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LONG-DISTANCE MOVEMENTS BY AMERICAN AVOCETS AND BLACK-NECKED STILTS

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Abstract.—Color-banded American Avocets (*Recurvirostra americana*) and Black-necked Stilts (*Himantopus mexicanus*) were resighted >50 km from their banding locations in the Great Basin. Records from 90 migration and winter resightings of birds banded in the Honey Lake Valley (northeastern California) and 3 birds banded at Great Salt Lake (Utah) provided unique data on long-distance movements by individuals of these species. Avocets and stilts left Honey Lake breeding areas and went to stopover areas at Mono Lake and in the Tulare Basin as early as July. Some individuals spent 48 days or more in the Tulare Basin. Both avocets and stilts were observed in sibling groups during migration. Although one pair of banded stilts was observed during migration, differences in sex ratio at a migration stopover site suggested that male and female stilts might have different wintering ranges or migration behavior. Avocets from Honey Lake were found wintering along the California coast from Arcata southward and along the west coast of Sinaloa, Mexico. First-year avocets were more often seen in coastal areas of California (relative to inland areas) than were adults. Stilts were found wintering in central California. Avocets and stilts banded in Utah were seen in the Tulare Basin (one stilt) and at wintering grounds in Mexico (one avocet and one stilt), indicating the potential for population mixing. We propose that avocets migrate in short hops, retain partial family group associations during migration, and may have age-specific differences in migratory behavior or wintering range. We propose that stilts retain partial family group associations during migration, maintain pair bonds beyond the breeding attempt, and have sexual differences in migratory behavior or wintering range. These results have important ramifications for understanding impacts of drainwater evaporation ponds in the Tulare Basin on nonbreeding avocets and stilts.

MOVIMIENTOS DE LARGA DISTANCIA EN *RECURVIROSTRA AMERICANA* Y EN *HIMANTOPUS MEXICANUS*

Sinopsis.—Individuos de *Recurvirostra americana* y de *Himantopus mexicanus* anillados con colores fueron redetectados visualmente sobre 50 km de los sitios donde se anillaron en la Gran Cuenca. Registros de 90 casos de redetección visual de aves marcadas con bandas de colores en el Valle del Lago Honey (California nororiental) y tres aves anilladas en Gran Lago Salado (Utah) son datos únicos para estudiar movimientos a larga distancia de estas especies durante la migración y el invierno. Las aves dejaron las áreas reproductivas del Lago Honey y fueron a áreas de descanso en el Lago Mono y en la Cuenca de Tulare tán temprano como en julio. Algunas aves estuvieron 48 días o más en la Cuenca del Tulare. Ambas especies se observaron en grupos de hermanos durante la migración. Aunque durante la migración se observó un par de *Himantopus mexicanus* con anillas de colores, las diferencias en razón de sexo detectadas en un lugar de parada migratoria sugieren que existen diferencias en áreas de invernación o en comportamiento migratorio entre los sexos de esta especie. Individuos de *Recurvirostra americana* del lago Honey se hallaron invernando a lo largo de la costa de California desde Arcata hacia el sur y a lo largo de la costa oeste de Sinaloa, Mexico. Las aves de un año de *Recurvirostra americana* se vieron más comúnmente que los adultos en las costas de California (en relación a zonas más internas). Se hallaron individuos de *Recurvirostra americana* invernando en el centro de California. Individuos de *Recurvirostra*

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americana y de *Himantopus mexicanus* anillados en Utah se observaron en la Cuenca del Tulare (un ave) y en terrenos de invernar en Mexico (una de cada especie), indicando el potencial para la mezcla interpoblacional. Proponemos que *Recurvirostra americana* migra en pequeños saltos, retienen asociaciones parciales de grupos familiares durante la migración, y pueden tener diferencias entre edades específicas con respecto al comportamiento migratorio o en su distribución invernal. Proponemos además que *Himantopus mexicanus* retienen parcialmente asociaciones de grupos familiares durante la migración, mantienen unìones de parejas más allá del esfuerzo en aparearse, y tienen diferencias sexuales en comportamiento migratorio o en la distribución invernal. Estos resultados tienen ramificaciones importantes para entender el impacto de las charcas de evaporación de aguas de escorrentía en la Cuenca del Tulare en aves no anidantes de ambas especies.

