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Aerial surveys of Nearctic shorebirds wintering in Mexico: Preliminary results of surveys on the Gulf of Mexico and Caribbean coasts

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Abstract

Aerial surveys of the Gulf of Mexico and Caribbean coastlines of Mexico were carried out in January 1993 to determine the distribution and numbers of wintering Nearctic shorebirds, as the second year of a planned three-year Mexican Shorebird Atlas Project. A total of 124 901 shorebirds was observed during the surveys. Small shorebirds were the most abundant group (63 771), consisting principally of "peeps" (50 837, unidentified small shorebirds, probably mostly Western Sandpipers and other small sandpipers) in areas with soft mudflats and Sanderlings (12 743) on ocean beaches. Medium-sized shorebirds (48 563) were the second most numerous category: dowitchers (25 726, both Long-billed and Short-billed dowitchers) were widely distributed, although with highest concentrations on the northern Gulf coast; Black-bellied Plovers were also widely distributed and found both in wetlands and on ocean beaches. Amongst the large shorebirds (12 567), American Avocets (5683) were the most numerous species and, like the Marbled Godwit (1567), were restricted mostly to the northern part of the Gulf coast. Black-necked Stilts (785) were widely distributed in coastal wetlands, highest numbers being recorded on the Yucatan Peninsula. Willets (2499) were widely distributed both in wetlands and along coastal beaches. Only one site, the Laguna Madre on the northern Gulf coast, held substantial totals of wintering shorebirds (80 924); this extensive lagoon system would be expected to qualify at least as an International Site (defined as a site supporting over 100 000 shorebirds during the year) under the criteria for the Western Hemisphere Shorebird Reserve Network when populations passing through the area on migration are taken into account. Rather modest numbers of wintering shorebirds were found at other wetlands on both Gulf and Caribbean coasts; possible reasons are discussed.

Shorebird numbers during migration periods need to be determined.

Resumen

En enero de 1993, se llevaron a cabo censos aéreos a lo largo de la costa mexicana del Golfo de México y del Caribe, para determinar la distribución y números de aves playeras neárticas invernantes. Este fue el segundo año de un plan de tres años para realizar el Proyecto del Atlas de Playeras Mexicanas. Durante estos censos se observaron 124 901 aves playeras. Los más abundantes fueron las aves playeras pequeñas (63 771), principalmente *Calidris mauri* y otras aves playeras pequeñas no identificadas (50 837) en áreas con zonas de marismas, y *C. alba* (12 743) en playas oceánicas. Las aves playeras medianas ocuparon el segundo lugar (48 563), de los cuales *Limnodromus* spp. (25 726, *Limnodromus scolopaceus* y *L. griseus*) fueron los más abundantes y ampliamente distribuidos, aunque las concentraciones mayores se encontraron en la costa norte del Golfo. Otra especie que también se encontró ampliamente distribuida fue *Pluvialis squatarola*, tanto en humedales como en playas oceánicas. Entre las aves playeras grandes (12 567), *Recurvirostra americana* fue la más numerosa (5 683); que al igual que *Limosa fedoa* (1 567) se les encontró restringidas principalmente a la parte norte de la costa del Golfo. *Himantopus mexicanus* (785) se encontró ampliamente distribuida en los humedales costeros, principalmente en la península de Yucatán. *Catoptrophorus semipalmatus* (2 499) se encontró bien distribuido, tanto en humedales como en playas costeras. Un solo sitio, la Laguna Madre en la costa norte del Golfo, presentó el número más importante de aves playeras invernantes observadas (80 924) y por tanto calificaría, al menos, como Sitio de Importancia Internacional (definido como un sitio donde se puedan mantener más de 100 000 aves playeras durante el año), bajo el criterio de la Red Hemisférica de Reservas de Aves Playeras, si tomamos en cuenta las poblaciones migratorias. En los demás humedales del Golfo y del Caribe, se encontraron números bajos de playeros; aquí se discuten las razones posibles de esta distribución. Se necesita determinar los números de playeras que ocurren en el área durante periodos migratorios.

Introduction

The coastal zone of Mexico extends along an estimated 6760 km of coastline on the Pacific Ocean and 2900 km on the Gulf of Mexico and Caribbean Sea. These coastlines contain a number of areas of major international importance for waterfowl (Scott and Carbonell 1986) and shorebirds (Morrison et al. 1992). Although aerial surveys for ducks,

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Table 1
Summary of information on 1993 aerial surveys along the Gulf of Mexico and Caribbean coasts of Mexico

Date	Time	Coverage	Weather
23 January	13:15-16:30	Matamoros - Laguna Madre - Matamoros	Strong southeast wind (25-35 km/h), cloudy, 25°C
24 January	13:15-17:10	Matamoros - Laguna Madre - Tampico	Strong northwest wind (35-55 km/h), cloudy, 12°C
25 January	09:35-12:45	Tampico - lagoons - Tampico	Light to moderate southeast wind, sunny, 18°C
	14:15-16:10	Tampico - Veracruz	Strong northeast wind, clear, 20°C
26 January	09:50-11:30	Veracruz - Minatitlan	Strong north wind (25-45 km/h), overcast, rain and fog, 20°C
27 January	11:10-13:50	Minatitlan - Ciudad del Carmen	Moderate north wind, cloudy, clearing, 20°C
	14:40-17:45	Ciudad del Carmen - Campeche - Merida	Clear, light west wind, 25°C
28 January	10:20-13:30	Merida - Puerto Progreso - Campeche - Puerto Progreso - Merida	Clear, light west wind, 28°C
29 January	08:00-12:20	Merida - Puerto Progreso - Rio Lagartos - Cancun	Clear, light northeast wind, 30°C
	14:30-16:45	Cancun - Cabo Catoche - Isla Contoy - Cancun - Playa del Carmen - Isla Cozumel - Cozumel	Clear, light northeast wind, 32°C
30 January	10:00-13:40	Cozumel - Playa del Carmen - Chetumal	Clear, light east wind, 30°C
	15:00-15:45	Chetumal - Bahia Chetumal - Chetumal	Clear, moderate northeast wind, 30°C

geese, and Neotropical water birds have been carried out for many years in Mexico (see references in Scott and Carbonell 1986, and unpublished U.S. Fish & Wildlife Service reports), little specific information is available on populations of Nearctic shorebirds either wintering in or migrating through these areas. Aerial surveys in recent years over extensive geographical areas in Mexico (Morrison et al. 1992), Panama (R.I.G. Morrison, R.K. Ross, F. Delgado, and R. Butler, unpubl. data), South America (Morrison and Ross 1989), and North America (Morrison and Myers 1989; Morrison 1992) have demonstrated that many species concentrate to a remarkable degree both during the winter and on migration. These ongoing studies led to the development of the Western Hemisphere Shorebird Reserve Network, which seeks to protect all the key sites used by the birds throughout their annual cycle and thus to maintain the integrity of the system of habitats upon which the birds depend for their survival.

A key requirement for future conservational planning and further development of the Western Hemisphere Shorebird Reserve Network is an assessment of the wintering distribution of shorebirds on the coastlines of Mexico. This report presents preliminary results of the second year of a planned three-year Mexican Shorebird Atlas Project, involving aerial surveys of the coastlines of the Gulf of Mexico and Caribbean Sea in January 1993 to determine the distribution and numbers of wintering Nearctic shorebirds. The project is being carried out under the Canada/Mexico/U.S.A. Tripartite Agreement and is part of the Canadian Wildlife Service Latin American Program.

Methods

Aerial surveys of the Gulf of Mexico and Caribbean coastlines of Mexico were carried out from 23 to 30 January 1993. Flight itineraries and conditions are shown in Table 1. Survey procedures followed those used in

previous surveys in South America and Mexico (Morrison and Ross 1989; Morrison et al. 1992). Surveys were conducted in a Cessna 182 fixed-wing aircraft flying at approximately 40-50 m above ground level and at an airspeed of 160-240 km/h, depending on the densities of shorebirds being encountered and the circuitousness of the flight path. The flights followed a line roughly 25 m offshore of the water's edge, with the two principal observers (RIGM and RKR) looking inland from the copilot's seat and the seat behind, respectively. All shorebirds seen were counted and observations recorded directly onto audio cassettes for later transcription. The third observer (JG or AE) counted shorebirds and other species of interest, made habitat descriptions, and alerted the principal observers to groups of shorebirds that flushed to the left of the aircraft. Every effort was made to cover all habitats, including lagoons, that were appropriate for those shorebirds that forage on muddy substrates or in the intertidal zone. Flights were carried out mostly between 09:00 and 17:30 local time in order to avoid glare caused by low sun angle (see Table 1).

