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IDENTIFICATION AND MOLT OF HYBRID GLAUCOUS-WINGED GULLS

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Large white-headed gulls of the genus Larus hybridize frequently (Pierotti 1987). In particular, the Glaucous-winged Gull (L. glaucescens) hybridizes readily with other large gulls wherever they breed sympatrically: with the Western (L. occidentalis) along the Washington and northern Oregon coasts (Bell 1996 and references therein), with the Slaty-backed (L. schistisagus) on the east coast of Kamchatka (Firsova and Levada 1982) and on the Commander Islands (V. I. Grabovski et al. unpublished data), with the Herring (L. argentatus smithsonianus) in southern Alaska (Williamson and Peyton 1963, Patten and Weisbrod 1974), and with the Glaucous (L. hyperboreus) in western Alaska (Strang 1977).

Probably nowhere else in the world do hybrids constitute such a large proportion of the total gull population as along the west coast of North America. Consequently, birders in this area have little choice but to familiarize themselves with the appearance and variability of hybrid gulls if the identification of scarce and vagrant gulls is to be attempted seriously. Unfortunately, current literature oversimplifies (or avoids) the relevant issues. For example, it is generally believed that Glaucous-winged x Western hybrids are much more abundant than Glaucous-winged x Herring hybrids in California (Grant 1986); while this may be true, we have found these hybrid combinations to be equally abundant at some northern California sites in winter. Our research suggests that Glaucous-winged x Herring hybrids have generally been overlooked, presumably identified either as Glaucous-winged x Western hybrids or as Thayer’s Gulls (Larus glaucolesx? thayeri).

The featured photo on the back cover of this issue shows a hybrid first-year Glaucous-winged x Western Gull, photographed by King at Laguna Point, Mendocino County, California, on 27 November 1997. This bird arguably resembles a Glaucous-winged more than a Western Gull so may not be a first-generation hybrid. The following characters suggest this hybrid combination: The outer webs and tips of the primaries and the upper tail, so far as visible, are rather dark in comparison to the tertials and wing coverts; the dark grayish brown body plumage is more typical of a juvenile Western Gull; the freshly molted scapulars of the first basic plumage show prominent dark basal and subterminal bars, a pattern more typical of a Western (the Glaucous-winged in first basic plumage normally shows pale plain or finely marked scapulars); the bases of the outer greater coverts are plain brown (the Glaucous-winged often shows white spotting and wavy patterning across the bases of all the greater coverts); and the bill appears to be deep, possibly more similar in shape to the Western’s than to the Glaucous-winged’s.

One further characteristic warranting attention is the timing of the first prebasic molt. Western Gulls undergo this molt from October through December, while in the Glaucous-winged Gull this molt may be initiated at any time from late October to March (pers. obs.). Hybrids vary widely between the extremes of the two parent species in the schedule of their first prebasic molt; in general, however, even hybrids that most closely resemble the Western Gull apparently delay the molt, more closely resembling the Glaucous-winged Gull in this respect. The featured gull shows more first basic scapulars than are expected in November for a pure Glaucous-winged Gull but certainly many fewer than are typical for a first-winter Western Gull by that time of year (pers. obs.).
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Cover photo by © Spencer G. Sealy of Winnipeg, Canada: Northern Saw-whet Owl (Aegolius acadicus brooksi), Langara Island, Queen Charlotte Islands, British Columbia, 5 April 1971.

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STATUS OF OWLS IN THE GLASS MOUNTAIN REGION, MONO COUNTY, CALIFORNIA

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In east-central California, avifaunal surveys have been conducted recently in the White-Inyo Range (Johnson and Cicero 1986, 1991) and in the Yosemite region and adjacent east slope of the Sierra Nevada (Gaines 1988). Knowledge of the distribution and abundance of most species of owls in these areas appears to be based on limited surveys or compilations of anecdotal observations. Shuford and Metropulos (1996) reported on the first five years of a breeding-bird-atlas project in the Glass Mountain region of Mono County, California. Here we present the results of intensive nocturnal owl surveys conducted as part of that atlas project in 1995 and 1996, supplemented by incidental observations of owls from diurnal surveys of all species from 1991 to 1996. We describe the distribution, elevational breeding limits, relative abundance, and general habitat requirements of owls in the Glass Mountain region, compare this knowledge to that of owls in nearby mountain ranges, and discuss factors that may limit owls in the region. Finally, we provide land managers in the region with a foundation of knowledge of owls, previously lacking, upon which to build more detailed studies needed to guide land-use decisions.

STUDY AREA AND METHODS

Study Area

The Glass Mountain study area is located in Mono County, California, on the western edge of the Great Basin desert and lies between the White-Inyo Range to the east and the Sierra Nevada to the west (Figure 1). The study area centers on Glass Mountain and its spur ridges and stretches from the Mono Craters and Adobe Hills on the north to the upper Owens Gorge on the south and from Highway 395 on the west to the east slope of the Benton...
Range on the east (Figure 2). Elevations in the study area range from a low of about 5800 ft in the upper Owens Gorge below the Upper Power Plant to 11,140 ft on the south peak of Glass Mountain. Much of the region has been shaped by volcanic activity.
Major terrestrial habitats (adapted from USFS 1981) include

(1) Sagebrush scrub—a moderately open shrubland usually dominated by Big Sagebrush (*Artemisia tridentata*), but other species, such as Bitterbrush (*Purshia tridentata*) and rabbitbrush (*Chrysothamnus* spp.), may be dominants or co-dominants. On alkaline soils, Greasewood (*Sarcobatus vermiculatus*) may dominate, as may Rubber Rabbitbrush (*C. nauseosus*), which also colonizes disturbed areas. Other frequent shrubs include Green Ephedra (*Ephedra viridis*), Hop-sage (*Grayia spinosa*), Desert Peach (*Prunus andersonii*), and horsebrush (*Tetradymia* spp.).

(2) Pinyon woodland—an open woodland usually dominated by Singleleaf Pinyon Pine (*Pinus monophylla*). In this region, junipers (*Juniperus* spp.) are important at only scattered sites, such as low on the east slope of the
Benton Range. Curl-leaf Mountain-mahogany (Cercocarpus ledifolius) may mix with the pinyons locally, and Big Sagebrush and Bitterbrush are important understory shrubs.

(3) Mountain-mahogany woodland—a moderately closed short woodland dominated by Curl-leaf Mountain-mahogany; Big Sagebrush and Bitterbrush are important understory shrubs.

(4) Jeffrey Pine forest—an open forest dominated by pure stands of primarily second-growth Jeffrey Pine (Pinus jeffreyi) with an open understory of Bitterbrush and sagebrush.

(5) Mixed conifer forest—an open to moderately closed forest of mixed stands of White Fir (Abies concolor) and Jeffrey Pine or Lodgepole Pine (Pinus contorta ssp. murrayana). The understory may be of small White Firs and scattered shrubs. Of very local occurrence on the west side of the study area.

(6) Lodgepole Pine forest—an open to moderately dense forest dominated by Lodgepole Pine. Important understory shrubs are Big Sagebrush, Bitterbrush, and, locally, currant (Ribes spp.).

(7) Limber Pine forest—an open subalpine forest dominated by Limber Pine (Pinus flexilis) found locally on dry steep slopes at high elevations. At the lower extent of its altitudinal range, Limber Pine mixes with Lodgepole Pine. The understory may be open or of scattered Big Sagebrush bushes.

(8) Whitebark Pine forest/woodland—a short subalpine forest or woodland dominated by Whitebark Pine (Pinus albicaulis), found only in patches on the top of Glass Mountain.

(9) Riparian forest/woodland—a dense to moderately open forest or woodland dominated by deciduous trees or shrubs, including willows (Salix spp.), Quaking Aspen (Populus tremuloides), Black Cottonwood (P. balsamifera ssp. trichocarpa), Wild Rose (Rosa woodsii var. ultramontana), Water Birch (Betula occidentalis), and, locally, Buffalo Berry (Shepherdia argentea).

(10) Dry meadow—a meadow that supports bunch grasses, annual grasses, and some forbs and shrubs; sedges (Carex douglasii) and rushes (Juncus spp.) tolerant of relatively dry conditions may mix with the grasses. Saltgrass (Distichlis spicata) dominates on saline alkali flats. The underlying water table fluctuates seasonally.

(11) Sand flat—pumice sand flats are covered sparsely with perennial forbs, such as Pussypaws (Calyptridium umbellatum), Hulsea (Hulsea vestita), evening primrose (Oenothera spp.), Mono Lake Lupine (Lupinus duranii), and Mono Milkvetch (Astragalus monoensis).

(12) Wet meadow—a meadow thickly vegetated with relatively short perennial sedges, rushes, and grasses that occurs on level or gently sloping areas with a year-round source of water. Small forbs are also common.

(13) Perennial grassland—limited areas dominated by native grasses are found in the sagebrush zone where fire or other disturbance has occurred.

(14) Alpine fell-field—on the top of Glass Mountain dry open pumice soil supports scattered patches of various perennial herbs and grasses.

(15) Barren areas—include areas largely devoid of vegetative cover, such as rock outcrops, rocky cliffs, earthen bluffs, talus slopes, volcanic craters, and some sand or alkali flats.
Important wetlands—open water of lakes, ponds, and streams and associated marshes and wet meadows—are found in Adobe Valley to the north of Glass Mountain and to the west and south in the Owens River/Crowley Lake drainage of Long Valley and the Owens Gorge.

The study area is managed primarily by the U. S. Forest Service/Inyo National Forest, Bureau of Land Management, and Los Angeles Department of Water and Power. Human habitation is minimal and clustered mostly in the Long Valley region in the southwestern portion of the study area, though human influence is widespread. Cattle grazing is extensive in meadows and riparian zones. Heavy logging, particularly of Jeffrey Pines, coupled with fire suppression over the last 100 years has greatly altered the remaining forests, leaving denser stands of smaller-diameter trees than existed historically (T. Higley pers. comm.).

Data Collection

**Atlas grid.** As in many other California atlas projects, the study area was divided by a grid of 5-km (3.11 mi) squares or blocks based on the Universal Transverse Mercator grid tick marks on 15-minute USGS topographic maps. The study area thus comprises 63 complete and 11 partial blocks (Figure 2). These blocks were the basic units of field work and for mapping the distribution of all species of owls.

**Nocturnal surveys.** In 1995 and 1996, 14 observers spent about 190 hours conducting nocturnal surveys for owls; we accounted for 74% of this total. Surveys were conducted primarily by driving the extensive network of dirt logging roads in the study area and stopping at irregular intervals in seemingly suitable habitat to try to detect owls. Because of steep terrain and a virtual lack of two-wheel-drive roads above 9200 ft, Shuford backpacked overnight on 7 July 1996 to an unnamed peak at 9961 ft above upper Wilfred Canyon and on 9 July 1996 to the upper elevational limits of Sentinel Meadow Research Natural Area at 10,171 ft. At lower elevations, observers also occasionally walked up to 1.5 mi. off roads, particularly on nights of or close to full moons. Also, a few owls were encountered fortuitously at night at camp sites. All nocturnal surveys were conducted from 27 April to 29 July (Figure 3).

Although some owls were recorded from spontaneous vocalizations, observers attempted to elicit responses from owls by playing tape-recorded calls or making vocal imitations of the various species. Because observers were so few, we focused on spreading coverage throughout all atlas blocks and elevations rather than on standardized routes and call points aimed at randomizing observations and documenting call frequencies over the season.

**Diurnal coverage.** From 1991 to 1996, observers spent 1861 hours conducting multi-species diurnal surveys for breeding birds in the study area. Although not ideal for detecting nocturnal species, these diurnal surveys provided important supplemental data on certain species of owls. We were able to cover most habitats in all blocks, except in riparian or wetland habitat in parts of three blocks along about a 7-mile stretch of private land on the upper Owens River. Methods used were similar to those followed by most breeding-bird-atlas projects in North America (Laughlin et al. 1982, 1990), as summarized by Shuford and Metropulos (1996). For each block, observ-
STATUS OF OWLS IN THE GLASS MOUNTAIN REGION, CALIFORNIA

Figure 3. Number of hours spent on nocturnal owl surveys by 10-day periods from April through July, 1995 and 1996.

ers recorded the most conclusive type of breeding evidence observed for each species encountered. Observers attempted to obtain adequate coverage of each block by visiting all habitats present until knowledge of species-habitat associations suggested that further field work was unlikely to add many breeding species to a particular block (see Shuford 1993:46–48) Nevertheless, as in all atlas projects, no matter how thorough, we assumed that some breeding species likely were missed in many blocks, particularly difficult-to-survey species such as owls. Likewise, because habitat, climate, prey populations, and other conditions change over time, species recorded in a block during the atlas period may not necessarily be found there in subsequent years.

Other information collected. On each visit to a block, whether nocturnal or diurnal, observers recorded (1) the elevational breeding limits (to the nearest 100 ft) of all species encountered, (2) the number of hours spent in the field (to the nearest 1/4 hr) as a measure of observer effort, (3) a count or estimate of the number of each species observed or heard, and (4) details of all confirmed breeding records. Elevations were estimated in the field from topographic maps or a calibrated altimeter. Observers also recorded whether owls were detected aurally and/or visually and, to the best of their ability, the habitats from which owls were vocalizing.

Incidental sightings. We also accepted any breeding evidence observed outside of regular atlas surveys that could be accurately assigned to a specific block. Such information was obtained by atlas participants in the course of miscellaneous travels or other field work or by reliable observers who transmitted their observations to atlas participants.

Relative distribution. In species accounts the relative extent of each species’ breeding distribution within the study area is described by means of
a ranking of the number of blocks in which the species occurred: very local = 1–15 blocks, local = 15–30 blocks, fairly widespread = 31–45 blocks, widespread = 46–60 blocks, and nearly ubiquitous = 61–74 blocks.

Estimates of owl numbers. The total numbers of each species of owl recorded on both nocturnal and diurnal surveys were converted to estimates of owl territories; these are not estimates of pairs of owls, as some territorial owls may not be paired, or of the total number of owl territories within the atlas study area. To make these conversions we assumed that (1) two owls calling at different pitches and cadences represented mated pairs on a mutual territory and (2) single adults, whether recorded by call or by sight, also represented one owl territory regardless if they were paired or not. Groups of fledglings, whether or not accompanied by adults, also obviously represented mated pairs on territory.

Comparative data. To obtain historical records of owls in the Glass Mountain area and information on the status of owls in nearby mountain ranges in California (White–Inyo Range, Mono and Inyo counties; eastern Sierra Nevada, Mono and Inyo counties; and Sweetwater Mountains, Mono County) (Figure 1), we searched the published literature, combed the unpublished files of the editors for the middle Pacific coast region of National Audubon Society Field Notes, corresponded with local experts, and obtained specimen and egg-set data from the Los Angeles County Museum of Natural History (LACM), Museum of Vertebrate Zoology (MVZ), San Bernardino County Museum (SBCM), San Diego Natural History Museum (SDNHM), Santa Barbara Museum of Natural History (SBMNH), and Western Foundation of Vertebrate Zoology (WFVZ). Records from American Birds are cited as AB: page number.

Observers cited: Al DeMartini (ADeM), Anthony Desch (ADes), Sam D. Fitton (SDF), Helen and Paul Green (H & PG), Mike McClaskey (MMcC), Debra Love Shearwater (DLSh), Dave Shuford (DS), and Emilie Strauss (ES).

RESULTS AND DISCUSSION

We recorded seven species of owl in the study area and know of the historical occurrence of one additional species, the Short-eared. From our detection rates, the Northern Saw-whet was the most abundant, followed by the Great Horned, Long-eared, Flammulated, Western Screech, Northern Pygmy, and Barn. The first three were numerous and fairly widely distributed, whereas the others were rare and occurred very locally. Although we confirmed breeding of only the three most numerous species, circumstantial evidence suggests the remaining species also breed in the study area. A decline of breeding Short-eared Owls throughout California (see account) may explain our current inability to find this species. Alternatively, the species may breed in the study area irregularly, depending on upswings in cycles of rodent abundance (Clark 1975, Voous 1988), as we have observed elsewhere in California. Also, we documented a range extension of a subspecies of the Western Screech-Owl, presumably Otus kennisottii inyoensis (Grinnell and Miller 1944), if this is adequately differentiated from aikeni (Marshall 1967).
Species Accounts

Barn Owl (*Tyto alba*)

A very local breeder (possibly a transient) recorded in only 1 (1.4%) of 74 atlas blocks (Figure 4). Our only record was of a single individual heard on a nocturnal survey at about 6200 ft in the upper Owens Gorge above the Upper Power Plant on 4 May 1996 (SDF). The habitat on the slopes of the gorge is dominated by sagebrush scrub with scattered pinyon and Jeffrey pines; clumps of willows and wet sedge meadow line the river below. Numerous potential nesting cavities are present in the extensive rock cliffs of the Owens Gorge. This location may be at the upper elevational limit of this species’ breeding in California. Grinnell and Miller (1994) listed the upper elevation of known “occurrence” as 5500 ft in the southern Sierra. Gaines (1988) considered the species a rare transient up to 6500 ft in the Mono Lake area, but his April to June records suggest the possibility of occasional breeding at that elevation. The species is a “fairly common” nesting bird to the south in the Owens Valley (T. and J. Heindel pers. comm.) but is unrecorded in the adjacent White-Inyo Range (Johnson and Cicero 1986, T. and J. Heindel pers. comm.). Likewise, we know of no records for the Sweetwater Mountains, though the species was seen on 10 September 1995 in the Bridgeport Valley (P. J. Metropulos pers. comm.) at the base of that range.

Flammulated Owl (*Otus flammeolus*)

A very local breeder recorded in 4 (5.4%) of 74 atlas blocks (Figure 4). Representative locations were about 1.5 mi. NE of Indiana Summit Research Natural Area (8300 ft, calling adult, 25 June 1995, DS), Sagehen Meadow (8400 ft, calling adult, 25 June and 10 July 1995; DS, DLSh), Wet Meadow (8800 ft, calling adult, 4 July 96, SDF et al.), about 1 mi. N of Sawmill Meadow (8600 ft, agitated adults, 11 July 1995; ADeM, DLSh), and about 0.5 mi. NW of Sawmill Meadow (9200 ft, pair, 10 June 1995, SDF). On nocturnal surveys, we detected eight vocalizing birds (one subsequently seen) representing seven Flammulated Owl territories. Of these, five were in mixed groves of aspens and either Jeffrey or Lodgepole pines; two were in pure stands of Jeffrey Pine forest. On 13 June 1992, D. and J. Parker (in litt.) found the wing of a Flammulated Owl at 8000 ft in a mixed woodland of Quaking Aspen, Black Cottonwood, juniper, and Jeffrey Pine in an unnamed canyon southeast of O’Harle Canyon; identification of the wing was confirmed by T. and J. Heindel (pers. comm.). Grinnell and Miller (1944) reported specimens collected on 20 and 22 June 1942 from 9 mi. W of Benton (8300 ft; MVZ 84823, 84824). A. H. Miller’s field notes (MVZ library) indicate that on these dates he and W. C. Russell were camped out in an aspen grove off the road to Sawmill Meadow on the northeast flank of Glass Mountain. They heard Flammulated Owls calling in Ponderosa (Jeffrey) Pine both on the edge of the aspen grove and up the drainage about one-quarter mile.

Knowledge of the species’ habitat requirements in California is still incomplete, and more work is needed to confirm the extent of the species’ apparent strong association in our study area with aspen–pine groves. Grinnell and Miller (1944) described breeding habitat as open or broken forests of various conifers often mixed with California Black Oak (*Quercus kelloggi*) or Oregon Oak (*Q. garryana*). Though recognizing the vegetative diversity of the Flammulated Owl’s breeding habitat, Winter (1974) reported its close association in California with yellow pine (*P. ponderosa* and *P. jeffreyi*). Black Oak, thought to be important for nest cavities, is a co-dominant with Ponderosa Pine in breeding habitat in northwestern California (Marcot and Hill 1980). Quaking Aspen is a key nesting tree in Idaho (Powers et al. 1996) and Colorado, where Webb (1982) also found a close association between this owl and the aspen–pine ecotone.

Gaines (1988) listed three May-to-August records from 6400 to 8200 ft in the eastern Sierra of Mono County; also, a specimen was obtained 3 May 1983 at 9000 ft at Lake George, Mammoth Lakes (LACM 103003). Similarly, T. and J. Heindel (in litt.)
Figure 4. Breeding distribution of the Barn Owl, Flammulated Owl, and Western Screech-Owl in the Glass Mountain region. Contour interval, 400 ft. Possible breeding, male or female observed or heard singing in suitable nesting habitat during its breeding season. Probable breeding, pair observed in suitable habitat during their breeding season, permanent territory presumed through song at same location on at least two occasions seven days or more apart or through defense of territory (chasing individuals of same species), or agitated behavior or anxiety calls from adults. Confirmed breeding, used nest found, recently fledged young restricted to the natal area by dependence on adults or limited mobility, adults entering or leaving a nest in circumstances indicating occupied nest, or nest with eggs or young (seen or heard).
know of only three May-to-July records from 8200 to 9700 ft in the eastern Sierra of Inyo County. The Flammulated Owl is unrecorded from the Sweetwater Mountains (Winter 1974, Johnson 1975). Kenyon (1947) found a dead Flammulated Owl in a Lodgepole Pine forest at 9500 ft on the west slope of the southern Sierra, Fresno County. But far and away the highest-elevation breeding record is of a nest with two young observed from 10 July to 7 August 1990 in a Western Bristlecone Pine (Pinus longaeva) at 10,500 ft in Schulman Grove of the White Mountains, Inyo County (AB 44:1187, T. and J. Heindel pers. comm.); the species previously was unrecorded from these mountains (Winter 1974, Johnson and Cicero 1986, 1991). It is unclear if sites meeting the Flammulated Owl’s insectivorous niche are localized at these higher elevations or if other factors explain the species’ patchy distribution at these elevations in the Great Basin.

Western Screech-Owl (Otus kennicottii)

A very local breeder recorded in 3 (4.0%) of 74 atlas blocks (Figure 4). Our only records were from 2 mi. NNE of the peak of Granite Mountain (7000 ft, duetting pair, 7 June 1996, DS), north-facing slope of Chido Canyon about 1.5 mi. E of Antelope Spring (6400–6600 ft, two duetting pairs, 26 May and 28 June 1996, SDF), and 1 mi. WSW of the peak of Casa Diablo Mountain (6900 ft, calling adult, 5 May 1996, DS). On nocturnal surveys we detected seven vocalizing birds (one also seen) representing four screech-owl territories. Also, I. Mandelbaum (in litt.) heard a screech-owl in the Adobe Hills, about 8–9 mi. E of Mono Lake and 2–3 mi. S of Deep Wells, just north of our study area, on 10 April 1996. These records extend the range of the Western Screech-Owl about 40–50 mi. NNW to NW, respectively, of the previously known northern limits of the subspecies O. k. inyoensis in California near Bishop in the Owens Valley and the White Mountains, Inyo County (Grinnell and Miller 1944, Miller and Miller 1951, Johnson and Cicero 1986); the subspecies also occurs to the north in Nevada (Alcorn 1946).

All screech-owls were found in pinyon woodlands ranging from large, moderately dense to small, very open stands; the owl’s densities were very low, as appears to be typical in this habitat elsewhere (Marshall 1967, J. Marshall pers. comm.). We did not detect screech-owls in groves of Black Cottonwood, Quaking Aspen, or willows, though the owl is found in deciduous trees at lower elevations in the Owens Valley (T. and J. Heindel pers. comm.).

Miller and Miller (1951) and Johnson and Cicero (1986) recorded the species up to 8250 ft in the White Mountains, where the latter authors considered the species “uncommon.” Thus, the low densities we detected presumably reflect the status near the upper elevational limit of this subspecies. The few records of screech-owls on the east slope of the central Sierra Nevada, Mono County, appear to represent transient individuals (Gaines 1988), and the species is unrecorded in the Sweetwater Mountains (N. K. Johnson in litt.).

Efforts should be made to find screech-owls elsewhere in California east of the Sierra Nevada, as we know of observations of this species on the east slope of the Sierra, Inyo County (T. and J. Heindel in litt.), in Sierra Valley, Plumas County (L. Jensen pers. comm., Shuford pers. obs.), and in the Susanville–Janesville area, Lassen County (B. Stovall in litt.), outside the species’ range as mapped by Grinnell and Miller (1944).

Great Horned Owl (Bubo virginianus)

A fairly widespread breeder recorded in 41 (55.4%) of 74 atlas blocks (Figure 5). Locations ranged in elevation from 5800 ft (canyon in Benton Range above Benton Hot Springs, fledglings, 2 June 1992, DS) to 9200 ft (Sawmill Meadow, calling adult, 29 June 1996; SDF, ADes). We encountered about 61 adult-sized birds and 14 fledglings representing about 56 territories. Of these, 20 adult-sized birds and 9 fledglings were from daytime observations (13, 9) or from miscellaneous dusk or nocturnal sightings (7, 0), and 41 adult-sized birds and 4 fledglings were from nocturnal surveys.
Figure 5. Breeding distribution of the Great Horned Owl and Northern Pygmy-Owl in the Glass Mountain region by level of nesting evidence. For definitions of possible, probable, and confirmed breeding, see Figure 4. Contour interval, 400 ft.
Of four nests found, one was in an old raptor nest in a large Jeffrey Pine and three were in cavities in rocky cliffs surrounded in two cases by sagebrush scrub and in the other by sagebrush and Jeffrey Pine forest. Of five additional fledged broods, one was seen in an aspen grove, two were seen in rocky canyons surrounded by either sagebrush scrub or pinyon woodland, and single juveniles were heard in pinyon woodland and Jeffrey Pine forest, in both cases with rocky cliffs in the vicinity.

Adult Great Horned Owls were found in almost all terrestrial habitats up into the lodgepole zone. Of 45 records with adequate habitat data, 14 were in pinyon woodland, 14 were in Jeffrey Pine forest, 8 were in sagebrush scrub or sand flats, 5 were in forests of Jeffrey Pine mixed with Singleleaf Pinyon Pine, Lodgepole Pine, or White Fir, 2 were in Lodgepole Pine forest, and 2 were in stands of various pines mixed with aspens.

Johnson and Cicero (1986) considered the Great Horned Owl a "fairly common" breeder up to 9500 ft in the White-Inyo Range, and Gaines (1988) termed the species a "fairly common resident below 7000 ft and uncommon resident or visitor to treeline" in the eastern Sierra Nevada. Gaines had records of calling birds at 10,000 ft in February, when birds should be pairing, but knew of no confirmed evidence of breeding above 7400 ft; subsequently, a successful nest was observed in spring 1990 at 8400 ft in the town of Bodie (P. Nicholson tide ES). Great Horned Owls also occur in the Sweetwater Mountains (e.g., 2 calling, 9400 ft, 3 mi. S of Lobdell Lake, 4 June 1996; ES, MMcC).

Northern Pygmy-Owl (Glaucidium gnoma)

A very local breeder recorded in 2 (2.7%) of 74 atlas blocks (Figure 5). The two records are from Taylor Canyon (7300 ft, calling adult, 23–24 June 1994, DS) and Wildrose Canyon (7700 ft, calling adult, 12 June 1995; DLSh, ADeM). These individuals, both encountered during the day, were in aspen groves bordered either by pinyon woodland (heard only) or a mixed woodland of Jeffrey and pinyon pine (seen and heard). N. K. Johnson (in litt.) also collected a Northern Pygmy-Owl on 6 June 1970 at 8600 ft at Wet Meadow (MVZ 162393).

Gaines (1988) considered this species a "rare resident" on the east slope of the Sierra Nevada to 8000 ft and cited a suspected nesting location, in our study area, at 7800 ft at O'Harrel Canyon. Similarly, T. and J. Heindel (pers. comm.) know of only four records for the eastern Sierra of Inyo County, including a copulating pair on 8 April 1995 (E. A. Cardiff) and a family group on 12–13 July 1997 (S. Blanchard), both at 7800 ft at Glacier Lodge 8.5 mi. WSW of Big Pine. The species also seems relatively rare in the White-Inyo Range. Records for the Inyos include an individual seen at 7100 ft at Upper Addie Springs on 5 August 1975 (D. Juliani tide T. and J. Heindel pers. comm.), a specimen from a pinyon-juniper woodland at 7700 ft near Waucoba Mountain on 27 June 1977 (Johnson and Cicero 1986), and one in pinyon woodland at 8500 ft east of Lone Pine on 16 June 1978 (AB 32:1209). We know of only one valid record from the White Mountains, Inyo County: a bird calling at 8400 ft at Grandview Campground on 23 May 1987 (AB 41:1488). Hall et al. (1991) listed several reports for the White Mountains, but these need further confirmation given that these authors listed a number of questionable records for other species. The Northern Pygmy-Owl also occurs in the Sweetwater Mountains (Johnson 1975). We suspect the species' rarity in the Glass Mountain region and other nearby mountain ranges may reflect, in part, declining abundance with elevation, as it is numerous only to about 6000 ft nearby on the west slope of the Sierra Nevada (Gaines 1988).

Long-eared Owl (Asio otus)

A fairly widespread breeder recorded in 33 (44.6%) of 74 atlas blocks (Figure 6). Notable records were from Antelope Spring (6500 ft, fledglings, 12 June 1994, H & PG), Sawmill Meadow (9100 ft, family group, 30 July 1992, J. Blanchard tide
Figure 6. Breeding distribution of the Long-eared Owl and Northern Saw-whet Owl in the Glass Mountain region by level of nesting evidence. For definitions of possible, probable, and confirmed breeding, see Figure 4. Contour interval, 400 ft.
D. Parker), and an unnamed peak above upper Wilfred Canyon (9900 ft, pair, 7 July 1996, DS). We encountered about 45 adult-sized birds and 21 fledglings representing about 42 territories. Of these, 28 adult-sized birds and 14 fledglings were from daytime observations (25, 14) or from miscellaneous dusk or nocturnal sightings (3, 0), and 17 adult-sized birds and 7 fledglings were from nocturnal surveys.

Of five nests detected, two were in old Black-billed Magpie (Pica pica) nests in willow-wildrose or Water Birch riparian bordered by wet meadow and sagebrush scrub, one was on a platform resembling an old squirrel nest in a Lodgepole Pine forest adjacent to a wet meadow, one was in an old corvid nest in one of a few dense pinyons on the edge of an open Jeffrey Pine forest bordered by Bitterbrush-sagebrush scrub, and one was in a cavity at the top of a Jeffrey Pine snag in a mixed stand of Jeffrey Pines and White Firs. Another probable nest site also was in a cavity atop a Jeffrey Pine snag in an open Jeffrey Pine forest near sagebrush scrub. Of six broods found out of nests, four were in willow-wildrose or Buffalo Berry riparian, one was in mountain-mahogany in a Jeffrey Pine-sagebrush matrix, and for one we lack specific habitat data. Although 50% of nests and broods with adequate habitat data were in lowland riparian groves, which provide the owls many nest platforms from old magpie nests and presumably a good prey base in adjacent meadows and sagebrush, we suspect these data overemphasize the importance of riparian habitats to these owls. First, riparian habitats, including aspen groves, account for less than 1% of the extent of potential Long-eared Owl habitat in the study area, and, second, owl nests and broods are much easier to find in the thin stringers of short riparian habitat that predominate in this region than in extensive stands of other forests and woodlands. When the owls did not nest in relatively open forests, the dense stands of trees where they nested were usually adjacent to or close to wet or dry meadows, sand flats, open sagebrush scrub, or other open foraging areas.

Of 29 other records of these owls adequate habitat data, 7 were from Lodgepole Pine forest, 6 from Jeffrey Pine forest, 5 from sagebrush scrub, 4 from riparian thickets, 2 from pinyon woodland, 2 from mountain-mahogany woodland/sagebrush scrub edge, 1 from mixed Lodgepole-Jeffrey Pine forest, 1 from mountain-mahogany woodland, and 1 from a mixed aspen/lodgepole forest on a meadow edge.

Gaines (1988) considered the Long-eared Owl "a locally uncommon summer resident" to 8000 ft in the eastern Sierra Nevada, and Johnson and Cicero (1986) termed the species "an uncommon resident" to 9500 ft in the White-Inyo Range. Records from the White Mountains of single individuals on 26 May 1919 at an unspecified location at 10,500 ft, Mono County (Dawson 1923, Grinnell and Miller 1944), and on 18 July 1997 at 10,400 ft at Silver Canyon, Inyo County (T. and J. Heindel pers. comm.), suggest possible nesting at these elevations. The status of this species in the Sweetwater Mountains is uncertain, though habitat conditions suggest it is just as numerous there as it is near Glass Mountain. Large declines in breeding populations of the Long-eared Owl have led to the species' designation as a Bird Species of Special Concern in California (Remsen 1978, S. Laymon pers. comm.). Gaines (1988) documented historical declines near Mono Lake caused by habitat destruction, but this is likely a local effect given our recent observations nearby in the Glass Mountain area. Grinnell and Miller (1944) considered "the northern Great Basin territory" to be among the species' "centers of abundance" in the state. Our observations, showing the Glass Mountain region currently to be a center of abundance in the state, and those of others to the north and south (Remsen 1978, Johnson and Cicero 1986, T. and J. Heindel in litt.) indicate the species probably is still numerous in the Great Basin portions of California all along the Cascade-Sierra axis.

Bloom (1994) considered habitat loss from urban development and agriculture to be the main cause of population declines of breeding Long-eared Owls in coastal southern California. Besides residing in areas far from urban centers and large-scale agriculture, Long-eared Owls in the Great Basin of California may benefit from a diverse and abundant prey base. Species richness of mammals, the owl's principal
Status of Owls in the Glass Mountain Region, California

Prey (Voous 1988), at the Great Basin–Sierra ecotone is among the highest in California (Howell 1924, Smith 1979) and in North America (Simpson 1964). Although the diet of Long-eared Owls near Glass Mountain is unknown, the area’s small mammal fauna is not only rich but includes several heteromyid rodents, long-lived species with life histories that tend to dampen their population fluctuations (Brown and Harney 1993). In the deserts of Idaho, where Long-eared Owls are numerous and breed regularly (Marks 1986), the species preys on a wide variety of small mammals, but primarily on about equal proportions of deer mice (Peromyscus), pocket mice (Perognathus), and kangaroo rats (Dipodomys) (Marks 1984). These rodents are numerous in the Mono Lake–Glass Mountain area (Howell 1924, Harris 1982), and the diet of wintering Long-eared Owls in the southern California deserts is totally dominated by the two heteromyid genera Perognathus and Dipodomys (Barrows 1989). By contrast, in much of their range, where they depend on highly fluctuating populations of voles (Microtus), Long-eared Owl populations fluctuate correspondingly (Voous 1988).

Short-eared Owl (Asio flammeus)

We did not record this species on our surveys of potential breeding habitat of marshes in Long and Adobe valleys. Dixon (1934) reported various records from “within a twenty-mile radius of June Lake,” including a nest of a Short-eared Owl found on 15 June 1933. Although the exact location of this sighting is uncertain it may have been within the western boundary of our study area. Also, Rowley (1939) reported a Short-eared Owl nest found on 19 May 1926 in a meadow near McGee Creek, Long Valley (WFVZ 26579), which apparently was within or just outside the western boundary of our study area. The only recent evidence of breeding of this species east of the central Sierra Nevada is the observation of two birds courting at 6500 ft in Bridgeport Valley in 1984, though there are also a few breeding-season observations for 6400 to 6500 ft at Mono Lake (Gaines 1988; AB 45:493, 1158). A breeding-season record for the Owens Valley is of an individual seen 3 mi. NE of Big Pine on 20 June 1978 (T. and J. Heindel pers. comm.). We know of no records of this species from the Sweetwater Mountains, and its status in the White Mountains is uncertain (Johnson and Cicero 1986). Because of statewide declines of breeding Short-eared Owls, the species is listed as a Bird Species of Special Concern in California (Remsen 1978, S. Laymon pers. comm.).

Northern Saw-whet Owl (Aegolius acadicus)

A fairly widespread breeder recorded in 38 (51.4%) of 74 atlas blocks (Figure 6). Notable records were from the upper Owens Gorge above the Upper Power Plant (6400 ft, calling adult, 4 May 1996, SDF), McGee Canyon (7800 ft, nest with young, 8–12 June 1995; DLSH, ADeM), and above Wilfred Canyon and E of Glass Mountain Ridge (9800 ft, calling adult, 7 July 1996, DS). We encountered about 84 individuals representing about 72 territories. All were on nocturnal surveys except for a pair at a nest hole 15 ft up in a Jeffrey Pine and an adult roosting in an aspen grove in the daytime. Gaines (1988) reported a record of a family group at 9500 ft on Glass Mountain, but that elevation is in error and probably was about 9000 ft (R. Stallcup pers. comm.).

Saw-whet Owls breed in a wide range of forests and woodlands of varying age, stature, and openness. Of 70 records with adequate habitat data, 27 were from Jeffrey Pine forest, 15 from pinyon woodland, 11 from Lodgepole Pine forest, 10 from mixed stands of Jeffrey Pine, Lodgepole Pine, or White Fir, and 7 from stands of Quaking Aspen or aspen mixed with Lodgepole or Jeffrey pine.

Gaines (1988) deemed the status east of the Sierra uncertain, but felt the species was “probably a rare summer resident” up to about 8500 ft. He listed a few nesting records for the east slope of the Sierra Nevada to which we can add two more: an adult
at a nest hole 8.2 ft up in an aspen tree near the Log Cabin Mine Road in lower Lee Vining Canyon (7800 ft, 6–10 June 1996, K. Farwell) and a nest with eggs and young about 40 ft up in a Jeffrey Pine snag cut down by a woodcutter at Glass Creek Campground (7500 ft, 15 May 1995, L. Trefty). In the eastern Sierra of Inyo County, two juveniles were found at 10,100 ft in Lodgepole Pine forest at Golden Trout Camp SW of Lone Pine 13–14 August 1984 (AB 39:98, T. and J. Heindel in litt.). Johnson and Cicero (1986, 1991) considered the species an “uncommon resident” to about 9000 ft in the White Mountains. Saw-whets also occur in the Sweetwater Mountains (Johnson 1975), where a specimen was taken on 3 July 1946 from Whitebark Pines at 10,000 ft in Sweetwater Canyon, Mono County (MVZ 98334).

Species Limits

We suspect that the rarity of the Barn Owl, Flammulated Owl, Western Screech-Owl, and Northern Pygmy-Owl in the Glass Mountain region reflects a funnelling of these species into fewer and fewer sites that meet their niche requirements as they reach or approach their elevational or ecological limits of breeding, perhaps as dictated by prey availability or climate. Of the four, the three species of small owls depend to varying degrees on insect prey (Voous 1988), the abundance of which may be reduced by colder temperatures at higher elevations. The Flammulated Owl seems further restricted primarily to aspen or aspen–pine groves, where insect abundance may be greater than in pure pine forests (Webb 1982). In Oregon, Flammulated Owls prefer warm east, south, or higher slopes, perhaps because prey are more abundant or active there (Bull et al. 1990). McCallum (1994) felt this owl’s upper elevational limits might be set by low nocturnal temperatures (and/or high humidity) as well as food availability. In some areas, competition for nest sites with other species of small owls may restrict Flammulated Owls to aspen groves where nest cavities generally are more numerous than in conifers (Webb 1982). The Northern Pygmy-Owl occurs in the study area very locally at riparian or meadow edges, where small birds, and presumably other prey, are more numerous than in most other habitats. Although riparian edges may be appealing foraging areas for Pygmy-Owls, they themselves may be subject to predation by Cooper’s Hawks, which in the Glass Mountain area breed in most major riparian groves at the elevations where the owls were recorded (Shuford pers. obs.).

Barn Owls may simply be limited by temperatures, which in the atlas area can drop below freezing in any month of the year, as the species is primarily a low-elevation and low-latitude breeder known to be affected by cold (Voous 1988). The Great Horned Owl appears to reach a slightly lower elevational breeding limit than the Long-eared and Northern Saw-whet owls, perhaps because the larger mammals that usually make up the bulk of the species’ diet by mass (Jaksic and Marti 1984) occur in small numbers at higher elevations. High on Glass Mountain we saw few lagomorphs or ground squirrels, species important in the diet of Great Horned Owls in the Lahontan Valley, Nevada (Alcorn 1942). Over broad areas, nest sites appeared to be limiting to all owls, as few were recorded, despite good coverage, in Adobe and Long valleys, where there are few trees and only localized cliffs.
Further Work

Much more work could be done to refine our knowledge of these difficult-to-study species. Because owls vary their vocal activity seasonally, tending to call most frequently in late winter or early spring (e.g., Great Horned Owl, Morrell et al. 1991), our concentration of field work in June and July may have somewhat skewed our understanding of the relative abundance of the various species. Surveying owls in the Glass Mountain region early in the season, though, will in most years be hampered by roads closed by snow. Also, because of the difficulty of conducting nocturnal surveys away from roads and on the steep slopes of Glass Mountain above 10,000 ft, we may have underestimated the upper elevational limits of breeding of some species of owls and missed covering some habitats at night that we surveyed in the day. Constraints of covering all atlas blocks with a few field workers likewise limited our ability to sample habitats relative to their availability, thus biasing our appreciation of the relative importance of various habitats to each owl species.

More studies are needed to elucidate the key habitat requirements of the various species so that land-management decisions can be made without threatening the viability of owl populations. Study of the effects of grazing and timber harvesting on owls would be especially valuable, as we know of no published studies on bird responses to these practices in this region. As most of the extensive Jeffrey Pine forest in the area has been logged, priority should be given to assessing the importance to owls of old-growth stands versus other seral stages and to the features of snags used for nesting. In Oregon, Flammulated Owls prefer to nest in mature forests in large-diameter snags (Bull et al. 1990). An important feature of Flammulated Owl territories in northwestern California is a locally dense clump of tall, mature trees located near a break in canopy closure and vegetation type; brush cover may provide insect prey and cover when the birds forage near the ground (Marcot and Hill 1980).

Finally, more diet studies should be undertaken. Little work has been conducted on owl diets in the Great Basin of California (e.g., Aigner et al. 1994), and almost nothing is known here about the trophic structure of the owl community relative to its prey base compared with such knowledge from similar habitats in Idaho (Marti et al. 1993).

SUMMARY

As part of a breeding-bird atlas, we documented the distribution, elevational breeding limits, relative abundance, and general habitat requirements of owls in the Glass Mountain region of Mono County, California, on the western edge of the Great Basin desert. We recorded seven species of owls; one other species, the Short-eared Owl, occurred historically. Three species (the Great Horned, Northern Saw-whet, and Long-eared) were relatively numerous and widespread breeders; the abundance of the latter two species in this region was not previously known. Four species (the Flammulated, Western Screech, Northern Pygmy, and Barn) that were relatively rare and local breeders appear to reach their elevational limits for
breeding, perhaps as restricted by prey availability or cold temperatures. Also, we documented a 40- to 50-mile range extension of the Western Screech-Owl, presumably of the subspecies O. k. inyoensis. The status of owls in the Glass Mountain region is fairly similar to that in other nearby mountain ranges, but more surveys are needed, particularly in the Sweetwater Mountains. Habitat data suggested that riparian thickets, aspen groves, and meadows may be of particular importance to breeding owls by providing nest sites and abundant prey. More work is needed to determine the relative importance to owls of various seral stages of forests, particularly old growth, and to elucidate features of snags used for nesting.

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LITERATURE CITED


STATUS OF OWLS IN THE GLASS MOUNTAIN REGION, CALIFORNIA


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THE SUBSPECIES OF THE NORTHERN SAW-WHET OWL ON THE QUEEN CHARLOTTE ISLANDS: AN ISLAND ENDEMIC AND A NONBREEDING VISITANT

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Two strongly differentiated subspecies of the Northern Saw-whet Owl (Aegolius acadicus) are recognized by the American Ornithologists’ Union (1957), A. a. brooksi, restricted to the Queen Charlotte Islands (known also as Haida Gwaii), British Columbia, and nominate acadicus, widespread elsewhere in North America.

I examined specimen and photographic records of the subspecies of the Northern Saw-whet Owl from the Queen Charlotte Islands and nearby British Columbia and Alaska to determine the extent of the range of brooksi and determine the seasonal distribution of nominate acadicus on the Queen Charlotte Islands. Records of acadicus on the Queen Charlotte Islands have not been compiled, and the inter-island distribution of brooksi has not been ascertained. Godfrey (1986:328) stated that Northern Saw-whet Owls (presumably brooksi) occur in “the northern Queen Charlotte Islands,” but the entire archipelago was shaded on his range map. Cowan (1989) stated that brooksi is found only on Graham and Moresby islands, the two largest islands of the archipelago.

The Queen Charlotte Islands comprise the most isolated archipelago off the Pacific coast of Canada. The islands are separated from the mainland of British Columbia by about 80 km and from the nearest Alaska islands, Forrester and Dall, by about 70 km and 50 km, respectively. The isolation of the Queen Charlotte Islands is reflected in their being the home of several endemic subspecies, some strongly differentiated. Seven have been described so far: in addition to A. a. brooksi, Picoides villosus picoideus (Osgood, 1901) (Hairy Woodpecker), Cyanocitta stelleri carlottae Osgood, 1901 (Steller’s Jay), Certhia familiaris stewarti Webster, 1986 (Brown Creeper), Catharus ustulatus phillipsi Ramos, 1991 (Swainson’s Thrush), Ixoreus naevius carlottae (Phillips, 1991) (Varied Thrush), and Pinicola enucleator carlottae Brooks, 1922 (Pine Grosbeak). Individuals of some of these disperse or migrate to a greater or lesser extent to the mainland in the winter. Several other distinctive subspecies occur on the islands as well as elsewhere in the humid Pacific Northwest.

TREATMENT OF RECORDS

I sought specimens through correspondence with many museums in North America and England (see Acknowledgments). I assembled 217 specimens: 90 were from the Queen Charlotte Islands (84 of brooksi, 6 of acadicus) and 127 were reference specimens of nominate acadicus taken in Alaska and elsewhere in British Columbia. Documentation of breeding of nominate acadicus in nearby Alaska is confirmed by specimens of a juvenile
THE SUBSPECIES OF THE NORTHERN SAW-WHET OWL

(MVZ 24409) and incubating female (USNM 241692) taken on Forrester Island. I examined all specimens except for 13 from Alaska (12 identified by D. D. Gibson, one by R. C. Banks). Three records from the Queen Charlotte Islands (two of brooksi that were captured and released and one privately held specimen of acadicus) were confirmed from photographs deposited in the Royal British Columbia Museum Photo-Duplicate File.

The subspecies are separable in the field (Figures 1 and 2), but, unfortunately, field observers have not noted the subspecies when reporting sightings, probably because they are not aware that acadicus occurs on the Queen Charlotte Islands in some seasons. I used sight records, therefore, only when they provided documentation of occurrence on the small islands of the archipelago. I assumed these sightings were all of brooksi; they were made primarily by seabird biologists between April and June when acadicus is not present on the Queen Charlotte Islands (see later). Sight records of Northern Saw-whet Owls in winter on the Queen Charlotte Islands (e.g., Hamel 1983), a time when acadicus has been recorded there, were not included.

A. a. brooksi differs strikingly from acadicus in its darker coloration, particularly on the breast and facial disk (Figures 1 and 2). Everywhere acadicus is white, brooksi is buff (Tawny Olive, Smithe 1975–1981). All of the browns are much deeper and richer in brooksi than in acadicus. Should brooksi occur off the Queen Charlotte Islands, therefore, it should be recognized readily. No intergrades between the two subspecies have been

Figure 1. Northern Saw-whet Owl (Aegolius acadicus brooksi) on Langara Island, Queen Charlotte Islands, British Columbia, 5 April 1971.

Photo by Spencer G. Sealy
Figure 2. Northern Saw-whet Owls. From left to right, A. a. brooksi (CMN 14053), male, Masset, Queen Charlotte Islands, 5 July 1919; A. a. brooksi (QCIM 8.1), male, 15 km south of Tlell, Queen Charlotte Islands, December 1978; A. a. acadicus (RBCM 15015), male, Peachland, British Columbia, 7 November 1952; A. a. acadicus (RBCM 13014), male, Merville, British Columbia, 6 November 1953.

identified. Females are larger than males in both subspecies, and the subspecies are about the same size (Cannings 1993).

STATUS ON THE QUEEN CHARLOTTE ISLANDS

Graham and Moresby Islands

I examined 84 specimens of brooksi and two photographs (RBCM Photos 1208, 1209) of live brooksi from the Queen Charlotte Islands. All but one of these records are from Graham and Moresby islands. Most individuals in basic plumage were taken from September to March, whereas those in juvenile plumage were collected between late June and September (Figure 3). The subspecies brooksi was named and described by Fleming (1916) on the basis of three adult females and one juvenile, all taken in 1915 on Graham Island. No specimens have been taken off the Queen Charlotte Islands. All subsequent specimens of this subspecies taken since 1915 were collected on the two largest islands, Graham and Moresby. This is not surprising because most of the human population on the islands is centered
THE SUBSPECIES OF THE NORTHERN SAW-WHET OWL

![Graph showing monthly distribution of dates of specimens and photographs of Northern Saw-whet Owls (A. a. brooksi) taken on the Queen Charlotte Islands. Three newly fledged juveniles taken by Patch (1922) from each of two broods on 5 and 21 July 1919 are considered as single records.](image-url)

Figure 3. Monthly distribution of dates of specimens and photographs of Northern Saw-whet Owls (A. a. brooksi) taken on the Queen Charlotte Islands. Three newly fledged juveniles taken by Patch (1922) from each of two broods on 5 and 21 July 1919 are considered as single records.

there, so specimens are more likely to be salvaged there, and the early efforts by ornithologists to collect Saw-whet Owls were concentrated on these two islands. Records from some of the smaller islands have been made since 1965 and are predominantly sightings made during censuses and studies of nesting Ancient Murrelets (*Synthliboramphus antiquus*).

In addition, five specimens (2 females, 3 males, all first-year) and one photograph (RBCM Photo 1207) of nominate *acadicus* have been obtained on Graham or Moresby island. One of these, ironically, is the first specimen of a Northern Saw-whet Owl from the Queen Charlotte Islands, a male taken on 12 December 1896 (not 19 December, see Deignan 1961) at Masset by Rev. J. H. Keen. On the basis of this single (type) specimen (USNM 168171), Osgood (1901) described a new subspecies, *scotaea*. Ridgway (1914) and subsequent authors treated *scotaea* as a synonym of nominate *acadicus*; it remained for Fleming (1916) to describe the endemic subspecies correctly.

The five other records of *acadicus* from the Queen Charlotte Islands fall between 12 October and 11 January: male (AMNH 754293), 11 January 1915; unsexed (RBCM Photo 1207), January 1965, Sandspit; male (UMZM 959), 10 November 1978, Sandspit; female (QCIM 60), December 1979; and female (QCIM B-190), 12 October 1984, Tlell. The period in which these specimens were collected is outside the breeding season of both *brooksi* and *acadicus* by several weeks, judging from the dates of records of juveniles (Figure 3). Therefore, mainland Saw-whet Owls occasionally reach the Queen Charlotte Islands during post-breeding movements or migration (Brooks and Swarth 1925). Specimens collected on the Bering Sea islands of St. Lawrence and St. Paul in October and November (Kessel and Gibson 1978) demonstrate even more extreme vagrancy of this subspecies.