Wetlands in the western United States have declined dramatically since 1780 (Dahl 1990). For example, inland wetlands in the California Central Valley have declined 91%; wetlands in Colorado, Idaho, and Nevada have declined more than 50%; and wetlands of Utah, Oregon, and Arizona have declined by 35% (Dahl 1990). American Avocets (*Recurvirostra americana*) and Black-necked Stilts (*Himantopus mexicanus*) are two of the most conspicuous breeding birds in wetlands of the Great Basin. Because avocets and stilts rely on these inland habitats for breeding, migration, and wintering, their populations have declined in response to this habitat loss (Page and Gill 1994). Dramatic annual changes in wetland availability make information on large-scale movements of shorebirds critical to conserving remaining wetlands (Alberico 1993, Skagen and Knopf 1993, Robinson and Warnock 1996).

In addition to wetland losses, many remaining wetlands in the western United States have been contaminated as a result of irrigation (U.S. Fish and Wildlife Service 1992). The discovery of selenium-induced teratogenesis in avocet and stilt embryos in central California (Hoffman et al. 1988; Ohlendorf et al. 1986a, 1989), has made an understanding of recurvirostrid life histories even more important. The impacts of complete reproductive failure at Kesterson Reservoir (Ohlendorf et al. 1990, Williams et al. 1989), and adverse effects at other California breeding sites (Grasslands, Ohlendorf et al. 1987; Tulare Basin, Skorupa and Ohlendorf 1991) can be better interpreted if the roles of contaminated wetlands in the species' annual cycles are known. In particular, it is important to know the role that these wetlands play in the migration and wintering of recurvirostrids breeding at noncontaminated sites in western North America.

Although recurvirostrid breeding and wintering behavior has been well-studied (e.g., Boettcher et al. 1994, Evans and Harris 1994, Gibson 1971, Hamilton 1975), and individuals were marked in several published studies (Gibson 1971, James 1995, Sordahl 1984), relatively little information exists on long-distance movements of known individuals. As part of breeding population studies, we have conducted large-scale banding of avocets and stilts at noncontaminated sites in the Great Basin. The magnitude of this effort, coupled with the assistance of numerous colleagues and volunteers, has provided considerable information on long-distance movements of individual American Avocets and Black-necked Stilts. Here, we present