Numbers of shorebirds were determined by direct counting when flocks were small or by visual estimation when larger concentrations were encountered. Identifications were made at the species level wherever possible, although birds had to be assigned to size categories (Table 2) when viewing conditions or the size and diversity of the flocks did not allow some species to be identified. The aircraft's position throughout the survey was accurately determined through onboard GPS systems and by regular time checks at and between known geographical locations. For this report, the shoreline covered was divided into 52 zones (Fig. 1, Table 3), each composed of a number of smaller sectors (total 235), to facilitate analysis. Sectors generally represent units of reasonably homogeneous habitat (e.g., sandy beach, estuarine mudflat, mangrove complex), usually bounded by obvious landmarks. Shorebird counts obtained by each principal observer were

Table 2
Size categories of species of Nearctic shorebirds observed during the 1993 aerial surveys along the coasts of the Gulf of Mexico and Caribbean Sea in Mexico

Common name	Scientific name	Code ^a
Small		
Snowy Plover	<i>Charadrius alexandrinus</i>	SNPL
Wilson's Plover	<i>Charadrius wilsonia</i>	WIPL
Semipalmated Plover	<i>Charadrius semipalmatus</i>	SEPL
Spotted Sandpiper	<i>Actitis macularia</i>	SPSA
Sanderling	<i>Calidris alba</i>	SAND
Western Sandpiper	<i>Calidris mauri</i>	WESA
Least Sandpiper	<i>Calidris minutilla</i>	LESA
Pectoral Sandpiper	<i>Calidris melanotos</i>	PESA
Dunlin	<i>Calidris alpina</i>	DUNL
Medium-sized		
Black-bellied Plover	<i>Pluvialis squatarola</i>	BBPL
Killdeer	<i>Charadrius vociferus</i>	KILL
Greater Yellowlegs	<i>Tringa melanoleuca</i>	GRYE
Lesser Yellowlegs	<i>Tringa flavipes</i>	LEYE
Ruddy Turnstone	<i>Arenaria interpres</i>	RUTU
Stilt Sandpiper	<i>Calidris himantopus</i>	STSA
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	LBDO
Short-billed Dowitcher	<i>Limnodromus griseus</i>	SBDO
Large		
American Oystercatcher	<i>Haematopus palliatus</i>	AMOY
Black-necked Stilt	<i>Himantopus mexicanus</i>	BNST
American Avocet	<i>Recurvirostra americana</i>	AMAV
Willet	<i>Catoptrophorus semipalmatus</i>	WILL
Whimbrel	<i>Numenius phaeopus</i>	WHIM
Long-billed Curlew	<i>Numenius americanus</i>	LBCU
Marbled Godwit	<i>Limosa fedoa</i>	MAGO

^a Other abbreviations/codes: PEEP = small shorebirds
YELL = yellowlegs
DOWI = dowitchers

compared for each sector, and the higher counts for each species or size group were used in the analysis. Small, but occasionally important, differences in counts may have resulted when an observer was temporarily involved in navigation, photography, or equipment checks. Zone totals have not been rounded in tables or text in the present report.

Some delays and difficulties were experienced with very windy weather during surveys of the Laguna Madre. Although all areas of the Laguna Madre were visited during the surveys, the very extensive areas of open intertidal mudflats made comprehensive coverage of all available habitats impracticable in the time available and under the windy conditions encountered, so that totals are likely to represent minimum numbers occurring in the area. High winds and sandstorms prevented coverage of one stretch of coast north of Veracruz, and parts of the Laguna Alvarado, which did not appear to contain suitable habitat for shorebirds, were not surveyed owing to high winds. Fog and rain were encountered between Alvarado and Coatzacoalcos, although coverage of the coastline was

completed. Survey conditions were ideal for the remaining parts of the Gulf of Mexico and all of the Yucatan Peninsula.

Results

A total of 124 901 shorebirds was observed during the surveys (Table 3), consisting of 63 771 small shorebirds (51.1%, Table 4), 48 563 medium-sized shorebirds (38.9%, Table 5), and 12 567 large shorebirds (10.1%, Table 6).

Most shorebirds were concentrated in large coastal wetlands or lagoon systems, with the exception of Sanderlings (scientific names of species mentioned in the text may be found in Table 2), which were found on ocean beaches. The top five sites or areas (Zones 2/3, 5, 20, 22, and 27) together held 104 276 or 83.5% of the shorebirds counted, although only one, the Laguna Madre, held more than 10 000 shorebirds, with two of the top five sites containing fewer than 5000 shorebirds.

Laguna Madre

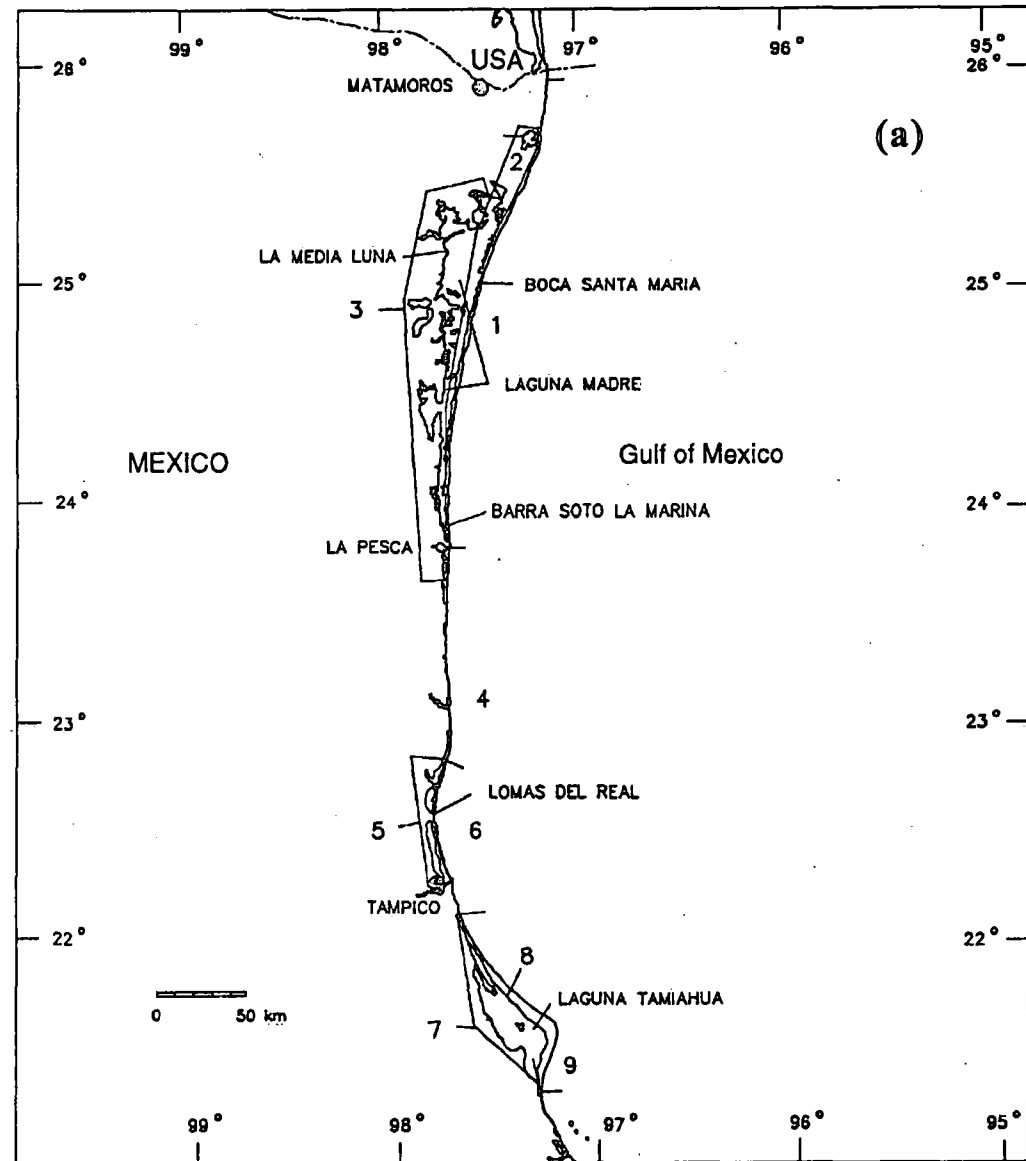
The very extensive wetlands of the Laguna Madre system (Zones 2 and 3), running from the border with Texas, U.S.A., to just south of La Pesca, were by far the most important area on the Gulf of Mexico/Caribbean coasts for wintering shorebirds, holding 80 924 or 64.8% of the total counted: these counts are likely to represent minimum numbers (see Methods above). The largest numbers were found on the western, mainland shores of the Laguna Madre system, particularly on the extensive mudflats that occur in the bays near La Media Luna, and on the eastern shores of the Laguna Madre towards its southern end along the lagoon side of the Barra Soto la Marina and near its central portion inshore of the Boca Santa Maria. The Laguna Madre held the only substantial numbers of peeps (unidentified small shorebirds, mostly small sandpipers, see Table 2) found on the 1993 surveys (35 075, 69% peep total) and was also important for dowitchers (24 110, 93.7%; 10 220 or 54.2% of the unidentified medium-sized shorebirds occurred in the area, many of which were likely dowitchers), American Avocets (5303, 92.7%), and Willets (1792, 71.7%). The only large concentration of Marbled Godwits (1550, 98.9%) occurred in the Laguna Madre, mostly (1500) on the interior, western shore.

