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ARTÍCULO ORIGINAL

Non-breeding distribution, density and population structure of American Avocet (*Recurvirostra americana,* Gmelin 1789) in Marismas Nacionales, Nayarit, Mexico

Distribución invernal, densidad y estructura poblaciona de Avoceta americana (*Recurvirostra americana*, Gmelin 1789) en Marismas Nacionales, Nayarit, México

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Abstract
The Marismas Nacionales wetland system (Nayarit, Mexico) is a Site of International Importance as designated by the Western Hemispheric Shorebird Reserve Network. The American Avocet (*Recurvirostra americana*) is one of the most numerous shorebirds in the area; nevertheless, there is little information about its overwintering stay at Marismas Nacionales, despite part of the site being decreed as a Biosphere Reserve. In order to clarify some aspects of American Avocet winter ecology, we used transects and scanning sampling method during the winter: to determine distribution and abundance in the Marismas Nacionales (2010-2011), as well as density and population structure in one of the sectors of the Biosphere Reserve (2011-2013). The American Avocet wintering population in the Biosphere Reserve was calculated to be about 26,000 individuals (5.7% of the world's population), but approximately 36% of avocet wintering population in Marismas Nacionales was outside of the reserve, also there was a certain preference for some wetlands. Evidence suggests that spring migration starts during the first weeks of March. We observed some spatial segregation between sexes, but our results, although valid, are inconclusive because of difficulties in sexing individuals in the field. In spite of local changes in these wetlands, American Avocet winter population has apparently been relatively stable over the last twenty years. Therefore, Marismas Nacionales remains a key wetland for American Avocet in North America.

Keywords: Recurvirostridae, shorebirds, wintering, North America, wetlands.

Resumen
El sistema estuarino-lagunar Marismas Nacionales (México) es un Sitio de Importancia Internacional designado por la Red Hemisférica de Reservas de Aves Playeras. La Avoceta americana (*Recurvirostra americana*) es una de las aves playeras invernantes más numerosas en el área. Sin embargo hay poca información sobre su estancia invernal en el sitio, a pesar de que el sitio fue decretado Reserva de la Biosfera. En este estudio determinamos, a través de trayectos y muestreo de barrido durante el invierno (noviembre-marzo), la distribución y abundancia en las Marismas Nacionales (2010-2011), así como densidad y estructura de población en uno de los sectores de la Reserva de la Biosfera durante 2011-2013. Estimamos en 26,000 individuos la población invernante de Avoceta Americana en la Reserva de la Biosfera (5.7% de la población mundial), pero aproximadamente el 36% de la población invernante la observamos en sitios fuera del polígono de la reserva. La evidencia sugiere que la migración de primavera comenzó durante las primeras semanas de marzo. Hemos observado alguna segregación espacial entre los sexos, pero nuestros resultados, aunque válidos, no son concluyentes debido a la dificultad de identificación de los sexos en algunos individuos. A pesar de los cambios en estos humedales, la población invernante de Avoceta americana ha permanecido relativamente estable en los últimos veinte años. Por lo que Marismas Nacionales sigue siendo un humedal clave para la Avoceta americana en Norteamérica.

Palabras clave: Recurvirostridae, aves playeras, invernación, Norteamérica, humedales.

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Introduction

The American Avocet is a migratory shorebird with blue-gray legs, slightly webbed feet and wing plumage with a chevron pattern. This bird inhabits a wide variety of wetlands, freshwater and brackish, preferably shallow, and with fine sediment (Hamilton 1975, Robinson *et al.* 1997, Danufsky and Colwell 2003); it preys upon a variety of invertebrates with its long, slender, recurved bill. During prealternate molt, the head becomes progressively cinnamon while the rest of the plumage remains light gray (Prater *et al.* 1977). Its total length is around 47 cm, with a 72 cm wingspan and an average weight of 360 g (275-440 g). Overall, sexes have similar plumage but show a certain degree of dimorphism regarding body size and bill shape (Hamilton 1975, Robinson *et al.* 1997).

This species' breeding range encompasses western, central and southern North America, whereas winter distribution extends on the Pacific coast from northern and interior of California, south, along the western coast of Mexico to Central America, where the species decreases markedly, and in the Atlantic coast from Virginia to the Yucatan Peninsula and inland from Chihuahua to the central valley of Mexico (Howell and Webb 1995, Robinson *et al.* 1997, AOU 1998). Most research about American Avocet addresses breeding biology aspects (Ackerman *et al.* 2013) and to a lesser extent the non-breeding period, although the latter mainly in the southern United States (Colwell 1994, Shuford *et al.* 1998, Page *et al.* 1999, Colwell *et al.* 2001, Shuford *et al.* 2007).

