

- Belton, W. 1984. Birds of Rio Grande do Sul, Brazil. Part 1. Rheidae through Fumariidae. *Bull. Am. Mus. Nat. Hist.* 178(4): 371–631.
- Bolster, D.C. & Robinson, S.K. 1990. Habitat use and relative abundance of migrant shorebirds in a western Amazonian site. *Condor* 92: 239–242.
- Casler, C.L. & Lira, J.R. 1979. Censos poblacionales de aves marinas de la costa occidental del Golfo de Venezuela. *Boletín Centro Invest. Biol.* 13: 37–85.
- Hagar, J.A. 1966. Nesting of the Hudsonian Godwit at Churchill, Manitoba. *Living Bird* 5: 5–43.
- Harrington, B.A., Leeuwenberg, F.J., Resende, S.L., McNeil, R., Thomas, B.T., Grear, J.S. & Martinez, E.F. 1991. Migration and mass change of White-rumped Sandpipers in North and South America. *Wilson Bull.* 104: 621–636.
- Harrington, B. A., Antas, P. de T. Z. & Silva, F. 1986. Northward shorebird migration on the Atlantic Coast of southern Brazil. *Vida Silvestre Neotropical* 1: 45–54.
- Hayes, F.E. & Fox, J.A. 1991. Seasonality, habitat use, and flock sizes of shorebirds at the Bahía de Asuncion, Paraguay. *Wilson Bull.* 103: 637–649.
- Hayes, F.E., Goodman, S.M., Fox, J.A., Granizo T., & Lipez, N.E. 1990. North American bird migrants in Paraguay. *Condor* 92: 947–960.
- Lara Resende, S. & Leeuwenberg, F. 1987. *Ecological studies of Lagoa do Peixe*. Unpublished report, World Wildlife Fund – U.S., July 1987. 52pp.
- McNeil, R. 1970. Hivernage et estivage d'oiseaux aquatiques Nord-Américains dans le Nord-est du Venezuela (mue, accumulation de graisse, capacité de vol et routes de migration). *L'Oiseau et la Revue Française D'Ornithologie* 40: 185–302.
- Morrison, R.I.G. 1984. Migration systems of some New World shorebirds. In: *Shorebirds: migration and foraging behavior*, pp 125–202, J. Burger & Olla, B. eds. Plenum Press, N. Y.
- Morrison, R.I.G. & Ross, R.K. 1989. Atlas of Nearctic shorebirds on the coast of South America. *Can. Wildl. Serv. Spec. Public.*, vol. 1, 128pp.
- Myers, J.P. & Myers, L.P. 1979. Shorebirds of coastal Buenos Aires Province, Argentina. *Ibis* 121: 186–200.
- Spaans, A.L. 1978. Status and numerical fluctuations of some North American waders along the Surinam coast. *Wilson Bull.* 90: 60–83.
- Thomas, B.T. 1987. Spring shorebird migration through central Venezuela. *Wilson Bull.* 99: 571–578.

A coastal, aerial winter shorebird survey on the Sonora and Sinaloa coasts of Mexico, January 1992

Brian A. Harrington

Harrington, B.A. 1993. A coastal, aerial winter shorebird survey on the Sonora and Sinaloa coasts of Mexico, January 1992. *Wader Study Group Bull.* 67: 44–49.

Brian A. Harrington, Manomet Bird Observatory, Manomet, MA 02345, USA.

INTRODUCTION AND METHODS

Little information on shorebird numbers wintering on the eastern coast of the Gulf of California has been published. This report summarizes observations made between 9 and 13 January 1992 during an aerial survey of shorebirds on the eastern shore of the Gulf of California. Observations were made from a U.S. Fish and Wildlife Service (USFWS) aircraft. Although the prin-

cipal mission of the trip was to survey for Brant *Branta bernicla*, a track was followed to sample potential shorebird wetland habitat whenever possible. Observers aboard the aircraft, in addition to myself, were Jim Volzer and Bruce Conant (USFWS), and Sergio Torres Morales of the Mexican Secretaria de Desarrollo Urbano y Ecología (SEDUE). The aircraft, specifically modified for aerial bird surveying, usually flew at a 50 m altitude and at a speed of about 120



