

WESTERN BIRDS



Vol. 40, No. 4, 2009

Western Specialty: **Pinyon Jay**



Photo by © Brian E. Small of Los Angeles, California:
Pinyon Jay (*Gymnorhinus cyanocephalus*)
Deschutes National Forest, Lake County, Oregon, 9 August 2006.

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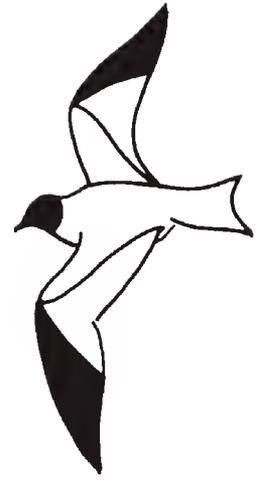
Front cover photo by © Todd Easterla of Rancho Cordova, California: Streaked Shearwater (*Calonectris leucomelas*), Monterey Bay, Monterey County, California, 12 October 2008. A species of the western Pacific, the Streaked Shearwater has been substantiated once in Oregon, 18 times in California (most frequently on Monterey Bay but once inland), and once in Wyoming.

Back cover "Featured Photo" by © Brad Schram of Arroyo Grande, California: juvenile Rufous-crowned Sparrow (*Aimophila ruficeps*), Deer Canyon, San Luis Obispo County, California, 6 August 2006. Note the pencil-streaked upper breast and sides over buff, streaked crown, and facial pattern, a paler version of the adult's.

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RECENT PURPLE MARTIN DECLINES IN THE SACRAMENTO REGION OF CALIFORNIA: RECOVERY IMPLICATIONS

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ABSTRACT: We monitored the Purple Martins (*Progne subis*) breeding in the Sacramento region, California, in 2008 and 2009, following similar monitoring from 2002 to 2007. This bridge-nesting population is the last remnant of the formerly widespread Central Valley population. All 11 colonies occupied in 2007 remained active in 2008, but the number of occupied colonies declined to 9 in 2009. From 2007 to 2009 the number of breeding pairs declined by 34%, from 106 to 70. Since 2004, the population has declined by 60% (103 pairs), and the annual rate of decline has increased. Probability calculations suggest the decline has been caused by factors other than chance fluctuation. If the decline continues at its current rate, the population will be extirpated within 22 years. Causes of the decline are unknown, but our previous studies have implicated mortality during the breeding season from vehicle collisions. Sacramento-area populations also are threatened by disturbance from a variety of construction projects and land-use changes that may affect habitat suitability. Recent losses in Sacramento represent a 6–11% decline in California's estimated Purple Martin population. Increased effort is needed to stabilize the Sacramento population, which would serve as the likely source for any future recovery within the Central Valley.

The Purple Martin (*Progne subis*) is recognized by the California Department of Fish and Game as species of special concern because of reductions in its geographic range and numbers (Airola and Williams 2008). The martin population in the Sacramento area (mostly within the city of Sacramento, as well as limited areas in adjacent Placer and Yolo counties) is a remnant of a population once more widespread in California's Central Valley. This population apparently has survived competition from the European Starling (*Sturnus vulgaris*) by nesting in overpasses and elevated freeways (collectively, bridges), which are entered through "weep holes" on the undersides of the structures (Airola and Grantham 2003). The Sacramento population has, until recently, constituted approximately 9–21% of the total estimated nesting in California (Airola and Williams 2008).

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We monitored the Purple Martins breeding around Sacramento from 2002 to 2007 (Airola et al. 2008) after conducting similar surveys in the early 1990s (Airola and Grantham 2003). Here, we report the population's status in 2008 and 2009 and implications of recent trends for conservation of the species.

STUDY AREA AND METHODS

We studied Purple Martins at bridges in the Sacramento region (Sacramento, Yolo, and western Placer counties) previously identified as occupied or suitable for use by the species. Locations of colonies and other suitable sites, and the criteria used to define them, were described by Airola and Grantham (2003), Leeman et al. (2003), and Kopp and Airola (2007).

Survey methods included mapping of holes in which martins nested, recording diagnostic nesting behaviors [carrying food to nests, removal of fecal sacs, juveniles begging, or seeing nestlings in holes (Airola and Grantham 2003, Leeman et al. 2003)], and video monitoring of a sample of accessible nest sites (see Airola et al. 2008 for methods). These methods provide a consistent and repeatable basis for estimating numbers.

We confirmed breeding by 93% and 96% of pairs in 2008 and 2009, respectively, through observation of diagnostic nesting behaviors and video monitoring at 35% (2008) and 38% (2009) of nest sites. Remaining nests were inferred on the basis of pairs entering holes frequently over the nesting season (see Airola and Grantham 2003 and Airola et al. 2008).

RESULTS

In 2008, Purple Martins bred in the same 11 sites they used in 2007 (Table 1). The newest site, at Highway 65 and Taylor Road in Placer County (Kopp and Airola 2007), was reoccupied by a single pair of Purple Martins that contained a male in typical dark after-second-year plumage (Pyle 1997), suggesting the return of the male that bred there in second-year plumage in 2007. As in 2007, the formerly used Marconi, Airbase, and Pole Line sites remained unoccupied again in 2008 and 2009. In 2009, martins bred at only nine colonies (Table 1), the first time since extensive surveys of all suitable sites were initiated in 2003 that the number of colonies has dropped below 11. Second-year birds were seen at both the Marconi and Pole Line colonies but did not nest. Fifteen other sites previously identified as suitable (Leeman et al. 2003, Kopp and Airola 2007) but never known to be occupied also were surveyed in 2008 and 2009 and did not support nesting martins.

The number of pairs of Purple Martins nesting around Sacramento declined during both 2008 and 2009. The 2009 total of 70 pairs represents a decline by 34% from the number in 2007, by 60% from the peak in 2004 (Table 1), and the fifth consecutive year of decline. At eight colonies, numbers in 2009 decreased from those in 2007, while they remained the same at one colony and increased at two. No obvious causes for the changes were evident. As in previous years, colonies in the more urbanized downtown areas (I St., 20th St., Broadway, 35th St., S St.) declined from 2007 to 2009

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Table 1 Number of Breeding Pairs of the Purple Martin around Sacramento, California, 2002–2008

Colony	2002	2003	2004	2005	2006	2007	2008	2009
I Street	37	29	35	32	17	11	6	5
20 th Street	14	21	23	23	16	15	6	5
Sutterville	4	6	8	5	6	6	5	6
Broadway	8	7	7	7	5	1	1	0
S Street	14	14	16	14	18	9	7	6
35 th Street	29	19	15	14	6	3	3	1
Redding Rd.	0	3	12	10	14	14	15	17
El Camino	ns ^a	15	23	21	21	20	11	5
Marconi	ns	1	4	3	0	0	0	0
Roseville Rd.	29	39	27	24	24	17	17	13
Arden	ns	0	3	6	13	9	11	12
Airbase	ns	0	0	1	1	0	0	0
Pole Line	ns	2	0	0	0	0	0	0
Hwy. 65/Taylor	ns	ns	ns	ns	ns	1	1	0
Total	135	156	173	160	141	106	83	70

^ans, not surveyed.

at a higher rate (59%) than did more outlying colonies (21%), although this difference is only marginally significant statistically ($\chi^2_1 = 3.05$, $P = 0.08$). Since 2004, when the size of the nesting population peaked, downtown colonies have declined by the significantly greater rate of 82% (from 96 to 17 pairs), while outlying colonies have declined by 31% (77 to 53 pairs; $\chi^2_1 = 79.7$, $P < 0.0001$).

DISCUSSION

The 2008 and 2009 declines in the number of Purple Martins nesting in Sacramento represent the fifth consecutive year of decline following two years of increases (Table 1). The 2008 and 2009 populations are lower than any recorded previously in 10 surveys since 1992 (Airola and Grantham 2003, Airola et al. 2008), despite surveys since 2003 being more comprehensive (Table 1).

How likely is it that recent declines represent a trend or a population fluctuation? We address this question in several ways. First, the annual rates of population decline appear to be accelerating, from 8% in 2004 and 12% in 2005 to 16–25% from 2007 through 2009. Second, we calculated the probability that by chance alone the population could have declined five years in a row over our eight years of monitoring. If the probability of an increase or decline in any one year is 0.5, the probability of five consecutive annual declines (one of six possible outcomes over seven years) is $P = 6(0.5)^7 = 0.047$, a figure strongly suggesting that a cause other than chance is responsible.

Notwithstanding the relatively large declines in 2008 and 2009, most recent colonies remained occupied. Several colonies that supported a single pair in 2008 (Broadway and Highway 65/Taylor Rd) were abandoned in 2009, and the 35th St. colony declined to a single pair. Maximizing the

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number of colonies may be important for conservation because the Purple Martin's colonial habits may discourage reoccupation of sites once they are abandoned, especially because declining populations likely reduce pressure on new breeders to disperse to unoccupied sites. The observation in 2009 of nonbreeding birds at two sites previously abandoned (Marconi and Pole Line), however, suggests the possibility of recolonization of these sites, and perhaps others, when the population is healthier.

A reduction in the number of active colony sites presumably increases the risk that a future disturbance or habitat changes at an occupied site could affect the population disproportionately. Such disturbance is a substantial threat, as 60% of the 2009 population is breeding at sites that have been recently affected by, or are proposed for, construction projects that may disturb the bridges, the lands below them, or alter the habitat immediately adjacent to sites (updated from Airola et al. 2008).

Protecting habitat at current colonies, however, also requires considerable understanding of local patterns of habitat use such as flight paths to nests, sources of nest material, and perch sites. Also, appropriate protection from construction disturbance requires recognition that Purple Martins tolerate considerable activity as long as nest sites remain secure (Airola et al. 2009). Excluding Purple Martins from their nesting areas during construction (as is typically done for other bridge-nesting swallows) reduced the subsequent nesting population at one Sacramento colony (Airola and Grantham 2003, Airola et al. 2004). Because such exclusion and displacement also likely reduces reproductive success and risks long-term abandonment of colonies (Airola and Grantham 2003) it should be used cautiously.

CONSERVATION IMPLICATIONS

The Purple Martin's nesting population in the Sacramento area has declined despite considerable efforts to protect and enhance it, including removing feral cats where they preyed on Purple Martins collecting nest material, reducing collision mortality with trains, reducing nestlings' falling out of nests, rehabilitating fallen nestlings, removing encroaching vegetation that blocked access to nest sites, and protecting colony sites from construction and from land uses beneath and adjacent to sites (Airola and Grantham 2003, Airola et al. 2008). Causes of the decline remain uncertain. Previous studies have indicated that the Sacramento bridge-nesting population is not limited by lack of suitable nesting habitat, infection by West Nile virus or other diseases, high predation rates, or competition with the European Starling (Airola and Grantham 2003, Leeman et al. 2002, Airola and Kopp 2007, Airola et al. 2008).

Airola et al. (2008) suggested that an increase in traffic and other disturbance associated with urban redevelopment may be increasing mortality from vehicle collisions during the nesting season. The higher rate of decline since 2004 at downtown colonies, where traffic volumes are higher, is consistent with this hypothesis. Notwithstanding evidence suggesting anthropogenic causes of decline, it remains possible that declines are related to short-term variation in weather, which we have not examined rigorously, or other unknown causes.

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More detailed evaluation of the timing of mortality (breeding season versus migratory and wintering period) is underway, which may help to illuminate critical causes of mortality. Additional evaluation of reproduction and mortality rates also is needed to clarify the role of these factors in determining the sizes of breeding populations.

Regardless of causes of declines, if the 16.5% average annual population decline from 2004 to 2009 were to continue, the Sacramento Purple Martin population would be eliminated within 22 years. However, the martin's colonial nature suggests benefits from group living (i.e., for increased fitness from extra-pair copulation and predator detection; Stutchbury 1991). Therefore, it is possible that as martin numbers at individual colonies decrease, the rate of population decline may accelerate further. The abandonment of two small colonies in 2009 may illustrate this process.

The recent decline in Sacramento's Purple Martin population is also important in a larger context, because of the small size and declining trend of the population statewide (Airola and Williams 2008). The recent decline by 103 pairs in Sacramento represents a loss of 6 to 11% of California's estimated population of 900–1850 pairs, which was based primarily on surveys conducted in the 1990s but updated to reflect the 2004 census for Sacramento (Airola and Williams 2008). Unfortunately, few other martin populations in California have been monitored systematically since Williams' (1998) surveys in the early 1990s, so it is unknown whether the recent declines in Sacramento are isolated or part of a broader trend. The population at Shasta Lake, the only other site of relatively consistent long-term monitoring in northern California, appears to be stable (Lindstrand 2008). A pilot survey initiated in 2009 by Airola and volunteers at a sample of northern California sites occupied in the 1990s may provide a broader indication of the martin's status in this region.

The continued decline in the number of Purple Martins breeding in Sacramento argues for higher conservation concern for this remnant population. Therefore, additional effort is warranted to continue monitoring the population to reveal the causes of recent declines, to minimize effects of construction projects, land-use changes, and vehicular traffic at martin colonies, and to establish a population nesting in boxes (Kostka et al. 2008, Elwood et al. 2009) to bolster the existing population and reduce risk of extirpation. Loss of the Sacramento population would eliminate the primary source of potential colonists for new bridges or nest boxes and so could preclude the possibility of population recovery in the Central Valley. The results of monitoring in 2008 and 2009 further support previous suggestions (Airola et al. 2008) that protection of the bridge-nesting martin population in Sacramento is critical as a strategy for recovery.

ACKNOWLEDGMENTS

We especially thank the Sacramento Audubon Society for funding. Kevin Thomas, Stan Kostka, Lynn Schmidt, and Ed Whisler assisted with monitoring. Mike Gleckler and other staff of the California Department of Parks and Recreation, State Railroad Museum, provided access and valuable assistance. Gabe Avila and Sharon Fultz (Sacramento Regional Transit), Bob Sleppy (California Department of General Services), and Lee Ann Lambirth (Caltrans) provided access to colony sites. Ron

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Schlorff, California Department of Fish and Game, assisted with permit acquisition. Len Lindstrand and Tim Manolis provided useful comments. Airola thanks Fereshteh (Angie) Raygani and Donya and Layla Airola for tolerating the extensive volunteer field time required for this study.

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Accepted 13 May 2009

FURTHER DECLINE IN NEST-BOX USE BY VAUX'S SWIFTS IN NORTHEASTERN OREGON

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ABSTRACT: Populations of the Vaux's Swift (*Chaetura vauxi*), a species of conservation concern, are declining in the Pacific Northwest. We compared the number of swifts nesting in boxes 2007–2008 to those nesting in the same boxes 1999–2002 to determine if numbers had changed. There were 51 nest attempts in the earlier 4-year period but only two to five nest attempts in the later 2-year period, an average decline of 72% in nest-box use. The cause of the decline is unknown. Northern Flying Squirrels (*Glaucomys sabrina*), Bushy-tailed Woodrats (*Neotoma cinerea*), and Red Squirrels (*Tamiasciurus hudsonicus*) usurped some of the nest boxes. Seven of seven swifts tested negative for the antibodies of West Nile virus. Conservation measures that protect existing nest and roost sites and create additional nesting sites (nest boxes and chimneys) would help ensure that habitat is not limiting Vaux's Swift populations.

From 1980 to 1999, on the basis of Breeding Bird Surveys, numbers of Vaux's Swifts (*Chaetura vauxi*) declined across their breeding range in the United States with a significant and steep decline in Washington (Bull and Collins 2007). Although the Vaux's Swift has no official status as threatened or endangered in any state within its breeding range, it is listed as a species of greatest conservation need in Washington's Comprehensive Wildlife Conservation Strategy (Washington Department of Fish and Wildlife 2005) and as a species of special concern in California (Hunter 2008). In 2003 in northeastern Oregon, Bull (2003a) recorded the swifts in only 46% of the forest stands they occupied in 1991 and significantly fewer swifts on survey transects. The cause for the decline in numbers of Vaux's Swifts in the Pacific Northwest is unknown, although loss of forest habitat, weather patterns, and disease are all potential factors. In addition, modification of their forest habitat, in the form of the harvest of large-diameter hollow trees and snags, eliminates the swifts' potential nest and roost sites. Other forest management that decreases the incidence of heartrot and reduces aerial insects could also reduce the number of the swifts' nesting and roosting sites as well as their prey (Bull 2003a). Currently, there is no quantitative information about the effect of adverse conditions, including weather and pesticide use, during migration or in wintering areas.

West Nile virus (*Flavivirus*) has spread rapidly across North America, causing deaths in humans, birds, mammals, and reptiles. Tens of thousands of birds have died, and local declines have been documented (McLean 2006, Clark et al. 2006), although it is difficult to attribute region-wide declines to West Nile virus specifically (Marra et al. 2004). In New York, 33% of the birds tested in 2000 were positive for West Nile virus (Kramer and Bernard 2001). In Ohio, Marshall et al. (2006) found 33% of Northern Cardinals (*Cardinalis cardinalis*) to be seropositive. Migratory birds are likely agents of the rapid spread of the disease (Rappole et al. 2000, McLean 2006).

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Populations of the Chimney Swift (*Chaetura pelagica*), closely related to the Vaux's Swift, have been adversely affected by West Nile virus (Komar 2003). The arrival of West Nile virus in the Pacific Northwest may be yet another factor increasing mortality and depressing Vaux's Swift populations.

The 103 nest boxes erected for swifts in northeastern Oregon in 1998 (Figure 1; Bull 2003b) provide a unique opportunity for the breeding activities of Vaux's Swifts to be quantified and for adults and nestlings to be captured and tested for the virus (Bull 2003a). In addition, these boxes provided us the opportunity to compare numbers of swifts using them at different times. The objectives of this study were to compare the numbers of swifts nesting in boxes 1999–2002 and 2007–2008 and to determine if West Nile virus antibodies are present in nesting Vaux's Swifts.

METHODS

We monitored 103 nest boxes erected for Vaux's Swifts at 12 localities in the Wallowa-Whitman and Umatilla national forests within 50 km of La



Figure 1. Nest box designed for Vaux's Swift, installed near La Grande, Oregon, in 1998.