Other lagoon systems

No other lagoon systems were found to hold more than 10 000 shorebirds. The lagoons north of Tampico (Zone 5) supported the second highest concentration of shorebirds observed on the surveys (9407, 7.5%), most being found in the northern part of the system north of Lomas del Real. Pollution appeared to be widespread in the lagoons near Tampico itself.

The extensive wetland complexes north of Campeche (Zone 22) held the third highest numbers of shorebirds found on the surveys (6732, 5.4%), most of which were peeps, mainly small sandpipers (5917, 9.3%), with lower numbers of medium-sized and large shorebirds.

Figure 1
Survey sectors and coverage during aerial surveys for shorebirds along the Gulf of Mexico and Caribbean
coasts of Mexico in January 1993: (a) northern Gulf coast, (b) central Gulf coast, (c) Yucatan Peninsula



Many of the other coastal lagoon systems on the Gulf of Mexico appeared to hold little habitat suitable for shorebirds, with mangroves, trees, or other vegetation to the water's edge and with few areas of exposed mud. Many of the rather modest numbers of shorebirds found in areas such as the Laguna Tamiahua (Zones 7 and 8, 2671, 2.1%) were found in wetland ponds behind the lagoon shoreline. Relatively few shorebirds were found in the lagoons around Alvarado (Zone 12, 0, partial coverage owing to windy conditions), in the Laguna el Carmen/Machana (Zone 15, 173, 0.1%), and in the Laguna de Terminos (Zone 19, 1070, 0.9%, most of which were in muddy areas east of Ciudad del Carmen), probably because of the limited availability of suitable habitat.

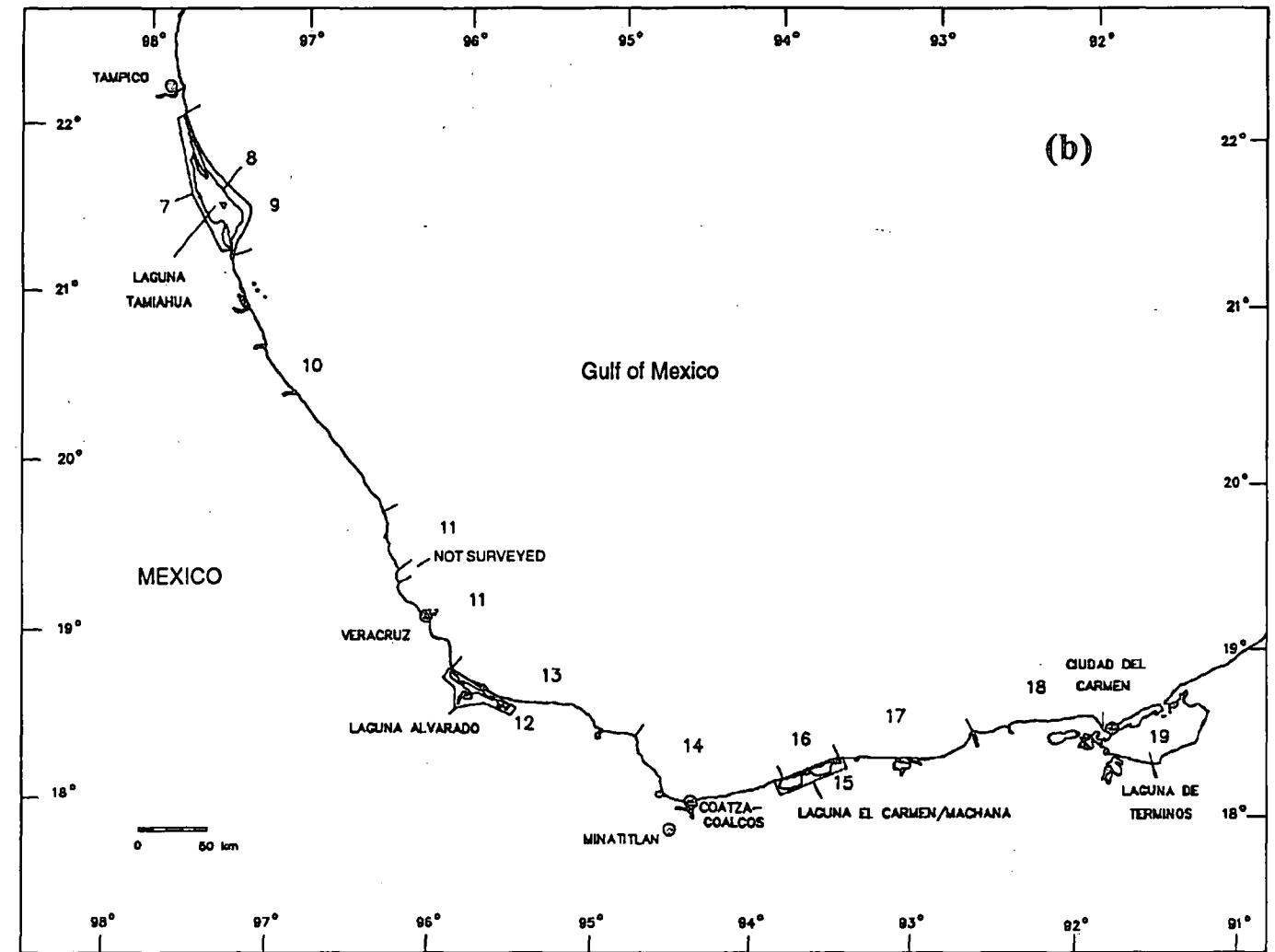
Few wintering shorebirds were found in many of the extensive coastal wetlands occurring on the Yucatan

Peninsula, including those in the Celestun area (Zone 24, 15, <0.05%), those around Puerto Progresso (Zone 26, 1080, 0.9% to west; Zone 28, 192, 0.2% to east), Telchac Puerto/Dzilam de Bravo (Zone 31, 54, <0.05%), or Rio Lagartos (Zones 33 and 34, 1013, 0.9%), or the extensive wetlands within the Sian Ka'an Biosphere Reserve (Zones 46-49, 201, 0.2%) on the east coast of the peninsula.

