SHOREBIRD POPULATION TRENDS ON STATE WILDLIFE AREAS IN THE NORTHERN SAN JOAQUIN VALLEY, CALIFORNIA 1993-2002

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Abstract

The California Department of Fish and Game manages several wildlife areas in the northern San Joaquin Valley, California, that contain wetland impoundments where water depth and vegetation types can be manipulated. The primary goal of these wetlands continues to be to attract wintering waterfowl, but recently shorebirds have also become a priority management interest. To better understand long-term shorebird patterns on wetland impoundments, we have been recording species richness and relative abundance information to determine population trends on the Los Banos and Volta Wildlife Areas. Standardized routes averaging 22 miles have been driven on both areas since 1993. Using binoculars and spotting scopes, every visible shorebird was counted and identified to the species level. Ninety percent of the shorebirds observed were Long-billed Dowitchers, Black-necked Stilts, Dunlins, Least Sandpipers, and Western Sandpipers (see Appendix 2 for scientific names). From 1993 to 2002, total shorebird density has significantly increased in the fall, decreased in the spring, and decreased in the winter. Abundances of Long-billed Dowitchers, Greater Yellowlegs, American Avocets, and Killdeer have been significantly increasing on our wildlife areas in the fall, and numbers of Long-billed Dowitchers, Least Sandpipers, Western Sandpipers, American Avocets and Common Snipes have been significantly declining in either the winter or spring. An increase in fall shorebird numbers may be related to a drawdown of the Buttonwillow Lakes at Los Banos in the fall of 2001. Limited information on shorebird population trends in the western United States makes it difficult to determine whether our results reflect actual population changes or merely changes in species distribution or management practices.

Keywords: shorebirds, wetlands, population trends, habitat use, wetland management

Introduction

California's Central Valley is one of the most important regions in western North America for migratory and wintering shorebirds (Shuford et al. 1998). The valley historically contained at least 4 million acres of wetlands, but urbanization and conversion to agriculture destroyed or altered more than 95% of wetland habitat. Of the current 284,000 wetland acres, two-thirds are privately owned and the remainder is divided between state and federally owned land (Heitmeyer et al. 1989). Of these remaining acres, 180,000 comprise western Merced County's Grassland Ecological Area (GEA). The GEA is 33% wetland and constitutes the largest contiguous wetland area in the state (Isola 1998). It is an important fall and spring migration stopover site for shorebirds, with peak numbers of more than 200,000 shorebirds observed (Page et al. 1992, Shuford et al. 1998). In 1991, the Western Hemisphere Shorebird Reserve Network recognized the GEA as an Internationally Significant Shorebird Site (WHSRN 2003). The GEA has also been

designated as a Globally Important Bird Area by the American Bird Conservancy and the National Audubon Society (Cooper 2001).

The California Department of Fish and Game (CDFG) manages approximately 3% of the GEA. Because of the importance of this stopover site to shorebirds, CDFG initiated surveys on the Los Banos and Volta Wildlife Areas in 1993 to better understand long-term shorebird patterns. This monitoring program was initially part of the Point Reyes Bird Observatory's Central Valley Shorebird Surveys, which included the collection of species richness and relative abundance information data. We have continued this survey to determine shorebird species composition on our wildlife areas, and to determine population trends of these species over a long period of time.

Study Area

The Los Banos and Volta Wildlife Areas (37^{o} 07' 55" N; 120^{o} 48' 50" W and 37^{o} 07' 28" N; 120^{o} 55' 14" W, respectively) are located in western Merced County, California, near the town of Los Banos (Figure 1). The terrain is very flat, with elevations ranging from 29 to 33 m. The climate is characterized by hot, dry summers, mild falls and springs, and cool, wet winters with an average annual rainfall of 21 cm (Los Banos Wildlife Area unpublished data 1970-2000). The 5,600-acre Los Banos Wildlife Area and the 3,000-acre Volta Wildlife Area are composed of seasonal wetlands, California annual grasslands, mixed willow riparian habitat, and shrublands.