Photo by Evelyn L. Bull

FURTHER DECLINE IN NEST-BOX USE BY VAUX'S SWIFTS IN OREGON

Grande in northeastern Oregon. All boxes within a 5.4-km radius were considered to be at a single locality because 5.4 km was the maximum distance Bull and Beckwith (1993) found that radio-tagged swifts traveled from the nest while rearing young in northeastern Oregon. Nest boxes were 3.5 m deep and 30 cm square and put in trees 10–15 m above the ground. Approximately one-third of the boxes were installed in each of three habitat types: late-seral stands of Grand Fir (*Abies grandis*), harvested stands of Grand Fir, and stands of Ponderosa Pine (*Pinus ponderosa*).

We determined use of the boxes by climbing to them 1999–2002 during an earlier study (Bull 2003b) and again in 2007 and 2008 for this study. In late June or early July we inspected the walls of each box with a flashlight for stick nests (Figure 2) or swifts and collected its contents, which we inspected for eggshell fragments, sticks, and the swifts' fecal material. The presence of small white eggshell fragments indicated that eggs had been laid in the box. The presence of more than 300 cm³ of the swifts' distinctive fecal material, containing lots of insect chitin, was a good indication that young had fledged successfully (Bull 2003b). The presence of only small sticks suggested that a nest had been started, but we did not consider these boxes to have been active if they contained no eggshell fragments. Some of the original 103 boxes had fallen or the trees to which they were attached had died and were unsafe to climb; only 92 and 86 boxes were checked in 2007 and 2008, respectively.

We netted swifts at active nests in early August 2007 and 2008 to collect a blood sample (<0.2 ml) from either the brachial vein or a toe nail.



Figure 2. Nest of Vaux's Swift in a box mounted on a tree near La Grande, Oregon.

Photo by Evelyn L. Bull

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The blood sample was put on filter paper containing preservative and dried and sent to Orange County Vector Control (Orange County, California) for testing for West Nile virus antibodies by the blocking ELISA technique (Jozan et al. 2003).

RESULTS

We found substantially fewer swift nests in 2007 (2 active nests) and 2008 (5 active nests) than during the earlier study (Bull 2003b) (Table 1). In the earlier 4-year period, 1999–2002, there were 51 nest attempts (in 30 different boxes). From 1999 to 2002 there were 12.75 nest attempts per year and a mean of 13.1% of the boxes were used each year. In 2007 and 2008 these figures were 3.2 and 4.0%, respectively.

In 2007, one box contained six live young swifts and a second box contained three dead nestlings; on the basis of the amount of fecal material in the box we presumed some additional nestlings had fledged. In 2008, the five active nest boxes contained (1) at least four nestlings, (2) one nestling (accumulated fecal material indicated that other young had already fledged); (3) eggshells and a detached wing; (4) four whole eggs on the box's floor; and (5) eggshells and a destroyed nest. These findings suggest that both nest attempts in 2007 and two of the five in 2008 were successful in hatching and probably fledging young.

We made no direct observations of Vaux's Swifts using nest boxes from 2003 to 2007. Ten additional boxes, however, had fecal material and/or egg shell fragments implying that swifts had nested in them sometime between 2003 and 2006. Nine of these contained >300 cm³ of fecal material, suggesting that young could have fledged from them (Bull 2003b). The one box with only eggshell fragments did not contain any fecal material, indicating this attempt failed. There were two boxes with 2000 and 2400 cm³ of the swifts' fecal material that we assumed represented at least 2 years of successful nesting.

Table 1 Variation by Year in Vaux's Swift Use of Nest Boxes in Northeastern Oregon

	Year(s)		
	1999–2002	2007	2008
Swift nests			
Boxes with swift eggs or nestlings	30	2	5
Nest attempts (boxes used)	51	2	5
Active nests each year	10–15	2	5
Nest attempts per year (mean)	12.75	2	5
Percent of active nests that fledged young	53%	100%	40%
Squirrel nests			
Boxes with lichen or grass nests	58	73 ^a	49
Years of monitoring	4	1	1
Boxes checked	103	92	86

^aAccumulated from 2003 to 2007.

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Two adult swifts and four nestlings in one nest box in 2007 and one nestling in 2008 were tested for WNV antibodies; all tests proved to be negative. While checking the nest boxes, we saw or heard free-flying swifts at only 4 of the 12 localities in 2007 and at 3 of the 12 localities in 2008.

A variety of other birds and mammals also used the nest boxes, making some of them unavailable to swifts. Northern Flickers (*Colaptes auratus*) and Pileated Woodpeckers (*Dryocopus pileatus*) roosted in the boxes regularly, leaving fecal material and wood chips. Pileated Woodpeckers had excavated additional entrance holes in five boxes by 2002 and in 19 boxes by 2008 (53% in stands of pine, 31% in harvested stands of fir, and 16% in late-seral stands of fir). We consider nest boxes with additional holes excavated in them unsuitable for swift nesting.

In 2007, seven boxes contained live Northern Flying Squirrels (*Glaucomys sabrinus*), and three boxes contained Bushy-tailed Woodrats (*Neotoma cinerea*). In 2008, Northern Flying Squirrels again occupied seven boxes, and unweaned Red Squirrels (*Tamiasciurus hudsonicus*) occupied one box. Nests of lichen or grass, presumably constructed by squirrels or woodrats, were found in 73 boxes (79%) in 2007. In 2008, rodents had built new nests in 49 of the boxes (56%). This one-year accumulation is greater than the total of 58 boxes with squirrel nests during the longer 1999–2002 study period. During that time, the percentage of the 58 swift nests that fledged young was 63% in boxes without a squirrel nest ($n = 46$) and 17% in boxes with a squirrel nest ($n = 12$).

The use of boxes in the various forest types changed over time. The swifts' use of late-seral stands of Grand Fir decreased but their use of stands of harvested Grand Fir and Ponderosa Pine increased. In all three forest types squirrels' use of boxes increased (Bull pers. obs.). Unfortunately, there are no data on squirrel population sizes during the study period.

DISCUSSION

The number of swifts nesting in boxes in northeastern Oregon decreased by 72% since the previous 1999–2002 study. In addition, in 2007 and 2008 Vaux's Swifts were seen or heard in only 4 and 3 of the 12 localities, respectively, whereas from 1997 to 2002 they were seen or heard in 11 of the 12 localities.

Numerous factors could influence Vaux's Swifts' use of nest boxes in northeastern Oregon. Some of these would include the size of the swift population in the area, the presence of squirrels in the boxes, and the condition of the boxes. Although all seven of the swifts captured tested negative for antibodies to West Nile virus, it might be argued that swifts that contacted the virus might have already succumbed to the disease, thus reducing the overall swift population in the study area. A wider program of West Nile virus testing in Vaux's Swifts would be informative. Squirrels occupying a box may make it less attractive, as evidenced by the success rate in boxes with squirrel nests being lower than in those without squirrel nests. As the number of squirrel nests in the boxes increased, the number of swift nests decreased. In addition to just appropriating the nest boxes, squirrels and woodrats could also be predators of eggs and hatchlings.

FURTHER DECLINE IN NEST-BOX USE BY VAUX'S SWIFTS IN OREGON

Among the 92 and 86 boxes that could be checked in 2007 and 2008, respectively, some were not suitable for swift nesting for several reasons. In 58 hollow trees used by Vaux's Swifts the average depth of natural cavities was 4.1 m (Bull and Collins 2007), and the nest was attached to the chamber wall 2.3 m below the entrance hole. When given a choice of nest boxes 1.2 m, 2.4 m, and 3.5 m deep, swifts frequently nested in the boxes 3.5 m deep, nested only once in a box 2.4 m deep, and never nested in the boxes 1.2 m deep (Bull 2003b). In the earlier study period (1999–2002), nest boxes were cleaned annually, so the accumulation of lichen and grass that squirrels brought in as nest material was minimal—usually less than 0.3 m deep on the bottom of the box. In 2007, after 5 years with no box maintenance, squirrel-nest material was more than 1.3 m deep in some of the boxes. By 2007 the accumulation of such large amounts of nest material may have made these boxes less attractive to the swifts by concealing their depth. The cleaning of the boxes in 2007 could have been partially responsible for the increase in nesting pairs in 2008; two of the swift nests that year were in boxes that had accumulated squirrel-nest material in them in 2007 and were thus not suitable.

Another explanation for some of the reduction in the swifts' use of the boxes is the higher incidence of Pileated Woodpecker entrance holes: in 19 boxes in 2008, in only five boxes 1999–2002. Additional entrance holes may make the box less attractive to swifts, perhaps because it is less secure from predators and the increased light may be undesirable. We had not anticipated that Pileated Woodpeckers would use these nest boxes for roosting. The excavation of additional holes in the boxes provides the woodpeckers with multiple avenues of escape should a predator enter the box. Multiple holes are also characteristic of Pileated Woodpecker roosts in hollow trees (Bull and Jackson 1995).

Only one stand of forest, containing four boxes, had been altered by fuel reduction since 2002, so it is unlikely that habitat alteration since 2002 significantly influenced the swift's population.

Conservation measures to prevent further declines of the Vaux's Swift population could include increasing opportunities for breeding by putting up nest boxes (Bull 2003b) or building mock chimneys as nest sites, as has been done for the Chimney Swift (Kyle and Kyle 2005). Cleaning of nest boxes just prior to nesting may also increase their use. It is also important to protect existing nest and roost sites (hollow trees and chimneys) in both the breeding range and at migration stop-over locations; their loss might be yet another factor contributing to the apparent decline of Vaux's Swift we have documented.

ACKNOWLEDGMENTS

We thank Ed Baird and Jim Harris for climbing to the boxes to check nest contents. Michael Snider and Paul and Georgan Kyle, Tom Ryan, Kathy Molina, and John Hunter made helpful comments on earlier drafts of the manuscript. Robert Cummings at Orange County Vector Control arranged for the testing of blood samples for West Nile virus antibodies. Funding was provided by the California State University Long Beach Foundation and the U.S. Forest Service Pacific Northwest Research Station.

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Accepted 17 September 2009

USE OF A NESTING PLATFORM BY GULL-BILLED TERNS AND BLACK SKIMMERS AT THE SALTON SEA, CALIFORNIA

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ABSTRACT: In 2006, we constructed an elevated nesting platform at the Salton Sea, California, and monitored its use by Gull-billed Terns and Black Skimmers over three subsequent breeding seasons. Black Skimmers were the first to colonize the platform with a total of five nests in 2006. In 2007 Gull-billed Terns colonized the platform with a total of 28 nests and the number of Black Skimmer nests increased to 20. Neither species nested on the platform in 2008. Low success for both species was probably influenced by at least two factors. First, when both species nested on the platform, nest densities were higher than is typical of their colonies on larger, earthen islands, and colony success may have been reduced by overcrowding. Second, lack of access to water may have reduced chicks' ability to thermoregulate effectively in the hot environment of the Salton Sea. Refinements to the size, design, and location of artificial nesting habitats are necessary to enhance productivity of colonial ground-nesting birds at the Salton Sea successfully.

Artificial or constructed nesting habitats have often been employed to increase the number of suitable breeding sites for ground-nesting colonial birds such as terns (Lampman et al. 1996, Quinn and Sirdevan 1998, Spear et al 2007, Jenniges and Plettner 2008). Such artificial nesting habitats have been provided to (1) accommodate the growth of newly colonizing populations, (2) enhance reproductive success, (3) create novel sites that are relatively free of predators or that reduce competition for space with more aggressive species (such as gulls; Molina 2004), and (4) augment the number of alternative sites when the suitability of existing natural habitats declines with the encroachment of vegetation or when the protective isolation of islands diminishes as lake levels fall. Constructed habitats are typically located in lakes, impoundments, or other shallow and protected waters. These nesting habitats often take the more traditional form of sand, rock, and earthen islands (usually formed with bottom sediments). Floating platforms such as rafts (Dunlop et al. 1991, Lampman et al. 1996) also have been used when the deposition of dredged sediments is infeasible. When natural nesting sites are limited, rafts and barges have been used to promote the colonization of alternative nesting habitats when land-use conflicts arise and colony relocation is desired (Collis et al. 2002). In some cases breeding larids have spontaneously (i.e., without the aid of audio-visual attractants such as decoys or call broadcasters) colonized the surfaces of existing floating or fixed platforms such as moored barges (Molina pers. obs.), the surfaces of navigational buoys (Karwowski et al. 1995), or even the flat gravel roof tops of buildings (Fisk 1975, Coburn et al. 1997).

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The Salton Sea is the largest terminal lake in California; this highly dynamic and productive saline ecosystem lies below sea level and lacks an outlet. Over the past decade, Gull-billed Terns (*Gelochelidon nilotica*) and Black Skimmers (*Rynchops niger*) breeding at the Salton Sea have experienced the loss of isolated nesting sites (islands) with declines in water level (Molina 2004). Since 2001, the continued decline of water levels has resulted in additional losses of the traditional nesting islands of Obsidian Butte, Morton Bay, and Elmore Desert Ranch by increasing mammalian predators' access to these sites and further intensifying waterbirds' demand for undisturbed nesting and resting sites (Molina 2004, 2007).

There is no precedent in California for breeding Gull-billed Terns and Black Skimmers nesting on habitats other than earth- or gravel-based islands (Molina 2008a, b) or rafts that mimic islands (Molina 2007). However, Gull-billed Terns (Molina and Erwin 2006), Least Terns (*Sternula antillarum*; Krogh and Schweitzer 1999), and Black Skimmers (Coburn et al. 1997) have spontaneously colonized elevated sites such as flat gravel roofs in coastal Louisiana and Florida. Given the propensity of larids in general to use artificial sites in other parts of North America, in 2006 we constructed a fixed and elevated platform at the south end of the Salton Sea to address the decline in the number of suitable colony sites and to enhance nesting for the Gull-billed Tern and its close nesting associate, the Black Skimmer. In this paper we report the number of breeding pairs, nest attempts, and young of Gull-billed Terns and Black Skimmers on this novel habitat and summarize the phenology of its use in 2006, 2007, and 2008. We also discuss the disadvantages and potential refinements of artificial nesting habitats at the Salton Sea.

METHODS

In April 2006, United States Geological Survey personnel in cooperation with the U. S. Fish and Wildlife Service constructed an elevated platform at the southeast end of the Salton Sea approximately 400 meters north of the northern seawall boundary of the Sonny Bono Salton Sea National Wildlife Refuge (Figure 1). Our criteria for the platform's location were that it be (1) placed on refuge property, (2) sufficiently isolated by water over a period of years to deter access by mammalian predators, (3) observable from a distance to minimize disturbance to nesting birds, and (4) in close proximity to traditionally active colony sites such as the islands within one of the refuge's impoundments (D pond) adjacent to the northern seawall. The wooden platform measured 4.9 × 7.3 m with approximately 35 m² of potential nesting area (Figure 2). The platform was supported by twelve 10 cm × 10 cm × 3.7 m posts driven about 1.5 m into the sediment, with the deck, consisting of ¾-inch tongue-and-groove plywood, placed approximately 1.2 m above the water's surface. The average elevation of the Salton Sea in April 2006 was -69.2 m (-227 ft), decreasing to -69.4 m (-227.8 ft) in April 2008 (Imperial Irrigation District); water depth at this location during the study was about 1 m. The deck was covered with a layer of about 2.5 cm of mixed sand and gravel which was then covered with a 10-cm layer of crushed barnacles collected from the Salton Sea's shoreline. Three plywood

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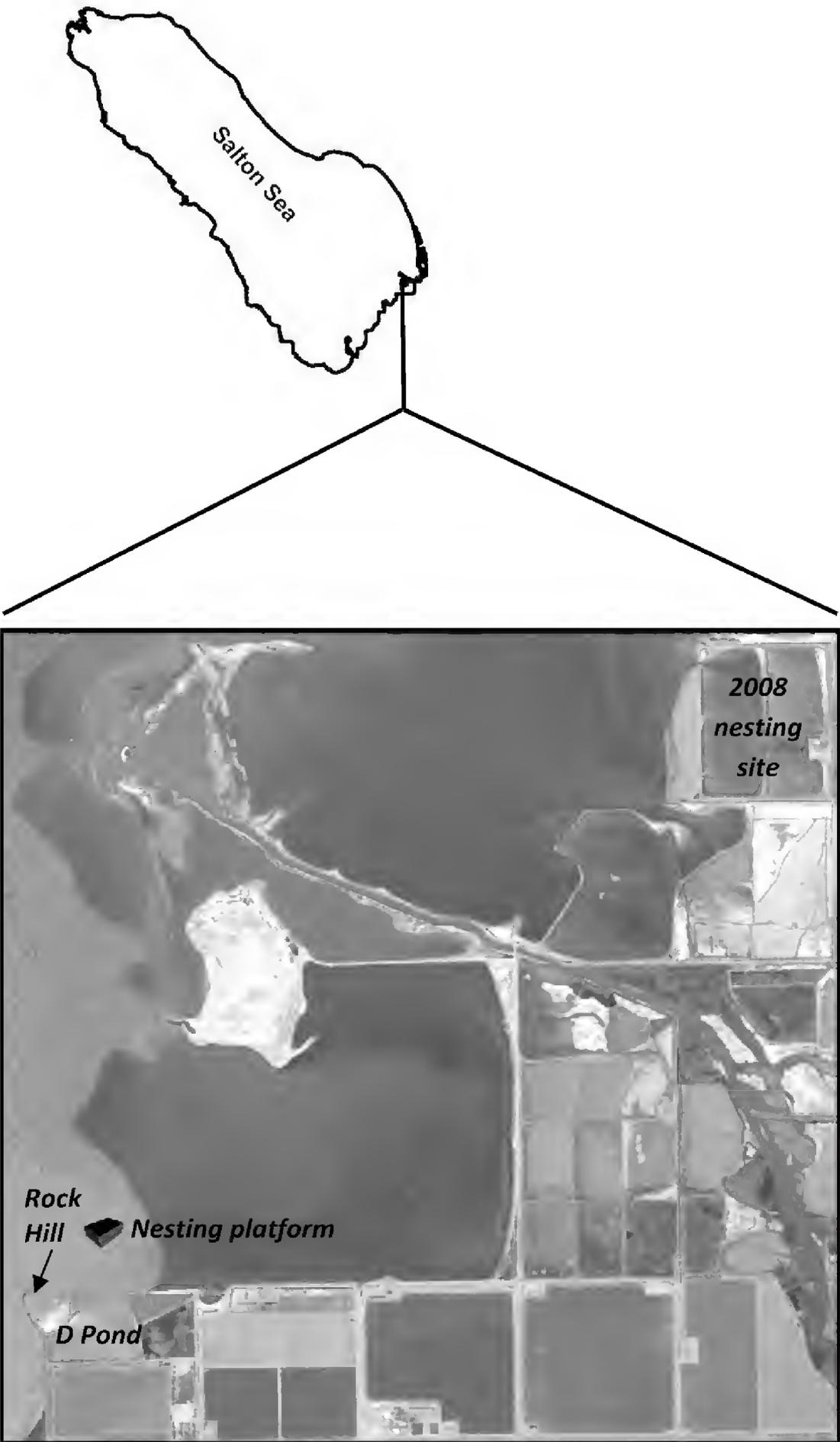


Figure 1. Geographical location of the study area and nesting platform.