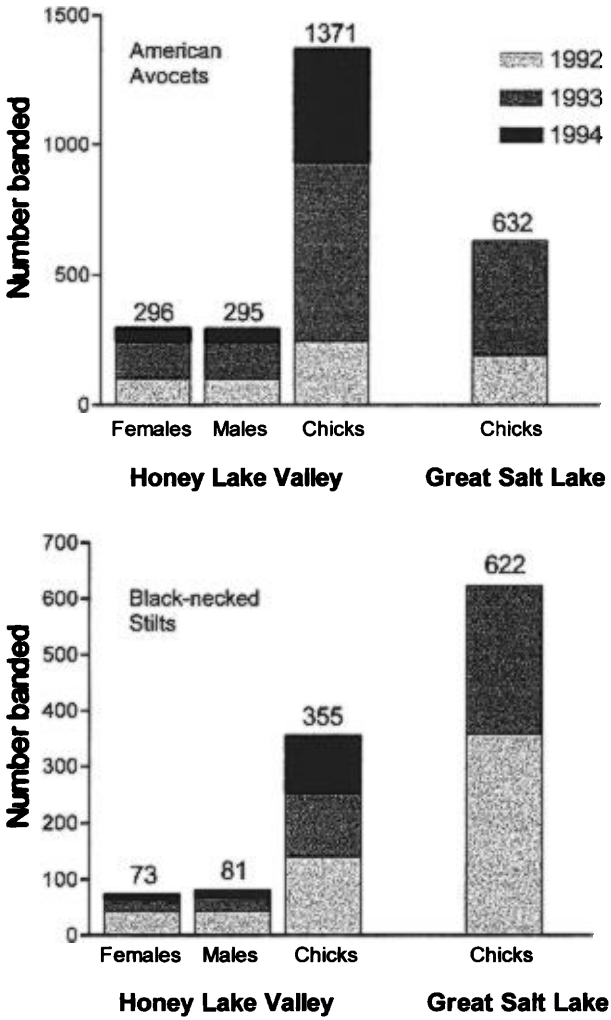

FIGURE 1. Numbers of American Avocets and Black-necked Stilts banded at Honey Lake Valley, California, and Great Salt Lake, Utah, 1992-1994.

resightings of migratory or wintering individuals and evaluate migration routes and wintering areas for each species.

STUDY AREAS AND METHODS

Totals of 591 adult avocets, 2003 juvenile avocets, 154 adult stilts, and 977 juvenile stilts were banded at two sites: the Honey Lake Valley, California and Great Salt Lake, Utah (Fig. 1). Birds were banded with unique combinations of UV-resistant colored bands (A. C. Hughes, Ltd., Middle-

sex, U.K.). Avocets were sexed by bill curvature (Palmer 1967), and stilts were sexed by plumage (Palmer 1967:151, Prater et al. 1977). Similar proportions of adult females and males were banded (386:391 for avocets, 73:84 for stilts).

In California, most banding was conducted in the Honey Lake Valley from 1992–1994 at three managed wetlands: the Jay Dow, Sr. Wetlands (40°10′N, 120°13′W), a research facility of the University of Nevada, Reno, and the two units of the Honey Lake State Wildlife Area, the Dakin Unit (40°18′N, 120°23′W), and the Fleming Unit (40°19′N, 120°17′W). Limited banding was also conducted at other sites in the valley including the Wild Goose Hunting Club (40°07′N, 120°13′W), Amedee Hot Springs (40°18′N, 120°12′W), and along the shore of Honey Lake itself (40°09′N, 120°15′W).

Juvenile avocets and stilts were marked with Utah-specific color band combinations at Great Salt Lake in 1992 and 1993. Banding in Utah was conducted primarily at Layton Marsh (41°02′N, 112°00′W), Ogden Bay Wildlife Management Area (41°12′N, 112°15′W), Harold Crane Wildlife Management Area (41°20′N, 112°10′W), Bear River National Wildlife Refuge (41°25′N, 112°15′W), and northeastern Farmington Bay (40°53′N, 112°03′W).

After trying many different trapping protocols in 1992, the following protocol was adopted in 1993 to minimize disturbance of breeding birds. Adults were trapped on the nest after 14 d of incubation. Set traps were visually monitored at a distance using a portable blind or field vehicle, and birds were removed immediately after they discovered they were confined. Birds were trapped during the heat of the day when they were highly motivated to incubate and were not kept off the nest for more than 20 min. To prevent damage to eggs by overheating or by the movements of the trapped bird, eggs were temporarily replaced with painted wooden replicas during trapping. The real eggs were concealed in shade near the nest when possible, or stored in an egg carton in the blind, and were replaced immediately after trapping. Members of a breeding pair were not trapped on consecutive days, and the second bird usually was trapped only when eggs were pipped. Chicks were banded within 6 h of hatch, or occasionally were run down after leaving the nest.

We publicized our banding effort using advertisements in birding magazines, the *Ornithological Newsletter*, and by direct contact with refuge managers, local Audubon Society chapters, and colleagues. In addition to the resightings reported to us, several metal bands were returned to the Bird Banding Laboratory, National Biological Service. Approximately 10,000 wintering avocets were examined by LWO on each of two censusing trips in Sinaloa, Mexico.

Prior to inclusion in the data set, Tulare Basin resightings were screened to remove birds banded locally by C. Marn. Resightings were classified as migratory or wintering, based on chronology of departure from the study site, arrivals of marked birds in the Tulare Basin, and wintering population trends at Humboldt Bay, California (Evans and Har-

ris 1994). Sightings any time after departure from the breeding site through October were classified as migratory observations. Sightings in November, December, January, or February were classified as wintering observations. We did not receive resightings that were clearly associated with spring migration. Breeding season resightings (April through July) will be presented elsewhere.