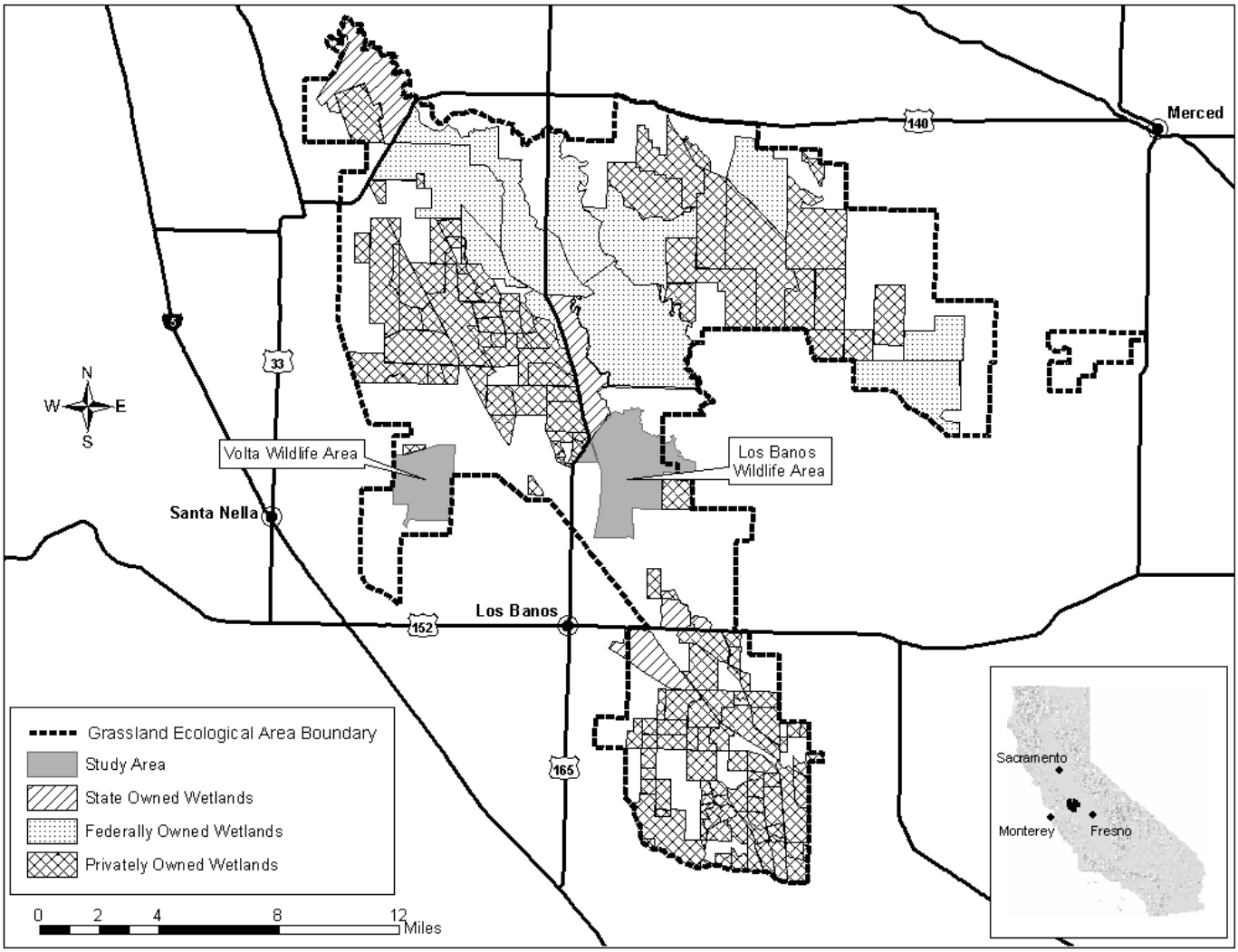

Figure 1. Map of the Los Banos and Volta Wildlife Areas located within the Grassland Ecological Area in western Merced County.