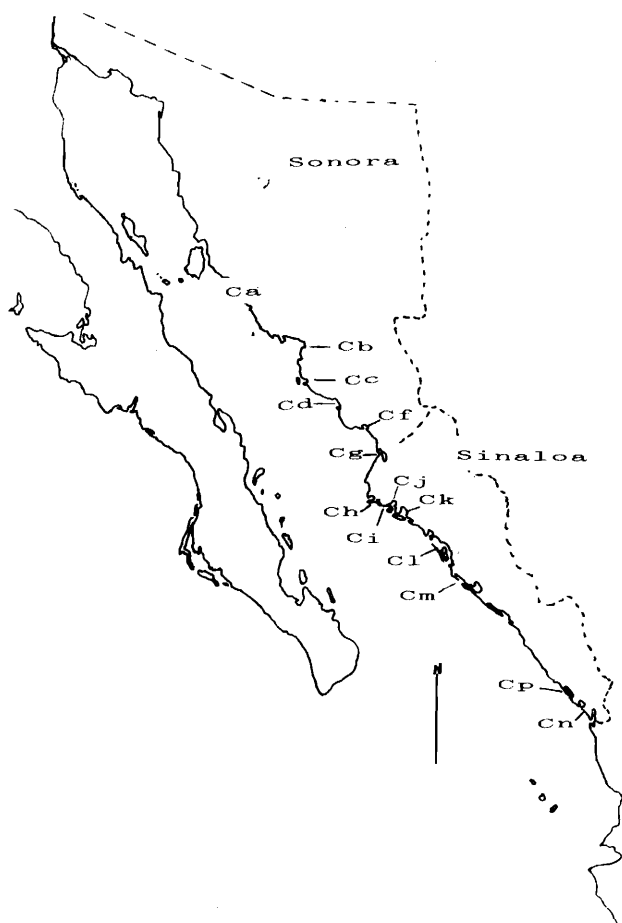


Figure 1. Survey areas of the Sonora and Sinaloa coasts. Identified locations correspond to those of Figure 4.

m.p.h. The altitude was suitable for shorebird counting, but the speed, sometimes reduced when bird densities were unusually high, was too fast for identification of most shorebirds. Identification comprehensiveness varied not only with aircraft speed, but also with bird density; at high bird densities identification precision, such as it was, reduced.

When species identification was not possible, shorebirds were categorized as 'large' (mostly Marbled Godwits *Limosa fedoa* and Willets *Catoptrophorus semipalmatus*, but also some Whimbrel *Numenius phaeopus* and Long-billed Curlews *N. americanus*), "medium" (mostly unidentified dowitcher *Limnodromus* sp. species, but also Red Knots *Calidris canutus*, unidentified yellowlegs species *Tringa* sp., and some Stilt Sandpipers *C. himantopus* in brackish and fresh water habitats), or 'small' (small calidrid sandpipers such as Western *C. mauri*, Semipalmated (?) *C. pusilla*, Least *C. minutilla*, Dunlin *C. alpina*, and Sanderling *C. alba*). Avocets *Recurvirostra americana* and Black-necked Stilts *Himantopus mexicanus* were readily identified. Occasional oystercatchers *Haematopus* sp., tattlers *Heteroscelus* sp., and Surfbirds *Aphriza virgata* also were seen, but numbers identified were inconsis-

quential as compared to other species, and the difficulty of seeing these species from the air certainly caused most individuals to be missed.

Figure 1 is a generalized map of the survey route and the location names used in Tables 1 and 2, and associated figures.

Weather and visibility conditions were excellent throughout the survey.

RESULTS AND DISCUSSION

Coverage

Survey coverage of wetland shorebird habitat varied with habitat and with time available for shorebird surveying. In general coverage of oceanfront beaches was more comprehensive than of expansive tidal flats or expansive vegetated wetlands. In any case, estimated the percentage of coverage of each area surveyed (see below). The survey did not include coverage of habitat between Laguna del Caimanera and Ensenada del Pabellon, nor of any habitats south of Sinaloa.