Contingency tables were analyzed using the Conditional Binomial Exact Test (Rice 1988). Analyses of contingency tables assume that each observation was independent. Although this assumption could have been violated by these data, avocets did not depart in cohesive flocks, and were not subsequently observed in flocks of cohesive composition. In addition, we attempted to protect the assumption of independence in constructing contingency tables. In no cases were members of a family group or former mates included in the same contingency table.

RESULTS AND DISCUSSION

Prior to initiation of this study only 13 recoveries of banded avocets and 10 recoveries of stilts were on file with the Bird Banding Laboratory, National Biological Survey. Only nine records, all of avocets, documented movement >50 km. Eight of these documented a movement from the banding site to a migration or wintering area, and can be summarized as follows: (1) A chick banded in northcentral California in 1940 wintered near San Francisco Bay. (2) Four avocets banded in northwestern Nevada 1969–1970 were recovered at the following wintering sites: San Francisco Bay, Salton Sea, Sinaloa, Mexico, and Michoacan, Mexico (Mexican recoveries were recorded only by state in the 1970s). (3) An avocet chick banded in Kansas in 1962 was recovered that winter in Florida. (4) An avocet chick banded in Nebraska in 1938 was recovered in the winter of 1943 in northern Arizona. (5) A chick banded in central Montana in 1983 was recovered in southeast Idaho that September.

Of 110 resightings received during this study, 90 were identifiable as individuals banded at Honey Lake (Table 1), 3 were banded in Utah, 5 were banded by other researchers, and 12 could not be identified to banding origin. Sixty-nine percent of resightings (n = 62, avocets and stilts combined) were from evaporation ponds in the Tulare Basin where a team of researchers conducted daily field observations. Some individuals were seen at more than one site or in more than one year (footnotes to Table 1). A total of 65 individuals was seen >50 km from the banding location in Honey Lake.

Migration routes for birds leaving Honey Lake.—Resighting of migrant avocets at Mono Lake, San Francisco Bay, and inland California, and the range of wintering sites (see below) suggest that avocets take a variety of migratory routes on leaving Honey Lake in summer (Fig. 2). Migrant stilts from Honey Lake were only seen on evaporation ponds in the Tulare Basin. Details of resightings of adults are presented in Table 2.

The success of the previous breeding attempt did not appear to influence where a bird was seen as a migrant. Of four adult avocets seen at

TABLE 1. Numbers of individual avocets and stilts marked in the Honey Lake Valley, California, and resighted farther than 50 km from the banding site.

Location	Avocet		Stilt	
	Adult	First Year	Adult	First Year
Coastal California				
Arcata Marshes	1[a]	2[b]		
Bolinas Lagoon	2	2[b]		
San Francisco Bay	1	6		
Monterey	1	1		
Inland California				
Sacramento NWR		1		1
Mono County	4			
Grassland Water District			1	
Tulare Basin	18[c]	7	9[d]	5[e]
Edwards Air Force Base	1			
Sinaloa, Mexico	2			
TOTAL: Migratory/wintering sightings[f]	30	19	10	6

[a] This bird was also resighted at the Tulare Basin.

[b] One individual was seen twice.

[c] 33 total resightings, 23 resightings of individuals at different locations in the Tulare Basin, 17 individuals, but one was seen in two different years.

[d] 14 total resightings, 12 resightings of individuals at different locations within the Tulare Basin, 9 individuals.

[e] 8 total resightings, 5 individuals.

[f] 90 total resightings, 72 resightings of individuals at different locations within each region, 65 individuals counted as noted above.