In Mexico, a number of studies have documented the presence of small local nesting colonies throughout the country (Valles-Rosales 1986, Palacios and Alfaro 1991, Mellink and Palacios 1993, Mellink *et al.* 1996, Carmona *et al.* 2000, Mellink *et al.* 2002, Erickson *et al.* 2007, Ayala-Pérez *et al.* 2014, Venegas-Holguín *et al.* 2015); however, during the winter season the greatest numbers have been reported on the Pacific coast, particularly in the Northwest region including the wetlands of Sinaloa and Nayarit (Morrison *et al.* 1992, Harrington 1993, Morrison *et al.* 1994, Engilis *et al.* 1998, Morrison and Ross 2009, Carmona and Danemann 2013). In the state of Nayarit, where the Marismas Nacionales estuarine system is located, the American Avocet has been determined to be one of the most numerous winter shorebirds (Morrison *et al.* 1994, Morrison and Ross 2009). Because of its importance to shorebirds, Marismas Nacionales was recognized as a Site of International Importance (WHSRN 1992). Later in 1995, it was identified as a Ramsar site (Ramsar Convention 1995) and in 1998 as an Important Bird Area (Arizmendi and Márquez-Valdelamar 2000). Also, its ecological features, biodiversity, and natural resource richness led that part of the wetland to be decreed as a Biosphere Reserve by the Mexican federal government (DOF 2010, CONANP 2013).

Nonetheless, there are few studies supporting the wintering, breeding or migrating importance of Marismas Nacionales for shorebirds (Ortega-Solís 2011, Ortega-Solís *et al.* 2017). Therefore, the aims of this study were to estimate American Avocet relative abundance and distribution at Marismas Nacionales, and specifically, to determine density and population structure (sex and age proportion) at El Chumbeño lagoon during three winter periods, because this wetland is considered as the numerically most important site for the species in the Biosphere Reserve (Ortega-Solís *et al.* 2011). This provides information for stakeholders for monitoring, management and conservation practices in the Biosphere Reserve.

Methods

Study area

Marismas Nacionales has an estimated area of 350,000 hm^2 (Bojórquez-Tapia *et al.* 2001) and lies between northwestern Nayarit and southern Sinaloa. The climate is humid and subtropical. The average precipitation is around 1,200 mm (Blanco *et al.* 2011), which gives the region a marked seasonality and affects ecosystem salinity and productivity (Blanco *et al.* 2011). This marshland (Figure 1) includes diverse landscapes such as 70,000-85,000 hm^2 of mangrove cover forest (*Laguncularia racemosa, Rhizophora mangle, Avicennia germinans* and *Conocarpus erectus*), but also important areas of

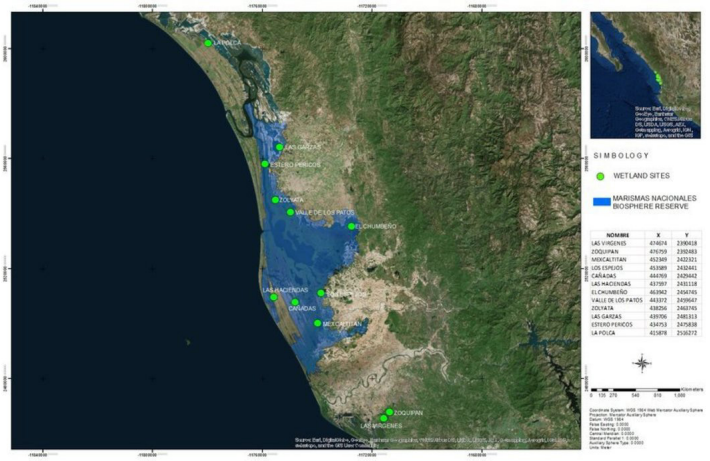

Figure 1. Marismas Nacionales wetlands ecosystem, it is located northwest of Nayarit and south of Sinaloa states. The Biosphere Reserve boundaries are indicated in blue, and only was decreed in Nayarit portion. Study sites are the green dots.

floodplains, mudflats, sandbars, marshes, and coastal lagoons (Bojórquez *et al.* 2006, Ruiz-Luna *et al.* 2006, CONABIO 2009, Berlanga-Robles *et al.* 2010). The region supports important artisanal fisheries (*e.g.*, white shrimp, oysters, and snook) and aquaculture farms, so a strong pressure on natural resources exists (González *et al.* 2009, CONANP 2013).