Table 1 summarizes the observations made, and Table 2 shows final estimates of shorebird numbers for each coastal section after adjustments were made for estimated degree of coverage. Because the comprehensiveness of identification was not comparable between different sectors of the survey (see above), the data of Table 1 have been combined into four categories, large, medium, and small shorebirds, plus a combined category for the readily identified avocets and stilts. These data are shown in Figure 2. Tables 1 and 2 show codes and names of the regions that are listed as codes on the X axis of this figure.

I also grossly categorized the habitats of the various regions we surveyed. Figure 3 shows the frequencies with which the different categories of shorebirds were found in different gross habitats.

General comments

Most of the shorebirds found during this survey were in habitats associated with estuaries and lagoons, especially on coastal sections of Sinaloa (Figures 2-5). Although no notes were kept that would allow statistical testing, I had the impression that in most estuaries the shorebirds were most abundant on intertidal (or sometimes flooded) habitats of the eastern shores of estuaries as opposed to western shores. This was especially true in the case of small and medium-sized shorebirds.



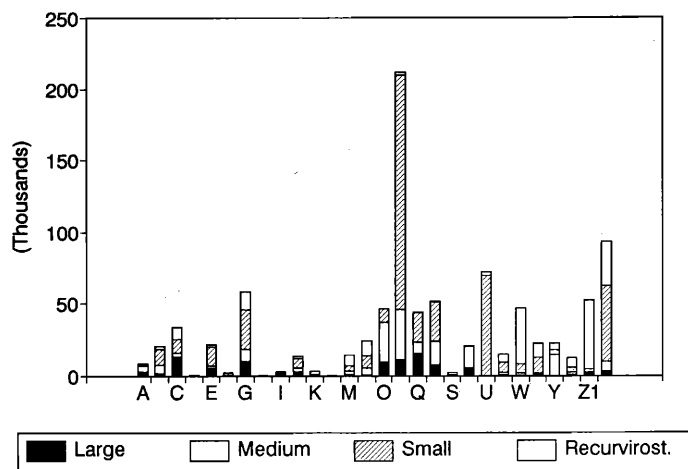


Figure 2. Total shorebirds by coastal section (see Table 2).

As a general pattern, most of the estuaries/bays showed 'habitat zones' which can be classified in very general terms (Figure 3). For discussion, I have subdivided these classifications into the following habitats: (a) outer (western) barrier beach shore, (b) inner barrier beach shores, (c) bayside shores fringing cienega (mangrove), (d) tidal or pond openings in cienega, (e) pannes and flats on the landward side of cienega, and (f) fresh (sometimes brackish ?) wetlands inland of tidal areas. The relative rank abundance of species groups within these habitat categories are shown in Table 3.

In general, highest peep concentrations seemed to be in habitats 'c' and 'e', medium shorebirds were most common in habitats 'c' and 'd', large shorebirds were in habitats 'b', 'c' and 'd', and avocets and stilts were most common in habitats 'c' and 'f'.

Large shorebirds (LS in the tables) include Willets (WILL), Marbled Godwits (MAGO), Whimbrels (WHIM), and Long-billed Curlews (LBCU), of which the Marbled Godwits and the Willets were, by far, the more common species. Both species were common on the shores and flats of estuaries, especially in regions south of Las Mochis, Sinaloa. Willets were sometimes seen on outer beaches, but clearly were most common in estuaries, especially on habitats 'b' and 'c'. Godwits were also common in these habitats, as well as in habitat 'd'.

Medium-sized shorebirds (MSS in the tables) include dowitchers (DOSP), both yellowlegs species (YESP), and Stilt Sandpipers (STSA) and possibly Red Knots (REKN) on ocean beaches of section A. Dowitchers were by far the most common of these categories, and were especially common on estuary shorelines and flats, and in habitat 'd'. Yellowlegs and Stilt Sandpipers were seen most often in habitats 'e' and 'f'.