Mono Lake, two left Honey Lake after being banded, and two left Honey Lake after their chicks had fledged. Of 19 adult avocets seen in the Tulare Basin after breeding at Honey Lake (18 individuals from Table 1 plus the individual seen again a second year), three left Honey Lake immediately after being banded, four left after their chicks hatched, two after their chicks fledged, and nine after their nests failed. One female seen in fall in the Tulare Basin, was only seen as a spring migrant at Honey Lake. Of nine Honey Lake stilts seen at the Tulare Basin, three left Honey Lake after banding, one left after chicks hatched, three after chicks fledged, and two after nest failure.

Sex ratios of avocets did not differ among migration sites. The numbers of female to male avocets were 2:2 at Mono Lake, and 10:7 at the Tulare Basin ($p = 0.43$). In contrast, more female than male stilts were seen in the Tulare Basin (7:2, $p = 0.067$), suggesting possible differential migration routes or timing.

First-year avocets were more likely than adults to be seen at coastal sites. We compared resightings in California because there were multiple inland and coastal observations (Fig. 2). Seven first-year avocets were seen

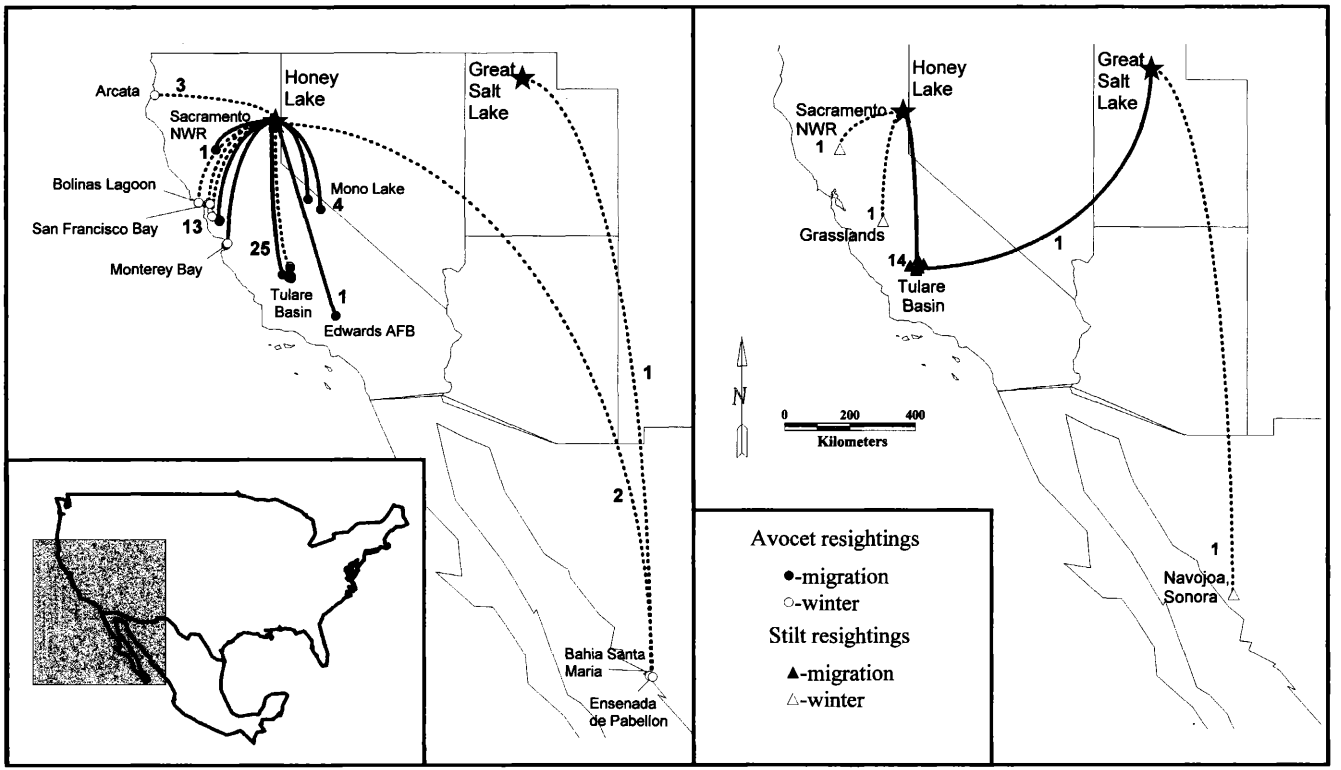

FIGURE 2. Migratory and wintering movements of American Avocets and Black-necked Stilts banded during this study. Solid lines connect banding sites with migration resightings. Dotted lines connect banding sites with winter resightings.