Small shorebirds (Table 4)

Small shorebirds were the most abundant group of shorebirds observed during the surveys, making up 63 771 (51.1%) of the total of 124 901. It was usually possible to distinguish between Sanderlings, as well as Spotted Sandpipers when encountered in small numbers away from large flocks of other shorebirds, and other small shorebirds

Figure 1 (cont'd)



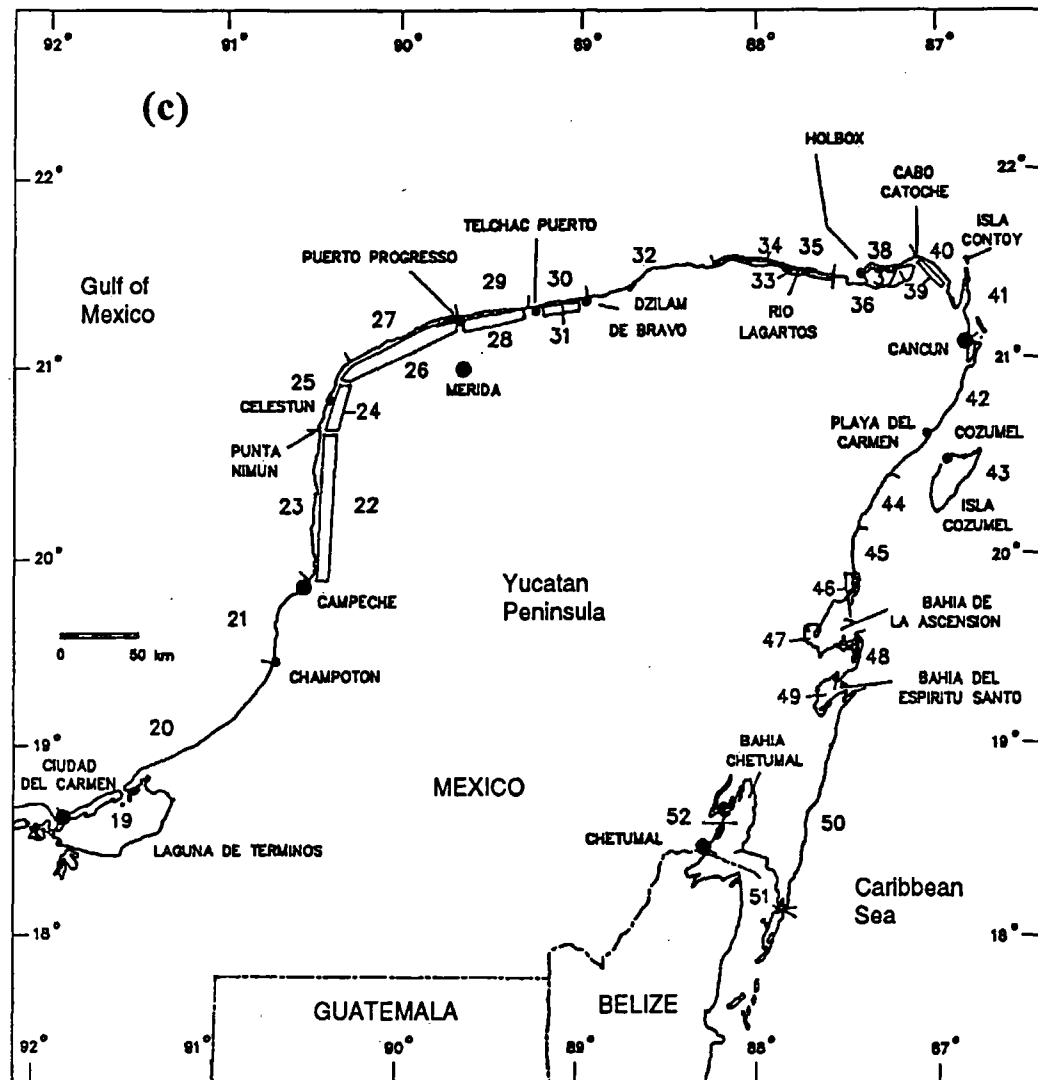
during the surveys. Other small shorebirds were grouped together in the general category of peeps. Peeps observed on ocean beaches are likely to have included the smaller plovers listed in Table 2.

Peeps. The most abundant peep occurring in large flocks in coastal wetlands and open or intertidal muddy habitats was probably the Western Sandpiper, although no ground checks were carried out during the present surveys. Least Sandpipers occur throughout the area, and Dunlin may occur in the northern part of the region towards the border with the United States (Blake 1953; Edwards 1972; MacKinnon 1992). It was not usually possible to distinguish between the various species of small sandpipers and other species of shorebirds in this category from the air, and peeps are likely to have included some Semipalmated Sandpipers, Least Sandpipers, Semipalmated Plovers, Spotted Sandpipers, and other species listed in Table 2, although in considerably lower numbers than Western Sandpipers.

A total of 50 837 peeps was counted on the surveys, most occurring in a few key wetlands, with the top five sites supporting 47 281 or 93% of the total. The Laguna Madre (Zones 2 and 3) was the only site that held substantial numbers of peeps (35 075, 69% of peep total), the majority (26 440, 52%) of which were found on the western, mainland shore. Highest numbers occurred on the extensive mudflats occurring in the bay systems around La Media Luna. Extensive mudflats were also found along some stretches of the east side of the lagoon, and highest numbers of peeps on this shoreline were recorded near the southern part of the Laguna Madre on the inside shore of the Barra Soto la Marina and farther north on the inside shore near Boca Santa Maria.

Numbers of peeps at other wetlands were substantially lower: only one other site contained more than 5000, and only two others had totals exceeding 1000 peeps. On the Yucatan Peninsula, the wetlands north of Campeche (Zone 22) supported 5916 (11.6%) peeps, whereas another 1010 (2%) were recorded along wetland areas adjacent to the coast between Celestun and Puerto Progresso (Zone 27).

Figure 1 (cont'd)



The lagoons around Tampico (Zone 5) held 4475 (8.8%) peeps, and another 805 (1.6%) were recorded on the west side of the Laguna Tamiahua (Zone 7). Nearly all were found on open areas of wet mud within the wetland complexes.

Sanderling. A total of 12 743 Sanderlings was observed during the surveys. This represents a fairly substantial population, being approximately twice the number (6646) observed in northwestern Mexico and Baja California in 1992 (Morrison et al. 1992) and about 11% of the South American wintering population of 111 815 (Morrison and Ross 1989). The species was widely distributed throughout the survey area, although numbers tended to be somewhat lower around the Yucatan Peninsula. Sanderlings were less concentrated than some other shorebirds, with 49.6% of the total occurring in the five most important zones. They were found almost exclusively on ocean beaches and were most numerous between Ciudad del Carmen and Champoton

(Zone 20, 2368, 18.6%), along the outer coastline of the Laguna Madre (Zone 1, 1389, 10.9%), and along the coast near Coatzacoalcos (Zone 14, 1244, 9.8%).