Methods

We conducted surveys at Los Banos Wildlife Area (Los Banos) and Volta Wildlife Area (Volta) twice each April, August, November, and February, corresponding to spring and fall migration, as well as early and late winter, respectively. We surveyed only under favorable weather conditions: good visibility, no precipitation, and light winds (<3 on Beaufort and sky scales; Appendix 1). We created fixed routes to ensure consistency and comparability between seasons and years. However, we altered survey routes due to poor road conditions, resulting in routes ranging from 15 to 49 miles (Los Banos averaged 23.9 miles, Volta averaged 16.5 miles). One to three observers used binoculars and spotting scopes to count every visible shorebird from the cab of a pickup truck. We began surveys at approximately 0800 and completed them in three to five hours.

We identified all shorebirds to the species level, except Dowitchers and, in some cases, small sandpipers. Most Dowitchers in the Central Valley have been identified as Long-billed Dowitchers, however, Long-billed and Short-billed Dowitchers are difficult to identify in the field and, thus, we identify them as "Dowitcher sp." (Manolis and Tangren 1975, Pitelka 1950, McCaskie et al. 1979, as cited in Shuford et al. 1998). We occasionally recorded large flocks of small sandpipers as "peeps" due to difficult viewing conditions and are grouped together with Least and Western Sandpipers for analysis.

Statistical Analysis

We standardized data prior to analysis by calculating the number of shorebirds per 100 acres along the survey route. Acreage was calculated for each survey by mapping the visible area surveyed. We estimated acreages for surveys conducted prior to 2000 by using maps of the routes. To determine whether we could combine the Los Banos data with the Volta data for analysis, we compared the total number of shorebirds per 100 acres at Los Banos with that of Volta by a 2-sample *t*-test. If no significant difference was found, we combined the data. To determine whether there were enough data to detect a 10% population change for each species per season over a five year period, we performed a power analysis using Program TRENDS (Gerrodette 1993). We performed simple linear regressions to determine trend data for each individual species per 100 acres, as well as total number of shorebirds per 100 acres during each

season. We used NCSS 2001 (Hintze 2001) for all statistical tests. We used an alpha level of 0.05 with two-tailed hypothesis testing. In each case, we examined the data to determine if they met the assumptions of normality and equal variance. If the data did not meet these assumptions, we transformed the data by a natural log or square root transformation. We present all summary statistics as means $\pm$ 1 standard error.

Results

We observed 20 species of shorebirds on Los Banos and Volta since 1993 (Appendix 2 and 3). We observed 11 species regularly on both areas; Dowitchers, Least and Western Sandpipers, Black-necked Stilts, Dunlin, American Avocets, Greater Yellowlegs, Killdeer, Common Snipe, Long-billed Curlews and Black-bellied Plovers. We observed the remaining nine species in very low numbers (less than five individuals per year). Dowitchers, Least and Western Sandpipers, Black-necked Stilts and Dunlin comprised greater than 90% of the total shorebirds recorded (Figure 2). Overall, we recorded twice as many shorebirds at Volta than at Los Banos.

Total shorebirds observed per 100 acres did not differ significantly between Los Banos (fall: 51 $\pm$ 40 shorebirds/100 acres; spring: 37 $\pm$ 31 shorebirds/100 acres) and Volta (fall: 45 $\pm$ 38 shorebirds/100 acres; spring: 72 $\pm$ 57 shorebirds/100 acres) in either the fall or spring (fall: t_{21} = 0.46, P = 0.65; spring: t_{17} = -1.43, P = 0.17). We observed significantly higher numbers of shorebirds at Volta (50 $\pm$ 39 shorebirds/100 acres) in the winter when compared with Los Banos (26 $\pm$ 17 shorebirds/100 acres; t_{47} = -2.83, P = 0.007). Based on this analysis, we grouped Los Banos and Volta total shorebird numbers for fall and spring trend analysis, but separated them for winter trend analysis.

The total number of shorebirds observed per 100 acres has significantly increased in the fall over the last ten years (R^2 = 0.30, P < 0.001). The number of fall shorebirds observed has increased fivefold between 1993 and 2002. However, spring trends have significantly decreased by 7% annually (R^2 = 0.20, P = 0.02). Winter trends at Los Banos have significantly decreased by 3.5% annually since 1993 (R^2 = 0.46, P = 0.001). Winter trends at Volta have not changed significantly (R^2 = 0.01, P = 0.61).