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Figure 2. Nesting platform at completion and close up of nesting substrate. Note solar panel at upper center and Gull-billed Tern decoys at left.

Photos by Mark Ricca

ramps measuring 3.6×1.2 m and extending below the water's surface were attached to the north, south, and east ends of the deck to facilitate the return of nonvolant young to the deck. The platform was equipped with visual and audio attractants in the form of 20 Gull-billed Tern decoys (Mad River Decoys, Waitsfield, VT) and a solar-powered sound system (MurreMaid, Bremen, ME) to continuously broadcast the Gull-billed Tern's vocalizations (Kress 1983). A motion-activated camera was initially installed but removed

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in mid-May 2006 along with ten decoys to increase the amount of potential nesting area. The solar-powered sound system was inoperable in 2007 and removed from the platform prior to the 2008 breeding season. All of the re-entry ramps were damaged or destroyed during high winds in April 2006, and subsequent attempts at repair and redesign were unsuccessful.

We monitored the presence or absence of terns and skimmers sitting or standing on the platform from at least early April through August of each year at roughly weekly intervals. In 2006 multiple censuses were made in most weeks, but there were gaps in observations of up to 14 days in July and August. In 2007 and 2008, we censused the platform at least every other week, often more frequently. Less regular observations continued into mid-October in 2006 and mid-September in 2007 and 2008. Because of larids' semi-precocial nature and sensitivity to disturbance, studies of birds nesting on rafts or elevated sites such as roof tops and our platform confront inherent difficulties because disturbance by investigators often reduces a colony's success (e.g., Krogh and Schweitzer 1999). Therefore, we observed from elevated locations from either the overlook at Rock Hill (about 500 m southwest of the platform) or from the refuge's northern seawall boundary (Figure 1). Our observations were distributed throughout the daylight period. The duration of observations ranged from 15 to 30 minutes, and for each observation we recorded the peak number of adult Gull-billed Terns and Black Skimmers on the platform as well as the platform's use by other species. We briefly visited the platform once or twice each season to confirm the number of suspected nests. To minimize the potential of older chicks being flushed from the platform, our first visit of the season was timed to precede expected hatching. When feathered young were not observed when expected, we made a second visit to confirm their absence. We did not uniquely mark individual birds or systematically monitor fates of individual nests, which precluded distinguishing re-nesting attempts from those of new pairs or robustly estimating nesting and fledging success. Instead, we report (1) the frequency of platform use by both species over time and (2) the peak numbers of active nest attempts and observed young on any single observation to estimate nesting use and reproductive success. Because in both species both male and female invest heavily in incubation and chick-rearing duties, and pairs raise only one brood per season, we assumed that the peak number of nest attempts accurately reflected a minimum number of nesting pairs for the platform.

RESULTS

Peak Numbers and Phenology of Platform Use

In 2006, the platform's first year, we observed only one adult Gull-billed Tern briefly in early April (Figure 3). In contrast, Black Skimmers were on the platform continuously from 17 June to 13 October with an average of 9 adults present (SD = 3, $n = 14$ observations). In any single day's observation, the maximum number of adults was 14 on 24 June (Figure 3). Four skimmer nests were first noted on 5 July, although exact initiation dates were unknown. A fifth nest was established by mid-September, inferred from the presence of four small downy young on 13 October.

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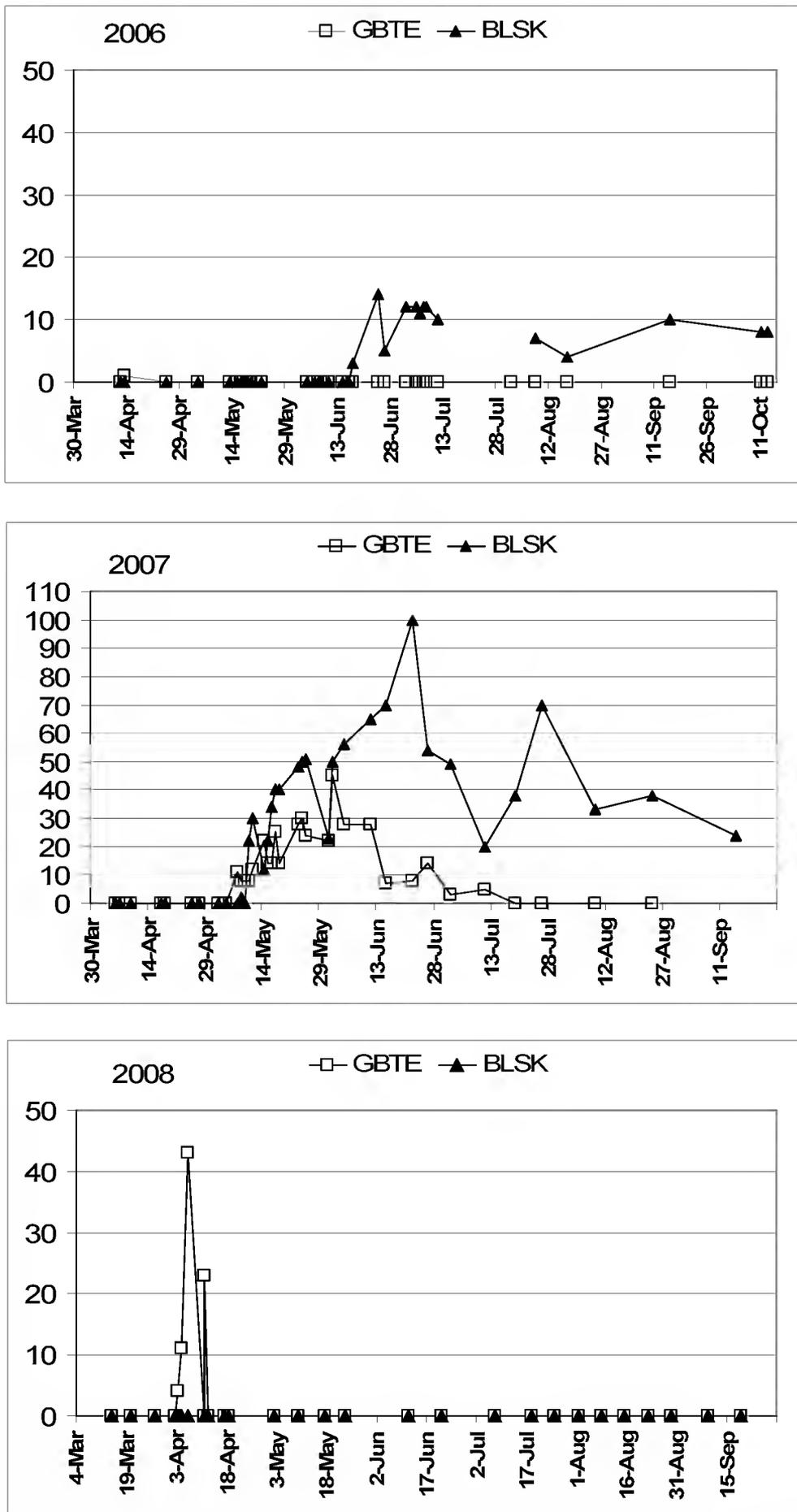


Figure 3. Phenology of platform use in 2006, 2007, and 2008 by Gull-billed Terns and Black Skimmers. Data reported are the peak numbers of adults present.

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In 2007, Gull-billed Terns increased interest in the platform with an average of 17.2 (SD = 11, $n = 22$ observations) adults present per visit from 7 May through 11 July (Figure 3). The maximum number of adult terns was 45 on 1 June. The first Gull-billed Tern nests were established between 4 and 7 May. However, by 15 June the number of adult terns present on the platform declined to seven. Over the next 10 days, when young should have been approaching fledging age and colony activity (adults attending and feeding chicks) should have been at its peak, the number of adults on the platform remained low (Figure 3). In contrast, Black Skimmers were continuously present from 10 May to 24 August (mean number and SD = 44 ± 20 adults, $n = 23$ observations). In 2007 the maximum number of adults on the platform was 100 on 24 June (Figure 3) and nests were first established between 24 May and 1 June.

In 2008, Gull-billed Terns were noted on the platform in early April (Figure 3), but use was brief and limited to the period around dusk. A maximum of 43 terns was present on the platform between 3 and 11 April. The terns were always absent on return visits at first light on the following mornings. Black Skimmers were never noted to land on the platform in 2008 (Figure 3).

Other species that occasionally rested on the platform when it was unoccupied by terns and skimmers were two Black-necked Stilts (*Himantopus mexicanus*), two Great Blue Herons (*Ardea herodias*), several Double-crested Cormorants (*Phalacrocorax auritus*), mainly on the platform's underlying cross beams, and, in 2008 only, as many as 26 Brown Pelicans (*Pelecanus occidentalis*).

Nesting Activity

The platform was used for nesting in two of the three years of our study by at least one of the two target species. In the first season of its availability (2006), the Black Skimmer was the only species to nest on the platform, establishing at least five nests. The number of active nests peaked at four (0.11 nests/m²) on 5 July. The peak number of five young was observed on 13 October; their size and development ranged from one nearly fledged chick to four small, downy chicks. In 2007, Gull-billed Terns colonized the platform with a total of 28 nests. A maximum of three tern chicks, all small and downy, was observed between 1 and 15 June, but no young or eggs were present on a visit on 3 July. In 2007, the number of nest attempts by Black Skimmers also increased from the previous year. The number of active skimmer nests peaked at 11 (0.31 nests/m²) on 27 July. A maximum of eight young (four large and feathered, four small and downy) was observed on 27 July. The number of active tern and skimmer nests taken together peaked at 32 (0.9 nests/m²) on 1 June. In 2008 neither species nested on the platform.

DISCUSSION

Black Skimmers immediately colonized the nesting platform in 2006 with at least four pairs (representing <1% of the Salton Sea's breeding population in that year) and increased to 20 pairs in 2007 (representing ~7% of the

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annual population). In contrast, at least 28 pairs of Gull-billed Terns (representing nearly 22% of the annual breeding population) initiated nesting on the platform in 2007. The lack of nesting by either species on the platform in 2008 may have been due to the proximity of a Great Horned Owl (*Bubo virginianus*) nest, active from early May through June, at Rock Hill. This owl is known to disrupt nesting colonies of Common (*Sterna hirundo*) and Least Terns in Maryland (Erwin et al. 2007). Gull-billed Terns and Black Skimmers colonized other breeding sites at the Salton Sea in 2008: terns nested on earthen islands (available since 2006) in a series of impoundments about 3 km to the east of the platform, and late that season skimmers nested on a small, newly available raft in the adjacent D pond (Figure 1). Terns also nested on a natural islet about 2.7 km to the southwest of the platform, a site where the species has nested occasionally since 1992 (Molina 2004). At the Salton Sea, Gull-billed Terns typically initiate nesting between late April and early May and Black Skimmers generally do so between late May and early June (Molina unpubl. data). In the year that each species colonized the platform, 2006 for the skimmer and 2007 for the tern, the timing of nest initiations on the platform was later than at other sites used in those years, suggesting the platform was less attractive than other sites and used by pairs whose earlier attempts had failed or by late nesters that could not find space elsewhere.

The ratio of young to nest attempts, which may be a useful indicator of colony success, was low for both species, particularly the tern. In 2007, the number of adult Gull-billed Terns diminished rapidly at a time when chicks near fledging age and a corresponding high level of nest-site attendance by adults were expected (Figure 3). These observations, accompanied by adult terns' delivering food to the platform infrequently, all indicated poor colony success. The causes of the low success for both species are conjectural. The concomitant increase in the larger, more aggressive skimmer at a vulnerable period (hatching) for the tern may have caused nest failure, chick deaths, and early abandonment of the site. Other factors possibly contributing to low colony success were (1) the platform's size potentially constraining nest densities above the optimum and (2) its unprotected location with respect to wind-driven waves on the surface of the Salton Sea coupled with the region's harsh environment.

Few studies of raft- or barge-nesting larids have specifically addressed the causes of mortality of young terns on these artificial sites. In a comparison of the relative proportions of Common Terns banded as fledglings in Britain and subsequently resighted in Africa, Norman (1987) found terns nesting on elevated platforms to be marginally more successful than those breeding at other sites, concluding that the main benefit of the platform was its inaccessibility to mammalian predators. Studies of raft-nesting Caspian and Common terns on Lake Ontario noted dead juveniles washed up on the mainland shore (Lampman et al. 1996), suggesting that some missing chicks, after falling into the water, were unable to navigate the ramps and return to the raft (Dunlop et al. 1991). We routinely searched along the northern seawall, the closest point on the shore and downwind from prevailing winds, for dead or live chicks displaced from the platform but never encountered any.

Nearest-neighbor distances of Gull-billed Tern nests on constructed

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islands at the Salton Sea are highly variable, ranging from 0.8 to 3.85 m (mean = 2.32, SD = 1.1, $n = 14$; Molina unpubl. data), but within the range of 0.3–20 m reported by Gochfeld and Burger (1996). Although we did not measure nearest-neighbor distances for nests on the platform, the density of concurrent tern and skimmer nests on it in 2007 (maximum = 0.9 nests/m²) was greater than the average density of 0.09 nests/m² (SD = 0.06, $n = 9$ colony sites) for Gull-billed Tern nests on constructed islands in 1999 and 2001 (Molina unpubl. data). The nesting asynchrony of Gull-billed Terns and Black Skimmers that often promotes a degree of temporal separation at shared colony sites at the Salton Sea (Molina unpubl. data) was not observed on the platform in 2007; nest densities and the likely nearest-neighbor distances we observed for terns and skimmers combined may have exceeded the Gull-billed Tern's levels of tolerance and suggests that the platform's area may have been insufficient to support the typically sized colonies of 30–50 pairs for both species (Molina and Erwin 2006, Gochfeld and Burger 1994).

In this unprotected location, our experimental platform was challenged immediately after construction by high wind-driven waves that briefly but completely swept the platform's deck. During successive periods of wind the platform's ramps were eventually washed away and a nonvolant chick's only means of return was eliminated. The loss of the ramps also prevented routine access to water by chicks and brooding adults for thermoregulation. At the Salton Sea, colonial birds that nest in exposed locations experience ambient temperatures that often exceed 42°C and corresponding high rates of insolation. Frequent foot and body soaking are important thermoregulatory behaviors for adult larids and their young in maintaining normal body temperature via evaporative cooling. These behaviors are also performed by incubating and brooding adults to maintain the eggs and nest at adequate temperature and humidity. Unrelieved heat stress may result in adults abandoning nests; chicks that lack access to water and constant brooding may die (Grant 1982, Molina pers. obs.).

Our platform's elevated design (Figure 2) more closely approximated the snags and trees in which herons and cormorants commonly nest at the Salton Sea (Molina and Sturm 2004) rather than the islands or rafts (which more closely mimic islands) typically used by larids. Such a design may be more appropriate for nesting by species with altricial or less precocial young and in regions where breeding adults and young are not exposed to high ambient temperatures that require birds have regular access to water for thermoregulation. Even if nesting larids do not use the platform in the future, the smaller-bodied terns and skimmers may still benefit if the platform attracts resting congregations of other large waterbirds, such as the White (*P. erythrorhynchos*) and Brown pelicans and Double-crested Cormorants, away from the terns' and skimmers' island nesting sites. In past years, resting flocks of these larger species have destroyed substantial numbers of tern and skimmer eggs by trampling them (Molina 2004, 2007).

More study is required for the size and design of constructed sites to be optimized for terns and skimmers in the region. We did find that audio attractants appeared unnecessary for colonization. Although artificial nesting substrates such as rafts and islands are usually installed in protected waters

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(Dunlop et al. 1991, Lampman et al. 1996, Molina 2007), our placement of the nesting platform was constrained by logistical and environmental considerations, including a paucity of such protected impoundments and a fluctuating sea-surface elevation and shoreline. If at the Salton Sea platforms can be successfully adapted to mimic islands more closely, that is, to maintain a degree of direct connectivity between the deck's surface and surrounding water (e.g., with permanent ramps or "skirts"), they will most certainly require placement in protected waters.

ACKNOWLEDGMENTS

Platform construction and initial monitoring costs were funded by the U. S. Fish and Wildlife Service Migratory Bird Office, Portland, Oregon. The Sonny Bono Salton Sea National Wildlife Refuge funded monitoring of nesting colonies and provided additional support for platform construction. We thank Nanette Seto for project support and Tom Anderson, Meg Harper, Susan Kaveggia, Cody Massing, Elizabeth Morgan, Keegan Ramey, and Amy Story for field assistance. We thank Brian Brinegar and Amy Story for construction assistance and Scott Story for construction design. Manuscript drafts were thoughtfully reviewed by Josh Ackerman, Tom Anderson, Charles Collins, Mike Erwin, Kimball Garrett, and MaryEllen Mueller, and Robert Gill provided editorial guidance. The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service or U.S. Geological Survey. Use of trade names does not imply governmental endorsement.

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Accepted 4 June 2009

BIRDS OF PREY AND THE BAND-TAILED PIGEON ON ISLA GUADALUPE, MEXICO

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ABSTRACT: We noted eight species of birds of prey at Isla Guadalupe during ten visits from 1991 to 2003. The most abundant species was the Burrowing Owl (*Athene cunicularia*), found throughout the island; second most numerous was the American Kestrel (*Falco sparverius*), widespread but uncommon. The frequency of the kestrel paralleled the population of mice, peaking 1992, a year of El Niño. We observed the Red-tailed Hawk (*Buteo jamaicensis*), Osprey (*Pandion haliaetus*), and Peregrine Falcon (*Falco peregrinus*) two or three times each, the Prairie Falcon (*F. mexicanus*) once. Our records of the Northern Harrier (*Circus cyaneus*) and Band-tailed Pigeon (*Patagioenas fasciata*) are the first for Isla Guadalupe.