Medium-sized shorebirds (Table 5)

A total of 48 563 medium-sized shorebirds was observed on the surveys, the second most abundant of the three size categories. Medium-sized species were often difficult to identify from the air during the surveys, as they were in many cases encountered amongst large concentrations of other small or large shorebirds, resulting in a fairly high proportion (18 853, 38.8%) being assigned to a general "medium-sized" category. Medium-sized species were especially common in the Laguna Madre (Zones 2 and 3), which held 35 042 or 72.2% of the total: other wetlands held fewer than 5000 medium-sized shorebirds, with the top five sites overall (Zones 2/3, 5, 7, 26, and 27) supporting 90.6% of the total. Other important areas for medium-sized shorebirds included the Tampico lagoons, some of the

Table 3
Summary of totals of small, medium-sized, and large shorebirds observed during aerial surveys in Mexico, January 1993*

Zone	Location	Small		Medium-sized		Large		All species	
		Total	%	Total	%	Total	%	Total	%
1	Laguna Madre: beach	1 392	2.2	142	0.3	228	1.8	1 762	1.4
2	Laguna Madre: east side	8 740	13.7	16 398	33.8	2 816	22.4	27 954	22.4
3	Laguna Madre: west side	26 551	41.6	18 644	38.4	7 775	61.9	52 970	42.4
4	Laguna Madre/N of Tampico	639	1.0	6	0.0	7	0.1	652	0.5
5	Tampico lagoons	4 502	7.1	4 536	9.3	369	2.9	9 407	7.5
6	Tampico: coast	401	0.6	32	0.1	5	0.0	438	0.4
7	Laguna Tamiahua (west)	818	1.3	1 531	3.2	170	1.4	2 519	2.0
8	Laguna Tamiahua (east)	15	0.0	58	0.1	79	0.6	152	0.1
9	Tampico/Laguna Tamiahua coast	569	0.9	81	0.2	29	0.2	679	0.5
10	Laguna Tamiahua/Veracruz	535	0.8	201	0.4	19	0.2	755	0.6
11	Veracruz coast	357	0.6	21	0.0	0	0	378	0.3
12	Laguna Alvarado	0	0	0	0	0	0	0	0
13	Alvarado coast	136	0.2	1	0.0	0	0	137	0.1
14	Coatzacoalcos coast	1 244	2.0	106	0.2	13	0.1	1 363	1.1
15	Laguna el Carmen/Machana	101	0.2	12	0.0	60	0.5	173	0.1
16	el Carmen/Machana coast	127	0.2	68	0.1	0	0	195	0.2
17	Machana/Rio Grijalva coast	447	0.7	57	0.1	8	0.1	512	0.4
18	Rio Grijalva/Ciudad del Carmen	492	0.8	70	0.1	3	0.0	565	0.5
19	Laguna de Terminos	780	1.2	220	0.5	70	0.6	1 070	0.9
20	Ciudad del Carmen/Champoton	2 807	4.4	463	1.0	108	0.9	3 378	2.7
21	Champoton/Campeche	229	0.4	335	0.7	18	0.1	582	0.5
22	Campeche/Punta Nimun (wetland)	5 917	9.3	513	1.1	302	2.4	6 732	5.4
23	Campeche/Punta Nimun (coast)	1	0.0	5	0.0	4	0.0	10	0.0
24	Celestun (estuary)	0	0	0	0	15	0.1	15	0.0
25	Celestun (coast)	1	0.0	10	0.0	6	0.0	17	0.0
26	Celestun/Puerto Progresso (wetland)	301	0.5	740	1.5	39	0.3	1 080	0.9
27	Celestun/Puerto Progresso (coast)	1 666	2.6	2 151	4.4	18	0.1	3 835	3.1
28	Puerto Progresso/Telchac Puerto (wetland)	2	0.0	155	0.3	35	0.3	192	0.2
29	Puerto Progresso/Telchac Puerto (coast)	101	0.2	53	0.1	18	0.1	172	0.1
30	Telchac Puerto/Dzilam de Bravo (coast)	1 125	1.8	136	0.3	11	0.1	1 272	1.0
31	Telchac Puerto/Dzilam de Bravo (wetland)	12	0.0	31	0.1	11	0.1	54	0.0
32	Dzilam de Bravo/San Felipe	436	0.7	701	1.4	74	0.6	1 211	1.0
33	Rio Lagartos (wetland, S side)	158	0.2	106	0.2	176	1.4	440	0.4
34	Rio Lagartos (wetland, N side)	155	0.2	403	0.8	15	0.1	573	0.5
35	Rio Lagartos (coast)	574	0.9	50	0.1	24	0.2	648	0.5
36	Laguna Conil (S side)	127	0.2	11	0.0	0	0	138	0.1
37	Laguna Conil (N side)	50	0.1	5	0.0	33	0.3	88	0.1
38	Holbox/Cabo Catoche	468	0.7	143	0.3	1	0.0	612	0.5
39	Cabo Catoche/Cancun (wetland)	8	0.0	2	0.0	0	0	10	0.0
40	Cabo Catoche/Cancun (coast)	261	0.4	60	0.1	4	0.0	325	0.3
41	Cabo Catoche/Cancun (islands)	698	1.1	35	0.1	2	0.0	735	0.6
42	Cancun/Playa del Carmen	21	0.0	2	0.0	0	0	23	0.0
43	Isla Cozumel	5	0.0	15	0.0	0	0	20	0.0
44	Playa del Carmen/Tulum	72	0.1	29	0.1	0	0	101	0.1
45	Tulum/Punta Allen	90	0.1	1	0.0	0	0	91	0.1
46	Laguna Campechen	4	0.0	62	0.1	1	0.0	67	0.1
47	Bahia de La Ascension	52	0.1	21	0.0	1	0.0	74	0.1
48	Punta Pajaros/Punta Nilut	33	0.1	0	0	0	0	33	0.0
49	Bahia del Espiritu Santo	1	0.0	26	0.1	0	0	27	0.0
50	Punta Herrero/Boca Bacalur Chico	537	0.8	108	0.2	0	0	645	0.5
51	Boca Bacalur Chico/Punta Calentura	1	0.0	0	0	0	0	1	0.0
52	Bahia Chetumal	12	0.0	7	0.0	0	0	19	0.0
% total		63 771	100.0	48 563	99.8	12 567	99.9	124 901	100.2
		51.1		38.9		10.1			

* All percentages have been rounded to the nearest 0.1%. Thus, figures shown as 0.0% are actually <0.05%.

Table 4
Totals of small shorebirds observed during aerial surveys in Mexico, January 1993. For abbreviations, see Table 2. For zone locations, see Table 3.^a

Zone	PEEP		SPSA		SAND		All small	
	Total	%	Total	%	Total	%	Total	%
1	3	0.0	0	0	1 389	10.9	1 392	2.2
2	8 635	17.0	0	0	105	0.8	8 740	13.7
3	26 440	52.0	1	0.5	110	0.9	26 551	41.6
4	0	0	0	0	639	5.0	639	1.0
5	4 475	8.8	2	1.0	25	0.2	4 502	7.1
6	0	0	0	0	401	3.1	401	0.6
7	805	1.6	13	6.8	0	0	818	1.3
8	0	0	15	7.9	0	0	15	0.0
9	1	0.0	0	0	568	4.5	569	0.9
10	0	0	0	0	535	4.2	535	0.8
11	0	0	0	0	357	2.8	357	0.6
12	0	0	0	0	0	0	0	0
13	0	0	0	0	136	1.1	136	0.2
14	0	0	0	0	1 244	9.8	1 244	2.0
15	60	0.1	14	7.3	27	0.2	101	0.2
16	0	0	0	0	127	1.0	127	0.2
17	65	0.1	2	1.0	380	3.0	447	0.7
18	66	0.1	4	2.1	422	3.3	492	0.8
19	765	1.5	15	7.9	0	0	780	1.2
20	426	0.8	13	6.8	2 368	18.6	2 807	4.4
21	20	0.0	13	6.8	196	1.5	229	0.4
22	5 916	11.6	1	0.5	0	0	5 917	9.3
23	0	0	1	0.5	0	0	1	0.0
24	0	0	0	0	0	0	0	0
25	0	0	0	0	1	0.0	1	0.0
26	300	0.6	1	0.5	0	0	301	0.5
27	1 010	2.0	0	0	656	5.1	1 666	2.6
28	1	0.0	1	0.5	0	0	2	0.0
29	0	0	0	0	101	0.8	101	0.2
30	756	1.5	0	0	369	2.9	1 125	1.8
31	12	0.0	0	0	0	0	12	0.0
32	390	0.8	12	6.3	34	0.3	436	0.7
33	157	0.3	1	0.5	0	0	158	0.2
34	152	0.3	3	1.6	0	0	155	0.2
35	12	0.0	0	0	562	4.4	574	0.9
36	21	0.0	1	0.5	105	0.8	127	0.2
37	50	0.1	0	0	0	0	50	0.1
38	171	0.3	2	1.0	295	2.3	468	0.7
39	8	0.0	0	0	0	0	8	0.0
40	0	0	4	2.1	257	2.0	261	0.4
41	35	0.1	3	1.6	660	5.2	698	1.1
42	15	0.0	6	3.1	0	0	21	0.0
43	3	0.0	2	1.0	0	0	5	0.0
44	2	0.0	4	2.1	66	0.5	72	0.1
45	8	0.0	3	1.6	79	0.6	90	0.1
46	2	0.0	2	1.0	0	0	4	0.0
47	50	0.1	2	1.0	0	0	52	0.1
48	3	0.0	10	5.2	20	0.2	33	0.1
49	0	0	1	0.5	0	0	1	0.0
50	2	0.0	26	13.6	509	4.0	537	0.8
51	0	0	1	0.5	0	0	1	0.0
52	0	0	12	6.3	0	0	12	0.0
% total	50 837	99.7	191	99.6	12 743	100.0	63 771	100.0
	79.1		0.3		20			

^a All percentages have been rounded to the nearest 0.1%. Thus, figures shown as 0.0% are actually <0.05%.