Vagrant Northern Saw-whet Owls are known to cross wide expanses of open ocean elsewhere (e.g. Sladen 1966, Desante and Ainley 1980, Soucy
THE SUBSPECIES OF THE NORTHERN SAW-WHET OWL

1982, Amos 1991). Stable-isotope analysis of tissues derived from 16 specimens of brooksi and two of acadicus from the Queen Charlotte Islands revealed that the diet of acadicus showed little marine protein compared with that of brooksi. These results suggest that individuals of acadicus do not remain long on the islands (Hobson and Sealy 1991). The origin of individuals of acadicus on the Queen Charlotte Islands should not be assumed to be from nearby source populations (see DeSante and Ainley 1980).

Small Islands

Northern Saw-whet Owls, assumed to be brooksi, have been seen or mist-netted on four small islands and one island group of the Queen Charlotte Islands, from Langara Island in the north to Kunghit Island in the south (Figure 4). I could not locate one specimen taken on Langara Island (Campbell 1969). These records add the following islands to the species’ known range on the Queen Charlotte Islands: Limestone, Reef, Lyell, and Kunghit. Additional investigations likely will reveal Saw-whet Owls on other islands of the archipelago as well.

Langara Island.—Noting that the call notes of brooksi are quite different from those of acadicus, Darcus (1930) stated that in 1927 he saw brooksi by day in the dense woods on Langara and Graham islands and heard it at night. Campbell (1969) considered Saw-whet Owls to be common on the grassy meadows at Dadens, and his party collected one specimen of brooksi. During the early morning of 5 April 1971, I mist-netted and photographed an individual of brooksi along the upper beach of Beal Cove (RBCM Photo 1209, Figure 1).

Limestone islands and Reef Island.—Gaston (1992, pers. comm.) made numerous references to Saw-whet Owls taking Ancient Murrelet chicks during their passage from their burrows to the sea. On 31 May 1996, R. Wayne Campbell and a group of naturalists watched one Saw-whet Owl pick up and fly away with a downy murrelet and observed a second owl eating a murrelet chick.

Lyell Island.—Blood et al. (1979) heard Saw-whet Owls at two sites, mist-netted one individual, and observed them hunting Ancient Murrelet chicks at Dodge Point. Between 20 April and 20 May 1982, Rodway et al. (1988) heard single Saw-whet Owls calling at night, one around their camp on a small peninsula west of Dodge Point, and one in the Ancient Murrelet colony at Dodge Point.

Kunghit Island.—On 27 November 1980, Mary Morris (pers. comm.) startled a sleeping Saw-whet Owl on the lower branches of a spruce tree about 1.5 m above the ground.

A. a. brooksi is unrecorded as a vagrant on the mainland. The breadth of prey used by this population (Sealy, unpubl. data), which includes considerable marine-derived food taken during the nonbreeding season (Hobson and Sealy 1991), possibly provides a stable food supply for these owls and, hence, individuals are not forced to leave the islands (see Korpimäki 1986). Individuals of brooksi, however, possibly move to the coastlines of the large islands (see Hobson and Sealy 1991) during the nonbreeding season as most specimens were collected or found dead
along the coastal highway then, when such movements likely occur. Nesting is somewhat later on the Queen Charlotte Islands than in south-eastern Alaska and on the mainland of British Columbia, with juveniles occurring into October rather than only to September.

SUMMARY

There are two field-identifiable subspecies of the Northern Saw-whet Owl, *Aegolius acadicus acadicus*, widespread on the mainland, and the strikingly
THE SUBSPECIES OF THE NORTHERN SAW-WHET OWL

darker *A. a. brooksi*, endemic to the Queen Charlotte Islands, British Columbia. The endemic subspecies occurs on some small islands as well as the two large ones, Graham and Moresby, but not off the Queen Charlotte Islands. It feeds heavily on intertidal invertebrates and Ancient Murrelet chicks. Juveniles of *brooksi* were taken into October rather than only to September, as in *acadicus* in nearby Alaska and mainland British Columbia. Examination of 90 specimens and two photographs of live Saw-whet Owls from the Queen Charlotte Islands revealed six records of vagrant *acadicus* from 12 October to 11 January.

ACKNOWLEDGMENTS

I am indebted to a great many people and institutions for assistance throughout this study. Personnel of the Royal British Columbia Museum, especially R. Wayne Campbell, supported me while on a sabbatical leave during which time the idea for this study germinated. Wayne has encouraged me from the outset of my work on birds along the British Columbia coast, and his knowledge of the avifauna of the area and the disposition of many museum specimens jump-started my quest for information on Northern Saw-whet Owl distribution. Trishia and Nicholas Gessler, former curators of the Queen Charlotte Islands (Haida Gwaii) Museum, permitted me to examine specimens under their care and provided logistical assistance during a trip to the Queen Charlotte Islands in 1986. Nathalie Macfarlane, curator of the Haida Gwaii Museum, permitted me to examine recently acquired specimens under her care. Daniel D. Gibson determined the subspecies of several specimens from Alaska and Richard C. Banks confirmed the subspecies of a specimen from Forrester Island. Al Breitkreutz, Donald A. Blood, Richard J. Cannings, Harry R. Carter, Paul Chytyk, Ian McTaggart Cowan, John D. Fraser, Anthony J. Gaston, Michael J. Gill, Charles J. Guignet, Anne E. Hetherington, Keith A. Hobson, Joe T. Marshall, Jr., Mary Morris, R. Wayne Nelson, Tom E. Reimchen, J. Dan Webster, and Mrs. George Willett provided general information, sight records, photographs, unpublished reports, or information on the disposition of specimens. My appreciation also goes to the many other people who responded to my inquiries. Robert W. Dickerman and David P. Mindell commented on an early draft of the manuscript. I thank Philip Unitt for his comments on the manuscript. Paula M. Grieff compiled records and organized other information. I am also grateful to the curators of the following institutions for loans of specimens or permission to examine specimens under their care: American Museum of Natural History (AMNH), New York; British Museum (Natural History), Tring; Canadian Museum of Nature (CMN), Ottawa; Charles R. Connor Museum, Washington State University, Pullman; Cowan Vertebrate Museum, University of British Columbia, Vancouver; Field Museum of Natural History, Chicago; Queen Charlotte Islands Museum (QCM), Skidegate; Museum of Vertebrate Zoology, University of California (MVZ), Berkeley; Museum of Comparative Zoology, Harvard University, Cambridge; National Museum of Natural History (USNM), Washington; Royal British Columbia Museum (RBCM), Victoria; Royal Ontario Museum, Toronto; University of Alaska Museum, Fairbanks; University of Manitoba Zoology Museum (UMZM), Winnipeg; and University of Michigan Museum of Zoology, Ann Arbor. Financial support was provided by the Natural Sciences and Engineering Research Council of Canada.

LITERATURE CITED


THE SUBSPECIES OF THE NORTHERN SAW-WHET OWL


Accepted 19 August 1997
ECCENTRIC FIRST-YEAR MOLT PATTERNS IN CERTAIN TYRANNID FLYCATCHERS

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Most passerines follow a similar sequence of remex molt, replacement of the primaries commencing with the innermost and proceeding distally, while that of the secondaries (except for the tertials, S7–S9) begins with the outermost and proceeds proximally (Ginn and Melville 1983). During the first-year molts (here defined as all periods of molting before the second prebasic molt), many passerines replace no remiges whereas others replace some or all remiges (Pyle et al. 1987, Jenni and Winkler 1994). “Incomplete” first-year remex molts occasionally result when the typical molting sequence is arrested, the distal juvenile primaries and proximal secondaries (excluding the tertials) being retained. This pattern of incomplete molt is found in several North American passerines, notably, the Phainopepla (Phainopepla nitens), Northern Cardinal (Cardinalis cardinalis), and Lark Sparrow (Chondestes grammacus) (Pyle et al. 1987, Thompson and Leu 1994).

In a few passerine species, incomplete first-year primary molts (and in some cases secondary molts) that do not follow the typical sequence but involve replacement of central or distal primaries in varying patterns have been documented (Jenni and Winkler 1994, Thompson and Leu 1994). These replacement patterns, termed “eccentric” by Jenni and Winkler (1994), are poorly understood. A common eccentric replacement pattern involves renewal of the outer four to six primaries and inner three to five secondaries, feather replacement proceeding distally in the primaries and proximally in the secondaries, as in the typical sequence, but commencing at different points along the wing (Jenni and Winkler 1994; Figure 1). This pattern has been documented in several North American passerines, notably, the Loggerhead Shrike (Lanius ludovicianus), Yellow-breasted Chat (Icteria virens), and Passerina buntings (Miller 1928, Phillips 1974, Thompson and Leu 1994).

While examining specimens of North American tyrannid flycatchers for molt-related age criteria, I found that first-year birds of several species of different genera display eccentric remex-replacement patterns. Depending on the species, replacement of remiges occurs during fall molting periods, spring molting periods, or both. Here I summarize these patterns, and suggest several hypotheses for their occurrence.

MATERIALS AND METHODS

This study was limited to birds collected during their first year. Results were based on data from 589 specimens of 22 north-temperate species examined at the California Academy of Sciences (CAS), Moore Laboratory of Zoology (MLZ), Museum of Vertebrate Zoology (MVZ), and Western Foundation of Vertebrate Zoology (WFVZ). On each specimen I carefully examined the primaries, secondaries, and primary coverts for feather-retention patterns.
Figure 1. Variation in the eccentric first prebasic molt of the Vermilion Flycatcher, from nine remiges and no primary coverts replaced (A) to all remiges and four primary coverts replaced (C). Shading denotes replaced feathers. Note the difference in shape and wear between retained juvenal primary coverts (inner six feathers in C) and replaced adult primary coverts (outer four feathers in C). In many other tyrannid flycatchers, adults have primary coverts uniformly broad and fresh and are thus separated from first-year birds, with entirely or mostly narrow, pointed, and worn coverts. See also Pyle (1997).

reflecting the extent of previous molts. Birds that had been undergoing active molt when collected (as evidenced by growing or sheathed remiges) were excluded from analyses of extent, as extent could not be determined from these specimens; however, I used specimens in molt for information on the timing and sequence of feather replacement. I examined both wings to assess molt patterns, while all specific data were recorded from the right wings.

During this study I discovered (as confirmed by replacement patterns on specimens collected during active primary molt) that most North American
tyrannid flycatchers retain most or all of their juvenile primary coverts until their second prebasic molt and that juvenile and adult (definitive) primary coverts could be identified by differences in shape, color pattern, and relative wear (Figure 1C; see also Pyle 1997). These differences, along with differences in outer primary shape, rectrix shape, feather wear, color of the wing bars, and color of the plumage (Pyle et al. 1987), allowed reliable separation of most first-year from older birds through the second or definitive prebasic molt. Even first-year birds with completely replaced remiges retain five or more inner primary coverts, allowing their accurate separation from adults.

First-year flycatchers show a variety of molting strategies (e.g., Johnson 1963, 1974; Pyle et al. 1987). Remiges can be replaced during the fall (July to November), the spring (March to May), or both (Dickey and van Rossem 1938, Johnson 1963, this study); thus, fall and winter birds can show up to two generations of remiges and spring and summer birds can show up to three generations of remiges. On first-year specimens, I recorded each remex and primary covert as either juvenile, “first fall” (feathers replaced during the fall), or “first spring” (feathers replaced during the spring). After the spring molting period, I distinguished juvenile, first-fall, and first-spring feathers by their relative wear, first-fall feathers being fresher than juvenile feathers but more worn than first-spring feathers.

RESULTS

Among first-year flycatchers, eccentric replacement patterns were found in eight species (Table 1): the Olive-sided Flycatcher (Contopus cooperi), Yellow-bellied Flycatcher (Empidonax flaviventris), western Willow Flycatcher (E. traillii brewsteri, adastus, and extimus), Vermilion Flycatcher

<table>
<thead>
<tr>
<th>Species</th>
<th>n</th>
<th>Inner Primaries</th>
<th>Outer Secondaries</th>
<th>Primary Coverts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olive-sided Flycatcher</td>
<td>28</td>
<td>7.8 (4-10)</td>
<td>6.9 (3-9)</td>
<td>0.9 (0-4)</td>
</tr>
<tr>
<td>Yellow-bellied Flycatcher</td>
<td>12</td>
<td>7.3 (6-10)</td>
<td>7.3 (6-9)</td>
<td>0.0 (—)</td>
</tr>
<tr>
<td>Western Willow Flycatcher</td>
<td>37</td>
<td>8.1 (5-10)</td>
<td>7.2 (3-9)</td>
<td>0.0 (—)</td>
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<tr>
<td>Vermilion Flycatcher</td>
<td>82</td>
<td>9.0 (5-10)</td>
<td>8.2 (3-9)</td>
<td>1.3 (0-5)</td>
</tr>
<tr>
<td>Western Tropical Kingbird</td>
<td>18</td>
<td>5.3 (5-6)</td>
<td>3.9 (3-6)</td>
<td>0.0 (—)</td>
</tr>
<tr>
<td>Cassin’s Kingbird</td>
<td>14</td>
<td>1.7 (0-5)</td>
<td>3.7 (3-5)</td>
<td>0.0 (—)</td>
</tr>
<tr>
<td>Western Kingbird</td>
<td>55</td>
<td>6.0 (5-7)</td>
<td>3.8 (3-6)</td>
<td>0.0 (—)</td>
</tr>
<tr>
<td>Scissor-tailed Flycatcher</td>
<td>16</td>
<td>6.5 (4-7)</td>
<td>3.5 (3-5)</td>
<td>0.0 (—)</td>
</tr>
</tbody>
</table>

*Starting point (primary number) for primary molts can be calculated as ten minus the number of feathers replaced.

*Note that one or more tertials can be replaced twice during the first year in kingbirds (see Table 2), but the totals for these species include each tertial once.
(Pyrocephalus rubinus), western Tropical Kingbird (Tyrannus melancholicus occidentalis; other subspecies were not examined for this study), Cassin's Kingbird (T. vociferans), Western Kingbird (T. verticalis), and Scissor-tailed Flycatcher (T. forficatus). Limited specimen evidence (n = 4) suggests that an eccentric replacement pattern also occurs in first-year Gray Kingbirds (T. dominicensis). Among other taxa of these genera, the Western (Contopus sordidulus; n = 26) and Eastern (C. virens; n = 12) wood-pewees, eastern Willow (E. t. campestris/traillii; n = 6) and Alder (E. alnorum; n = 22) flycatchers, and Eastern Kingbird (T. tyrannus; n = 12) replaced all remiges, whereas the Greater Pewee (C. peritax; n = 15), the remaining Empidonax flycatchers (virescens, n = 9; minimus, n = 18; hammondii, n = 28; oberholseri, n = 27; wrightii, n = 24; difficilis, n = 30; occidentalis, n = 16; and fulvifrons, n = 15), and the Thick-billed Kingbird (T. crassirostris; n = 16) replaced no remiges or primary coverts, other than the tertials on some birds.

The eccentric replacement pattern is well illustrated in the Vermilion Flycatcher (Figure 1, Table 1). The number of remiges replaced ranged from all secondaries and primaries (in 53.7% of 82 first-year specimens examined, identified by the retention of juvenile primary coverts) to nine of 19 feathers (five outer primaries and four inner secondaries; CAS 39678). The number of outer primary coverts replaced varied from none (23.1%) to five (2.4%). In all cases, replacement proceeded consecutively from the starting points to the outermost primary and primary covert and to the innermost secondary other than the tertials. The sequence was confirmed with eight specimens collected during active molt. This pattern was also typical of first-year remex in the other flycatcher species showing the eccentric pattern, except for most Cassin’s Kingbirds (see below). All replacement of remiges by Vermilion Flycatchers occurs in the late summer and fall; no spring replacement of flight feathers was found.

First-year Yellow-bellied and western Willow flycatchers differ from the Vermilion Flycatcher in that remex molt occurs during the spring rather than the fall (see also Dickey and van Rossem 1938, Mengel 1952, Johnson 1963); adults of these forms replace flight feathers in the fall (Johnson 1963, P. Unitt pers. comm.). First-year Olive-sided Flycatchers appear to have one protracted over-winter molt of flight feathers, commencing in September or October and concluding in March or April, although this needs confirmation as only three specimens I examined were collected on the winter grounds. Among first-spring Olive-sided Flycatcher specimens, 21.4% of 28 had replaced all remiges.

In the kingbirds, remex molt begins in the fall, is suspended over winter, and resumes in the spring (Table 2). The outer primary molt begins with one of P4, P5, or P6 (P7 in one Scissor-tailed Flycatcher), and the inner secondary molt (excluding the tertials, which typically molt before other secondaries) with one of S4, S5, or S6 (see Figure 1 for remex numbering). No specimens collected in winter (November through February; see Table 2) were in active molt, confirming that remex replacement occurs in stages rather than continuously through the winter. Cassin’s Kingbird differs from the other three species in that fewer remiges are replaced during the first year (Table 1), including no primaries or secondaries (except tertials) in 36%
ECCENTRIC FIRST-YEAR MOLT PATTERNS IN CERTAIN TYRANNID FLYCATCHERS

Table 2 Numbers (Mean and Range) of Remiges Replaced During the First Fall and Spring Molts in Four Species of Kingbirds

<table>
<thead>
<tr>
<th>Species</th>
<th>First fall molt&lt;sup&gt;a&lt;/sup&gt;</th>
<th>First spring molt&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Outer primaries</td>
</tr>
<tr>
<td>Tropical Kingbird</td>
<td>12</td>
<td>2.3 (1–5)</td>
</tr>
<tr>
<td>Cassin's Kingbird</td>
<td>16</td>
<td>0.3 (0–1)</td>
</tr>
<tr>
<td>Western Kingbird</td>
<td>27</td>
<td>1.6 (0–3)</td>
</tr>
<tr>
<td>Scissor-tailed Flycatcher</td>
<td>21</td>
<td>1.9 (0–5)</td>
</tr>
</tbody>
</table>

<sup>a</sup>Based on specimens collected from November through February. Number of secondaries replaced during the fall molt includes the tertials, which are often replaced again during the spring molt (see text). Compare with the data presented in Table 1.

<sup>b</sup>Based on specimens collected from April through July.

of 14 specimens, and that the molt is usually (in 77% of the nine specimens showing replacement of primaries) arrested before the outermost primaries are replaced. Thus, many first-spring Cassin's Kingbirds had replaced, e.g., only P6–P7 and S6 (CAS 46202) or P5–P7 and S5–S6 (MVZ 4299).

The evidence indicates that the replacement of primaries in spring continues where the fall molt is suspended. Numerous spring and summer kingbirds show three generations of primaries, with the number and sequence of first-fall feathers (e.g., P5–P7 or P6–P7) being typical of fall replacement patterns shown by mid-winter birds. Among 27 Western Kingbirds collected in their first winter, for example, the mean number of primaries replaced during fall molts was 1.603 (± 0.907 [standard deviation]), whereas the mean number of first-fall primaries detected on 45 spring and summer birds was 1.589 (± 0.920). These similar figures (ANOVA, \( P = 0.824 \)) support the premise that no primaries replaced during the fall molt are replaced again during the spring molt.

Among the secondaries, however, the tertials appeared to be replaced during the fall molt and again during the spring molt (see Table 2). Among Western Kingbirds, only six of 45 spring and summer birds (mean 0.155 ± 0.424) had retained one or two first-fall tertials, whereas 27 winter birds had replaced a mean of 2.885 (± 0.824) juvenile tertials. This highly significant difference (ANOVA, \( P < 0.0001 \)) in the number of first-fall tertials present in winter versus spring indicates that the tertials typically replaced in the fall are replaced again in the spring. The other three species of kingbirds show similar patterns of fall and spring replacement of remiges (Table 2).

DISCUSSION

In several respects eccentric replacement patterns in tyrannid flycatchers differ from those documented in other North American passerines. The highly variable commencement points of this molt in the Vermilion and other flycatchers, the suspended eccentric pattern of the kingbirds, and the
suspended and arrested eccentric pattern of most Cassin’s Kingbirds are strategies that have rarely been documented, even in Europe (Jenni and Winkler 1994).

It has been suggested that eccentric molts occur in species that are more exposed to bright sunlight or that suffer higher feather wear due to harsh vegetation, the renewal of outer primaries and inner secondaries being needed for protection of underlying feathers and improved flight (Dwight 1900, Mester and Prünte 1982, Jenni and Winkler 1994). Willoughby (1991) suggested that vegetation might be more important than exposure to sunlight in the extent of first-year molts of Spizella sparrows. Many North American species that have eccentric primary molts, including the Verdin (Auriparus flaviiceps), White-eyed Vireo (Vireo griseus), Yellow-breasted Chat, Field Sparrow (Spizella pusilla), Passerina buntings, and several species of wrens, thrashers, sparrows, and orioles (Willoughby 1991, Thompson and Leu 1994, Pyle 1997), reside in harsh vegetation. The occurrence of eccentric primary molting patterns in other species such as the tyrannid flycatchers, Loggerhead Shrike, Lark Bunting (Calamospiza melanocorys), and House Finch (Carpodacus mexicanus), extensively exposed to sunlight but not to harsh vegetation, suggests that exposure to sunlight may also affect the occurrence of these molts. In addition, variation within tyrannid genera suggests a correlation between length of migration and the extent of remex molts, those taxa that winter in South America generally replacing their remiges completely, those wintering in Central America largely showing eccentric patterns, and those wintering in Mexico or the United States molting fewer remiges on average. This corresponds, in general, with patterns found in European migrants (Jenni and Winkler 1994), although it differs from what is found among Passerina buntings, where both migratory and resident species molt to a similar extent (Thompson 1991, Young 1991, Thompson and Leu 1995). Migration distance, as well as vegetation, exposure to sunlight, and other factors, should thus be considered when causes and extents of eccentric molts are addressed.

Clearly, more study is needed on eccentric molts in North American passeres, their causes, and to what extent these molts in different genera represent homologous patterns.

ACKNOWLEDGMENTS

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LITERATURE CITED


ECCENTRIC FIRST-YEAR MOLT PATTERNS IN CERTAIN TYRANNID FLYCATCHERS


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EXTRALIMITAL BREEDING OF THE BUFFLEHEAD IN CALIFORNIA

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The Bufflehead (Bucephala albeola) is a common winter visitor throughout California, occurring mostly along the coast in ocean bays and estuaries. In the interior it winters in small numbers on lakes and ponds. Small numbers of nonbreeding individuals also summer along the coast, and even fewer still summer on inland lakes and ponds (Zeiner et al. 1990).

A small population of the Bufflehead breeds in northeastern California in Modoc, Shasta, Lassen, Tehama, Butte, and Plumas counties (Figure 1) (Zeiner et al. 1990, D. Airola pers. comm.). Prior to 1996, there were no confirmed breeding records for the Bufflehead in California south of its limited range in those counties. During the 1980s, Airola (pers. comm.) queried all wildlife biologists working in the Sierra Nevada about nesting Buffleheads outside of this range; none had been observed.

Here I report three instances of successful breeding by the Bufflehead 250 to 650 km south of the species’ known breeding range during summer 1996. Juvenile birds from downy to three-quarters size were found in diverse habitats in Tuolumne, Inyo, and Los Angeles counties (Figure 1).

TUOLUMNE COUNTY

On 4 and 5 June 1996, U.S. Fish and Wildlife Service staff observed an adult female Bufflehead with two downy chicks at Catfish Lake,Tuolumne County (K. Corey pers. comm.). The small lake (approximately 2 ha) is at 1800 m elevation, approximately 0.4 km north of Pinecrest Lake in the Stanislaus National Forest. It is surrounded by Sierran mixed conifer forest (Mayer and Laudenslayer 1988) dominated by Jeffrey Pine (Pinus jeffreyi) and Douglas-fir (Pseudotsuga menziesii) that grow to the edge of the lake. Catfish Lake is shallow and supports emergent vegetation such as horsetails (Equisetum sp.).

Pileated Woodpeckers (Dryocopus pileatus) nested at the edge of Catfish Lake in 1996, and a few old woodpecker holes were in the area. Northern Flickers (Colaptes auratus), whose cavities Buffleheads prefer for nesting, were not observed at Catfish Lake in 1996 are fairly common in the vicinity. Pileated Woodpecker cavities are also likely suitable sites for nesting Buffleheads. A brief search for the Bufflehead’s nesting cavity at Catfish Lake was unsuccessful. Several Mallards (Anas platyrhynchos) were also present and possibly breeding.

Catfish Lake is approximately 250 km south of the nearest previously known Bufflehead nesting location near Lake Almanor in Plumas County. No follow-up visits to determine the fate of the young Buffleheads were made. This constitutes the first known breeding record of the Bufflehead in Tuolumne County.
Figure 1. Extralimital breeding locations (light circles) and known breeding range (dark area) of the Bufflehead in California.
EXTRALIMITAL BREEDING OF THE BUFFLEHEAD IN CALIFORNIA

INYO COUNTY

Normally, wintering Buffleheads depart Inyo County in late April, although stragglers may remain until the second week of May (T. and J. Heindel pers. comm.). On 30 May 1996, however, Tom and Jo Heindel observed one juvenile Bufflehead with an adult female at the Bishop sewer ponds. It was still partly downy and about two-thirds the size of the adult female. It could not fly, and its primary feathers appeared to be very short as it flapped its wings and ran across the water. These birds were still present on 3 June, when the Heindels found a second juvenile Bufflehead following a different adult female, plus an adult male. These two juvenile Buffleheads, with separate adults, were noticeably different in size and were on separate parts of the pond. On 24 June, they found only the juvenile birds, and on 8 July, when the Heindels last visited the ponds, the young Buffleheads were still present and appeared to be doing well. The departure date for the juvenile birds was not determined and no attempt was made to find the nest site.

This presumed successful breeding of the Bufflehead constitutes a first record for Inyo County (T. and J. Heindel pers. comm.). The Heindels photographed one of the juveniles with its presumed mother on 30 May. They retain the photograph in their files, available to researchers (P. O. Box 400, Big Pine, CA 93513).

The ponds, located 1.6 km east of Highway 395 east of Bishop at 1200 m elevation, are a series of diked impoundments used for secondary sewage treatment by the city of Bishop. They are surrounded by mixed stands of mature cottonwoods (Populus fremontii) and willows (Salix spp.). Northern Flickers nest commonly in this portion of Inyo County (T. Heindel pers. comm.), suggesting the availability of preferred nesting cavities for Buffleheads. Other ducks breeding in these ponds include the Mallard, Wood Duck (Aix sponsa), Gadwall (Anas strepera), Cinnamon Teal (Anas cyanoptera), Northern Pintail (Anas acuta), Redhead (Aythya americana), and Ruddy Duck (Oxyura jamaicensis) (T. Heindel pers. comm.).

LOS ANGELES COUNTY

I observed a male Bufflehead at Piute Ponds on 9 June 1996. Buffleheads have usually departed Los Angeles County by early May, but early summer records are not unprecedented (Garrett and Dunn 1981). On 7 July 1996 Bruce Broadbooks, Tom Wurster, and I observed two juvenile Buffleheads, three-quarters the size of an accompanying adult female. A male (probably the same individual observed on 9 June) remained about 100 m distant from the juveniles and female. On 14 July the juveniles were with both adults and noticeably larger than when they were first discovered on 7 July, being nearly the same size as the adult female. The adults were clearly disturbed by our presence and attempted to hide the young birds in the sparse vegetation on the opposite side of the pond. The juveniles made several attempts to fly away from us but their wings were not yet sufficiently developed to allow them to take flight. Their body feathers appeared to be slightly browner than the female’s. The male, in eclipse plumage, showed considerably more white in the head and was larger than the others. On 21 July, three
BUFFLEHEADS of the same size were present, but the juveniles could not be distinguished from the female. This is the first presumed confirmation of Buffleheads breeding in Los Angeles County.

The Piute Ponds, located at the southwestern corner of Edwards Air Force Base in the Antelope Valley, are a series of diked ponds filled with secondary sewage effluent discharged from the nearby Lancaster sewage treatment plant. The ponds are located in flat desert terrain where trees are limited to naturalized and artificial plantings of tamarisk (Tamarix sp.) and scattered cottonwoods. They are surrounded by desert scrub with remnants of a Joshua Tree (Yucca brevifolia) forest. The ponds are shallow and support abundant emergent edge growth including bulrush (Scirpus sp.) and cattails (Typha sp.). They provide habitat for large numbers of herons, wintering ducks, migrating shorebirds, and resident passerines. The Mallard, Gadwall, Cinnamon Teal, Redhead, and Ruddy Duck are common breeders at Piute Ponds.

On 21 July 1996 Kimball Garrett and I searched around the ponds but could not locate the nest site. We searched a land spit that was isolated as an island when water levels were higher in June but could not locate a nest site. We also searched numerous Joshua Trees with some possible cavities large enough for Buffleheads that were adjacent to the ponds, but they showed no evidence of nesting use by Buffleheads. The nesting cavity could easily have been overlooked because we did not search all of the Joshua Trees in the area. Northern Flickers are not known to nest in the area. Ladder-backed Woodpeckers (Picoides scalaris) frequently nest in Joshua Trees in the region but their cavities are too small for Buffleheads. Planted cottonwoods in the vicinity of where the young were found did not appear to have suitable nest cavities.

DISCUSSION

Nonbreeding or very late migrant adult Buffleheads were also found at various other sites in California during late spring and summer 1996, including one female or eclipse male, 29 May at Furnace Creek Ranch, Inyo County (J. Morlan pers. comm.); one female, 30 May on a small pond 6.4 km south of Indian Creek Reservoir in Alpine County (S. Laymon pers. comm.); one male, 8 June at the Perris Valley Water Reclamation Facility, Riverside County (R. Hamilton pers. comm.); and one male 11 May–2 July at the mouth of Cayucos Creek, Santa Barbara County (T. Edell pers. comm.). These sites were not checked later in the year to determine if breeding Buffleheads were present but should be surveyed for breeding birds in the future. Typically, a few nonbreeding Buffleheads are seen outside of their breeding range in California during most years.

Buffleheads have previously been reported using atypical sites and habitats in locations far from their normal breeding range. For example, broods of Buffleheads have been observed in South Dakota far from any trees with possible nesting cavities and in open prairie lands in Saskatchewan (Erskine 1972). In these locations it is unknown where the Buffleheads may find nesting cavities.

Female Buffleheads usually return to their natal and breeding areas, so the exceptional California sites found in 1996 should be checked for the birds'
return in subsequent seasons. Buffleheads may adapt to man-made environments. They accept nest boxes, which could be placed at locations where nonbreeding birds summer. Artificial but otherwise suitable ponds may offer potential for the Bufflehead’s breeding range to be extended purposefully.

There are no published breeding records of Buffleheads in California outside their normal limited range in the extreme northeastern part of the state prior to the 1996 breeding season. It is not known what factors may have led to the extralimital breeding of Buffleheads in California in 1996, but the species has shown adaptability to abnormal sites outside of its normal range. Conditions at the new sites were not unusual. Sewage ponds offer a new habitat with superabundant invertebrate food, possibly stimulating Buffleheads to nest at new sites if nest cavities and other conditions are suitable.

ACKNOWLEDGMENTS

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LITERATURE CITED


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FIRST RECORDS OF THE WHITE-WINGED JUNCO FOR CALIFORNIA

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The White-winged Junco (Junco [hyemalis] aikeni) is a United States endemic with a limited range and few acceptable extralimital records. Two of these extralimital records have been in California in recent years, thus adding a taxon to the list of birds recorded in the state. The first of these records was of a bird photographed at a feeder at San Rafael, Marin County, December 1990–23 March 1991 (Yee et al. 1991a, 1991b). The second record was of a bird observed at Lake Tamarisk, Desert Center, Riverside County, 3 November 1996 (McCaskie 1997). Even though each of the taxa discussed are currently recognized (A.O.U. 1983) as subspecies or subspecies groups of the Dark-eyed Junco (Junco hyemalis), for clarity’s sake we use common names for their distinct forms.

The White-winged Junco at San Rafael was first noted by Carter L. Faust in December 1990 as it visited his feeder with a small flock of Oregon Juncos (probably J. h. shufeldti and J. h. thurberi). This bird was seen regularly over the next month by Faust but was not confirmed as a White-winged Junco until 28 January 1991 by Stallcup, and subsequently by Bailey on 14 March 1991. On these occasions, the White-winged Junco was carefully studied at close range and was photographed (Figure 1). The following characters were critical in diagnosing this bird as California’s first record of this taxon: (1) the narrow, complete, bilaterally symmetrical white wingbars, (2) the overall blue-gray plumage, lacking any black tones, (3) the excessive white in the lateral rectrices, (4) the white terminal tail band, and (5) the large size overall and large bill. The following description of this bird was edited from an account written by Bailey (with some additions to the description from notes taken by Stallcup):

The White-winged Junco could be picked out easily by its big white tail flash at a distance of at least 15 m, even when one was not looking directly at the bird. It was an obvious junco. In direct comparison with the accompanying Oregon Juncos, it was clearly larger and especially longer and less compact in shape. Most obviously longer was the tail. The legs were also obviously longer; the White-winged stood taller than any of the perhaps 20 Oregon Juncos present. The head and body looked a little larger. When I thought to look at the bill, it was definitely somewhat larger than that of any of the Oregons’ bills, especially the maxilla. It was about the same sharp-tipped conical shape as the Oregons’ bills, or maybe a bit longer in proportion. The bill was all whitish-pink. The eyes were dark. The long, slender tarsi were pale, but I did not note their exact color.

Except for the wingbars and tail, the White-winged Junco was colored like a male Slate-colored Junco [i.e., a male J. h. hyemalis], but paler. The overall color was a medium-pale gray with absolutely no brownish tones in any light conditions but instead a slight bluish cast in some lights. This color covered the upperparts and most
of the head, throat, breast, sides, and flanks. It gradually darkened into the face, so that the loral region (and perhaps the chin) was quite dark gray though not black. The belly, vent, and undertail coverts were white. The boundary between the white belly and the gray breast, sides, and flanks curved in a high arc (convex upward), similar to the pattern on a Slate-colored Junco, although the gray may have come slightly lower on the lower breast. The gray flanks looked more extensive than on a Slate-colored.

The wings, both coverts and remiges, were a good shade paler than expected in a Slate-colored Junco, and this color was a flat gray. Each greater and median secondary covert was neatly tipped in white, forming a pair of narrow white wingbars on each wing. These were clear when the bird was seen well. Against the flat, rather pale gray background color the pair of narrow white wingbars did not contrast strikingly; wingbars of that strength would have been more noticeable against the darker background color of a Slate-colored Junco's wing. The wingbars were bilaterally symmetrical.

The tail had about twice as much white as an Oregon Junco’s tail. There were perhaps four white rectrices on each side of the tail. On one occasion when the tail did not fold completely, the right side was largely exposed and it looked (to the naked eye) completely white except for the completely dark central rectrices. A narrow white tip crossed the tail because the tail tip was slightly forked and the central rectrices (one or two pairs) were slightly shorter than all of the white rectrices. Thus from a dorsal view the white of the longer rectrices showed just past the tips of the dark central rectrices. From a ventral view the tail looked completely white.

The Desert Center White-winged Junco was observed (using binoculars) by Patten and Jutta C. Burger at close range (to 5 m) from 0930 to 0950 PST under excellent conditions (clear and ±75° F, with a steady Beaufort 2 northwest wind). The bird was with a flock that included ±25 Oregon Juncos
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(probably *J. h. montanus* and *J. h. thurberi*), one male Slate-colored Junco (*J. h. hyemalis*), a few Savannah (Passerculus sandwichensis nevadensis) and White-crowned (*Zonotrichia leucophrys gambelii*) sparrows, and a single Song Sparrow (*Melospiza melodia*, probably *M. m. fisherella*). Numerous other Oregon Juncos, two additional Slate-colored Juncos, two Gray-headed Juncos (*J. h. caniceps*), and a single Pink-sided Junco (*J. h. mearnsi*) were also observed at Desert Center on 3 November 1996 (Patten pers. obs.). The following description of the White-winged Junco is taken from Patten’s field notes:

The White-winged Junco was substantially larger (bigger, bulkier, and longer-tailed) than all of the other juncos present. Even more striking was the bird’s larger, heavier bill (it was a bit longer and distinctly deeper than a “typical” junco bill). The bill was uniform pink and had a straight culmen. The irides were dark. The plumage was highly distinctive. The overall coloration was a uniform soft mouse-gray (with a slight bluish-gray cast) throughout the head, mantle, wings, uppertail, breast, and flanks. There was absolutely no darkening on the lores or around the eyes (i.e., unlike on *caniceps* and *mearnsi*), and the head and breast were not even close to the dark slate-gray of a Slate-colored Junco (i.e., the overall gray shade was more like that of a *caniceps*, although slightly paler than even that). There was absolutely no contrast between the mantle and wings and the head and breast. There were bold white tips to the median coverts, forming distinct upper wingbars. The greater coverts were tipped with pale whitish-gray, such that at some angles (e.g., when it was on the ground) the lower bars did not stand out, but at others (e.g., when it was perched eye-level in a *Nerium oleander*) the lower wingbars were quite evident. The tail was extensively white; the three outermost rectrices on either side of the tail appeared to be wholly white, and rectrix 3 on either side appeared to be mostly white. Indeed, in flight and on the ground, this bird looked like it had a white tail with a dark stripe (i.e., its central rectrices) running down the center. The central belly and undertail coverts were clean white, with this white meeting the gray in a smooth, inverted U shape. Its call was a typical junco “tip” note.

The Desert Center bird was also observed in the afternoon of 3 November 1996 by Vernon Howe and Andrew Howe, but it could not be relocated on subsequent days, despite considerable effort (R. A. Erickson pers. comm., G. McCaskie pers. comm.). Although the White-winged Junco winters regularly west to southwestern Colorado (see below), the Desert Center record corresponded with exceptionally high numbers of them in that region during the winter of 1996/1997 (T. Leukering in litt.). A 10 October–2 November 1996 report from Cheyenne, Wyoming (Truan and Percival 1997), and a February 1997 report from western Texas (fide T. Leukering) also fit this pattern, although the latter lacks sufficient documentation (G. W. Lasley pers. comm.).

DISTRIBUTIONAL SUMMARY

FIRST RECORDS OF THE WHITE-WINGED JUNCO FOR CALIFORNIA

(A.O.U. 1957, Rising 1996). White-winged Juncos regularly winter throughout their breeding range and south through southwestern Colorado (Andrews and Righter 1992), north-central New Mexico (Hubbard 1978), and western Oklahoma and western Kansas (A.O.U. 1957), and east to central South Dakota (Rising 1996). They are more scarcely recorded at this season in central Kansas and central Oklahoma (Rising 1996).

There are few extralimital records of the White-winged Junco, and "almost no instances of migration out of the plains and Rocky Mountain regions that are based on critically determined specimens" (Miller 1941:346). However, it has been recorded once in Texas (a specimen from Briscoe County), it has been reported from Tennessee (Rising 1996:230), central Nebraska (A.O.U. 1957), and south-central Wyoming (Truan and Percival 1997), and there is a putative report from Massachusetts (Harlow 1995).

West of the Rocky Mountains, there are at least nine records for Arizona, with most in a single winter; a minimum of seven birds, six collected and one banded, were located from 21 November 1936 through 26 February 1937 in northeastern Arizona, particularly around Flagstaff, Coconino County (Hargrave et al. 1939). Since that winter, there have been but two records (Monson and Phillips 1981): one was collected 23 February 1971 at Flagstaff (Russell P. Balda; specimen at the Museum of Northern Arizona), and one was observed 13-14 November 1971 at Roll, lower Gila River, Yuma County (Amadeo M. Rea).

Aside from the two California records we present, the only other record of aikeni for western North America is of one photographed 25 February-7 March 1987 at a feeder in Bend, Oregon (Crabtree 1987, Gilligan et al. 1994). Although the bird may occur in Utah (Behle and Perry 1975, Behle et al. 1985), there are no definite records (Ella D. Sorenson pers. comm.); thus, the single published sight record for that state (near Soapstone, Summit County, 15 August 1960) is best treated as hypothetical (Behle 1985:115).

IDENTIFICATION SUMMARY

When all characters are considered together, the White-winged Junco presents a relatively straightforward field identification. Also, the White-winged Junco is less sexually dimorphic in both size and coloration than any other junco in the United States (Rising 1996:228), reducing the need for consideration of intersexual variation. The White-winged Junco is most similar to the nominate Slate-colored Junco (and to the similar J. h. carolinensis of the Appalachian Mountains) in overall plumage pattern and coloration, in that both are largely uniform gray, without a contrasting head or back. However, the White-winged differs significantly and consistently from the Slate-colored in several key ways; indeed, Miller (1941:346) noted that "In spite of the approach of J. h. hyemalis and aikeni in all essential points of difference, the absence of any consequential overlap in a large number of characters precludes the possibility of confusion of the two forms when all of them are considered. I have yet to examine an equivocal specimen, so far as these two forms are concerned. Their status as distinct species seems entirely satisfactory."
These plumage differences led Hargrave et al. (1937) to remark that “in life aikeni much more closely resembles caniceps than it does either hyemalis or mearnsi, and that any competent observer familiar with the species mentioned here can properly distinguish all under normal field conditions.” This statement probably stemmed from the pale gray head, breast, and flank coloration of caniceps, which matches aikeni better than does the dark slate coloration of hyemalis. The cool bluish-gray of head coloration of mearnsi is probably a better match still, although aikeni, unlike mearnsi, caniceps, and dorsalis, shows little to no blackish darkening in the lores. A review of specimens revealed that this mark is variable, with some aikeni showing a faint dark mask, and others have a concolorous head. The San Rafael bird showed some orlal darkening, but the Desert Center bird showed none. Such differences did not appear to be related to sex, but more work is needed to be certain.

Also unlike any Oregon, Gray-headed, Red-backed (J. [h.] dorsalis), Pink-sided, or henshawi [= cismontanus] Slate-colored junco, White-winged Juncos usually do not show brown or rust coloration in the back, although a hint of this color may be present, especially on immature females (T. Leukering in litt., B. E. Webb in litt). Like the Gray-headed, male hyemalis and carolinensis Slate-colored, and Red-backed juncos, the White-winged Junco always shows gray flanks that do not contrast with the breast and head. Only the nominate and carolinensis Slate-colored Juncos combine the concolorous gray mantle, head, breast, and flanks, and the distinctly contrasting white belly and undertail coverts, that aikeni shares. The White-winged Junco further shares the all-pink bill and white belly meeting the gray breast in an inverted U.

The White-winged is the largest of all juncos in the United States, surpassing even the Pink-sided in overall size and bulk. Thus, aikeni is much larger than hyemalis, a feature especially evident in direct comparison. Aside from overall bulk, the best size distinctions are the proportionately longer tail of aikeni and the distinctly longer, straighter, deeper bill of aikeni (Miller 1941, Rising 1996).

The most consistent plumage distinctions between the White-winged and Slate-colored juncos are (1) the overall pale bluish-gray coloration of aikeni, in contrast to the much darker, slate-gray of the aptly named Slate-colored Junco (e.g., the illustration of hyemalis on Plate 23 of Byers et al. 1995 is much too pale gray), (2) the narrow white wingbars of aikeni (but see below), and (3) the more extensive white in the tail of aikeni. With regard to this last point, the extent of white on rectrices 3 and 4 (with rectrix 6 being the outermost on each side) is the key. Rectrix 4 is typically uniform white (or nearly so) in aikeni, but with much more blackish (especially on the outer web) in hyemalis (Rising 1996:225), such that in hyemalis at most 80% of this feather is white (Figure 2). Only 2% of hyemalis show white on rectrix 3 (and then usually only at the tip), whereas 94% of aikeni show white along the shaft (Figure 2; Miller 1941:346, Rising 1996:225).

The most problematic aspect of field identification is occasional white tips to the secondary coverts on other juncos. The frequency of white "wingbars" on other juncos ranges anywhere from 1% in the Oregon (J. h. thurberi; Miller 1941:277) to 1.8% in the Pink-sided (Miller 1941:347) to 3% on the
Slate-colored (Miller 1936, 1941:346); they also have been noted on the Gray-headed Junco (Killpack 1986). Aside from aikeni, "white tips on the wing coverts occur more frequently in hyemalis than in any other form" (Miller 1941:315). Conversely, about 12% of White-winged Juncos (especially females) lack white wingbars, and about 5% have only one obvious wingbar, on the middle coverts only (Miller 1941:347). If white is absent, aikeni shows light gray margins to these feathers, unlike hyemalis (Miller 1941:346); such birds can still be identified as aikeni by overall size and color, bill size and shape, and tail pattern (Figure 2). Few if any aikeni have broad bright wingbars like those shown in some field guides (e.g., Pough 1949, Robbins et al. 1983).

A Slate-colored Junco with white wingbars can give the impression of a White-winged Junco (Killpack 1986, Rising 1996), leading to misidentifications (e.g., Robbins and Easterla 1992:345-346); conversely, an aikeni lacking white wingbars may be mistaken for a hyemalis. Both Killpack (1986) and Robbins and Easterla (1992:346) published photographs of Slate-colored Juncos with white wingbars, and Rising (1996, Plate 20) included an illustration of one. The cases discussed by Killpack (1986) and Robbins and Easterla (1992) involved mist-netted birds studied and verified to be aberrant Slate-colored Juncos by their overall darker slate-gray coloration, less white in their tail, and smaller size. The authors in each case
emphasized the dangers of relying only on the presence of white wingbars for identification, with Robbins and Easterla (1992:346) further stating that *hyemalis* can have “white-tipped wing coverts (giving the appearance of wing-bars) and an unusual amount of white in the tail.” As discussed above, there exists plenty of evidence for white tips to the wing coverts on *hyemalis*, but we question the basis for the statement about the “unusual amount of white in the tail” because it does not match Miller’s (1941) analysis or the identification criteria provided by Rising (1996). For example, a specimen at the Natural History Museum of Los Angeles County (LACM 90805) is a male *hyemalis* with white wingbars taken 30 November 1976 at Gaithersburg, Maryland. Despite the wingbars, the tail pattern is distinctly that of *hyemalis*: rectrices 5 and 6 are white, but a mere 30% on the vane of the inner web of rectrix 4 is white.

Thus, a combination of overall size (preferably in direct comparison with other juncos), tail length, bill depth, overall coloration, the presence of white wingbars, and the extent of white in the tail ought to serve as conclusive identification criteria for the White-winged Junco.

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Carter L. Faust kindly allowed Stallcup and Bailey to see the junco in his yard. Kimball L. Garrett (Natural History Museum of Los Angeles County) and Philip Unitt (San Diego Natural History Museum) facilitated access to junco specimens in their care. Richard A. Erickson provided useful discussion and references to pertinent literature. Greg W. Lasley and Ella D. Sorenson supplied information about White-winged Junco records in Texas and Utah, respectively. The paper benefitted from thoughtful reviews by Tony Leukering, Philip Unitt, and Bruce E. Webb.

**LITERATURE CITED**


FIRST RECORDS OF THE WHITE-WINGED JUNCO FOR CALIFORNIA


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FIRST RECORD OF THE BLACK-TAILED GULL FOR MEXICO

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On 7 June 1997 we (along with Ted J. Nordhagen) observed an adult Black-tailed Gull, *Larus crassirostris*, at the fishing village of El Golfo de Santa Clara, near the mouth of the Colorado River in extreme northwestern Sonora, Mexico (31° 42' N, 114° 30' W). Field descriptions and a series of color photographs (three of which reproduced in black and white as Figures 1–3) confirm the identity of this distinctive eastern Palearctic gull, which has previously been recorded as near to Mexico as San Diego, California (Monroe 1955, Heindel and Patten 1996) and Belize (Howell and Webb 1995). We located the bird on the beach at the north end of town and watched it for about 20 minutes, at distances as little as 15 m. The description below is based on a few notes and sketches made in the field while the bird was under observation, as well as more extensive notes made fifteen minutes after the sighting. It was mostly clear (a few clouds), calm, and about 27° C; the tide was rather low (the tidal range at the northern end of the Gulf of California is tremendous), exposing 100+ m of flats on the beach.

Figure 1. Black-tailed Gull (center), with Heermann's Gull (*Larus heermanni*, left) and Yellow-footed Gull (*L. livens*).  
*Photo by Kimball L. Garrett*
Garrett first noticed the bird as it began to take flight in a group of 25+ Heermann’s (Larus heermanni) and Yellow-footed (L. livens) gulls among the pangas and fish and ray offal on the upper, dry part of the beach. Immediately noticeable was the exceptionally long yellow bill with a mostly black tip, a rather dark mantle, and, as the bird flew away toward the water’s edge, a clean, thick black band across the white tail; the bird looked like a medium-sized gull on this initial quick observation. Subsequent scope views reaffirmed our initial feeling the bird might be a Black-tailed Gull; our views were leisurely, with Molina and Nordhagen using spotting scopes and Garrett approaching and attempting to obtain photographs. The bird was still sitting on the beach (after we flushed it twice for short distances) when we left. Despite searches of the area by K. Radamaker on 8 June and S. N. G. Howell and M. San Miguel on 10 and 11 June, the bird was never relocated.

DESCRIPTION AND IDENTIFICATION

The following description is taken verbatim from notes written by KLG immediately after the sighting; additional words provided for clarity are in brackets.

"Bill" strikingly long for size of bird. Long curve at tip of culmen; [bill] moderately slender, but with moderate gonydeal angle. Basal ~2/3 (or almost 3/4) bright deep yellow. Most of remaining (distal) portion black, which extended slightly farther posterior on mandible than on maxilla. Very tip of maxilla (along curved tip) orange-red; also [orange-red] on very tip (last
FIRST RECORD OF THE BLACK-TAILED GULL FOR MEXICO

Figure 3. Black-tailed Gull in flight; note long bill, extensive white trailing edge to the secondaries, white apical spots on inner primaries, and black subterminal tail band bordered laterally by white.

Photo by Kimball L. Garrett

~3 mm) of mandible. Touch of red on mandible behind black. Iris white (maybe with slight yellow tint); eye moderately large. Thin, rather bright red orbital ring. Head pure white—feathering on hindcrown/hindneck a bit matted, stringy. Underparts pure white. Mantle slaty-gray—[shade] about like [that of a] Laughing Gull or Heermann's—definitely paler than Yellow-footed Gull, but darker than a California and much darker than a Ring-billed. Lower back and rump white. [Wing:] Small white crescent at tips of secondaries. Primaries long—bird long and tapered at rear. [Primaries] darker than mantle—dull blackish; no white tips on primaries, but [primaries] rather worn. Tail white at base with broad, solid black band all the way across distal ~1/2 (2/3?). Thin, distinct white terminal band on tail. Legs rather deep yellow; no tint of green or pink. In flight dark gray mantle grades gradually into blacker primaries. White trailing edge to secondaries. Black tail band clean and obvious. Size: elongate, slender. Slightly smaller than Heermann's or Ring-billed. Dwarfed by Yellow-footed Gull.