Early publications on the birds of Isla Guadalupe (Gaylord 1897, Anthony 1925, Hanna 1925) were devoted largely to the endemic species that “fascinated biologists” (Jehl and Everett 1985). Thus the history of some of the taxa now extinct, such as the Guadalupe Caracara (*Caracara lutosa*) are well documented, but some others remain scarcely known. Luna-Mendoza et al. (2005) and Quintana-Barrios et al. (2006) summarized the island’s avifauna most recently. Here, on the basis of 10 visits to Isla Guadalupe from 1991 to 2003, we report our observations of the island’s raptors and owls, their relationships with their prey, and an accidental occurrence of the Band-tailed Pigeon (*Patagioenas fasciata*).

STUDY SITE AND METHODS

Isla Guadalupe (29° 00' N, 118° 20' W), of volcanic origin, lies within the waters of the California Current, 260 km off Baja California. Northwesterly winds predominate (Berdegué 1957). The orientation of the island and its elongated shape (37 km long and 6.5–9.5 km wide) act as a barrier against the prevailing winds and generate updrafts at various altitudes. Fog covers the mid-northern portion of the island almost daily. The climate is semi-arid to temperate, the annual mean temperature is 28° C, and winters are cool, mean temperature in the coldest month (January) being <17° C (Montañez et al. 2000).

The northern part of the island is high, culminating at Monte Augusta (1370 m). This area of the island has a relict forest of cypress trees (*Callitropsis guadalupensis*), an almost extinguished stand of pines (*Pinus radiata* var. *binata*), fan palms (*Brahea edulis*), island oaks (*Quercus tomentella*), grasslands dominated by several introduced species (*Hordeum murinum*, *Avena barbata*, *A. fatua*, *Bromus* spp.), and the introduced tree tobacco (*Nicotiana glauca*). Most of the middle part of the island is a large grass-covered plateau,

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culminating at Monte Esther (1250 m). To the south, the terrain is lower, with numerous small cinder cones, and vegetated largely by shrubs such as *Ambrosia camphorata* and introduced grasses (Rico-Cerda 1983).

Our observations were made during expeditions to census the Guadalupe Fur Seal (*Arctocephalus townsendi*), California Sea Lion (*Zalophus californianus*), and Northern Elephant Seal (*Mirounga angustirostris*) along the eastern coast of the island and while censusing Laysan Albatrosses (*Phoebastria immutabilis*) at Punta Sur (Gallo-Reynoso and Figueroa-Carranza 1996, Pitman et al. 2005). Aided with 10 × 50 binoculars, our observations were made from a 24-foot fiberglass skiff and spread over 213 days and 10 expeditions: 11–21 February, 16 June–22 July, and 27 November–7 December 1991, 3–25 February, 21 June–16 August, and 11–26 November 1992, 21 June–26 August 1993, 6–12 January 2000, 12–23 February, 2003, and 6–18 July 2003. Birds were also observed from our campsites, one on the southeastern coast of the island in the area called “Sealer’s ruins” or Corralitos, the other at the barracks of Campo Norte, and while we were traveling by the dirt roads from Punta Sur to Campo Norte, from Caleta del Oeste (west anchorage) to the airstrip in the island’s middle and from Campo Norte to El Aguaje.

ANNOTATED LIST

Osprey (*Pandion haliaetus*). Visitor. Two birds observed flying together near Dos Arroyos (Twin Canyons) on the northeastern coast of the island in February and July 1992. No nests were observed, and no other birds were observed in 2000 and 2003. The Osprey has not been reported from Isla Guadalupe since specimens were collected on 11 July 1922 (Anthony 1925, Hanna 1925) and 25 July 1941 (Bond and Meyer de Schauensee 1944). Karl W. Kenyon visited Guadalupe in 1965 and saw no ospreys but reported two presumed nests near the north end of the island (Jehl and Everett 1985), near where we observed the species.

Red-tailed Hawk (*Buteo jamaicensis*). Howell and Cade (1954) considered the Red-tailed Hawk “apparently resident until at least 1932.” Anthony (1925) reported several in 1922. We observed the Red-tailed Hawk on three occasions. The first was in July 1991 at Monte Augusta, where two individuals ascended in circling flight. One captured a White-winged Dove (*Zenaida asiatica*). The White-winged Dove, known from Isla Guadalupe from only two previous reports (Howell and Cade 1954, Mellink and Palacios 1990), is a less likely prey for the Red-tailed Hawk than the Mourning Doves (*Z. macroura*), now a common resident of the island (population estimated at >2000; Barton et al. 2004, 2005). The second observation, in November 1991, was of a lone hawk flying over the mid-southern portion of the island. The third, also of a single individual, was in July 1993 near the airstrip in the middle of the island, elevation ~1000 m. In April 2007 S. Gallo-Corona (pers. comm.) observed a Red-tailed Hawk attack a fledgling Rock Wren (*Salpinctes obsoletus guadeloupensis*) that had been banded in the open area between the cypress forest and the pine grove.

Guadalupe Caracara (*Caracara lutosa*). Extinct (Anthony 1925, Jehl and Everett 1985). No report of living birds in the past 100 years. The history of this species, its taxonomy and extinction, were described by Abbott (1933) and Brown and Amadon (1968). We propose that its extinction was precipitated by the decimation of the fur and elephant seals, eliminating the pups, placental tissue, and carcasses that probably sustained these predators/carrion eaters.

American Kestrel (*Falco sparverius*). Resident. Bond (1943) described the Guadalupe population as a subspecies (*F. s. guadalupensis*), though other authors have

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not recognized this status. Jehl and Everett (1985) reported its population as small, and Barton et al. (2004, 2005) estimated a population of >15. Quintana-Barrios et al. (2006) suggested that on Guadalupe kestrels nest primarily in rock crevices. We observed kestrels regularly at all seasons from our campsite at Corralitos and along the road from the south end of the island to the cypress forest. In 1991, 1992, and 1993 we noted kestrels feeding on introduced House Mice (*Mus musculus*). Because of the abundance of grass seeds, the mouse population grew exponentially during the years of El Niño (1992–1993). In the summer of 1991, we observed only one mouse at our campsite at Corralitos, but in 1992 and 1993 mice were abundant. At our Corralitos campsite, we captured an average of 14 per night (standard deviation ± 5 , range 6–21, $n = 25$ nights) in 1992, 10 ± 6 (range 4–18, $n = 27$ nights) in 1993, with a simple trap consisting of a 25-liter plastic bucket filled with 6 liters of sea water. We ran a steel wire through the middle of an empty tin can and secured it to the bucket's wall. For bait, we tied a bit of flour dough to the outside of the can. The trap was set near the rocks surrounding the campsite with a piece of wood to serve as a bridge and make it easier for the mouse to jump to the dough. When the mouse jumped, the can turned, and the mouse fell into the water and drowned. The number of kestrels observed per day during the summer increased significantly from 1991 (mean 0.4 ± 0.5 , range 0–1, $n = 20$ days) to 1992 (mean 1.27 ± 0.4 , range 1–2, $n = 30$ days) then decreased in 1993 (mean 0.9 ± 0.7 , range 0–2, $n = 40$ days).

Peregrine Falcon (*Falco peregrinus*). Possibly resident. In June 1991 we observed one bird flying and one bird standing on the cliffs of the mid-eastern coast of the island, at an estimated height of 45 m above sea level. In July 1992 we saw a solitary bird flying north along the coast at the Corralitos campsite. The only previous record for Isla Guadalupe is the observation of a single bird on 19 September 1896 by Gaylord (1897). Subsequently, the species has been noted in both summer and winter at the south end and on the west side of the island by Barton et al. (2004, 2005), Luna-Mendoza et al. (2005), and R. A. Erickson (pers. comm.), suggesting that it may now occur regularly and breed.

Prairie Falcon (*Falco mexicanus*). Vagrant. On 18 July 1992, near the Corralitos campsite, we noted a lone individual, identifying it as a Prairie Falcon by its size, generally pale color, and darker axillars. Bryant (1889) reported seeing the species on “two or three occasions” in 1886. Although Jehl and Everett (1985) suspected that Bryant had misidentified the Peregrine Falcon, the coloration of the individual we observed was distinct and corresponded to the Prairie Falcon.

Northern Harrier (*Circus cyaneus*). Vagrant. We noted a solitary male on 18 July 2003 at an elevation of 500 m in an area of basaltic rocks and grasses along the road from the airstrip to Campo Oeste. The bird was perched on a basaltic boulder then flew away, in its typical low slow flight with wings angled up in a shallow V. We identified it by its grayish color, white rump patch, facial disk, black wingtips and trailing edge of the wing, and long tail. This is the first record of this species at Isla Guadalupe.

Barn Owl (*Tyto alba*). Status uncertain. Sweet et al. (2001) found a flank feather near the airstrip and deposited it at Colección Nacional de Aves, Instituto de Biología, Universidad Nacional Autónoma de México, providing the first documentation of the Barn Owl on the island. In 1991 we found large pellets, larger than those of the Burrowing Owl, on the navigational light tower of Caleta Melpómene. The two pellets analyzed contained cat and mouse hairs and storm-petrel (*Oceanodroma* sp.) and Black-vented Shearwater (*Puffinus opisthomelas*) feathers. Because of their large size and containing cat hair these pellets may represent the Barn Owl. The navy personnel stationed at the military base at Punta Sur and fishermen at Caleta del Oeste have reported seeing large white owls or *tecolotes* on the island, although their reports have been sporadic (1991, 1993 and 2003).

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Burrowing Owl (*Athene cunicularia*). Resident; widespread and common (Jehl and Everett 1985, Barton et al. 2004, 2005). Common around our campsite at Corralitos year round and at our campsite at Campo Norte in winter. Burrowing Owls feed on Leach's Storm-Petrel (*Oceanodroma leucorhoa*) and on Xantus's Murrelet (*Synthliboramphus hypoleucus*), as we found the wings and some other body parts of these birds in the entrances of four owl burrows at the southern end of the island (near the lighthouse in 1991), at some burrows near our campsite at Corralitos (1991–1993), and at one place where the owls perch at the Campo Norte campsite (2003). Barton et al. (2004, 2005) also observed such predation at Islote Negro and Islote Zapato. Of 31 Burrowing Owl pellets recovered from a rocky perch near the navigational tower at Campo Norte in February and July 2003 (probably representing food items of a pair of owls over several months), 11 contained crickets, moths, and other insects, including parts such as shields, antennae and legs, 10 contained hair and bones of House Mice, three contained feathers of storm-petrels, one contained the introduced cockroach *Periplaneta americana*, one contained feathers of the Guadalupe Junco (*Junco insularis*), two contained Burrowing Owl feathers, one contained sand, and, unexpectedly, two contained skin and hair of the elephant seal, which are shed each spring during the seals' molt on the beach. We infer that the owls scavenge the elephant seals' shed skin.

Band-tailed Pigeon (*Patagioenas fasciata*). Vagrant. On 12 July 2003, we saw one adult in the canyon that comes down from Aguaje to Campo Norte. It was sitting on a rock overlooking a cliff; when we approached to take photographs it took flight. The bird flew over us several times before coming to rest far away on a towering cliff. We identified it by the white band on the nape, green iridescence on the neck, purplish head and chest, yellow beak, grayish tail with a darker gray band, and grayish wings with darker primaries. It was similar in size to the Rock Pigeon (*Columba livia*), found at Punta Sur, where it was introduced by the military personnel and fishermen. This constitutes the first record of the Band-tailed Pigeon for Isla Guadalupe.

DISCUSSION

The American Kestrel and Burrowing Owl are the only birds of prey definitely known to breed at Isla Guadalupe currently. The status of the Osprey, Red-tailed Hawk, Peregrine Falcon, and Barn Owl, possibly resident in very small numbers, requires further investigation.

Most studies of the avifauna of Isla Guadalupe have focused on seabirds and wooded areas, not the grasslands and lowlands where potential prey for raptors are more numerous. Certain insects (principally moths, crickets, and cockroaches), mice, doves, feral cats, and even feral dogs supply prey for raptors throughout the year. Still, there are no detailed studies of these birds' feeding habits, their relation to the vegetation, or their general ecology on the island. With the eradication of the feral goats responsible for extinctions of several plants (Ezcurra et al. 2005) and the ecosystem's nascent recovery, such studies should be encouraged. Mexico has taken a major step toward the island's conservation by declaring Isla Guadalupe a biosphere reserve (Diario Oficial de la Federación 2005).

ACKNOWLEDGMENTS

We are indebted to the Secretaría de Marina and to fishermen of "Cooperativa de langosteros y abuloneros de Ensenada," which provided transportation to and logistic support on the island. Our work was conducted under permits 0596, 2538,

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and 4933 from the Secretaría de Desarrollo Urbano y Ecología and 7095 from the Secretaría de Medio Ambiente y Recursos Naturales, México. We thank the Education Abroad Program of the University of California and the Dirección General de Intercambio Académico of the Universidad Nacional Autónoma de México for funding three expeditions. The National Geographic Society partially funded one expedition, and the University of California Institute for Mexico and the United States funded two expeditions (1992 and 2003). Thanks to Rex Passion, Dan Crocker, Octavio Maravilla, Carlos Niño, Horacio Cabrera, and David Larsen for their help in the field. Thanks to Sandra Gallo-Corona for allowing us to use her recent observations and commenting on the manuscript. The manuscript benefited from the comments of Dan Anderson, Philip Unitt, and Richard A. Erickson.

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Accepted 24 September 2009



Burrowing Owl

Sketch by George C. West

FOOD HABITS OF WILD TURKEYS IN NATIONAL FORESTS OF NORTHERN CALIFORNIA AND CENTRAL OREGON

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ABSTRACT: We studied the diet of the Wild Turkey (*Meleagris gallopavo*) in five national forests in northern California and two national forests in central Oregon by collecting turkey droppings and analyzing them for specific food items. In all national forests the diet included insects; in all but one it included grasses. We analyzed the diet by sex and season and found that it varied seasonally and that females from California consumed more insects than did males. Seeds made up a small percentage of the diet in most national forests but constituted a majority of the diet in the Tahoe National Forest in California.

The Wild Turkey (*Meleagris gallopavo*) ranged historically from southeastern Canada and the eastern and southwestern United States to northern Mexico (Kennamer et al. 1992). It is not native to California or Oregon, although a similar fossil species (*M. californica*) occurred prehistorically in California until about 11,500 years before present (Bochenski and Campbell 2006). Introductions by various agencies of three subspecies, the Rio Grande (*M. g. intermedia*), Eastern (*M. g. silvestris*), and Merriam's (*M. g. merriami*), to west coast states as early as 1877 and into the 20th century have proven successful, and the turkey's range and numbers in these states are increasing (Wunz 1992, Keegan and Crawford 1999, Delgado 2004, California Department of Fish and Game 2004).

The Wild Turkey is a generalist omnivore whose diet consists largely of plant material and insects (Hurst 1992). The literature on the food habits of the Wild Turkey in California and Oregon is limited, addressing mostly macro- and microhabitat selection for foraging (Delgado 2004). The single published study addressing the diet of the Wild Turkey in California, focusing on San Luis Obispo County on the central coast found that turkeys foraged primarily on grasses, forbs, and hardwood mast (Smith and Browning 1967). In southern California, turkeys select as macrohabitat grasslands, mixed coniferous, and hardwood forest; as microhabitat for feeding they use primarily meadows (Delgado 2004).

Because Wild Turkeys are not native to California and Oregon, the question whether they consume animals and plants of conservation concern has been raised (California Department of Fish and Game 2004, Oregon Department of Fish and Wildlife 2004). To date, there is no documentation of Wild Turkeys' potential effects on native species in California and Oregon, whether through direct consumption or indirect modification of habitat. In this study, we provide the first data on the diet of Wild Turkeys in previously

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unstudied areas of northern California and central Oregon. We describe the sexual and seasonal differences of the Wild Turkey's diet in selected national forests within this region.

METHODS

From 2003 through 2005, samples of turkey feces were collected opportunistically through the volunteer efforts of United States Forest Service personnel and independent researchers. Areas sampled in California were the El Dorado, Modoc, Plumas, Tahoe, and Mendocino national forests; those in Oregon were the Deschutes and Ochoco national forests (Figure 1). Samples were collected only when turkeys were observed in the area, ensuring that only fresh samples were collected and seasonal differences in diet composition could be estimated accurately. As many samples as possible were gathered at each site and stored in paper bags until analysis. When possible, sex of the turkey that deposited the sample was determined by direct observation. Typically, however, the sex of the bird that left the sample could not be identified, so we determined the sex from the shape and configuration of the sample itself, as feces of the sexes differ (Bailey 1956). In most cases, age class of the turkey could not be determined from the sample. Samples were collected during March, April, May, July, August, September, and October.

The samples were analyzed microhistologically for diet composition at the Wildlife Habitat Laboratory at Washington State University, under director Bruce Davitt, by the methods of Sparks and Malachek (1967). For quantitative analyses we examined both insect and vegetation matter similarly, though for lack of resources we were unable to classify insects more precisely than to the broad category "insects." We categorized the samples by sex, season, and site and calculated the percentage cover of each type of food item on microscope slides made with a subsample of the pooled sample of each category. For the purposes of this study, we defined spring samples as those collected in March, April, or May, summer samples as those collected in July, August, or September, and fall samples as those collected in October. Using NCSS (Kaysville, UT), we compared the percentages of various food items in the diet of males and females with paired *t* tests.

RESULTS

At least 435 individual droppings were analyzed for this study. Because we were uncertain how many individual droppings some collections included, we based quantitative analyses only on collections in which the total number of droppings was known. Collections of droppings in which the total number was unknown were used for descriptive analyses only.