Fieldwork

In order to estimate American Avocet winter population in Marismas Nacionales (*i.e.* abundance), we surveyed 12 wetland-sites (Table I). The selection of these wetlands was based on the results of previous counts of shorebirds in the Marismas Nacionales wetland complex (Ortega-Solís 2011, Carmona *et al.* 2012), where was noted that these wetlands support the largest population of shorebirds during the non-breeding period. Also, we assessed the density and population structure at El Chumbeño lagoon (3,900 hm^2). This is a shallow body of water and it is located 32 km from the coastline (1 m elevation); water level fluctuations at shoreline favors mudflat exposure and an annual mean salinity of 20.3±19.2 ppm (Güemez-Álvarez 2011). We chose this lagoon because previous counts in Marismas Nacionales indicated the importance of the site, in numerical terms, for the American Avocet (Ortega-Solis 2011) and because the greater relative abundance of avocets observed in winter 2010-2011.

The boundaries of selected wetlands are variable and, within each wetland, the habitat portion suitable for American Avocet varies depending on the month; because of this, sampling effort was stratified, as it was focused on the habitat portions suitable for avocets, like shallow waters and mudflats. The numbers of avocets were estimated between November 2010 and June 2011, and we conducted 96 surveys in total (eight months and twelve sites, Table I). The count of avocets was done through transects. Due to the peculiar characteristics of each site the observations were carried out walking, on a boat or in a terrestrial motor vehicle, these latter two at low

Table I. Sampled locations in Marismas Nacionales, Nayarit, visited during the 2010-2011 winter period to estimate American Avocet population numbers.

Wetland	Area covered (hm)	Transect mode (lenght in km)	Habitat type
Zoquipan	200	Boat (2.5)	Freshwater and estuarine lagoon; red mangrove forest, freshwater marsh.
Las Vírgenes	100	Boat (2.6)	Permanent small lagoons, with red mangrove forest and pickleweed beds (*Salicornia*).
Mexcaltitán	950	Boat (14.2)	Brackish shallow lagoon system. White mangrove and freshwater vegetation (*Typha, Eichhornia*).
Los Espejos	135	Walk (2.2)	Seasonal wetland; white and black mangrove forest, pickleweed beds, mudflats.
Las Cañadas	2800	Automobile (13.0)	Extensive shallow-brackish lagoons; sandbars, white mangrove patches, pickleweed beds (mainly *Batis*).
Las Haciendas	1850	Automobile (9.45)	Seasonal and permanent shallow brackish lagoons; white mangrove patches, pickleweed beds, mudflats.
El Chumbeño	2600	Boat, Walk (19.2)	Permanent shallow brackish lagoon; sparsely white mangrove bushes, mudflats.
La Zolyata	315	Boat (4.5)	Permanent shallow brackish lagoon; dense white mangrove forest, marshes.
Valle Los Patos	850	Boat (7.35)	Permanent brackish shallow waters; dense white mangrove forest.
Las Garzas	1530	Walk (15.8)	Shallow brackish lagoon; mudflats, pickleweed marsh, button mangrove patches.
Los Pericos	830	Walk (8.5)	Extensive estuarine shallow waters. Sparse mangrove cover, marsh pickleweed beds.
La Polca-Estacada	7100	Boat, Walk (34.5)	Permanent shallow brackish lagoon. Button mangrove patches, mudflats.

speed (5-10 km/h). The implementation of each transect was systematic in each wetland. Also, transect total length depended on the size of the wetland, trying to maximize the estimation of avocets in the suitable habitat area. Transects were adjusted to the shoreline or along the middle of the body of water of the wetlands. It is important to note that during the non-breeding period, shorebirds usually congregate in mixed and sometimes extensive flocks, which makes it difficult to count groups. So when we crossed the sites, we tried to count carefully the abundance of birds, meaning that when the number of American Avocet was low, a one by one count was possible, but when this is not possible, i.e. when the size of the group was too large (≥300 birds) we stopped and made an estimate of "blocks of the flock", that is, a portion of the group was counted, and that "block", was extrapolated to the rest of the group (Howes and Bakewell 1989, Kasprzyk and Harrington 1989).