Figures 1–3 show several of the characters described above. The orange-red bill tip is visible but difficult to see in the original color photos. The flight photos show white terminal spots on the inner 4 primaries. They also show a narrow margin of white on the outer rectrices lateral to the black tail band. The photos confirm that the bird is smaller (at least in bulk) than the Ring-billed and Heermann's gulls, though certainly longer billed and longer winged than those two species.
The combination of white eye, red orbital ring, long yellow bill with black distal portion and red tip, moderately dark mantle, black tail band with white on the terminal and lateral edges, yellow legs, elongate appearance, and medium-small size makes this a striking and easily identified gull. The most thorough discussion of plumages of crassirostris is that in Higgins and Davies (1996). From their discussion we are reluctant to age the bird for certain as an adult (as opposed to one in second alternate plumage), but feel the brightness of the bill and legs, purity of the white head and underparts, and distinct white apical spots on the inner primaries do suggest an adult. There was no hint of any brown in the wing coverts, and although the primaries were a bit dull (worn?), they were more blackish than dusky. The limited red tip on the bill of this individual may be within the normal range of variation for adults.

Published illustrations of this species range from adequate to poor. The only North American field guides depicting this species are those by Pough (1957) and Griggs (1997). In both the bill shape is incorrect; the former shows a bill too small, and the latter shows one far too thick. The plate in Higgins and Davies (1996) is accurate, although copies I have examined show the mantle and wing coverts too pale. The portrayals in Flint et al. (1984) and Wild Bird Society of Japan (1982) severely distort the species’ general shape and bill shape. Several depictions, including those in Harrison (1983), del Hoyo (1996), and Griggs (1997) show the bill too thick, and some texts also mention that the bill is heavy (as suggested by the specific epithet crassirostris). This did not appear to us to be the case: although the bill is not especially slender, its length (relative to the size of the bird) and long curved culmen tip give it a unique appearance. Harrison (1983) accurately captured the elongate and tapered body and wings of this species. Correct bill shape, body proportions, and plumage are shown well in some published photos, as in Takano (1981), Pringle (1987), and Petersen (1995). The identification of first-year birds was discussed by Rosenberg (1997).

DISTRIBUTION AND DISCUSSION

As with most cases of transoceanic vagrancy in gulls, we cannot rule out some kind of ship assistance in explaining this bird’s occurrence at the head of the Gulf of California; however, a recent wide pattern of vagrancy in this species suggests the record may pertain to a natural vagrant. In addition to the records cited above for San Diego, California (280 km WNW of El Golfo; 26–28 November 1954) and Belize (11 March 1988), there are also recent records for the east coast of North America as well as western and southern Alaska.

Gibson and Kessel (1992) cited four May and June records for western Alaska, all of adults, and Heinl (1997) listed three summer and fall records (two adults and one bird in second alternate plumage) in southeastern Alaska. Since those summaries three additional birds (two in first alternate plumage, one subadult) have been found in southern and southeastern Alaska in summer and fall 1995 (Tobish 1995, 1996a) and an adult was at Gambell, St. Lawrence Island, in June 1996 (Tobish 1996b). There is a sight record for the Queen Charlotte Islands in northwestern British Columbia, Canada, on 22 November 1991 (Siddle 1992). The only mid-continental
record is a sight report for southern Manitoba on 2 June 1987 (Knapton 1990), although we feel the published description does not eliminate other gulls, including alternate-plumaged Band-tailed (Larus belcheri) and Olrog’s (L. atlanticus) gulls. Along the Atlantic coast of North America there are records for Maryland in July 1984 (Armistead 1984), Virginia in March–April 1995 (O’Brien et al. 1995) and in March and December 1996 (E. A. T. Blom pers. comm.), and in Rhode Island in the summer and fall of 1995 (Petersen 1995) and again in summer 1996 (Petersen 1996). There is also a May–June 1997 record for Sable Island, Nova Scotia (Lucas 1997). Some of these records may pertain to the same individual, and the natural occurrence of each has been considered uncertain. The San Diego record was not included in the state list published by McCaskie et al. (1970) because of the perceived possibility of the bird’s having been transported to San Diego by ship traffic from Asia during the Korean War. The California Records Committee has since reassessed this record and accepted it for the state list (Heindel and Patten 1996). The wide geographic spread of the North American records suggests a pattern of repeated natural vagrancy, frequent ship-assisted travel, or perhaps some combination of the two.

El Golfo de Santa Clara is the northernmost important fishing village in the Gulf of California, lying at the southeast edge of the Colorado River delta. Much fish offal is dumped on the beach here after the fishing pangas have returned with their catch, and we suspect El Golfo will prove to be an excellent place to study gulls. On eight other visits here we have recorded one first-winter Glaucous Gull (Larus hyperboreus), one first-winter Glaucous-winged Gull (L. glaucescens), and at least seven Western Gulls (L. occidentalis), along with the more expected species. Puerto Peñasco, a much larger fishing town about 110 km southeast of El Golfo, has proven one of the best places in Mexico for “northern” gulls, with numerous records of the Glaucous Gull.

ACKNOWLEDGMENTS

We thank E. A. T. Blom for gathering information on Atlantic-coast records of this species. Steve Heindel’s review and Philip Unitt’s editing improved the manuscript. J. Fisher of the Western Foundation of Vertebrate Zoology helped us track down a reference. T. Wurster, F. Hertel, and T. J. Nordhagen have helped us with our field work in the El Golfo de Santa Clara area over the past two years.

LITERATURE CITED


FIRST RECORD OF THE BLACK-TAILED GULL FOR MEXICO


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TWO CAPTURE METHODS FOR BLACK-BILLED MAGPIES

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“It has long been recognized by those involved in pest control and research that the Black-billed Magpie is one of the most wary and difficult birds to capture alive”—Alsager et al. (1972).

A number of characteristics contribute to the difficulties involved in capturing Black-billed Magpies (Pica pica). They are extremely wary, tending to avoid unusual objects (e.g., wire traps or mist-net poles) that have been recently introduced into their environment. Some are particularly reluctant to walk into enclosed traps (Birkhead 1991, J. M. Marzluff pers. comm.). Magpies also tend to be opportunistic feeders, making it virtually impossible to predict flight paths for the placement of mist nets. Finally, they learn very quickly and will avoid any trap in which they have previously been caught or nearly caught. They may even avoid traps in which they have merely seen other birds captured.

Researchers have coped with these problems in several ways. Variations of funnel-entrance traps (e.g., Alsager et al. 1972) have been used with considerable success in some populations (Erpino 1968, Reese and Kadlec 1985) but with little or no success in others (Birkhead 1991, J. M. Marzluff pers. comm.). Buitron (1983) has used nooses hidden in grass and baited with suet to capture adult magpies, while Marzluff (pers. comm.) has used modified mammal leg-hold traps hidden under vegetation and baited with eggs. Unfortunately, individuals may learn to avoid any of these traps. To overcome this problem, one can use an arsenal of different traps, introducing new varieties as individuals learn to avoid those currently employed. Another common solution (e.g., Birkhead 1991) has been simply to abandon efforts to capture adults and rely on the banding of juveniles in the nest. Of course, this solution is practical only for those conducting relatively long-term studies of magpies dispersing only short distances.

We experienced the difficulties involved in capturing adult magpies while trying to color-band a small population near Reno, Nevada. We came to rely on two trapping methods, one a modified traditional trap (the noose carpet), the other a modified method of mist-netting. Based on the design of the bal-chatri trap (Berger and Mueller 1959) traditionally used for raptors, a noose carpet is a flat piece of wire mesh to which have been tied numerous monofilament nooses. Noose carpets have been used to capture raptors and galliforms (Bloom 1987, Bub 1991), but their design and use for corvids has not previously been described in detail in the literature. We also developed and refined a capture technique using mist nets that we call the “bait-and-chase” method. We were able to rely on these two methods exclusively because magpies were relatively slow to learn to avoid them. Both methods had the further advantages of allowing the capture of multiple birds simultaneously and the targeting of desired individuals; they should be useful for capturing other corvids and trap-shy species.
TWO CAPTURE METHODS FOR BLACK-BILLED MAGPIES

METHODS

Study Area

Our study area was located on the University of Nevada Agricultural Experiment Station just east of Reno, Nevada. The station lies along the Truckee River and includes a 1.5-km strip of riparian habitat. This strip varies in width from 5 to 100 m and is characterized by dense willow thickets (*Salix* spp.) interspersed with cottonwoods (*Populus trichocarpa*). The area is bordered by agricultural fields and farm buildings.

Noose Carpet

We constructed a noose carpet using a 1 × 0.75-m piece of heavy-duty 12.5-mm wire mesh. Before attaching nooses, we spray-painted the mesh a flat brown to make it less visible. Using 17-pound-test monofilament line, we made nooses approximately 7 cm in diameter and tied them to the mesh, spaced at 4-cm intervals. The nooses were tied with the knot described by Berger and Mueller (1959; cited by Bub 1991:197). The corners of the mesh were then staked to the ground in a conspicuous location on or near the territories of individuals that we wished to capture, and bait was placed in the center of the carpet. The best times of day for noosing were during the morning or late afternoon, when the birds were either leaving for or returning from foraging areas.

Bait and Chase with Mist-Nets

Locations for mist-netting were selected on the basis of proximity to the territories of target birds and conditions that tended to hide the net. Magpies were easily attracted to bait placed about 1 m from center of the net. However, we found that even if numerous magpies were flying to and from the bait, they were always quite aware of the net and avoided it successfully. We solved this problem by developing a “bait-and-chase” technique using two people, an observer and a chaser. The observer sits at least 100 m away from the net, the closest distance that does not deter birds from approaching the bait. The chaser hides completely in or behind vegetation located approximately 25 m from the net. The chaser watches only the observer and does not attempt to observe the birds or the net. If the chaser can see the birds, then they will usually see him. For this reason, “bait-and-chase” with one person as observer/chaser was an abject failure. The observer watches the bait and net through a spotting scope and waits until one or more target birds are at the net. When the birds begin to show decreased vigilance (e.g., sustained foraging with head down), the observer signals the chaser, who then charges toward the birds, usually flushing them into the net.

Baiting

After trying out various forms of bait, including cracked corn, dog food, bacon, fish, and eggs, we determined that Cheetos brand snack food worked best for our purposes. The bright orange color of this snack can attract the attention of magpies from a considerable distance (M. D. Reynolds pers. comm.). It is also of an appropriate size for caching, so individual magpies
often make repeated trips to the trap area. In addition to placing bait on the noose carpet or beside the mist-net, we also placed a small pile of bait 2–10 m away from the primary bait pile in as conspicuous a location as possible. This satellite pile allowed the birds to sample the bait without having to approach the trap directly, which they were always reluctant to do. Having sampled from the satellite pile, individuals were more likely to visit the main bait pile after the satellite pile had been exhausted. To aid the birds in making the connection between the two piles, we placed a trail of bait from the satellite pile to the main bait pile.

RESULTS AND DISCUSSION

Our initial attempts to capture magpies by simply baiting them to mist-nets were not very successful—we caught only one magpie during 9 hours of effort (0.1 birds/hr). Using the "bait-and-chase" technique, however, we were able to capture 9 magpies in 13 hours (0.7 birds/hr), and the noose carpet was even more successful, capturing 11 magpies in 10 hours (1.1 birds/hr). Sessions with any of these techniques usually lasted about an hour. Using simple baiting, we were successful during one out of seven sessions. With bait-and-chase, four of ten sessions were successful, and with the noose carpet, seven of ten sessions were successful. Unsuccessful sessions with either of the latter techniques could often be attributed to interference from other species, primarily European Starlings (Sturnus vulgaris) and Red-winged Blackbirds (Agelaius phoenicius). During some sessions, individuals of these species were captured, and the magpies proved quite capable of learning from their examples. More care was taken in later sessions to avoid locations where these species were common.

An advantage shared by both the bait-and-chase and noose-carpet methods is the ability to capture multiple magpies not only during a single capture session but even simultaneously. As individuals made more trips to the bait pile, they became less vigilant and lingered longer near the mist net. As these first visitors became more comfortable their presence often attracted others. We found that by exercising patience, we could regularly net two or three magpies with a single chase. During one 2-hour bait-and-chase session, we were able to capture five magpies, three of which were netted together with a single chase.

When a magpie became entangled in the noose carpet, its first reactions seemed to be of confusion and curiosity, rather than fear. Most individuals began struggling actively against the nooses only after 1 to 5 minutes. If we waited for a noosed bird to begin to struggle before going to the trap, then we would occasionally snare another bird during this interval. On two occasions we captured two birds simultaneously with the noose carpet, catching a total of three magpies during both of these one-hour sessions. As with the bait-and-chase technique, patience is the key to catching multiple birds with the noose carpet.

Both of the capture methods that we have developed are easy to use, and neither requires the construction of large or expensive traps. No birds were injured by either method, yet both yielded relatively high capture rates.
TWO CAPTURE METHODS FOR BLACK-BILLED MAGPIES

Furthermore, both methods allowed the capture of multiple birds at once and the targeting of desired individuals. Because magpies appeared to learn to avoid these traps relatively slowly, these methods could be used alone for small-scale trapping studies. If many individuals need to be captured over a number of years, these methods would be valuable additions to an arsenal, since a larger arsenal increases capture rates by increasing the amount of time between exposure to any given technique. The use of both the noose carpet and bait-and-chase mist-netting should facilitate additional studies of Black-billed Magpie demography and behavior and should be applicable to the capture of other corvids and perhaps of wary birds in general.

ACKNOWLEDGMENTS

We thank Don Kennedy and the University of Nevada Agricultural Experiment Station for access to the site. Erik Doerr was supported by an National Science Foundation Graduate Fellowship, Veronica Doerr by a University of Nevada Graduate School Fellowship. The manuscript was improved by the comments of Deborah Buitron, David Green, Elizabeth Krebs, and Peter Bloom.

LITERATURE CITED


Accepted 28 July 1997
BOOK REVIEWS


This exciting new photographic guide provides a welcome addition to the growing references available for those bird species grouped under the heading of “seabirds,” in this case the penguins, Procellariiformes, most Pelecaniformes, the skuas, gulls, most terns, one skimmer, and the auks. Intelligently, nonmarine species such as the “white” pelicans, are omitted. The misrepresented “complete reference” title reflects, presumably, the pushing hand of commercial publishers; this book is co-published in Britain as the Photographic Handbook of the Seabirds of the World.

The format is along “coffee-table” lines, with a patchwork of photos opposite concise species accounts. The text for each species comprises field-oriented descriptions of the main geographic and age-related plumage variations and a section on status and distribution, including conservation status. Given their brevity, these accounts are good (e.g., far better than the accounts in Harrison’s seabird photo guide), as might be hoped from an author who has many years of dedicated seabird study to his credit. This book has kept up well with recent changes in taxonomy and nomenclature (e.g., the correct spelling of De Filippi’s Petrel has been adopted) but, inevitably, has already been overtaken by other changes, e.g., the recent revision of albatross genera by Nunn et al. (1996; Auk 113:784–801). The selected bibliography is short (only 34 titles) but varied, suggesting an eclectic sampling of relevant literature.

Books such as this tend to be judged by their photos, and this books stands up well to the test. The 800 or so photos range, for the most part, from good to excellent and cover many plumages, but with an emphasis on “breeding” adults and less treatment of immatures. For example, about 60% of the gull photos are of adults. Many of the photos I have not seen published elsewhere (e.g., several southern storm-petrels and diving-petrels), and this alone will make the book of value to seabird enthusiasts. It is pleasing to see an effort made to give location and date given for the photos, but, unfortunately, many lack such data and, even when data are noted, one could wish for more precision. Thus, an Audubon’s Shearwater labeled “Costa Rica, April” could be from either the Caribbean or Pacific population (the latter, I would guess), which are good candidates for separate species. Poorer photos with data would be more valuable than great photos without. Many photos, especially of Pterodroma petrels and storm-petrels, are in hand and/or on land at the breeding grounds. While this should ensure correct species- or population-level identification, if such data are given, it is not so helpful for at-sea identification. I encourage those who submit photos for possible inclusion in such works to include date and location on all photos.

It is rare for a review these days to not pick nits and highlight errors, and this review is no exception. The following points, however, are noted with a view to improving an already high-quality work, should future editions be planned. Perhaps the most glaring omission is that of a labeled map of the world’s oceans and (relevant) islands, which would help greatly in interpreting the status and distribution sections.

The ethnocentric British bias we have come to expect from the “... of the World” books is manifest such that the Pacific Ocean, home to more seabirds than any other area in the world, is given short shrift. Failure to read widely available North American literature (including a paper listed in the bibliography) has led to the perpetuation of certain identification errors: white axillar spurs are not diagnostic of the Magnificent Frigatebird (see Howell 1994; Birding 26:400–415); a white hindneck is not diagnostic of the White-necked versus Juan Fernandez Petrel (see Spear et al. 1992; Colonial Waterbirds 15:202–218); Kermadec Petrels can lack skualike white wing-flashes (Spear et al., op. cit.). Peruvian Pelicans range regularly to Ecuador, not simply...
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Peru. The distinctive eastern Pacific race granti (a candidate for species status!) of the Masked Booby is ignored in the text but shown in Figure 1, page 115. The text implies that both sexes of the eastern Pacific race breustleri of the Brown Booby have a whitish hood when only the male does, and sex-specific differences in bare-part colors of Brown Boobies are overlooked (a pair of breustleri is shown in Figure 4, page 116). I hope information for other areas of the world is better.

The unhelpful word “jizz” is often used as a convenient way to avoid describing features that have a structural basis; indeed, these days jizz seems increasingly to be used as a synonym for structure. The continued use of archaic terms such as “adult breeding” (arguably better than summer/winter) does little to help an understanding of molts and plumages and can be inherently misleading. For example, contrast the “breeding” and “nonbreeding” plumages of Xantus’ Murrelet with the photo of Craveri’s Murrelet, which lacks any seasonal modifier.

Few photographic bird guides are free from misidentified or mislabeled photos, and this one is no exception. I found the following on a quick scan through, and I imagine there are others. Figure 3 (page 39) is a Southern not Northern Giant-Petrel; Figure 5 (page 53) is a Juan Fernandez Petrel not a De Filippi’s (in fact, the same photo, with different cropping, is used on page 59 for a Juan Fernandez); Figure 12 (page 117) is a Double-crested Cormorant, not a Brandt’s; the upper (flying) bird in Figure 8 (page 137) is an immature Great Frigatebird, not a Magnificent. Figure 3 (page 33), labeled as a Shy Albatross, looks suspiciously like an immature Black-browed, but the photo size and quality are insufficient to confirm or deny this possibility.

Also, before readers of Western Birds panic and wonder if they missed something, captions for Figures 4 and 5 (page 55) are switched, and the dark-morph Herald Petrel was surely off “Atlantic coast, USA,” not Pacific!

These errors of commission and omission aside, I recommend Seabirds of the World as a very useful addition to the library of all interested in seabirds, and I commend both the author and photographic editor for bringing together this wealth of information in an attractive book.

Steve N. G. Howell


Co-published in the U.K. by Pica Press (which explains why the Parasitic Jaeger is called the Arctic Skua!), this excellent work treats the three jaegers and four skuas with an emphasis on identification. With 190 pages devoted to only seven species, an enviable level of detail has been included.

The well-written introduction includes brief sections on taxonomy, general characteristics (such as plumage polymorphism and kleptoparasitism), breeding behavior; age development and molt, skuas and man, observing skuas in the field; and an explanation of the species accounts. Then follow 13 painted plates (12 in color), the species accounts which comprise the bulk of the book, a selection of color photographs, an extensive bibliography, and the index.

Unlike almost all other books in the Pica et al. “... of the World” series, the introduction includes frequent citations of data to source and I hope this trend is continued by future authors. Occasional lapses in citations, such as some that might have benefitted the introductory paragraph on taxonomy, are annoying, but it is all too easy to assume, albeit wrongly, that one’s readers have an equal grasp of the subject. A minor gripe is that the introduction’s “organization” results in redundant repetition,
BOOK REVIEWS

e.g., pages 16–19 where the discussion of lemmings and the breeding of Pomarine Jaeger is covered three times when once would do. It is good to see in the explanation of the species accounts that measurements such as "wing length" are defined, and to learn that the plates portray individual plumages rather than an amalgam that may, or may not, represent a typical plumage.

The excellent color plates are attractive and well laid out, and the facing-page captions provide succinct species-specific identification criteria (extracting such information from the lengthy species accounts is far harder), although they would benefit from noting the (approximate) date of the plumages portrayed. Most illustrations are of flying birds, with only one plate (juveniles) of standing birds and no paintings of birds on the water, reflecting a not unsurprising European bias; jaegers along and off the Pacific coast of the Americas are seen far more often at rest on the water than on shore and thus present a somewhat different slant to identification. A surprising absence from the plates is any Brown or South Polar Skua hybrid, presumably not a rare product of pairings in the Antarctic Peninsula and certainly an identification nightmare.

The species accounts include extensive sections on field identification, molt, plumage descriptions of all ages/morphs, geographic variation, biometrics, and migration and wintering, with shorter discussions of voice, food, and breeding. Accounts range from 7 pages for the Chilean Skua (with 9 black-and-white photos and a full-page range map) to 21 pages for Parasitic Jaeger (with 29 black-and-white photos, 3 black-and-white figures—including one showing six morphs of adults, and a full-page map).

The high level of detail in the species accounts is, except for molt (see below), likely to tell you all you want to know (and more!). There is, however, much repetition among the field identification, molt, and detailed description sections, such that a different format might have saved a few pages over the book’s length and perhaps increased the user-friendly nature of the text. The many black-and-white photos scattered through the species accounts are good to excellent in quality, and I congratulate the authors for including location and date for apparently all photos. Oddly, the captions appear to have been written for color reproduction—note the frequent reference to cold and warm tones that are not apparent in black and white. The book’s European bias is again manifest by the lack of any photos of juvenile Brown or Chilean skuas and only two (presumed) immature South Polar Skuas. The obverse of this is that these real or apparent gaps can be seen and, one hopes, addressed by photographers.

The relatively large-scale range maps are a plus, although the Americas, in particular the eastern Pacific Ocean, seem (as in all European-spawned seabird books) to be the subject of some confusion: I would have thought the "main" non-breeding range of the Pomarine Jaeger should extend north to western Mexico, and I am unaware of any conclusive records of Brown Skua from the west coast of South America. The text for Brown Skua mentions two vagrants from Brazil (not shown on the map), and I suspect the vagrant Great Skua plotted for Nicaragua should instead be from Belize.

My only serious complaint is that the authors missed an important opportunity to elucidate upon the molts of jaegers and skuas rather than to confuse the issue further with inappropriate use of "summer" and "winter" terminology. In this case, the northern European penchant for detail runs into an almost impenetrable mass of trees that do not emerge as a forest. Want of data (with which I sympathize) is certainly one factor, but the problem is compounded by trying to fit what undoubtedly are very complex molt patterns into an unsuitable terminology. The authors also seem wrongly to equate "first summer" with "first alternate," as in the Long-tailed Jaeger, for which they note (p. 154) "probably some head and mantle feathers are molted again during
BOOK REVIEWS

spring,” followed by the potentially contradictory “molts directly from first-winter to second-winter.” Is there a first-alternate plumage in the first summer? Are there three cycles of (at least some) body feather replacement by the end of a bird’s first summer (as in gulls)—in which case the authors’ first-winter/first-summer jaegers are, in fact, first-winter/first-summer/second-winter birds! It appears that the Long-tailed Jaeger has a protracted complete first prebasic molt so that the “first-winter” plumage is attained over the first summer and that there may be no first alternate plumage, at least in the first summer. It seems unlikely to me that the remiges would be molted again within a few months of having been replaced (e.g., most gulls do not do this, although certain terns do, in part); rather, it seems possible that a partial (first prealternate?) molt in the second winter could produce the first alternate plumage worn through the second summer and in which birds are seen on the breeding grounds. Subsequent molts would be expected to follow the adult cycle but perhaps averaging slightly earlier for a year or two. A corollary of all this is that the age-labels for several photos may be in error, pending a clarification of the molt of Long-tailed Jaeger: Figure 112 looks like a juvenile (and note the confusing caption), Figures 113, 114, and 126 could be variations of first-alternate plumage (“second-summer” birds), and Figures 124 and 125 could be first basic plumage. Simple bar-chart diagrams showing when various tracts (especially the flight feathers) are replaced would help cut through the confusion generated by the detailed but dispersed text on molt and highlight where critical study is still needed. Confused? I’ll stop here, but similar problems exist for molt in the other jaegers, and then there are the skuas...

Editing overall seems good and typos rare, although on the diagrams of skua topography the line to the bill’s “cutting edge” (tomium, I presume) instead points at the culmen. The design is attractive but following on from columns on one page to the opposite page is unconventional—bottom to top rather than sequential left to right (e.g., see pages 132/133).

Beside the molt dilemma (which is very much a “work in progress”), these are all minor gripes in a remarkable work that sets a new standard in terms of field identification texts. In short, this is one of the best books I have seen in a long time and I recommend it to all west-coast birders whose gaze or thoughts veer away from the confines of land.

Steve N. G. Howell
FEATURED PHOTO

This feature new to Western Birds aims to illustrate and discuss subjects of interest to field ornithologists, using unpublished material whenever possible. It is not a “photo quiz” but, rather, will use good-quality photos to explore topics including (but not limited to) individual plumage variation, molt, geographic variation, hybrids, aberrant plumages, and behavior. We welcome contributions from readers. Please send material for possible inclusion to Robert A. Hamilton, P. O. Box 961, Trabuco Canyon, California 92678; e-mail robbham@flash.net.

TAIL-PATTERN VARIATION
IN FIRST-YEAR HERRING GULLS

STEVE N. G. HOWELL and JON R. KING, Point Reyes Bird Observatory, 4990 Shoreline Highway, Stinson Beach, California 94970

As is often mentioned, a key to good field birding is to become thoroughly familiar with variation in common species. Large gulls, with their inherent plumage variability and propensity to interbreed, provide almost limitless potential for observation and learning. How many of us can say we really look that hard at one of the most widespread North American gulls, the Herring Gull (Larus argentatus)?

To identify any gull, a critical first step is to determine its age. Large “brown” gulls, such as the one shown on the back cover, can generally be considered safely as first-year birds. (The specifics of gull molts and plumage sequence, even for common species, are not well understood, so “first year” is a safe if imprecise term.) Features that, in combination, point to a first-year Herring Gull are contrasting pale panel or “window” on the inner primaries, the size and shape of the black-tipped pink bill, and the effect of a “clean-cut” whitish head. Most birders, if they take the time to look at immature gulls, tend to walk way after an identification has been made to the level of species, but this is the point at which things can become even more interesting.

Tail pattern can be a critical species-level identification feature for immature gulls, but only if we understand the variation within any given taxon (species or subspecies). Ask any of the best birders in North America (or Europe) the following and see what happens: “How variable is the tail pattern in first-year Herring Gulls of the North American subspecies smithsonianus?”

In his seminal work, Grant (1986) noted that smithsonianus Herring Gulls have an “almost wholly uniform dark tail,” and this seems to have been accepted, with little comment, as conventional wisdom. Thus, writing recently in a comparison to European forms of the Herring Gull, Dubois (1997) repeated this belief: “Probably the best feature to consider when identifying first-winter smithsonianus is the tail. This appears all-dark, only the outermost feathers showing fine white notches at very close range (and brownish ones at the base of the outer tail feathers, visible usually only in the hand).”

Many first-year smithsonianus do indeed show this pattern, but many, like the one in this issue’s Featured Photo, show a quite different tail pattern, one more reminiscent of the typical, banded pattern of a first-year Thayer’s Gull (L. [glaucoides?] thayeri). When we first noted Herring Gulls with this “banded” tail pattern (spring
migrants at Bolinas Lagoon, Marin County, California), we wondered if they might be of a subspecies other than smithsonianus, perhaps the Siberian form vegae. Continued observations, in both California and New England, plus examination of museum specimens, showed the “banded” tail pattern to be quite frequent in smithsonianus Herring Gulls. Interestingly, a specimen of vegae collected in Japan shows a very similar tail pattern. Most vegae, however, appear to have a largely white tail with a narrow blackish distal band.

The Herring Gull featured on the back cover was off Monterey, California, on 24 May 1997; we thank Debra Shearwater for her willingness to stop the boat and Steven R. Emmons for his willingness to photograph “just a Herring Gull.” We also thank Chris Corben, whose insights and photos have been pivotal to our learning about Herring Gulls, and the staff of the Ornithology Department, American Museum of Natural History, New York, for permission to examine specimens in their care. This note benefited from the comments of Dave Shuford. This is contribution 753 of the Point Reyes Bird Observatory.

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WESTERN BIRDS

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The California Bird Records Committee of Western Field Ornithologists recently revised its 10-column Field List of California Birds (June 1996). The last list covered 578 accepted species; the new list covers 592 species. Please send orders to WFO, c/o Dori Myers, Treasurer, 6011 Saddletree Lane, Yorba Linda, CA 92886. California addresses please add 7.75% sales tax.

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Cover photo by © Ronald M. Saldino of El Cajon, California: Violet-crowned Hummingbird (Amazilia violiceps), Carlsbad, California, November, 1996.

Western Birds solicits papers that are both useful to and understandable by amateur field ornithologists and also contribute significantly to scientific literature. The journal welcomes contributions from both professionals and amateurs. Appropriate topics include distribution, migration, status, identification, geographic variation, conservation, behavior, ecology, population dynamics, habitat requirements, the effects of pollution, and techniques for censusing, sound recording, and photographing birds in the field. Papers of general interest will be considered regardless of their geographic origin, but particularly desired are reports of studies done in or bearing on the Rocky Mountain and Pacific states and provinces, including Alaska and Hawaii, western Texas, northwestern Mexico, and the northeastern Pacific Ocean.

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BIRDS OF THE MAD RIVER RANGER DISTRICT, SIX RIVERS NATIONAL FOREST, CALIFORNIA

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The Mad River Ranger District (MRRD) of the Six Rivers National Forest (SRNF) is located in northwestern California (Figure 1). We compiled data on the status and distribution of the birds of this area for three primary reasons. First, except for collecting trips to South Fork Mountain and nearby areas in the 1930s (Grinnell and Miller 1944), this area has been little studied (Harris 1996). While the MRRD was included by Harris (1991, 1996), we sought to provide more detailed information for a unique area. Second, we hoped to provide resource managers and others with local status and distribution data. Much of our data has been gleaned from obscure sources not generally accessible to most workers. While more detailed distribution and life history data are needed for most species, this report can serve as a starting point for further management considerations and research. Third, while the MRRD contains several noteworthy birding areas in Humboldt (e.g., Mount Lassie and Blake Mountain) and Trinity (e.g., Ruth Lake, Hettenshaw Valley, and Ant Point) counties, the isolation of this area relative to population centers has resulted in relatively little recreational birdwatching to date. We hope this report will stimulate others to explore the MRRD and other portions of interior northwestern California.

STUDY AREA

We included all areas within the administrative boundaries of the MRRD, including private inholdings. The 113,000-ha MRRD lies primarily within southwestern Trinity County, with some portions extending into southeastern Humboldt County (Figure 1). The climate and vegetation of the MRRD exhibit characteristics of both the humid coastal belt and the more arid interior of northwestern California. Miller (1951) noted that the moisture
gradient near the Humboldt–Trinity county line has played an important role in the distribution of the birds of this region. The avifauna of the MRRD reflects the transitional nature of this area from the conifer-dominated Klamath Mountains to the oak (Quercus spp.), brush, and grassland-dominated habitats of interior central California. Physiographically, the MRRD generally falls in the High and Inner North Coast Ranges Districts of Hickman (1993), while the remainder of the SRNF lies to the north in the Klamath Ranges.
Except for flat areas in valleys, the topography is moderate to steep. Elevations range from 440 m along the lower North Fork Eel River to 1850 m at Horse Ridge. Regionally important waterways originating within the MRRD are the Mad, the North Fork Eel, and the Van Duzen rivers (Figure 1). The entire eastern boundary of the MRRD is formed by the extensive ridge known as South Fork Mountain. The climate of the MRRD is characterized by hot, dry summers and cold, wet winters. The summer dry season is not moderated by coastal fog, and summer showers are infrequent and short. Average annual precipitation varies from about 125 cm at the lower elevations to 200 cm at the higher elevations. Moderate to heavy snow can fall above 600 m elevation, and sometimes persists into June above 1200 m.

About 60% of the MRRD is covered with Douglas-fir (Pseudotsuga menziesii) forests in many successional stages resulting from natural disturbances and intensive timber harvest (USDA 1995a). Other conifer species such as pines (Pinus spp.) and White Fir (Abies concolor) also may be present in the overstory. The midstory may be dominated by conifers or hardwoods including Tanoak (Lithocarpus densiflora), Pacific Madrone (Arbutus menziesii), or California Black Oak (Q. kelloggi). True firs (Abies spp.) cover about 12% of the MRRD; White Fir (A. concolor) becomes prevalent above 1500 m, and some stands of Red Fir (A. magnifica) occur at the highest elevations. About 23% of the conifer forests can be characterized as late mature and old growth with dominant conifers >53 cm diameter at breast height. Oregon White Oak (Q. garryana) and California Black Oak woodlands and annual grasslands occupy about 17 and 6% of the MRRD, respectively.

About 5% of the MRRD consists of miscellaneous cover types. Near Mount Lassic, stands of open-canopy Jeffrey Pine (P. jeffreyi) woodlands are found. Most riparian habitats consist of narrow bands along perennial streams and rivers that are dominated by Red Alder (Alnus rubra). The banks of the upper Mad River support remnant stands of Black Cottonwood (Populus trichocarpa) and willow (Salix spp.) habitats. Other riparian species of the MRRD include the Bigleaf Maple (Acer macrophyllum) and Oregon Ash (Fraxinus latifolia). Chaparral habitats consist of mixtures of ceanothus (Ceanothus spp.), manzanita (Arctostaphylos spp.), mountain mahogany (Cercocarpus spp.), Brewer’s Oak (Q. g. breweri), and other brush species, and are most conspicuous in the southern portion of the MRRD. Chamise (Adenostoma fasciculatum) is known only from a single location near the confluence of Hoaglin and Salt creeks. Ruth Lake (445 ha when full) was formed by a dam on the Mad River in 1962 and provides the only open-water habitat. Ruth Lake is steep-sided and has very little emergent vegetation. Exposed mudflats appear at the south end of the lake as water levels recede in the late summer and fall. Fields and pastures occur in a few locations such as Hettenshaw Valley. Commercial buildings, human dwellings, and outbuildings are found primarily near the community of Mad River along the lower Van Duzen River and the community of Ruth along the upper Mad River. Hunter et al. (1997) and USDA (1995a, 1995b) provided more detailed information on the MRRD.
METHODS

Much of our data resulted from our personal fieldwork in the MRRD and information solicited from other observers. We also consulted the SRNF bird-sightings database, which contained anecdotal sightings starting in 1967 that were submitted by Forest Service employees and forest visitors. We also used other unpublished administrative studies and miscellaneous files located at the SRNF supervisor’s office in Eureka. As part of another study (Hunter et al. 1997), 5563 point counts were conducted at 189 random sites in late mature and old-growth Douglas-fir (mean 29 counts/site) between late April and early August during 1995 and 1996. Each point count lasted 10 minutes and all individuals detected were tallied. Peregrine Falcon prey remains were collected from nest sites within the MRRD and were identified by N. John Schmitt of the Western Foundation of Vertebrate Zoology. We also include some previously published records from American Birds (AB), National Audubon Society Field Notes (NASFN), Harris (1991, 1996) and other sources.

We used the following terms to describe the status of a species: Resident—present throughout the year, although turnover of individuals or populations (including subspecies) may occur. Transient—occurs during migration or dispersal; modified by season if abundances differ. Breeder—breeding has been confirmed, unless prefixed by “probable” or “possible.” Determination of breeding status (i.e., confirmed, probable, or possible) generally follows criteria used by Roberson and Tenney (1993). Visitor—present during only part of the year, not including migration or dispersal; modified by season if abundances differ. More than one term may be used to describe a species, e.g., some individuals of a species may be resident while others are transient. Abundance estimates assume reasonable effort by a competent observer in appropriate habitat and proper season during a 24-hour period. Abundant—always present, usually encountered in very large (>500) numbers. Common—always present, usually encountered in large (100–500) numbers. Fairly common—always present, usually encountered in small (10–100) numbers. Uncommon—usually present, usually encountered in very small (<10) numbers. Rare—unlikely to be encountered, and only in very small (<10) numbers. Casual—few records but reasonably expected again, unlikely to be encountered. Accidental—few records and very unpredictable, very unlikely to be encountered. Hypothetical—all reports are “unconfirmed.” We considered records from observers known by us to be competent, and records from other observers when accompanied by convincing details, as “confirmed.” All other reports were considered unconfirmed. Species for which all reports are from Peregrine Falcon prey remains were also considered hypothetical because falcons may forage long distances from nest sites. We chose not to exclude unconfirmed reports because doing so could preclude or delay detection of emerging patterns of bird distribution. Reports were not included, however, if available details were unconvincing.

All records are from Trinity County unless otherwise specified. When pertinent, we included some records from outside the MRRD; locations outside the MRRD are preceded by an asterisk (*). All locations mentioned can be found on U.S. Geological Survey 7½-minute quadrangles or on
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national forest visitor’s maps. Codes used for California counties are HUM, Humboldt; MEN, Mendocino; TRI, Trinity. Other abbreviations used are CG, Campground; Cr., Creek; FS, Forest Service; Hwy., Highway; HSUM, Humboldt State University Museum; L., Lake; Mt., Mount; Mtn., Mountain; MVZ, Museum of Vertebrate Zoology, Berkeley; Pt., Point; Rch., Ranch; Rdg., Ridge; R., River; Rd., Road; V., Valley. The cutoff date for records included in this compilation was 31 December 1997.

ANNOTATED LIST


Pied-billed Grebe (Podilymbus podiceps). Rare summer visitor and casual breeder at Ruth L., uncommon in winter. An adult with a downy young was seen 17 Aug 1994 (JH, KS).


Western Grebe (Aechmophorus occidentalis). Rare fall transient and winter visitor at Ruth L. High count was six on 27 Nov 1995 (JH).


Double-crested Cormorant (Phalacrocorax auritus). Casual summer visitor, uncommon winter visitor at Ruth L. Immatures seem to predominate; four immatures were seen 9 Sep 1995 (JH, GH).


Great Egret (Ardea alba). Uncommon fall transient at Ruth L. High count was 11 on 9 Sep 1995 (JH, GH).

Green Heron (Butorides virescens). Rare summer visitor at Ruth L. and along rivers. Probable breeder on the basis of apparent pairs seen at Ruth L. 10 Jul 1979 (JMB) and 12 Aug 1995 (JH).

Turkey Vulture (Cathartes aura). Uncommon summer visitor and possible breeder. Casual in winter; three were near the Mad R. Ranger Station 25 Feb 1979 (JMB). Breeding status unclear because of lack of breeding evidence.


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Wood Duck (Aix sponsa). Uncommon resident and breeder, increasing to fairly common in fall at Ruth L.

Green-winged Teal (Anas crecca). Uncommon fall transient, rare spring transient and winter visitor at Ruth L.

Mallard (Anas platyrhynchos). Common transient, uncommon resident and breeder at Ruth L. and other locations such as the Mad R. and Hettenshaw V.

Northern Pintail (Anas acuta). Rare fall transient at Ruth L. High count was four on 26 Oct 1994 (JH).

Cinnamon Teal (Anas cyanoptera). Casual fall transient at Ruth L. High count was 20 on 23 Oct 1978 (RE).

Northern Shoveler (Anas clypeata). Casual to rare fall transient at Ruth L. High count was 14 on 1 Oct 1979 (JR).

American Wigeon (Anas americana). Casual to rare fall transient at Ruth L. High count was eight on 27 Oct 1994 (JH).


Ring-necked Duck (Aythya collaris). Uncommon to fairly common transient and winter visitor at Ruth L. High count was 26 on 14 Dec 1996 (JH).

Greater Scaup (Aythya marila). Rare transient and casual winter visitor at Ruth L. High count was two on 9 Oct 1995 (JH, GS, TL).

Lesser Scaup (Aythya affinis). Fairly common transient and winter visitor at Ruth L. High count was 25 on 23 Nov 1996 (JH).


Barrow’s Goldeneye (Bucephala islandica). Accidental. One record, of a male at Ruth L., sometime in Dec 1993 (J. Ballard).


Hooded Merganser (Lophodytes cucullatus). Casual to rare fall and winter visitor. Two pairs seen along the Mad R. near the Mad R. CG 31 Jan 1989 (PU) and an independent hatch-year bird at Ruth L. 31 Jul 1995 (SM) suggest possible breeding.

Common Merganser (Mergus merganser). Fairly common resident and breeder along rivers and at Ruth L. A group of about 200 were seen foraging together on Ruth L. 27 Oct 1994 (JH; Harris 1996).


Ruddy Duck (Oxyura jamaicensis). Uncommon winter visitor at Ruth L. High count was 40 on 21 Jan 1979 (JMB).

Osprey (Pandion haliaetus). Uncommon breeder and rare winter visitor at Ruth L. and along rivers.

Bald Eagle (Haliaetus leucocephalus). Rare resident and breeder at Ruth L., where a pair usually nests near Marshall Rock. Increases to uncommon in winter along the Mad R., at Ruth L., Soldier Basin, and other locations. Unconfirmed reports of breeding at Soldier Basin in the mid-1960s (Tompkins). High count was six at Ruth L. 26 Feb–11 Apr 1979 (JMB).
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Sharp-shinned Hawk (Accipiter striatus). Uncommon transient and winter visitor; rare resident and breeder.

Cooper’s Hawk (Accipiter cooperi). Uncommon transient and winter visitor; rare resident and breeder.

Northern Goshawk (Accipiter gentilis). Rare resident and breeder. There are a minimum of 17 active territories in the MRRD, and the SRNF bird-sightings database has 188 records starting in 1971, with 23 from 1995–96. The abundance of this species in the MRRD is higher than on the remainder of the SRNF; where surveys in 1994–95 were unable to find any active nesting territories (K. Schmidt, SRNF, unpubl. data).

Red-shouldered Hawk (Buteo lineatus). Casual fall transient. One was near Ruth 2 Jul–12 Oct 1996 (EE, GH et al.). Unconfirmed report of one near Ruth 20 Dec (no year; JMB).

Swainson’s Hawk (Buteo swainsoni). Hypothetical. Three unconfirmed reports, of one east of Kettenpom V. 21 Jul 1980 (KO), one about 3 km northeast of Pine Mtn. 9 Sep 1980 (B. Horn), and one at Ruth L. 7 Oct 1979 (JMB).

Red-tailed Hawk (Buteo jamaicensis). Fairly common transient, resident, and breeder.


Rough-legged Hawk (Buteo lagopus). Casual fall transient and winter visitor. Three records, of a well-described bird at Hettenshaw V. 6 Nov 1986 (RM), one near Mad R. CG 14 Dec 1996 (JH), and one at Hettenshaw V. 26 Dec 1997 (JH, J. Booker).


American Kestrel (Falco sparverius). Uncommon resident and breeder; numbers decrease slightly in winter. Grinnell (1933) described one eating a Hermit Warbler 13 km southeast of Ruth 23 May 1933.


Peregrine Falcon (Falco peregrinus). Rare transient, resident, and breeder. At least some breeders probably overwinter, as suggested by an adult F. p. anatum within a nesting territory in Nov 1983 and Jan 1984 (B. Woodbridge).

Prairie Falcon (Falco mexicanus). Casual fall transient and winter visitor. Three of the five records are of single birds at Hettenshaw V. 10 Jan 1981 (BG, JR), 27 Aug 1981 (JR, RM), and 25–26 Oct 1979 (RE, JR). References in unpublished SRNF files suggest breeding in the MRRD but we could find no specific information.

Ruffed Grouse (Bonasa umbellus). Status unclear, probably a rare resident and breeder. There are two records of single birds from near Buck Mtn., HUM, 25 Apr–18 May 1995 (JP) and 25 May 1990 (G. Reid, W. Forsberg), and one near Pilot Cr.,
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HUM, 23 May 1992 (GS). Also a cluster of records just northwest of the MRRD, including one near *Lake Mtn. Rch. 7 Jun 1995 (K. Nelson), another at *Big Slide CG 17 Jun 1996 (M. Maxwell), and an adult with a juvenile along *Grapevine Cr. 2 Aug 1975 (KL). West of the MRRD, Grinnell and Miller (1944) mentioned juveniles 6 km northeast of *Bridgeville, HUM, 2 Jul 1926, and Yocom (1978) indicated two records from near *Alderpoint, HUM, sometime in 1973.


Wild Turkey (*Meleagris gallopavo). Rare resident and breeder. First release in the area was of 28 M. g. merriami from San Luis Obispo County on 23 Dec 1963 near *Indian Dick Guard Station (USFS 1967). First birds in the MRRD, presumably from this release, were seen near Red Mtn. in Sep 1966. Many subsequent releases in the MRRD, including 12 more M. g. merriami at Eightmile Rdg., HUM, 6 Nov 1971, 60–100 M. g. silvestris to the Salt Cr. and West Fork Van Duzen R. areas, and an unknown number of wild M. g. silvestris from Pennsylvania to Boles Opening 24 Jan 1992. An unknown number of M. g. gallopavo were released somewhere in the area in 1967. First confirmed reproduction in the MRRD was of three or four young seen on Henry Rdg., HUM, 12 Jul 1972 (B. German).

California Quail (*Callipepla californica). Fairly common resident and breeder.

Mountain Quail (*Oreortyx pictus). Fairly common resident and breeder.

Sora (*Porzana carolina). Hypothetical. One record as prey remains collected from a Peregrine Falcon eyrie in the spring of 1980.

American Coot (*Fulica americana). Common winter visitor at Ruth L. No summer records for the MRRD, but four were in a pond west of *Zenia 21 Jun 1996 (EE), two were in a pond near *Lake Mtn. Rch. 22 Jul 1995 (B. Baker), and adults and young were on *Howard L., MEN, 13 Jul 1995 (GH, JH).

Killdeer (*Charadrius vociferus). Uncommon to fairly common resident and breeder.

Mountain Plover (*Charadrius montanus). Hypothetical. One record as prey remains collected from a Peregrine Falcon eyrie in the spring of 1992. There are no other reports of this species from inland northwestern California.

Greater Yellowlegs (*Tringa melanoleuca). Rare fall and casual spring transient at the south end of Ruth L. and along the upper Mad R. Earliest fall record 2 Jul 1996 (JH), latest 2 Oct 1996 (JH, GH). One was reported flying over Ant Pt. 16 Jul 1995 (EE). High count was two on 12 Jul 1996 (SM). One spring record, of one near Ruth 7 May 1995 (SM).


Wandering Tattler (*Heteroscelus incanus). Hypothetical. One record as prey remains collected at a Peregrine Falcon eyrie in the spring of 1990.

Spotted Sandpiper (*Actitis macularia). Rare resident, increasing to uncommon in summer as a breeder.


Least Sandpiper (Calidris minutila). Rare fall transient at the south end of Ruth L. Encountered slightly more often and in slightly larger numbers than the Western Sandpiper. Earliest fall record 10 Jul 1995 (GH), latest 23 Sep 1996 (JH, JS, TL). High count was 12 near Sandy Pt. 16 Jul 1995 (EE, SM; Harris 1996).

Pectoral Sandpiper (Calidris melanotos). Accidental. One record, of three at the south end of Ruth L. 12 Oct 1996 (GH, JH). At least one, presumably from the same group, was still present 19 Oct 1996 (GH).

Long-billed Dowitcher (Limnodromus scolopaceus). Casual fall transient at the south end of Ruth L. Two confirmed records, of birds present 17–31 Jul 1995 (GH, EE, JH) with a high count of four on 19 Jul 1995 (GH), and two on 23 Jul 1996 (SM). Limnodromus sp. remains were also collected at a Peregrine Falcon eyrie in the spring of 1982.


California Gull (Larus californicus). Casual to rare transient at Ruth L. Five records. High count was seven on 16 Jul 1995 (EE, SM). Six records as Peregrine Falcon prey remains.

Caspian Tern (Sterna caspia). Casual transient. Four records, of one at Ruth L. 15 Jun 1996 (KRD, KLD), a nighttime flyover of calling adults and hatch-year birds near Zenia 26 Jun 1995 (EE, SM, GH), five at Ruth L. 29 Jun 1990 (S. Rovell, PU), and another at Ruth L. 2 Sep 1996 (GH).

Rock Dove (Columba livia). Casual, but it is unclear if any records represent wild birds. Numerous records as Peregrine Falcon prey remains, many of which were banded. “Feral pigeons” were reported roosting near Mad R. Rock 16 Jun 1978 (A), and at some point there was apparently a pigeon owner along Van Duzen R. Rd. (A). One was seen along the roadside about 2 km south of Blake Summit, HUM, 7 May 1994 (GS).

Band-tailed Pigeon (Columba fasciata). Uncommon summer visitor and probable breeder, rare in winter. About 1000 birds were seen feeding on Blue Elderberry (Sambucus cerulea) in the Blake Mtn. burn, HUM, 26 Oct 1995 (GS).

Mourning Dove (Zenaida macroura). Fairly common summer visitor and breeder, rare in winter.

Greater Roadrunner (Geococcyx californianus). Status unclear, but probably a casual visitor. Eight records of single birds, Travis Rch. 11 Apr 1978 (LU), Travis Rch. 30 Apr 1979 (LU), one “cooing” near Willie Hoaglin Place 6 May 1980 (CF), near Double A Rch. 2 Aug 1978 (L. Evans et al.), near Russ Place 8 Aug 1978 (J. Kahl), near Ruth 8 Sep 1980 (D. Browning), south of Ruth 10 Sep 1970 (Kennedy; Yocom and Harris 1975), and at Duncan Rch. Rd. 29 Feb (no year; CF). Harris (1991) mentions other nearby locations.
Barn Owl (Tyto alba). Status unclear, but probably a rare resident and breeder. Two records. Two were well described roosting and foraging just north of the MRRD near the headwaters of "Last Chance Cr., HUM, 29–30 Jun 1979, and there were apparently inactive Barn Owl nests nearby in large Douglas-fir trees (T. Mull). One was seen about 10 km southeast of there in the Blake Mtn. burn, HUM, 30 Oct 1996 (GS).


Western Screech-Owl (Otus kennicottii). Uncommon resident and breeder.

Great Horned Owl (Bubo virginianus). Rare resident and breeder.

Snowy Owl (Nyctea scandiaca). Hypothetical. One unconfirmed report from the "upper end of Ruth Lake–Marshall Rock area, feeding on jackrabbits," only other details are "mid-Jan" (Branmum).

Northern Pygmy-Owl (Glaucidium gnoma). Uncommon resident and breeder.

Burrowing Owl (Athene cunicularia). Casual fall transient. Two records, of one seen foraging on grasshoppers (Acrididae) near High Salt Ground on Whiting Rdg., HUM, 15 Jul 1996 (CO), and another seen foraging about 2 km from Hwy. 36 along FS Route 1 on 30 Oct 1996 (GS).

Spotted Owl (Strix occidentalis). Uncommon resident and breeder. During any given year there are an estimated 70 occupied territories in the MRRD.