In all the national forests the turkey's diet consisted of various combinations of the following general categories: grasses, sedges/rushes, forbs, coniferous trees, shrubs, mosses, seeds, roots, ferns, and insects. Within these groups, we distinguished only grasses, rushes/sedges, forbs, coniferous trees, and shrubs further, in most cases to genus (Appendix A). Some of the conifer and shrub parts were identified to species. A group consisting of agricultural

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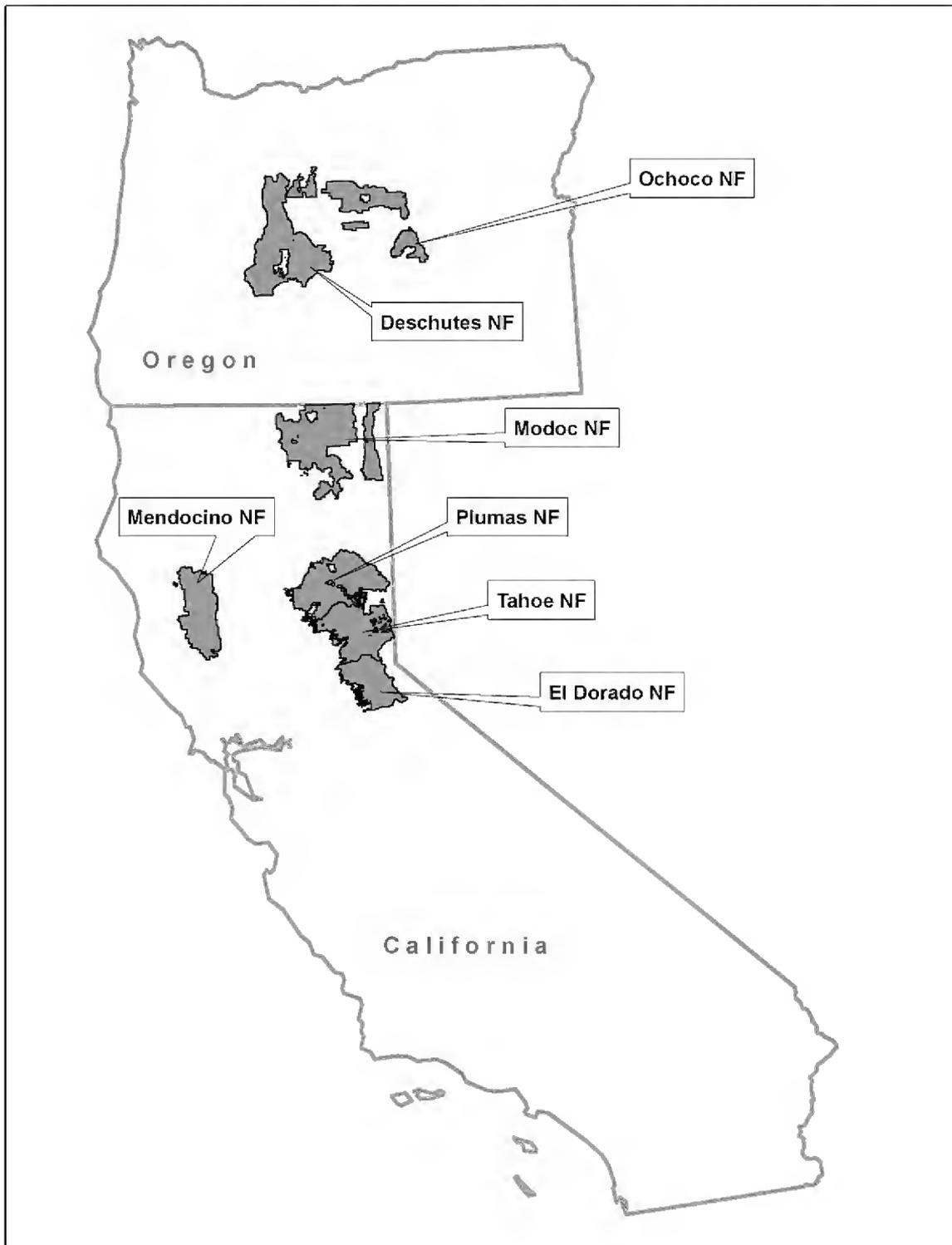


Figure 1. National forests in California and Oregon where feces of the Wild Turkey were sampled for this study of food habits, 2003–2005.

grains (barley and oats) were distinguished from grasses and forbs since the turkeys presumably obtained these foods from agricultural stocks rather than from grasses and forbs growing in the wild. For the plant foods listed (Appendix A), most of the parts found in the droppings were from seeds and flowers rather than from stems, roots, or leaves.

Grasses were present in fecal samples from all national forests except Tahoe and ranged from 1.3% of the diet in spring droppings from males

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in the Modoc National Forest (NF) to 66.8% in summer droppings from males in the Plumas NF. Insects were present in samples from all national forests and ranged from 0.6% in spring droppings from the Modoc NF to 39.9% in summer droppings from the Ochoco NF. Agricultural grains were only found in droppings from the Plumas NF (a maximum of 36.3% of food items in fall droppings from females), Deschutes NF (maximum 32.7% in spring droppings from males), and Mendocino NF (maximum 0.6% in fall droppings from females). Conifer seeds and “berries” constituted a majority of food items found in droppings from spring males in the El Dorado NF (61.9%) and from spring females in the Deschutes NF (79.9%). In most areas rushes/sedges made up a small percentage of food items, with a maximum of 9.0% in fall droppings from females in the Modoc NF. Forbs were found in samples from all areas and consistently made up a large proportion of food items found in droppings, from 3.3% in summer males in the Plumas NF to 95.8% in spring males in the Modoc NF.

Mosses were present in samples from a few national forests but always in low proportions (maximum 2.7% in summer droppings from males in the Modoc NF). Ferns were present in samples from only Modoc NF and Plumas NF, always in small proportions (maximum 1.4% in fall samples from females in the Plumas NF). Roots were uncommon in fecal samples and were not found in those from the El Dorado NF, Tahoe NF, or Deschutes NF. The maximum percentage of roots was 4.4% in summer samples from the Modoc NF. In most areas seeds of unknown origin made up a small percentage of the diet ($\leq 5.6\%$), but in the Tahoe NF they constituted 88.9% of food items found in the samples. Finally, in many of the forests, material from shrubs made up a moderate percentage of food items in the samples, from 0.1% in spring females from the Ochoco NF to 29.4% in fall females from the Modoc NF.

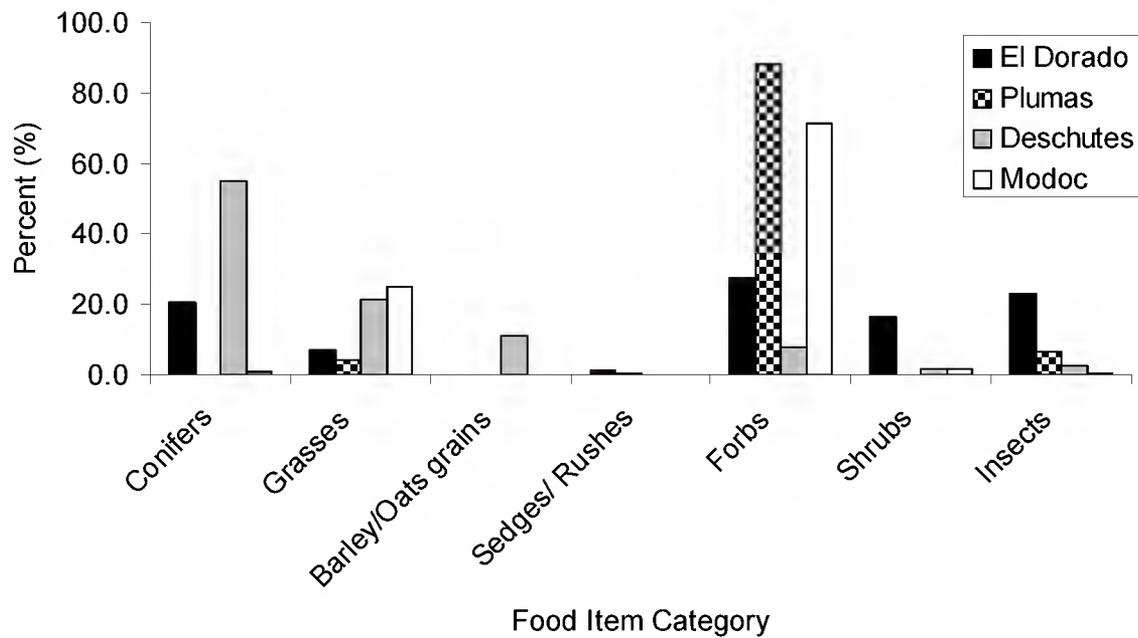
The turkeys' diet varied by season and site (Figure 2). The only national forest from which samples were collected in all three seasons (spring, summer, fall) was the Modoc NF. In this area, the percentage of forbs decreased from 71.5% to 47.3% to 45.0% from spring to summer to fall. The percentage of grasses fluctuated from 24.9% to 33.0% to 5.3% in spring, summer, and fall, respectively. In fall, shrubs were important in the diet at 29.4% but contributed only 1.7% and 2.0% in the spring and summer, respectively. Sedges/rushes were less common in the spring diet (0.1% of droppings) than in the summer (8.6%) and fall (9.0%). At all seasons conifers, mosses, seeds, roots, ferns, and insects each constituted a small percentage of the diet; of these the maximum percentage was for insects at 6.3% in the summer.

The only significant difference between the diets of the sexes was in the percentage of insects in California. In all California samples combined, by season, the mean percentage of fecal samples containing insects was greater for female turkeys ($7.3 \pm 2.9\%$) (mean \pm standard error) than for males ($4.2 \pm 2.2\%$, $t_6 = 3.3$, $P = 0.02$). But this relationship did not hold when samples from both California and Oregon were pooled ($t_7 = 1.7$, $P > 0.05$). For all other food items, the sexes' percentage composition of the fecal samples was not statistically different ($P > 0.05$).

Because of the large variation among the sites in habitat and anthropogenic influence, we did not analyze differences among the sites statistically; results would likely be biased by vastly different availabilities of food items.

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a)



b)

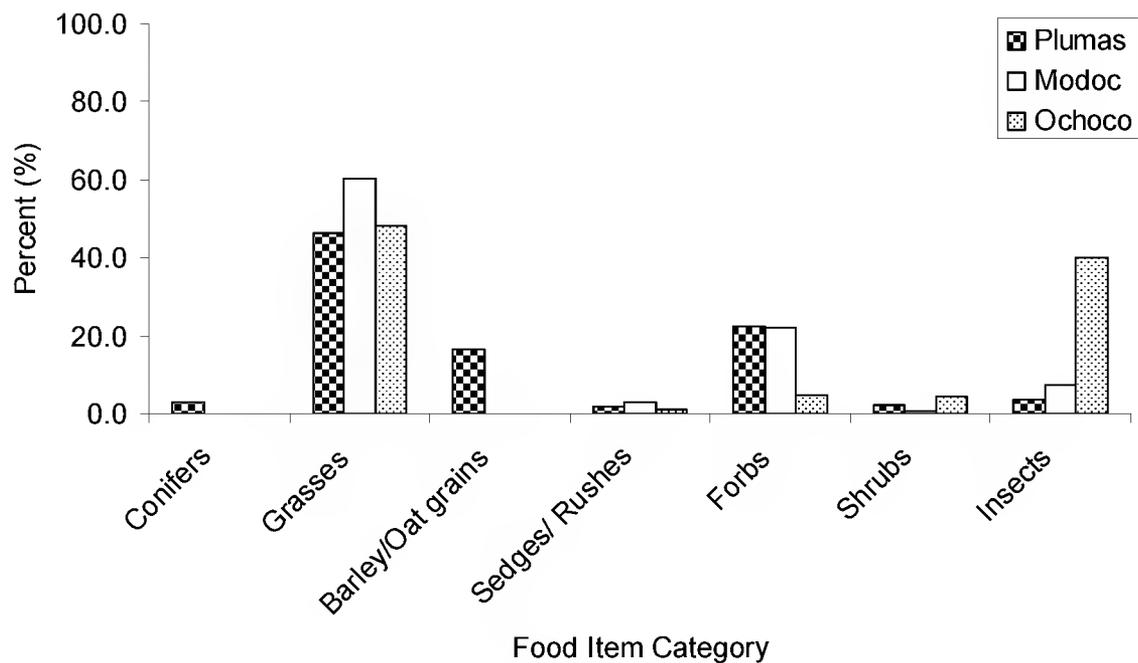


Figure 2. Percent composition of categories of food items in fecal samples from Wild Turkeys in various national forests in California and Oregon in (a) spring and (b) summer.

DISCUSSION

In the national forests of California and Oregon we studied, the Wild Turkey's diet is variable, by both season and sex, as found also in central California (Smith and Browning 1967) and other western states (Wakeling

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and Rogers 1996, York and Schemnitz 2003). Although we were unable to compare diet by season for most national forests in our study area, in the Modoc NF we found seasonal changes in percentages of certain food items, most notably forbs and shrubs. In central California, Smith and Browning (1967) reported changes in the volume and frequency of some of the most important items in the turkey's diet, including various species of oats and grass leaves. In Arizona York and Schemnitz (2003) found that the dominant constituent of the diet changed seasonally from fruits to certain types of grasses. In South Dakota the turkey's diet also shifts seasonally between green foliage and grass seeds (Rumble and Anderson 1996).

Between females and males, we found differences in percent composition of droppings only for insects. Other studies found differences between the sexes in other diet items; for example, in north-central Arizona the sexes differ in their winter diets (Wakeling and Rogers 1996). That study found fecal samples from females to be composed of large amounts of juniper (*Juniperus deppeana*) berries, those from males to have a high percentage of pinyon pine (*Pinus edulis*) seeds. These diets changed in the late winter, the sexes again differing (Wakeling and Rogers 1996). In our study, since samples from males and females were collected at the same sites, it is probable that the sexes were using similar habitats as well, so the differences (or lack thereof) we found were not likely confounded by habitat use.

Unfortunately, we were unable to assess variation in the turkeys' diet by age class. Other studies indicate that insect matter is important to juveniles and constitutes a good proportion of their diet (California Department of Fish and Game 2004). Furthermore, insect matter is an essential protein source for poults (Hurst 1992); it is likely that females' relatively high consumption of insects was associated with the learning of their broods (Appleby et al. 2004).

Future studies of the diet of the Wild Turkey in California and Oregon should follow a more systematic design in which fecal samples are collected repeatedly from the same sites throughout all seasons. Such a design would allow a more detailed analysis of the changes in diet with the seasons due to seasonal variation in the abundance of particular food items or to seasonal changes in the turkeys' preference or dietary requirements. A helpful addition would include a detailed analysis of the availability of various food items in the surrounding habitat that turkeys use, allowing comparison of the use versus the availability of food items, indicating actual food selection.

Given the recent concern over the possibility that Wild Turkeys prey on species of concern in California (California Department of Fish and Game 2004), a focus in the areas where these species and the Wild Turkey overlap could give insight to the validity of this concern. Furthermore, a future study should include molecular techniques, such as the polymerase chain reaction or stable-isotope analyses, which might increase the detectability of soft-bodied insects and vertebrates and other diet items typically under-represented in these types of studies. Species of concern should be surveyed concurrently with the analysis of the turkey's diet. Such a study will indicate the availability of these sensitive species and allow their presence or absence in the turkey's diet to be compared to their availability.

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ACKNOWLEDGMENTS

For their efforts toward collecting samples and logistics we thank Karen Hayden, Mary Flores, Matt Triggs and Dave Zalunardo, of the U.S. Forest Service, Richard Shinn of California Department of Fish and Game, and Don Lantz, Scott Vance, and the many other volunteers that helped gather samples and data.

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Accepted 23 June 2009

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Appendix A. Complete list of food items found in turkey droppings for the turkey food habits study on seven National Forests in California and Oregon, 2003–2005. Food items were identified to lowest taxonomic level possible, in most cases to genus.

Grasses	<i>Descurainia</i>	<i>Trifolium/Medicago/</i>
<i>Agropyron</i>	<i>Draba</i>	<i>Melilotus</i>
<i>Agrostis</i>	<i>Equisetum</i>	<i>Vicia</i>
<i>Alopecurus</i>	<i>Erigeron</i>	<i>Viola</i>
<i>Andropogon</i>	<i>Eriogonum</i> (leaf)	Unidentified composite
<i>Avena</i> (grain)	<i>Erysimum</i>	(flower)
<i>Bromus</i>	<i>Euphorbia</i>	Unidentified legume
<i>Bromus tectorum</i>	<i>Fragaria</i>	(pod, hair)
<i>Calamagrostis</i>	<i>Galium</i>	Unidentified flower
<i>Dactylis glomerata</i>	<i>Geranium</i>	Trees and Shrubs
<i>Danthonia</i>	<i>Geum</i>	<i>Acer</i> (seed)
<i>Deschampsia</i>	<i>Hackelia</i>	<i>Artemisia</i>
<i>Elymus</i>	<i>Hieracium</i>	<i>Berberis</i> (seed)
<i>Festuca</i>	<i>Hydrophyllum</i>	<i>Ceanothus</i> (leaf)
<i>Hordeum</i> (grain)	<i>Hypochaeris</i>	<i>Juniperus</i> (berry, needle)
<i>Koeleria</i>	<i>Lathyrus</i>	<i>Pinus ponderosa</i>
<i>Melica</i>	<i>Lomatium</i>	(needle, cone, seed)
<i>Phleum</i>	<i>Lotus/Lupinus</i>	<i>Pinus</i> sp. (nut/skin)
<i>Poa</i>	<i>Mirabilis</i>	<i>Prunus</i> (berry)
<i>Sitanion</i>	<i>Montia</i>	<i>Quercus</i> (stem, bud,
<i>Stipa</i>	Mustard (flower)	acorn)
Forbs	<i>Penstemon</i>	<i>Ribes</i> (seed)
<i>Achillea</i>	<i>Phacelia</i>	<i>Rosa</i> (hip)
<i>Allium</i>	<i>Phlox/Leptodactylon</i>	<i>Rubus</i> (berry)
<i>Arabis</i>	<i>Plantago</i>	<i>Vaccinium</i> (berry, seed)
<i>Arenaria</i>	<i>Polemonium</i>	Unidentified (leaf, stem)
<i>Aster</i>	<i>Polygonum</i>	Mosses (unidentified)
<i>Astragalus</i>	<i>Potentilla</i>	Ferns (unidentified)
<i>Borago</i>	<i>Ranunculus</i>	Other unidentified plants
<i>Brassica</i>	<i>Rumex</i>	(berry, nut, leaf, seed,
<i>Brodiaea</i>	<i>Saxifraga</i>	root)
<i>Cerastium</i>	<i>Senecio</i>	Insects
<i>Calochortus</i>	<i>Sisyrinchium</i>	
<i>Cirsium</i>	<i>Solidago</i>	
<i>Coreopsis/</i>	<i>Stellaria</i>	
<i>Leucanthemum</i>	<i>Taraxacum</i>	

SEASONAL VARIATION IN THE DIET OF THE BARN OWL IN NORTHWESTERN NEVADA

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ABSTRACT: The Barn Owl (*Tyto alba*) is a widespread predator of small mammals that is declining in many parts of its range. We analyzed the Barn Owl's diet at Stillwater National Wildlife Refuge, Churchill County, Nevada, by identifying remains in pellets collected during the summer (May–September 2007) and winter (October 2007–February 2008). In 306 pellets (143 from summer, 163 from winter), we identified 796 vertebrate prey items including 9 genera of mammals and several species of birds. At both seasons, mammals, primarily of the genera *Microtus* (voles), *Peromyscus* (white-footed mice), *Reithrodontomys* (harvest mice), and *Dipodomys* (kangaroo rats) were found in >93% of pellets. Bird remains were found in 15.5% and 11.1% of pellets in summer and winter, respectively. Remains of giant water bugs (family Belostomatidae) were present in 7.7% of summer pellets but absent in winter. Although the diet was dominated by the same five categories of prey (four mammal genera and birds) at both seasons, the proportions of *Microtus* and *Peromyscus* declined during the winter, while those of *Reithrodontomys* and *Dipodomys* increased.