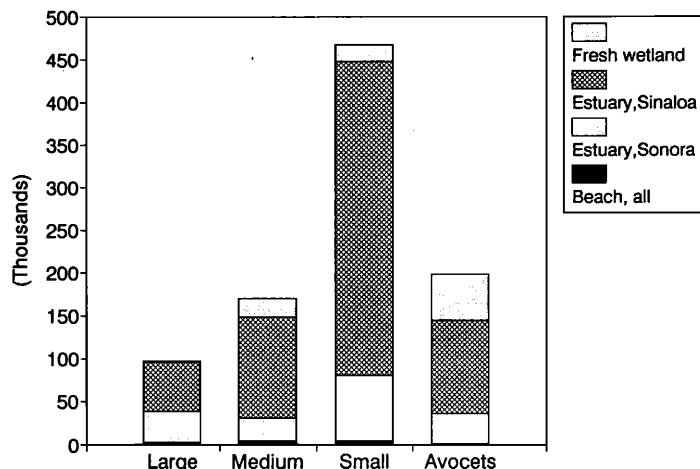


Figure 3. Shorebird abundance in four habitat classes.

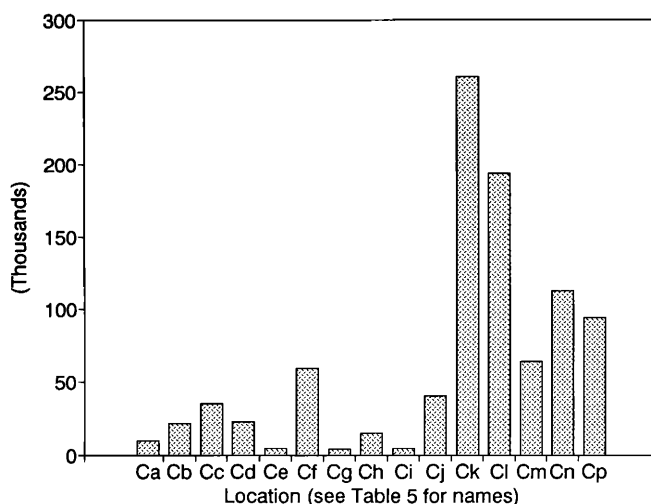


Figure 4. Total shorebirds by location.

Small shorebirds (PEEP in the tables) potentially include Western Sandpipers, Semipalmated Sandpipers (?), Least Sandpipers, Dunlin, and Sanderlings (SAND), but none of these except Sanderling were definitively identified. Peeps were most common in habitats 'c' and 'e'.

Avocets and stilts were most common in habitats 'c' and 'f'; the vast majority were Avocets (Table 1).

CONSERVATION ISSUES

The Western Hemisphere Shorebird Reserve Network (WHSRN) seeks to recognize and assist with protection of sites in the Western Hemisphere that host large numbers of shorebirds. Reserves of four categories are recognized:

- ◆ *Hemispheric* for sites hosting 300,000 or more shorebirds,
- ◆ *International* for sites hosting 100,000 or more,



Table 1. Observed numbers of shorebirds, Sonora and Sinaloa, January 1992.