Because the estimates are inaccurate counts, it is appropriate to point out that it is rather a relative estimation index between wetlands. Counts were made by two experienced observers, each in a two man team and these efforts were systematic. A single observer may find it difficult to count and record large numbers of birds without the aid of the second observer who records this in a field notebook and allows discussion on numbers estimated and identification by a second observer (Howes and Bakewell 1989).

In this site, tide has a very low daily variation and apparently has a no effect or influence on American Avocet numbers; we did not take it into account for sampling. We began surveying one hour after sunrise (around 07:00-07:30 h) and although the end of the counts varied according to the wetlands and avocets present, it was normally around 11:00-12:00 h which is when the temperature is higher and the apparent activity of birds decreases. It is important to indicate that during the counts the total area of the wetlands was not covered, in addition to the fact that the boundaries of some sites are not fully defined.

Likewise, in El Chumbeño lagoon we carried out observations in two later winter seasons (Nov 2011- Mar 2012 and Nov 2012- Mar 2013) to determine density and population structure. Based on previous observations in the lagoon, the habitat available to shorebirds and specific to the American Avocet is restricted to two portions of the wetland: one towards the inner part of the lagoon known as Pescadero and the other at the outer portion, named El Fraile; so the observation effort was concentrated in these two areas. Both areas have extensive and relatively shallow waters, with little variation in water level.

In order to estimate the population density in the lagoon, we delimited seven sampling subunits in each of the two areas (Pescadero and El Fraile). The selection, although random, was related to previous observations in the mentioned areas and the delimitation of the subunits was a function of landscape features, such as sandbars, channels or mangrove rows. These subunits covered a total area of 950 hm^2 (500 hm^2 at Pescadero and 450 hm^2 in El Fraile). To estimate the density we used $D=N/A$, where D=mean density at the area, N=number of avocets per subunit and A=subunit size. Because of this, we consider it a good estimate of the density of avocets in the available habitat.

We determined sex using bill shape. Avocets with relatively straight bills were classified as males and those with markedly recurved bills were recorded as females (Hamilton 1975, Prater *et al.* 1977). Sometimes we could not determine individual sex for three reasons: 1) some birds have a slightly recurved bill and it is difficult to establish the sex; 2) resting avocets conceal the bill between flight feathers, so it was impossible to us determine sex, and 3) related to the distance between bird and observer, visual distortions due to evaporation and/or light reflection make determination difficult.

Age was determined based on plumage characteristics (color and wear) but it was limited to November since at later dates, molting of the plumage hinders the separation of age classes. In late autumn-early winter, adult avocets are characterized by more marked and sharp tones in plumage, head coloration is practically light gray and superficially show less worn and molting feathers. Conversely immature individuals show a paler shade of plumage, more worn and less consolidated appearance (more brownish to black), and it has been pointed out that part of the immature population maintains pink tones in the plumage of the head, even at the end of the autumn period (Hamilton 1975, Pyle 2008). Counts in all wetlands were made with the aid of a 20-60x scope, field data were captured by a handheld recorder or by a second observer in a notebook; it should be noted that the observations at the Chumbeño lagoon were carried out by the same observer team.

Data analysis

Temporal and spatial variations of the number of avocets estimated were analyzed through a two-way analysis of variance. In each case, controlling variables were months and wetlands. Also, to be able to compare the relative abundances among wetlands, a kilometric abundance index (KAI) was determined, which is the number of avocets observed per kilometer surveyed (Sánchez-Bon *et al.* 2010).

To evaluate the linkage between months, population structure, and sites (*i.e.* Pescadero and El Fraile), we implemented a Xi^2 multiple independent test, where variables were months and sites. Age was compared by Xi^2 independent test, considering winter seasons as treatments (Zar 2010); however, we only could determine the age at early winter. Confidence level was set at 95% in all cases (α=0.05). To perform analyses and visualize results we used Minitab 16.1 (Minitab 2010) and Statistica 9.0 (StatSoft Inc. 2007).

Results

Distribution and abundance. The estimated cumulative abundance of American Avocet reached 138,164 individuals (November 2010 – June 2011). Numerically, the most important wetland was El Chumbeño (50.2% of cumulative recorded avocets), followed by La Polca (31.3%) and Las Garzas-Chahuin (7.5%) (Table II). We found that estimated abundance between localities and along winter months varies, not only temporally but also spatially ($F_{7,11}$=8.68; P<0.05).