Barred Owl (Strix varia). Casual in summer and probable breeder; winter status unclear. An individual was reported near Lynch Cr. 25 Apr–15 Sep 1988 and 17 Apr–13 Jun 1989 (PU, J. Gonzales, K. Sanchez et al; AB 43:1364). A Spotted Owl with an aberrant five-note call was found there 20 Jun 1995 (JH). We are unclear if the report of this species about 8 km away near Round Mtn. 13 Jun 1989 (J. Harris, W. Forsberg) refers to the Lynch Cr. territory. There is another, unconfirmed report of a Barred Owl near Torrey Rdg., HUM, 27 Jul 1992 (L. Arsenault, M. Maier). There are also records near *Lake Mtn. Rch. 12 May 1992 (DF, A. Franklin) and 31 May 1995 (K. Baker).

Long-eared Owl (Asio otus). Rare summer visitor. Probable breeder on the basis of a pair at Blake Summit, HUM, 31 Jul 1976 (RAE, TS) and a vocal pair there 2–15 Sep 1993 (GS, KS, JH).

Northern Saw-whet Owl (Aegolius acadicus). Uncommon summer visitor and probable breeder. Probable resident, although winter status unclear because of lack of records.


Common Poorwill (Phalaenoptilus nuttallii). Rare summer visitor and probable breeder. Earliest spring record is of a roadkill near Ruth L. 18 Apr 1981 (JMB); latest fall record is from Last Chance Rdg. 30 Sep 1993 (GS, KS). Most apparent in the Swim Rdg. and Van Horn Rdg. areas. Casual in the Black Lassic area, HUM and TRI, where the most recent record is of four on 8 Jun 1986 (PS).

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Vaux’s Swift (Chaetura vauxi). Uncommon transient; casual to rare in summer; possible breeder. The only detection during point counts was of one 2 km southwest of Mt. Lassic, HUM, 22 Jun 1995 (EE).

Black-chinned Hummingbird (Archilochus alexandri). Hypothetical. Three unconfirmed reports of single birds, a male at the end of FS road 2S16D 31 May 1994 (JP), another male on the Duncan Rch. 11 Jun 1997 (JP), and a bird at a feeder at the Mad R. Ranger Station 2 Sep 1979 (JR).

Anna’s Hummingbird (Calypte anna). Uncommon resident and breeder, rare in winter.

Calliope Hummingbird (Stellula calliope). Casual spring transient; breeding status unclear. Grinnell and Miller (1944) indicated breeding on South Fork Mtn.; there are four specimens at MVZ that were collected there May–Jun during the early 1930s, including a hatch-year bird taken 21 Jun 1930 (JG; MVZ 56286). Four recent sight records, of a male displaying to a female in willows along Van Horn Cr. 13 Apr 1978 (JB, GL), two south of Blake Summit, TRI, 4 Jun 1972 (S. Summers, R. Willmarth), one near Mt. Lassic, HUM, 9 Jun 1984 (JS, L. Doerflinger et al.), and a pair copulating along *Olsen Cr. near Hyampom 16 Jun 1983 (RAE; AB 37:1024).

Rufous Hummingbird (Selasphorus rufus). Rare transient. We assume that the six males seen at Ant Pt. 3 Jul 1981 (PS, Kl; Harris 1991) were early fall migrants.

Allen’s Hummingbird (Selasphorus sasin). Uncommon transient, summer visitor, and probable breeder. A male was seen chasing a female that was visiting a probable nest site near Red Lassic 13 Jun 1996 (JH).

Belted Kingfisher (Ceryle alcyon). Uncommon resident and breeder.

Lewis’s Woodpecker (Melanerpes lewis). Uncommon fall transient and casual in winter, although not detected in some years. High count was about 20 in the Blake Mtn. burn, HUM, 15 Sep 1993 (GS, JH).

Acorn Woodpecker (Melanerpes formicivorus). Fairly common resident and breeder.

Red-breasted Sapsucker (Sphyrapicus ruber). Fairly common resident and breeder. Detected during point counts at 38.1% of the sites.

Williamson’s Sapsucker (Sphyrapicus thyroideus). Accidental. Two records, both of single females, one on Blake Summit, HUM, 15–16 Sep 1993 (JH, GS; AB 48:149), and one on the west slope of Black Lassic, HUM, 1 Nov 1990 (GSL; AB 45:148).

Downy Woodpecker (Picoides pubescens). Uncommon resident and breeder.

Hairy Woodpecker (Picoides villosus). Fairly common resident and breeder.

White-headed Woodpecker (Picoides albolarvatus). Uncommon resident and breeder.


Northern Flicker (Colaptes auratus). Fairly common to common resident and breeder. Detected during point counts at 95.2% of the sites. A Yellow-shafted Flicker (C. a. luteus) was seen on Blake Mtn., HUM, 9 Sep 1993 (GS).

Pileated Woodpecker (Dryocopus pileatus). Uncommon resident and breeder.

Olive-sided Flycatcher (Contopus cooperi). Fairly common summer visitor and breeder.
Western Wood-Pewee (*Contopus sordidulus*). Fairly common summer visitor and breeder.


Hammond’s Flycatcher (*Empidonax hammondii*). Uncommon summer visitor and breeder.

Dusky Flycatcher (*Empidonax oberholseri*). Fairly common summer visitor and breeder.

Gray Flycatcher (*Empidonax wrightii*). Casual spring transient. One record, of one about 2 km northwest of North Kelsey Peak 10 May 1995 (SM).

Pacific-slope Flycatcher (*Empidonax difficilis*). Fairly common transient, summer visitor, and breeder.

Black Phoebe (*Sayornis nigricans*). Uncommon resident and breeder.

Say’s Phoebe (*Sayornis saya*). Casual transient. Six records, 1 for Feb, 2 for Mar, 1 for Sep, and 2 for Oct. High count was two on 23 Sep 1996 when one was at Hettenshaw V. and another was near Brown’s Camp (JS, TL, JH).

Ash-throated Flycatcher (*Myiarchus cinerascens*). Uncommon summer visitor and breeder.

Western Kingbird (*Tyrannus verticalis*). Fairly common summer visitor and breeder.


Cassin’s Vireo (*Vireo cassini*). Fairly common transient, summer visitor, and breeder.

Hutton’s Vireo (*Vireo huttoni*). Fairly common resident and breeder.

Warbling Vireo (*Vireo gilvus*). Fairly common transient, summer visitor, and breeder.

Gray Jay (*Perisoreus canadensis*). Status unclear; no winter records. Seven records, of one on Blake Mtn., HUM, 6 May 1994 (GS), one about 2 km northeast of Waggit Spring 31 May 1996 (M. Beeve), one near Ruth L. 1 Jun 1979 (GL), two collected near Blake Summit, HUM, 24 Jun 1930 (JG; MVZ 56292-3), one on Blake Mtn, HUM, 2 Sep and 2 Oct 1993 (GS, KS), and one collected 16 km north of Ruth 3 Sep 1918 (H. Wilder; MVZ 29475).

Steller’s Jay (*Cyancitta stelleri*). Common resident and breeder. Very widespread, detected during point counts at 100% of the sites.

Western Scrub-Jay (*Aphelocoma californica*). Common resident and breeder. Because this species is typically found in the valleys, it was detected during point counts at only 7.9% of the sites.

Clark’s Nutcracker (*Nucifraga columbiana*). Casual transient. Four records, of one at Dan East trailhead, HUM, 16 Feb 1995 (CO), three near the Lassics 13 Jun 1988 (PS, VS; AB 42:1338), one on Blake Mtn., HUM, 17 Sep 1996 (GS), and two near Mt. Lassic, HUM and TRI, 1 Nov 1990 (GSL, L. Lester).

American Crow (*Corvus brachyrhynchos*). Uncommon resident and breeder. Because this species is typically found in the valleys, it was detected during point counts at only 6.3% of the sites.

Common Raven (*Corvus corax*). Fairly common resident and breeder. Detected during point counts at 85.7% of the sites.

Purple Martin (Progne subis). Casual transient, summer visitor, and possible breeder. Nine records. Earliest spring record is of six (high count) at Ruth L. 29 May 1996 (EE); latest fall record is of one near Oak Grove 31 Jul 1995 (JP). Other noteworthy records include two near Horse Rdg. 2 Jun 1996 (EE), one at *Dinsmore Airport, HUM, 20 Jun 1996 (GS), five at Black Lassic 23 Jun 1977 (D. Anderson), and one at Mt. Lassic, HUM, 23 Jun 1988 (RAE).

Tree Swallow (Tachycineta bicolor). Fairly common transient, summer visitor, and breeder.

Violet-green Swallow (Tachycineta thalassina). Uncommon transient, summer visitor, and breeder.

Northern Rough-winged Swallow (Stelgidopteryx serripennis). Fairly common transient, summer visitor, and breeder.

Barn Swallow (Hirundo rustica). Uncommon transient, summer visitor, and breeder.

Cliff Swallow (Petrochelidon pyrrhonota). Uncommon transient, summer visitor, and breeder.

Mountain Chickadee (Poecile gambeli). Common resident and breeder. Wanders to lower elevations (e.g., Ruth L.) in winter.

Chestnut-backed Chickadee (Poecile rufescens). Common resident and breeder.

Oak Titmouse (Baeolophus inornatus). Rare resident and breeder. Breeding first documented when two adults were seen at a nest with young near Mad R. Rock 27 May 1978 (RH).

Bushtit (Psaltriparus minimus). Fairly common resident and breeder.

Red-breasted Nuthatch (Sitta canadensis). Common resident and breeder.

White-breasted Nuthatch (Sitta carolinensis). Uncommon resident and breeder.

Brown Creeper (Certhia americana). Uncommon resident and breeder.

Rock Wren (Salpinctes obsoletus). Rare summer visitor and probable breeder; no winter records. Known only from the Hayden Roughs and Red Mtn. areas. High count eight at Red Mtn. 29 Jun 1996 (EE).

Canyon Wren (Catherpes mexicanus). Casual summer visitor and probable breeder; no winter records. Known only from Mad R. Rock where one was heard singing 8 May–24 Aug 1976 and 11 Jun 1978 (RH, EP et al.).

Bewick’s Wren (Thryomanes bewickii). Fairly common resident and breeder.

House Wren (Troglodytes aedon). Fairly common transient, summer visitor, and breeder.

Winter Wren (Troglodytes troglodytes). Uncommon transient, resident, and breeder.

American Dipper (Cinclus mexicanus). Rare resident, increasing to uncommon in summer as a breeder.

Blue-gray Gnatcatcher (Polioptila caerulea). Uncommon summer visitor and breeder; no winter records. Breeding first documented when adults were seen feeding young near Red Mtn. 12 Aug 1995 (JH).
Golden-crowned Kinglet (Regulus satrapa). Fairly common resident and breeder. Ruby-crowned Kinglet (Regulus calendula). Fairly common to common transient and winter visitor.

Western Bluebird (Sialia mexicana). Uncommon resident and breeder. More conspicuous in winter when flocks assemble in valleys.


Townsend’s Solitaire (Myadestes townsendi). Uncommon summer visitor and breeder; casual in winter.

Swainson’s Thrush (Catharus ustulatus). Rare fall transient, summer visitor, and possible breeder. Detected during only five point counts at five sites.

Hermit Thrush (Catharus guttatus). Uncommon winter visitor. Fairly common in summer as a breeder. Detected during point counts at 64.6% of the sites.

American Robin (Turdus migratorius). Common transient, resident, and breeder. Detected during point counts at 99.0% of the sites. Often abundant during fall and winter congregations.

Varied Thrush (Ixoreus naevius). Casual to rare resident and possible breeder; fairly common fall transient and winter visitor. Detected during only two point counts at two sites. High count was about 3000 birds in the Lassics area, HUM and TRI, 26 Oct 1994 (JH; NASFN 49:98).

Wrentit (Chamaea fasciata). Fairly common resident and breeder.

California Thrasher (Toxostoma redivivum). Rare resident and breeder. Most apparent in the Red Mtn. area, where six (high count) were seen 29 Jun 1996 (EE). Records from other locations include one northeast of Kettenpom V. 14 Jun 1996 (SM), and two in the chamise stands near the confluence of Hoaglin and Salt Creeks 17 Jun 1996 (EE), and two near Hayden Roughs 18 Jun 1995 (EE).

European Starling (Sturnus vulgaris). Fairly common to common transient, resident, and breeder.


American Pipit (Anthus rubescens). Common fall transient; uncommon winter visitor.

Cedar Waxwing (Bombycilla cedrorum). Casual to rare visitor and possible breeder; uncommon fall transient. High count was about 50 near the Ruth L. Marina 13 Jan 1979 (JMB).

Phainopepla (Phainopepla nitens). Hypothetical. What was possibly this species was reported at the south end of Ruth L. 23 Oct 1988 (RE). Reported as “Phainopepla (?) not verified. One individual seen flycatching over land, appears dark, white in wings.”

Orange-crowned Warbler (Vermivora celata). Uncommon transient, summer visitor, and breeder.

Nashville Warbler (Vermivora ruficapilla). Fairly common transient, summer visitor, and breeder.

Yellow Warbler (Dendroica petechia). Uncommon transient, summer visitor, and breeder.
Yellow-rumped Warbler (*Dendroica coronata*). Common transient, summer visitor, and breeder. Uncommon in winter. All reports that differentiated subspecies indicated *D. c. auduboni*.

Black-throated Gray Warbler (*Dendroica nigrescens*). Fairly common transient, summer visitor, and breeder.

Townsend’s Warbler (*Dendroica townsendi*). Uncommon transient; casual winter visitor. Summer status unclear. A male was well described about 4 km north of Rutledge Opening near Mad R. Rock 3 Jul 1996 (JP). Two other unconfirmed summer reports, of one seen on a point count 2 km southwest of Mt. Lassic, HUM, 8 Jun 1995 (M. Conrad) and one seen near Rutledge Opening 25 Jun 1996 (O. Williams).

Hermit Warbler (*Dendroica occidentalis*). Uncommon transient; common summer visitor and breeder.

MacGillivray’s Warbler (*Oporornis tolmiei*). Uncommon transient; fairly common summer visitor and breeder.

Common Yellowthroat (*Geothlypis trichas*). Uncommon transient.

Wilson’s Warbler (*Wilsonia pusilla*). Fairly common transient; uncommon summer visitor and breeder.

Yellow-breasted Chat (*Icteria virens*). Uncommon summer visitor and probable breeder. High count was 11 at Hettenshaw V. 8 Jun 1995 (SM).

Western Tanager (*Piranga ludovician*). Uncommon transient; common summer visitor and breeder. Detected during point counts at 99.5% of the sites.

Green-tailed Towhee (*Pipilo chlorurus*). Uncommon summer visitor and breeder.

Spotted Towhee (*Pipilo maculatus*). Fairly common resident and breeder.

California Towhee (*Pipilo crissalis*). Fairly common resident and breeder.

Chipping Sparrow (*Spizella passerina*). Fairly common transient; fairly common to common summer visitor and breeder.

Black-chinned Sparrow (*Spizella atrogularis*). Rare summer visitor and breeder. Known only from the Ant Pt. and Red Mtn. area. Specimens taken near Ant Pt. 8 Jul 1975 (RH; HSUM 3727 and HSUM 3728) have been tentatively identified as *S. a. caurina* (C. Tenney, Big Sur Ornithology Lab, pers. comm.). Harris (1991, 1996) provided additional details.

Vesper Sparrow (*Pooecetes gramineus*). Rare fall transient. High count was on 23 Sep 1996, when there were at least three at Hettenshaw V. and one or two at the south end of Ruth L. (JS, JH, TL).

Lark Sparrow (*Chondestes grammacus*). Fairly common transient, summer visitor, and breeder.

Black-throated Sparrow (*Amphispiza bilineata*). Casual summer visitor and probable breeder. Earliest historic report was of a juvenile near the Boundary Trail trailhead 6 Jul 1976 (KL). At least two singing males were present in the Red Mtn. area 27 Jun–6 Jul 1996 (EE et al.).

Sage Sparrow (*Amphispiza belli*). Casual summer visitor and breeder near Ant Pt. Noteworthy records from this area include an *A. b. belli* collected 8 Jul 1976 (RH; HSUM 3729), two adults and six juveniles seen 16 Jul 1976 (TS), and 10 seen 10 Aug 1979 (RH, EP). Earliest spring record 3 Jul 1981 (PS, VS); latest fall record 23 Aug 1976 (RH, S. Harris). We also have confirmed records for 1977 and 1981. While not
detected during searches there in 1995–96, a single juvenile was seen 21–22 Jun 1997 (W. Widdowson, JH, GH), and a family group of two adults and three juveniles was seen 26 Jul 1997 (KSL).

Savannah Sparrow (*Passerculus sandwichensis*). Fairly common to common fall transient; uncommon winter visitor. High counts of about 200 were recorded at Hettenshaw V. 12 Oct and 23 Oct 1996 (JH).

Grasshopper Sparrow (*Ammodramus savannarum*). Uncommon summer visitor and breeder at Hettenshaw V. Two fledglings were seen there 17 Jul 1996 (GS). Records from two other locations are of a single singing male near Ruth 31 May 1996 (SM) and another singing male along FS Route 1 between Cold Springs and Hwy. 36 sometime in Jun 1995 (JB, GSL).

Fox Sparrow (*Passerella iliaca*). Uncommon as a breeder. Fairly common transient and winter visitor.

Song Sparrow (*Melospiza melodia*). Fairly common resident and breeder.

Lincoln’s Sparrow (*Melospiza lincolnii*). Uncommon transient and winter visitor. No summer records, but adults were seen feeding young about 30 km southeast of the MRRD near *Government Flat, Tehama County, 12 Jul 1995 (JH, GH).

White-crowned Sparrow (*Zonotrichia leucophrys*). Fairly common transient and winter visitor. Casual summer visitor and possible breeder. The only two summer records are of a singing male (thought to be *Z. l. oriantha*) near Miller Spring Camp 19 Jul 1995 (GH) and one near the upper end of the Little Van Duzen R., HUM, 16 Jul 1996 (GS).

Golden-crowned Sparrow (*Zonotrichia atricapilla*). Common to abundant transient and winter visitor.

Dark-eyed Junco (*Junco hyemalis*). Common to abundant resident and breeder. A Slate-colored Junco (*J. h. hyemalis* or *cismontanus*) was seen near Brown’s Camp 23 Nov 1996 (JH).

Black-headed Grosbeak (*Pheucticus melanocephalus*). Uncommon transient; common summer visitor and breeder. Detected during point counts at 97.3% of the sites.

Lazuli Bunting (*Passerina amoena*). Fairly common summer visitor and breeder. Clear-cutting of timber has improved habitat conditions for this species.

Indigo Bunting (*Passerina cyanea*). Hypothetical. A male was reported on the trail to Ant Pt. 15 Jun 1982 (KI). Single males were also detected west of Dinsmore, along Hwy. 36, near *Burr Cr., HUM, 20 Apr 1992 (SM) and 22 Jun 1995 (SM).

Red-winged Blackbird (*Agelaius phoeniceus*). Uncommon resident. Increases in summer to fairly common as a breeder.


Western Meadowlark (*Sturnella neglecta*). Uncommon resident. Increases to fairly common in summer as a breeder.

Brewer’s Blackbird (*Euphagus cyanocephalus*). Rare resident. Increases to uncommon in summer as a breeder.

Brown-headed Cowbird (*Molothrus ater*). Uncommon summer visitor and breeder.

Bullock’s Oriole (*Icterus bullockii*). Uncommon summer visitor and breeder.

Purple Finch (*Carpodacus purpureus*). Uncommon resident and breeder.
BIRDS OF THE MAD RIVER RANGER DISTRICT, CALIFORNIA

Cassin's Finch (Carpodacus cassinii). Uncommon resident and breeder along South Fork Mtn., HUM and TRI, and near the Lassics, HUM and TRI. Two singing males, one orange, were seen 1 km south of Blake Summit, HUM, 14 Jul 1993 (GS).

House Finch (Carpodacus mexicanus). Rare resident and breeder near Mad River, Ruth, and Brown's Camp.

Red Crossbill (Loxia curvirostra). Rare resident and probable breeder.

Pine Siskin (Carduelis pinus). Fairly common resident and breeder.

Lesser Goldfinch (Carduelis psaltria). Common resident and breeder.

Lawrence's Goldfinch (Carduelis lawrencei). Casual summer visitor and breeder. Prior to 1996 there was a report of three at Ruth L. 16 Jul 1976 (TS; Harris 1991, AB 30:1001), a record as Peregrine Falcon prey remains collected in 1987, and a few records from other nearby locations (Grinnell and Miller 1944). During the summers of 1996 and 1997, however, birds were detected at numerous locations in the southern portion of the MRRD (EE, SM et al.). Breeding evidence consists of a pair at Ruth Fire Station throughout Jun 1996 (EE, JH), a female nest-building with a male in attendance near *Covelo, MEN, on 10 Jun 1996 (SM), adults feeding young near Red Mtn. 29 Jun 1996 (SM), and a family group of two adults and three juveniles at the Red Mtn. trailhead 26 Jul 1997 (KSI). Harris (1996) provided other nearby records.

American Goldfinch (Carduelis tristis). Rare summer visitor and possible breeder. Increases to fairly common in fall.

Evening Grosbeak (Coccothraustes vespertinus). Rare resident, transient, and possible breeder. High count was 20 near the Lassics 8 June 1982 (PS).

House Sparrow (Passer domesticus). Uncommon resident and breeder, found only near buildings associated with Mad River, Ruth, and Brown's Camp.

OBSERVERS

David A. Anderson, Anonymous (A), Lee Arsenault, Bill S. Baker, Kris K. Baker, Jeff Ballard, Janet M. Barager (JMB), Michael Beeve, James D. Booker, John Brack (JB), Brannum, David Browning, Dan Dixon, Linda Doerflinger, Kiel L. Drake (KLD), Katherine R. Drake (KRD), Elias E. Elias (EE), Richard A. Erickson (RAE), Ron Escaño (RE), L. Evans, David Fix (DF), Clay Fletcher (CF), William Forsberg, Alan B. Franklin, Barrett Garrison (BG), Bill German, D. Golnick, Jessica Gonzales, Joseph Grinnell (JG), Jay Harris, Stanley W. Harris, Gjon C. Hazard (GH), Norwood Hazard, Randy Hill (RH), Beau Horn, John E. Hunter (JH), Ken Irwin (KI), Jack Kahl, Kennedy, Greg Leisten (GL), Tom Leskiw (TL), Gary S. Lester (GSL), Lauren P. Lester, Mary Maier, Merry Maxwell, Sean E. McAllister (SM), Rolando Mendez (RM), Tom Mull, Kristi H. Nelson, Chet Ogan (CO), David Ogden, Kathy O'Halloran (KO), Elaine Payne (EP), Dan Pervorse, Jessie Plumage (JP), Jude C. Power, Gaia Reid, Jack Reneau (JR), Steve Rowell, Ken Sanchez, Herb Savercool (HS), Gregory A. Schmidt (GS), Kristin N. Schmidt (KS), Tom S. Schulenberg (TS), Kieth Slauzon (KSI), Paul F. Springer (PS), Virginia Springer (VS), John C. Sterling (JS), Ron Storrs, Steve Summers, Tompkins, Pam Udd (PU), Lisa Uerkuitz (LU), Ralph Warington, William Widdowson, Darren Wiemeyer, H. E. Wilder, Orian Williams, Roger Willmarth, Brian Woodbridge.

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LITERATURE CITED


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NONGAME AND UPLAND GAMEBIRD SURVEYS ON SACRAMENTO VALLEY NATIONAL WILDLIFE REFUGES, 1986-1993

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The Sacramento Valley forms the northern reach of California's Central Valley, one of the most intensively farmed regions in North America. Over 90% of the Central Valley's wetlands and riparian habitats have been lost or degraded through agriculture and urban development since the early 1900s (U.S. Fish and Wildlife Service 1978, Frayer et al. 1989). In spite of habitat loss, the Sacramento Valley still provides important breeding areas and serves as critical wintering grounds for millions of migratory birds in the Pacific Flyway (Gilmer et al. 1982). The importance of the Sacramento Valley to the Pacific Flyway and the scarcity of its remaining natural habitats emphasize the need for closely monitoring avian use of these areas.

Information on the abundance and distribution of nongame species in the Sacramento Valley is sparse, especially in comparison to game species such as waterfowl. In an effort to expand bird monitoring, managers at the Sacramento National Wildlife Refuge Complex (NWRC) developed a long-term survey program to gather basic information on nongame migratory bird populations. Based on support from trained volunteer staff, surveys were initiated in 1986. The initiation of year-round refuge surveys complemented traditional Breeding Bird Surveys (Robbins et al. 1986) conducted nearby off the refuges.

The purpose of this paper is to describe surveys of nongame and upland gamebird populations conducted from 1986 through 1993 and to report the findings on seasonal distribution, frequency of occurrence, and trends in abundance of selected species on the Sacramento NWRC.

STUDY AREAS

The surveyed areas included the Sacramento, Delevan, Colusa, and Sutter refuges of the Sacramento NWRC. All refuges are located within a 30-km radius of Colusa in the Sacramento Valley (Figure 1) and range in size from 1161 (Sutter) to 4415 ha (Sacramento). The climate is characterized by mild wet winters and long hot summers. Annual precipitation averages 46 cm, most falling from October through April.

Seasonal wetland is the most common habitat type on all the refuges (Table 1). Typically, these wetlands are drawn down in April or May, remain mostly dry during summer, and are reflooded in late summer and early fall. Uplands consist mostly of halophytic herbaceous vegetation and annual grasslands with lesser acreages of riparian woodlands along waterways.
Figure 1. Sacramento Valley, California, and study areas, including Sacramento, Delevan, Colusa, and Sutter national wildlife refuges.

(Oswald and Silveira 1995). Permanent wetlands constitute less than 10% of all wetlands.

Sacramento, Delevan, and Colusa refuges are situated in the Colusa Plains, historically an alkali grassland interspersed with seasonal wetlands.
and sparse trees and shrubs along drainages (Hall 1975). Intensive rice cultivation began in the Colusa Plains in the early and mid-1900s, and rice growing continued on certain refuge units until the late 1980s. Currently refuge lands are managed mostly as seasonally flooded marshes and natural uplands. Riparian woodlands now occur on many of the developed waterways that originally were treeless ephemeral streams.

Sutter Refuge is located almost entirely within a 1.6-km-wide bypass channel built to control flooding by containing overflow water from the Sacramento River. Historically, this area was part of the lower reaches of Butte Creek, a tributary of the Sacramento River. Rice was cultivated at Sutter Refuge through the mid-1980s, but the area is currently managed for wetlands. Sutter Refuge supports more riparian woodland than the other refuges because of its relatively high water table and floodplain location.

**METHODS**

On each refuge, surveys were conducted by means of fixed-radius roadside point counts modified from Hutto et al. (1986). Routes were established along improved roads, with stops spaced 0.8 km apart to avoid disturbance to vegetation and wildlife. We used a systematic rather than a randomized spacing of stops to ensure reliable access, repeatable sampling of habitats, and to enable use of a standardized radius for observations. Route length and the number of stops per survey route were 27 km, 34 stops at Sacramento, 21 km, 26 stops at Delevan, 18 km, 22 stops at Colusa, and 14 km, 18 stops at Sutter. At each stop, nongame birds and four upland gamebird
species seen or heard within a visually estimated 0.4-km radius and within 5 minutes were recorded. Any portion of the circular sample site that was outside the refuge boundary was not considered. Ten-power binoculars and a 15- to 45-power spotting scope were used to aid species identification. Most surveys were conducted during the middle of each month throughout the year, with additional surveys in the spring (March, April, May) and fall (September, October, November) (Table 2) when migrants were present and trained volunteers were available. To maximize bird detection, surveys were started at about 0700 and usually completed within 4 hours. If winds exceeded approximately 24 km/hr, or visibility was below 1.6 km, the survey was postponed until the next acceptable day. Some stops or routes were omitted temporarily during the 8-year study because of flooding or poor road conditions. Seasonal flooding occasionally hindered our normal survey schedule, especially at Sutter and Colusa refuges. Monthly surveys on each refuge were conducted on different days, but surveys in the same month were usually done within 14 days of each other.

We used a geographic information system (ESRI 1995) to determine the area of habitat type (seasonal wetlands, permanent wetlands, riparian woodlands, and grasslands) within each refuge and within 0.4 km of each stop. We compared the habitat composition of survey stops to the overall habitat composition of each refuge habitat using an overall chi-square test of independence (SAS Institute 1989) and a Bonferroni Z statistic (Neu et al. 1974) to determine specific variations in habitat proportions.

Regression analyses (SAS Institute 1989) were used to evaluate trends in species’ frequency of occurrence (the percentage of stops on a survey where at least one individual of the species was observed) and number observed (the mean number of a given species observed on a survey for all stops where the species was observed) over the eight years of the study. To ensure a reasonable sample of observations as a basis for assessing change, we selected only species that were observed on more than two surveys per season per year, and considered only the spring and fall seasons when surveys were conducted most consistently.

Table 2 Bird Surveys Conducted in the Sacramento NWRC, 1986–1993

<table>
<thead>
<tr>
<th>Refuge</th>
<th>Number of Surveys*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Winter</td>
</tr>
<tr>
<td>Sacramento</td>
<td>13 (7)</td>
</tr>
<tr>
<td>Delevan</td>
<td>8 (5)</td>
</tr>
<tr>
<td>Colusa</td>
<td>7 (4)</td>
</tr>
<tr>
<td>Sutter</td>
<td>4 (2)</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
</tr>
</tbody>
</table>

*Number of years surveys conducted shown in parentheses.
We compared the portion of wetland at each stop with total spring plus fall observations for each species group (i.e., diving birds, wading birds, shorebirds, raptors, and other landbirds). We pooled data for Sacramento, Delevan, and Colusa refuges because of the nearly equal survey effort for each refuge and their similar habitats. Sutter Refuge was omitted because of its lower survey effort and unique habitat. A total observation value (observations/stop) for combined spring and fall surveys was determined for each category and for each species group.

RESULTS

Species Richness and Abundance

We observed 139 species (Table 3) during a total of 191 surveys at 5141 stops, for 28,635 sightings on the four refuges over eight years. Species richness was greatest during spring, when we identified a total of 88 species of landbirds and 40 of waterbirds on all refuges combined. The number of species observed per stop was highest for landbirds at Sutter in the spring (7.74) and for waterbirds at Delevan in spring (1.96).

Species detected during all surveys and at more than 25% of all stops were the Red-winged Blackbird (44% of stops), Red-tailed Hawk (43%), and Marsh Wren (38%) during winter; Ring-necked Pheasant (62%), Western Meadowlark (56%), Marsh Wren (51%), and Red-winged Blackbird (49%) during spring; Red-winged Blackbird (35%), Western Kingbird (32%), and Western Meadowlark (29%) during summer; and Red-winged Blackbird (56%), Red-tailed Hawk (30%), and Marsh Wren (27%) during fall. In contrast, 17 species were sighted only once during the entire eight years.

Population Trends

Observations of 56 species were sufficient to test for population trends in spring (53 species) and fall (42 species). In spring, 15 species had positive trend estimates, 21 had negative trends, and 17 had mixed trends for frequency of occurrence and number observed; of these, the trend was significant (P < 0.05) for 15 (Table 4). In fall, seven species had positive trend estimates, 17 had negative trends, and 18 had mixed trends; the trend was significant for nine (Table 4). The Ring-necked Pheasant declined significantly in both variables in spring, as did Brewer's Blackbird in both spring and fall.

Diving birds (six species, including the Belted Kingfisher) peaked during spring migration. The Pied-billed Grebe was the most common diver (583 observations), the Eared the least (9). During spring and fall diving birds were observed most frequently (0.26 observations/survey/stop) at Colusa Refuge, where deep water was more abundant along survey routes than on other refuges. Trends in this group (Table 4) included declines of the Pied-billed Grebe and Double-crested Cormorant in fall and spring, respectively, and an increase in the frequency of occurrence of the American White Pelican in spring.

Wading birds (13 species) were common year round. The Great Egret, the most commonly encountered wader (995 observations), and Great Blue
Table 3 Seasonal Bird Observations during Surveys in the Sacramento NWRC, 1986–1993

<table>
<thead>
<tr>
<th>Species</th>
<th>Migratory status</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
<th>Observed</th>
<th>Refuges</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Stops</td>
<td>Mean</td>
<td>% Stops</td>
<td>Mean</td>
<td>% Stops</td>
<td>Mean</td>
<td>% Stops</td>
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<tr>
<td>Diving birds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pied-billed Grebe, <em>Podilymbus podiceps</em></td>
<td>R</td>
<td>8.9</td>
<td>1.2</td>
<td>19.6</td>
<td>1.2</td>
<td>6.8</td>
<td>1.2</td>
</tr>
<tr>
<td>Eared Grebe, <em>Podiceps nigricolli</em></td>
<td>W</td>
<td>0.2</td>
<td>1.0</td>
<td>0.2</td>
<td>1.7</td>
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<tr>
<td>Clark’s/Western Grebe, <em>Aechmophorus clarkii/occidentalis</em></td>
<td>B</td>
<td>0.4</td>
<td>1.3</td>
<td>0.5</td>
<td>3.8</td>
<td>0.5</td>
<td>4.0</td>
</tr>
<tr>
<td>American White Pelican, <em>Pelecanus erythrorhynchos</em></td>
<td>T</td>
<td>2.2</td>
<td>17.1</td>
<td>4.4</td>
<td>11.3</td>
<td>3.5</td>
<td>12.9</td>
</tr>
<tr>
<td>Double-crested Cormorant, <em>Phalacrocorax auritus</em></td>
<td>R</td>
<td>5.4</td>
<td>1.9</td>
<td>5.2</td>
<td>3.6</td>
<td>4.3</td>
<td>1.7</td>
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<tr>
<td>Wading birds</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
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<td>American Bitter, <em>Botaurus lentiginosus</em></td>
<td>R</td>
<td>2.9</td>
<td>1.0</td>
<td>9.0</td>
<td>1.2</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Least Bitter, <em>Ixobrychus exilis</em></td>
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<td>0.0</td>
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<td>0.0</td>
<td>0.3</td>
<td>1.0</td>
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<tr>
<td>Great Blue Heron, <em>Ardea herodias</em></td>
<td>R</td>
<td>15.0</td>
<td>1.3</td>
<td>20.1</td>
<td>1.8</td>
<td>15.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Great Egret, <em>A. alba</em></td>
<td>R</td>
<td>20.1</td>
<td>1.6</td>
<td>24.0</td>
<td>3.1</td>
<td>19.6</td>
<td>3.1</td>
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<tr>
<td>Snowy Egret, <em>Egretta thula</em></td>
<td>R</td>
<td>2.9</td>
<td>2.6</td>
<td>10.3</td>
<td>3.4</td>
<td>13.8</td>
<td>9.3</td>
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<tr>
<td>Cattle Egret, <em>Bubulcus ibis</em></td>
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<tr>
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<tr>
<td>Sora, <em>Porzana carolina</em></td>
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</table>

**Shorebirds**

| Black-bellied Plover, Pluvialis squatarola | T | 0.0 | 0.0 | 0.7 | 15.5 | 0.3 | 1.0 | 0.4 | 7.2 | S, D, C | 7 |
| Semipalmated Plover, Charadrius semipalmatus | T | 0.0 | 0.0 | 0.2 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | S, D, Su | 3 |
| Killdeer, C. vociferus | R | 11.2 | 1.7 | 22.3 | 1.6 | 7.5 | 1.6 | 15.7 | 2.7 | S, D, C, Su | 8 |
| Black-necked Stilt, Himantopus mexicanus | R | 6.2 | 5.8 | 15.0 | 4.4 | 6.0 | 8.5 | 4.9 | 13.8 | S, D, C, Su | 8 |
| American Avocet, Recurvirostra americana | B | 1.5 | 3.4 | 15.5 | 4.5 | 3.0 | 4.4 | 0.5 | 4.0 | S, D, C, Su | 8 |
| Greater Yellowlegs, Tringa melanoleuca | T | 4.4 | 1.5 | 10.0 | 2.6 | 1.5 | 3.3 | 4.2 | 2.5 | S, D, C, Su | 8 |
| Lesser Yellowlegs, T. flavipes | T | 0.1 | 1.0 | 0.4 | 2.3 | 0.5 | 1.0 | 0.7 | 3.6 | S, D, C | 8 |
| Willet, Catoptrophorus semipalmatus | T | 0.0 | 0.0 | 0.1 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | S | 1 |
| Whimbrel, Numenius phaeopus | T | 0.0 | 0.0 | 0.2 | 3.0 | 0.0 | 0.0 | 0.1 | 2.0 | S, C, Su | 2 |
| Long-billed Curlew, Numenius americanus | T | 2.1 | 22.3 | 1.3 | 14.6 | 0.8 | 3.0 | 2.7 | 39.7 | S, D, C, Su | 8 |
| Marbled Godwit, Limosa fedoa | T | 0.0 | 0.0 | 0.1 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | D | 1 |
| Western Sandpiper, Calidris mauri | T | 0.0 | 0.0 | 1.1 | 57.5 | 0.8 | 42.7 | 0.6 | 32.0 | S, D, C, Su | 7 |
| Least Sandpiper, C. minutilla | T | 0.0 | 0.0 | 0.3 | 28.7 | 0.0 | 0.0 | 0.3 | 12.5 | S, D, C, Su | 4 |
| Undifferentiated Sandpiper | T | 2.1 | 34.2 | 1.6 | 34.8 | 0.5 | 22.5 | 1.4 | 9.2 | S, D, C, Su | 8 |
| Dunlin, C. alpina | T | 1.4 | 65.8 | 2.9 | 150 | 0.0 | 0.0 | 1.3 | 22.8 | S, D, C | 8 |
| Long-billed Dowitcher, Limnodromus scolopaceus | T | 3.7 | 61.3 | 4.9 | 128.7 | 0.8 | 22 | 3.9 | 101.3 | S, D, C, Su | 8 |
| Common Snipe, Gallinago gallinago | T | 0.8 | 1.4 | 0.4 | 2.4 | 0.0 | 0.0 | 1.1 | 1.3 | S, D, C, Su | 6 |
| Wilson's Phalarope, Phalaropus tricolor | T | 0.0 | 0.0 | 0.1 | 3.5 | 0.0 | 0.0 | 0.0 | 0.0 | S, C | 2 |
| Red-necked Phalarope, P. lobatus | T | 0.0 | 0.0 | 0.1 | 1.0 | 0.0 | 0.0 | 0.2 | 8.3 | S, D, C | 3 |

**Gulls and terns**

<p>| Ring-billed Gull, Larus delawarensis | W | 9.1 | 4.6 | 3.4 | 5.2 | 0.3 | 5.0 | 3.9 | 30.2 | S, D, C, Su | 8 |
| Herring Gull, L. argentatus | W | 5.4 | 6.2 | 0.7 | 2.6 | 0.0 | 0.0 | 0.6 | 3.1 | S, D, C, Su | 7 |
| Caspian Tern, Sterna caspia | T | 0.0 | 0.0 | 0.2 | 1.7 | 0.0 | 0.0 | 0.3 | 2.3 | S, C, Su | 5 |
| Forster's Tern, S. forsteri | T | 0.0 | 0.0 | 0.1 | 4.0 | 0.5 | 1.0 | 0.0 | 0.0 | S, D | 3 |</p>
<table>
<thead>
<tr>
<th>Species</th>
<th>Season</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
<th>% Stops Mean</th>
<th>% Stops Mean</th>
<th>% Stops Mean</th>
<th>% Stops Mean</th>
<th>Refuges% Years</th>
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<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>6 S, D</td>
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<tr>
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<td>4.8</td>
<td>1.5</td>
<td>18.8</td>
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<td>10.7</td>
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<td>1.2</td>
<td>9.3</td>
<td>1.2</td>
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<td>1.2</td>
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<td>1.0</td>
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<td>1.0</td>
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<td>1.0</td>
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<tr>
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<td>1.0</td>
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<td>1.0</td>
<td>0.2</td>
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<th>Data</th>
<th>Date</th>
<th>Observation</th>
</tr>
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<tr>
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<td>3.6</td>
<td>61.6</td>
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<tr>
<td>Mourning Dove, <em>Zenaida macroura</em></td>
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<td>Belted Kingfisher, <em>Ceryle alcyon</em></td>
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<td>1.1</td>
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<td>R</td>
<td>2.8</td>
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<td>Northern Flicker, <em>Colaptes auratus</em></td>
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<tr>
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<td>Black Phoebe, <em>Sayornis nigricans</em></td>
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<td>10.6</td>
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<td>Violet-green Swallow, <em>T. thalassina</em></td>
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<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
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<td>1.8</td>
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<td>D, C, Su 8</td>
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<td>0.4</td>
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<tr>
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<td>1.2</td>
<td>2.4</td>
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<td>0.7</td>
<td>S, D, C, Su 8</td>
</tr>
<tr>
<td><strong>Northern Mockingbird, Mimus polyglottos</strong></td>
<td>R</td>
<td>0.2</td>
<td>1.0</td>
<td>1.9</td>
<td>0.6</td>
<td>S, D, C, Su 8</td>
</tr>
<tr>
<td><strong>American Pipit, Anthus rubescens</strong></td>
<td>W</td>
<td>10.7</td>
<td>2.1</td>
<td>3.1</td>
<td>4.9</td>
<td>S, D, C, Su 8</td>
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<td><strong>Cedar Waxwing, Bombycilla cedrorum</strong></td>
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<td>0.0</td>
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<td>7.0</td>
<td>S, D, C, Su 8</td>
</tr>
<tr>
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<td>Scientific Name</td>
<td>Minimum</td>
<td>Maximum</td>
<td>Mean</td>
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Table 3 (Continued)

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<th>Summer</th>
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<td>Mean</td>
<td>% Stops</td>
<td>Mean</td>
<td>% Stops</td>
<td>Mean</td>
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<td>10.0</td>
<td>11.1</td>
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<td>1.5</td>
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<tr>
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<td>68.3</td>
<td>48.6</td>
<td>20.8</td>
<td>34.6</td>
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<td>100.0</td>
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<td>19.3</td>
<td>1.8</td>
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<td>2.5</td>
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<td>1.9</td>
<td>6.5</td>
<td>1.0</td>
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<td>Brewer’s Blackbird, <em>Euphagus cyanocephalus</em></td>
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<td>18.2</td>
<td>15.7</td>
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<td>7.3</td>
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<td>0.0</td>
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<td>10.3</td>
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<td>23.0</td>
<td>2.1</td>
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<tr>
<td>Lesser Goldfinch, <em>Carduelis psaltria</em></td>
<td>W</td>
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<td>7.7</td>
<td>1.3</td>
<td>2.7</td>
<td>1.0</td>
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<tr>
<td>American Goldfinch, <em>C. tristis</em></td>
<td>W</td>
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<td>17.2</td>
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<tr>
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<td>3.7</td>
<td>8.0</td>
<td>2.7</td>
<td>5.3</td>
</tr>
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</table>

*a* B, summer breeder; R, year-round resident; W, winter resident; T, transient/migrant.

*b* Winter: December, January, February; spring: March, April, May; summer: June, July, August; fall: September, October, November.

*c* Percentage of stops on which the species was observed.

*d* Mean number of birds per stop.

*e* S, Sacramento; D, Delevan; C, Colusa; Su, Sutter.

*f* Number of years (of a maximum 8) in which the species was observed.

*g* Observations for these two species were combined.
Heron (814) were routinely encountered at all seasons. In contrast, we observed only one Least Bittern. Cattle Egrets occurred in relatively great numbers for short durations, but sightings (11) were sporadic. The White-faced Ibis reached peak numbers during winter in 1989 and 1990. Wading birds were observed at the highest rate (0.63 obs./survey/stop) during spring and fall at Delevan Refuge. Declines in mean number observed were noted for the Snowy and Great Egrets during spring and fall, respectively (Table 4). The Great Blue Heron declined in frequency of occurrence during spring. Numbers of shorebirds (18 species) peaked in spring and, to a lesser degree, fall, as migrants sought out shallow refuge wetlands. Routine marsh drawdowns in spring and flooding in late summer and fall provided suitable water depths for feeding and loafing. The Killdeer was the most commonly observed shorebird (817 observations). Shorebirds, gulls, and terns combined were observed at the highest rate (0.68 observations/survey/stop) during spring and fall at Delevan Refuge. The Black-necked Stilt and Killdeer declined in the percentage of survey stops where they were observed in fall and spring, respectively. An increase was noted for Long-billed Curlew in the fall (Table 4).

All five species of gulls and terns were observed during the spring but fewer were recorded at other seasons. The Ring-billed was the most common (208 observations), although the Herring was common on the refuges in winter, when they concentrated to feed on waterfowl carcasses resulting from avian cholera outbreaks. No significant trends were detected in this group.

Diurnal raptors and vultures (15 species) reached peak numbers during the nonbreeding seasons. The most prominent species were the Red-tailed Hawk (1261 observations), Northern Harrier (755), and Turkey Vulture (429). White-tailed Kites typically were observed as pairs, but flocks of 20 or more were occasionally recorded outside the breeding season. All raptors were observed at the highest rate (0.63 observations/survey/stop) during spring and fall at Colusa Refuge. As expected, because our surveys were during the day, we rarely observed owls (5 species), except for nesting Great Horned Owls (71 observations), which were encountered regularly in spring. We saw the Burrowing Owl only twice, despite the availability of apparently suitable habitats along survey routes. No significant trends in raptors were detected during the 8-year survey.

Gamebirds (4 species) were dominated by the Ring-necked Pheasant (1947 observations) and Mourning Dove (641), although pheasants seen in spring declined during the study (Table 4). Trends in other gamebird species were not apparent. California Quail (13 observations) were seen mostly as occasional pairs in the spring. Quail densities were low in comparison to historical numbers, but the current population appears stable. Mourning Dove were abundant as breeders on the refuges in the spring and summer, with fewer seen at other times. Large flocks occurred on nearby agricultural lands in winter.

Dominant species of songbirds were the conspicuous Red-winged Blackbird (2370 observations), Western Meadowlark (1895), and Marsh Wren (1841). Many species (e.g., Anna’s Hummingbird, Bank Swallow, Cedar Waxwing, Macgillivray’s and Townsend’s Warblers, Olive-sided and Western Flycatch-
### Table 4 Species Showing Significant\(^a\) Trends on the Sacramento, Delevan, and Colusa National Wildlife Refuges, 1986–1993

<table>
<thead>
<tr>
<th>Species</th>
<th>Variable</th>
<th>Season</th>
<th>(n^d)</th>
<th>Slope</th>
<th>SE(^e)</th>
<th>(r^2)</th>
<th>(T)</th>
<th>(P)</th>
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<tr>
<td><em>Diving birds</em></td>
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<tr>
<td>Pied-billed Grebe</td>
<td>M</td>
<td>F</td>
<td>44</td>
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<td>0.045</td>
<td>0.105</td>
<td>-2.216</td>
<td>0.032</td>
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<td>S</td>
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<td>0.142</td>
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<td>Double-crested Cormorant</td>
<td>M</td>
<td>S</td>
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<td>0.094</td>
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<td><em>Wading birds</em></td>
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<tr>
<td>Snowy Egret</td>
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<td>S</td>
<td>56</td>
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<td>F</td>
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<td>Great Blue Heron</td>
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<td>S</td>
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<tr>
<td>Black-necked Stilt</td>
<td>P</td>
<td>F</td>
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<td>0.400</td>
<td>0.219</td>
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<td>0.193</td>
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<td>0.225</td>
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<td>0.346</td>
<td>0.179</td>
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<td>0.144</td>
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<td>0.269</td>
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<tr>
<td>House Finch</td>
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<td>0.076</td>
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<td>0.262</td>
<td>0.162</td>
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</table>

\(^a\)\(a = 0.05.\)

\(^b\)M, mean number of a species observed on a survey for all stops where the species was observed; P, percentage of stops on a survey where at least one individual of the species was observed.

\(^c\)S, spring; F, fall.

\(^d\)Number of surveys observed.

\(^e\)Coefficient of determination.

\(^f\)\(T\) statistic for testing \(H_0: \text{slope} = 0.\)

\(^g\)Probability > \(T\).
ers, Hutton’s, Warbling and Solitary Vireos, Chipping, Fox and Lark Sparrows) were sighted less than three times each. Landbirds (including gamebirds) were observed at the highest rate (5.8 obs./survey/stop) at Sutter Refuge. Refuge grasslands and other upland habitats were attractive to certain species, as reflected in the abundance of the American Goldfinch, and Savannah, White-crowned, and Golden-crowned Sparrows during migration. Blackbirds, especially the Red-winged and Brewer’s, were common at all seasons, but numbers of Brewer’s Blackbird declined significantly in both spring and fall. The Tricolored and Yellow-headed Blackbirds were present at all seasons, but their numbers varied greatly because colonies occasionally shifted in relation to survey routes. The mean number observed declined for the Barn Swallow, Marsh Wren, and Brewer’s Blackbird but increased for the Golden-crowned Sparrow, Red-winged Blackbird, and House Finch (Table 4). The frequency of occurrence declined for American Crow, Western Meadowlark, Brewer’s Blackbird, and Brown-headed Cowbird but increased for the European Starling and Savannah Sparrow (Table 4).

Habitat Relationships

The habitat composition of survey stops generally reflected the habitat composition of the refuge (Table 1), but survey-route constraints did result in some differences ($\chi^2 < 78$, 3 df, $P \geq 0.001$). Our stops oversampled grasslands at Delevan but undersampled grasslands at Sutter and seasonal wetlands at Delevan and Colusa ($Z = 2.5$, 3 df, Bonferroni $P \leq 0.05$). Seasonal wetlands (68%) were the dominant habitat type for all survey routes, followed by grasslands (20%), permanent wetlands (6%), and riparian woodlands (6%) (Table 1).

As expected, wetland-dependent species were observed at the highest rates at survey stops comprising a high proportion of seasonal and permanent wetlands. In contrast, high rates of landbird and raptor observations were associated with stops containing more diverse habitats. On Sacramento, Delevan, and Colusa refuges, non-wetland areas were mostly grasslands, whereas on Sutter Refuge these habitats were mostly riparian woodlands. Observation rates (obs./stop) for spring and fall for Sacramento, Delevan, and Colusa refuges combined (mean 39 surveys) for each species group and habitat category (A >90% wetland, B 50–90% wetland, C <50% wetland) were as follows: diving birds, A = 10.5, B = 9.5, C = 3.1; wading birds, A = 26.6, B = 26.9, C = 11.2; shorebirds, gulls and terns, A = 38.7, B = 22.5, C = 14.3; raptors, A = 21.3, B = 22.6, C = 24.8; other landbirds (including gamebirds), A = 132.0, B = 138.0, C = 164.0.

DISCUSSION

Survey Design and Utility

Survey methods for this study were selected to optimize survey costs in relation to the quality and utility of the acquired data. This design gave us baseline data on a wide range of species at minimum cost but restricted our analyses to comparisons of relative change in abundance and distribution. Population estimates would require visibility corrections. Reproductive infor-
mation such as nest success and recruitment would require more intensive and costly methods, such as mist-netting and nest searches, that normally focus only on a few species.

