-Álvarez, and A. Navarro. 2009. Notas sobre la distribución de algunas aves en Morelos, México. *Huitzil* 10:30-37.
- Valencia-Herverth, J., R. Valencia-Herverth, and F. Mendoza-Quijano. 2008. Registros adicionales de aves para Hidalgo, México. *Acta Zoológica Mexicana* (n.s.) 24:115-123.
- Weller, W.M. 1999. *Wetland bird. Habitat resources and conservation implications*. Cambridge University Press. Cambridge, UK.
- Wilson, R.G. and H. Ceballos-Lascuráin. 1993. *The birds of Mexico City*, 2nd ed. BBC Printing and Graphics. Burlington, Ontario.
- Zamudio, S.R., J. Rzedowski, E. Carranza, and G. Calderón. 1992. *La vegetación del estado de Querétaro*. Instituto de Ecología, Centro Regional del Bajío. Querétaro.

Received: 4th February 2010; Revision accepted: 8th September 2010.
Associated editor: Patricia Ramírez Bastida.

Appendix 1. Location and characterization of sampled reservoirs for aquatic birds in Querétaro.

Name and symbol of the reservoir	Latitude N	Longitude W	Altitude (m)	Area (ha)	Vegetation cover (ha)	Vegetation type***
El Zapote (Z)	20°39'45"	100°32'40"	1890	18.5	0.4	F
Mompaní (M)	20°41'55"	100°30'30"	1953	20.1	2.1	S, C
El Salitre (S)	20°40'12"	100°24'46"	1876	13.2	0.2	C
Juriquilla (J)	20°41'45"	100°27'14"	1879	26.6	2.0	A, S
Santa Catarina (Ca)	20°47'11"	100°27'12"	1999	174.3	45.7	S, C, F
Benito Juárez (B)	20°37'08"	100°23'53"	1826	16.9	0.4	S, T
El Centenario (Ce)	20°30'44"	99°53'41"	1882	192.1	46.7	S, T
Paso de Tablas (T)	20°32'48"	99°50'19"	1877	29.7	1.0	A, S
La Llave (Ll)	20°27'42"	99°59'41"	1892	380.4	87.3	A, S
Constitución de 1917* (Cn)	20°24'25"	100°04'50"	1956	592	21.8	A, S
San Luis* (L)	20°33'40"	99°58'20"	1920	25.8	2.0	S, C, F
El Carmen* (Cr)	20°34'35"	100°16'56"	1938	22.1	0.8	A, S
Amealco**	20°11'31"	100°08'38"	2550	0.8	0.2	A

* Reservoirs sampled only in the second year.

** Reservoir sampled occasionally.

***A: aquatic permanent (see text), S: semiaquatic (see text), C: crops flooded (mainly corn *Zea mays*), F: flooded land with terrestrial plant species.

Appendix 2. Aquatic birds observed in 12 reservoirs in southern Querétaro, Mexico. Species in bold type are new records for the state or confirmations of previously recorded species.

Family	Species
Anatidae	<i>Dendrocygna autumnalis</i> <i>Dendrocygna bicolor</i> <i>Chen caerulescens</i> <i>Aix sponsa</i> <i>Anas strepera</i> <i>Anas americana</i> <i>Anas platyrhynchos diazi</i> <i>Anas discors</i> <i>Anas cyanoptera</i> <i>Anas clypeata</i> <i>Anas acuta</i> <i>Anas crecca</i> <i>Aythya valisineria</i> <i>Aythya americana</i> <i>Aythya collaris</i> <i>Aythya affinis</i> <i>Lophodytes cucullatus</i> <i>Oxyura jamaicensis</i> <i>Gavia immer</i>
Gaviidae	
Podicipedidae	<i>Tachybaptus dominicus</i> <i>Podilymbus podiceps</i> <i>Podiceps nigricollis</i>
Phalacrocoracidae	<i>Phalacrocorax brasilianus</i>
Pelecanidae	<i>Pelecanus erythrorhynchos</i> <i>Pelecanus occidentalis</i>
Ardeidae	<i>Ixobrychus exilis</i> <i>Ardea herodias</i> <i>Ardea alba</i> <i>Egretta thula</i> <i>Egretta caerulea</i> <i>Egretta tricolor</i> <i>Bubulcus ibis</i> <i>Butorides virescens</i> <i>Nycticorax nycticorax</i>
Threskiornithidae	<i>Plegadis chihi</i>
Pandionidae	<i>Pandion haliaetus</i>
Rallidae	<i>Porzana carolina</i> <i>Gallinula chloropus</i> <i>Fulica americana</i>
Charadriidae	<i>Pluvialis squatarola</i> <i>Pluvialis dominica</i> <i>Charadrius semipalmatus</i> <i>Charadrius vociferus</i> <i>Himantopus mexicanus</i> <i>Recurvirostra americana</i>
Recurvirostridae	
Jacanidae	<i>Jacana spinosa</i>
Scolopacidae	<i>Actitis macularius</i> <i>Tringa solitaria</i> <i>Tringa melanoleuca</i> <i>Tringa flavipes</i> <i>Bartramia longicauda</i> <i>Numenius phaeopus</i>

	<i>Limosa haemastica</i>
	<i>Calidris mauri</i>
	<i>Calidris minutilla</i>
	<i>Calidris bairdii</i>
	<i>Calidris himantopus</i>
	<i>Limnodromus scolopaceus</i>
	<i>Gallinago delicata</i>
	<i>Phalaropus tricolor</i>
Laridae	<i>Leucophaeus atricilla</i>
	<i>Leucophaeus pipixcan</i>
	<i>Larus delawarensis</i>
	<i>Sterna forsteri</i>
Alcedinidae	<i>Thalasseus maximus</i>
	<i>Megasceryle alcyon</i>
	<i>Chloroceryle americana</i>
Troglodytidae	<i>Cistothorus palustris</i>
Parulidae	<i>Geothlypis trichas</i>