We did not have enough power to detect a 10% annual population change for species other than Black-necked Stilts and Greater Yellowlegs in winter. However, we were able to

detect annual population changes for five other species, Dowitcher sp., Least and Western Sandpiper, American Avocet, Killdeer, and Common Snipe (Table 1 and 2).

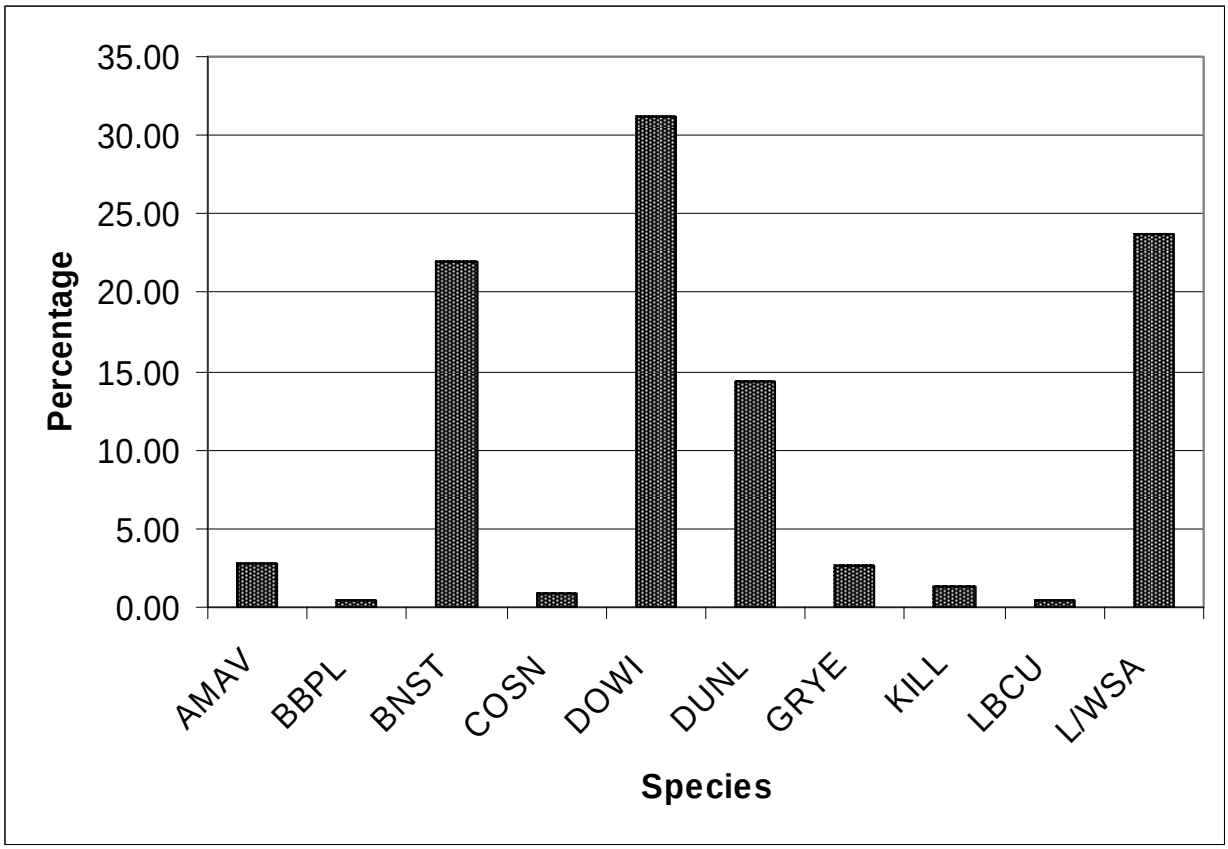

Figure 2. Percentage of the ten most abundant shorebird species found on study plots in the San Joaquin Valley, California, 1993-2002 (wildlife areas and all seasons combined). AMAV = American Avocet, BBPL = Black-bellied Plover, BNST = Black-necked Stilt, COSN = Common Snipe, DOWI = Dowitcher sp., DUNL = Dunlin, GRYE = Greater Yellowlegs, KILL = Killdeer, LBCU = Long-billed Curlew, L/WSA = Least and Western Sandpiper.