Location	Code	AMOY	AMAV	BNST	BBPL	MAGO	WHIM	LBCU	WILL	YESP	RUTU	DOSP	SAND	REKN	NOJA	LS	MSS	PEEP	S BSP
Coast N. of Guaymas	A	17	700	0	72	170	10	0	330	4	0	404	176	1002	0	1628	2154	930	0
Cienega Pitahaya	B	1	587	0	0	42	4	0	192	10	0	85	0	0	0	202	1285	2820	130
Bahia de Lobos	C	25	2650	0	1	700	53	0	16	26	0	77	0	0	0	3299	490	2975	200
Outer beach S. of Lobos	D	0	100	0	0	0	0	0	20	0	0	0	0	0	0	200	25	525	0
Laguna Tobarí	E	10	875	30	0	45	10	0	105	1	0	0	0	0	0	2685	845	6750	0
Outer beach S. of Tobarí	F	0	0	0	0	0	0	0	60	0	0	0	0	0	0	30	275	2075	0
Bahia Santa Barbara	G	0	3825	0	0	0	0	0	0	0	0	0	0	0	0	3000	2665	8200	0
Beach S. of St. Barbara	H	2	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
Estero Agiabampo	I	0	72	5	1	16	8	0	12	59	0	25	10	0	0	142	310	415	33
Bahia de Esteban	J	0	497	15	0	72	5	0	282	5	0	100	0	0	0	537	721	2125	75
Bahia Topolobampo	K	0	25	0	0	61	1	0	42	1	0	0	0	0	0	80	275	760	0
Bahia Ohuira; outer	L	0	0	0	0	15	4	0	24	0	0	0	0	0	0	55	0	120	0
Bahia Ohuira; upper	M	0	5540	5	0	175	0	0	300	0	0	0	0	0	0	575	1875	2825	0
Wetlands E. of Bah. Ohuira	N	0	3125	31	0	0	0	0	1	1	0	1	0	0	0	200	1505	2620	0
Bahia de Navachis	O	0	20	35	0	330	0	0	646	5	0	0	0	0	0	1005	4508	1950	1000
Flats NE of B. de Navachis	P	0	225	0	3	100	1	0	17	16	0	0	0	0	0	1000	3475	16440	0
Santa María; Part A	Q	0	0	0	3	67	24	0	145	0	0	40	20	0	0	2845	780	4250	775
Santa María; Part B	R	0	270	0	0	1530	0	0	930	0	0	1000	0	0	0	1340	7225	13850	150
Santa María; Part C	S	0	250	15	2	175	2	0	125	0	15	845	0	0	0	140	575	325	0
Santa María; Part D	T	0	465	2	2	335	44	0	511	0	0	3015	0	0	0	3600	8980	25	0
Santa María; Part E	U	0	240	50	0	0	0	0	0	0	0	0	0	0	0	0	0	6925	0
Ensen. de Babelon; A	V	0	4660	6	2	495	0	0	215	0	0	85	0	0	0	1445	5655	0	0
Ensen. de Babelon; B	W	0	3900	0	0	0	0	0	25	0	0	200	0	0	0	0	0	675	0
Marismas Nacional; SE shore	X	0	2098	356	5	30	0	5	3	15	0	32	0	0	0	352	125	2765	50
M. Nacional; agric farmponds	Y1	0	30	200	0	0	0	0	0	0	0	0	0	0	30	0	715	200	0
M. Nacional; cienega	Z	0	3050	505	0	0	0	0	115	17	0	0	0	0	0	190	560	1830	315
N. Nacional; N. end	Z1	1	11620	355	2	0	0	7	11	4	0	0	0	0	0	540	440	65	200
Lag del Caimanera	Z2	0	15400	290	0	0	2	0	690	0	0	1600	0	0	0	810	1780	2625	200

AMOY=Am. Oystercatcher, AMAV=Am. Avocet, BNST=Black-necked Stilt, BBPL=Bl.-bellied Plover, MAGO=Marbled Godwit, WHIM=Whimbrel, LBCU=Long-billed Curlew, WILL=Willet, YESP=Yellowlegs sp., RUTU=Ruddy Turnstone, DOSP=Dowitcher sp., SAND=Sanderling, REKN=Red Knot, NOJA=Northern Jacana, LS= Unidentified large shorebird, MSS= unident. medium-size shorebird, PEEP= unident. small calidrid sandpiper, SBSP= unident. shorebird, size not recorded.

- ◆ *Regional* for sites hosting 50,000 or more, and
- ◆ *Endangered Species* for sites hosting endangered species.

In order to establish whether sites in Sonora and Sinaloa would qualify as WHSRN sites, I grouped data from Table 2 according to location (versus location and habitat as presented in Figure 2). The summarized results (Table 4 and Figure 4) show that six sites meet



WESTERN HEMISPHERE SECTION

Table 2. Estimated shorebird numbers (adjusted for percentage of survey coverage) during a single aerial survey of the Sonora and Sinaloa coast of Mexico, January 1992.