Table 5
Totals of medium-sized shorebirds observed during aerial surveys in Mexico, January 1993. For abbreviations, see Table 2. For zone locations, see Table 3.^a

Zone	Unidentified medium-sized		KILL		BBPL		YELL		GRYE		RUTU		DOWI		All medium-sized	
	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
1	8	0.0	0	0	113	5.0	3	0.3	0	0	18	3.6	0	0	142	0.3
2	4 895	26.0	0	0	120	5.3	45	3.8	9	42.9	43	8.5	11 286	43.9	16 398	33.8
3	5 325	28.2	2	50.0	276	12.2	214	18.0	0	0	3	0.6	12 824	49.8	18 644	38.4
4	0	0	0	0	6	0.3	0	0	0	0	0	0	0	0	6	0.0
5	2 915	15.5	0	0	53	2.3	52	4.4	0	0	6	1.2	1 510	5.9	4 536	9.3
6	0	0	0	0	31	1.4	0	0	0	0	1	0.2	0	0	32	0.1
7	1 371	7.3	0	0	68	3.0	0	0	0	0	7	1.4	85	0.3	1 531	3.2
8	0	0	0	0	44	1.9	14	1.2	0	0	0	0	0	0	58	0.1
9	12	0.1	0	0	65	2.9	0	0	0	0	4	0.8	0	0	81	0.2
10	1	0.0	0	0	199	8.8	1	0.1	0	0	0	0	0	0	201	0.4
11	0	0	0	0	21	0.9	0	0	0	0	0	0	0	0	21	0.0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	1	0.0	0	0	0	0	0	0	0	0	1	0.0
14	1	0.0	0	0	99	4.4	0	0	0	0	6	1.2	0	0	106	0.2
15	0	0	0	0	3	0.1	5	0.4	0	0	0	0	4	0.0	12	0.0
16	47	0.2	0	0	20	0.9	0	0	0	0	1	0.2	0	0	68	0.1
17	5	0.0	0	0	49	2.2	2	0.2	0	0	1	0.2	0	0	57	0.1
18	0	0	0	0	65	2.9	0	0	0	0	5	1.0	0	0	70	0.1
19	108	0.6	0	0	111	4.9	0	0	0	0	1	0.2	0	0	220	0.5
20	163	0.9	0	0	172	7.6	0	0	0	0	128	25.4	0	0	463	1.0
21	135	0.7	1	25.0	85	3.8	4	0.3	0	0	110	21.9	0	0	335	0.7
22	80	0.4	0	0	13	0.6	414	34.8	6	28.6	0	0	0	0	513	1.1
23	0	0	0	0	0	0	5	0.4	0	0	0	0	0	0	5	0.0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	10	0.1	0	0	0	0	0	0	0	0	0	0	0	0	10	0.0
26	585	3.1	0	0	0	0	155	13.0	0	0	0	0	0	0	740	1.5
27	2 024	10.7	0	0	126	5.6	0	0	0	0	1	0.2	0	0	2 151	4.4
28	24	0.1	0	0	110	4.9	21	1.8	0	0	0	0	0	0	155	0.3
29	0	0	0	0	53	2.3	0	0	0	0	0	0	0	0	53	0.1
30	76	0.4	0	0	60	2.6	0	0	0	0	0	0	0	0	136	0.3
31	0	0	0	0	12	0.5	19	1.6	0	0	0	0	0	0	31	0.1
32	555	2.9	0	0	76	3.4	45	3.8	0	0	10	2.0	15	0.1	701	1.4
33	30	0.2	0	0	13	0.6	56	4.7	0	0	7	1.4	0	0	106	0.2
34	330	1.8	0	0	5	0.2	68	5.7	0	0	0	0	0	0	403	0.8
35	3	0.0	0	0	47	2.1	0	0	0	0	0	0	0	0	50	0.1
36	0	0	0	0	11	0.5	0	0	0	0	0	0	0	0	11	0.0
37	3	0.0	0	0	2	0.1	0	0	0	0	0	0	0	0	5	0.0
38	66	0.4	0	0	52	2.3	0	0	0	0	25	5.0	0	0	143	0.3
39	0	0	0	0	2	0.1	0	0	0	0	0	0	0	0	2	0.0
40	49	0.3	0	0	6	0.3	3	0.3	0	0	2	0.4	0	0	60	0.1
41	30	0.2	0	0	2	0.1	0	0	0	0	3	0.6	0	0	35	0.1
42	0	0	0	0	2	0.1	0	0	0	0	0	0	0	0	2	0.0
43	0	0	0	0	1	0.0	9	0.8	0	0	5	1.0	0	0	15	0.0
44	0	0	0	0	13	0.6	0	0	0	0	16	3.2	0	0	29	0.1
45	0	0	0	0	1	0.0	0	0	0	0	0	0	0	0	1	0.0
46	0	0	0	0	34	1.5	21	1.8	0	0	5	1.0	2	0.0	62	0.1
47	1	0.0	0	0	5	0.2	8	0.7	6	28.6	1	0.2	0	0	21	0.0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	25	2.1	0	0	1	0.2	0	0	26	0.1
50	0	0	0	0	14	0.6	1	0.1	0	0	93	18.5	0	0	108	0.2
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	1	0.0	1	25.0	4	0.2	1	0.1	0	0	0	0	0	0	7	0.0
% total	18 853	100.1	4	100.0	2 265	100.2	1 191	100.4	21	100.1	503	100.1	25 726	100.0	48 563	99.8
	38.8		0		4.7		2.5		0		1		53.0			

^a All percentages have been rounded to the nearest 0.1%. Thus, figures shown as 0.0% are actually <0.05%.

Table 6
Totals of large shorebirds observed during aerial surveys in Mexico, January 1993. For abbreviations, see Table 2. For zone locations, see Table 3.^a