Table 1. Population trends of the ten most abundant shorebird species, and percent annual change for species with significant trends in fall (August), winter (November – February), and spring (April) for the Los Banos Wildlife Area located in the San Joaquin Valley, California, 1993 – 2002. Species with "No change" had power of detectability greater than 0.80.

	Season					
	Fall		**Winter**		**Spring**	
Species	*Trend*	*% Change*	*Trend*	*% Change*	*Trend*	*% Change*
Dowitcher sp.	+[a]	67%	–[b]	3.4%	n.s.[c]	
Least/Western Sandpiper	n.s.		n.s.		n.s.	
Black-necked Stilt	n.s.		n.s.	No change	n.s.	
Dunlin	n.s.		n.s.		n.s.	
Greater Yellowlegs	n.s.		n.s.	No change	n.s.	
American Avocet	+	180%	–	4.6%	n.s.	
Killdeer	n.s.		n.s.		n.s.	
Common Snipe	–	11%	n.s.		n.s.	
Long-billed Curlew	n.s.		n.s.		n.s.	
Black-bellied Plover	n.s.		n.s.		n.s.	

[a] Significant increasing trend
[b] Significant decreasing trend
[c] not significant

Table 2. Population trends of the ten most abundant shorebird species, and percent annual change for species with significant trends in fall (August), winter (November – February), and spring (April) for the Volta Wildlife Area located in the San Joaquin Valley, California, 1993 – 2002. Species with "No change" had power of detectability greater than 0.80.

	Season					
	Fall		**Winter**		**Spring**	
Species	*Trend*	*% Change*	*Trend*	*% Change*	*Trend*	*% Change*
Dowitcher sp.	+ [a]	71%	n.s.[c]		n.s.	
Least/Western Sandpiper	n.s.		n.s.		– [b]	1.7%
Black-necked Stilt	n.s.		+	29%	n.s.	
Dunlin	n.s.		n.s.		n.s.	
Greater Yellowlegs	+	56%	n.s.	No change	n.s.	
American Avocet	n.s.		n.s.		–	0.8%
Killdeer	+	135%	n.s.		n.s.	
Common Snipe	n.s.		+	130%	–	2.5%
Long-billed Curlew	n.s.		n.s.		n.s.	
Black-bellied Plover	n.s.		n.s.		n.s.	

[a] Significant increasing trend
[b] Significant decreasing trend
[c] not significant

Trends of individual species on Los Banos and Volta over the last ten years vary by species, wildlife area and season (Table 1 and Table 2). In the fall, the number of Dowitchers per 100 acres has significantly increased at Los Banos by 67% annually ($R^2 = 0.53$, $P = 0.01$) and by 71% annually at Volta ($R^2 = 0.35$, $P = 0.04$), but have decreased by 3.4% annually at Los Banos in winter ($R^2 = 0.39$, $P < 0.001$). At Volta in the fall, abundance of Greater Yellowlegs ($R^2 = 0.32$, $P = 0.05$) and Killdeer ($R^2 = 0.39$, $P = 0.03$) has significantly increased annually by 56% and 135%, respectively. American Avocet numbers have increased 180% annually during the fall at Los Banos ($R^2 = 0.42$, $P = 0.03$), whereas Common Snipe numbers have decreased by 11% ($R^2 = 0.42$, $P = 0.03$). Significant annual springtime decreases occurred at Volta for Least and Western Sandpipers (1.7%, $R^2 = 0.44$, $P = 0.04$), American Avocets (0.8%, $R^2 = 0.90$, $P < 0.001$), and Common Snipe (2.5%, $R^2 = 0.46$, $P = 0.03$). Spring population levels of these species at Los Banos have not changed significantly. Winter numbers of Black-necked Stilts at Volta have increased by 29% annually ($R^2 = 0.18$, $P = 0.03$), and Common Snipe have been increasing by 130% annually ($R^2 = 0.19$, $P = 0.02$). American Avocets at Los Banos in the winter have increased annually by 4.6% ($R^2 = 0.37$, $P = 0.003$).