Location	% cover Code	age	AMOY	AMAV	BNST	BBPL	MAGO	WHIM	WILL	YESP
Coast N. of Guaymas	A	80	21	875	0	90	213	13	413	5
Cienega Pitahaya	B	25	4	2348	0	0	168	16	768	40
Bahia de Lobos	C	30	8833	0	3	2000	177	53	87	
Outer beach S. of Lobos	D	80	0	125	0	0	0	0	25	0
Laguna Tobarí	E	50	20	1750	60	0	90	20	210	2
Outer beach S. of Tobarí	F	80	0	0	0	0	0	0	75	0
Bahia Santa Barbara	G	30	0	13000	0	0	0	0	0	0
Beach S. of St. Barbara	H	80	3	0	0	0	0	0	6	0
Estero Agiabampo	I	30	0	240	17	3	53	27	40	197
Bahia de Esteban	J	30	0	1657	50	0	240	17	940	17
Bahia Topolobampo	K	30	0	83	0	0	203	3	140	3
Bahia Ohuira- outer	L	80	0	0	0	0	19	5	30	0
Bahia Ohuira- upper	M	75	0	7387	7	0	233	0	400	0
Wetlands E. of Bah. Ohuira	N	30	0	10000	103	0	0	0	3	3
Bahia de Navachis	O	20	0	100	175	0	2000	0	3000	25
Flats ne of B. de Navachis	P	10	0	2250	0	30	1000	10	170	160
Santa Maria- Part A	Q	20	0	0	0	15	335	120	725	0
Santa Maria- Part B	R	50	0	540	0	0	3000	0	2000	0
Santa Maria- Part C	S	80	0	313	19	3	219	3	156	0
Santa Maria- Part D	T	80	0	581	3	3	419	55	639	0
Santa Maria- Part E	U	10	0	2400	500	0	0	0	0	0
Ensen. de Babelon- A	V	80	0	5825	8	3	619	0	269	0
Ensen. de Babelon- B	W	10	0	39000	0	0	0	0	250	0
Marismas Nacional- se shore	X	25	0	8392	1000	20	120	0	12	60
M.Nacional- agric farmponds	Y	5	0	600	4000	0	0	0	0	0
M.Nacional- cienega	Z	50	0	6100	1000	0	0	0	230	34
M.Nacional- N. end	Z1	25	4	46000	1000	8	0	0	44	16
Lag. del Caimanera	Z2	50	0	31000	580	0	0	4	1000	0

Table 2 (continued)

DOSP	SAND	REKN	LS	MSS	PEEP	SBSP	LGTOT	MEDTOT	SMTOT	TOTL
505	220	1000	2035	2693	1163	0	2673	4545	1383	9496
340	0	0	808	5140	11280	520	1760	6040	11280	21432
257	0	0	11000	1633	9917	667	14000	2647	9917	35040
0	0	0	250	31	656	0	275	31	656	1088
0	0	0	5370	1690	13500	0	5690	1692	13500	22712
0	0	0	38	344	2594	0	113	344	2594	3050
0	0	0	10000	8883	27333	0	10000	8883	27333	58967
0	0	0	0	0	0	0	6	0	0	9
83	33	0	473	1033	1383	110	593	1427	1417	3693
333	0	0	1790	2403	7083	250	2987	3003	7083	14780
0	0	0	267	917	2533	0	613	920	2533	4150
0	0	0	69	0	150	0	123	0	150	273
0	0	0	767	2500	3767	0	1400	2500	3767	15060
33	0	0	667	5017	8733	0	670	5053	8733	24977
0	0	0	5025	23000	9750	5000	9905	27565	9750	47495
0	0	0	10000	35000	164000	0	11000	34940	164000	213000
200	100	0	14000	3900	21250	4000	15000	7990	21350	44745
2000	0	0	2680	14000	27700	300	7600	16750	27700	52590
1000	0	0	175	719	406	0	553	1778	406	3068
4000	0	0	4500	11000	31	0	5613	14996	31	21224
0	0	0	0	0	69250	0	0	0	69250	72150
106	0	0	0	1806	7069	0	888	1915	7069	15704
2000	0	0	0	0	6750	0	250	2000	6750	48000
128	0	0	1408	500	11060	200	1540	908	11060	23324
0	0	0	0	14000	4000	0	0	14300	4000	22900
0	0	0	380	1120	3660	630	610	1784	3660	13164
0	0	0	2160	1760	260	800	2204	2584	260	52952
3000	0	0	1620	3560	52500	400	3004	7160	52500	94044