TABLE 2. Earliest fall departure dates and subsequent resightings for adult American Avocets and Black-necked Stilts banded in the Honey Lake Valley[a].

Earliest departure	Resighting				ID[d]	Status at Honey Lake
	Date	Region	km[b]	Days[c]		
Avocet females						
28 May 92	5 Aug. 92	Tulare	469	67	708	bred 92, 94
30 May 92	21 Aug. 92	Tulare	474	81	670	bred 92, 93, 94
1 Jun. 92[e]	15 Aug. 92	Mono	252	74	675	bred 92, seen 94
1 Jun. 92	17 Aug. 92	Tulare	478	76	628	bred 92, 94
11 Jun. 92	29 Jul. 92	Tulare	474	48	643	bred 92, seen 94
11 Jun. 92	21 Aug. 92	Tulare	474	70	688	bred 92, seen 94
14 Jun. 92	17 Aug. 92	Tulare	478	63	709	bred 92
19 Jun. 92	7 Dec. 93	Mexico	2040	528	701	bred 92, seen 94
28 Jun. 92	4 Aug. 92	Tulare	478	36	714	bred 92. seen 93, 94
29 Jun. 92	23 Aug. 92	Edwards	617	54	625	bred 92, 93, 94
9 Jul. 92	15 Aug. 92	Mono	252	36	684	bred 92, 94
9 May 93	25 Aug. 93	Tulare	474	106	659	bred 92, seen 93
14 May 93	6 Dec. 93	Mexico	2040	202	655	bred 92, seen 93, bred 94
29 May 93	4 Aug. 93	Tulare	478	67	737	bred 93
13 Jul. 93	8 Aug. 93	Tulare	478	26	845	bred 93, 94
18 Aug. 93	26 Feb. 95	Bolinas	331	548	735	bred 93
Avocet males						
28 May 92[e]	10 Jul. 92	Tulare	474	42	39[f]	bred 92, 93
2 Jun. 92[e]	19 Jul. 92	Mono	297	47	82	bred 92, 94
10 Jun. 92	12 Jul. 92	Tulare	478	32	79	bred 92, 93, seen 94
28 Jul. 92	15 Aug. 92	Mono	252	17	49	bred 92, 93, 94
12 Jun. 93[e]	25 Aug. 93	Tulare	481	73	140	bred 93
23 Jun. 93	7 Jul. 93	Tulare	478	14	141	bred 93
26 Jun. 93	15 Aug. 93	Tulare	481	49	39[f]	bred 92, 93
3 Jul. 93	24 Aug. 93	Tulare	469	51	221	bred 93
18 Jul. 93	18 Aug. 93	Tulare	478	30	149	bred 93, seen in Arcata 12/2/93

TABLE 2. Continued.

Earliest departure	Resighting				ID[d]	Status at Honey Lake
	Date	Region	km[b]	Days[c]		
Stilt females						
1 Jun. 92[e]	5 Aug. 92	Tulare	474	64	641	bred 92, seen 94
15 Jun. 92	23 Jul. 94	Tulare	474	758	611	bred 92
26 Jun. 92	18 Aug. 92	Tulare	478	52	615	bred 92
28 Jul. 92	26 Jul. 93	Tulare	478	358	640	bred 92
5 Aug. 92	3 Dec. 94	Grasslands	336	838	607	bred 92
28 May 93[e]	18 Aug. 93	Tulare	466	80	649	bred 93
2 Jul. 93[e]	11 Jul. 93	Tulare	478	9	655	bred 93, 94
14 Jul. 93	20 Jul. 93	Tulare	478	6	662	bred 93
Stilt males						
14 Jul. 92	5 Aug. 92	Tulare	474	21	8	bred 92, seen 94
19 Aug. 92	9 Aug. 93	Tulare	478	350	38	bred 92

[a] Table shows 25 adult avocets and 10 adult stilts. The 25 avocets plus 4 avocets excluded because identification could not be made to a single individual, plus the sighting of avocet male #149 at Arcata equals 30 avocet individuals in Table 1.