We estimated the highest numbers during the middle of the winter (January, at least 39,000 wintering American Avocets) and the lowest in summer (121 individuals). Avocets were well represented in November, increased markedly from December through January, when the highest winter population size was estimated, followed by a 40% decreased in February; this trend continuing until reaching minimum values in June.

Likewise, the KAI showed differences between months and sites. On average, in Marismas Nacionales the KAI highest value occurred during January (168.5 avocets/kilometer), while the lowest value was in June (0.70 avocets/kilometer) (Figure 2). The Chumbeño lagoon presented the highest KAI during most of the months, that is, from November to March, with the maximum values between November and January. The Polca lagoon had, in general, the KAI of second major importance, with maximum values in December through January. However, at the end of the non-breeding season, between April and June, sites such as Valle de Los Patos, La Zolyata and Las Haciendas become relatively important.

American Avocet density and population structure in El Chumbeño. Average density was 5.29 avocets/hm^2 ±3.78 (range 0-15.12 avocets/hm^2) at El Chumbeño lagoon during the study period (November-March). The highest density occurred during winter and less in migratory periods ($F_{4,65}$=12.8, P<0.05) (Figure 3). However, no difference was detected between Pescadero (5.15 avocets/hm^2 ±4.24, inner coast) and El Fraile (5.44 avocets/hm^2 ±3.30, outer coast) areas ($F_{1,78}$=0.10, P=0.75).

Table II. Monthly and cumulative abundance of American Avocet in Marismas Nacionales, Mexico (2010-2011 winter season).

Month /Wetland	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Cumulative abundance
El Chumbeño	19869	21056	17476	8710	2010	122	99	60	69,402
La Polca-Estacada	4007	11676	15924	10785	682	22	108	0	43,204
Garzas- Chahuin	2406	2272	3623	1682	129	27	144	27	10,310
Valle de Los Patos	329	58	1921	570	440	875	429	0	4,622
Las Haciendas	1063	1461	154	261	2	44	108	33	3,126
Cañadas	525	452	503	1503	17	57	0	1	3,058
Estero Pericos	1554	52	40	75	20	0	0	0	1,741
Laguna Zoyata	207	520	113	94	63	315	93	0	1,405
Las Vírgenes	40	29	130	261	257	0	81	0	798
Los Espejos	147	102	23	6	3	0	0	0	281
Mexcaltitan	44	50	5	7	2	2	0	0	110
Zoquipan	0	3	35	66	3	0	0	0	107
Total	30191	37731	39947	24020	3628	1464	1062	121	138,164

In relation to the population structure, and combining the observations of both winter periods, males accounted for 53.2% and females 46.8%. Under a local spatial framework, we detected a slight predominance of females at Pescadero, that is, in the innermost section of the lagoon (Xi^2_6=12.8, P=0.04), and a stronger male presence in the outermost zone (Xi^2_6=227.3, P<0.01). Also, apparently females tended to leave the area first (Xi^2_3=97.9, P<0.01) (Figure 4A). Taking into account the age, American Avocet population in El Chumbeño lagoon was dominated by adults (80%, n=1,021) and winter season did not affect the immature proportion (Xi^2_1=1.3, P=0.25) (Figure 4B).

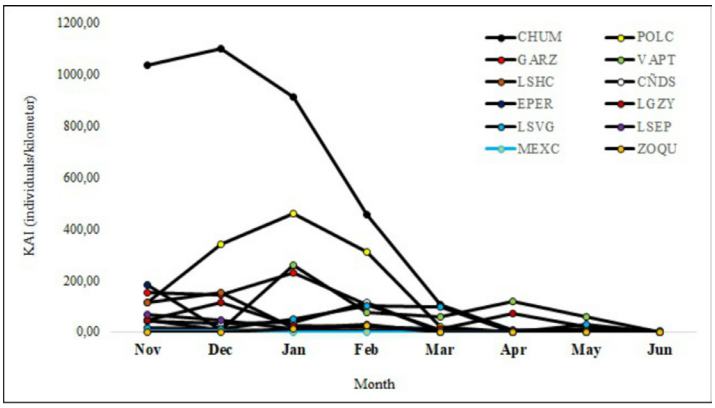

Figure 2. Spatial and temporal variation of the Kilometer Abundance Index (KAI) of American Avocets in Marismas Nacionales over the winter. (CHUM=Chumbeño, GARZ=Las Garzas, LSHC=Las Haciendas, EPER=Estero Pericos, LSVG=Las Vírgenes, MEXC=Mexcaltitán, POLC=La Polca, VAPT=Valle de los Patos, CÑDS=Cañadas, LGZY=La Zolyata, LSEP=Los Espejos and ZOQU=Zoquipan).