Zone	Unidentified large		AMOY		BNST		AMAV		MAGO		WHIM		LBCU		WILL		All large	
	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
1	0	0	28	27.5	0	0	0	0	0	0	3	5.3	0	0	197	7.9	228	1.8
2	0	0	22	21.6	38	4.8	2 038	35.9	50	3.2	0	0	8	29.6	660	26.4	2 816	22.4
3	1 832	99.2	1	1.0	20	2.5	3 265	57.5	1 500	95.7	18	31.6	7	25.9	1 132	45.3	7 775	61.9
4	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0.3	7	0.1	
5	11	0.6	6	5.9	48	6.1	272	4.8	0	0	0	0	8	29.6	24	1.0	369	2.9
6	0	0	3	2.9	0	0	0	0	0	0	0	0	0	2	0.1	5	0.0	
7	0	0	2	2.0	34	4.3	108	1.9	2	0.1	1	1.8	4	14.8	19	0.8	170	1.4
8	0	0	0	0	4	0.5	0	0	0	0	0	0	0	75	3.0	79	0.6	
9	0	0	2	2.0	1	0.1	0	0	0	0	0	0	0	26	1.0	29	0.2	
10	4	0.2	0	0	0	0	0	0	0	0	0	2	3.5	13	0.5	19	0.2	
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14	0	0	0	0	0	0	0	0	0	0	7	12.3	0	0	6	0.2	13	0.1
15	0	0	0	0	0	0	0	0	15	1.0	1	1.8	0	0	44	1.8	60	0.5
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
17	0	0	0	0	0	0	0	0	0	0	1	1.8	0	0	7	0.3	8	0.1
18	0	0	0	0	0	0	0	0	0	0	1	1.8	0	0	2	0.1	3	0.0
19	0	0	0	0	25	3.2	0	0	0	0	21	36.8	0	0	24	1.0	70	0.6
20	0	0	8	7.8	0	0	0	0	0	0	0	0	0	100	4.0	108	0.9	
21	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0.7	18	0.1	
22	0	0	0	0	292	37.2	0	0	0	0	0	0	0	10	0.4	302	2.4	
23	0	0	0	0	3	0.4	0	0	0	0	0	0	0	1	0.0	4	0.0	
24	0	0	0	0	15	1.9	0	0	0	0	0	0	0	0	0	15	0.1	
25	0	0	6	5.9	0	0	0	0	0	0	0	0	0	0	0	6	0.0	
26	0	0	0	0	39	5.0	0	0	0	0	0	0	0	0	0	39	0.3	
27	0	0	8	7.8	0	0	0	0	0	0	0	0	0	10	0.4	18	0.1	
28	0	0	0	0	35	4.5	0	0	0	0	0	0	0	0	0	35	0.3	
29	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0.7	18	0.1	
30	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0.4	11	0.1	
31	0	0	0	0	10	1.3	0	0	0	0	0	0	0	1	0.0	11	0.1	
32	0	0	0	0	62	7.9	0	0	0	0	0	0	0	12	0.5	74	0.6	
33	0	0	0	0	155	19.7	0	0	0	0	1	1.8	0	0	20	0.8	176	1.4
34	0	0	0	0	3	0.4	0	0	0	0	1	1.8	0	0	11	0.4	15	0.1
35	0	0	12	11.8	0	0	0	0	0	0	0	0	0	12	0.5	24	0.2	
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
37	0	0	0	0	0	0	0	0	0	0	0	0	0	33	1.3	33	0.3	
38	0	0	1	1.0	0	0	0	0	0	0	0	0	0	0	0	1	0.0	
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
40	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0.2	4	0.0	
41	0	0	2	2.0	0	0	0	0	0	0	0	0	0	0	0	2	0.0	
42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
46	0	0	0	0	1	0.1	0	0	0	0	0	0	0	0	0	1	0.0	
47	0	0	1	1.0	0	0	0	0	0	0	0	0	0	0	0	1	0.0	
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
% total	1 847	100.0	102	100.2	785	99.9	5 683	100.1	1 567	100.0	57	100.3	27	99.9	2 499	100.0	12 567	99.9
		14.7		0.8		6.2		45.2		12.5		0.5		0.2		19.9		

^a All percentages have been rounded to the nearest 0.1%. Thus, figures shown as 0.0% are actually <0.05%.

ponds surrounding the Laguna Tamiahua, and the wetlands and coastline between Celestun and Puerto Progreso on the Yucatan Peninsula.

Black-bellied Plover. In total, 2265 Black-bellied Plovers were identified during the surveys. The species was very widely distributed, occurring on the coasts of both the Gulf of Mexico and Caribbean Sea, although numbers were generally lower around the Yucatan Peninsula. Black-bellied Plovers used a variety of habitats, occurring regularly along ocean beaches in small concentrations, as well as in wetlands and lagoons with muddy areas, usually in areas with firm substrates. The most important area was the Laguna Madre (Zones 2 and 3), where 396 (17.5%) of the birds were found, with a further 113 (5%) along the outer ocean beach (Zone 1).

Ruddy Turnstone. The 503 Ruddy Turnstones identified during the surveys were widely distributed throughout the area covered. The most notable concentrations were found between Ciudad del Carmen and Campeche (Zones 20 and 21, 238, 47.3%), where the coastline included many stretches of rocky or sandy shore with heavy accumulations of weedy wrack. Turnstones were also found regularly along sandy coastlines, including those on all sides of the Yucatan Peninsula, and in some wetlands where relatively firm substrates were encountered, such as the Laguna Madre (Zones 2 and 3, 46, 9.1%).

Yellowlegs. In total, 1191 yellowlegs, including both Greater and Lesser yellowlegs, were counted during the surveys, with a further 21 birds identified as Greater Yellowlegs. They were widely distributed throughout the area surveyed, occurring mainly in wetland areas and lagoons lying behind the outer coast. The wetlands on the western and northern coasts of the Yucatan Peninsula supported some of the largest concentrations, with 414 (34.8%) between Campeche and Punta Nimun (Zone 22), 155 (13.0%) between Celestun and Puerto Progreso (Zone 26), and 124 (10.4%) in the Rio Lagartos system (Zones 33 and 34). The highest numbers farther north on the Gulf of Mexico occurred in the Laguna Madre (Zones 2 and 3, 259, 21.8%, mostly on the west side) and in the Tampico lagoons (Zone 5, 52, 4.4%).

Dowitchers. Dowitchers were the most numerous of the medium-sized species, making up 25 726 (53.0%) of this category, and it is likely that many of the 18 853 unidentified medium-sized shorebirds were also dowitchers. The majority of the identified dowitchers (24 110, 93.7%) were found in the Laguna Madre (Zones 2 and 3), being fairly evenly distributed between the east and west sides, with a further 1510 (5.9%) in the Tampico lagoons (Zone 5). Although few dowitchers were specifically identified south of the Laguna Tamiahua, the moderate numbers of unidentified medium-sized shorebirds found in most other wetlands along the coast of the

Gulf of Mexico, including the western and northern sides of the Yucatan Peninsula, indicated that dowitchers were likely to have occurred in small concentrations in these areas.

Large shorebirds (Table 6)

Large shorebirds included a variety of species occupying a number of different habitat types and comprised 12 567 or 10.1% of the shorebirds counted during the surveys. Large shorebirds were most numerous in the Laguna Madre (Zones 2 and 3), which held 10 591 (84.3%) of the total; numbers generally declined around the coast of the Gulf of Mexico and on the western and northern coasts of the Yucatan Peninsula, and few occurred on the eastern side of the Yucatan Peninsula. The large size and relatively distinct appearance of many of the large species resulted in the majority being identified to species: 1847 or 14.7% were unidentified, most of which were encountered amongst large concentrations of shorebirds in the Laguna Madre (1832) (many are likely to have been Willets).

American Oystercatcher. American Oystercatchers were widely distributed, although in small numbers (total 102), throughout the survey area. They were most numerous around the Laguna Madre (Zones 1 and 2, 50, 49.1%) on both shores of the outer barrier enclosing the lagoon. The remainder were found in small numbers mostly along ocean beaches, although some small flocks were observed in coastal wetlands where firm muddy substrates were encountered.

Black-necked Stilt. The 785 Black-necked Stilts observed on the surveys were found in brackish or freshwater wetlands. The highest numbers occurred around the eastern and northern coasts of the Yucatan Peninsula in the coastal wetlands north of Campeche (Zone 22, 292, 37.2%) and in the Rio Lagartos system (Zones 33 and 34, 158, 20.1%) and wetlands just to the west (Zones 31 and 32, 72, 9.2%). Smaller numbers were found in the lagoons on the northern part of the Gulf of Mexico, including the Laguna Madre (Zones 2 and 3, 58, 7.4%), Tampico lagoons (Zone 5, 48, 6.1%), and Laguna Tamiahua (Zone 7, 34, 4.3%).

American Avocet. American Avocets were the most numerous species (total 5683) identified amongst the large shorebirds. They were restricted to the northern part of the coast of the Gulf of Mexico, being recorded in the Laguna Madre (Zones 2 and 3, 5303, 93.3%), Tampico lagoons (Zone 5, 272, 4.8%), and Laguna Tamiahua (Zone 7, 108, 1.9%). Avocets were found in open pans in wetlands some distance from the shore, as well as in brackish coastal habitats.