[b] Distance between banding location and resighting location, in km.

[c] Number of days between date last seen at Honey Lake and first resighting date elsewhere.

[d] Identification number unique to each avocet or stilt.

[e] Indicates bird was last seen at the time of banding.

[f] The same individual was seen at Honey Lake and in the Tulare Basin in each of two years.

inland and 12 were seen at coastal sites. In contrast, 23 adult avocets were seen at inland sites and 5 at coastal sites ($p = 0.001$).

Birds seen as migrants within the Tulare Basin were often seen on more than one date and sometimes moved between evaporation ponds (6–25 km). Adult avocets were seen in the Tulare Basin an average of 1.88 times (median = 2, range = 1–5), and adult stilts were seen an average of 1.5 times (median = 1, range 1–3). Adult avocets seen at least once were later seen at another site (on a different evaporation pond within the Tulare Basin) in 5 of 18 cases (28%), stilts in 3 of 9 cases (33%). For those birds seen more than once in the Tulare Basin, avocets were present a mean minimum of 21.33 days (SD = 10.38, range = 2–26, $n = 9$), and stilts were present a mean minimum of 28.5 days (SD = 14.75, range = 13–48, $n = 4$, counting a brood of three siblings as one observation). Thus, at least some individuals spent long periods of time in the Tulare Basin.

The complexity of migration movements is demonstrated by avocet male #149 (Table 2). After breeding at Honey Lake, he was seen on migration in the Tulare Basin (480 km to the south) from 18 Aug.–7 Sep. 1993, and again wintering at Arcata, California (700 km to the north) on 2 Dec. 1993. The bird did not return to Honey Lake to breed in 1994.

Members of family groups were resighted together in three cases. (1) Two avocet siblings in their hatch year were sighted on the same pond in the Tulare Basin on 3 Sep. 1992. One of these siblings was later seen at the mouth of the Salinas River on 17 Sep. 1992, and finally returned and bred in the Honey Lake Valley. (2) Three stilt siblings in their hatch year were sighted twice on an evaporation pond in the Tulare Basin. Some groups of siblings in both species may migrate together as hypothesized by Alberico et al. (1992) for Spotted Sandpipers (*Actitis macularia*). (3) A pair of stilts that had bred together in the Honey Lake Valley were sighted together in the Tulare Basin on 5 Aug. 1992. The male was later seen alone on 17 Aug. 1992. This observation suggests the possibility that pair bonds extend beyond nesting in this species.

Wintering areas.—Avocets wintered along the California coast from Arcata southward and along the west coast of Mexico (Fig. 2). Avocet use of Arcata Marshes and Humboldt Bay has been increasing over the last 50 yr (Evans and Harris 1994). The Sinaloa coast is a major wintering area for avocets (Harrington 1992, and unpublished reports for 1993 and 1994, Morrison et al. 1992). Resightings of adult avocets were distributed as follows: one at Arcata Marshes, two at Bolinas Lagoon, one at Monterey, one at San Francisco Bay, and two in Sinaloa (at Bahia Santa Maria and Ensenada de Pabellon). Resightings of first-year avocets were distributed as follows: two at Arcata Marshes, one at Bolinas Lagoon, two at San Francisco Bay, and two in the Tulare Basin. Based on consecutive resightings, one first-year avocet spent a minimum of 51 d wintering in Arcata, and another spent 121 d wintering at Bolinas Lagoon. Stilts from Honey Lake have been sighted in the Sacramento National Wildlife Refuge com-

plex, and at the ponds of the Grasslands Water District as wintering birds (Fig. 2).