Discussion

In the present study, we estimate a wintering population of at least 39,000 American Avocets in Marismas Nacionales (8.7% of the whole population; Andres *et al.* 2012). Although this abundance is greater than previously reported for the region: 25,400 (Morrison *et al.* 1994), 20,500 (Ortega-Solís 2011) and 27,000 (Carmona and Danemann 2013), it is important to mention that estimates of wintering groups have been under different methods of estimation and covered different surface area (*e.g.* we include Sinaloa wetland), some surveys were aerial (Morrison *et al.* 1994) and some on foot and vehicle (Ortega-Solís 2011, this study), also were temporarily restricted (Morrison *et al.* 1994, Carmona and Danemann 2013) while others sampled over the winter (Ortega-Solís 2011, Carmona *et al.* 2012), thus this limits comparison (Figure 5).

However, taking into account only the sites in Marismas Nacionales (Nayarit), the present study estimated a wintering population of at least 26,000 American Avocets, which des-

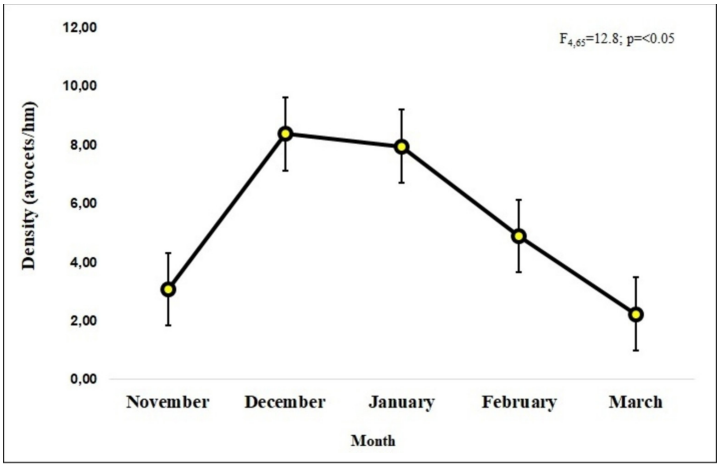

Figure 3. American Avocet density at El Chumbeño lagoon during winter season, two winter periods pooled (2011-2013; mean bar, EE line).

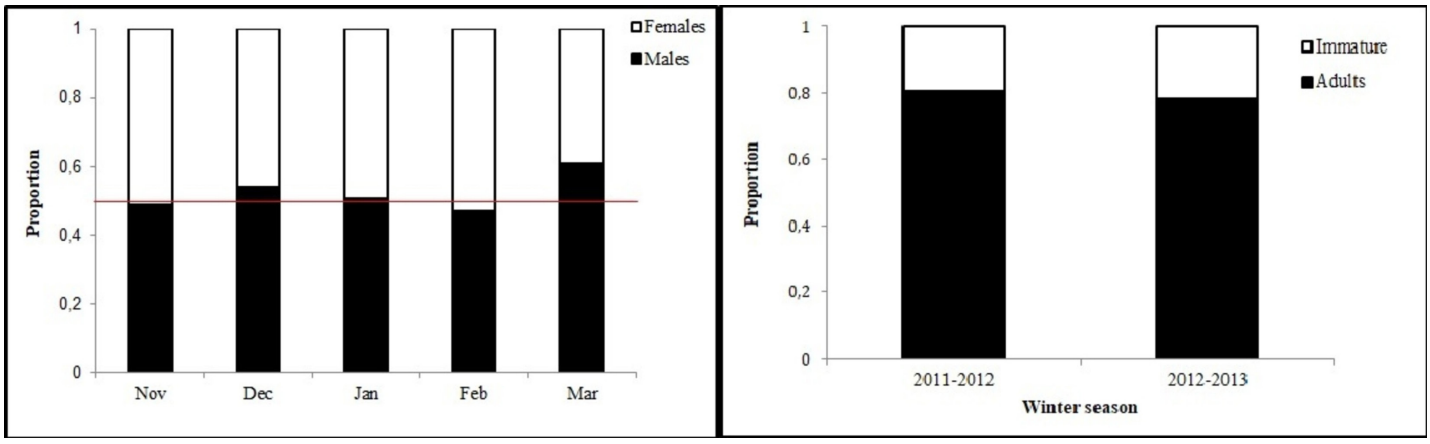

Figure 4. A) Temporal variation of males and females proportion within El Chumbeño lagoon, Marismas Nacionales (winter periods 2011-2012 and 2012-2013). B) Interannual variation of adults and immatures proportion within El Chumbeño lagoon, Marismas Nacionales (winter periods 2011-2012 and 2012-2013).