Regurgitated pellets have commonly been used to examine the composition of and both spatial and temporal variation in the diet of owls. The Barn Owl (*Tyto alba*) has been the subject of many diet studies owing to its broad distribution in North America, concern over its declining numbers in some regions, and its tendency to nest in artificial sites (e.g., buildings or nest boxes) that allow easy collection of pellets (Marti 1992). Most studies have found that small mammals, particularly rodents and shrews, dominate the Barn Owl's diet, although the primary prey species vary substantially both by location (reviewed in Marti 1992) and by season or year at a single location (Otteni et al. 1972, Smith et al. 1972, Marti 1973, 1988, Franzreb and Laudenslayer 1982, Gubanyi et al. 1992).

We studied the diet of the Barn Owl at the Stillwater National Wildlife Refuge in northwestern Nevada during both summer and winter. Although the Barn Owl's diet is well studied in some regions of North America, little information on it is available for the Great Basin of Nevada, a region where populations appear to be relatively stable (Floyd et al. 2007). The only two published accounts of the owl's diet in Nevada were based on 89 (Alcorn 1942) and 14 (Bogiatto et al. 2006) pellets. Our objective was to describe the composition of this Barn Owl population's prey and to evaluate if the diet varied seasonally.

METHODS

We collected pellets from six sites in or near Stillwater National Wildlife Refuge within Churchill County, Nevada. The sites were centered primarily on nest boxes that the owls used for breeding in summer and roosting in winter, except for one in the attic of a deserted building. Prior to our study,

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pellets had been regularly removed from these sites, so that the “summer” pellets we collected were deposited between May and September 2007, the “winter” pellets between October 2007 and February 2008. The surrounding landscape consisted of a mixture of agricultural fields of alfalfa (*Medicago sativa*) and other hay crops and upland desert scrub dominated by black greasewood (*Sarcobatus vermiculatus*) and four-wing saltbush (*Atriplex canescens*). Irrigation ditches with cattails (*Typha* spp.) were present at all sites, often with associated stands of Fremont cottonwood (*Populus fremontii*). One site was near several large lakes edged by marshes of cattails and tule (*Scirpus* spp.).

Before dissecting them, we dried the pellets for ~1 hr at 150° C to kill potential pathogens and then weighed them. We dissected the pellets by standard methods, identifying skull remains to the genus or species level by means of skull keys and a reference collection of local species. For each species, we used the maximum count of crania, left dentaries, or right dentaries to determine the number of individuals in each pellet. Finally, we used G tests of independence to determine if the proportional importance of each of the five most abundant categories of prey differed by season.

RESULTS

We identified 387 individual items of vertebrate prey in 143 summer pellets (total dry mass of all pellets, 1.004 kg) and 409 prey items in 163 winter pellets (total dry mass, 1.035 kg). We found mammal remains in 135 summer pellets (94%) and 152 winter pellets (93%) and identified seven genera of mammals in summer pellets and eight genera in winter pellets (Table 1). We found bird remains in 15.5% and 11.1% of pellets in summer and winter, respectively. We were unable to identify all bird remains to family or species, but several skulls were of icterids, likely the Red-winged (*Agelaius phoeniceus*) or Yellow-headed (*Xanthocephalus xanthocephalus*) blackbirds, or sparrows (family Emberizidae), and one pellet contained the legs of a small rail, probably a Sora (*Porzana carolina*). Although we found some insect parts in association with bird remains, particularly within gizzards, we identified the remains of giant water bugs (family Belostomatidae, likely *Lethocerus americanus*) independent of bird remains in 7.7% of summer pellets, suggesting that the owls occasionally targeted these large insects as prey.

During both summer and winter, the diet of this owl population was dominated by the same 5 categories of prey; voles (*Microtus* spp.), white-footed mice (*Peromyscus* spp.), harvest mice (*Reithrodontomys* spp.), kangaroo rats (*Dipodomys* spp.), and birds. The importance of the various taxa in the diet, however, varied by season (Table 1). Voles were the most common prey in both seasons, but their importance was greater in the summer. The proportion of pellets that contained *Peromyscus* mice did not differ by season, but these mice made up a greater proportion of the total vertebrate prey items consumed during summer than winter. Harvest mice showed the greatest seasonal shift and were significantly more important in the owls' diet during winter. Kangaroo rats showed a similar pattern of increased importance during winter. The importance of birds in the diet did not differ by season.

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Table 1 Prey contents of Barn Owl pellets collected during summer (May–Sept 2007; $n = 143$) and winter (Jan–Feb 2008; $n = 163$) at Stillwater National Wildlife Refuge, Churchill County, Nevada

Prey and season	Total individuals ^a	Individuals per pellet ^b	Proportion of pellets ^c		Proportion of total vertebrate prey items ^d	
Voles (<i>Microtus</i> spp.)						
Summer	144	1.02 (1.06)	0.620	$P = 0.09$	0.372	$P = 0.06$
Winter	126	0.77 (0.94)	0.528		0.308	
White-footed mice (<i>Peromyscus</i> spp.)						
Summer	140	0.98 (1.59)	0.415	$P = 0.64$	0.362	$P = 0.001$
Winter	105	0.64 (1.00)	0.387		0.257	
Harvest mice (<i>Reithrodontomys</i> spp.)						
Summer	35	0.30 (0.62)	0.176	$P = 0.003$	0.090	$P < 0.001$
Winter	90	0.55 (0.99)	0.319		0.220	
Kangaroo rats (<i>Dipodomys</i> spp.)						
Summer	26	0.18 (0.45)	0.155	$P = 0.06$	0.067	$P = 0.006$
Winter	51	0.31 (0.64)	0.239		0.124	
Botta's pocket gopher (<i>Thomomys bottae</i>)						
Summer	10	0.07 (0.26)	0.070		0.026	
Winter	6	0.04 (0.19)	0.037		0.015	
Mountain cottontail (<i>Sylvilagus nuttalli</i>)						
Summer	4	0.03 (0.17)	0.028		0.010	
Winter	2	0.01 (0.11)	0.012		0.005	
Woodrats (<i>Neotoma</i> spp.)						
Summer	0	0.00	0.000		—	
Winter	3	0.02 (0.13)	0.018		0.005	
Muskrat (<i>Ondatra zibethicus</i>)						
Summer	3	0.02 (0.14)	0.021		0.008	
Winter	0	0.00	0.000		—	
Bats (<i>Myotis</i> spp.)						
Summer	0	0.00	0.000		—	
Winter	1	0.01 (0.08)	0.006		0.002	
Birds						
Summer	25	0.18 (0.40)	0.155	$P = 0.15$	0.065	$P = 0.84$
Winter	25	0.15 (0.54)	0.110		0.061	
Invertebrates						
Summer	12	0.08 (0.27)	0.081			
Winter	0	0.00	0.000			

^aMinimum total number of individuals identified in all pellets for each season and category of prey.

^bMean number of individuals per pellet on the basis of all pellets for the season (standard deviation).

^cProportion of all pellets for the season that contained the category of prey. Probability values are from G tests of independence comparing the proportions in winter and summer of the five principal categories of prey.

^dProbability values are from G tests of independence comparing the proportions in winter and summer of the five principal categories of prey, on the basis of 387 and 409 total vertebrate prey items detected during summer and winter, respectively.

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DISCUSSION

As most published studies elsewhere have found (Marti 1992), small mammals dominated the diet of the Barn Owl population we studied. Although the dominant prey species taken by Barn Owls vary by location (Marti 1992), the four main mammalian prey in our study, voles, *Peromyscus* mice, harvest mice, and kangaroo rats, have all been documented as common components of Barn Owl diet in at least some western habitats (Jones 1949, Smith et al. 1972, Marti 1973, 1988, Gubanyi et al. 1992, Van Vuren et al. 1998, Lockwood and Jones 2000). Some seasonal variation in diet was apparent, but it mainly took the form of a complementary shift in use of these same four prey; use of voles and *Peromyscus* mice declined during winter, while use of harvest mice and kangaroo rats increased. Whether these shifts in diet relate to seasonal changes in abundance of these species, and whether these shifts are typical of most years, is unknown.

At Stillwater, Barn Owls rarely took larger prey (adults >100 g). Pocket gophers (*Thomomys* spp.) have been documented as a major constituent of the Barn Owl's diet at some western sites, particularly during summer when small, dispersing young are available (e.g., Knight and Jackman 1984, Gubanyi et al. 1992, Van Vuren et al. 1998). The owls we studied may have taken gophers infrequently because they were rare in the region or, more likely, because other smaller prey items were more available and easily captured. Other studies have also documented cottontail rabbits (*Sylvilagus* spp.) and muskrats (*Ondatra zibethicus*) as rare but regular components of the Barn Owl's diet (e.g., Marti 1973, Franzeb and Laudenslayer 1982, Van Vuren et al. 1998). The size of adults of these species may limit the owls' using them as prey; on the basis of skull size, all cottontail and muskrat remains in our pellets were of juveniles.

Birds were taken regularly, representing just over 6% of all vertebrate prey items in both seasons. Birds have often been documented in the Barn Owl's diet, although most studies in the western United States have reported that they represent <5% of all prey items (Jones 1949, Marti 1973, 1988, Gubanyi et al. 1992, Van Vuren et al. 1998, Lockwood and Jones 2000). Otteni et al. (1972) suggested that Barn Owls may opportunistically increase their use of birds, particularly abundant colonially nesting or roosting birds, when the availability of rodents is low. Although we found no seasonal pattern in use of birds within our population, our study and another of the Barn Owl's diet at a site nearby in Nevada (Alcorn 1942) found most bird prey items to consist of colonial marsh birds, especially icterids.

Large invertebrates have occasionally been reported in the diet of some Barn Owl populations (Marti 1992). For example, in western North America, Jerusalem crickets (family Stenopelmatidae) are eaten at many locations, and in some areas are regular prey (Smith and Hopkins 1937, Maser et al. 1980, Knight and Jackman 1984). To our knowledge, our study is the first to document the giant water bug as Barn Owl prey. These insects are apparently large enough (50–60 mm; Bland and Jaques 1978) to be worth pursuit when encountered. However, as in most Barn Owl populations, invertebrates likely represented a tiny proportion of the total biomass of prey taken.

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ACKNOWLEDGMENTS

We thank Raymond Bogiatto, Juliana Bosi del Almeida, and Motti Charter for providing comments that improved the manuscript. Support for this research was provided by the Stillwater National Wildlife Refuge and by Penn State University–Hazleton.

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Accepted 28 July 2009

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FIRST RECORD OF A MANGROVE YELLOW WARBLER IN ARIZONA

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On 31 July 2004 at 1130 MST we captured a Mangrove Yellow Warbler (*Dendroica petechia erithachorides* subspecies group), the first to be recorded in Arizona and the northernmost ever. The bird was captured in a mist net along Tonto Creek (33.75415°N, 111.22273°W), which flows into the north end of Roosevelt Lake, in Gila County about 90 km northeast of Phoenix. The bird was netted in early successional riparian habitat consisting of Goodding's Willow (*Salix gooddingii*) and tamarisk (*Tamarix* spp.) that is established along the lake's inflows as a result of periodic fluctuations of the lake's level. To document this significant record, we took 15 digital photographs that clearly show diagnostic features such as a chestnut face, throat, and forecrown, thin chestnut streaks on the breast, and yellow spots on the inner webs of the rectrices (Figures 1, 2). These diagnostic photos led the Arizona Bird Committee to accept this record as the first of a Mangrove Warbler in Arizona (Rosenberg et al. 2007). Although the subspecies of the Mangrove Warbler we captured could not be ascertained, the subspecies *rhizophorae* breeds the closest to Arizona. It is resident in coastal mangroves north to the vicinity of Bahía Kino, Sonora, Mexico (Russell and Monson 1998), about 550 km south of Roosevelt Lake.

Mangrove Warblers are currently recognized as a group of subspecies within the Yellow Warbler (Browning 1994, Dunn and Garrett 1997, AOU 1998, Lowther et al. 1999). The Yellow Warbler currently contains 43 subspecies divided among three groups, the Yellow Warbler in the narrow sense (*aestiva* group), the Golden Warbler (*petechia* group), and the Mangrove Warbler (*erithachorides* group), which differ in plumage, breeding strategy, distribution, and habitat (Lowther et al. 1999). Genetic studies of Yellow Warblers suggest these may constitute more than one species, especially a northern migratory species distinct from a southern species largely restricted to mangroves (Klein and Brown 1994).

While all male Yellow Warblers share the generally yellow plumage, chestnut streaking on the breast, and yellow tail spots, the color of the adult male's head distinguishes the three Yellow Warbler groups (Mennill 2000). In most populations of the Mangrove group, the male has a distinct chestnut hood (Dunn and Garrett 1997). The individual we captured had an overall yellow appearance with a distinct chestnut face and chestnut streaks on the upper breast (Figure 1). Chestnut on the face extended from the throat along the side of the face behind the eyes to the top of the head. The extent of chestnut on the head indicated it was a second-year male; after-second-year males have a complete chestnut hood. J. Salgado-Ortiz, who has studied Mangrove Yellow Warblers on the Yucatan Peninsula, Mexico, confirmed the bird's age and sex.

The bird was molting extensively, and its feathers were worn and in poor condition, giving it a ragged appearance. The bird was actively molting in the eye ring, face, head, throat, and breast (Figure 1) as well as the back, primaries, tertials, upper and underwing coverts, and rectrices (Figure 2). The six remaining unmolting rectrices were a brownish olive with distinct pale yellow spots on the inner webs. These spots

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Figure 1. Mangrove Yellow Warbler caught at Roosevelt Lake, Gila Co., Arizona on 31 July 2004, showing active molt and extensive chestnut on the head.

Photo by Nathan K. Banfield

were larger and more noticeable on the outer rectrices, but most of the inner rectrices were missing or in extremely poor condition. Bright new feathers were noticeable on the tertials, upper wing coverts, and inner primaries (Figure 2). Old wing feathers had slight pale yellow edges, whereas newer feathers had distinct brighter and wider yellow-olive edges. This contrast was especially noticeable on the new tertials, which had exceptionally wide and bright edges (Figure 2).

Mangrove Warblers are generally considered to be nonmigratory and are found along the coasts of Mexico and Central America south to the northern coasts of South America and in the Galapagos Archipelago (AOU 1998). In most of their range, Mangrove Warblers are restricted almost exclusively to coastal mangroves, especially the red mangrove (*Rhizophora mangle*) (Lowther et al. 1999). On the Yucatan peninsula, Salgado-Ortiz (pers. comm.) noted the use of habitats other than coastal mangroves only twice, both times within 5 km of mangroves. The riparian habitat in which we captured the Mangrove Warbler, consisting of dense willow and tamarisk groves, is structurally similar to the mangrove habitat this subspecies group occupies.

This warbler's appearance in Arizona corresponded to the schedule of the North American monsoon system, on the northern fringe of which Arizona is located. During the monsoon, from the end of June through September (Ropelewski et al. 2005), winds originate primarily from the Gulf of California and the Gulf of Mexico (Adams and Comrie 1997, Ellis et al. 2004). Patten and McCaskie (2004) reported a pattern of northward dispersal of subtropical waterbirds into southern California during the monsoonal period from May to October, but no such correlation with vagrancy of landbirds is known. During the monsoonal season post-breeding dispersal has brought into Arizona a number of subtropical landbirds such as the Eared Quetzal (*Euptilotis neoxenus*), Aztec Thrush (*Ridgwayia pinicola*), and Sinaloa Wren (*Thryothorus si-*

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Figure 2. The same individual, showing worn and missing rectrices and active molt on the wings.

Photo by Nathan K. Banfield

naloe) (G. H. Rosenberg pers. comm.), but monsoonal winds have probably played little or no role in such occurrences.

Prior records of Mangrove Warblers in the United States have all come from south-coastal Texas and are presumably of the Gulf of Mexico subspecies *oraria* (Lockwood and Freeman 2004). In the winters of 2003 to 2007, ten or more male and female Mangrove Warblers were documented in patches of the black mangrove (*Avicennia germinans*) on barrier islands off South Padre Island (S. Colley pers. comm.).

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Since our discovery, the Mangrove Warbler has occurred twice in southern California, once at the mouth of the Alamo River south end of the Salton Sea (18 December 2007, O. Johnson; McCaskie and Garrett 2008) and once at San Diego (13 January–27 March 2009, M. J. Billings; McCaskie and Garrett in press); both identifications are supported by photographs.