Species Richness and Diversity

The influx of spring migrants produced peaks in the number of species observed per stop on all refuges. Highest spring and overall species densities were observed on Sutter Refuge, which contained the largest contiguous tract of riparian woodlands. The structural diversity (MacArthur and MacArthur 1961) created by extensive riparian woodlands adjacent to other natural habitats made Sutter Refuge highly attractive to landbirds, especially spring migrants. Stevens et al. (1977) reported that western riparian areas contain up to 10 times more migrants per hectare than adjacent nonriparian habitats.

Highest species densities of waterbirds were characteristic of the larger refuges with greater wetland diversity and better opportunity for observing waterbird species. Waterbird numbers on Sutter were consistently lower than on other refuges. This may have been because wetlands at Sutter are densely vegetated and become attractive for shorebirds and other waterbirds only during brief drawdown and flood-up cycles. Additionally, survey effort at Sutter Refuge was consistently the lowest, contributing to the lower species densities observed during winter.

Population Trends

Trends on the Sacramento NWRC may result from local, regional, or continental changes in populations. The results of our trend analysis may reflect actual population changes, but these variations may also be explained by normal population fluctuations, variations in timing of migration, redistribution of birds because of habitat conditions (e.g., drought), or observational chance.

Local habitat changes may cause local shifts in populations. For instance, an increase in pelican observations may have been caused when these birds were attracted to abundant fish on refuge wetlands. Regional changes in populations may have been reflected in an increase in the use of Sacramento NWRC by the White-faced Ibis during the period of survey. During the 1970s ibis were rarely observed on the refuges. Peterjohn et al. (1995) reported that breeding populations of ibis in North America have increased dramatically since 1966, whereas others (Johnson and Jehl 1994) suggested that geographic shifts may account for such changes. Diurnal raptor observations increased through fall and winter (Wilkinson and Debban 1980) as these birds, especially the Red-tailed Hawk, found numerous perching sites and abundant prey on the refuges.

Breeding Bird Surveys (BBS) conducted from 1966 to 1992 (Peterjohn et al. 1995) suggest national trends. Like our findings, the BBS noted negative trends for the Ring-necked Pheasant, Brewer’s Blackbird, and Brown-headed Cowbird and a positive trend for the American White Pelican. In contrast to our study, however, the BBS suggested trends increasing for the American Crow and decreasing for European Starling and Red-winged
Blackbird. It implied no significant trend for the other 17 species for which we noted increases or decreases.

Christmas Bird Counts (CBC) are another source of trend data that can be compared to surveys on the Sacramento NWRC. Using CBC data, Root and McDaniel (1995) inferred population trends for 27 species of songbirds. They reported that the Western Meadowlark and Savannah Sparrow declined in several states and increased in no state, whereas the American Crow increased in more states than it declined. Similarly, we found significant negative trends for frequency of occurrence in both spring and fall for the Western Meadowlark at Sacramento NWRC. In contrast to the CBC analysis, the Savannah Sparrow increased and American Crow decreased in our spring surveys. Additional studies are needed to determine whether agreement between our results and national surveys (e.g., BBS and CBC) reflects true population changes. Agreement on species with negative trends should reinforce the need to determine causes.

Habitat Relationships

Fragmentation of riparian zones that link the foothills surrounding the Sacramento Valley with the valley floor may affect the abundance and diversity of migrant songbirds on the refuges. Several creeks that flow through the Sacramento NWRC have been converted to water-delivery systems with augmented banks and associated water-control structures. Off-refuge maintenance of these systems typically involves elimination of riparian vegetation.

Exotic species and modification of original habitats can increase bird diversity (Knopf 1992), especially for landbirds. Furthermore, the availability of riparian and wetland vegetation on the refuges has increased because of year-round water management. These habitats may increase diversity but possibly at the expense of habitat for grassland species such as Swainson’s Hawk, Western Meadowlark, Savannah Sparrow, and Burrowing Owl.

Rare or Absent Species

Several riparian breeding species, including the Yellow Warbler, Song Sparrow, and Warbling Vireo, were observed in very low numbers or not detected during breeding season. Their scarcity is supported by data from the nearby Sacramento River (Geupel et al. 1996). These species appear to breed in substantial numbers in the upper Sacramento River basin but not in the lower reaches of the Sacramento Valley.

Our daylight surveys were inadequate to detect most owls with the exception of the Burrowing. Once a common breeder on the Sacramento NWRC, it was rarely observed during this study. Sparse sightings of the Burrowing Owl during other wildlife surveys conducted by refuge staff (unpubl. data) agree with our findings. Encroachment of thick ground vegetation may have reduced open areas required for suitable owl burrows. The Great Horned Owl, a suspected predator of the Burrowing in the Sacramento NWRC (J. Silveria pers. comm.), has benefited from an increase in trees along riparian corridors. It consumes primarily birds (61%) during the nesting season in central North Dakota (Gilmer et al. 1983). Feral cats, common on all refuges (G. Mensik pers. comm.), eat mainly birds,
especially in the spring (Hubbs 1951). Glading (1938) noted feral cats preying on quail nests. Undoubtedly, feral cats, and concentrations of predators on the refuges, have a detrimental effect on ground- and burrow-nesting birds such as the Western Meadowlark, California Quail, Ring-necked Pheasants, and Burrowing Owl.

CONCLUSIONS

The study achieved some noteworthy goals: the data collected established baseline information on nongame bird populations that may serve as a basis for evaluating future findings, the survey methods will serve as a basis for developing the next generation of nongame surveys, and the study demonstrated that with adequate planning, staff support, and trained volunteers, ongoing long-term surveys can be an integral part of refuge-management programs.

Future surveys should be more frequent and focus on a few key nongame species (e.g., riparian obligates, species of special concern, threatened or endangered species) in order to address specific management needs. A potential improvement may be the use of a variable- (rather than fixed-) radius survey stop. For instance, a small (100 m) radius would facilitate counting small or difficult-to-detect birds (particularly in riparian woodlands), an intermediate radius (200 m) could be used for relatively visible small to medium-sized birds (e.g., shorebirds), and a large radius (0.4 km) could be used for the largest and most visible birds. Survey routes and number of stops may have to be reduced to allow for more intensive sampling. Innovative and more intensive surveys (e.g., nest searches) needed to assess management programs will become more important as resource professionals are expected to carry out comprehensive management strategies. The integration of local survey programs into national programs such as MAPS (Monitoring Avian Productivity and Survivorship) and BBIRD (Breeding Biology Research and Monitoring Database) (Martin et al. 1995) will increase our understanding of how local, regional, and continental population changes are related. A network of local and national surveys can provide much higher-quality and responsive information on status and trends by measuring demographics and patterns of change throughout the range of many species. An important consideration will be standardization of monitoring techniques. An ongoing mist-netting program, such as proposed by the MAPS program, would augment demographic information (Ralph et al. 1993) on target species at specific sites (e.g., Swainson’s Thrush at Sutter Refuge).

Future studies should attempt to identify relationships between native species and their habitat requirements such as patch size, successional stage, and dispersal corridors. Data on landbird use of seasonal wetlands in the Sacramento Valley are scarce, and the refuge complex would be an appropriate area to study this relationship. The approach we took of conducting a general, long-term survey for baseline data on the distribution and abundance of nongame and upland gamebirds in the Sacramento NWRC was a first step to assist refuge managers in evaluating overall avian
resources. The tabulation of species and the frequency of observations provide a basis for developing more refined survey methodologies and improving management strategies for monitoring bird diversity and status.

The Sacramento NWRC has been involved in habitat-development projects that focus primarily on waterbirds. The number of riparian and grassland bird species observed suggests that these habitats should be protected and enhanced where appropriate to conserve bird species diversity.

SUMMARY

We conducted a study of nongame bird populations on the Sacramento, Delevan, Colusa, and Sutter national wildlife refuges involving standardized surveys approximately every month over an 8-year period from 1986 to 1993. Survey objectives, weather, and personnel constraints necessitated that the survey effort focus on the spring and fall with reduced survey schedules during the summer and winter. The study provided the first comprehensive assessment of the refuges' nongame birds and will serve as a basis for developing future refuge surveys to assist in the conservation of nongame birds.

ACKNOWLEDGMENTS

We thank all the Sacramento NWRC staff that provided their ideas and effort in designing and conducting this project, especially Pat O'Halloran, Greg Mensik, Marguerite Ross-Hills, and Mark Strong. Melanie Paquin, Mike Casazza, John Day, and Chris Gregory provided assistance in data processing. Bruce Deuel, Joe Fleskes, Geoffrey Geupel, Greg Mensik, and Joe Silveira provided helpful suggestions in the preparation of the manuscript.

LITERATURE CITED


Accepted 13 January 1998
DISTRIBUTION, ABUNDANCE, AND IMPLICATIONS FOR CONSERVATION OF WINTER WATERBIRDS ON TOMALES BAY, CALIFORNIA

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Tomases Bay, on the Marin County coast, is one of California's largest and least disturbed estuaries, yet little has been published on the status of its waterbirds or their vulnerability to environmental threats. Shuford et al. (1989) reported the results of waterbird censuses of up to 10 consecutive years in the adjacent Point Reyes area between 1965 and 1982 but provided limited information on waterbird use of Tomases Bay. Other anecdotal accounts and aerial survey work over the last 30 years suggest that Tomases Bay supports unusually high abundances of some waterbird species (Moffitt 1943, Grinnell and Miller 1944, Calif. Dept. Fish and Game unpubl. data, U.S. Fish and Wildlife Service unpubl. data, National Audubon Society Christmas Bird Counts) and is worthy of protection (National Oceanic and Atmospheric Administration 1987, Neubacher et al. 1995).

In this paper, we present results from seven winters of baywide waterbird censuses on Tomases Bay, compare results with other studies to provide a historical and geographical perspective on the importance of Tomases Bay to waterbirds, evaluate species distributions within the bay with regard to possible habitat relationships and the importance of particular habitat areas, and, on the basis of these evaluations, identify needs for conservation of winter waterbird populations on Tomases Bay. We address these objectives with regard to all waterbird species associated with Tomases Bay and immediately adjacent ponds and marshes, with the exception of sandpipers (Scolopacidae), plovers (Charadriidae), and large and medium-sized gulls (Laridae; Table 1). Most gulls were excluded from the study because of difficulties in counting large numbers of moving birds and identifying species. Sandpipers, plovers, and gulls were also difficult or impossible to observe from survey boats because these species often concentrated on exposed tidal flats or in alternative habitats away from the bay. Abundances of winter shorebirds and gulls on Tomases Bay have been reported elsewhere (Kelly 1993, Kelly et al. 1996).

STUDY AREA

The long straight expanse of Tomases Bay floods the lower 20 km of the fault-generated Olema Valley on the central California coast, about 45 km northwest of San Francisco (Figure 1; Galloway 1977). The bay differs from other, generally shallower, Pacific coast estuaries and lagoons in having a much greater area of open water at low tide and therefore more waterbird habitat through the tidal cycle. Approximately 91% of the bay's 28.5-km² area is subtidal. With hills surrounding the narrow (1–2 km) bay, and little fetch when winds blow from directions other than northwest, surface waters remain relatively calm during winter. Tomases Bay contains 37 eelgrass (Zostera marina) beds covering a total area of 392 hectares, predominantly in the
<table>
<thead>
<tr>
<th>Species</th>
<th>Density (birds/km²)</th>
<th>Baywide abundance</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>South of Tomasini Pt.</td>
<td>Tomasini Pt. to Pelican Pt.</td>
</tr>
<tr>
<td>Red-throated Loon, Gavia stellata</td>
<td>0.55 (0.11)</td>
<td>7.96 (1.02)</td>
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<td>Pacific Loon, G. pacifica</td>
<td>0.25 (0.08)</td>
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<td>0.71 (0.10)</td>
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<td>0.14 (0.05)</td>
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<td>Horned Grebe, Podiceps auritus</td>
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<td>28.55 (4.59)</td>
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<td>0.01 (0.01)</td>
<td>0.13 (0.06)</td>
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<td>Eared Grebe, P. nigricollis</td>
<td>0.43 (0.12)</td>
<td>10.20 (1.39)</td>
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<td>Eared/Horned Grebe</td>
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<td>4.48 (2.01)</td>
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<td>30.00 (3.82)</td>
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<td>0.66 (0.18)</td>
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<td>0.21 (0.04)</td>
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<td>0.09 (0.02)</td>
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<td>0.05 (0.02)</td>
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<td>0.40 (0.35)</td>
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<td>Mean</td>
<td>SE 95% CI</td>
</tr>
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<td>---------------------------------------</td>
<td>------</td>
<td>-----------</td>
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<td>(1.48)</td>
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<td>(0.02)</td>
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<td>(0.02)</td>
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<td>(0.15)</td>
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<td>(0.00)</td>
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<td>Oldsquaw, Clangula hyemalis</td>
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<td>(0.00)</td>
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<td>(0.15)</td>
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<td>(0.00)</td>
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<tr>
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<td>158.17</td>
<td>(10.98)</td>
</tr>
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<td>Hooded Merganser, Lophodytes cucullatus</td>
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<td>(0.02)</td>
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<td>Red-breasted Merganser, Mergus serrator</td>
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<td>(0.18)</td>
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<td>Ruddy Duck, Oxyura jamaicensis</td>
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<td>(17.93)</td>
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<td>(1.15)</td>
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<td>(0.05)</td>
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<td>(0.04)</td>
</tr>
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<td>(0.33)</td>
</tr>
<tr>
<td>Common Murre, Uria algea</td>
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<td>(0.00)</td>
</tr>
<tr>
<td>Cassin's Auklet, Ptychoramphus aleuticus</td>
<td>0.00</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Rhinoceros Auklet, Cerorhinas monocerata</td>
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<td>(0.00)</td>
</tr>
<tr>
<td>Waterbird total</td>
<td>515.60</td>
<td>(34.58)</td>
</tr>
</tbody>
</table>

*Figures in parentheses are standard errors.

^Mean abundance of Black Brant in December/January (n = 15), prior to February arrivals of migrants, was 1,047.4, SE 155.70, range 12–1781.
WINTER WATERBIRDS ON TOMALES BAY, CALIFORNIA

Figure 1. Tomales Bay study area. Shadings denote winter waterbird count sections; parallel lines denote three boat transects. Supplementary counting points (circled) are (1) Walker Creek, (2) Livermore Marsh, (3) Millerton Gulch to Bivalve, (4) Bivalve, and (5) Inverness.

northern half of the bay from Pelican Point northward to Tom’s Point (Figure 1, Spratt 1989). Water depths in the bay average about 3 m below mean lower low water (MLLW) and vary from intertidal shoals along the east shore
Numerous transects through the waterbirds to areas up to 20 m deep in the main channel along the west shore. In general, sediments grade from primarily fine to coarse sand in the northern reaches of the bay to muddier substrates in southern portions (Daetwyler 1966).

The two primary points of freshwater inflow, and the largest tidal flats and marshes, are at Lagunitas Creek at the south end of the bay and Walker Creek near the north end (Figure 1). Numerous smaller perennial and ephemeral streams enter the bay along its perimeter, each associated with a small, generally insular delta marsh. Rainfall is highly seasonal, with 95% of annual rain falling from October through April and 55% from December through February, based on 42-year averages at Cypress Grove Preserve. Spatial and temporal variations in the bay’s salinity are influenced by variably high levels of freshwater inflow during winter, low flows in summer, and constraints on tidal exchange with the ocean imposed by the linear shape of the bay and the narrow mouth at its northwest end. Therefore salinities in the southern reaches of the bay are highly variable, ranging from nearly fresh after heavy winter runoff to slightly hypersaline in summer, whereas regular tidal mixing at the north end of the bay maintains salinities that consistently reflect those of the outer coastal waters (Hollibaugh et al. 1988).

The difference between mean high and mean low tides is about 1.1 m, with an average annual maximum tide swing of about 2.5 m, based on National Oceanic and Atmospheric Administration predictions. Tidal currents are strongest along the west shore within about 6 km of the northwest end but are generally gentle.

METHODS

We conducted 21 (mean 3/yr, minimum 1, maximum 4) baywide counts of waterbirds on Tomales Bay over the seven winters from 1989–90 to 1995–96. Each year, consecutive counts were made at 2- to 3-week intervals from mid-December to late February each year. Each baywide survey encompassed simultaneous counts conducted from three 17- to 21-ft (5.3- to 6.6-m) Boston Whalers or similar boats. The boats traveled in formation, following parallel 18-km transects from Millerton Point near the south end of the bay north to the Sand Point Buoy (Figure 1). Boats following the east-shore and west-shore transects each carried one team of observers. The midbay boat carried two (port and starboard) teams. Each team consisted of two competent waterbird observers, using binoculars, and one data recorder. Observers on the east-shore boat counted all waterbirds in a transect bounded by the path of their boat and the east shore. Similarly, observers on the west-shore boat counted all waterbirds in a transect bounded by their boat and the west shore. Observers on the midbay boat counted all waterbirds between the other two boats. Drivers of the east- and west-shore boats continually adjusted their positions visually to maintain roughly equal distances between boats and transect boundaries. Therefore, shoreline transects each represented approximately a fourth of the areal extent of the bay and the midbay transect covered approximately half of the bay’s extent.

We maintained continual radio communication among observation boats to facilitate adjustments of interboat and boat-to-shore distances and to clarify counts of confusing birds or flocks along the transect borders.
Observers on each boat counted only those birds that passed southward through an imaginary vertical plane defined by the bows of the three boats. The boats traveled at velocities of about 4 knots, but occasionally we stopped to count dense aggregations of birds. Birds flushing ahead of the moving boats were not counted until they eventually passed southward through the observation plane. Birds passing northward over or around the boats were subtracted from the counts, but this seldom occurred as long as boats maintained a constant velocity.

Counts were generally conducted during rising neap tides, with at least a 4.5-ft tide height (MLLW) when the boats arrived at the shallow Walker Creek Delta/Tom’s Point area, about two hours after starting each count. We began the counts between 0930 and 1000 to avoid early morning fog and rough afternoon seas, and each count was completed in about 3.5 hours. Conditions during counts were generally calm (Beaufort scale 0–2). In areas that could not be reached by boats, we conducted supplementary counts immediately prior to the boat counts, using telescopes from shore (Figure 1).

During each count, we partitioned the raw transect data into four sections: (1) south of Tomasini Point; (2) Tomasini Point to Pelican Point; (3) Pelican Point to Tom’s Point; (4) Tom’s Point to Sand Point (Figure 1). The sections correspond to intervals distinguished by estuarine conditions that might influence the composition, distribution, or availability of food for waterbirds. Such conditions include differences in water turbidity and color (pers. obs.), eelgrass distribution (Spratt 1989), substrate texture (Daetwyler 1966), water temperature, freshwater inflow, and ocean-water exchange (Hollibaugh et al. 1988). Therefore, data from each count were partitioned into 12 subsets, delineated by three transects each divided into four sections. Supplemental shore-based data were pooled with the appropriate section and transect counts. We recorded all waterbirds in the shallows at the extreme south end of the bay (south of Millerton Point) as occurring in either east-shore or west-shore transects.

We identified waterbirds to species whenever possible. Undifferentiated loons, Horned/Eared grebes, Western/Clark’s grebes, cormorants, scap, and scoters were allocated to species in proportion to the number of identified birds of those species, within each transect section on each count day, if the number of identified individuals exceeded the number of undifferentiated individuals and the number of identified individuals was greater than 50 for grebes or 100 for cormorants, scap, or scoters. Generally, only very small numbers of birds were undifferentiated in the field.

To facilitate comparisons among count areas of different sizes, we transformed species abundances within each count area (section within transect) into densities (birds/km²). We modeled differences in waterbird densities using a mixed-model analysis of covariance (ANCOVA), designating section and transect as fixed effects and year (winter season) as a random effect. Species that commonly exploit freshwater habitats in winter (43% of species analyzed) could exhibit intraseasonal fluctuations as a result of variable rainfall patterns and corresponding changes in the availability of freshwater wetlands in this region (Shuford et al. 1989). Furthermore, late migrants of some species could arrive during the winter census period. Therefore, we used days (since 1 December within each winter) as a covariate to control for possible differences...
related to the intraseasonal timing of counts. Species densities were log-transformed prior to analysis to improve the normality of the data. For species with significant section or transect effects on densities, we used the Tukey procedure for multiple pairwise comparisons to determine which section or transect means differed from others (Dixon 1992). We also conducted pairwise comparisons of proportional species diversity, based on the Shannon index (Magurran 1988), and species richness, but because sections and transects varied in extent, we limited our interpretation of differences to those that were not confounded by possible species–area effects. Finally, we looked for possible temporal trends by examining partial regression coefficients of baywide abundances on year and days.

RESULTS

We observed 51 species of waterbirds during our surveys on Tomales Bay. The total number of waterbirds averaged 21,943 individuals per count [standard error (SE) 647, min. 14,842, max. 25,553]. Mean waterbird density on Tomales Bay was 770 birds/km² (SE 22.7). Variability in total numbers of waterbirds was primarily a function of the numbers of the Surf Scoter, Bufflehead, Greater Scaup, Ruddy Duck, and Black Brant (Figure 2, Table 1). Waterfowl (Anatidae) accounted for 51.0% of the species and 85.3% of the total individuals observed; the Surf Scoter, Bufflehead, and Greater Scaup together accounted for 70.0% of the total waterbirds. Surface-feeding ducks, such as the Northern Pintail and Mallard, typically occurred in only low numbers.

All waterbird species for which our data were adequate for parametric analysis selected habitats within Tomales Bay nonrandomly with respect to the transects or sections used in this study (P < 0.05; Table 2). Area counts were generally not biased by the effects of observation boats on movements of waterbirds because birds rarely flushed across count-area boundaries. Results for the Greater Scaup and Black Scoter included a slight transect bias because they occasionally flushed from east-shore to midbay waters before they were counted, but they did not flush cross section boundaries. In general, waterbird densities were highest along the east shore and between Pelican Point and Tom's Point (Figure 2, Table 2). However, several species preferred other areas (Figure 2, Tables 1 and 2). For example, Pacific and Red-throated loons and Western Grebes occurred in significantly greater densities in the midbay transect and in the section from Tomasini Point to Pelican Point. Horned and Eared grebes concentrated in the middle two sections of the bay. Red-necked Grebes occurred almost exclusively north of Pelican Point, especially in the deep channel near the west shore (Table 1 and pers. obs.). Black Brant concentrated in the northern third of the bay, with highest densities between Pelican Point and Tom's Point (Figure 2, Table 2). In contrast, Greater Scaup concentrated south of Pelican Point, especially along the east shore north of Tomasini Point. Black Scoters also concentrated along the east shore north of Tomasini Point (Table 1 and pers. obs.).

Because species diversity and richness varied positively with section size, we could not determine if section differences were independent of possible species–area effects. We also found no significant differences in propor-
Figure 2. Relative waterbird densities by section and transect (Figure 1) and mean baywide abundances (standard errors) of waterbirds on Tomales Bay. Sections: 1, south of Tomasini Point; 2, Tomasini Point to Pelican Point; 3, Pelican Point to Tom’s Point; 4, Tom’s Point to Sand Point. Transects: W, west shore; M, midbay; E, east shore. Differences among section and transect densities are analyzed in Table 2.
Table 2 Effects of Section, Transect, and Year on Waterbird Densities in Tomales Bay

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<thead>
<tr>
<th>Species</th>
<th>ANCOVA</th>
<th>Section</th>
<th>Transect</th>
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<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>Red-throated Loon</td>
<td>S**, T</td>
<td>A</td>
<td>C</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Pacific Loon</td>
<td>S**, T*, ST**</td>
<td>A</td>
<td>B</td>
<td>A</td>
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</tr>
<tr>
<td>Common Loon</td>
<td>S**, ST*</td>
<td>A</td>
<td>B</td>
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</tr>
<tr>
<td>Horned Grebe</td>
<td>S**, T*, ST**, TY</td>
<td>A</td>
<td>C</td>
<td>B</td>
<td>B</td>
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<tr>
<td>Western Grebe</td>
<td>S**, T**, Y*, ST**</td>
<td>C</td>
<td>D</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>Double-crested Cormorant</td>
<td>S**, T*, ST**</td>
<td>B</td>
<td>C</td>
<td>B, C</td>
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</tr>
<tr>
<td>Brandt's Cormorant</td>
<td>S**, T*, ST**</td>
<td>A</td>
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<tr>
<td>Pelagic</td>
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<td>B</td>
<td>D</td>
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<td>A, B</td>
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<td>Surf Scoter</td>
<td>S**, ST*</td>
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<td>Bufflehead</td>
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<tr>
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<td>B</td>
<td>C</td>
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<td>American Coot</td>
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<td>Waterbird Total</td>
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<td>A</td>
<td>B</td>
<td>C</td>
<td>A, B</td>
</tr>
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</table>

*aEach significant main effect for section or transect is followed with multiple pairwise comparisons: means with the same letter are not significantly different (Tukey procedure, experimentwise P > 0.05). Significant differences among means are ranked: A < B < C < D. Section and transect preferences, suggested by significantly highest means and means that do not differ from significantly highest means, are in boldface. See Figure 1 for section and transect locations.

*bMixed-model analysis of covariance. Covariate, days since 1 December within year (winter season); letter indicates F ratio significant at P < 0.05. *P < 0.01, **P < 0.001.

...tional species diversity among transects (P > 0.10). However, species richness was significantly greater along the east shore (mean 31.0, SE 0.94, n = 21) than in either the midbay (mean 24.4, SE 0.82, n = 21) or west-shore (mean 24.4, SE 0.62, n = 21) transects—in spite of the larger area represented by the midbay transect (experimentwise P < 0.01).

We found significant seven-year population trends (P < 0.05) reflecting annual increases for the Common Loon (mean annual increase, b = 15.8),
Eared Grebe ($b = 38.3$), Western Grebe ($b = 93.6$), Black Brant (December/January only, to exclude northward migrants: $b = 231.6$), Common Golden-eye ($b = 15.6$), Red-breasted Merganser ($b = 17.0$), and American Coot ($b = 65.0$). Partial regression coefficients revealed slight but significant ($P < 0.05$) 7-year declines for the White Pelican ($b = -2.1$) and White-winged Scoter ($b = -3.9$) and a large annual decrease for the Surf Scoter ($b = -515.9$). However, the significant regression for Surf Scoter resulted from relatively high numbers in 1989–90 (mean 10,470; SE 347.6, $n = 2$); thereafter, abundances remained at significantly lower levels (mean 6315; SE 1601, $n = 19$; $t = 8.1$, $P < 0.001$) with no annual trend ($P > 0.05$). Similarly, the dramatic trend in wintering Black Brant resulted primarily from an early increase, from 1989–90 (mean 17.5, SE 5.5, $n = 2$) to 1991–92 (mean 1342; SE 356.5, $n = 2$); December/January abundances apparently stabilized at this level for the remainder of the study (mean 1275; SE 120.0, $n = 12$).

Regularly occurring species with the greatest variation from year to year were the Pacific Loon [coefficient of variation (CV) 0.83], Pied-billed Grebe (CV 1.02), White Pelican (CV 1.67), Brown Pelican (CV 0.88), Bonaparte’s Gull (CV 0.90), and Forster’s Tern (CV 0.97). In contrast, we observed relatively stable annual abundances of the Red-throated Loon (CV 0.37), Double-crested Cormorant (CV 0.30), Bufflehead (CV 0.25), and Ruddy Duck (CV 0.36). We found significant intraseasonal trends in the abundances of only a few species. The White Pelican, Bonaparte’s Gull, Bufflehead, and American Wigeon declined significantly as winter progressed, while the Eared Grebe and White-winged Scoter increased significantly ($P < 0.05$).

DISCUSSION

Tomales Bay Populations

The number of waterbird species we observed on Tomales Bay was similar to that normally occurring in other wetlands along the outer Marin and Sonoma County coast (Shuford et al. 1989). Densities of many species were also similar to those reported for other estuaries in the Point Reyes area, but waterbird abundances were dramatically higher, presumably because of the greater extent of Tomales Bay in comparison to other sites (cf. Page et al. 1983, Shuford et al. 1989). In addition to the high waterbird numbers documented by our study, Tomales Bay also supports 11,000 to 18,000 wintering shorebirds (Kelly 1993) and tens of thousands of wintering gulls (Kelly et al. 1996 and unpubl. data).

Tomales Bay is probably of statewide significance for some waterbird species. Population estimates derived from the aerial Midwinter Waterfowl Survey during the same period (U.S. Fish and Wildlife Service, unpubl. data) are not directly comparable with the data we collected from boats on Tomales Bay. Waterbird abundances recorded from boats are based on relatively thorough observation, frequently using actual counts rather than estimates, and are probably closer to the actual numbers of birds than abundances recorded from aerial surveys (Conant et al. 1988). Comparisons of our January boat count data with January U. S. Fish and Wildlife Service (USFWS) aerial surveys of Tomales Bay, available only for 1990, 1991, and 1993, suggest that aerial counts underestimated numbers of Bufflehead,
scoters, and Black Brant by 49.5%, 41.5%, and 17.4%, respectively (see also Conant et al. 1988). Using these differences to adjust comparisons with statewide results from 1989–90 to 1995–96 reported by the USFWS Midwinter Waterfowl Survey, we estimate that winter populations of the Bufflehead, scoters, and Black Brant (December/January only) on Tomales Bay represent 12.3%, 6.4%, and 30.8%, respectively, of statewide populations. We emphasize that these estimates are rough approximations at best and should be interpreted cautiously. In general, our data suggest that Tomales Bay supports numbers of Bufflehead, scoters, and Black Brant comparable to totals for all estuaries and lagoons in Mendocino, Humboldt, and Del Norte counties combined. Tomales Bay may be the single most important estuary, with the exception of San Francisco Bay, south of the Columbia River for wintering Bufflehead (cf. USFWS Midwinter Waterfowl Survey unpubl. data; Monroe 1973, Barnhart et al. 1992). On the basis of aerial surveys conducted from 1968 to 1970 by the California Department of Fish and Game and the Point Reyes Bird Observatory, Smail (1972) reported high counts of scoters (5788), Bufflehead (7502), and scaup (1437) and overall waterfowl abundances (mean 6786, max. 19,997), providing some evidence that waterbird numbers on Tomales Bay were similar to those observed in our study. In a statewide study of seabird abundances, Briggs et al. (1987) identified Tomales Bay as an important area of concentration for the Red-throated, Pacific, and Common loons, Eared and Horned grebes, and scoters.

Audubon Christmas Bird Count (CBC) results for Tomales Bay prior to 1989 provide rough estimates at best for waterbird species, because of the near impossibility of estimating baywide abundances from the single observation boat used on those counts. However, species with restricted distributions in the bay may be monitored more accurately by CBC data. For example, comparisons of our results with CBC data suggest that the number of American Coots has declined by an order of magnitude since the 1970s, a pattern that is also evident elsewhere in the Point Reyes area (Shuford et al. 1989). The median number of Redheads recorded on the Point Reyes CBC from 1970 to 1981, primarily from near the mouth of Walker Creek on Tomales Bay, was 376 (min. 1, max. 784) but has since dwindled to 9 (min. 0, max. 15). Since 1989, CBC data for Tomales Bay have been derived from December counts conducted for this study.

We have assumed, except where noted otherwise, that our data represent “wintering” populations only, but abundances of some species may have swelled or declined because of arrivals or departures of late migrants or birds with intraseasonal local or regional movements. The significant intraseasonal declines we detected in the Bufflehead and American Wigeon may have resulted from emigration associated with midwinter increases in rainfall and corresponding increases in the availability of seasonal and interior wetlands (Shuford et al. 1989). In contrast, significant intraseasonal increases in Eared Grebes conformed to patterns reported in San Francisco Bay salt ponds (Swarth et al. 1982) and other wetlands in the Point Reyes area (Shuford et al. 1989), possibly resulting from a protracted fall migration (Jehl 1988).

In general, the east shore of the Tomales Bay, with shallow shoals and mudflats, headlands and protected coves, supports greater abundances and
more species of waterbirds than either the midbay or west shore. Nevertheless, preferred habitats of various species occur throughout the bay (Figure 2, Table 2). Waterbird distributions on Tomales Bay are associated with strong winter salinity and temperature gradients, differences in water circulation, turbidity, and exchange rates with nearshore coastal waters (Hollibaugh et al. 1988), distribution of eelgrass beds (Spratt 1989), and a wide range of bottom substrates (Daetwyler 1966). The most diverse and abundant concentrations of waterbirds in the bay occur between Pelican Point and Tom’s Point, where eelgrass beds are the most concentrated and estuarine circulation is enriched by the tidal delivery of nutrients and plankton from the outer ocean, as well as by the inflow of freshwater and nutrients from Walker Creek, i.e., where habitat diversity and nutrient supplies are greatest (Figure 1; Hollibaugh et al. 1988, Smith and Hollibaugh 1997). The quality and extent of inflow from Walker Creek depends on management of a 189-km² watershed, which is dominated by agricultural grasslands, coastal scrub, mixed evergreen forest, and oak woodland, and on managed water releases from the Soulajule Reservoir (Storm 1972, Madrone Associates 1976).

Conservation Implications

The importance of wintering areas in the dynamics of waterbird populations is suggested by the potentially crucial role these areas play in courtship or pairing and deposition of fat stores used later as energy for reproduction (Heitmeyer and Fredrickson 1981, James 1989, Baldassarre and Bolen 1994). Winter habitat quality has been linked to annual survival, recruitment, and reproductive success of waterfowl (Raveling 1979, Haramis et al. 1986, Raveling and Heitmeyer 1989, Baldassarre and Bolen 1994).

Eelgrass, the most abundant large marine plant in Tomales Bay (Hardwick 1973), provides crucial winter food for Black Brant, surface-feeding ducks, and other waterfowl (Yocum and Keller 1961, Baldassarre and Bolen 1994). Our results show a recent increase in the use of Tomales Bay by wintering Black Brant, with abundances well above winter averages of approximately 200 birds in the 1980s (Calif. Dept. Fish and Game unpubl. data). Eelgrass also supports a rich estuarine fauna that provides additional food for waterbirds (Day et al. 1989). Although the distribution of eelgrass in Tomales Bay has been relatively stable (Spratt 1989, Moore and Mello 1995), it is sensitive to changes in salinity, turbidity, and temperature (Day et al. 1989, Baldassarre and Bolen 1994) and thus potentially vulnerable to reductions in the quality or quantity of fresh water supplied by Walker Creek.

In Tomales Bay, eelgrass provides winter spawning habitat for approximately 5500 tons (20-year average) of Pacific Herring (Clupea harengus pallasii; Moore and Mello 1995). From December through March, scoters, Bufflehead, scaup, Black Brant, goldeneyes, American Coots, and other species of waterbirds heavily exploit the roe of Pacific Herring (Hardwick 1973, Bayer 1980, Briggs et al. 1987, Haegele 1993), while adult herring are consumed by loons, large grebes, and cormorants (Palmer 1962). High rates of kleptoparasitism by gulls can limit the foraging activities of waterbirds feeding on recently deposited herring eggs (Bayer 1980). Such disturbance is probably enhanced by the daily arrival at Walker Creek delta
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of several thousand gulls from a local landfill near Cotati, Sonoma County (Kelly et al. 1996).

If some waterbirds depend on herring (or herring roe) in winter, overharvest by the commercial herring fishery could limit their populations. Because annual harvest quotas are based on estimates of spawning biomass from the previous year, which fluctuate considerably, the fishery can over- or underestimate the proportion of herring being harvested (Suer 1987, Moore and Mello 1995). Well-informed ecosystem management will require focused research on the link between Pacific herring and waterbirds, accurate forecasts of spawning biomass, and cautious harvest quotas to guide the commercial herring fishery.

Interestingly, scoters occur in large numbers south as well as north of Pelican Point, rather than concentrating over the dense eelgrass areas (available to spawning herring) to the north. Also, Greater Scaup concentrate in the southern portion of the bay. However, herring normally spawn as far south as Tomasini Point, suggesting that the herring's habit of spawning in eelgrass is influenced by a preference for reduced salinities that could cause them to shift southward when the flow of fresh water into the bay is reduced (Moore and Mello 1995). Alternatively, the spatial responses of waterbirds to irregular herring runs may not be adequately sampled by our counts. Scoters and scap also feed on molluscs and other invertebrates (Bellrose 1976), suggesting that bottom sediments at the southern end of the bay (Daetwyler 1966) provide important foraging substrates for these species. Black Scoters, near the southern end of their Pacific winter range, are uncommon to rare elsewhere along the California coast (Grinnell and Miller 1944, McCaskie et al. 1979, Garrett and Dunn 1981). Our study indicates that annual concentrations of approximately 70 (max. 180) Black Scoters are regular along the east shore just north of Tomasini Point, reflecting similar concentrations, of approximately 60 birds, observed just below Highway One in this area each winter since 1961 (R. Stallcup pers. comm.) The cobbles and gravelly and shelly shoals that dominate the bottom substrates in this area (Daetwyler 1966) are consistent with preferred foraging substrates reported elsewhere for this species (Bordage and Savard 1995).

During winter, salinities, turbidity, sedimentation, and water exchange between the bay and the outer ocean vary greatly with the extent of freshwater runoff, especially near Lagunitas Creek (Holibaugh et al. 1988). Because of the linear configuration of the bay, the availability of prey species may be especially sensitive to anthropogenic and other terrogenous influences. For example, the long water-residence times of up to four months in the southern part of the bay during drought or summer (Holibaugh et al. 1988) imply that the bay may retain contaminants for long periods of time, potentially allowing toxic materials derived from watershed runoff to enter food webs or become trapped in bay sediments. Most diving ducks depend on benthic prey, which are in turn vulnerable to sediment contamination from the watershed (Cain 1988). Common Loons and other fish-eating birds avoid highly turbid water, presumably because it interferes with prey detection (Pehrsson 1984, Haney 1990). Extended water-residence times between periods of peak winter runoff interact with watershed erosion, leading to extended periods of high turbidity. Thus some waterbirds that concentrate
in the shallow southern end of the bay or near the mouth of Walker Creek could be limited by high turbidity generated by development or other activities in the watershed. Rafts of Western and Clark’s grebes usually concentrate over deeper areas (pers. obs.), possibly to avoid turbid runoff by foraging in pockets of clearer saline water near the bottom (Pehrsson 1984), although they may also reflect concentrations of prey fishes.

In a substantial portion of the bay, commercial aquaculture of oysters (Crassostrea gigas) and bay mussels (Mytilus edulis) has introduced various racks, floats, and bags that alter waterbird habitat on the surface and in the water column and may alter the structure of bottom substrates where diving ducks feed (Kelly et al. 1996). To our knowledge, scientific information on the effects of such structures on waterbird habitat does not exist.

In winter, waterbirds occupy open habitats where they generally rely on flight as a response to disturbance by predators or humans. Even diving birds such as loons and small grebes frequently rely on flight to escape disturbance by approaching boats, although large grebes escape by diving. Flight is energetically expensive in birds, with costs as high as 15 times the basal metabolic rate (King 1974). Optimal-foraging theory (Krebs et al. 1983) provides a framework for understanding disturbance, by predicting that birds must compensate for increased levels of disturbance, either by increasing their rate of food intake or flying to other, less profitable but less disturbed areas to feed. Many wintering waterbirds must also accumulate fat and protein reserves to override periods of low food availability and to prepare for spring migration (Davidson and Rothwell 1993, Baldassarre and Bolen 1994). If feeding opportunities are already restricted, or waterbirds are close to their energy threshold, direct disturbance by humans could have considerable energetic effects on individual birds, leading to abandonment of an area or starvation (Davidson and Rothwell 1993).

We observed dramatic increases in sport fishing, kayaking, and other recreational boating on Tomales Bay during the course of this study, especially where waterbirds concentrate in the northern third of the bay. Each boat is associated with a radius of disturbance determined by its speed of movement and the sensitivity of bird species. Fast-moving power boats, motorized personal watercraft (“jet skis”), and aggregations of boats such as occur around popular fishing spots create larger zones of disturbance (Burger 1981; pers. obs.). A few boats distributed across an eelgrass bed can prevent most waterbirds from using the area. Sea kayaks, unlike other recreational boats, tend to travel in loose groups that displace waterbirds from marsh edges, shallow coves, and sand bars. Low-flying aircraft occasionally track the linear shape of the bay, resulting in a wider band of disturbance than observed around boats (R. Stallcup pers. comm.).

Estuarine waterfowl may be seriously affected by even occasional disturbance during key parts of the feeding cycle. American Wigeon feeding in eelgrass beds return to feed if disturbed early in the (tidal) feeding cycle but abandon the site altogether, until the next tidal cycle, if disturbed after the eelgrass is exposed by the tide (Fox et al. 1993). Black Brant, which also feed on eelgrass in Tomales Bay, show similar avoidance responses to increased presence of humans (Stock 1993). In Tomales Bay, hunting disturbance is concentrated near the mouths of Lagunitas and Walker creeks; because
these are the only two large areas of coastal marsh habitat, similar areas are not available for refuge elsewhere on the bay. We did not measure flight distances, return rates, or other behaviors of birds that flushed occasionally in response to the movement of our observation boats.

The array of potential conflicts between human activities and wintering waterbirds on Tomales Bay implies the likelihood of cumulative or synergistic effects. Long-term protection of waterbird populations on Tomales Bay may depend on broad-based planning, in which diverse agencies cooperatively consider overall management effects on abundances and distributions of waterbirds. We recommend that management efforts focus on controlling boat traffic and other forms of direct human disturbance, protecting eelgrass beds, assessing the effects of herring harvest and aquaculture on waterbirds, and monitoring human land use and other processes in the watershed that may affect the quality of waterbird habitats in the estuary.

SUMMARY

We analyzed patterns of abundance and distribution of wintering waterbirds in Tomales Bay, California, on the basis of 21 baywide winter surveys over 7 years from 1989-90 to 1995-96. Total waterbird abundances averaged 21,943 (min. 14,842, max. 25,553), excluding shorebirds and gulls. Mean waterbird density was 770 birds/km² with the greatest concentrations along the east shore and between Pelican and Tom's points. The Surf Scoter, Bufflehead, and Greater Scaup together accounted for 70% of the total waterbirds. Aerial count data from the U. S. Fish and Wildlife Service Midwinter Waterfowl Survey underestimated the numbers of waterbirds in comparison to our counts made from boats. Such differences adjusted for, our abundance estimates for scoters and Bufflehead appear similar to other abundances reported in the 1960s and 1970s. Compared to other coastal wetlands in California, Tomales Bay provides particularly important winter habitat for the Red-throated and Common loon, Eared and Horned grebe, Black Brant, Surf and Black scoter. Except for San Francisco Bay, Tomales Bay may provide the most important winter habitat for the Bufflehead on the Pacific coast south of the Columbia River. Waterbird distributions on Tomales Bay are associated with a dynamic array of habitat conditions. Increasing human activities in Tomales Bay and its watershed interact with these processes and conditions and suggest several concerns for conservation of winter waterbirds. Protection of waterbird populations will require particular attention to the control of human disturbance, protection of eelgrass beds, the possible effects of the herring fishery and aquaculture, and management of processes in the watershed.

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We thank the following: Tom Baty for his excellent leadership and assistance in planning, coordinating, and conducting the counts; Richard Allen, Tom Baty, Robert Cardwell, George Curth, Sam Dakin, Rick Grieve, Richard Plant, Erich Rienecker, and the Inverness Yacht Club for volunteering their boats and skills as boat operators; Bill Beal, Grant Fletcher, David Hartje, Kirk Hastings, Pat Garmy, and Skip Schwartz for operating the Audubon Canyon Ranch boat; David Shuford and Rich Stallcup for helpful suggestions on census methods and excellent comments on an earlier draft of this paper; and Stephen F. Bailey and Tim Manolis for helpful suggestions on improving the final manuscript. This paper is a contribution of Audubon Canyon Ranch.

LITERATURE CITED


WINTER WATERBIRDS ON TOMALES BAY, CALIFORNIA


WINTER WATERBIRDS ON TOMALES BAY, CALIFORNIA


Accepted 13 January 1998
NOTES

FLICKER DESTROYS VACANT CLIFF SWALLOW NESTS

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During the winters of 1994-95 and 1995-96, over a dozen Cliff Swallow (Petrochelidon pyrrhonota) nests on the campus of California Polytechnic State University, San Luis Obispo, California, were totally destroyed. The nests, originally built about 9 m from the ground on Fisher Science Hall, were knocked down, leaving clods of dried mud on the pavement below and only the outlines of the nests under the overhang where they were built. In the first case, a student told me he had seen a Northern Flicker (Colaptes auratus) destroy them. In the second case, a fellow faculty member unfamiliar with bird identification described what could only have been a flicker doing the damage. On 11 December 1996 I witnessed a flicker (sex undetermined) attacking nests in the same location as the previous years. At 11:00 AM the bird flew in from an adjacent building, which later proved to have two destroyed swallow nests, and landed in typical woodpecker posture on the first of 11 nests under an overhang. To the unaided eye, there were no obvious insects or other prey items on the nests. The bird proceeded to strike the side of the nest below the opening several times with its bill, showering the pavement with large chunks of dried mud and opening a hole about 15 cm across into the nest's interior. Its movement were indistinguishable from normal flicker tree-trunk foraging. I was unable to determine whether it obtained anything to eat. After about 20 sec it moved to the next nest in line and repeated the behavior. After visiting a third nest and partially destroying it, the flicker flew away. On 31 December 1996 I returned to the building and noted that all 15 nests on this site (11 on one wall, 4 on another) had been completely destroyed, and the shattered remains were on the ground.

Neither Bent (1939) nor Moore (1995) mentioned this as a foraging tactic for any flicker, and Brown and Brown (1995, 1996) did not record any flicker damage to Cliff Swallow colonies. Red-headed Woodpeckers (Melanerpes erythrocephalus) have been noted drilling holes in nests (Brown and Brown 1995), Acorn Woodpeckers (M. formicivorus) removing eggs after enlarging or destroying the necks of nests (Fajer et al. 1987), but these activities took place during the breeding season. Possibly, the bird in question has, in the past, been rewarded for this behavior by obtaining food, though flickers' diets are primarily ants (Beal 1911), and the lateness of the season of these observations probably precludes an infestation of ants in the colony due to broken eggs or dead chicks. In the winter, nest boxes in coastal San Luis Obispo County frequently contain small numbers of a species of bumble bee (Apidae: Bombus), as well as occasional wax brood chambers containing grubs of these insects (pers. obs.). Additionally, there are sometimes maggots (Diptera, probably Calliphoridae) and beetles (Coleoptera). All of these might also occur in vacant Cliff Swallow nests and represent potential prey (Beal 1911).

An additional possibility arises from the fact that flickers, especially in western North America, are known to damage buildings by pecking holes in cornices, cupolas, eaves, and walls for nesting or roosting places (Beal 1911, Bent 1939). If this bird was attempting to excavate a roost hole, it must surely have been frustrated by the insubstantial nature of the substrate.
NOTES

LITERATURE CITED


Accepted 11 January 1998

SOOTY TERN REACHES THE ALEUTIAN ISLANDS, ALASKA

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From 4 to 16 September 1997 two of us (Winker and Dickerman), representing the University of Alaska Museum and with the cooperation of the Alaska Maritime National Wildlife Refuge and the U.S. Coast Guard, conducted an intensive survey of the early-fall avifauna in the Massacre Bay area of Attu Island, the westernmost of the Aleutian Islands, Alaska. The Coast Guard operates a Long Range Navigation (LORAN) Station there (at 52° 50'N, 173° 11'E), which for decades has formed part of the primary source of marine navigational information for the North Pacific. Its 650-ft tower probably provides a biologically insignificant hazard to birds but does cause some mortality.

Supplementing our work on the local breeding landbird species, we searched nearly daily beneath the tower cables, where we found the feather remains (usually without bones) of birds that had hit the guy wires and that had been consumed or partly consumed by scavenging Arctic Foxes (Alopex lagopus) or Norway Rats (Rattus norvegicus), the former introduced long ago by Russian explorers and the latter introduced either by these same explorers or by later visiting ships, American or Japanese.

Tower casualties that we discovered during this period included two Short-tailed Shearwaters (Puffinus tenuirostris), 12–15 Fork-tailed Storm-Petrels (Oceanodroma furcata), one Black-legged Kittiwake (Rissa tridactyla), one Short-eared Owl (Asio flammeus), one Lapland Longspur (Calcarius lapponicus), and a headless "black and white" waterbird—a featherless trunk skeleton with both attached legs and feet and both attached wings. Only the proximal half of one wing was feathered, but we found some associated, unattached primary remiges and other feathers. We collected these
remains (RWD 24224), tentatively considering them to be those of an unidentified shearwater. Subsequently, at the University of Alaska Museum this specimen (UAM 7280) was provisionally identified by Gibson as an adult Sooty Tern (Sterna fuscata), an identification later confirmed at the U.S. National Museum by Roger B. Clapp, Carla J. Dove, and Richard C. Banks (in litt.). There is no previous Alaska record of this abundant pantropical species.

This bird likely reached Attu driven by one of several storms that originated as typhoons in the northwest Pacific originate in the area between 5° and 20°N and between 170°E and the Philippines (Gould 1974), deep within the range of the Sooty Tern. Initially these storms move west or west-northwest from the source region; those that reach higher latitudes tend to recurve and move northeast (ibid.). The Alaska Sooty Tern is thus probably an example of S. f. nubilosa Sparrman, which nests in the Indian Ocean, tropical Asian waters, and western Pacific islands north to the southern Ryukyu Islands (Peters 1934, Ornithological Society of Japan 1974), or, if separable, of S. f. oahuensis Bloxham, which breeds in the tropical North Pacific from Christmas Island and the Hawaiian Islands to Marcus Island (Peters 1934). Occurrences in the main Japanese islands, as far north as Hokkaido, have taken place "mainly after late summer and early autumn typhoons from July to October" (Brazil 1991:159). Although nubilosa is the only subspecies attributed to the main islands of Japan (Ornithological Society of Japan 1974, Brazil 1991), there have been at least nine recoveries there of typhoon-driven Sooty Terns that had been banded in the Hawaiian Islands or at Johnston Atoll (Gould 1974). The only well-supported characters used to differentiate subspecies of the Sooty Tern are bill shape and color of plumage of the lower belly and crissum. Since the Attu specimen lacks these parts, it is not possible to evaluate its subspecific identity directly.

For support and generous cooperation we acknowledge the University of Alaska Museum, Kodiak National Wildlife Refuge, Alaska Maritime National Wildlife Refuge, and the United States Coast Guard (at Juneau, Kodiak, and Attu); and we thank Robert L. Pitman and Philip Unitt for their reviews of the manuscript.

LITERATURE CITED


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FIRST RECORD OF A CUCULUS CUCKOO ON MIDWAY ATOLL AND THE HAWAIIAN ISLANDS

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On 23 May 1997 we found and photographed a gray-plumaged cuckoo of the genus *Cuculus* on Midway Atoll, constituting the first record of this genus in the Hawaiian Islands and in the central Pacific Ocean east of Palau. We suspect it was a Common Cuckoo of the southeastern subspecies (*C. canorus* *telephonus*) but cannot eliminate the Oriental Cuckoo (*C. saturatus*) at this time.