AMOY=Am.Oystercatcher, AMAV=Am.Avocet, BNST=Black-necked Stilt, BBPL=Blk.-bellied Plover, MAGO=Marbled Godwit, WHIM=Whimbrel, WILL=Willet, YESP=Yellowlegs sp. DOSP=Dowitcher sp., SAND=Sanderling, REKN=Red Knot, LS= Unidentified large shorebird, MSS= unident. medium-size shorebird, PEEP= unident. small calidrid sandpiper, SBSP= unident. shorebird, size not recorded, LGTOT= sum of all identified + unidentified large shorebirds, MSS= sum of all identified + unidentified medium-sized shorebirds, SMTOT= sum of all identified + unidentified small shorebirds, TOTL= grand total.



Table 3. Ranking of habitat occurrence of shorebird species seen during aerial survey of the Sinaloa and Sonora coasts of Mexico, January 1992.

	Habitat classification (see Text)					
	a	b	c	d	e	f
Black-bellied Pl.	-	2	1	-	-	-
Willet	4	2	1	3	5	-
Whimbrel	-	2	3	1	4	-
Marbled Godwit	4	2	1	3	-	-
Am. Avocet	-	-	1	-	-	2
Peeps	-	-	1	3	2	4
Sanderling	1	-	-	-	-	-
Am. Oystercatch.	1	-	-	-	-	-
Red Knot	1	-	-	-	-	-
Yellowlegs sp.	-	-	4	3	1	2
Dowitcher sp.	-	2	1	2	3	4
Bl.-necked Stilt	-	-	-	-	2	1
Long-bill. Curlew	-	-	-	?	?	-
Northern Jacana	-	-	-	-	-	1

Table 4. Locations and codes used in Figures 1 and 4.

Coastal area	Code
Outer beach, Sonora	Ca
Ciénega Pitahaya	Cb
Bahia de Lobos	Cc
Laguna Tobarí	Cd
Outer beach, Sinaloa	Ce
Bahia Santa Barbara	Cf
Estero Agiabampo	Cg
Bahia de Esteban	Ch
Bahia Topolobampo	Ci
Bahia Ohuira	Cj
Bahia de Navachis	Ck
Bahia Santa Maria	Cl
Ensenada de Pabellón	Cm
Marismas Nacional	Cn
Laguna del Caimanera	Cp

WHSRN criteria as follows:

Bahia Santa Barbara	<i>Regional</i>
Bahia de Navachis	<i>International</i>
Bahia Santa Maria	<i>International</i>
Ensenada de Pabellón	<i>Regional</i>
Marismas Nacional	<i>International</i>
Laguna del Caimanera	<i>Regional (International ?)</i>

The WHSRN criteria also make provision for designating sites that are used by high proportions of continental shorebird populations. In this survey comprehensive species identification was not possible for any species except American Avocet and Black-necked Stilt. The continental population of American Avocets, found to be especially abundant in southern Sinaloa during this survey, is unknown. It is conceivable that numbers at Marismas Nacional and Laguna Caimanera represent a substantial fraction of the continental population.

ACKNOWLEDGEMENTS

I would like to thank staff of the Office of Migratory Bird Management, USFWS for allowing me to participate in their survey, and especially Bruce Conant, Jim Volzer, Copelia Hayes, and Elizabeth Cummings. I also thank Dra. Graciela De La Garza Garcia and staff of SEDUE for arranging appropriate permits, and the Manomet Bird Observatory which paid for my expenses of this survey.