Discussion

Species Richness

Shorebird species richness and composition observed on our surveys is consistent with other studies within the San Joaquin Valley. Jurek (1974) and Shuford et al. (1998) reported 16 and 22 species respectively, and found Dowitcher sp., Western and Least Sandpipers, Black-necked Stilts and Dunlins to be the most numerous species within the Central Valley. Shuford et al. (1998) also reported a much higher density of Long-billed Curlews and Snowy Plovers than we detected on the wildlife areas. These species were found on agricultural fields and evaporation ponds, which are habitats that were not present along our survey routes.

Trend Surveys

Our power analyses revealed that with our data set it was possible to detect a 10% annual population change for Black-necked Stilts and Greater Yellowlegs in the winter. However, we were able to detect population changes for several other species as well. We did not have enough power to detect 10% annual changes for several species. Reasons for not being able to detect population changes include the high variability in our data between surveys, seasons or years, the irregularity of a species seen on our wildlife areas, and not enough survey repetitions. To improve our likelihood to detect population changes, we could add more surveys over a greater area.

Information on shorebird population trends is very limited, especially in the western United States, making it difficult to compare our shorebird trends with other studies. Trend information has been collected in the eastern United States using surveys such as the International Shorebird Survey (ISS) (Howe et al. 1989) and the Maritimes Shorebird Survey (MSS) (Morrison et al. 1994). Howe et al. (1989) found that Whimbrel, Dowitcher sp. (mainly Short-billed Dowitchers), and Sanderling (*Calidris alba*) have significantly decreased from 1972 to 1983 in the Atlantic Coast region. Morrison et al. (1994) found significant declines in Least Sandpipers, Semipalmated Sandpipers (*Calidris pusilla*) and Short-billed Dowitchers in Canada. The majority of species analyzed in the ISS and MSS are different from the species we observed, making comparisons impossible.

Focused studies have found several species to be declining in the western United States including the Snowy Plover (Page et al. 1991, as cited in Gill et al. 1995), Killdeer (Page and Gill 1994), Mountain Plover (*Charadrius montanus*) (Knopf 1994), and American Avocet (Page and Gill 1994). Black-necked Stilts reportedly have stable population levels (Sauer and Droege 1995, as cited in Gill et al. 1995). Other surveys looking at overall shorebird populations have only recently begun in the western United States. The Western Shorebird Survey was created in 2000 by the United States Fish and Wildlife Service and the United States Geological Survey to look at the non-breeding shorebird population trends

in the western United States, but data have not been recorded for a sufficient number of years to determine population trends (Bart 2002).

Due to the lack of information on shorebird trends at a larger scale, it is difficult to know if our trends reflect actual changes in populations or are just reflective of local distributional or management changes. For example, winter shorebird trends have not changed dramatically over the last ten years, and may be the result of consistent sizes and types of winter wetlands on our wildlife areas during that time. Conversely, fall shorebird abundance has shown a dramatic increase, which may be due to recent changes in management practices on state wildlife areas. One such change began in 2001, when the Buttonwillow Lakes on the Los Banos Wildlife Area were drawn down to provide shorebird habitat and to encourage riparian growth. Prior to 2001, these lakes were flooded deeply throughout the year, providing little shorebird habitat. As a result of the drawdown, shorebird numbers increased from approximately 600 to a peak of 2,000. This practice greatly increased the shorebird habitat from what was previously found on the wildlife area, and could explain the increasing trend in fall shorebird numbers.

It is unclear what may be causing the decrease in spring shorebird numbers on our wildlife areas. Wildlife area managers believed there was more shorebird habitat available throughout the Grasslands during the spring in recent years; however, personal communication finds this not to be the case (Tim Poole, pers. communication).