Connectedness of the eastern and western Great Basin.—To date, none of the birds banded at Great Salt Lake have been seen breeding in the western Great Basin. However, three birds from Great Salt Lake have been resighted at other times of the year. A hatch-year avocet was seen wintering near Bahia Santa Maria, Sinaloa, Mexico in December 1993. A hatch-year stilt was recovered near Navojoa, Sonora, Mexico in November 1992, and a second-year stilt was seen in the Tulare Basin in September 1993. Thus, it appears that at least some birds from the eastern Great Basin winter in the same locations as do birds from the western Great Basin.

CONCLUSIONS

Avocets and stilts from the western Great Basin rely on the wetlands of California for stopovers during migration. Avocets and stilts breeding in California and the western Great Basin share wintering areas, and migrants from northern California mix with breeders at sites in central California. Although it is impossible to distinguish heavy bird use from heavy observation effort, it is clear that the controversial evaporation ponds of the Tulare Basin (Williams 1994) are used by many migratory avocets and stilts that breed in noncontaminated areas.

No single wetland complex can currently be identified as most important for migratory avocets. The broad geographic dispersion of wintering American Avocets from Honey Lake was similar to that reported for Pied Avocets (*R. avosetta*) from England (Cadbury and Olney 1978) and France (Watier and Fournier 1980). In contrast, habitat use by migratory Black-necked Stilts was restricted to inland sites. Stilts might depend more strongly than avocets on wetlands of central California as stopover sites on their way to wintering sites in western Mexico.

We have documented that some avocets and stilts from the eastern Great Basin join birds from the western Great Basin at wintering sites along the west coast of Mexico. Thus, the potential for some population mixing exists, as is confirmed by the observation of a Great Salt Lake stilt during September in the Tulare Basin. Since birds from the eastern and western Great Basin share wintering sites, can the Great Salt Lake be considered part of the Pacific Flyway for recurvirostrids (cf. Page and Gill 1994)? The Nebraska to Arizona migration documented by the Bird Banding Laboratory suggests that the heuristic constructs of the Pacific and Central Flyways (cf. Morrison 1984) cannot unambiguously be applied to avocets. At first glance, our evidence supports the concept of Great Salt Lake being part of the Pacific Flyway. However, considering the heavy observer presence in the Tulare Basin, we saw many fewer Utah birds than we would have expected if mixis occurred between the eastern and western Great Basin. At California sites used during migration, there appears to be nearly complete separation of the eastern and western Great Basin birds. Further observation of the degree of mixing at wintering areas will be necessary to understand the degree of isolation between

eastern and western Great Basin. With the exception of birds breeding in the western Great Basin and central California, the continent-wide patterns of avocet and stilt migration remain unknown.

These results are relevant to understanding the effects of irrigation drainwater on avocet and stilt populations. We now know that selenium-contaminated evaporation ponds in the Tulare Basin are used by avocets and stilts migrating from noncontaminated sites in northern California (this study), and the rest of the western Great Basin (Bird Banding Laboratory recoveries). Evaporation ponds could have positive impacts (by providing food-rich stopover areas) as well as negative impacts (through selenium bioaccumulation) on migrants. Some birds reside in these ponds for as long as 48 d, long enough for significant selenium bioaccumulation to occur (Heinz et al. 1990). As a corollary, avocets or stilts collected on evaporation ponds during July (e.g., Ohlendorf et al. 1990) were not necessarily breeding residents in the Tulare Basin. The unknown histories of collected birds could partially explain variability in selenium bioaccumulation in livers of collected adults (Ohlendorf et al. 1986b).

Our observations lead to several general hypotheses about migratory movements of avocets and stilts. For avocets, we hypothesize that (1) avocets make small "hops" between wetland sites as they move from breeding to wintering areas, (2) avocet siblings sometimes migrate together to stopover sites, and (3) first-year avocets have migratory behavior that differs from adults such that they more often use coastal sites. For stilts, we hypothesize that (1) stilt siblings sometimes migrate together to stopover sites, (2) stilt pair bonds sometimes extend beyond the breeding attempt, but (3) that male and female stilts may differ in their migratory behavior or wintering ranges. These hypotheses will be testable as our studies of marked avocets and stilts continue.

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