First authorship was determined by a coin toss. Funding for the work to which our observation was incidental was provided by the U.S. Bureau of Reclamation, U.S. Geological Survey, and the U.S. Forest Service. We thank Javier Salgado-Ortiz for verification of the bird's age and sex and Scarlet Colley for information on Mangrove Warblers she observed in Texas. Eben H. Paxton, Mark K. Sogge, Talima Pearson, and Gary H. Rosenberg reviewed early drafts of the manuscript.

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Accepted 10 June 2009

PREY REMAINS IN NESTS OF FOUR CORNERS GOLDEN EAGLES, 1998–2008

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The Golden Eagle (*Aquila chrysaetos*) is among the most studied of raptors (Watson 1997, Kochert et al. 2002). The easiest way to monitor its diet during the breeding season has been to sample remains in active nests (Collopy 1983). In western North America, Golden Eagle nests contain remains primarily of leporids (rabbits and hares) and sciurids (ground squirrels) but also of many other species (Olendorff 1976, Palmer 1988, Kochert et al. 2002). Published information for the southwestern U. S. is limited to prey collected from 41 nests in southeastern New Mexico and western Texas in the 1960s (Mollhagen et al. 1972), nine nests in central Arizona in 1985 (Eakle and Grubb 1986), and time-lapse photography and prey collected at four nests over two years in the trans-Pecos region of Texas (Lockhart 1976). Mammals, mostly hares, rabbits, and sciurids, dominate these samples.

From 1998 to 2008 we rappelled into 182 active Golden Eagle nests in 90 territories in northeastern Arizona, southeastern Utah, and northwestern New Mexico, visiting each territory one to five times for a total of 191 nest checks. The primary reason for these May and June visits was to band nestlings at an age of 4 to 6 weeks. The nests studied from 1998 to 2001 were distributed throughout the 65,000-km² Navajo Nation; those studied from 2003 to 2008 were in the much smaller 3550-km² Jicarilla Nation. All nests were on rock substrates (cliffs and buttes) within a variety of habitats ranging from nearly barren deserts at 1250 m elevation near the Colorado River in Arizona to rugged mesas and 2500-m mountains of the Navajo Nation, woodlands and forests near the continental divide, and the 2500-m mountains of the Jicarilla Nation in New Mexico. Great Basin desert scrub and desert grasslands dominate the lower desert habitats, while ponderosa pine (*Pinus ponderosa*) forests cover the mountainous areas; woodlands of pinyon pine (*P. edulis*) and juniper (*Juniperus* spp.) and flats with sagebrush (*Artemisia tridentata*, *A. frigida*) occupy the middle elevations (Brown 1982). While habitats varied, all nests were within the Colorado Plateau ecoregion. We did not census populations of prey, but lagomorphs were generally widespread and sometimes abundant, and ground squirrels and Gunnison's prairie dogs (*Cynomys gunnisoni*) were locally common. Large avian prey was lacking throughout the region, except for waterfowl at mountain lakes and Wild Turkeys (*Meleagris gallopavo*) in montane forests and openings.

During visits to nests we documented 660 prey items of 24 species (Table 1). We enumerated all species as the minimum number based on full bodies or counting of

Table 1 Prey Remains Found in 191 Visits to Golden Eagle Nests, Four Corners Region of Utah, Arizona, and New Mexico, 1998–2008

Prey	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	Total
Mammals											
Black-tailed Jackrabbit, <i>Lepus californicus</i>	62	34	63	25	2	14	4	6	2	7	219
Cottontail, <i>Sylvilagus</i> sp.	13	17	24	8	1	4	32	47	89	45	280
Gunnison's Prairie Dog, <i>Cynomys gunnisoni</i>	2	4	6	4		4	4	7	7	2	40
Golden-mantled Ground Squirrel, <i>Spermophilus lateralis</i>	2										2
Rock Squirrel, <i>Spermophilus variegatus</i>			4	1	1	2		1	7	6	22
Porcupine, <i>Erethizon dorsatum</i>				1							1
Red Fox, <i>Vulpes vulpes</i>			1								1
Mule Deer, <i>Odocoileus hemionus</i>									1		1
Sheep (domestic), <i>Ovis aries</i>	2	2	3	1							8
Mammal Totals	81	57	101	40	4	24	40	61	106	60	574
Birds											
Gadwall, <i>Anas strepera</i>							1		1		2
Mallard, <i>Anas platyrhynchos</i>		1									1
Northern Shoveler, <i>Anas clypeata</i>								1			1
Wild Turkey, <i>Meleagris gallapavo</i>	1	1					1		1		3

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Table 1 (Continued)

Prey	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	Total
Great Blue Heron, <i>Ardea herodias</i>			1								1
Rock Dove, <i>Columba livia</i>			1								1
Red-tailed Hawk, <i>Buteo jamaicensis</i>	3										3
American Coot, <i>Fulica americana</i>					12						12
Great Horned Owl, <i>Bubo virginianus</i>	1	1						1			3
Northern Flicker, <i>Colaptes auratus</i>			1					1			2
Pinyon Jay, <i>Gymnorhinus cyanocephalus</i>			2	2		1	2	1	1		9
Clark's Nutcracker, <i>Nucifraga columbiana</i>			1								1
Common Raven, <i>Corvus corax</i>	3	1	5	7		1	1	2	1	3	24
Bird totals	7	5	11	9	0	14	5	5	5	3	63
Gopher Snake, <i>Pituophis catenifer</i>	6	1	3	7	1		3		1		22
Brown Trout, <i>Salmo trutta</i>					1						1
Nest visits	32	22	37	21	5	9	14	18	16	17	191
Mammals per visit	2.5	2.6	2.7	1.9	0.8	2.7	2.9	3.4	6.6	3.5	3.0
Snakes per visit	0.19	0.05	0.08	0.33	0.2		0.21		0.06		0.11
Birds per visit	0.22	0.18	0.30	0.43	0	1.55	0.36	0.28	0.31	0.18	0.33

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parts (legs/wings/skulls). We based identification and counts of avian prey on bodies or parts with feathers attached, sometimes by a few to numerous feathers found in the nest. We never used just one feather to verify predation, assuming that it may have occurred there by chance.

Most (87%) of the prey remains were of mammals, and most of these (75.5%) were Black-tailed Jackrabbits (*Lepus californicus*: 33.2%) and cottontails (*Sylvilagus* spp.: 42.3%). Jackrabbits constituted 75% of leporids on the Navajo Nation (1998–2001), but cottontails constituted 86% of leporids on the Jicarilla Nation (2003–2008). Sciurids, including 64 individuals of three species, constituted <10% of remains. In nests on the Navajo Nation, where sheep grazing is common, we found parts of domestic sheep (*Ovis aries*) annually. More unusual was a red fox (*Vulpes vulpes*) in a nest in Apache County, Arizona, on 20 May 1999 (see also Mikesic and LaRue 2003). Finally, we found a porcupine (*Erethizon dorsatum*) below a nest in McKinley County, New Mexico, on 6 May 2001; the eaglet in this nest had a quill embedded in one foot. Over our entire study, we found 3.0 mammals per nest visit (Table 1).

Gopher snakes (*Pituophis catenifer*) were the only reptiles found in nests but were found seven of ten years and contributed 3.3% of all prey items. Gopher snakes were more commonly found in nests on the Navajo Nation (1998–2001). A brown trout (*Salmo trutta*) found in a nest in Rio Arriba County, New Mexico, on 28 May 2003 was likely scavenged from the shore of a nearby reservoir.

Among bird remains were nestlings of two species, one not previously reported as Golden Eagle prey, and several species taken under unique circumstances. The 63 avian prey belonged to 13 species (Table 1), representing nine families in nine orders. Two families, the Anatidae and Corvidae, were each represented by three species. We noted Common Raven (*Corvus corax*) remains in 24 nest visits in nine of ten years, making the raven by far the most common avian prey in these Golden Eagle nests. Ellis et al. (2000) considered the Common Raven as unusual prey.

American Coots (*Fulica americana*) were the second most numerous avian prey, but all coot parts were found on a single nest visit. On 18 June 2004, a Golden Eagle nest in western Rio Arriba County contained 23 coot legs. The likely source of this prey was incubating adult coots nesting among the sparse emergent bulrushes of a large, shallow lake 3 km from the eagle nest. Interestingly, we found no coot legs in this same nest earlier the following year on 26 May 2005; coots were present, but not nesting, on the same lake. We surmise that swimming coots are quick to dive underwater to avoid an attacking eagle, while incubating coots are reluctant to leave their nests until too late.

The third most common avian prey was another corvid, the Pinyon Jay (*Gymnorhinus cyanocephalus*), with nine individuals identified in six different years. This species had not previously been documented as Golden Eagle prey. On 7 May 2000 we found sheathed flight feathers of nestling Pinyon Jays in two nests 25 km apart in southwestern McKinley County, New Mexico. On 7 May 2001, we found two large-bodied Pinyon Jay nestlings in a third McKinley County nest, 38 km from the nearest 2000 nest with jay remains. The nestlings were about 75% grown and had sheathed primaries and remiges 10 mm long. Finally, we found one more body of a nearly fledged Pinyon Jay in a nest in western Rio Arriba County on 6 May 2007, about 150 km from the McKinley County nests. We could not age the jays from the feathers found in the other four cases.

In North America Golden Eagles are known to have taken nine species of diurnal raptors and four species of owls (Olendorff 1976, Cooper 1991, Kochert et al. 2002), including nestlings of five of those species (Kochert et al. 2002). Our most unusual observation involved a diurnal raptor. On 20 May 1998 we entered an eagle nest in eastern Apache County, Arizona, containing two large eaglets. Also in the nest were a freshly killed adult Red-tailed Hawk (*Buteo jamaicensis*), with only the skull opened and the brain eaten, and two 3- to 5-day-old nestlings of the same species. We surmise

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that an eagle killed the hawk while it brooded the young and then made multiple trips to get all three hawks to the eyrie. If this inference is correct, this observation constitutes the first documentation of such an attack on a vulnerable adult on an open nest. This is also the first report of Red-tailed Hawk nestlings found as prey in a Golden Eagle nest. Both hawk nestlings were preserved and deposited in the Navajo Natural Heritage Program's animal collection (NNHP 0205) in Window Rock, Arizona.

Finally, we found the dried neck and head of a Great Blue Heron (*Ardea herodias*) in a nest in western Sandoval County, New Mexico, on 15 May 2000. Although this heron commonly forages terrestrially for small mammals, it does so mainly in uplands within a reasonable distance of nesting or roosting trees and more typical open-water foraging areas. The Golden Eagle nest where the heron head was found was at least 30 km from any stream, and it is most logical that the heron was taken while flying through the territory in migration, perhaps a month or more previously.

As other studies in the Southwest (Mollhagen et al. 1972, Lockhart 1976, Eakle and Grubb 1986) and elsewhere in North America (Olendorff 1976, Palmer 1988, Kochert et al. 2002) have also found, in the Four Corners region we found leporids to be by far the most frequent prey in Golden Eagle nests. Overall, we found mammals (3.0/nest visit) ten times more frequently than birds (0.33/nest visit) and 30 times more frequently than snakes (0.11/nest visit). An unusual high of 1.55 birds/nest visit in 2004 was due to one pair's propensity for capturing a locally abundant prey, the American Coot. Similarly, Ellis et al. (2000) documented a high proportion of fox (*Vulpes* spp.) remains in one Golden Eagle nest in Mongolia; they suggested that populations of the normal prey of hares (*Lepus tolai*) and marmots (*Marmota sibirica*) were locally depressed. Our above-average high of 6.6 mammals/nest visit in 2007 coincided with an obvious abundance of cottontails on the Jicarilla Nation that year. Conversely, lows in both rates in 2003 paralleled the eagles' reduced nesting in 2002 and 2003 that likely coincided with low prey availability (see Steenhof et al. 1997). Ultimately, Golden Eagles exploit prey that is most abundant and vulnerable within their local hunting areas, even other predators.

Interestingly, Mollhagen et al. (1972) found only one species of bird in 41 visits to Golden Eagle nests. Furthermore, Lockhart (1976) identified only three birds among 120 (2.5%) prey items recorded by time-lapse photography and six birds among 446 (1.3%) prey items found in 17 Golden Eagle nests in trans-Pecos Texas. Only six of their combined 58 nest visits took place when the nest was active. Therefore we surmise that either avian prey remains are less likely to persist in Golden Eagle nests or that eagles in that part of New Mexico and Texas preyed very little on other birds. Eakle and Grubb (1986) reported six species of birds among the 38 prey items they found. Thus our compilation of prey over ten years from active nests adds significantly to the knowledge of the diversity of prey taken by breeding Golden Eagles in the southwestern U. S., particularly in the kinds and numbers of birds taken.

Our work was supported by contracts with the Navajo Nation Department of Fish and Wildlife, the Navajo Nation Department of Justice, and the Jicarilla Game and Fish Department. John Keith, Jackie Krypta, and A. Read also rappelled into nests and collected prey remains. We thank C. R. Preston for a thorough review of the manuscript.

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Accepted 23 August 2009



Golden Eagle

Sketch by George C. West

BOOK REVIEWS

Small Mountain Owls, by Scott Rashid. 2009. Schiffer Publishing, Ltd. 176 pages, over 160 color photos and drawings. Hardback, \$39.99. ISBN 0-7643-3282-1.

Small Mountain Owls is a small coffee-table book that details the life histories of the Northern Pygmy Owl, Flammulated Owl, Northern Saw-whet Owl, and Boreal Owl in the western United States, primarily in Rocky Mountain National Park. The book's text is divided into four parts, with well-ordered accounts for each of the four species that address identification, anatomy, coloration, vocalizations of adults and fledglings, distribution and range, territory size, hunting habits, diet, nesting, courtship behavior, interactions between adults and nestlings, longevity, mortality, and more.

The reader may legitimately ask the question as did I: does the world really need another book about owls? A quick scan of some major book outlets reveals at least three dozen titles about owls currently on the market. And many of us who consider ourselves owl watchers already own at least a few of the major works, such as *The Owls of North America*, *Guide to Owl Watching in North America*, *North American Owls: Biology and Natural History*, or *Owls of the World*.

But among these many other books *Small Mountain Owls* holds its own. This unique and rather refreshing book includes a plethora of engaging first-hand observations of the four small owls gleaned from the author's 20 years of experience studying them in Colorado. And the author did not merely observe these owls from afar but gained valuable insights about them during his years of banding and rehabilitating them.

One might also consider buying the book solely for the exquisite art work and incredible photos of the four small owls. Most of the images were artfully produced by the author himself. Even better, these delightful drawings, watercolors, and photos helpfully illustrate the owls' various ages, behaviors, and postures mentioned in the text.

Almost inevitably, books of this nature have at least a few weaknesses, and *Small Mountain Owls* is no exception. First of all, a few of the range maps seem inaccurate. For example, the breeding range of the Northern Pygmy-Owl is not shown to include the mountains of central Idaho or central Oregon, where it nests according to *The Birds of North America Online*. In addition, the maps for the Northern Pygmy-Owl and Flammulated Owl both indicate breeding in the Columbia Basin, an expansive arid region of south-central Washington and north-central Oregon that generally does not support trees, let alone these forest owls.

Additionally, *Small Mountain Owls* seems a bit too provincial in places; the accounts do not encompass the species' entire geographic range. Examples of this are found on page 25: "Northern Pygmy Owls are found from approximately 6,000 to 12,000 feet above sea level," and on page 120: "Pygmy-Owls...often vocalize on an exposed limb, sometimes as high as 60 feet from the ground." In the Pacific Northwest they are common below 2000 feet and can be found locally to sea level in coastal forests. We often see them perched atop conifers that easily exceed 100 feet in height. The discussion of Christmas bird counts on page 73 leads with the apparently unresearched statement, "Christmas bird counts have been an anticipated winter activity for bird enthusiasts since 1900 in the East and 1960 in the West." That assertion is clearly in error: both Pueblo, Colorado, and Pacific Grove, California, inaugurated their counts in 1900. That said, these errors are minor distractions and do not detract from the book's ability to inform and delight.

Who might benefit by owning this book? Those planning a trip to see these four owl species, especially in Colorado, should find the book valuable because it offers a great deal of information on habitat and phenology that is useful for finding the owls. If you have trouble distinguishing the similar Northern Saw-whet and Boreal

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Owls, *Small Mountain Owls* offers many pictorial comparisons of these two species, including several images of the two perched side by side. Readers with an interest in the biology of these owls should want this book's studiously detailed account of these owls' lives.

Finally, I recommend this book for anyone who appreciates the incomparable beauty of these small, delightful owls. The sharp, close-up photos and pleasing artwork will justify a place it on any owl lover's coffee table or bookshelf.

Dave Trochlell

Breeding Bird Atlas of Santa Clara County, California, by William G. Bousman. 2007. Santa Clara Audubon Society, Cupertino, CA. 547 pages, over 180 black and white illustrations of birds, 177 species maps, 81 figures. Paperback. \$15.00. Order with www.scvas.org/pdf/book_order_form.pdf. ISBN 978-0-9796038-0-8.

This book joins an expanding shelf of breeding bird atlases published for California. It follows the geographic format of focusing on a single county established with the publication of the standard-setting *Marin County Breeding Bird Atlas* (W. D. Shuford, 1993, Bushtit Books, Bolinas, CA). Although the Santa Clara book was published in 2007, it is based on field work from 1987 to 1993, although it is updated with information on additional species breeding from 1994 to 2006. What I first noticed about this book was its size—a whopping 547 pages—which at least partly explains why the book took so long to get completed after the field work was finished. So when I read the first line of the introduction stating that the purpose of the book was to “to determine the birds that breed within a geographic area,” I was surprised. It greatly surpasses this simple stated purpose and provides a rich understanding of the breeding avifauna (and more) of Santa Clara County.

I enjoyed reading the first hundred pages of introduction, divided into six chapters, which serve to inform the reader of many aspects of the county as well as to describe the atlas project. The first chapter discusses the county's general geography, climate (including historical rainfall patterns), and parklands. Chapter 2 describes the tectonic history of this county that straddles the San Andreas Fault. I am not sure how it relates directly to breeding birds in the 20th century, but it was an interesting read. Chapter 3 provides descriptions and maps of habitats and vegetation communities. Chapter 4 delves into the history of the county's human habitation and landscape changes. By page 70 we reach the first inkling that this book is about bird distribution with Chapter 5, which outlines the atlas project—its organization and methods. Chapter 6 is a nine-page summary of the project's results.