Management Recommendations

These surveys were conducted to determine species richness and local population changes, and were not designed to address the specific effects of wildlife area management on shorebirds. Still, based on the positive shorebird response to the drawdown of the Buttonwillow Lakes, we recommend continuing this practice and duplicating it where feasible on other wildlife areas to create additional foraging and loafing opportunities for shorebirds during the July to October time period. Studies have found that the timing of water drawdown is

important to shorebird use of wetlands (Hands et al. 1991, Rundle and Fredrickson 1981). Hands et al. (1991) suggests drawing down water just before or during shorebird migration. To provide more shorebird habitat on the wildlife areas during spring migration, we recommend staggering the timing of water drawdowns on wetland fields, as well as drawing down the water at a slower rate. This procedure will provide more shorebird habitat over a longer period of time during the end of March through April.

Studies examining ideal foraging depths for shorebirds have generally found that shorebirds use water depths ranging from 0 to 10 cm (Isola et al. 2000, Fredrickson and Reid 1986). We recommend increasing the amount of topography within wetlands where feasible in order to provide more water depth heterogeneity. By creating islands and hummocks, and decreasing the slope aspect of the levees within wetland fields, a variety of water depths becomes available to not only shorebirds but also to waterfowl and waders. Increasing the amount of shoreline and mudflat will provide more foraging area for shorebirds, as well as loafing habitat for waterfowl, while the hummocks or deeper channels will provide deep water for waterfowl foraging.

To address waterbird response to management, a new survey, the Waterbird Habitat Use Project, was created in 2000 to examine several factors that may affect wetland use by shorebirds and other waterbirds such as waterfowl and waders. This project will examine how the water depths of our wetland impoundments and the types of wetland habitats affect waterbirds. Other factors include how open a wetland is, and the size and location of a wetland on our wildlife areas. Data are currently being analyzed, and a report is forthcoming.

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Appendix 1 – Weather Codes

Wind Conditions

Wind Speed (mph)	Beaufort Number	Indicators of wind speed
>1	0	Smoke rises vertically
1-3	1	Wind direction shown by smoke drift
4-7	2	Wind felt on face, leaves rustle
8-12	3	Leaves and small twigs in constant motion
13-18	4	Raises dust, moves small branches
19-24	5	Small trees sway

Sky Conditions

Number Code	Sky Description
0	Clear or a few clouds
1	Partly cloudy (scattered)
2	Cloudy (broken)
3	Overcast
4	Fog or smoke
5	Drizzle
6	Showers

Appendix 2 – List of species seen at the Los Banos Wildlife Area, with average numbers seen per survey by season (± Standard Error) for all years combined, as well as 2002.

	Season					
	Fall		Winter		Spring	
Species	1994-2001	2002	1994-2001	2002	1994-2001	2002
Dowitcher sp. *Limnodromus* sp.	522 ± 164	1791 ± 96	371 ± 90	263 ± 79	383 ± 107	542 ± 371
Least/Western Sandpiper *Calidris minutilla/C.mauri*	308 ± 84	771 ± 65	182 ± 51	87 ± 46	512 ± 199	186 ± 32
Black-necked Stilt *Himantopus mexicanus*	160 ± 25	691 ± 76	175 ± 25	246 ± 18	70 ± 31	49 ± 46
Dunlin *Calidris alpina*	35 ± 29	183 ± 175	109 ± 33	52 ± 32	264 ± 121	75 ± 60
Greater Yellowlegs *Tringa melanoleuca*	27 ± 9	37 ± 3	20 ± 3	32 ± 6	13 ± 4	34 ± 31
American Avocet *Recurvirostra Americana*	33 ± 15	411 ± 223	6 ± 2	3 ± 2	27 ± 7	55 ± 17
Killdeer *Charadrius vociferus*	14 ± 4	18 ± 4	22 ± 5	30 ± 7	15 ± 4	18 ± 5
Common Snipe *Gallinago gallinago*	1 ± 0.5	0	16 ± 6	23 ± 9	7 ± 4	0
Long-billed Curlew *Numenius americanus*	0	1 ± 1	4 ± 1	4 ± 1	13 ± 9	0.5 ± 0.5
Black-bellied Plover *Pluvialis squatarola*	18 ± 18	0	0.2 ± 0.2	0	0.1 ± 0.1	1 ± 1
Whimbrel *Numenius phaeopus*	0	0	0	0	0.1 ± 0.1	0
Red-necked Phalarope *Phalaropus lobatus*	5 ± 3	14 ± 14	0	0	0	0
Wilson's Phalarope *Phalaropus tricolor*	1 ± 1	16 ± 14	0	0	0	0
Lesser Yellowlegs *Tringa flavipes*	0	0	0.2 ± 0.1	0	0.3 ± 0.3	0
Snowy Plover *Charadrius alexandrinus*	0	0	0	0	0	0
Spotted Sandpiper *Actitis macularia*	0	0	0	0	0	0
Willet *Catoptrophorus semipalmatus*	0	0	0	0	0	0
Marbled Godwit *Limosa fedoa*	0	0	0	0	0	0
Semipalmated Plover *Charadrius semipalmatus*	0.1 ± 0.1	0	0	0	1 ± 1	0
Total Shorebirds	1124 ± 212	3930 ± 145	906 ± 156	739 ± 142	1306 ± 434	960 ± 463