Marbled Godwit. Marbled Godwits (total 1567) were not commonly encountered during the surveys. They were restricted to the northern part of the coast of the Gulf of

Mexico, nearly all occurring in the Laguna Madre (Zones 2 and 3, 1550, 98.9%, mostly in one flock [1500] on the west side of the lagoon system), with small numbers being found south to the Laguna el Carmen/Machana.

Whimbrel. Small numbers (total 57) of Whimbrels were seen during the surveys, most occurring in the Laguna de Terminos (Zone 19, 21, 36.8%) and Laguna Madre (Zone 3, 18, 31.6%); all but two of the remainder occurred between these areas, the last two being observed in the Rio Lagartos wetlands.

Long-billed Curlew. Small numbers (total 27) of Long-billed Curlews were counted during the surveys, all in the wetlands of the Laguna Madre (Zones 2 and 3, 15, 55.6%), Tampico lagoons (Zone 5, 8, 29.6%), and Laguna Tamiahua (Zone 7, 4, 14.8%).

Willet. The Willet was the second most common large shorebird observed on the surveys (total 2499) and was one of the most widespread, being found on most parts of the coast between the Laguna Madre and the northeastern Yucatan Peninsula; none was observed south of Cancun on the east coast of the Yucatan Peninsula. The species was regularly observed in small numbers along ocean beaches and also occurred in coastal lagoons, usually in areas with firm substrates. Most of the birds were found in the Laguna Madre (Zones 2 and 3, 1792, 71.7%) itself or along the outer barrier beach (Zone 1, 197, 7.9%), and many of the 1832 unidentified large shorebirds counted on the west side of the Laguna Madre are also likely to have been Willets. Although the species was widespread, zone totals rarely exceeded a few tens in other parts of the coast, reflecting the birds' dispersed distribution along beaches.

Discussion

The total of 124 901 Nearctic shorebirds found along the coasts of the Gulf of Mexico and Caribbean Sea was low in comparison with the total of 815 531 counted at sites on the Pacific coast of northwest Mexico and around the Baja California Peninsula in 1992 (Morrison et al. 1992). The most important site and the only one with substantial numbers of wintering shorebirds was the Laguna Madre, where 80 924 were counted. Survey conditions indicated that this figure was a minimum count; when the additional numbers of birds that would pass through the area during migration are taken into account, it is clear that the site would support at least 100 000 shorebirds during the course of the year, probably considerably more. The Laguna Madre would thus qualify, under the Western Hemisphere Shorebird Reserve Network criteria, as an International Site, defined as one supporting 100 000 shorebirds or 15% of a species' flyway population during the year (Morrison et al. 1991). Given the extensive habitat and apparent importance of the area, further detailed surveys should be carried out during migration periods to obtain more information on the numbers of shorebirds using the area.

The Laguna Madre is considered to fall within the Nearctic Realm, in contrast to the other main wetlands surveyed, which fall within the Neotropical Realm (Scott and Carbonell 1986). Perales and Balderas (1986) listed 20 species of shorebirds as occurring in the Laguna Madre; 15 of these were found during the winter—11 occurred throughout the year, three were considered migrants, and one was listed as occasional. Two species recorded on the surveys, the Marbled Godwit and Whimbrel, were not listed as winter visitors by Perales and Balderas (1986), although they are within the wintering ranges of the species, as indicated by Blake (1953) and Edwards (1972, 1978). Other species not listed by Perales and Balderas (1986) that may possibly occur as winter visitors or migrants include Piping Plover *Charadrius melodus*, Semipalmated Plover, Dunlin, Lesser Yellowlegs, Stilt Sandpiper, and Red Knot *Calidris canutus*, and further ground surveys to clarify the status of these species would be most valuable.

Numbers of shorebirds at other sites were substantially lower, in all cases less than 10 000 birds, and with only two sites in the 5000–10 000 range. The area supporting the second highest total of shorebirds was the coastal lagoon system north of Tampico, the northernmost wetland complex within the tropical zone (Scott and Carbonell 1986). Most of the shorebirds were found in the open muddy areas and salt pans in the northern part of the system north of Lomas del Real, which appeared less affected by pollution than the lagoons immediately north of Tampico.

Scott and Carbonell (1986) indicated that many of the wetlands on the west and north coasts of the Yucatan Peninsula are important for wintering shorebirds and shorebirds that are passing through on migration. The current surveys suggest that wintering populations of shorebirds may be rather modest. The very extensive coastal wetlands north of Campeche contained much open muddy habitat, and the area supported the third highest total of shorebirds found on the surveys (6732), most of which occurred in the southern portion of the area. The wetlands between Celestun and Puerto Progreso were also important (3835 in coastal/nearshore habitats, 1080 in interior areas), most birds occurring near Puerto Progreso.

Scott and Carbonell (1986) indicated that other wetland areas along the north coast of the Yucatan Peninsula, such as those around Dzilam de Bravo, in the Rio Lagartos complex, and near Holbox, are of considerable importance for shorebirds. The present surveys, however, failed to reveal any substantial populations of wintering shorebirds in these areas, totals generally being between 1000 and 2000. Survey conditions in these areas in 1993 were ideal in terms of weather, visibility, and coverage, and it was unlikely that any major concentrations would have been missed.

Very low populations of wintering shorebirds were also found around Bahia de La Ascension and Bahia del Espiritu Santo in the Sian Ka'an Biosphere Reserve on the east coast of the Yucatan Peninsula, despite the presence of vast amounts of wetland habitats including open muddy areas. Very modest numbers of Nearctic shorebirds were seen during monthly ground surveys carried out in the Biosphere Reserve in 1992–93 (J. Guzman, unpubl. data). Although

these areas are important for a wide variety of waterfowl and wading birds, they do not form an important area for wintering Anatidae (Scott and Carbonell 1986). The area may not be productive in terms of the types of food resources needed to support large wintering populations of Nearctic shorebirds: much of the substrate is highly calcareous and may be unsuitable for supporting the kinds of invertebrates used by shorebirds; the tidal amplitude is very low, so that little nutrient flux occurs; parts of the area are seasonally flooded between December and April; and salinities vary considerably between wet and dry seasons. Much of the area is covered by "dwarf" mangrove, suggesting that low nutrient availability limits growth of vegetation.

Wetlands on the north coast of the Yucatan Peninsula may also produce relatively few invertebrate resources that can be used by shorebirds. Tidal amplitudes here are again very small, and no rivers flow into the major wetlands, such as the Rio Lagartos, so that inundation of muddy areas may depend on seasonal precipitation, resulting in little regular nutrient input and highly variable salinities. Morrison and Ross (1989) noted that numbers of wintering shorebirds were very low on some tropical estuaries in South America, such as those near Salvador in Brasil and in the Gulf of Guayaquil in Ecuador, and it is possible that lack of suitable sizes or types of food may limit the attractiveness of such areas to shorebirds. Recent surveys in Panama have also shown that very few shorebirds occur on wetland areas on the northern Caribbean coast of the country in situations where there is very little tidal amplitude and limited nutrient input from either terrestrial or marine sources (R.I.G. Morrison, R.K. Ross, F. Delgado, and R. Butler, unpubl. data). A consistent pattern is emerging of low wintering populations of Nearctic shorebirds in areas with such conditions. The question of how many birds may pass through these areas during migration does, however, need to be investigated, as reports of large migrant populations exist for some areas where wintering populations were low, and food resources and availability of habitat may vary considerably between wet and dry seasons (e.g., in Brasil [Antas 1983]; see Scott and Carbonell [1986] for Mexican wetlands in the areas surveyed in 1993).

In summary, the most important wetlands on the Gulf of Mexico and Caribbean coasts of Mexico appeared to be on the northern sectors of the Gulf coast, especially the Laguna Madre, which was the only area found to support significant concentrations of wintering Nearctic shorebirds. The Laguna Madre would qualify as an International Site for the Western Hemisphere Shorebird Reserve Network when populations passing through the area on migration are taken into account, although further surveys are needed to determine its importance as a migration area. Although rather modest numbers of wintering shorebirds were found in other areas on the coast of the Gulf of Mexico and around the Yucatan Peninsula, the use of coastal wetlands in these areas during migration periods needs to be determined.

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