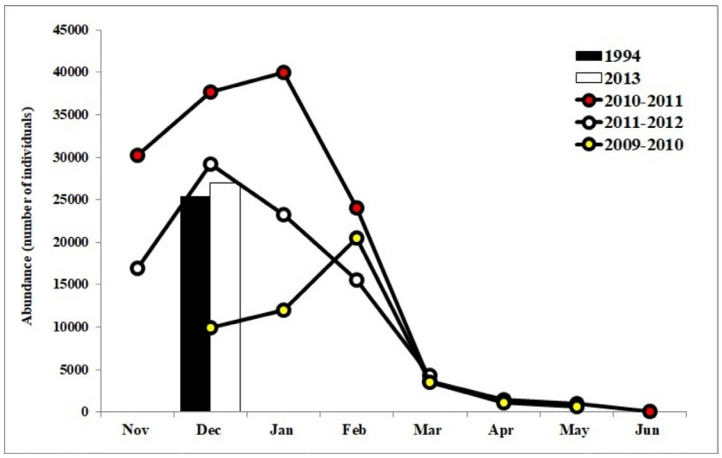

Figure 5. Comparison of American Avocets wintering numbers in Marismas Nacionales, Nayarit. This study (red circles), Ortega-Solís (yellow circles), Carmona *et al.* 2012 (white circles), Morrison *et al.* 1994 (black bar), Carmona and Danemann 2013 (white bar).

pite the differences in the estimation methods employed, is in agreement with the previous estimates. In this sense, these studies and the present one emphasize the importance of the Marismas Nacionales Biosphere Reserve for avocets, since it holds at least 5.7% of whole population.

These showed that winter population of American Avocet over last twenty years in Marismas Nacionales has apparently been relatively stable, despite local changes in environment, *i.e.* an increase in aquaculture area (loss of 8% of mangrove cover) and altered flood dynamics (Blanco *et al.* 2011). In this study Marismas Nacionales was apparently used primarily as an overwintering site. From February through June no increases in avocet numbers were observed; although wintering groups of thousands of individuals have been reported south of Marismas Nacionales (Morrison and Ross 2009). Ortega-Solís (2011) notes that Marismas Nacionales might be more used as a passage area for birds heading north, instead of an overwintering site. It is noteworthy that Ortega-Solís (2011) did not include wetlands located in the Sinaloa portion, but even excluding those sites the use pattern remains as an overwintering area. A subsequent unpublished study (Carmona *et al.* 2012) is consistent with the pattern shown here: higher abundance during November through January, and a subsequent decrease.

However there are many factors that can affect count results, like climatic events, observer experience, dating, human disturbance, and presence of predators, among others. Besides that the avocet's abundance could vary seasonally (Ackerman *et al.* 2013). To analyze this, long-term studies are needed (Ackerman *et al.* 2013), and either way counts do not provide information about turnover rate (Reed *et al.* 1996).

Beyond these differences, in agreement with Ortega-Solís (2011) among others (Carmona *et al.* 2012, Carmona and Danemann 2013), is that El Chumbeño lagoon was, based on numbers, the most important site for American Avocet on the Biosphere Reserve (Figure 6). We determined that at least 21,000 American Avocets used this wetland during winter, which represents 80% of the avocet wintering population among the sites visited within the Biosphere Reserve. This lagoon is a sedimentation wetland (Blanco *et al.* 2011), and this is consistent with what American Avocet prefers: sites with finer sediments, because their bill is very sensitive (Colwell *et al.* 2001, Danufsky and Colwell 2003, Ackerman et *al.* 2013).

The general greatest KIA of American Avocet in El Chumbeño and La Polca-Estacada lagoons, is presumed to be related to its character of being perennial coastal wetlands, with a wide range of depths (0 to >20 cm). This is because it is assumed that American Avocet prefers non-tidal wetlands and deeper areas than other shorebirds (Boettcher *et al.* 1994, Boettcher *et al.* 1995, Robinson *et al.* 1997).