Appendix 3 – List of species seen at the Volta Wildlife Area, with average numbers seen by season per survey (± Standard Error) for all years combined, as well as 2002.

	Season					
	Fall		Winter		Spring	
Species	1994-2001	2002	1994-2001	2002	1994-2001	2002
Dowitcher sp. *Limnodromus* sp.	189 ± 69	776 ± 514	368 ± 91	201 ± 69	354 ± 155	360 ± 97
Least/Western Sandpiper *Calidris minutilla/C.mauri*	87 ± 27	359 ± 182	266 ± 73	111 ± 37	760 ± 253	210 ± 176
Black-necked Stilt *Himantopus mexicanus*	391 ± 66	1259 ± 141	321 ± 44	269 ± 16	63 ± 18	43 ± 33
Dunlin *Calidris alpina*	8 ± 5	0	154 ± 48	113 ± 46	545 ± 235	650 ± 629
Greater Yellowlegs *Tringa melanoleuca*	33 ± 7	174 ± 71	31 ± 6	42 ± 3	26 ± 7	21 ± 16
American Avocet *Recurvirostra Americana*	0.4 ± 0.2	0	20 ± 6	27 ± 8	84 ± 27	17 ± 1
Killdeer *Charadrius vociferus*	6 ± 1	24 ± 0.5	22 ± 7	12 ± 4	10 ± 3	8 ± 3
Common Snipe *Gallinago gallinago*	0.1 ± 0.1	2 ± 2	10 ± 3	69 ± 24	0.6 ± 0.3	0.5 ± 0.5
Long-billed Curlew *Numenius americanus*	0 ± 0	2 ± 1	6 ± 5	1 ± 1	20 ± 15	0.5 ± 0.5
Black-bellied Plover *Pluvialis squatarola*	0.2 ± 0.1	0.5 ± 0.5	4 ± 2	2 ± 1	17 ± 12	52 ± 4
Whimbrel *Numenius phaeopus*	0	0	0	0	16 ± 16	8 ± 3
Red-necked Phalarope *Phalaropus lobatus*	2 ± 1	0	0	0	0	0
Wilson's Phalarope *Phalaropus tricolor*	0	0	0	0	0	0
Lesser Yellowlegs *Tringa flavipes*	0.7 ± 0.5	1.5 ± 1.5	0.2 ± 0.1	0	0.1 ± 0.1	0
Snowy Plover *Charadrius alexandrinus*	0	0	0.7 ± 0.7	0	0	0
Spotted Sandpiper *Actitis macularia*	0	0	0.7 ± 0.7	0	0	0
Willet *Catoptrophorus semipalmatus*	0	0	0	0	0.6 ± 0.6	0
Marbled Godwit *Limosa fedoa*	0.1 ± 0.1	0	0	0	0	0
Semipalmated Plover *Charadrius semipalmatus*	0	0	0	0	0	0
Total Shorebirds	718 ± 126	2597 ± 908	1204 ± 180	847 ± 132	1899 ± 578	1368 ± 689