Pyle discovered the cuckoo at about 1530 as it flew down the active runway toward Frigate Point at the southwestern tip of the island. He alerted Nestler by phone, then, in the company of several volunteers assisting with seabird research, pursued the bird around the vicinity of Frigate Point. We saw the bird both sitting and in flight and obtained several photographs (Figure 1). The bird was last seen at about 1630 flying

Figure 1. Cuckoo (*Cuculus* sp.) on Midway Atoll, northwest Hawaiian Islands, 23 May 1997.

*Photo by Peter Pyle*
into a grove of ironwoods (Casuarina equisetifolia) to the south of the runway. We observed the bird for a total of 5 to 10 minutes, with 8x and 10x binoculars, at ranges as close as 20 m.

Both of us recognized the bird as either a Common or an Oriental cuckoo, and we concentrated on the underparts and undertail coverts of the bird, knowing that this area was important for identification but not knowing how these two similar species differed in the plumage of this region. We described the bird and Pyle sketched it before consulting any literature. The following is a composite description based on these original field notes:

A large cuckoo, larger than a Yellow-billed Cuckoo (Coccyzus americanus) and about the size of a female Sharp-shinned Hawk (Accipiter striatus) or, in direct comparison, a Brown Noddy (Anous stolidus). The upperparts, head, and breast were uniformly medium-dark gray with a bluish tinge. The cuckoo was about the same color, if not a bit paler, than that of the upperparts of an adult Sharp-shinned or Cooper’s (Accipiter cooperii) hawk. The tail was blackish or black, contrasting distinctly with the paler back and uppertail coverts. When the bird wheeled in flight (being chased by noddies), four or five partial white bars across the tail were visible. The underparts below the breast were white, with indistinct grayish barring. The grayish bars were approximately 1 mm wide and did not contrast markedly with the white base coloration. The exact point at which the barring stopped, ventrally, was not noted, but the undertail coverts and vent area appeared to be white, without barring. The iris was yellow. The bill was blackish above with a yellow base that extended farther along the mandible than along the maxilla.

The literature (e. g., Cramp 1985, Redman 1985, Parkes 1990, Kennerley and Leader 1991) indicates that the Common and Oriental cuckoos are difficult to separate in the field, the Oriental averaging darker on the upperparts, which do not contrast markedly in color with the tail, and buffer or more ochre on the underparts, with thicker and blacker barring, the ochre and barring extending to the undertail coverts. The subspecies of the Common Cuckoo occurring in central Asia and Japan, C. c. telephonus, has paler barring on the underparts than does the nominate subspecies occurring from Europe to Siberia (Cramp 1985. Parkes 1990, Kennerley and Leader 1991). The Oriental Cuckoo shows moderate geographic variation in size but little or no variation in plumage (Cramp 1985). To evaluate the identification of the Midway bird, Pyle examined all 24 specimens of the Common and all 7 specimens of the Oriental Cuckoo at the Museum of Vertebrate Zoology (MVZ), Berkeley, California. This specimen examination confirmed the variation noted above (see Figure 2) and suggested that the Midway bird was a Common Cuckoo of the subspecies telephonus.

The specimens of the Common Cuckoo included 17 telephonus and 4 canorus. The specimens of telephonus (nine of which were collected between 18 May and 7 June) had very indistinct barring on the underparts and, especially, the undertail coverts in comparison with nominate canorus and the Oriental Cuckoo (four of which were collected between 16 and 27 May); there was no overlap among the specimens in underpart plumage between telephonus and either of these other forms (Figure 2). The bird of Midway had barring that matched the paler specimens of telephonus; in particular, a bird collected 23 May 1953 near Seoul, South Korea (MVZ 130838; Figure 2), was nearly identical in underpart plumage to that of the Midway bird. Additionally, the Oriental Cuckoos all had buffy or ochre-colored base coloration to the underparts and undertail coverts, in contrast to the pure white coloration of the Common Cuckoos and the Midway bird. These specimens imply that telephonus differs in underpart plumage more from nominate canorus than the latter does from the Oriental Cuckoo, as noted by Parkes (1990).
Figure 2. Specimens of *Cuculus canorus canorus* (right two birds), *C. c. telephonus* (center two birds), and *C. saturatus* (left two birds). In each case the specimen (of those at MVZ; see text) with the boldest barring within each form is on the left, and the specimen with the sparsest barring is on the right. The appearance of the bird from Midway matched the paler specimen of *telephonus* (third specimen from the left). From left to right, MVZ 101637 (collected 12 May), 109077 (2 July), 143575 (17 September), 130838 (23 May), 134619 (19 May), and 140272 (16 May).

The upperparts of all Common Cuckoo specimens were similar in coloration, and differed from those of all specimens of the Oriental Cuckoo in being paler and contrasting markedly with the duskier tail. The upperparts of the Oriental Cuckoos were uniformly dark grayish to dusky, contrasting only slightly with the darker coloration of the rectrices. Again, in these differences, the Midway bird matched the Common rather than the Oriental Cuckoo.

The best ways to separate Common and Oriental cuckoos in the hand are by the amount of barring on the carpal coverts and the pattern of the underwing coverts (Parkes 1990, Kennerley and Leader 1991), areas that were not observed on the Midway bird. Although the Midway bird matched the pale extreme of the Common Cuckoo specimens examined, there may be overlap in underpart plumage between *C. c. telephonus* and the Oriental Cuckoo, perhaps confounded by age/sex-specific variation. The full range of this overlap, if it exists, has yet to be determined (M. R. Leven, P. J. Leader, and G. Carey pers. comm.). Thus, until a thorough study is made, we feel it prudent to leave the specific identity of the Midway bird indeterminate. Should there prove to be little or no overlap in underpart plumage between Oriental Cuckoo and *C. c. telephonus*, however, we would feel confident considering the Midway bird as the latter.

In the western Pacific, the Common Cuckoo has been recorded in Palau but on no other islands of Micronesia (Pyle and Engbring 1985, Pratt et al. 1987, Reichel and Glass 1991), whereas the Oriental Cuckoo has been recorded in Palau and Yap (Pyle
and Engbring 1985) and perhaps is the more expected species in the region (Pratt et al. 1987). Both species reach Alaska rarely but regularly (Gibson and Kessel 1997).

The Midway record constitutes the first for this genus in the Hawaiian Islands. A Yellow-billed Cuckoo photographed on Laysan Island on 1 November 1994 (R. L. Pyle pers. comm.) constitutes the only other record of a cuculiform in these islands.

We thank Oceanic Society Expeditions and the U.S. Fish and Wildlife Service for facilitating our presence on Midway, which was converted from a naval base to a National Wildlife Refuge on 1 July 1997. Pyle thanks Ned K. Johnson and Barbara Stein of MVZ for permission to examine specimens there, R. L. Pyle for information on the Yellow-billed Cuckoo, and G. Carey, D. D. Gibson, Steve N. G. Howell, J. P. Leader, and M. R. Leven for reviewing the manuscript. This is contribution 744 of the Point Reyes Bird Observatory.

LITERATURE CITED


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BOOK REVIEWS


This is the second edition of a book first published in 1983, from which the present work differs mainly in its additional treatment of all hummingbird species found south to the Isthmus of Tehuantepec, in southern Mexico, thus widening the definition of North America to a biogeographic rather than political boundary. The first edition was widely reviewed and praised (e.g., Wilson Bulletin 96:155–156, 1984; Auk 101:407–408, 1984), and it pleasing to see that reviewers’ comments have been addressed in the present edition. For example, despite its expanded scope, the second edition is 25 pages shorter than the first because of more intelligent use of page space.

The book has two sections. Part 1 (Comparative Biology of Hummingbirds) is an overview of this fascinating avian family, with brief summaries of classification, distribution, evolution, anatomy, ecology, behavior, and breeding biology. Part 2 (Natural Histories of North American Hummingbirds) comprises species accounts, with maps, for all 47 species covered. Four appendices (synoptic identification keys [bills often appear too short] for both North American and Mexican species, a glossary, and a discussion of the origins of scientific names), a useful bibliography, and index round out this recommended work. The former appendix of “hummingbird-adapted plants” is omitted from the second edition. The sixteen color plates from the original edition have been supplemented with four in similar style showing Mexican species at identified food plants, plus a reproduction (very yellow in my copy) of Sophie Webb’s four hummingbird plates from A Guide to the Birds of Mexico and Northern Central America (Howell and Webb 1995, Oxford Univ. Press).

Looking through the second edition, I was struck by two thoughts. First, classification is not this book’s forte. While one may not necessarily agree with the American Ornithologists’ Union, many generally accepted taxonomic opinions are not noted in Hummingbirds: e.g., AOU (1983) recognized the Long-tailed Sabrewing as a species; AOU (1991 supplement) split the Short-crested Coquette as a species, and AOU (1993 supplement) split the Mexican Woodnymph as a species. Second, the copy editor should seek work in another field: typos are rife, at least in the newly added material. For example, on page 111 see Townsend (sic = Howell) and Webb (1995) and Escalante-Pilego (correctly cited as Escalante-Pliego a few lines above), on page 259, “from the Green [sic = Greek] kuanos.”

While some may criticize technical content, and I wouldn’t rely on the field-identification sections (on the basis of the first species I checked, the Berylline Hummingbird), Johnsgard’s writing style makes information accessible to lay person, field birder, and professional museum ornithologist alike. I recommend this book as a good general reference, and anyone with an interest in hummingbirds could learn something from it.

Steve N. G. Howell

California’s fourth breeding atlas and the first for southern California, this volume reports on data collected from 1985 to 1990, plus selected records through 1994. Dividing the county into 5 × 5-km squares yielded 61 full and 50 partial blocks, a respectable 79 percent of which Gallagher deems to have been covered to a “good” or “excellent” degree; because the Santa Ana Mountains account for most of the area afforded “poor” to “marginal” coverage, I expect that exciting discoveries still lurk in this poorly known range. Gallagher properly notes that drought prevailed during the six years of atlasing, which undoubtedly depressed populations of many species.

A lengthy introductory table summarizes each species’ habitat usage (nesting and foraging) and status (threatened, endangered, or a subjective assessment of the local status). The habitat information is generally accurate, but treat with caution the “status” column. Among breeding birds said to be “declining,” the Tree Swallow and Western Bluebird seem clearly to be increasing in Orange County (following earlier decline), and the Royal Tern colonized Orange County in 1988 and maintains a tiny outpost at Bolsa Chica State Ecological Reserve; meanwhile, the elusive Long-eared Owl receives no status, though the “rare” code is applied to such uncommon (to locally common) species as Allen’s Hummingbird, Downy Woodpecker, and Purple Finch, as well as the Northern Shoveler, which is not known to nest in the county.

The layout and execution are comparable with, but a step below, those found in Betty Burridge’s 1995 *Sonoma County Breeding Bird Atlas* (Madrone Audubon Society, Santa Rosa, Calif.). As in that atlas, acetate overlays are provided for placement over range maps to augment the information provided; their utility is marginal, however, mainly because of the tiny scale of the maps and the large size of the atlas blocks. The species accounts in these two atlases are also comparable, but Gallagher did not limit her treatments to a single page; readers will find welcome extra detail for many scarce and declining species, including the Great Blue Heron, Clapper Rail, Snowy Plover, Least Tern, Cactus Wren, California Gnatcatcher, Bell’s Vireo, and Tricolored Blackbird. Each account includes a black-and-white photograph and a range map showing blocks where breeding was considered “possible,” “probable,” or “confirmed,” plus the estimated breeding abundance (order of magnitude) within each block. Gallagher found it necessary to adjust participants’ abundance estimates for “many blocks” on the basis of “more credible reports in nearby [sic] blocks,” and she warns that this information “should be used with caution.”

Atlas participants documented nesting, or at least probable nesting, for the vast majority of species expected within parts of the county that were adequately covered, and owls are surprisingly well represented. Abundance codes do not appear to be inflated for any species, and reports of rare species are generally credible, though skepticism is occasionally warranted. For example, Orange County’s only “confirmed” nesting record of Cattle Egret amounts to “a small number of Cattle Egret nests with young on the small island in the lake in Laguna Niguel Regional Park [observed] during the spring of 1987 or 1988.” A detailed description, year, and date(s) should be mandatory for such an exceptional claim.

The species accounts overcome indifferent organization to impart worthwhile information, including natural history gleanings from 159 cited references, many local and regional. Among the book’s more important contributions is the liberal provision of dates for locally observed nesting behaviors, such as nest-building, egg-laying, and fledging; original descriptions of breeding behavior, habitat composition, nest placement, etc., are occasionally furnished. As atlas projects are particularly well suited to generating location-specific breeding information, atlas compilers are encouraged to solicit its accurate collection for incorporation into future publications.
Typographic errors are rare, but a few layout miscues are evident: the Osprey's map is missing, the account of the Peregrine Falcon features a photograph of a Northern Harrier, and the Prairie Falcon account shows a Peregrine. More importantly, readers occasionally may be confused by the mix of atlas-period and post-atlas records, and it's often hard to ignore the considerable lag between the 1990/1994 data cutoff and the 1997 publication date. For example, "Category 2" candidacy for federal listing is cited for several species, but this classification has been defunct since February 1996, and the book's sole account of nesting by a pair of Western or Clark's Grebe at Oso Reservoir in "May 1988" tells a dated and incomplete story, since dozens of pairs of each species nested there in 1995 and 1996; Doug Willick and I published this information in *The Birds of Orange County, California; Status and Distribution* (Sea & Sage Audubon Press, Irvine, Calif.), a 1996 publication cited as a 1994 manuscript. These types of difficulties cannot be overcome easily once publication falls substantially behind schedule, a point to be carefully considered by would-be atlas compilers.

Each species account concludes with worthwhile tips on viewing the species in Orange County and, usually, one or more management recommendations. Gallagher properly encourages birders to provide nest boxes for embattled secondary cavity-nesters, and is at her best urging land managers to preserve weedy patches and emergent vegetation while eliminating invasive exotic species. Regrettably, however, some recommendations betray a lack of sophistication regarding land-use policies and regulations. Most grievously, I detected no mention of the Natural Communities Conservation Plan (NCCP), the comprehensive land-planning venture that has relegated great chunks of Orange County to destruction in order to create a massive (37,000 acres to date) and reasonably cohesive natural reserve system intended to conserve local (and ultimately regional) populations of the Cactus Wren and California Gnatcatcher, plus a host of other biologically "sensitive" species.

Following the species accounts is a section of "Former, Hypothetical, and Possible Future Breeders," which would seem the proper place for consideration of most species that were not "confirmed" or at least "probable" breeders between 1985 and 1994 (e.g., the American Bittern, Least Bittern, Osprey, Prairie Falcon, Willow Flycatcher, Purple Martin, Solitary Vireo). Among background material presented in 10 appendices, Appendix F contains brief descriptions of habitats and imminent changes within each atlas block that may be of use to certain researchers.

As distributional references and conservation tools, breeding bird atlases possess great intrinsic value due to the breadth and depth of information gathered across large areas over extended periods. Thus, while this atlas may not serve as an ideal model for others to follow, it is highly recommended to biologists, birders, land planners, and others interested in the status and distribution of breeding birds in southern California. Those involved are to be commended for producing an atlas before most California counties have commenced such a project; it will serve as a useful benchmark. Copies may be purchased at Sea & Sage Audubon House in Irvine, or ordered by telephone for mail delivery: (714) 261-7963.

Robert A. Hamilton
FEATURED PHOTO

VARIATION IN THE SHARP-TAILED SPARROWS

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In 1995, following Greenlaw (1993), the AOU split the Sharp-tailed Sparrow into two species, the Saltmarsh (Ammodramus caudacutus) and Nelson’s (A. nelsoni) Sharp-tailed Sparrows. The former breeds in coastal saltmarshes of the central East Coast, the latter in the northern interior, around the southern coast of Hudson Bay, and along the northeastern seaboard. Both species winter along the southern Atlantic coast of the U.S.; Nelson’s also occurs along the northern coast of the Gulf of Mexico, and small numbers reach coastal California.

Rising (1996) discussed plumage features distinguishing the Saltmarsh from Nelson’s in the field and indicated that these species are readily separable by fairly simple means (e.g., presence vs. absence of breast streaking). Sibley (1996) covered the plumage and structure of the sharp-tailed sparrows, acknowledged identification pitfalls due to hybridization and plumage variability, and proposed field marks to help refine our ability to distinguish the two. Mlodinow (1997) voiced concerns that photographs in Sibley (1996) did not always agree with the text and that some birds pictured might not be identifiable to species in the field, valid points that reflect two related issues. First, even an excellent photograph does not always enable a bird to be identified; take heed of this when watching any problematic species—do not walk away once you think you have a good photograph. Rather, watch the bird, make sketches and field notes, and try to obtain a series of photos. Second, the two species of sharp-tailed sparrow can indeed be difficult to distinguish!

Integral to advancing our knowledge of any such identification problem is an appreciation of individual variation within a species. In California, the only known sharp-tailed sparrow is the brightly marked nominate race of Nelson’s (A. n. nelsoni), on geographic grounds the form most expected to occur. The Saltmarsh Sharp-tailed Sparrow is most unlikely in the West. Key plumage features Sibley (1996) listed for nominate Nelson’s relative to the Saltmarsh: bright orange in face contrasts little or not at all with the orange breast and usually buffy throat; grayish whisker line, so orange submoustachial blends directly into buffy throat; breast streaking usually faint grayish or brownish, mainly on sides of lower breast; the orange breast contrasts sharply and cleanly with the white belly. The duller, northeast Atlantic coast race of Nelson’s, A. n. subvirgatus, is relatively distinctive, as discussed by both Rising (1996) and Sibley (1996).

Howell photographed the trio shown on the back cover when they were caught and banded at Bolinas Lagoon, Marin County, California, on 25 January 1990. All were considered to be nominate Nelson’s (supported by measurements), and they showed a healthy degree of intraspecific variation. In particular, the heavy dark breast streaking of two birds, and the dark whisker and whitish throat of the center bird, are atypical of Nelson’s. One visible plumage feature favoring Nelson’s is the similar color and tone of orange on the face and chest. Interestingly, though, a different, close-up photo of one of these birds suggests that the face is brighter than the chest (similar to Figure 12 of Sibley 1996), again highlighting the danger of using photos to evaluate subtle tones and contrasts. Other photos of all three birds show a contrasting white belly (not shown well in the Featured Photo, but good for Nelson’s).

Which plumage features should be given greater weight in establishing an identification? Having learned the inherent variability of some plumage features, many field
observers are extending their focus to structural characters that tend to be less variable. For example, while the typical colors of female Scarlet (Piranga olivacea) and Summer (P. rubra) tanagers are reasonably distinctive, an oddly plumaged bird could present problems—but not if one studies details of bill structure. Sibley (1996) noted two structural characters that might be of use for separating Nelson’s and Saltmarsh sharp-tailed sparrows: bill size and primary projection, i.e., how far the primaries on the closed wing project beyond the tertials.

Nominate Nelson’s (such as the left-hand bird in the Featured Photo) typically has a shorter and proportionately less slender bill than the Saltmarsh (cf. Figure 3 in Sibley 1996). Note, though, that all sharp-tailed sparrows have relatively long, slender bills, that the two species’ bill lengths overlap (Pyle 1997), and that clear views from the side are needed to evaluate this feature accurately (cf. the foreshortened bill in Figure 1 of Sibley 1996). Because the two species’ bill depths are similar, however, it is the ratio of length to depth that contributes to the longer, more slender-looking bill of the Saltmarsh Sharp-tailed Sparrow. Thus, in eleven specimens each of A. n. nelsoni and A. c. caudacutus, exposed culmen divided by bill depth at the base gave ratios of 1.6 to 1.9 (mean 1.75) for Nelson’s, 1.9 to 2.1 (mean 2.0) for the Saltmarsh. Pyle (1997) gave primary projections of 5–12 mm for Nelson’s, which migrates farther, and 0–7 mm for the Saltmarsh. Thus, little to no primary projection indicates a Saltmarsh Sharp-tailed, a moderately long primary projection a Nelson’s. Nevertheless, the two species’ bill shapes and wing-tip projections can overlap, and a suite of characters should be used in any attempt to identify problematic birds.

Nominate Nelson’s appears slightly smaller with a shorter, smaller bill and more rounded head, the Saltmarsh slightly larger, longer billed, and flatter headed. These structural differences are quite noticeable in direct comparison, though their use as field marks requires some comparative experience. Among plumage features, we suggest that observers ignore breast streaking and focus on the overall brightness and contrast of the underparts: nominate Nelson’s appears more uniformly washed with orange on the face and chest, and the white belly contrasts relatively strongly with the orange chest. The Saltmarsh typically shows the brightest orange in its face, with the breast a paler shade that does not contrast strongly with the dingier belly.

Sharp-tailed sparrows often creep through dense vegetation, so some birds may not be seen well enough to discern the characters needed to confirm identification. As always, responsible field identification must include the willingness to let some birds “get away” as unidentified, rather trying to force upon them an identity.

We thank Luis Baptista and Karen Cebra at the California Academy of Sciences for access to specimens in their care, and Nina Karnovsky and Peter Pyle for their help with catching and banding the birds shown here. The manuscript benefited from comments by Robb Hamilton. This is contribution number 754 of the Point Reyes Bird Observatory.

LITERATURE CITED


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Good photographs of rare and unusual birds, unaccompanied by an article but with caption including species, date, locality and other pertinent information, are wanted for publication in Western Birds. Submit photos and captions to Photo Editor. Also needed are black and white pen and ink drawings of western birds. Please send these, with captions, to Graphics Manager.
REPORT OF THE CALIFORNIA BIRD RECORDS COMMITTEE: 1995 RECORDS

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This report covers 136 records of 73 species submitted to the California Bird Records Committee (hereafter the CBRC or the Committee). Although most records pertain to birds found in 1995, the period covered by this report extends from 1970 (and 1918 for one specimen record) to 1996. Accepted were 102 records of 56 species, for a fairly typical acceptance rate of 75%. Of the records not accepted, 31 were excluded on the basis of identification not established, three on questions of natural occurrence. Counties best represented by accepted records were San Francisco (15, nearly all from Southeast Farallon Island), San Diego (10), Monterey (9), Imperial (8), Marin (7), Los Angeles (6), and Humboldt, Kern, and Santa Barbara (5 each).

Highlights of this report include accepted records of three species of Old World warblers (family Sylviidae), two of which are new to the California list: the Lanceolated Warbler (Locustella lanceolata) and Arctic Warbler (Phylloscopus borealis). After deliberations that lasted nearly as long as the CBRC itself, acceptance of a 1972 record of the Black Vulture (Coragyps atratus) added that species to the state list as well. A previously accepted 1970 record of the Band-rumped Storm-Petrel (Oceanodroma castro) was reassessed, and the final vote resulted in the deletion of that species from the state list. With a net gain of two species, the California list as of this report stands at 599, incorporating species-level splits from the American Ornithologists’ Union (1997). In addition, the Swallow-tailed Gull (Creagrus furcatus), Red-legged Kittiwake (Rissa brevirostris), Ivory Gull (Pagophila eburnea), and White-winged Tern (Chlidonias leucopeterus) have been accepted for the state list and will be treated in the next CBRC report. With these four species the California bird list will be 603. Further prospective additions currently under review by the Committee are the Shy Albatross (Thalassarche cauta), Parkinson’s Petrel (Procellaria parkinsoni), Great-
winged Petrel (Pterodroma macroptera), Crested Caracara (Caracara plancus), Slaty-backed Gull (Larus schistisagus), and Buff-collared Nightjar (Caprimulgus ridgwayi).

Committee News. At the January 1998 Committee meeting held in Alviso the duties of the secretary position were further divided. Michael M. Rogers was elected secretary in a non-voting capacity; immediate past secretary David V. Blue will continue in the role of CBRC technical-support specialist. The Committee’s membership at the close of the January 1998 meeting consisted of Michael M. Rogers and the following ten voting members: Richard A. Erickson (chair), Matthew T. Heindel (vice-chair), Kimball L. Garrett, Steven N. G. Howell, Alvaro Jaramillo, Guy McCaskie, Joseph Morlan, Mike San Miguel, Stephen C. Rottenborn, and Daniel S. Singer. Additional recent Committee members who voted on many of the records treated in this report include Shawneen E. Finnegan, Michael A. Patten, Peter Pyle, and Scott B. Terrill. The most important by-law change adopted was the limitation of members to a single three-year term before a mandatory hiatus from the Committee (prior to this change, members could be elected to two consecutive three-year terms before being ineligible for reelection); the Committee hopes that the new system will increase participation in the review process.

The Scissor-tailed Flycatcher (Tyrannus forficatus) was removed from the Review List, whereas the recently split Long-billed Murrelet (Brachyramphus perdix) and Blue-headed Vireo (Vireo solitarius) were added. The Committee will review all records of the murrelet and all records after July 1997 of the vireo; documentation for earlier records of the Blue-headed Vireo is requested but will be analyzed differently. The Review List may be obtained from the Committee’s World Wide Web site (www.wfo-cbrc.org). This site also includes the California state list, a reporting form for direct e-mail submission of records to the CBRC, the addresses of current Committee members, a photo gallery of recent submissions, a list of relevant publications by CBRC members, and other information about the CBRC, as well as about Western Field Ornithologists and Western Birds.

One minor change adopted here involves the format of the record number; that number now consists of the year (of submission) followed by a three-digit individual number assigned to the record. For example, what was formerly record number 31-1995 becomes 1995-031.

CBRC Functions. All records reviewed by the CBRC (including copies of descriptions, photographs, videotapes, audio recordings, and Committee comments) are archived at the Western Foundation of Vertebrate Zoology, 439 Calle San Pablo, Camarillo, California 93012, and are available for public review. The CBRC solicits and encourages observers to submit documentation for all species on the Review List, as well as species unrecorded in California. Documentation should be sent to Michael M. Rogers, CBRC Secretary, P. O. Box 340, Moffett Field, CA 94035-0340 (e-mail: mrogers@nas.nasa.gov).

Documentation. For records in the present report an average of 2.58 observers/record submitted reports, but this number was higher (2.97 submissions/record) for accepted records than for those not accepted on the basis of identification (1.30 submissions/record). Documentation in the
form of photographs accompanied 55% of the accepted records but only
17% of the records not accepted on the basis of identification. Occasionally
records with seemingly good photographic documentation are not accepted
because there are no accompanying written details; Committee members
(and birders in general) are well aware of how photographs (especially a
single exposure) can be misleading, and it is always desirable to augment this
"tangible" documentation with written descriptions and accounts of the
conditions and circumstances of observation.

Relatively few records are supported by original notes (or copies) taken in
the field during observation. Such "contemporaneous" documentation is
highly desirable, since it is inevitable that details will be lost or muddled if
there is a significant time lag between observation and the production of
documentation. Committee members and knowledgeable birders tend to
reject the notion of "photographic memory." In general, descriptions are
viewed less favorably if written long after the observation or after references
such as field guides or handbooks are consulted. Observers submitting
documentation should always indicate when the documentation was written
and whether or not it was based on notes taken during the observation;
photocopies of contemporaneous field notes or sketches should always be
submitted if they exist. For the present report, only 13.4% of observers of
accepted records submitted copies of notes made in the field during
observation; this percentage dropped to 5.1% for unaccepted records. An
additional 8.9% of observers of accepted records explicitly indicated that
their documentation was based on notes made in the field even though
copies of those notes were not included.

"Ideal" documentation for non-specimen records might include a series of
photographs (and videotape or audiotape, where appropriate), copies of
notes and sketches taken in the field during observation, and additional
documentation neatly written, signed, and dated by the observer. Submission
of such documentation by multiple observers is obviously desirable. We
recognize that it is often difficult or impossible to obtain photographs and
that the generation of notes and sketches in the field during observation
must be balanced with careful and critical viewing and confirmation of
characters. Since it is generally not possible to observe and write descrip-
tions at exactly the same time (although tape recorders are helpful in this
regard), the notion of "contemporaneous" documentation must be viewed
realistically.

Format and Abbreviations. As in other recent CBRC reports, records are
listed geographically, from north to south, and/or chronologically by first
date of occurrence. Included with each record is the location, county
abbreviation (see below), and date span. The date span usually follows that
published in National Audubon Society Field Notes (formerly American
Birds, and now simply Field Notes) but, if the CBRC accepts a date span
that differs from a published source, the differing dates are italicized. Initials
of the observer(s) responsible for first finding and/or identifying the bird(s)—
if known and if they have supplied documentation—are followed by a
semicolon, then the initials of additional observers submitting documenta-
tion, then the CBRC record number. All records are sight records unless
indicated otherwise: initials followed by a dagger (†) indicate the observer
supplied an identifiable photograph; (*) indicates videotape; ($) indicates a voice recording; and (#) indicates a specimen record, followed by the acronym (see below) of the institution housing the specimen and that institution’s specimen catalog number.

An asterisk (*) prior to a species’ name indicates that the species is no longer on the CBRC Review List. The first number in parentheses after the species’ name is the number of records accepted by the CBRC through this report; the second is the number of new records accepted in this report (because this number excludes records thought to pertain to returning individuals, this number may be zero). Two asterisks (**) after the species’ total indicate that the number of accepted records refers only to a restricted review period or includes records accepted for statistical purposes only—see Roberson (1986) for more information.

When individual birds return to a location after a lengthy or seasonal absence, each occurrence is reviewed under a separate record number, and the Committee members indicate whether or not they believe the bird is the same as one accepted previously. Such decisions follow the opinion of the majority of members and, if a bird is considered a returning individual, the total number of records remains unchanged.

Although the CBRC does not formally review the age, sex, or subspecies of each bird, information on these subjects is often provided during the review process (and in some cases a strong or unanimous consensus is arrived at). We have tried to report as much of this information as possible.

The CBRC uses standard abbreviations for California counties; those used in this report are: BUT, Butte; DN, Del Norte; FRE, Fresno; HUM, Humboldt; IMP, Imperial; INY, Inyo; KER, Kern; LA, Los Angeles; MRN, Marin; MEN, Mendocino; MOD, Modoc; MTY, Monterey; ORA, Orange; PLU, Plumas; RIV, Riverside; SBE, San Bernardino; SD, San Diego; SF, San Francisco; SM, San Mateo; SBA, Santa Barbara; SCL, Santa Clara; SCZ, Santa Cruz; SIS, Siskiyou; SOL, Solano; SON, Sonoma; TEH, Tehama; VEN, Ventura. A full list of county abbreviations is available on the WFO-CBRC web site.

Museum collections housing specimens cited in this report or which allowed access to Committee members for research, or which are otherwise cited, are: California Academy of Sciences (CAS), Natural History Museum of Los Angeles County (LACM), Pacific Grove Museum of Natural History (PGMNH), San Diego Natural History Museum (SDNHM), Museum of Vertebrate Zoology, at the University of California, Berkeley (MVZ), Burke Memorial Museum at the University of Washington (UWBM). Other abbreviation: NAS, National Audubon Society.

RECORDS ACCEPTED

ARCTIC LOON Gavia arctica (3, 1). One was seen and extensively photographed at Bodega Bay, SON, 5 May–18 Jun 1995 (ANW†; CCF, JM, BDP, DEQT, RAR†, SBT†; 1995-057). Photographs taken on 14 May were published by Birch and Lee (1997); additional photos taken on 11 June show the bird to have been lightly oiled, although it was still capable of flight at that time. The first two California records, in November and December 1991, also on the central coast, were detailed by Reinking and Howell (1993) and Patten et al. (1995). The single dissenting vote on the current
record, which passed 9-1, cited the suggestion of a Common Loon (G. immer) neck pattern as possibly indicating a hybrid; the combination Gavia immer × arctica has been reported by Hunter and Dennis (1972). Identification of the Arctic Loon was discussed by Reinking and Howell (1993) and Birch and Lee (1997).

YELLOW-BILLED LOON Gavia adamsii (58, 1). One was near the mouth of Walker Creek, Tomales Bay, MRN, 19 Feb-16 Mar 1995, with the bird's two-to-three-day-old corpse found on Dillon Beach, just outside Tomales Bay, on 19 Mar (KB; GMCc, JM, DSG, RS†; 1995-031; #CAS 85767). A bird arriving in Monterey Bay, MTY, in alternate plumage 10 Nov 1995 (DR†; BMcK†, JM, DLSh, DSG, JCW†; 1995-120) and remaining until 10 Feb 1996 was judged to be a returning bird that had arrived, also in alternate plumage, in the same area on 7 Nov 1994 (one of three birds treated under CBRC record 1994-178; see Howell and Pyle 1997). The Yellow-billed Loon is now of annual occurrence in California, with the great majority of records coming from the central coast in winter.

STREAKED SHEARWATER Calonectris leucomelas (6, 1). One was found exhausted in a supermarket parking lot in Red Bluff, TEH, on 5 Aug 1993; it was brought to a bird rehabilitator and ultimately released at the mouth of Humboldt Bay, HUM, on 13 Aug 1993 (BY; SWHT†; 1993-133). With two dissenting votes, the Committee voted that the bird's presence in the northern Sacramento Valley likely represented a natural occurrence. Nearly all procellariiforms recorded inland in California have been at the Salton Sea or adjacent regions of the Sonoran Desert; most have occurred during the late April to late September season of southerly monsoon winds, but few have been clearly related to tropical storms in Mexico (Patten and Mimbich 1997). In addition to this one, anomalous interior records are of a Black Storm-Petrel (Oceanodroma melania) found in Kings Canyon National Park, Tulare Co., 5 Oct 1994 (NAS Field Notes 49:96, 1995) and a Laysan Albatross at Whiskeytown Reservoir, Trinity Co. (Am. Birds 45:492, 1991); the latter bird was thought by some to have been transported artificially, as it had been marked on the head with paint. Procellariiforms are generally rare within San Francisco Bay away from the mouth of the Golden Gate; the occurrence of the Streaked Shearwater in Red Bluff suggests to some a route from the bay up the Sacramento River, though other scenarios (including transport by humans—both Sacramento and Stockton are busy shipping ports) certainly cannot be ruled out.

MANX SHEARWATER Puffinus puffinus (12, 4). Single birds were observed just off Southeast Farallon Island, SF, on 22 Mar 1995 (PP; 1995-141) and 15 Oct 1995 (PP†; 1995-135). Single birds were also in Monterey Bay, MTY, on 10 Sep 1995 (TE†; DLB†; 1995-122) and in both the Monterey and Santa Cruz county portions of Monterey Bay on 29 Oct 1995 (SNGH; BMcK†, SW; 1995-110); the committee received no documentation for four other sightings in Monterey Bay during fall 1995 reported by Yee et al. (1996). These records continue a trend since 1993 of annual occurrence in California, primarily in fall (Erickson and Terrill 1996, Howell and Pyle 1997). Several additional records since 1995 are currently under review by the Committee.

BROWN BOOBY Sula leucogaster (45, 1). A subadult male with blue facial skin, a few whitish feathers on the crown, and some brown flecking on the sides of the breast (probably of the northernmost eastern Pacific subspecies breustri) was at Southeast Farallon Island, SF, 27 Sep-11 Oct 1995 (PP; 1995-136). A first-year Brown Booby was in the same general area 9 Aug-4 Sep 1994 (CBRC record 1994-182; Howell and Pyle 1997), but the Committee followed the lead of the observer in considering the 1995 bird to be a different individual.

TRICOLORED HERON Egretta tricolor (15**, 1). One of undetermined age was at the south end of the Salton Sea, IMP, 13 May-19 Aug 1995 (GMCc; 1995-074).
The resightings of this individual by different observers through 19 Aug were not submitted to the CBRC; observers are urged to always submit details on Review List species to add to the body of documentation and to help the Committee consider issues such as date span.

**REDDISH EGRET** *Egretta rufescens* (68, 0). The perennially wintering bird around the south end of San Diego Bay, SD, was refound 7 Oct–26 Nov 1995 (GMcC; 1995-100) and presumably remained in the area through the winter; it has returned annually since 1982 and is individually recognizable by a bill deformity. Clapp et al. (1982) gave a longevity record of 12 years, 3 months for this species, which the San Diego bird has now surpassed.

**YELLOW-CROWNED NIGHT-HERON** *Nyctanassa violacea* (17, 1). A first-year bird was at the Point Mugu Gun Club near Port Hueneme, VEN, 30 Aug–4 Sep 1995 (DD†; GMcC, TRC; 1995-035; Figure 1). This is one of the few records of an immature accepted for California. The adult present since 1981 continued at and near La Jolla, SD, in 1995, with a sighting from 4 March 1995 submitted to the Committee (GMcC; 1995-101); since this bird was in adult plumage when first discovered, it was at least 16 years old in 1995. No longevity data for this species were provided by Clapp et al. (1982) or Watts (1995).

**BLACK VULTURE** *Coragyps atratus* (1, 1). A sight record of a single bird over the Chico Sewage Treatment Plant, 4 miles southwest of Chico, BUT, on 13 Apr 1972 (TM; 1972-012) becomes the first accepted record of this species for California and illustrates a number of points about the Committee's review process. Single-observer sight reports of first state records are rarely accepted by the Committee, although there is no formal barrier to acceptance of such records. In the present case, the combination of an experienced observer, excellent views, and a thorough description of a distinctive species ultimately satisfied the Committee on the identification. The final vote was completed in 1997, well after a widely seen and thoroughly documented Black Vulture appeared in Arcata, HUM (that record is currently in circulation). The more important issue relating to the Chico record is the question of natural occurrence. There is no firm evidence that this species is commonly kept in captivity, though much speculation centered on that issue, particularly the species' possible use in location shooting for the film industry. Committee members disagreed on the magnitude of movement within southwestern and western Mexican populations of the Black Vulture, and even whether a California bird might have originated from eastern North America; some expressed concern that the natural occurrence of "supporting" records from Idaho, British Columbia, and the Yukon had been questioned by local experts. Ultimately, the record was accepted on a 9–1 vote, the dissenters questioning the bird's natural occurrence.

**BLACK-BELLIED WHISTLING-DUCK** *Dendrocygna autumnalis* (15, 4). Four records, all from the Salton basin, were thought to pertain to different individuals, although several committee members suspected some duplication. One was at the mouth of the Whitewater River at the north end of the Salton Sea, RIV, 12 Jul–20 Aug 1993 (GJH; RWH; 1993-140). One was near the mouth of the New River, IMP, 10 Aug 1994 (KCM, KS†; 1994-146). One at Ramer Lake near Calipatria, IMP, 27–28 Aug 1994 (GMcC; 1994-157) was thought by only a minority of Committee members to be the same as the one at the New River earlier the same month. Finally, another was at Ramer Lake 29 May–3 Jun 1995 (AME; EDG†, MSM, MJSM, JOZ; 1995-063).

**EMPEROR GOOSE** *Chen canagica* (61, 2). Two different adults shot by sport hunters were documented by photographs of the taxidermy mounts. One at North Humboldt Bay, HUM, 5–11 Dec 1994 was shot on the last date (photos of mount obtained by SE; 1996-002). One in the Arcata Bottoms, HUM, was shot 13 Dec 1994 (photo of specimen provided by GSL; 1996-003).
GARGANEY Anas querquedula (18, 3). A female was at Ocean Ranch, Eel River Wildlife Area, HUM, 16–23 Sep 1995 (GSL†, LPL; 1996-004). This is another case where numerous observers saw a Review List species but documentation was submitted only in the form of one brief description and two undated photos. One, thought to be an immature or eclipse male, was on Vandenberg Air Force Base, SBA, 29 Dec 1995–29 Feb 1996 (BHT; JMC, TRC, SEF, PAG, PEL, CAM, GMcC; 1996-010); a photograph was published in NAS Field Notes 50:222. One, probably a first-year male, was near Cantil, KER, 28 Sep–1 Oct 1995 (MTH; NBB, MOC, JLD, GMcC, DEQ, JCW; 1995-102), the second record for this desert locality.

ZONE-TAILED HAWK Buteo albonotatus (48, 0). Returning individuals were in Irvine Regional Park, ORA, 3–8 Nov 1995 (GMcC; 1995-118), and in Santee, SD, 5 Feb 1995 (GMcC; 1995-032); both presumably remained through the winter. The Irvine bird was in at least its third winter, the Santee bird its fourth.

MONGOLIAN PLOVER Charadrius mongolicus (6, 1). A juvenile was at the Ventura Duck Club near Oxnard, VEN, 3–7 Sep 1995 (DDT; MJSM, MSM; 1995-098). All of the six accepted records for the state have been between 7 August and 25 September, except for a returning adult that appeared as early as 12 July in years following its initial appearance.

EURASIAN DOTTEREL Charadrius morinellus (6, 1). Two were together at Lake Talawa, DN, 8–12 Sep 1992 (FG†, GSL†, RLeV, MMT†; 1992-249). Photographs such as that published in Am. Birds 47:169, 1993, clearly show one bird to have been a juvenile; the second, slightly less contrastingly marked, might have been a juvenile as well. A third bird was reported present, but the Committee received no documentation.

HUDSONIAN GODWIT Limosa haemastica (13, 1). A juvenile was well described from Mystic Lake, San Jacinto Valley, RIV, 16 Sep 1995 (MAP, BDS; 1995-086). All three previous southern California records had been for spring (9-22 May), although seven of the eight northern California records are for fall (9 August to 3 October).

BAR-TAILED GODWIT Limosa lapponica (20, 3). A sight record of one at Horseshoe Pond, Pt. Reyes National Seashore, MRN, 12 Aug 1993 (PD, 1993-176) was unanimously accepted after three circulations; the description was written two months after the observation, a factor troubling several Committee members on the initial circulations. One was photographed at the Cliff House, San Francisco, SF, 8–9 Aug 1994 (ASH†; 1995-087). An adult was at Abbott's Lagoon, Pt. Reyes National Seashore, MRN, 2-21 Oct 1995 (SMI; RST†, BDP, EDG†, JM, SBT; 1995-105; Figure 2); another photograph was published in NAS Field Notes 50:219, 1996.

LITTLE GULL Larus minutus (58, 5). A first-summer bird was in Alviso, SCL, 4-11 May 1995 (MMR†; 1995-065), representing a first county record. An adult was off Pt. Fermin, San Pedro, LA, 23 Dec 1995 (MSM, KLG; 1996-011). Adults in alternate plumage were at the south end of the Salton Sea, IMP, 7 May 1995 (RJN; 1995-076) and near Mecca, RIV, 15 Jun 1995 (PGR; 1995-077); these were thought by the majority of Committee members to be different individuals. Finally, a bird molting out of first alternate plumage was at the south end of the Salton Sea, IMP, 24 Jul–12 Aug 1995 (JN†, GMcC; TRC, JLD, MTH†, MAP†, SBT†; 1995-081).

BLACK-HEADED GULL Larus ridibundus (19, 2). An adult was at Ravenswood Open Space Preserve, Menlo Park, SM, 17–18 Feb 1995 (RST, JoM; 1995-037). A first-winter bird at the mouth of the Santa Ynez River, SBA, 5–10 Jan 1995 (BHT; 1995-052) was documented only with two photographs taken on 6 January without accompanying notes; observers are urged to fill in details about observations even when photographs are assumed to “speak for themselves.” A returning wintering adult was in Santa Barbara, SBA, 21 Nov 1995 to at least 30 Jan 1996 (BHT, RL, CAM, GMcC; 1996-009).
LESSTER BLACK-BACKED GULL Larus fuscus (8, 1). An adult was at Coyote Creek Riparian Station and Alviso, SCL, 22 Oct 1995–23 Mar 1996 (NL†; BDP, DEQ, RJR, MMr†, SCR, SBt; 1995-114); it was seen just across the county line near the Newby Island Dump, ALA, 13–16 Feb 1996 and represented a first record for both counties.

SOTTY TERN Sterna fuscata (3, 1). An adult was at the Santa Clara River estuary (McGrath State Beach), VEN, 28 May 1995 (WW; 1995-055). One at Bolsa Chica Reserve near Huntington Beach, ORA, 17 Jun–8 Aug 1995 (TRC, JLD, PLK†, JL, CAM, GMcC, DR, MAP, BDS; 1995-070; Figure 3) was considered the same bird as an adult present there 30 Jul–10 Aug 1994 (1994-109; see Erickson and Terrill 1996, Howell and Pyle 1997).

THICK-BILLED MURRE Uria lomvia (34, 1). One was photographed on Monterey Bay off Pacific Grove, MTY, 16 Oct 1995 (RMS†; 1995-111); most California records are from this area.

CRESTED AUKLET Aethia cristatella (2, 1). One off Bodega Bay, SON, 24 Jun 1995 (LL†, SBt†; MD†, EDG, BDP, RMSt; DLSh; 1995-069; Figure 4) was extensively photographed and videotaped. The first California record was of a single bird at Bolinas, MRN, 16–17 Jul 1979 and found dead on the latter date (Weyman 1980). This pattern of summer occurrences of far northern alcids is further supported by California records of an adult Least Auklet (Aethia pusilla) in June (Bailey 1989), a juvenile Kittlitz’s Murrelet (Brachyramphus brevirostris) in August (Devillers 1972), at least two June and July Parakeet Auklets (Aethia psittacula), and numerous Horned Puffins (Fratercula corniculata); there is also a July record of an adult Crested Auklet in Baja California (Pitman et al. 1983).

RUDDY GROUND-DOVE Columbina talpacoti (61, 1). A male was at Furnace Creek Ranch, Death Valley, INY, 21–22 Oct 1995 (GMcC; 1995-113). This species is nearly an annual visitor to this part of the state, although reports have decreased in recent years.

GROOVE-BILLED ANI Crotophaga sulcirostris (10, 1). One in Wilmington, LA, 2 Dec 1995–4 May 1996 (TK, NP, PDS; TRC, AME, KLG, CAM, GMcC, BMK, MAP, BDS, MSM, MJSM, JHT†; 1995-125) was the second for Los Angeles Co. and is perhaps only the second to have wintered in the state. Descriptions and photographs showed a relatively small-billed individual with shallow grooves, suggesting it may have been an immature female (Pyle 1997); a photograph was published in NAS Field Notes 50:224, 1996.

GREATER PEWEE Contopus pertinax (30, 0). One on the grounds of the San Diego Zoo, SD, 7–21 Jan 1995 (GMcC; 1995-016) was considered by most Committee members to be a returning individual; this record fits the California pattern dominated by wintering (and often returning) birds.


THICK-BILLED KINGBIRD Tyrannus crassirostris (13, 0). One at Pomona, LA, 30 Nov 1995–24 Mar 1996 (TRC, KLG†, CAM, GMcC, MSM; 1995-126) returned for its fourth consecutive winter, though no documentation has been submitted supporting its presence during the winter of 1993-1994.

*SCISSOR-TAILED FLYCATCHER Tyrannus forficatus (94, 2). One at Crannell Bottoms, HUM, 26–28 May 1995 (MH; JEH, LPL; 1995-072) was probably an adult male; another at Point Loma, SD, 27–31 May 1995 (PU; 78-1995) was considered
an immature. This species was removed from the CBRC Review List as of the January 1998 meeting, so post-1997 records will no longer be reviewed.

**YELLOW-THROATED VIREO** *Vireo flavifrons* (56, 1). One was at Vandenberg Air Force Base, SBA, 9 Jun 1995 (JAY; BH†, 1995-079). This species is decidedly more common in spring than fall, with almost 70% of accepted records from late April to June.


**YELLOW-GREEN VIREO** *Vireo flavouririsidis* (43, 4). One at Galileo Hill Park, KER, 21–26 Sep 1995 (MTH†; JLD, GMcC, MAP, BDS; 1995-091) was a county first and only the second accepted record from the interior. More typical were individuals coastaly at Wilmington, LA, 7–8 Oct 1995 (MSM; NBB, KL†; 1995-099), at Lake Merced, SF, 16–28 Oct 1995 (JM, DSG, SBT; 1995-130), and at Sunset State Beach, SCZ, 17 Oct 1995 (BMe; DLSu; 1995-096).

**LANCEOLATED WARBLER** *Locustella lanceolata* (1, 1). One at SE Farallon I., SF, 11–12 Sep 1995 (PC, CH, BW†; 1996-014; Figure 5) was a first for the state and only the second record for North America; a record of up to 25 birds on Attu I., Alaska, in summer 1984 was detailed by Tobish (1985). Among the diverse array of vagrants found on Southeast Farallon Island, this ranks as one of the most unusual. Identification of this species is relatively straightforward (Riddiford and Harvey 1992, Leader 1994). Hickey et al. (1996) discussed this record and the identification criteria for this species.

**DUSKY WARBLER** *Phylloscopus fuscatus* (5, 1). One at Vandenberg AFB, SBA, 31 Oct–3 Nov 1995 (BH†; JEL, GMcC, REW†§; 1995-119) was only the fifth for California, though the second for Santa Barbara County. Photographs and tape recordings provided excellent supporting documentation; one photo was published in *NAS Field Notes* 50:116, 1996. Erickson and Terrill (1996) summarized the status and major identification points of this species. The fall of 1997 saw an influx of this species into the state; at least three records are currently under review by the CBRC.

**ARCTIC WARBLER** *Phylloscopus borealis* (1, 1). This primarily Old World species was added to the state list on the basis of an individual caught and banded at the Big Sur Ornithology Lab at Andrew Molera State Park, MTY, 13 Sep 1995 (AS†, CE, AI; 1995-106; Figure 6). Remarkably, this is only the second record of this species south of Alaska, the first being from Baja California Sur in 1991 (Pyle and Howell 1993); an additional California record from 1996 is currently under review by the Committee. Despite measurements and in-hand photographs, no consensus was reached as to the subspecies involved; *kennicotti*, which breeds in Alaska, may seem most likely on geographic grounds, but the Baja California record was suspected to represent one of the Asiatic forms. An analysis of the photographs by Paul J. Leader of Hong Kong was most helpful in conclusively eliminating other *Phylloscopus* warblers from consideration.

**NORTHERN WHEATEAR** *Oenanthe oenanthe* (8, 1). One, probably an immature, was at Baker Beach, SF, 23 Sep 1995 (DSG†; JM; 1995-127; Figure 7).

**GRAY CATBIRD** *Dumetella carolinensis* (71, 3). Individuals were at Ocotillo, IMP, 13–17 Jun 1995 (GMcC; 1995-066), Furnace Creek Ranch, INY, 2 Oct 1995 (MTH†; TH, SBT†; 1995-128), and near California City, KER, 30 Sep–1 Oct 1995 (MOC, MTH†, JCW†; 1995-142).
YELLOW WAGTAIL Motacilla flava (11, 1). An immature was at Lake Earl, DN, 29 Aug 1995 (GSL†, LPL; 1996-006; Figure 8). This marks the earliest seasonal occurrence in the state, with all records spanning 29 Aug-20 Sep.

BLACK-BACKED WAGTAIL Motacilla lugens (6, 1). An immature male was at Bolinas, MRN, 3 Nov 1995 (PP, SNHG, RSt†, SW; 1995-117; Figure 9). White and Black-backed wagtails in first basic plumage can often be distinguished from older birds by their two generations of upperwing coverts: the fresher first-basic medians contrasting with the more worn juvenile greater (Pyle 1997); determination of the age of the Bolinas bird was a critical precursor to confident species identification.

*RED-THROATED PIPIT Anthus cervinus (105, 1). A bird heard flying over Montezuma Slough, SOL, 21 Oct 1991 (RS; 1993-045) finally gained acceptance after going 9-1 during the third round. All Committee members agreed the identification was correct but many were troubled by the skimpy documentation for this and other “heard-only” records. Most members eventually voted to accept because the species is no longer on the Review List, the bird occurred during a strong flight year for this species in California, and the observer had extensive experience with this and other pipit species. The Committee, however, has been inconsistent in its treatment of “heard only” records of the Red-throated Pipit.