During winter American Avocet displayed regional movements, which results in temporal and spatial changes in abundance among wetlands (Demers *et al.* 2010). The preference for certain sites could be reflected in the population density at those wetlands. Shuford *et al.* (2007) in the Central Valley of California, considered that higher avocet density is associated with lack of tidal effect and constant availability of foraging habitat. In El Chumbeño lagoon tidal fluctuation caused null changes in water levels (Blanco *et al.* 2011), so foraging areas are not restricted and remain available. In addition, energy cost associated with movements between resting and feeding areas is important in site selection (Farmer and Parent 1997), in this wetland both type of areas are close, and so this energy expenditure is reduced.

The major departure of avocets to breeding areas started in the first two weeks of March (Ortega-Solís 2011, Carmona *et al.* 2012, this study), linked with the fact that nesting typically begins in April (Cavitt 2007, Ackerman *et al.* 2013), and at the same time, it is noted that there is a decrease in trophic resources in these wetlands, i.e. invertebrates (Molina *et al.* 2013).

The sexual dimorphism in shorebirds, it has been linked with competition for resources (Myers 1981), and in some species it is indicated as a driver in geographical segregation patterns between sexes (Nebel *et al.* 2002, Nebel 2005). In this study, we observed similar sex proportion, so there is nothing that suggest us to assume geographic segregation. However, American Avocet sex ratio (1:0.88 in favor males), probably it is associated with reduced competition. Also, avocets are not strictly territorial, because breeding grounds are unpredic-

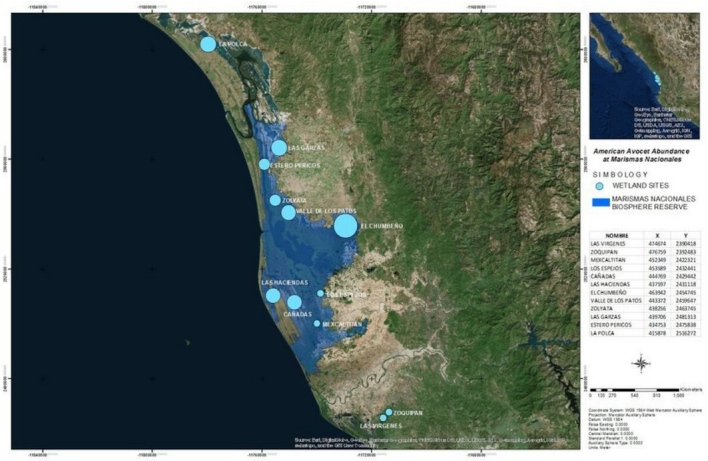

Figure 6. American Avocet relative abundance in Marismas Nacionales wetlands during winter stay; diameter of circle it is a representation of relative abundance. Biosphere Reserve surface it is indicated in blue shape.

table in terms of resources (Plissner *et al.* 1999, Ackerman *et al.* 2013), so latitudinal sex segregation is not advantageous. Therefore, in this case, individuals, regardless of sex, tend to be concentrated in favorable areas.

The observed lowest female' proportion in March apparently indicates an early sex-biased departure to the north, but Gibson (1971) mentioned that both sexes come "simultaneously" and coupled to breeding sites, this is because mating does not have a territorial component (Sordahl 1984, Ackerman *et al.* 2013); in addition, the sample size in this study during March was too small and could not be representative of the whole wintering population. Due to the above, we can only indicate a similar proportion of males and females in El Chumbeño.

Robinson and Oring (1996) indicated that American Avocet adults preferably occupy inland wetlands and immature classes are excluded to less profitable areas, like coastal sites. El Chumbeño is an internal wetland (32 km distance from the coastline), not subject to tidal fluctuations, with extensive shallow waters and constant prey availability (Blanco *et al.* 2011, Molina *et al.* 2013). This factors could explain the predominance of adults in this lagoon (Robinson and Oring 1996, Robinson *et al.* 1997, Colwell *et al.* 2001) and like other shorebird species (Fernández and Lank 2006, Van den Hout *et al.* 2014), point out a spatial segregation related to age. Although it is possible to be valid, our observations was temporarily and spatially restricted. In addition, it is possible that a lower proportion of immature avocets derived from natural processes of mortality in this age group.

The above implies that Marismas Nacionales still is a profitable winter wetland for American Avocet in North America. The origin of American Avocet winter population definitely implies several breeding colonies (Robinson and Oring 1996). According to this, it is noteworthy to mention that although data are scarce, there is a certain migratory connectivity between the Intermountain West and Marismas Nacionales regions (Robinson and Oring 1996, Utah Linking Communities 2015).

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