Chapter 7 is the heart of the book, with a brief introduction to guide the reader in interpreting the species accounts, followed by a single-page glossary, then 177 species accounts. Each account is illustrated by one of 20 artists, and, as can be expected, the illustration styles vary with each artist. Thankfully, the species accounts are all organized consistently with text on one page. The facing page contains a map illustrating the breeding or possible breeding locations, a graph estimating local population trends on the bases of Christmas Bird Counts and Palo Alto summer bird counts, and a graph showing seasonal or phenological information on breeding.

The text of the species accounts consists of four to six paragraphs, the first briefly summarizing the species' global, California, and Santa Clara County distribution and relative abundance. The following paragraphs provide details relevant to Santa Clara County, with information on historical distribution, population trends, results of the atlas field work, breeding phenology, and important comments on habitat preferences and data gaps. There is a lot of information here. Although the bulk of the species accounts was written by William Bousman, additional contributors include local ornithologists Stephen Rottenborn, Michael Rogers, Michael Mammoser, and others.

BOOK REVIEWS

Twenty-four pages of references at the end of the book attest to the large number of sources used to compile background information in the species accounts and other chapters. I noticed that some literature cited is secondary, but this is to be expected in such a large undertaking, and ample primary literature is cited too.

There are nine appendices, the first listing the project's contributors. Next come a 17-page history of local ornithology, a summary of historical population and distributional changes of 187 species, breeding-season dates for a few species, the range of estimates of population sizes for 159 species documented during the atlas period, the list of common and scientific names of plants and animals mentioned in the book, local place names no longer in use, accounts of species breeding historically, accounts of exotic species not established, and notes on two additional species found breeding in 2006.

I did not read every species account, but the many that I did read were consistently well written, and the information in each rang true. I was particularly fond of the constant attempts to pull in information from neighboring counties and states in order to provide a context with which local situation could be interpreted. I was also pleased that the authors did not attempt to discuss general natural history readily available in other sources but kept their focus on local, relevant information. There is very little, if any, "fluff" in these accounts.

As someone not completely familiar with the county, I found the maps a bit difficult to read. For background they show only waterways, so the standard references evident on a road map are absent from the atlas maps—no roads, cities, or towns. But with a bit of practice this obstacle is easily overcome. The display of Christmas Bird Count data varies by species, with some graphs showing birds/party-hour and others showing just the total count of birds. How this information fits into the purpose of the book is not clear; it would have been more relevant if the book had addressed distribution in the nonbreeding season as did the San Diego County Bird Atlas (P. Unitt, 2004, Proc. San Diego Soc. Nat. Hist. 39). To me, this book suffers from an identity crisis, as it is much more than a standard breeding bird atlas but not enough to qualify as a standard reference to the local avifauna or to the local natural/human history. However, it is a monumental work of which the authors and editor as well as the many other contributors should be proud. It was worth the wait.

If you have a collection of bird atlases for California, add the *Breeding Bird Atlas of Santa Clara County, California*. Birders and wildlife biologists who reside in or work in Santa Clara and neighboring counties should read and use this book extensively. Everyone with a thirst for distributional information on California birds should be satisfied with this book, and I recommend it wholeheartedly.

John Sterling

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JUVENAL PLUMAGE OF THE RUFIOUS-CROWNED SPARROW

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Field guides treat the juvenal plumage of the Rufous-crowned Sparrow (*Aimophila ruficeps*) with varying success. The treatment itself can be misleading, perhaps because of individual variation in wear and molt. Sources of information, though not illustrations of the species' molt and juvenile plumage, include Pyle's (1997) *Identification Guide to North American Birds* and the account for *The Birds of North America* (Collins 1999). Although the Rufous-crowned Sparrow is widely distributed in appropriate habitat of the Southwest, California, and Mexico, in the field its juvenal plumage can pose an identification challenge.

In his detailed study of the Rufous-crowned Sparrow Hubbard (1975) recognized 12 subspecies in the southwestern U.S. (east to western Arkansas) and Mexico south to Oaxaca. Five additional subspecies are found in California and Baja California (Collins 1999). The adult plumage of the five subspecies occurring in the U.S. ranges from darkest on California's Channel Islands to palest in Texas and Oklahoma.

Rufous-crowned Sparrows retain juvenal plumage from fledging through summer, replacing it from August to October (Pyle 1997). The juvenal plumage is largely if not entirely shed by about 20 September, however. This discussion, therefore, deals with a brief interval when one may encounter this plumage, which changes through the summer with wear. The molt that replaces the juvenal plumage (termed "first prebasic molt" by Pyle 1997) results in fresh body feathers and, usually (Collins 1999), wing coverts. The juvenal remiges are retained, but some or all (in 41% of specimens examined by Pyle 1997) the juvenal rufous-edged tail feathers are replaced by November. The signature rufous crown appears in September but in fresh plumage is partially obscured by gray feather edges. Little is known about the plumage subtleties of juvenile birds from the various subspecies (Louis Bevier, Paul Collins pers. comm.).

Of the five subspecies of the Rufous-crowned Sparrow constituting the Pacific coastal group, three occur in the U.S.: *ruficeps* (the subspecies featured on this issue's back cover), resident in central California and the along the coast south to the western Transverse Ranges; *obscura*, resident on Santa Cruz and Anacapa—and, formerly, Santa Catalina— islands in California's Channel Islands; and *canescens*, resident in southwestern California on lower slopes of the eastern Transverse Ranges, locally on the coastal plain, and in the Peninsular Ranges (Collins 1999). Grinnell and Miller (1944) mapped *canescens* as extending through the western Transverse Ranges to the Pacific in western Santa Barbara County, although subsequent field work has shown the Rufous-crowned Sparrows there to be *ruficeps* (P. Collins pers. comm.).

Rufous-crowned Sparrows are essentially sedentary, although there seems to be a degree of post-breeding movement by some adults to habitat not far from their breeding territories. Juvenile birds disperse from the fledging territory into adjacent, possibly marginal, habitat in fall and winter. There are only a handful of records of true vagrants (Collins 1999).

The juvenile shown in Figure 1 and on the back cover exemplifies the time of post-breeding dispersal. It was one of two juveniles visiting my property at Deer Canyon, Arroyo Grande, California, on 6 August 2006, allowing a few quick photos. A previous juvenile at the same location on 19 July 2004 was likewise a one-day occurrence. Although closer territories may exist, the closest known breeding territory is at least 3 air miles distant. Even this degree of wandering is somewhat noteworthy because of

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Figure 1. Rufous-crowned Sparrow (*Aimophila ruficeps*), Deer Canyon, Arroyo Grande, San Luis Obispo County, California, 6 August 2006. Note the streaky crown, strong gray malar stripe typical of the species, and facial pattern subtler than in adults.

the Rufous-crowned Sparrow's highly sedentary habits. But juvenile Rufous-crowned Sparrows may thus be found away from breeding territories, presenting the observer with a potential identification problem.

The Rufous-crowned is roughly intermediate in size between the *Spizella* and *Zonotrichia* sparrows. In the field its proportions remind one more of a Lincoln's Sparrow (*Melospiza lincolnii*) than one of the slightly smaller, slender-tailed species of *Spizella*. Apart from the strong dark malar stripe and inconspicuous wingbars, in general appearance juvenile Rufous-crowned Sparrows show less contrast than adults of the species, appearing fairly nondescript. "Drab, brown, and streaky" may be an accurate impression of the bird but is somehow unfulfilling as a complete description.

Perhaps the first thing that must be noted about the juvenal plumage of the Rufous-crowned Sparrow is its *lack* of a rufous-crown, as shown on the back cover. The base color is instead the same warm medium brown of the back, finely streaked with dusky. Indeed, the crown, nape, and back share a common base color and streaks throughout. Two other features stand out as well: the dark gray malar stripe characteristic of the species and the two wing bars formed by the pale tips to the juvenal greater and median coverts. Adult wing coverts have dusky centers with grayish edges. The greater and median coverts of the juvenal wing, however, are dusky-centered with *buff* edges. This gives the juvenile Rufous-crowned Sparrow two wing bars, field marks not generally associated with the species. Because juvenile birds' first molt replaces the median and greater coverts, after September the contrast is lost.

The underparts of the juvenal plumage are variable. In the individual depicted here note the pattern of medium-brown pencil-thin streaks over a wash of buff on the upper breast and sides and seemingly random narrow streaks over whitish on the breast below. The belly is unmarked whitish, with morning dampness on the lower breast separating the feathers, giving the mistaken impression of a dark gray spot. The narrowness and sparseness of the streaking may be due to wear and, possibly,

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the beginning of body molt. In some newly fledged Rufous-crowned Sparrows, the dark stripes extend down over a pale brown to buff breast to the whitish belly and over light brown to buff all the way down the flanks. But in other fledglings the streaking is as minimal as in the individual photographed. The undertail coverts on juvenile birds are the same pale brown to buff of the breast's ground color, without the streaks.

Apart from the flattish head, slightly bulbous bill, and the dark gray malar stripe, a juvenile Rufous-crowned Sparrow's facial pattern can likewise confuse. The facial pattern simply echoes, in subtle form, that of an adult. A pale buffy fore-supercilium changes posteriorly to pale brown extending to the nape, beneath the finely streaked crown, as shown in Figure 1 and on the back cover. A medium-brown eye-stripe extends from the lores to the nape. The pale brown auricular seems somewhat better defined than that of an adult, owing partially to the small gray mark edging the auricular below and behind the eye. (This mark also appears on study skins of juvenile *ruficeps* in the collection of the Santa Barbara Museum of Natural History.) The juvenile's bill pattern, pink below with a grayish culmen, shows plainly in the photos.

The field problem posed by juvenile Rufous-crowned Sparrows is due to their unexpected plumage characteristics, variable treatment in field guides, and being encountered infrequently by most observers. The lack of a rufous crown, the presence of two wing bars, and breast streaking faintly like that of Lincoln's Sparrow are all features at variance with the adult. These photographs give one a glimpse of the briefly worn post-fledging plumage.

I thank Paul Collins, curator of vertebrate zoology at the Santa Barbara Museum of Natural History, for helpful discussion and comments on this note and for access to the museum's collection of specimens. Bill Bousman, Peter Pyle, and Mike Rogers commented on an earlier draft of the manuscript, improving it markedly. Their time and expertise is greatly appreciated. Philip Unitt, Paul Lehman and Joseph Morlan likewise suggested helpful upgrades to the text. Finally, I thank Louis Bevier and David Sibley for helpful remarks regarding the Rufous-crowned Sparrow's juvenal plumage.

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THANKS TO WESTERN BIRDS' REVIEWERS AND ASSOCIATE EDITORS

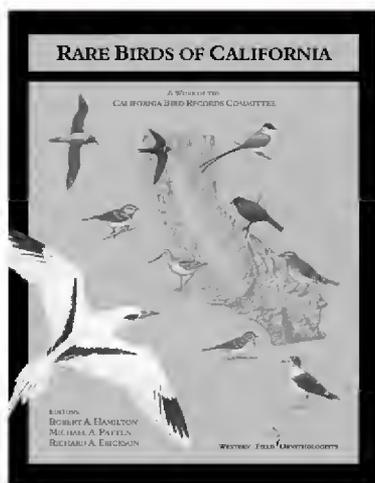
Peer review is a critical step in the publication of a scientific journal. I thank the following people for their generosity in taking the time to provide this essential service sustaining the scientific quality of *Western Birds* for volume 40: Daniel A. Airola, Pat Baird, Tom Blankinship, Raymond J. Bogiatto, William G. Bousman, Peter Carlson, Motti Charter, Charles T. Collins, Paul W. Collins, Robin Corcoran, Peter Donaldson, Jon L. Dunn, Kirsten Dybala, Richard A. Erickson, Mike Erwin, Ted Floyd, Scott Gardner, Kimball L. Garrett, Geoff Geupel, Gary Graves, Paul Hendricks, Osvel Hinojosa-Huerta, Steve N. G. Howell, John E. Hunter, Alvaro Jaramillo, Matthew J. Johnson, Kathy Keane, Dave Krueper, Len Lindstrand III, Steve Matsuoka, Rachel McCaffrey, Carol L. McIntyre, Charles Preston, Katy Purcell, Peter Pyle, C. J. Ralph, Martin Raphael, J. Van Remsen, Leslie Robb, Michael M. Rogers, Gary Rosenberg, Tom Ryan, Mark Seamans, Nathaniel Seavy, Larry Semo, Rodney Siegel, Douglas Tempel, Theodore G. Tobish, Jr., Robert Tweit, and Jeffrey C. Williams.

Many thanks too to our associate editors, Doug Faulkner, Thomas Gardali, Daniel D. Gibson, Robert E. Gill, Ron LeValley, Tim Manolis, Kathy Molina, and Dan Reinking, plus featured-photo editor Joseph Morlan, who serve also as reviewers themselves. *Western Birds* is not possible without their dedication. Special thanks to Tim Manolis, who has decided to take a "sabbatical" from *Western Birds* after serving as an associate editor since 1984 and as a member of *Western Birds'* founding editorial board in 1974, not to mention as Western Field Ornithologists' president from 1986 to 1989! There are few people whose service to Western Field Ornithologists is as great as Tim's. We welcome Gjon C. Hazard (U.S. Fish and Wildlife Service, Carlsbad, California) as a new associate editor. I'm grateful to Dan Gibson for taking on the compilation of this volume's index. The help of all these accomplished ornithologists as associate editors is vital to the quality of *Western Birds*.

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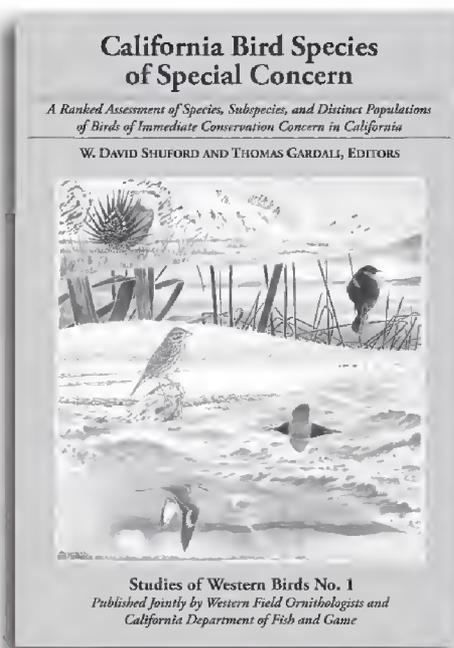
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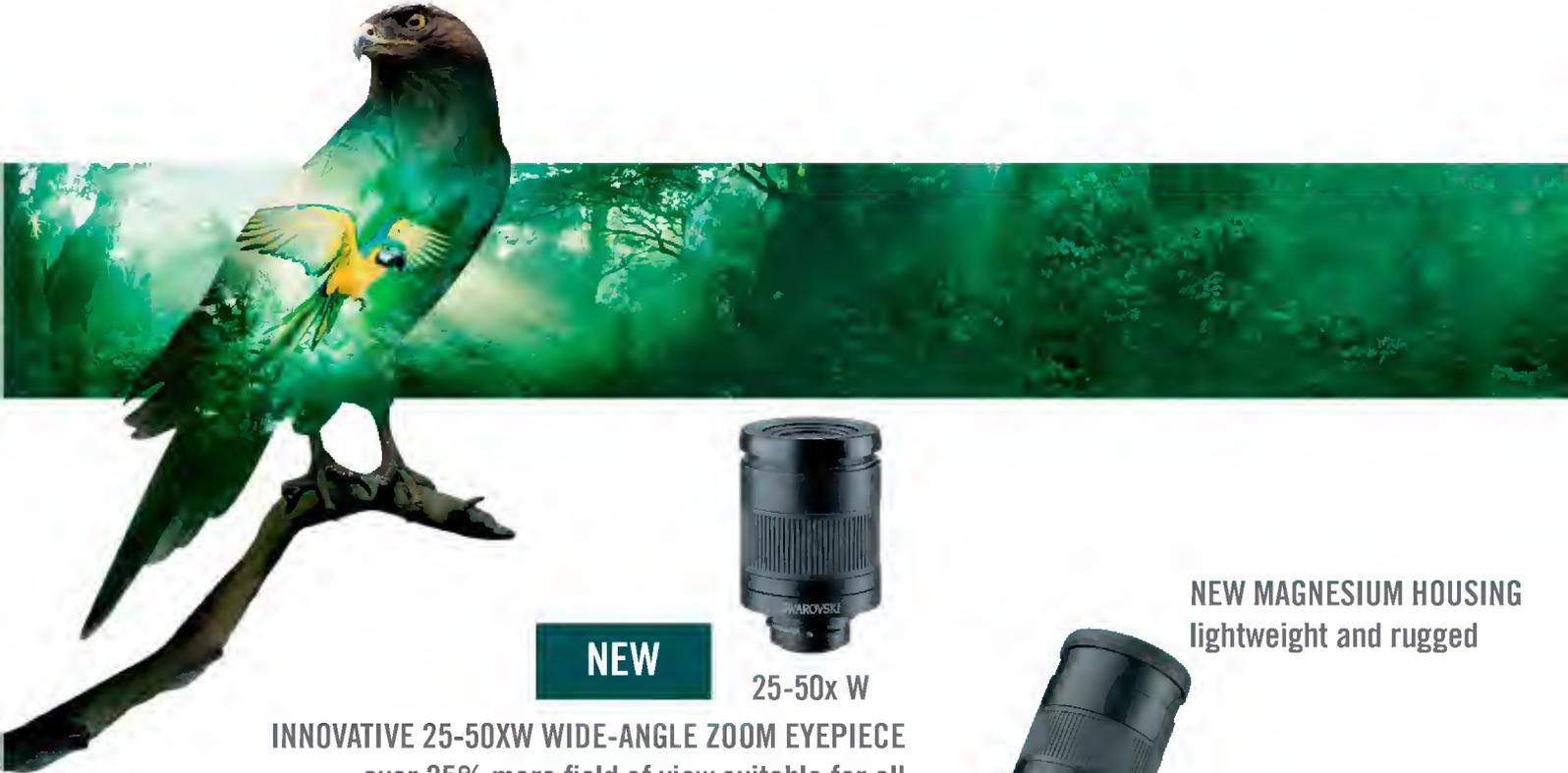
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