SPRAGUE’S PIPIT Anthus spraguei (23, 1). An immature female was at Desert Center, RIV, 1 Oct 1995 (MAP†, BDS; #SDNHM 49303; 1995-093); the specimen was obtained after the pipit was chased and grounded by a Loggerhead Shrike (Lanius ludovicianus).

BLUE-WINGED WARBLER Vermivora pinus (21, 1). After several years of multiple records only one was recorded in 1995: an immature at Galileo Hill Park, KER, 24–26 Sep (SS, NBB, JLD†, MTH†, GMcC, MAP, DEQ†, MSM, MJSM, BDS; 1995-092). Several observers and Committee members thought the bird was most likely a female from the extent of olivé on the crown, but many remained noncommittal, pointing out the hazards of seeing some species from photographs and field descriptions.

GOLDEN-WINGED WARBLER Vermivora chrysoptera (54, 3). A male was at Pescadero, SM, 25–30 Aug 1995 (RST; BMcK, SBT; 1995-131) for the state’s second August record. Kern County’s first fall record was of a male at Galileo Hill Park, KRN, 21–24 Sep 1995 (MTH†, GMcC, MJSM; 1995-104), and a male was in Huntington Beach, ORA, 19 Oct 1995 (JRG†, SRG; 1996-024).

YELLOW-THROATED WARBLER Dendroica dominica (76, 2). One at Point Reyes, MRN, 31 May–4 June 1995 was of the expected white-lored subspecies albilora (RS; JM, BDP; 1995-058). Far more unusual was a yellow-lored individual at Ramer Lake, IMP, 17 Dec 1995–16 Mar 1996 (TRC, JLD, LJE†, Rli, JLM, CAM, GMcC, MAP, RMS†, MJSM, BDS; 1995-143). Though likely of the nominate form, dominica, the restricted-range subspecies stoddardi could not be eliminated by the descriptions or photographs. Dominica and stoddardi typically have bright yellow supraloral areas and no white on the chin; albilora may show pale yellow in the anterior supercilium and usually have at least some white in the chin (Dunn and Garrett 1997). The subspecies stoddardi, breeding in a limited area of coastal northwestern Florida and adjacent Alabama and with a winter range that remains unknown, does not seem to be a likely candidate to occur in California, and its validity has been questioned by some authors.

GRACE’S WARBLER Dendroica gracae (31, 2). A female at Clark Mtn., SB, 3 Jun 1995 (MAP; BDS, SBT; 1995-060) was noteworthy as all other acceptable records there are of males and, though long speculated, breeding has never been confirmed at this site; up to two males on Clark Mountain at the same time are still under review. One wintered at 1650 m elevation at Chilao in the San Gabriel Mtns., LA, 22 Oct 1995–10 Mar 1996 (TK, NP; CAM, KLG, TN, MJN, GP, MSM; 1996-030).
PINE WARBLER *Dendroica pinus* (52, 1). A male at La Mirada, LA, 13 Jan - 18 Feb 1995 (LJS; JLD, KLG, RAH†, CAM, GMcC, MAP, MSM; 1995-012) was thought by some to be an immature.

CERULEAN WARBLER *Dendroica cerulea* (14, 1). A HY male was banded at the Big Sur Ornithology Lab, MTY, 4 Oct 1995 (DR†; 1995-107). This individual was readily aged by the juvenal rectrices and judged to be a male on the basis of its black back streaking.

WORM-EATING WARBLER *Helmitheros vermivorus* (79, 4). One was at Owl Canyon, Bodega Bay, SON, 15-16 Sep 1995 (BDP; 1995-094), and another wintered in San Francisco, SF, 19 Nov 1995-20 Mar 1996 (SH, JLM, JoM, DSg; 1996-013). Two collided with windows in Monterey Co.: the first was found dead 26 Oct 1995 in Monterey (BJW†; #PGMNH 2320A; 1996-001), whereas the second, in Pacific Grove, 6 Dec 1995 (EC†; 1996-018), was only stunned and soon flew off.

LOUISIANA WATERTHRUSH *Seiurus motacilla* (8, 1). One was at Yucca Valley, SBE, 7-10 Jun 1995 (EAC†; NBB, BED, RJN, MAP, LP, SJF, BDS; 1995-061). This is the second early June record for California; Louisiana Waterthrushes have largely reached their breeding grounds in eastern North America by late April, and fall migration there begins by early July, exceptionally in June (Dunn and Garrett 1997). June records in California are therefore difficult to interpret but probably involve late spring wanderers.

CONNECTICUT WARBLER *Oporornis agilis* (77, 3). Immatures, two of which were banded, were at Southeast Farallon Island, SF, 9 Sep 1995 (PC, BW†; 1995-137), 21 Sep 1995 (BW; 1995-138), and 23 Sep 1995 (PP; PC†; 1995-016).

PYRRHULOXIA *Cardinalis sinuatus* (18, 4). Up to four, including a female on a nest, were at Chemehuevi Wash, SBE, 28 May-8 Jul 1995 (RLi, DR†; EDG†, GMcC, MAP, MSM, MJSM, BDS; 1995-056; Figure 10). This species nested here in 1977 (Garrett and Dunn 1981).

PAINTED BUNTING *Passerina ciris* (50, 4). In central California one was near Davenport, SCZ, 15 Sep 1992 (KK; 1992-247), another in Santa Cruz, SCZ, 3-17 Nov 1995 (SH; JD†, SG, JM, KMck, BDP, DR, DLSu, SBt†; 1995-132). More expected were single birds in San Diego, SD, 4 Sep 1992 (NW; 1993-024) and Imperial Beach, SD, 2-3 Dec 1995 (TAC, GMcC; 1995-133). This species continues to present difficulties for Committee members. The two 1992 records took four rounds before acceptance. Issues of identification, which generally result from scant documentation, as well as concerns over natural occurrence, remain problematic. None of these individuals was an adult male.

CASSIN’S SPARROW *Aimophila cassinii* (39, 1). One on Southeast Farallon Island, SF, 15-17 Oct 1995 (BW, PP; 1995-140) was the first there since 1988; most of the fall records for California are from this locality.

LE CONTE’S SPARROW *Ammodramus leconteii* (27, 1). One in first basic plumage was banded on Southeast Farallon Island, SF, 27 Oct 1995 (BW†, PP; 1996-017).

SMITH’S LONGSPUR *Calcarius piceus* (3, 1). An immature male was at Point Reyes National Seashore, MRN, 24-31 Oct 1995 (TAC, JDK, LL†, GMcC; JM, BDP, DEQ, JW; 1995-097). Two recent records of this species are currently under review.

SNOW BUNTING *Plectrophenax nivalis* (58, 3). One was at Point Reyes, MRN, 22-31 Oct 1995 (BMck; TRC, LL†, GMcC, JoM, BDP, DEQ; 1995-108), two were at L. Talawa, DN, 22 Nov 1995 (GMcC; 1995-134), and up to eight were at the Eel R. mouth, HUM, 10 Nov 1995–6 Jan 1996 (CAM, PAG; 1996-120). Sexing this
species in the field remains challenging, and most Committee members refrained from commenting. Nevertheless, videotape of the Point Reyes bird appears to show a secondary and primary covert pattern consistent with that of a male. The Lake Talawaa birds were thought by the observer to be females.

RECORDS NOT ACCEPTED: IDENTIFICATION NOT ESTABLISHED

*MURPHY'S PETREL Pterodroma ultima. One reported 12 miles west of Southeast Farallon Island, SF, 3 Jun 1985 (1985-068) was originally submitted (and subsequently rejected) as a Solander's Petrel (Pterodroma solandri); this rejection was not published in any CBRC report. The record was then recirculated as a Murphy's Petrel, going four circulations and ultimately receiving six "accept" votes, shy of the nine necessary for acceptance. It was the consensus of the CBRC that the bird was most likely a Murphy's, considered the "default" dark Pterodroma petrel in the waters off California. Decision by "default," however, is not acceptable to many CBRC members, and the two recent independent sightings of an apparent Great-winged Petrel (P. macroptera, currently under CBRC review) are testimony to the dangers of such assumptions. Furthermore, Solander's Petrel has been collected at 40° N in the North Pacific Ocean (LACM #102806), albeit well west of California, so that species' occurrence off California should still be deemed possible.

One reported off Pt. Arena, MEN, 21 May 1981 (1981-045; distant photo) has a similar history. Originally submitted as a Solander's, it was nearly accepted as that species (reaching eight accept votes in its third circulation) but ultimately rejected. The establishment of Murphy's as the "expected" dark Pterodroma off California led to reassessment of this record as that species, but it was finally rejected on a 5-5 vote. This record came from a period prior to any accepted records of dark Pterodroma in California waters, and before much useful field identification information on the several dark Pacific Ocean species was available (Bailey et al. 1989).

STEJNEGER'S PETREL Pterodroma longirostris. After four circulations, a report of four seen and one photographed (with no accompanying description) on 10 Oct 1991 about 120 miles WSW of Pt. Conception, SBA, (1992-053) received a 5-5 vote and thus was not accepted. The small image in the slides suggested Stejneger's to most Committee members, but some were not convinced. The report fits within the seasonal (July to November) pattern of the six accepted California records of this species; see the discussion of seasonal patterns by Heindel and Patten (1996). This is another case of an experienced seabird observer on a research cruise not being able to provide convincing documentation, pointing to the problems of seabird documentation and identification discussed by Howell and Pyle (1997).

BULWER'S PETREL Bulweria bulwerii. A medium-small dark procellariform seen at the mouth of the Whitewater River at the north end of the Salton Sea, RIV, 10 Jul 1993 (1993-118) was thought to be this species. The sighting occurred during a small incursion of tubenoses, which included a Cook's Petrel (Pterodroma cookii) and a Least Storm-Petrel (Oceanodroma microsoma) (McCaskie 1993, Patten and Minnich 1997). Several committee members were convinced that a Bulweria was seen but not that Jouanin's Petrel (B. fallax) could be eliminated; only one of the eight rejecting Committee members specifically indicated that the record was acceptable as Bulweria sp.? Although the size and bill-shape differences between the two Bulweria species are usually marked, most California observers are understandably poorly versed in this problem; this, coupled with the difficulty of putting seabird size and shape into perspective on a relatively calm desert sea, made the specific identification of this potential first state record less than convincing for several committee members. Bulwer's Petrel is a warm-water species reported without documentation as far north as the waters south of Clipperton Island and possibly the Islas Revillagigedos (Howell and Webb 1995).
Figure 1. This Yellow-crowned Night Heron, *Nyctanassa violacea* (1993-035), near Pt. Mugu, Ventura Co., 4 September 1995, is one of the few in first-year plumage to be found in California. Note the stout, dark bill and long-legged appearance.

*BAND-RUMPED STORM-PETREL Oceanodroma castro*. One reported 12 Sep 1970 about 25 miles west of Mission Bay, San Diego SD (1973-103), had been accepted previously (Luther et al. 1983); details are provided by McCaskie (1990). Of the agonizing seabird-related decisions facing the Committee and detailed in these Committee reports, this record certainly stands out as one of the most difficult. Re-analysis and ultimate rejection of long-accepted state records is not to be taken lightly, and the Committee was deeply split in this case. One matter of concern for many members was the lack of any well-documented and accepted records of this species since this 1970 sighting, despite increased offshore coverage. Indeed, several claimed Band-rumped Storm-Petrels have failed to gain CBRC acceptance, as most recently reported by Erickson and Terrill (1996). The 1970 bird off San Diego was identified by plumage, shape, and flight characters; assessment of these characters can be tricky, especially given the range of uppertail covert patterns and overall size shown by eastern Pacific Ocean Leach's Storm-Petrels (*Oceanodroma leucorhoa*; see Ainley 1980). Field identification of the Band-rumped Storm-Petrel was discussed by Lee (1984) and references therein.
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Figure 2. Bar-tailed Godwit, Limosa lapponica (1995-105), in flight (on left) with a Marbled Godwit, L. fedoa, at Abbott’s Lagoon, Pt. Reyes National Seashore, Marin Co., 12 October 1995.

Photo by Ed Greaves

BROWN BOOBY Sula leucogaster. One reported flying over the junction of Interstate 15 and Highway 163 just north of San Diego, SD, 5 Jan 1995 (1995-48) had essentially no accompanying description from the single observer and was thus unacceptable to all ten Committee members.

ANHINGA Anhinga anhinga. A single-observer sight report of one seen in flight over Irvine, ORA, 30 Jul 1995 (1995-088) received three accept votes but was not considered adequately described by the remaining Committee members. In addition, the possibility of the occurrence of escapees of other Anhinga species (“darters”) cannot be ruled out by brief descriptions. There remain but three accepted records of this species for California.

TRUMPETER SWAN Cygnus buccinator. Two adults and an immature reported at Lake Almanor, PLU, 15 Feb 1993 (1993-068) were narrowly rejected, receiving seven “accept” votes. None of the birds was neck-collared (as many recent Trumpeters in California have been). Those failing to accept the record were primarily concerned with the difficulty of assessing critical features of bill shape and face pattern at the great distance of observation (>400 m), as well as the fact that the birds were not heard to call. A major point favoring acceptance was the obviously larger size of these birds in a large flock of Tundra Swans (Cygnus columbianus). For the identification of Tundra and Trumpeter swans see Patten and Heindel (1994).

SMEW Mergellus albellus. One reported 14 February 1995 at Buena Vista Lake, KER, (1995-040) was described briefly and gained only a single vote to accept. The largely white plumage suggested the Smew but did not rule out, for example, the Oldsquaw (Clangula hyemalis) or various leucistic ducks.

MISSISSIPPI KITE Ictinia mississippiensis. One reported south of Imperial Beach, SD, by a single observer on 5 Jun 1983 (1993-142) received seven accept votes; dissenting Committee members cited the brevity of the observation, distance of the bird from the observer, and delayed submission of the record.
CRESTED CARACARA Caracara plancus. An intriguing second-hand report of two birds seen from (and one even briefly striking) a hang-glider over Oriflamme Mountain, Anza-Borrego Desert State Park, SD, 20 Jun 1995 (1996-026) was unanimously considered to lack adequate documentation.

RED-NECKED STINT Calidris ruficollis. An adult reported from the Santa Clara River estuary, VEN, 4 Jul 1987 (1992-215) split the committee rather evenly; several rejecting members were concerned that the Little Stint (C. minuta) was not completely eliminated. Plumage variability in alternate-plumaged Little Stints is probably underappreciated.

LITTLE STINT Calidris minuta. A juvenile photographed at Bodega Bay, SON, 27 Jul 1992 (1992-259) had the Committee rather evenly divided between considering it a Little Stint or a bright Semipalmated Sandpiper (C. pusilla). The photograph was then reviewed by P. J. Leader and G. Carey in Hong Kong, who strongly felt that the bird was neither a Little Stint nor a Red-necked Stint.

RUDDY GROUND-DOVE Columbina talpacoti. One was briefly described from Iron Mountain Pump Station, SBE, 24 Sep 1994 (1994-170); bill color and underwing covert color were not noted, and the description of the underparts as "gray" did not seem to fit with the "reddish-brown" upperparts. This was the only report of this species in California in 1994; it has been nearly annual since 1984, with acceptable records lacking only in 1986 and 1994.

BLACK-BILLED CUCKOO Coccyzus erythropthalmus. Photographs of a specimen at the University of Washington Burke Museum (UWBM #10199; 1995-042)
Figure 4. Crested Auklet, *Aethia cristatella* (1995-069), just off Bodega Head, near Bodega Bay, Sonoma Co., 26 June 1995. This makes the second record for California; the first was of a beached bird in Marin Co. in 1979.

*Photo by Ron Saldino*

were forwarded to the Committee for review and provided an interesting example of the process of evaluation. The specimen label indicated that the bird was collected by R. H. Palmer in March 1918 in Fresno, FRE. All members agreed that a March record in California was extremely unlikely, and many questioned whether the date, collection locality, or both might be incorrect on the label. The specimen was accessioned into the Burke Museum collection in 1928, and it appears the information on the tag was written at that time (*fide* C. Wood), raising concern of a transcription error. The record failed to go more than a single round, although all Committee members agreed the specimen was correctly identified.

Note that in cases where basic locality and/or date information are questionable, a rejection of a record is considered to be on the basis of identification (even when the identity of the bird is agreed to be the claimed species).

GREATER PEWEE *Contopus pertinax*. Reports of a singing bird in the Laguna Mountains, SD, 28 May 1995 (1995-090) and another at the south end of the Salton Sea, IMP, 29 May 1995 (1995-064) lacked adequate documentation, given the unprecedented time of year for both reports (all accepted California records lie between 11 Sep and 14 Apr and pertain to fall or wintering individuals). Unseasonal records are invariably treated with great caution, and the fullest documentation is usually necessary to convince this Committee to accept. Both records were thought to be correct by several members, but in each case it was not clear that the observers fully appreciated the significance of the dates.

EASTERN WOOD-PEWEE *Contopus virens*. A bird photographed and tape-recorded in Huntington Beach, ORA, on 29 Nov 1994 (1995-014) was considered more likely a Western Wood-Pewee (*C. sordidulus*) from plumage features, including a

*Photo by Brett Walker*

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Figure 6. Arctic Warbler, *Phylloscopus borealis* (1995-106), Big Sur River mouth, Monterey Co., 13 September 1995. The very long supercilium, mottled auriculars, and long primary projection helped identify this species, a first for California.

*Photo by Allen Spaulding*

*Photo by Daniel S. Singer*


*Photo by Gary S. Lester*

*Photo by Rich Stallcup*

Figure 10. Female Pyrrhuloxia, *Cardinalis sinuatus* (1995-056), Chemehuevi Wash, San Bernardino Co., 29 May 1995. Three males were also present.

*Photo by Don Roberson*
mostly if not entirely dark lower mandible, dull olive back, and dingy underparts. Committee members were less certain of the bird’s call, with some considering the bird a possible virens from its repeating a down-slurred note. Any wood-pewee observed after mid-October should be studied carefully, and the observers are commended for going to such lengths to document this bird. The identification of these two taxa remains one of the more difficult challenges in North American field ornithology.

DUSKY-CAPPED FLYCATCHER Myiarchus tuberculifer. One reported at Point Lobos, MTY, 30 Nov 1994 (1994-187) was rejected because the documentation submitted failed to eliminate the Ash-throated Flycatcher (M. cinerascens).

*SCISSOR-TAILED FLYCATCHER Tyrannus forficatus. One near Imperial Beach, SD, 10 Oct 1995 (1993-057) went four rounds before being rejected 8–2 on grounds of identification. This record points out how the committee process may conflict with “reality” as perceived by the birding public. Virtually all members felt a Scissor-tailed Flycatcher was indeed present and, in fact, was seen by many local observers. Unfortunately, only one observer submitted details, and a minority of members felt that the documentation was inadequate to establish the identification; the Committee welcomes additional documentation from others who observed this bird and might provide grounds for reevaluation of this record.

EYEBROWED THRUSH Turdus obscurus. A report from William Heise County Park, near Julian, SD, 19 Feb 1995 (1995-144) lacked detail sufficient for a potential

Figure 11. This meadowlark, Sturnella sp. (1989-011), was captured and photographed on Southeast Farallon I., San Francisco Co., 29 October 1985, and submitted as a possible Eastern Meadowlark (S. magna). Fresh-plumaged Western Meadowlarks (S. neglecta) may lack significant yellow in the malar region and can be unusually dark above; a consensus of CBRC members and outside experts was this individual was likely a Western.

Photo by Peter Pyle
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first state record. Curiously, the four California reports (none accepted) of this species fall between 19 February and 6 March.


YELLOW-THROATED WARBLER Dendroica dominica. One reported from Point Reyes, MRN, 2 Jun 1992 (1993-046) and another from near Point Bonita, MRN, 22 May 1993 (1993-126) both went four rounds before a decision was reached. These records lacked sufficient documentation, though each was supported by a majority of Committee members.

MOURNING WARBLER Oporornis philadelphia. One reported at Galileo Hill, KER, 24 Sep 1994 (1994-136) was considered a MacGillivray's Warbler (O. tolmei) by most members.

SNOW BUNTING Plectrophenax nivalis. A report from Death Valley, INY, 4 Nov 1989 (1992-234) would represent only the third record for the California deserts. The bird was seen very briefly as it flew overhead and the documentation, albeit from an experienced observer, was therefore sparse.

EASTERN MEADOWLARK Sturnella magna. A report from Southeast Farallon Island, SF, 27-30 Oct 1985 (1989-011; Figure 11) went three rounds, with votes of 1-9, 7-3, and 2-8, implying the difficulty of such an identification. Expert opinion from several authorities largely supported identification as an Eastern Meadowlark, though one reviewer was adamant that the bird was not an Eastern and all agreed that 100% certainty was impossible. Subsequent research on specimens by several Committee members cast ample doubt on the identification, and ultimately the record had little support. Some morphologically intermediate meadowlarks may be impossible to identify without in-hand examination or a specimen (Pyle 1997).

COMMON GRACKLE Quiscalus quiscula. One reported near Bishop, INY, 29 Sep 1993 (1993-186) lacked sufficient documentation. Most members felt a Common Grackle was seen, but the head gloss was described as purple, a characteristic atypical for Q. q. versicolor, the only subspecies of the Common Grackle recorded in California. Although interpretation of color is subjective, the word "blue" perhaps best describes the head gloss in versicolor.

RECORDS NOT ACCEPTED: NATURAL OCCURRENCE QUESTIONABLE (IDENTIFICATION ACCEPTABLE)

TRUMPETER SWAN Cygnus buccinator. The rejection of two birds at Modoc National Wildlife Refuge, MOD, 30 Nov-26 Dec 1993 (RLR; 1994-004) pointed to a growing problem with this species in California, that of how to deal with birds transported from Idaho to Oregon and subsequently wandering to California. This record was rejected on the issue of natural occurrence because of this management practice; the birds were recognizable as transplanted individuals by their combination of green neck collars and pink-dyed wings.

CRESTED CARACARA Caracara plancus. One well-described and photographed at Sweetwater Marsh National Wildlife Refuge, Chula Vista, SD, on 9 Feb 1995 (RC; BMo, DWA; 1995-021) received three accept votes but was suspected by the other
seven Committee members, citing the coastal, urban locality, of being of questionable origin. The question of the natural occurrence of California’s Crested Caracaras has not been satisfactorily established by the Committee. Three records from remote, rural localities 650–1300 km north of the present record—near Mono Lake, MON, in the Shasta Valley, SIS, and at Ft. Dick, DN—have been rejected by the CBRC because of questions about natural occurrence; the species has been placed on the Supplemental List. Given this conservative approach, which stems in part from the lack of any clear pattern of northward vagrancy by this neotropical species, a marked decline in southeastern Arizona, and reports of known escapees, it is not surprising that a record from an urban area was not viewed favorably. Some wondered whether the occurrence of the caracara at Chula Vista might have been related to a possibly natural influx of Harris’ Hawks (Parabuteo unicinctus) into southern California from 1994 to 1996 currently under CBRC review; however, the lack of any obvious ecological tie-ins between the two species perhaps rendered such speculation moot.

PAINTED BUNTING *Passerina ciris*. An adult male visited a feeder in Hiouchi, DN, 5–10 Nov 1995 (CCr; 1996-007). Members were fairly evenly split over the issue of natural occurrence.

CONTRIBUTORS

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LITERATURE CITED


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Our knowledge of the birds on Mitlenatch Island, British Columbia, is largely confined to a list of species seen by many naturalists and visitors, recently compiled by Sirk et al. (1993). Sirk et al. mixed information on the status of birds on Mitlenatch with that from nearby Cortes Island, but this leads to erroneous results for Mitlenatch. During the 12 years (1981–1995, minus 1982, 1989, and 1992) my colleagues and I did research on Mitlenatch Island, we kept a daily record of species seen and their numbers. My objective here is to list the species we saw, which includes 32 species new for the island, report on the status of each, provide some details of the nesting activities of the breeding birds, and compare the avifauna on Mitlenatch Island with that of Cortes Island.

STUDY AREA AND METHODS

Mitlenatch Island (36 ha), located at the north end of the Strait of Georgia (Fig. 1), southern British Columbia, is isolated from other islands in the region. It lies 6 km from Hernando Island to the northeast, 7 km from Cortes Island (122 km²) to the north, and 13 km from Miracle Beach on Vancouver Island to the west. Cortes is covered mostly with Douglas Fir (Pseudotsuga menziesii). Nine salt-water bays and four brackish lagoons are scattered around the island, while the interior has a number of lakes, ponds, marshes, meadows as well as small streams with riparian vegetation. The human population lives mostly on the southern half of the island (Sirk et al. 1993). Sirk and others have made an inventory of the birds of Cortes starting in the early 1970s. In contrast, Mitlenatch, a seabird sanctuary, is uninhabited and has few trees, mostly patches of Lodgepole Pine (Pinus contorta), Scouler's Willow (Salix scouleriana), and Quaking Aspen (Populus tremuloides). Most of the island is covered with grassy meadows, moss-covered rocks, and copses of shrubs (Brooke et al. 1983). Fresh water is limited to a few vernal pools and small rocky troughs. Two large bays provide intertidal habitat, but most of the shoreline consists of steep, rocky cliffs. The island provides nesting habitat for, among others, a large colony of Glaucous-winged Gulls (Larus glaucescens), Pigeon Guillemots (Cepphus columba), and a large population of Northwestern Crows (Corvus caurinus). We spent a total of 871 days on Mitlenatch while studying the gulls, guillemots, and crows: 108 days in the second half of April, 331 in May, 226 in June, 152 in July and 54 in the first half of August. These 871 days were spread over 41 months.

I calculated the abundance of each species on Mitlenatch as follows: Annual occurrence (seen one out of 12 years scored 1, seen every year scored 12) times monthly occurrence (seen during 1–3 months, out of a total of 41 months, scored 1, 4–20 scored 2, 21–37 scored 3, and 38–41 scored
THE STATUS OF SPRING AND SUMMER BIRDS ON MITLENATCH ISLAND

Figure 1. Location of Mitlenatch Island in relation to Hernando and Cortes islands at the north end of Georgia Strait, British Columbia.

4) times number of weeks seen (1–4 weeks, out of a total of 124 weeks, scored 1, 5–20 scored 2, 21–62 scored 3, 63–104 scored 4, 105–120 scored 5, and 121–124 scored 6). The product of annual, monthly, and weekly occurrence was used to define the abundance categories as follows: 1–9 accidental, 10–46 very rare, 47–144 rare, 145–242 uncommon, 243–279 common, and 280–288 abundant. In parentheses behind each species are given its abundance (abbreviated), the number of years in which it was seen (maximum 12), the total number of days it was seen (maximum 871), expressed in absolute numbers and as a percentage.

RESULTS

Loons and Grebes

Red-throated Loon (Gavia stellata): one on 1 May 1984 and 1 Jul 1985 (ac, 2, 2, 0.2%). Pacific Loon (G. pacifica): Apr–Jun, mostly in May (vr, 10, 44, 5.1%). Common Loon (G. immer): Apr–Jul (r, 12, 228, 26.2%). Yellow-billed Loon (G. adamsii): one immature 11–21 May 1984 (ac, 1, 5, 0.6%). Horned Grebe (Podiceps auritus): Apr and early May, rarely to mid-May. In

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years with an early spring it may be absent in May (vr, 12, 82, 9.4%). Red-necked Grebe (*P. grisegena*): occasional Apr–May and once in Aug. Latest spring record 19 May (vr, 5, 29, 3.3%). Western Grebe (*Aechmophorus occidentalis*): recorded twice in Apr and in May; may occur more commonly offshore and thus be overlooked (ac, 4, 4, 4.6%).

**Storm-Petrels, Cormorants, and Herons**

Fork-tailed Storm-Petrel (*Oceanodroma furcata*): seen 16 Aug 1984 (ac, 1, 1, 0.1%). Double-crested Cormorant (*Phalacrocorax auritus*): present in small numbers and found nesting (9 nests) in 1991 (W. Campbell pers. comm.) (a, 12, 871, 100%). I have no information on first egg dates for this and the next species as we did not want to disturb the birds. Pelagic Cormorant (*P. pelagicus*): about 330 birds nested in 1985 (a, 12, 871, 100%). Great Blue Heron (*Ardea herodias*): mostly single birds (up to five) Apr–Aug, typically on calm days. Usually do not stay around very long because the Glaucous-winged Gulls often harass them (r, 12, 62, 7.1%).

**Geese and Ducks**

Greater White-fronted Goose (*Anser albifrons*): a pair grazed on grassy knolls on 1, 4, 6 and 18 May 1991; occasionally migrating flocks pass the island in May (ac, 4, 12, 1.4%). Snow Goose (*Chen caerulescens*): five grazed on the island 25 May–5 Jun 1988; occasional migrating flocks seen offshore in Apr (ac, 4, 11, 1.3%). Brant (*Branta bernicla*): migrating flocks offshore in Apr and May, and smaller numbers (1–3) seen occasionally in Jun and Jul. One single bird in the intertidal from 4 Jun to 3 Jul 1986 (vr, 6, 33, 3.8%). Canada Goose (*B. canadensis*): single birds or pairs in Apr and May, possibly looking for nesting opportunities, and the occasional offshore flock. The species breeds in southwestern British Columbia. One Cackling Canada Goose (*B. c. minima*) was present on 28 Apr 1993 along with two bigger Canada Geese (vr, 8, 12, 1.4%).

Green-winged Teal (*Anas crecca*): Apr–Aug, mostly in May. Seen singly or in groups of up to 56 resting or feeding near the tide line (r, 12, 62, 7.1%). Mallard (*A. platyrhynchos*): seen mostly in Apr and May, less frequently in Jun and Jul. Breeding on the island was suspected earlier but not confirmed until 1986 when two nests were found (10 eggs 18 May, 8 eggs 19 May). Other nests were found in 1988 (5 eggs 26 Apr, 9 eggs 29 Apr), 1990 (8 eggs 29 Apr, fledged 24 May), 1993 (7 chicks 14 May), 1994 (11 eggs 26 Apr, fledged 13 May and a second nest not checked for its content), and 1995 (10 eggs 18 Apr, fledged 17 May). Nests are located in tall grass near shore or inland, at times 250 m from shore. Ducks manage to lead their chicks safely to shore, often fighting Glaucous-winged Gulls along the way. Once on the water chicks are harassed by Bald Eagles (*Haliaeetus leucocephalus*), Glaucous-winged Gulls, and Northwestern Crows, and they do not survive beyond 24 hours (r, 12, 148, 17.0%). Northern Pintail (*A. acuta*): most frequent in Apr, also May–Aug in small numbers (1–3) (vr, 7, 12, 1.4%). Blue-winged Teal (*A. discors*): present in most years in small numbers (1–12) Apr–Jun; earliest 25 Apr, latest 8 Jun (vr, 9, 15, 1.7%). Cinnamon Teal (*A. cyanoptera*): pairs or single males 29 Apr, 6, 11, and 12
May, and 12 Jun (vr, 5, 5, 0.6%). Northern Shoveler (A. clypeata): in Apr, May (especially), and Jun. Earliest 27 Apr, latest 4 Jun (vr, 10, 21, 2.4%). American Wigeon (A. americana): 1–11 birds in Apr and May, feeding among intertidal algae. Earliest 21 Apr, latest 20 May (vr, 9, 25, 2.9%).

Greater Scaup (Aythya marila): seen on 30 Apr 1984 and 17 May 1983 (ac, 2, 2, 0.2%). Harlequin Duck (Histrionicus histrionicus): seen every day. Increases from about 50 in Apr, 100 in May, to 150–200 in Jun and Jul. No counts are available for Aug (a, 12, 871, 100%). Oldsquaw (Clangula hyemalis): seen offshore in Apr and May (vr, 5, 10, 1.1%). Black Scoter (Melanitta nigra) (ac, 4, 12, 1.4%), the least common of the scoters, seen in all months (except Aug), as is the Surf Scoter (M. perspicillata) (r, 12, 107, 12.3%) and White-winged Scoter (M. fusca) (r, 12, 54, 6.2%). Common Goldeneye (Bucephala clangula) (ac, 2, 10, 1.1%) and Barrow’s Goldeneye (B. islandica) (ac, 3, 12, 1.4%) seen rarely in Apr and May. Bufflehead (B. albeola): inshore in Apr and May (ac, 5, 18, 2.1%). Common Merganser (Mergus merganser) (ac, 6, 14, 1.6%) and the more common Red-breasted Merganser (M. serrator) (vr, 10, 80, 9.2%) occur Apr–Jul.

Diurnal Birds of Prey

Turkey Vulture (Cathartus aura): small numbers (1–3) on windy, sunny days Apr–Jul (vr, 12, 28, 3.2%). Osprey (Pandion haliaetus): seen May–Aug (vr, 5, 6, 0.7%). Bald Eagle: present every day and nesting on the island since 1994. Takes adult Glaucous-winged Gulls at sea and on, or near, the nest, as well as gull chicks (a, 12, 871, 100%). Northern Harrier (Circus cyaneus): single birds seen in Apr, May, Jul and Aug. Do not stay long as they are chased off the island by Northwestern Crows (vr, 9, 42, 4.8%). Sharp-shinned Hawk (Accipiter striatus) (vr, 7, 12, 1.4%) and Cooper’s Hawk (A. cooperii) (ac, 3, 3, 0.3%) present as single birds that stay around for at most a few hours. Red-tailed Hawk (Buteo jamaicensis): seen infrequently in Apr, May, and Jul (ac, 3, 10, 1.1%). American Kestrel (Falco sparverius): seen every month but mostly in Apr (ac, 3, 12, 1.4%). Merlin (F. columbarius): occur in Apr and May and again in Aug but do not stay long because Northwestern Crows harass them (vr, 8, 18, 2.1%). Peregrine Falcon (F. peregrinus): most frequent in Apr and May but occurs also in Jun and Aug. Arrival on Mitlenatch coincides closely with the spring arrival of Whimbrels (Numineus phaeopus). One was seen to capture a Whimbrel (vr, 10, 34, 3.9%). Gyrfalcon (F. rusticolus): 19 and 20 Apr 1985, 28 Jul 1985 (the first Jul record for this species in south-coastal British Columbia; Campbell et al. 1990), and between 5 and 17 Aug 1984 (ac, 2, 9, 1.3%).

Shorebirds

Black-bellied Plover (Pluvialis squatarola): seen mainly in Apr (earliest 23) and May (latest 29), once 11–13 Jun and on 5 Jul (vr, 10, 42, 4.8%). Lesser Golden-Plover (P. dominica): single birds on 10 May 1990 and 13 Jun 1983 (ac, 2, 2, 0.2%). Semipalmated Plover (Charadrius semipalmatus): a rare transient between 8 and 19 May (ac, 3, 6, 0.7%). Killdeer (C. vociferus): occurs almost every year from Apr to Aug. A male
was present throughout late Apr 1995 but he had not attracted a female by the
the time I left in late May (r, 10, 90, 10.3%). Black Oystercatcher
(Haematopus bachmani): at least 5–8 pairs nest on Mitlenatch. Median
date of first eggs is 13 May (standard deviation 5 days, range 4–23, n = 33
nests) (a, 12, 871, 100%). Greater Yellowlegs (Tringa melanoleuca): small
numbers (1–9) Apr–Aug (r, 12, 73, 8.4%). Lesser Yellowlegs (T. flavipes):
less common than the Greater and not seen in Apr (vr, 10, 29, 3.3%).
Wandering Tattler (Heteroscelus incanus): appears in late Apr in some
years (earliest record 28 Apr), but the bulk shows up in May. A few birds seen
in Jun in some years are nonbreeders (Campbell et al. 1990). Returning
migrants visit the island from early Jul into Aug (c, 12, 291, 33.4%). Spotted
Sandpiper (Actitis macularia): appears around mid-May to early Jun and
again from late Jul to Aug (r, 12, 48, 5.5%). Whimbrel: present in late Apr
early May as single birds or in flocks of as many as 37. They may feed on
grassy knolls, but more often they are not seen during the day but reappear
again in the evening to roost (see also under Peregrine) (r, 12, 256, 29.4%).
Long-billed Curlew (Numenius americanus): seen once on 25 Apr 1983
(ac, 1, 1, 0.1%). Marbled Godwit (Limosa fedoa): 1–3 seen between 11 and
26 May, sometimes in the company of Whimbrels. One bird was present
23–25 Aug 1984 (vr, 5, 9, 1.0%). Ruddy Turnstone (Arenaria interpres):
appears in May and Jul, mostly along the south side of the island (vr, 12, 15,
1.7%). Black Turnstone (A. melanochephalus): more common than the
Ruddy, occurring more frequently in Apr than in May, absent in June, and
reappearing in Jul and Aug (r, 12, 183, 21.0%). Surfbird (Aphriza virgata):
present Apr–Aug and particularly frequent in Jul (r, 12, 49, 5.6%). Red Knot
( Calidris canutus): seen on 21 and 26 Apr, 26 May, and 22 Jul (ac, 4, 4,
0.5%). Not reported in Apr by Campbell et al. (1990). Sanderling (C. alba):
seen rarely (10 Jul and 11 Aug), perhaps because the island does not provide
appropriate beach habitat (ac, 2, 2, 0.2%). Semipalmated Sandpiper (C.
pusilla): seen on 28 Jun and throughout Jul (ac, 4, 11, 1.3%). Western
Sandpiper (C. mauri) (r, 12, 108, 12.4%) and Least Sandpiper (C. minutilla)
(r, 12, 120, 13.8%), the two most often seen of the peeps, occur Apr–Aug,
most frequently in Jul during southward migration. Pectoral Sandpiper (C.
melanotos): seen on 22 and 25 May 1991 and 14–22 Jul 1983 (ac, 2, 6,
0.7%). The species is considered a rare to locally common spring migrant
along the coast (Campbell et al. 1990). Rock Sandpiper (C. ptilocnemis):
seen twice in May, but it is rather easily overlooked as most of the rocky
coastline cannot be seen from land (ac, 2, 2, 0.2%). Dunlin (C. alpina): seen
mostly in ones or twos (rarely more than ten) in Apr and as late as 26 May;
one bird on 14 and 15 Jul (vr, 9, 55, 6.3%). Short-billed Dowitcher
(Limnodromus griseus) (vr, 11, 27, 3.1%) and Long-billed Dowitcher (L.
scolopaceus) (r, 12, 44, 5.1%) occur mostly in groups of 1–3 birds,
oncasionally up to 11, during Apr, May and Jul; not seen in Aug and rarely
seen in Jun. Common Snipe (Gallinago gallinago): appear during the night
in stormy, wet weather, in all months except Aug. They may stay a few days
if sufficient rain has fallen to provide temporary areas with standing water (vr,
7, 11, 1.3%). Red-necked Phalarope (Phalaropus lobatus): a rare sighting
of 42 birds on 26 May 1983 (ac, 1, 1, 0.1%).
Jaegers, Gulls, Terns, and Auks

Pomarine Jaeger (Stercorarius pomarinus): two seen on 16 Aug 1984 (ac, 1, 1, 0.1%). Franklin’s Gull (Larus pipixcan): one seen on 1 Jun 1983 (ac, 1, 1, 0.1%). Bonaparte’s Gull (L. philadelphia): seen singly or in flocks of up to 70 birds, present throughout spring and summer, especially in Apr and Aug (r, 10, 61, 7.0%). Mew Gull (L. canus): 5 adults on 25 Apr 1984, 1 adult on 22 Apr 1986, single immatures on 2 May 1987 and 31 Jul 1986 (ac, 3, 4, 0.5%). Surprisingly uncommon, considering that Campbell et al. (1990) regarded it a common to abundant spring migrant along the coast. Ring-billed Gull (L. delawarensis): small numbers May–Aug (vr, 6, 28, 3.2%). California Gull (L. californicus): 1–6 seen almost daily flying over the island or roosting among Glaucous-winged Gulls (a, 12, 506, 58.1%). Herring Gull (L. argentatus): may occur more frequently than indicated, but they are difficult to distinguish with certainty from the many hybrid Glaucous-winged Gulls (ac, 3, 3, 0.3%). Glaucous-winged Gull: about 2100 pairs nest (Campbell et al. 1990); median date of first eggs 2 Jun (range 17 May–18 Jun, n = 285 nests; Verbeek unpubl. data) (a, 12, 871, 100%). Glaucous Gull (L. hyperboreus): one second-year bird seen on 30 May 1983 (ac, 1, 1, 0.1%). Sabine’s Gull (Xema sabini): one seen offshore on 6 Jun 1985 (ac, 1, 1, 0.1%). Caspian Tern (Sterna caspia): 1–12 individuals fly over the island early May–Aug, occasionally diving for fish in the bays and rarely roosting among the Glaucous-winged Gulls on the beach (r, 12, 280, 32.1%). Arctic Tern (S. paradisaea): seen once on 14 May 1987 (ac, 1, 1, 0.1%).

Common Murre (Uria aalge): present offshore Apr–Aug (a, 12, 161, 18.5%). Pigeon Guillemot: about 134 pairs nest; median date of first eggs 8 Jun (range 26 May–23 Jun, n = 173 nests; Emms and Morgan 1989) (a, 12, 871, 100%). Marbled Murrelet (Brachyramphus marmoratus): present Apr–Aug (a, 12, 871, 100%). Rhinoceros Auklet (Cerorhinca monocerata): may be seen in late Apr but generally not until May–Aug. We found six severed heads in a meadow at Echo Bay on 27 Jun 1980. A search for possible nests nearby yielded none. Four nests found in 1991 (W. Campbell pers. comm.) (c, 12, 871, 100%). Tufted Puffin (Fratercula cirrhata): single birds flying by on 11 May 1983 and 23 Jul 1985 (ac, 2, 2, 0.2%).

Doves, Owls, and Nighthawks

Rock Dove (Columbia livia): seen on 17 and 30 Jun 1985 (ac, 1, 2, 0.2%). Mourning Dove (Zenaida macroura): one seen 25 May 1984 and 12 May 1993 (ac, 2, 2, 2.3%). Barn Owl (Tyto alba): one on 24 Aug 1984 and 25 Apr 1994. The latter was being mobbed by Northwestern Crows (ac, 2, 2, 0.2%). Long-eared Owl (Asio otus): one bird mobbed by crows on 23 May 1988 (ac, 1, 1, 0.1%). Snowy Owl (Nyctea scandiaca): one bird present 30 Apr–14 May 1985 (ac, 1, 15, 1.7%). The latest previous coastal record for British Columbia was 12 May (Campbell et al. 1990). Northern Pygmy-Owl (Glaucidium gnoma): a skeleton found in the woods on 11 May 1985. The bird probably died during the winter. Short-eared Owl (Asio flammeus): one on 3 May 1984, 16 May 1985, and 5 May 1988 (ac, 3, 3,
THE STATUS OF SPRING AND SUMMER BIRDS ON MITLENATCH ISLAND

0.3%). Common Nighthawk (Chordeiles minor): single birds seen between 4 and 21 Jun (ac, 4, 7, 0.8%). They probably reside on nearby islands and occasionally move farther afield on calm evenings.

Swifts, Hummingbirds, Kingfishers, and Woodpeckers

Black Swift (Cypselooides niger) (vr, 5, 6, 0.7%) and Vaux’s Swift (Chaetura vaux): present Apr-Aug. Rufous Hummingbird (Selasphorus rufus): present Apr-Aug. No nests found; however, a female collected spider webs in 1984, suggesting that she was building a nest (c, 12, 308, 35.4%). Belted Kingfisher (Ceryle alcyon): infrequent Apr-Aug. The island offers few suitable perches from which they can dive, and the Northwestern Crows pursue them when they have caught a fish. They generally do not stay very long (vr, 9, 40, 4.6%). Downy Woodpecker (Picoides pubescens): seen 27 Apr 1984 (ac, 1, 1, 0.1%). Northern Flicker (Colaptes auratus): present 5-9 Aug 1985 (ac, 1, 5, 0.6%).

Flycatchers, Larks, and Swallows

Western Wood-Pewee (Contopus sordidulus): earliest and latest record 4 and 31 May, respectively (ac, 4, 7, 0.8%). Willow Flycatcher (Empidonax traillii): seen Jun to Aug (vr, 6, 25, 2.9%). Hammond’s Flycatcher (E. hammondii): one seen 10-11 May 1993 (ac, 1, 2, 0.2%). Pacific-slope Flycatcher (E. difficilis): occasional visitor, heard between 11 May and 20 Jun (ac, 5, 8, 0.9%). Say’s Phoebe (Sayornis saya): a rare transient on the coast of British Columbia (Campbell et al. 1997). One present 14–16 May 1981 (ac, 1, 3, 0.3%). Western Kingbird (Tyrannus verticalis): present on 19 Jun 1984 (ac, 1, 1, 0.1%). Eastern Kingbird (T. tyrannus): present on 10 Jul 1987 (ac, 1, 1, 0.1%). Horned Lark (Eremophila alpestris): 1-4 birds 20 Apr–15 May, median passage day 3 May (vr, 5, 13, 1.5%). The race of these larks was not identified. E. a. strigata, which occurred in southern British Columbia, may be extirpated. Perhaps remnants of this race still persist on some of the islands (W. Campbell pers. comm.). Purple Martin (Progne subis): two flew over the island on 21 Jun 1990 (ac, 1, 1, 0.1%). Tree Swallow (Tachycineta bicolor): 6 seen on 3 May 1985 (ac, 1, 1, 0.1%). Violet-green Swallow (T. thalassina): nests in rock crevices and in a nest box; present from Apr to about the third week in Jul; during cold, wet, windy days in Apr and early May they are absent. Eggs from late May to mid-Jun, 4 fledglings on 8 Jul 1985 and 10 Jul 1987 (c, 12, 623, 71.5%). Northern Rough-winged Swallow (Stelgidopteryx serripennis): rare Apr-Jul (ac, 4, 8, 0.9%). Bank Swallow (Riparia riparia): one seen on 17 Aug 1984 (ac, 1, 1, 0.1%). Cliff Swallow (Hirundo pyrrhonota): rare in Apr, May, and Aug (ac, 2, 4, 0.5%). Barn Swallow (H. rustica): median arrival date 27 Apr (range 23 Apr–1 May, n = 11 years), present to Aug; absent on cold, wet windy days in Apr and early May. Nests on the cabin. Median date of first eggs in first clutches 29 May (13 May–14 Jun, n = 37), in second clutches 6 Jul (2–11 Jul, n = 8). Median clutch size 5 (4–6, n = 22). Coast Garter Snakes (Thamnophis elegans) and Northwestern Crows are predators of
nestlings. The number of breeding pairs has declined from 10 pairs in 1985 to 1 pair in 1997 (a, 12, 736, 84.5%). Similar declines have been reported elsewhere in British Columbia (Campbell et al. 1997).

Crows, Chickadees, Nuthatches, and Wrens

Northwestern Crow: about 55 pairs nest on the island; median date of first eggs is 6 May (range 17 Apr–6 Jun, n = 348 nests) (a, 12, 871, 100%). Common Raven (corvus corax): a pair was present most days in 1986 and built a nest but no eggs were laid. Particularly common 1984–86, much less common since then (r, 11, 186, 21.3%). Mountain Chickadee (Parus gambeli): one seen 21 Apr–6 May 1985 (ac, 1, 14, 1.6%). Chestnut-backed Chickadee (P. rufescens): one on 29 and 30 Apr 1993 (ac, 1, 2, 0.2%). Red-breasted Nuthatch (Sitta canadensis): rare, Apr–Jun (ac, 3, 8, 0.9%). Bewick’s Wren (Thryomanes bewickii): a breeding pair Apr–Aug 1984; they had five fledglings on 23 May. A single bird on 1 Jul 1987 (ac, 2, 100, 11.5%). Winter Wren (Troglodytes troglodytes): mostly single birds in Apr and throughout May and twice in Jun (18 and 25 Jun). It is not clear whether these are migrants or local dispersers (vr, 9, 17, 2.0%).

Kinglets and Thrushes

Golden-crowned Kinglet (Regulus satrapa): 1–2 (up to 12) seen per day, in Apr and May, and one record for 13 Jun 1990 (vr, 10, 43, 4.9%). Ruby-crowned Kinglet (R. calendula): 1–2 (up to 5) birds per day in Apr and May (vr, 10, 46, 5.3%). Mountain Bluebird (Sialia currucoides): a female seen on 3 May 1985, when Mitlenatch was enveloped in a dense morning fog (ac, 1, 1, 0.1%). Campbell et al. (1997) listed the species as an uncommon spring transient around Georgia Strait. Townsend’s Solitaire (Myadestes townsendi): seen on 10 and 11 May 1993. Mitlenatch was in a dense fog during the night of 9–10 May (ac, 1, 2, 0.2%). Swainson’s Thrush (Catharus ustulatus): a pair nested in 1983, otherwise rare in May, Jun, and Jul (ac, 3, 43, 4.9%). Hermit Thrush (C. guttatus): single birds, staying on average 2 days, almost every year between 24 Apr and 19 May (vr, 8, 22, 2.5%). American Robin (Turdus migratorius): frequent visitor Apr–Aug, with some singing males but no nests (r, 12, 158, 18.1%). Varied Thrush (Ixoreus naevius): accidental in Apr and May (ac, 3, 12, 1.4%).

Pipits, Waxwings, Starling, and Vireos

American Pipit (Anthus rubescens): migrating individuals and small flocks from Apr to mid-May, with stragglers through late May (vr, 12, 205, 23.5%). Cedar Waxwing (Bombycilla cedrorum): three seen on 2 Jul 1984 and 23 May 1985 (ac, 2, 2, 0.2%). European Starling (Sturnus vulgaris): nests in crevices in cliffs and rotten tree trunks. Flocks come from neighbouring islands to roost in the lodgepole pine stands (250 birds in Jun, 400 in Jul). Starlings are probably the main agent for the introduction of fruiting trees and shrubs (Brooke et al. 1983) such as the Red Elderberry (Sambucus racemosa), which arrived on the island in 1992 (Verbeek unpubl. data) (a, 12, 871, 100%). Solitary Vireo (Vireo solitarius): single sightings on 21 Apr 1985, 20 May 1990, and 5 Jun 1990 (ac, 2, 3, 0.3%). Warbling Vireo (V.
gilvus): single birds on 19 and 26 May 1986, 12 and 28 May 1987, 28 May 1990, and 4 Jun 1985 (ac, 4, 6, 0.7%).

Wood Warblers

Orange-crowned Warbler (Vermivora celata): regular Apr–May migrant and likely present before we arrived in some years (r, 12, 182, 20.9%). Yellow Warbler (Dendroica petechia): mainly May and early Jun and occasionally in early Jul. Earliest sighting 3 May 1983, median 22 May (r, 12, 87, 10.0%). Yellow-rumped Warbler (D. coronata): Apr–Jul, but mostly moving through in May (r, 12, 131, 15.5%). Black-throated Gray Warbler (D. nigrescens): occurs along the southern mainland coast of British Columbia (Munro and Cowan 1947). Seen on 26 and 30 Apr 1993 and 10 May 1994. Infrequent, perhaps because its high-pitched song may be lost among the noise made by the gulls (ac, 2, 3, 0.3%). Townsend’s Warbler (D. townsendi): a male seen on 3 May 1995 (ac, 1, 2, 0.2%). Individuals that end up on the island may not stay long because of the absence of suitable habitat, which may explain the species’ rarity. Macgillivray’s Warbler (Oporornis tolmiei): earliest record 29 Apr 1993, most birds in May, and recorded once in Jun and Aug (vr, 5, 10, 1.1%). Common Yellowthroat (Geothlypis trichas): seen infrequently from late Apr to Aug; earliest record 23 Apr 1984 (vr, 10, 70, 8.0%). Wilson’s Warbler (Wilsonia pusilla): mainly a May migrant, earliest 30 Apr 1985, latest 5 Jun 1990, median 20 May (r, 12, 78, 9.0%).

Tanagers, Grosbeaks, and Sparrows

Western Tanager (Piranga ludovici): single males on 25 May 1984 and 19 May 1988 (ac, 2, 2, 0.2%). Black-headed Grosbeak (Pheucticus melanocephalus): one seen on 23 Jul 1983 (ac, 1, 1, 0.1%). Spotted Towhee (Pipilo maculatus): about 7 pairs nest. Nest with 3 eggs on 24 Apr 1984, fledglings 15 May 1981, 23 May 1984 and 1986 (a, 12, 871, 100%). Chipping Sparrow (Spizella passerina): seen on 14, 16, and 25 May, and on 19 and 24 Jul (vr, 5, 5, 0.6%). Savannah Sparrow (Passerculus sandwichensis): present when we arrived in mid-Apr to about the third week in May, with stragglers until the end of May (vr, 12, 346, 39.7%). Fox Sparrow (Passerella iliaca): earliest record 22 April 1986, last 11 May. One territorial male sang from 26 Apr until 11 May 1988 but failed to attract a mate and left (ac, 3, 15, 1.7%). Song Sparrow (Melospiza melodia): common breeding bird (a, 12, 871, 100%). Lincoln’s Sparrow (M. lincolni): earliest record 26 Apr 1985, last 14 May 1985, median 3 May (ac, 6, 16, 1.8%). Golden-crowned Sparrow (Zonotrichia atricapilla) (vr, 12, 61, 7.0%) and White-crowned Sparrow (Z. leucomystax) (vr, 12, 63, 7.2%) pass through in Apr and early May. Occasionally a male White-crown establishes a territory, sings several weeks (to 22 May in 1986), and then leaves. Dark-eyed Junco (Junco hyemalis): found in the woods in Apr and May, and rarely Jun (vr, 6, 12, 1.4%).

Meadowlark, Blackbirds, and Finches

Red-winged Blackbird (Agelaius phoeniceus): infrequent Apr–Jul (vr, 7, 22, 2.5%). Western Meadowlark (Sturnella neglecta): usually single birds,
often staying in the meadow 2–3 days, Apr–Jun. Their appearance usually coincides with strong winds and substantial rainfall during the night (vr, 6, 14, 1.6%). Yellow-headed Blackbird (Xanthocephalus xanthocephalus): seen Apr–Jun, most frequently in May (vr, 6, 15, 1.7%). Regarded a casual visitor to the Puget Sound lowlands and gulf islands by Munro and Cowan (1947). Brewer’s Blackbird (Euphagus cyanocephalus): two birds on 23 May 1983 (ac, 1, 1, 0.1%). Brown-headed Cowbird (Molothrus ater): pairs to groups of up to 27 birds, Apr–Aug. More common in the 1980s than in the 1990s. A fledgling fed by a Song Sparrow on 8 Jul 1981 (c, 12, 532, 61.1%). Purple Finch (Carpodacus purpureus): a male 2–3 May 1986 and 29 April 1988 (ac, 2, 3, 0.3%). House Finch (C. mexicanus): a few seen May–Jul (vr, 5, 9, 1.0%). Red Crossbill (Loxia curvirostra): individuals mostly fly over Mitlenatch, without landing, May–Jul, most commonly in Jun (vr, 7, 24, 2.8%). Pine Siskin (Carduelis pinus): mostly fly over the island Apr–Jul, most often in May (r, 11, 138, 15.8%). American Goldfinch (C. tristis): Apr–Aug, most frequent in May and Jun. Increase in numbers in May coincides with fruiting of dandelions (Taraxacum officinale). May breed on the island; adults feeding a recent fledgling 27 Jul 1984 (u, 12, 502, 57.6%). Evening Grosbeak (Coccothraustes vespertinus): seen on 7 Jun 1981, 8 and 9 Jun 1990, and 1 May 1995 (ac, 3, 4, 0.5%).

DISCUSSION

I observed 166 species of birds on Mitlenatch Island between mid-April and mid-August, 1981–1995. Twelve of these are known to breed or to have bred on the island. Sirk et al. (1993) listed an additional 11 species reported in the same period in other years. Ten of these are accidental and one is very rare. Sirk et al. provided information on the relative abundance of species of birds on Cortes and assumed that the results apply to Mitlenatch as well. Given the differences between the two islands this is unrealistic in many cases. For instance, the Belted Kingfisher and California Gull on Cortes, to name but two, are considered common and rare in summer, respectively, while on Mitlenatch they are uncommon and abundant, respectively. In addition, Sirk et al. (1993) indicated the status of some species on the basis of a whole year, for parts of the year for others, even if such species are present all year (e.g., Black Turnstone). As my Mitlenatch data apply only to the period mid-April to mid-August, I had to determine the status of all birds on Cortes that occurred in that same period. I did this consistently as follows. Sirk et al. (1993) divided each month in four weeks. If a species was present in a given week they assessed its abundance as abundant, common, uncommon, rare, very rare, or accidental. I gave the rating for abundant 6 points, common 5, uncommon 4, rare 3, very rare 2, and accidental 1. All scores for each week (maximum 16 weeks) from mid-April to mid-Aug were then added. I then assigned an abundance value to each species as follows: 1–3 accidental, 4–15 very rare, 16–48 rare, 49–81 uncommon, 82–93 common, and 94–96 abundant. I analysed the results (Table 1) separately for aquatic (loons to ducks, rails to puffins) and terrestrial species, because many of the aquatic species share the waters between the two islands, while terrestrial species may be hampered in reaching Mitlenatch by those same waters.
Table 1 Relative Numbers of Species of Birds in Six Abundance Classes on Cortes and Mitlenatch Islands, Mid-April–Mid-August

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<th>Abundance</th>
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</tr>
<tr>
<td>Abundant</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Common</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Uncommon</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Rare</td>
<td>5</td>
<td>33</td>
</tr>
<tr>
<td>Very rare</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Accidental</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>63</td>
</tr>
</tbody>
</table>

*Status of birds on Cortes determined from information in Sirk et al. (1993) (see Discussion).*

Cortes and Mitlenatch share 63 species of aquatic birds. The status of some species is the same on both islands (e.g., Surf Scoter, Western Sandpiper); for some it is very different (e.g., Great Blue Heron common on Cortes, rare on Mitlenatch; California Gull abundant on Mitlenatch, rare on Cortes). Among the 19 species that are found only on Cortes, Pied-billed Grebes (*Podilymbus podiceps*) require ponds with some emergent vegetation, and Wood Ducks (*Aix sponsa*) and Hooded Mergansers (*Lophodytes cucullatus*) need wooded sloughs, which are not available on Mitlenatch. Most aquatic species recorded exclusively from Cortes (19 species) or from Mitlenatch (14 species) are very rare or accidental (68% on Cortes, 100% on Mitlenatch); none of them are abundant or common. Mitlenatch has a higher proportion (64%) of very rare and accidental aquatic species than does Cortes (37%), as expected from its smaller size and lack of fresh water.

Cortes and Mitlenatch share 83 species of terrestrial birds (Table 1), and, as with aquatic birds, the status of each species may be the same or different on each island (e.g., Chestnut-backed Chickadee and Ruby-crowned Kinglet common on Cortes, accidental and very rare, respectively, on Mitlenatch). Among the 25 species lacking from Mitlenatch, 11 are common to uncommon and presumably breed on Cortes. One of these, the Blue Grouse (*Dendragapus obscurus*), is not able to fly to Mitlenatch. The Brown Creeper (*Certhia americana*) and three resident woodpeckers, the Hairy (*Picoides villosus*) and Pileated (*Dryocopus pileatus*), and Red-breasted Sapsucker (*Sphyrapicus ruber*), could reach Mitlenatch, as do other resident woodpeckers (Downy and Northern Flicker, both accidental on Mitlenatch), and may be expected to do so accidentally in the future. Woodpeckers in general may avoid flying over large bodies of water. The six remaining uncommon species on Cortes, the Band-tailed Pigeon (*Columba fasciata*), Barred Owl (*Strix varia*), Olive-sided Flycatcher (*Contopus borealis*), Steller’s Jay (*Cyanocitta stelleri*), House Wren (*Troglodytes aedon*) and
Hutton’s Vireo (Vireo huttoni) were not seen on Mitlenatch during my study. Three times as many terrestrial birds on Mitlenatch (82%) are accidentals or very rare (Table 1) than on Cortes (26%).

One advantage for an observer on Mitlenatch is good visibility so that even birds that visit the island rarely nevertheless have a good chance of being sighted. For many birds Mitlenatch would seem to be on the way to nowhere, and most, particularly passerines, may well arrive by accident. If by accident they end up near Mitlenatch, the island probably serves as a magnet, particularly for migrating passerines during rainy nights with strong winds, during which sudden influxes of species, particularly passerines, are common. Those that are stranded on the island apparently find it hard to make a living on it and soon leave or are still programmed to migrate. Of 58 species of presumed breeding passerines on Cortes, 52 have been seen on Mitlenatch as well. Yet only 6 of the 52 species breed there every year, including two species of swallow, obviously not restricted by habitat, and two additional species are known to have bred there once during this study.

ACKNOWLEDGMENTS

I thank E. Basalyga, S. Emms, M. Guillemette, J. Hagen, B. Jobin, R. Malcolm, P. McConnell, K. Sars, and J. Wieczorek for their assistance in the field. I thank W. Campbell for information on the breeding of Double-crested Cormorants and Rhinoceros Auklets. The British Columbia Department of Lands, Parks and Housing gave permission for my research on Mitlenatch Island. M. Dueck and M. Rody gave much appreciated logistical support, and the Natural Sciences and Engineering Research Council of Canada supported my research of which this paper is a spin-off. I thank W. Campbell and P. Unitt for their comments and suggestions.

LITERATURE CITED


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FORAGING BEHAVIOR OF THE PYGMY NUTHATCH IN COLORADO PONDEROSA PINE FORESTS

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The Pygmy Nuthatch (Sitta pygmaea) is a permanent resident of montane habitats in the Rocky Mountain region, occurring most commonly in forests of Ponderosa Pine (Pinus ponderosa). In Colorado, the center of its distribution is in the lower montane region (1660 to 2425 m) (Bailey and Niedrach 1965, Andrews and Righter 1992). The breeding season (egg laying through fledgling stage) in Colorado lasts from early May to August (Bent 1964, Bailey and Niedrach 1965).

The diet of the Pygmy Nuthatch consists of both insect and vegetable matter. In Monterey County, California, Beal (1907) found that during late spring and early summer the diet consisted of 83% animal matter and 17% conifer seeds. Beal found that the insect diet is dominated by Hymenoptera (38%), Homoptera (23%) and Coleoptera (12%). Norris (1958) found that in Marin County, California, in winter nuthatches ate an average of 85 to 95% vegetable matter (pine seeds) while from April-September, they ate an average of 40 to 60% vegetable matter. In Larimer County, Colorado, McEllin (1979) noted that the nuthatches' diet shifted from primarily insects in the summer to primarily pine seeds in the winter.

We observed the foraging behavior of Pygmy Nuthatches during the breeding (10 June–31 August 1995 and 15 June–31 August 1996) and non-breeding season (1 March–30 April, 1995, 15 January–30 April 1996, and 1 September 1996–1 March 1997) in the Ponderosa Pine foothills of Colorado, focusing on foraging technique, position during foraging, and foraging location. Our goal was to increase understanding of how the Pygmy Nuthatch uses the Ponderosa Pine forests.

STUDY AREAS AND METHODS

The study areas were open woodlands (Betasso Preserve, Mount Sanitas Open Space, Flagstaff Mountain, and Shanahan Ridge) consisting mainly of stands of ponderosa pines mixed with Douglas Fir (Pseudotsuga menziesii) and Common Juniper (Juniperus communis) trees in Boulder County, Colorado (elev. 1550 to 2150 m).

Every bird that was encountered while foraging was recorded. Each bird was watched until it ceased a single foraging attempt. Thus, no observations were made in succession on the same birds. We estimate that a minimum 30 individuals were observed. In total 259 observations were made, 131 during the breeding season and 128 during the nonbreeding season.

Foraging behaviors were divided into three categories (Cruz 1987). One category, foraging technique, consisted of probing (removal of a food item by penetrating of the surface), gleaning (removal of a food item from the surface), pecking (removal of prey item by tapping and then penetrating surface), sallying (prey caught in flight), or cracking seeds/pounding (repeated pounding of the bird's beak on a seed). Another category, position
during foraging, consisted of stationary facing up, stationary facing down, vertical movement upward (usually on a trunk), vertical movement downward, lateral movement toward the trunk, lateral movement away from the trunk (resulting from a bird starting near the trunk and moving usually on branches toward the outer margins of the tree), movement among cone/needle clusters, and sallying. The final category was foraging location, consisting of top of branch, bottom of branch, top and bottom of branch, cone/needle cluster, trunk, base of branch, ground, and air. All statistical comparisons were done using the one-way chi-square test for independence and significance was determined if $P < 0.05$.

RESULTS

Nonbreeding Season

Probing was used significantly more often than all three other foraging techniques, namely, pecking/flaking bark ($\chi^2 = 11.8$, df = 1, $P < 0.05$), cracking seeds/pounding ($\chi^2 = 23.5$, df = 1, $P < 0.05$), and sallying ($\chi^2 = 27.3$, df = 1, $P < 0.05$). Pecking/flaking bark was only used significantly more than sallying ($\chi^2 = 5.8$, df = 1, $P < 0.05$). Gleaning was preferred over both cracking seeds/pounding ($\chi^2 = 11.2$, df = 1, $P < 0.05$), and sallying ($\chi^2 = 14.5$, df = 1, $P < 0.05$) (Table 1).

Pygmy Nuthatches were observed significantly more often in the stationary-facing-up, lateral-movement-away-from-the-trunk, and cone/needle-cluster positions than in the stationary-facing-down position ($\chi^2 = 8.0$, 5.4, 8.4, df = 1, $P < 0.05$). Stationary facing up was also used significantly more frequently than vertical movement upward ($\chi^2 = 5.7$, df = 1, $P < 0.05$) and lateral movement toward the trunk ($\chi^2 = 5.0$, df = 1, $P < 0.05$). Likewise, movement among cone/needle clusters was also performed more frequently than vertical movement upward ($\chi^2 = 6.1$, df = 1, $P < 0.05$) and lateral movement toward the trunk ($\chi^2 = 5.4$, df = 1, $P < 0.05$) (Table 2).

Nuthatches were observed significantly more often on the upper side of branches ($\chi^2 = 11.2$, df = 1, $P < 0.05$) and cone/needle clusters ($\chi^2 = 9.3$, df = 1, $P < 0.05$) than on the under side of branches (Table 3). Likewise, these foraging locations were both used significantly more frequently than the upper and under sides of branches ($\chi^2 = 11.2$, 9.3, df = 1, $P < 0.05$), bases of branches ($\chi^2 = 7.8$, 6.2, df = 1, $P < 0.05$), air ($\chi^2 = 14.5$, 12.5, df = 1, $P < 0.05$), and twigs ($\chi^2 = 8.5$, 6.9 df = 1, $P < 0.05$). In addition, the trunk was preferred significantly more than both the ground ($\chi^2 = 4.5$, df = 1, $P < 0.05$) and air ($\chi^2 = 6.3$, df = 1, $P < 0.05$) (Table 3).

Breeding Season

The nuthatches showed a preference for three of the foraging techniques (Table 1). Probing ($\chi^2 = 16.9$, df = 1, $P < 0.01$), pecking/flaking bark ($\chi^2 = 17.9$, df = 1, $P < 0.05$), and gleaning ($\chi^2 = 15.4$, df = 1, $P < 0.05$) were all used significantly more than either cracking seeds/pounding or sallying (Table 1).

With respect to position during foraging, stationary facing up was found to be used significantly more than stationary facing down ($\chi^2 = 4.5$, df = 1, $P < 0.05$), vertical movement downward ($\chi^2 = 4.5$, df = 1, $P < 0.05$), lateral
FORAGING BEHAVIOR OF THE PYGMY NUTHATCH IN COLORADO

Table 1 Pygmy Nuthatch Foraging Technique in the Colorado Front Range, 1995–1997

<table>
<thead>
<tr>
<th>Technique</th>
<th>Breeding Season (n = 131)</th>
<th>Nonbreeding Season (n = 128)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probing</td>
<td>32.0% (42)</td>
<td>49.2% (63)</td>
</tr>
<tr>
<td>Pecking/flaking bark</td>
<td>33.6% (44)</td>
<td>14.8% (19)</td>
</tr>
<tr>
<td>Gleaning</td>
<td>29.8% (39)</td>
<td>28.9% (37)</td>
</tr>
<tr>
<td>Cracking seeds/pounding</td>
<td>2.3% (3)</td>
<td>4.7% (6)</td>
</tr>
<tr>
<td>Sallying</td>
<td>2.3% (3)</td>
<td>2.4% (3)</td>
</tr>
</tbody>
</table>

movement toward trunk ($\chi^2 = 8.9, df = 1, P < 0.05$), and sallying ($\chi^2 = 12.0, df = 1, P < 0.05$) (Table 2).

The nuthatches foraged in the cone/needle clusters significantly more than in all other locations except upper side of branch (Table 3). These other subcategories included under side of branch ($\chi^2 = 8.5, df = 1, P < 0.05$), upper and under sides of branch ($\chi^2 = 11.3, df = 1, P < 0.05$), trunk ($\chi^2 = 6.9, df = 1, P < 0.05$), base of branch ($\chi^2 = 5.0, df = 1, P < 0.05$), ground ($\chi^2 = 11.3, df = 1, P < 0.05$), air ($\chi^2 = 13.5, df = 1, P < 0.05$), and twigs ($\chi^2 = 7.7, df = 1, P < 0.05$). The other location that was preferred significantly more by the nuthatches was upper side of branch (Table 3). This was used significantly more frequently than under side of branch ($\chi^2 = 4.4, df = 1, P < 0.05$), upper and under sides of branch ($\chi^2 = 6.7, df = 1, P < 0.05$), ground ($\chi^2 = 7.7, df = 1, P < 0.05$), and air ($\chi^2 = 7.7, df = 1, P < 0.05$).

Breeding Season vs. Nonbreeding Season

Of the various foraging categories, only foraging technique was found to differ significantly between the two seasons. Probing ($\chi^2 = 9.39, df = 1, P < 0.05$) and pecking/flaking bark ($\chi^2 = 9.39, df = 1, P < 0.05$) were used significantly more in the nonbreeding than in the breeding season (Table 1). Although there were numerical differences in frequency between other foraging behaviors in the two seasons, none was found to be significant.

Table 2 Pygmy Nuthatch Positions during Foraging in the Colorado Front Range, 1995–1997

<table>
<thead>
<tr>
<th>Position</th>
<th>Breeding Season (n = 131)</th>
<th>Nonbreeding Season (n = 128)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stationary facing up</td>
<td>24.4% (32)</td>
<td>23.4% (30)</td>
</tr>
<tr>
<td>Stationary facing down</td>
<td>9.2% (6)</td>
<td>4.7% (6)</td>
</tr>
<tr>
<td>Moving vertically upward</td>
<td>10.7% (14)</td>
<td>7.0% (9)</td>
</tr>
<tr>
<td>Moving vertically downward</td>
<td>9.2% (12)</td>
<td>11.7% (15)</td>
</tr>
<tr>
<td>Lateral toward trunk</td>
<td>4.6% (6)</td>
<td>7.8% (10)</td>
</tr>
<tr>
<td>Lateral away from trunk</td>
<td>19.1% (25)</td>
<td>19.0% (24)</td>
</tr>
<tr>
<td>Among cone/needle clusters</td>
<td>20.6% (27)</td>
<td>19.0% (24)</td>
</tr>
<tr>
<td>Sallying</td>
<td>2.3% (3)</td>
<td>2.3% (3)</td>
</tr>
</tbody>
</table>
DISCUSSION

The diversity of positions and substrates used during foraging suggest that nuthatches are generalists in these variables. These findings are supported by McEllin (1979), who said Pygmy Nuthatches are "generalists in location and specialists in prey strategy." However, the prevalence of several subcategories demonstrates a preference for certain behaviors.

The nuthatches made greatest use of the upper sides of branches and cone/needle clusters. This is in agreement with findings of Norris (1958) in California and Bock (1969) and McEllin (1979) in Colorado. Ground foraging, however, was found by Richardson (1942) in California and Stallcup (1968) in Colorado, whereas we observed it infrequently.

The frequent use of the stationary-facing-up position and lateral movements away from the trunk are associated with the use of the upper side of branches. Likewise, movement among cone/needle clusters clearly suggests foraging attempts within cone/needle clusters, the second major foraging location.

Although nuthatches are generalized in foraging location and positions, they appear to be exploiting fairly specific resources. This is suggested by the high frequencies of probing, pecking/flaking bark, and gleaning, paralleling the findings of Richardson (1942), Hay (1977) in Riverside County, California, and McEllin (1979). All three of these foraging techniques demonstrate use of resources and prey that are present on or in the bark of trees. Since this is a small subset of the resources available, this suggests that nuthatches are technique and prey specialists.

During our study, we rarely observed ground feeding. In contrast, Stallcup (1968) found that during the nonbreeding season nuthatches in Larimer County, Colorado, frequently (19.3%) fed on the ground. The ground was used mainly for extracting seeds from fallen pine cones.

Our data support cone/needle clusters and the upper sides of branches as the Pygmy Nuthatch's primary foraging areas. Past findings also supported high use of cone/needle clusters (Norris 1958, Bock 1968, McEllin 1979). This is relevant to management since only healthy adult pines produce cone
crops. As a result, healthy mature Ponderosa Pines appear to offer the Pygmy Nuthatch the best foraging habitat.

The lack of difference in the main foraging behaviors observed between seasons was surprising. Differences in foraging behaviors across seasons have been reported in Colorado by Stallcup (1968), who found that the nuthatches used more foraging zones during the breeding season than during the rest of the year. Similarly, Manolis (1977) found in Lassen County, California, that the most frequent foraging locations in summer and winter differed. McEllin (1979), however, found no seasonal difference in foraging technique in Colorado.

ACKNOWLEDGMENTS

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LITERATURE CITED


Accepted 3 November 1997
COWBIRD PARASITISM AND NEST SUCCESS OF THE LAZULI BUNTING IN THE SACRAMENTO VALLEY

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Reports of the frequency of Brown-headed Cowbird (Molothrus ater) parasitism on the Lazuli Bunting (Passerina amoena) vary greatly. The bunting has often been described as an uncommon host (Friedmann et al. 1977, Friedmann and Kiff 1985), though King (1954) found two of three nests parasitized and four family groups of fledglings with a juvenile cowbird. Greene et al. (1996) reported substantial geographic and local variations in parasitism rates, from 0 to 100%. The higher levels may not be surprising, as the closely related Indigo Bunting (P. cyanea) has long been considered a common cowbird host (Payne 1992).

As a result of the conversion of native habitats to farms and pastures, the Brown-headed Cowbird has undergone a remarkable population explosion and range expansion during this century (Rothstein et al. 1980, Laymon 1987, Lowther 1993). Cowbird parasitism is frequently cited as a contributing factor threatening the populations of many host species in North America (Gaines 1974, Brittingham and Temple 1983, Terborg 1989). Breeding-Bird-Survey data from the past 25 years suggest that Lazuli Bunting is declining in California, although the trends are not significant (Sauer et al. 1997). Over 25 years, the number of migrating Lazuli Buntings trapped on Southeast Farallon Island has declined significantly in both fall and spring (Pyle et al. 1994). A concordant significant decline in the proportion of immatures to adults suggests decreased productivity on the breeding grounds.

We found a high rate of cowbird parasitism on Lazuli Buntings in the Sacramento Valley of California. We present parasitism rates, nest success, and an index of "cowbird pressure."

METHODS

From 1993 to 1997 we monitored nests at six locations along the Sacramento River (Figure 1). Four of the study sites (La Barranca, Ohm, Flynn, and River Vista) are on the Sacramento National Wildlife Refuge; the other two (Kopta Slough and Stony Creek) are owned and managed by The Nature Conservancy. The refuge sites (except River Vista) are remnants of the Sacramento River's riparian forests, while the Nature Conservancy sites and River Vista are revegetated riparian plots planted between 1989 and 1993. The remnant riparian plots are wooded with Fremont Cottonwood (Populus fremontii), California Black Walnut (Juglans californica), Valley Oak (Quercus lobata), Oregon Ash (Fraxinus latifolia), Goodding's Black Willow (Salix gooddingii), Arroyo Willow (Salix lasiolepis), and Sandbar Willow (Salix sessilifolia). Dominant shrubs are Blue Elderberry (Sambucus mexicana), California Blackberry (Rubus ursinus), and Himalayan Blackberry (R. discolor); dominant herbs are Mugwort (Artemisia douglasiana), Stinging Nettle (Urtica dioica) and sedge (Carex sp.). The revegetated

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Figure 1. Location of study sites in the Sacramento River Valley, California.

riparian plots were planted primarily with Fremont Cottonwood, Valley Oak, Arroyo Willow, and Blue Elderberry; Mugwort and annual grasses compose most of the herbaceous layer.

We located and monitored nests using standardized procedures described by Martin and Geupel (1993). Nest-finding began in late April and lasted until breeding activity declined in mid-July. Plots were searched as often as possible, sometimes every day. Nests were checked every 1–4 days until their outcome was determined, usually by conditions at the nest or by observing fledglings near the nest. We tried to minimize observer-related mortality (for further description see Martin and Geupel 1993).

RESULTS

We based our analyses on nests with known outcomes only. Brown-headed Cowbirds parasitized 39 of 45 (86.7%) Lazuli Bunting nests found. The annual parasitism rate ranged from 71 to 100% (Table 1). Of the 39 parasitized nests, three (8%) fledged a total of 4 cowbirds and six (15%) fledged a total of 13 buntings (Table 2). The six unparasitized nests failed to fledge any buntings. We considered a nest successful if it fledged one or more Lazuli Buntings; two nests that fledged only a cowbird were considered unsuccessful. Nest success for all 6 years combined was 11.1%, by fraction estimates. Total nest survivorship by the Mayfield method (1975) was 11.7% (daily survivorship = 0.923 ± 0.013).
COWBIRD PARASITISM AND NEST SUCCESS OF THE LAZULI BUNTING

Of the 39 parasitized nests, 18 (46%) contained one cowbird egg, 15 (39%) contained two eggs, three (8%) contained three eggs, two (5%) contained four eggs, and one (3%) contained six eggs. In ten of these nests only cowbird eggs were observed. Cowbird eggs were accepted by Lazuli Buntings at 29 (74.4%) nests. We found no evidence that buntings removed cowbird eggs or buried them within the lining of the nest. Failure due to parasitism was often difficult to ascertain, but we estimate that 11 nests failed as a result of parasitism. Failure of this type was most often due to abandonment either immediately after cowbird eggs were laid or during incubation. In one instance a bunting incubated 4 cowbird eggs for 16 days before abandoning. In another instance a cowbird laid an egg in a nest that was under construction, resulting in abandonment.

McGeen (1972) presented a cowbird-pressure index that he suggested is dependent upon and reflects cowbird female density with respect to available hosts (based upon the incidence and intensity of parasitism). This index is the mean of the incidence (percent of nests parasitized) and the intensity of parasitism as measured by the percent frequency of multiple cowbird eggs (>1 cowbird egg) with respect to total cowbird eggs laid. The cowbird-pressure index for Lazuli Buntings at our study sites was 81.3 (all years combined).

DISCUSSION

The very high parasitism rates (71 to 100%) Lazuli Buntings suffered at our study sites are comparable only to those reported by Greene et al. (1996) from western Montana. Our cowbird-pressure index (81.3) is higher than any of those calculated by McGeen (1972). His indices for the American Goldfinch (Carduelis tristis), Willow Flycatcher (Empidonax traillii), Yellow Warbler (Dendroica petechia), and Song Sparrow (Melospiza melodia) range from 0 to 64.

Many factors have been reported as contributing to the cause and intensity of cowbird parasitism. Microhabitat features such as nest concealment (Burhans 1997), proximity to open habitat (Brittingham and Temple 1983), host behavior (Uyehara and Narins 1995), cowbird abundance (McGeen 1972, Hoover and Brittingham 1993, Robinson et al. 1995), and the cowbirds’ habitat preferences (Hahn and Hatfield 1995) may all influence rates of parasitism. Studies in mid-western and eastern North America have reported the highest rates of parasitism (and predation) along forest edges created by fragmentation (reviewed in Yahner 1988, Robinson 1992).

Table 1 Frequency of Parasitism of Lazuli Bunting Nests along the Sacramento River, 1993-1997

<table>
<thead>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unparasitized nests</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Parasitized nests</td>
<td>2</td>
<td>16</td>
<td>5</td>
<td>8</td>
<td>8</td>
<td>39</td>
</tr>
<tr>
<td>Parasitism (%)</td>
<td>100</td>
<td>100</td>
<td>71</td>
<td>73</td>
<td>89</td>
<td>87</td>
</tr>
</tbody>
</table>
Table 2 Productivity of Parasitized and Unparasitized Lazuli Bunting Nests along the Sacramento River, 1993–1997

<table>
<thead>
<tr>
<th></th>
<th>Parasitized Nests</th>
<th>Unparasitized Nests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of nests</td>
<td>39 (87%)</td>
<td>6 (13%)</td>
</tr>
<tr>
<td>Nests that fledged cowbirds</td>
<td>3 (8%)</td>
<td>—</td>
</tr>
<tr>
<td>Number of cowbirds produced per nest</td>
<td>0.10</td>
<td>—</td>
</tr>
<tr>
<td>Nests that fledged buntings</td>
<td>6 (15%)</td>
<td>0</td>
</tr>
<tr>
<td>Number of buntings produced per nest</td>
<td>0.33</td>
<td>0</td>
</tr>
</tbody>
</table>

We believe that the high rate of parasitism on Lazuli Buntings at our study sites reflects a combination of many factors. According to McGeen (1972), a high cowbird-pressure index indicates a high density of female cowbirds. Density of female cowbirds alone, however, may not play as large a role as other factors at our study sites. For example, the scarcity of alternate host species along the Sacramento River probably contributed to the observed high rates of parasitism of the Lazuli Bunting. Many of the species most frequently targeted by cowbirds, including Bell’s Vireo (Vireo bellii), Warbling Vireo (V. gilvus), Yellow Warbler (Dendroica petechia), Common Yellowthroat (Geothlypis trichas) and Song Sparrow, have been extirpated or have suffered severe declines in the Sacramento Valley (Gaines 1974, PRBO unpublished data). The cowbirds may be resorting to a secondary host whose nesting success is low and is not effective at raising young cowbirds. This suggests that there are more factors than abundance of hosts and cowbirds affecting population viability for the Lazuli Bunting (and perhaps the Brown-headed Cowbird) in the Sacramento Valley.

What factors influence the incidence of parasitism? The cowbird is an edge-loving species, and the creation of forest edges by fragmentation has been reported as one of the most influential factors affecting the incidence of parasitism (Brittingham and Temple 1983, Robinson 1992). Vegetation along the Sacramento river is indeed fragmented, linear, and narrow (the greatest estimated width of riparian woodland at our sites being 500 meters). Today the Sacramento River’s riparian vegetation is 1.5% of what it was historically (Roberts et al. 1980). Habitat loss, limiting the amount of potential nest sites, is likely compounding the effects of fragmentation in relation to cowbird parasitism. Our study sites are habitat islands providing the last remaining breeding areas for the majority of songbird species in the Sacramento River Valley (PRBO unpublished report). As it has been demonstrated that cowbirds seek hosts in forested habitats (Hahn and Hatfield 1995), we would expect high rates of parasitism. Riparian vegetation in the Sacramento River Valley has been replaced by orchards, row crops, pasture, and human habitation, all of which provide suitable foraging areas for cowbirds (Lowther 1993).

In addition to high parasitism rates, buntings on our study sites suffered very low nest success (11.7%), indicating that parasitism is not their only threat. Their nest success was much lower than the average calculated by Martin (1992) for 32 neotropical migrant species (42%) and lower than that
of any individual species except Bell's Vireo (11%) and Indigo Bunting (7.7%). Like the cowbird, nest predators may be benefiting from the conversion of native habitats. It has been suggested that the creation of edges may increase predator activity and nest visibility, and surrounding areas may provide additional food sources that attract predators (Suarez et al. 1997). Robinson et al. (1995) suggested that populations of migratory songbirds with daily nest mortality rates of 6% (≥80% of all nests lost) or higher are not self sustaining.

We fear that the Lazuli Bunting population along the Sacramento River may represent a "sink" that can be maintained only by immigrants from areas exposed to less parasitism and predation (Hassel and May 1974, Robinson et al. 1995). Since the fidelity of Lazuli Buntings to their nest territories is low (Greene et al. 1996), heavy losses in the Sacramento Valley may be draining the population over a wider area. Thus, the future of the Lazuli Bunting in the Sacramento Valley and perhaps throughout northern California warrants concern.

ACKNOWLEDGMENTS

This research was funded by the U. S. Fish and Wildlife Service, The Nature Conservancy, and the National Fish and Wildlife Foundation. We thank the staff of the Sacramento Wildlife Refuge and the Stony Creek Preserve, particularly Ramon Vega, Joe Silveira, John Carlon, and Tom Griggs, for assistance with study design and logistical arrangements. Grant Ballard designed database files, analysis programs, and the map. Nadav Nur aided in study design and provided useful comments to an early version of the manuscript. Special thanks to the numerous skilled and dedicated field biologists that found and monitored most of the nests, especially Matt Noel. Pamela L. Williams, Stephen A. Laymon, and Philip Unitt provided helpful comments on the manuscript. This is contribution 808 of the Point Reyes Bird Observatory.

LITERATURE CITED


COWBIRD PARASITISM AND NEST SUCCESS OF THE LAZULI BUNTING


Accepted 25 March 1998

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IDENTIFICATION OF WHITE AND BLACK-BACKED WAGTAILS IN BASIC PLUMAGE

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The breeding range of the White Wagtail (Motacilla alba) circles much of the northern hemisphere, extending from southeastern Greenland and Iceland east across Eurasia to Siberia and westernmost Alaska. Through this broad range there is extensive subspecific variation, with a total of ten subspecies recognized (Mayr and Greenway 1960, Cramp 1988); the form nesting in western Alaska and northeastern Siberia is M. a. ocularis (Swinhoe's White Wagtail). The Black-backed Wagtail (M. lugens), nesting in eastern Siberia and Japan, was split by the AOU (1983) from the White Wagtail.

Both the Swinhoe’s White and Black-backed wagtails are distinguished from other white-faced subspecies of the White Wagtail by a dark stripe through the eye. All other subspecies of the White Wagtail (including M. a. alba, which has strayed to Labrador and could occur farther south in eastern North America) lack the pattern of a distinct dark eyestripe in a white face, although immatures of all subspecies (including nominate alba) can have dusky auricul"ars.

Adults of the White and Black-backed wagtails are easily distinguished by the mostly white primaries and secondaries of the Black-backed, which are acquired in the second prebasic molt (July to September). First-year Black-backeds have dark remiges much like those of all White Wagtails and consequently are harder to identify.

Primarily from examination of museum specimens we found several features that, particularly if used in combination, permit the identification of most individual Swinhoe’s White and Black-backed wagtails. In general, basic-plumaged adult wagtails are marked more strongly than immatures and, within age classes, males are marked more strongly than females. Thus, there is a gradation from the brightest adult male to the dullest immature female. In addition, immature Black-backeds are marked more strongly than immature Swinhoe’s. Consequently, the most difficult identification problems lie in distinguishing immature female Black-backeds from adult female and well-marked immature male Swinhoe’s. Immature female and dull immature male Swinhoe’s, and most immature male Black-backeds and adult male Swinhoe’s, are all fairly distinctive.

We recognize that this paper is far from the last word on the identification of these two forms, and observers with an opportunity to study these wagtails critically in the field, or hand, could add significantly to our knowledge of their identification. In this respect, we acknowledge our debt to important prior work by Morlan (1981) and the unpublished notes of David Bell, archived in the files of the California Bird Records Committee.

METHODS

At the museums listed in the acknowledgments we examined 138 winter specimens of Swinhoe’s White Wagtail and 78 of first-winter Black-backed
Wagtails. All specimens examined were collected between September and mid March: a few from September still had some juvenal feathers on their face and throat, and most from mid or late March onward had begun to attain some black alternate plumage on the crown and throat.

The main characters we examined were forehead color, crown color, back and rump color and contrast, wing pattern, and the pattern of the outermost rectrix. To analyze characters we segregated specimens tentatively by age on the basis of wear and plumage, and by sex on the basis of specimen labels, measurements (males average larger than females), and plumage.

The potential of hybrids was a concern. Although we encountered some troublesome birds, when all characters were evaluated in combination we found fewer than 5% of specimens that might be hybrids. We omitted such birds from our analyses, but this problem must be borne in mind by both field and museum workers.

RESULTS AND DISCUSSION

Molt

An understanding of molt is integral to determining the age and thus identification of a wagtail. Details of the molts of Swinhoe’s White and Black-backed wagtails appear not to be well known. Because the extents of the prebasic and prealternate molts of the Yellow (M. flava), Gray (M. cinerea), and White (M. a. alba and M. a. yerrellii) wagtails in Europe are all much alike (Jenni and Winkler 1994), however, we suspect that the prebasic molts of Swinhoe’s White and Black-backed wagtails follow a similar pattern.

Although Morlan (1981), citing Sharpe (1885) and Stejneger (1892), noted that “lugens differs from other races [of the White Wagtail] in that it has a three-year molt sequence,” we doubt this. A careful reading of these sources suggests that Stejneger (1892) misinterpreted Sharpe (1885), but, after examination of a larger series of specimens, even the former concluded that “we are reluctantly forced to admit that still more examples are needed to get to the bottom of the question.” Although labels of photographs in BMRC (1983) suggest that third-year Black-backed Wagtails show more white in the wings than second-year birds, the text (translated from the Japanese) notes “after second winter molting, the black and white pattern of plumage is fixed.” We believe that individual variation is responsible for the supposed differences between first basic and second basic remiges. To our knowledge, a consistent pattern difference between first basic and second basic remiges would be unique among passerines and should be supported by incontrovertible evidence.

Prebasic molt. The prebasic molt of European White Wagtails occurs mostly to entirely on the summer grounds. This molt is complete in adults, most of which finish molting from late August to early October (Cramp 1988). The BMRC (1983) noted that molt of adult Black-backed Wagtails occurs before migration, during July and August; California records, however, suggest that in some vagrant Black-backed Wagtails the prebasic molt can occur or finish at migration stop-over sites.

As in most passerines, the first prebasic molt of wagtails does not include the flight feathers other than a variable number of rectrices (48.2% of
European White Wagtails molt no rectrices, 15.6% molt only two rectrices, usually the central pair, and only 4.4% molt the whole tail; Jenni and Winkler 1994). Most importantly, the first prebasic molt rarely includes all of the upperwing coverts. In Europe, first-year White Wagtails replace 0–10 (i.e., none to all; mean 5.3) of the greater coverts on each wing; 10.6% of birds molt no greater coverts, and only 4.5% replace all greater coverts (Jenni and Winkler 1994). In the British subspecies yarrellii, males tend to replace more coverts than females (Baggott 1970). Apparently all birds replace all median coverts, while birds that replace all of their greater coverts often replace one or more tertials and rectrices (Jenni and Winkler 1994).

Thus, in autumn and winter, the best age criterion for wagtails is what are known as "molt limits" (Jenni and Winkler 1994, Pyle 1997), i.e., contrast in pattern and/or wear among the greater coverts or between the greater and median coverts. First-year birds often show such contrast [e.g., Figure 1; also see figures 142–143 of Jenni and Winkler (1994) and pp. 206–208 of Pyle (1997)], but adults, which have a complete molt, do not. The contrast can be seen in the field as early as August or September (P. Alstrom pers. obs.). Because the juvénal and adult remiges of White Wagtails are similar, however, the few first-year birds of this species that replace all of their greater coverts and tail may not be distinguished safely from adults. The first prebasic molt also can include from none to all three tertials, but it may be difficult to distinguish molt-related contrast in these feathers. Our examination of specimens also suggests that forehead color is useful for ageing some White Wagtails into early winter (see below).

Prealternate molt. The prealternate molt of both first-year and adult European White Wagtails begins between December and February and completes between late February and April, prior to spring migration (Cramp 1988). This molt includes 0–7 greater coverts (mean 3.4) and 0–3

Figure 1. Immature male Black-backed Wagtail at Bolinas, Marin Co., California, 3 November 1995. Note the large bill with a pale fleshy base to the mandible, the bright white (first basic) median coverts that contrast with the duller (juvenile) greater coverts, and the sharply contrasting black lower rump.

Photo by Steve N. G. Howell
tertials on each wing, and 0-8 rectrices (Jenni and Winkler 1994), with the black areas on the head and throat among the last feathers to be replaced. For both Swinhoe’s White and Black-backed wagtails, our examination of specimens revealed that molt of the black areas on the head and throat is mainly from February onward, while many specimens from February and March were missing the outermost rectrices.

In Europe, adult White Wagtails molt earlier, on average, than do first-year birds, while males have a more extensive molt than females, and some first-year females do not molt in spring at all (Cramp 1988). Unless a bird retains worn juvenile greater coverts, ageing a wagtail in spring and summer is very difficult (Svensson 1984, Jenni and Winkler 1994). By summer, however, it appears that the primary coverts and remiges of first-year birds often are notably browner and more abraded than the blacker and relatively fresh adult feathers.

The prealternate molt of the Black-backed Wagtail extends from February to April (BMRC 1983). An immature male Black-backed Wagtail that wintered in California (January to April 1996) started to attain black back feathers in early February, and the back showed progressively more black until late March, when the upperparts and throat filled in quickly with black by 6 April (CBRC files). Molt of the greater upperwing coverts began in early February, when the inner one or two were replaced, and then was suspended until early March, when the rest were replaced by early April (CBRC files).

This broad spectrum of variation in molt may seem overwhelming, but the bottom line for a wagtail seen in autumn and early winter is that contrast between two generations of feathers among or between the greater and median upperwing coverts indicates a first-year bird. Determining the age of a winter White Wagtail may not always be possible, however, because a few birds undergo an extensive first prebasic molt. Because the prealternate molt of both first-year and adult birds can be similar in timing and extent, a wagtail in that molt cannot be aged safely unless it is retaining juvenile feathers.

Forehead Color

The color and contrast of the forehead with the crown may be useful for ageing Swinhoe’s White Wagtails in the field through early winter. We assessed forehead color of each specimen by means of three categories: (a) white or whitish; (b) mottled or flecked dusky; (c) mostly or all dusky (Figure 2).

Adult Swinhoe’s and Black-backed wagtails have a white or whitish forehead that typically contrasts distinctly with the gray or black crown. A few adult female Swinhoe’s may have a slightly dusky forehead, but we found no adults with an all-gray forehead concolorous with the crown.

In October and November, most immature Swinhoe’s have foreheads that are dusky to mottled dusky; by January, most have white foreheads (Table 1). The Black-backed appears to attain the white forehead more quickly, and we found no immature males with a dusky forehead (Table 1). On average, males of both forms attain white foreheads earlier than do females (Table 1).

Thus wagtails with a dusky gray forehead concolorous with the gray crown are immatures (White and some immature female Black-backed), those with a contrasting whitish forehead through early winter are mainly immature
Figure 2. Variation in crown and forehead pattern: (a) forehead white, crown with 65% black; (b) forehead mottled or flecked dusky, crown 5% black; (c) forehead dusky, crown 0% black.

Table 1 Seasonal Variation in Forehead Color of Immature Black-backed and Swinhoe's White Wagtails from September to March

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<tr>
<th>Species</th>
<th>Sex</th>
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*See Figure 2 (adults have clean white or whitish foreheads year-round). Foreheads become increasingly whiter through the winter, perhaps from abrasion of dusky feather tips in combination with molt. Males may attain whiter foreheads earlier than females; in early winter, the Black-backed Wagtail generally has a whiter forehead than the Swinhoe's White Wagtail.*
Black-backed or adult Swinhoe’s. We are unsure if this change in forehead color reflects the last, prolonged stages of the first prebasic molt or if it is due simply to the wearing away of dusky feather tips; it may be a combination of both of these factors.

Crown Color

We estimated the percentage of black on the crown of all specimens (Figure 2, Table 2); zero percent black indicates an all-gray crown. We noted an occasional fresh black crown feather in some mid-December immatures but not until February did we frequently detect new black feathers. These crown patterns can be seen in the field if good views are obtained of a bird.

Males in basic plumage have, on average, more black in their crowns than do females. In Swinhoe’s White Wagtail, only adults have mostly or all-black crowns, an all-black crown being typical of adult males: 44 specimens of basic-plumaged adult males had 45–100% (mean 93%) of their crown black, while 19 adult females had 0–70% (mean 30%) black. Most immature Swinhoe’s have mostly or all-gray crowns (Table 2). Immature Black-backeds often have extensive black on their crown, and both males and apparently females can have an all-black crown in first basic plumage (Table 2).

Back and Rump Color/Contrast

Table 2 Seasonal Variation in the Percentage of Black on the Crown of Immature Black-backed and Swinhoe’s White Wagtails from September to Marcha

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aSee Figure 2. Preliminary molt of new black feathers starts in late February or March, although rarely a few black feathers appear from mid December.

bThe crown of none exceeded 50% black.
WHITE AND BLACK-BACKED WAGTAILS IN BASIC PLUMAGE

The back and upper rump of Swinhoe’s White and immature Black-backed wagtails in basic plumage are gray, ranging from slightly dusker gray in the Black-backed to brighter bluish gray in the adult Swinhoe’s. Some immature Black-backeds (males at least) show diagnostic black flecks on the scapulars and lower back.

The lower rump of immature Swinhoe’s White Wagtails is mostly or all gray, with black or darker gray feathers concentrated distally where they merge with the black upper tail-coverts. Adult Swinhoe’s, however, especially males, can have the lower rump contrastingly dark, blackish gray. In many immature male Black-backeds the lower rump is mostly or all black, contrasting strongly with the gray upper rump. In immature female Black-backeds, the lower rump can be dusky gray, similar to that of Swinhoe’s. The rump contrast can be seen clearly on birds in the field when the wings are held drooped (e.g., Figure 1).

Thus other similarities between immature Black-backed and adult Swinhoe’s White wagtails are paralleled by rump contrast. Although adult Swinhoe’s can show a fairly contrasting blackish-gray lower rump, abrupt contrast of a solidly black lower rump appears diagnostic of an immature male Black-backed Wagtail.

Wing Pattern

The exact pattern of the median coverts provides perhaps the most useful single clue to a wagtail’s identity. In the field, the bases of the median coverts are often covered by the scapulars, so care should be taken in evaluating this feature. The pattern of the greater coverts is also important, as is the overall pattern created by the coverts and by the edges of the secondaries and primaries.

Immature Swinhoe’s White Wagtails have distinct dark bases to the median coverts, often appearing as a narrow dark “chain” between the gray scapulars and white tips of the coverts (Figures 3a, 4a/b). Although the first basic median coverts of most female Black-backeds have diffuse gray smudges at the base and narrow gray shaft streaks, these do not contrast strongly with the white feather tips (Figures 3b, 4c). The first basic median coverts of male Black-backeds are bright white, usually without any obvious dusky at the base (Figures 1, 3c, 4d). Adult male Swinhoe’s typically have all-white median coverts like immature male Black-backeds.

![Figure 3. Pattern of median upperwing coverts: (a) adult female/immature Swinhoe’s White Wagtail; (b) immature female Black-backed Wagtail; (c) immature male Black-backed/adult male Swinhoe’s White Wagtail.](image-url)
Figure 4. Variation in upperwing-covert patterns: (a) narrow white wingbars (feathers usually worn); (b) distinct white wingbars; (c) broad white wingbars tending to a white panel; (d) broken/mostly solid white panel; (e) solid white panel.

The greater coverts are also more patterned in immature Swinhoe's White Wagtails, whose coverts usually have blackish-gray centers, creating wingbars or a jagged "toothed" pattern intermediate between wingbars and a solid panel (Figure 4a/b). On the immature Black-backed, any dark color is a paler, poorly defined gray that does not contrast strongly with the white edges (Figure 4c/d) and tends not to interfere with the impression of a white panel.

Given that detailed analysis of feather pattern is often not possible in the field, we divided the overall pattern formed by the median and greater
coverts into five categories (Figure 4). As with other characters, adult Swinhoe's average bolder in wing pattern than immatures, and males average bolder than females.

Basic-plumaged adult male Swinhoe's White Wagtails have solid white wing panels (Figure 4d/e), and adult females have a broken panel (Figure 4c/d). Immatures typically have two wingbars, bolder in fresh plumage (through mid winter) and narrower when worn (in late winter) (Figure 4a/b).

Immature Black-backed Wagtails (Figure 4c/e) have a pattern much bolder than in immature Swinhoe's but similar to that of adult Swinhoe's. Rarely, heavily worn immature female Black-backeds show broad wingbars (Figure 4b) similar to those of some immature Swinhoe's (e.g., plate 1, figure 7, of BMRC 1983).

Adult male Swinhoe's often have bold white edges to the primaries and secondaries, narrower at the base of the feathers but still distinct; other plumages typically have duller, whitish to pale brownish edges to their primaries and secondaries. These edges are narrower than on the Black-backed and become narrower or absent at the base of the feathers (Figure 5a). Thus adult female and immature Swinhoe's generally have dark-based secondaries that can form a kinglet-like dark bar between the white-tipped greater coverts and the white-edged secondaries; this pattern is less apparent on adult females. The pattern on the primaries tends to be harder to see (as these feathers are usually covered in the field), but the Swinhoe's often has a dark crescent adjacent to the primary coverts.

Conversely, on immature Black-backed Wagtails the white edges of the secondaries and primaries are more distinct, whitish to white, and become broader at the base of the feathers (Figure 5b); only a few females in late winter have dull, worn edges. These broad edges create a continuous white panel on the secondaries of the folded wing, merging with the white of the greater coverts. The white primary edges widen to include the shaft just adjacent to the primary coverts, creating on some birds a small pale crescent

Figure 5. Pattern of white edging on the inner secondaries: (a) white edging narrows at base (typical of an immature Swinhoe's White Wagtail); (b) white edging widens at base (typical of an immature Black-backed Wagtail).
next to the primary coverts like that shown by an immature female Black-throated Blue Warbler (*Dendroica caerulescens*).

Howell (1989) noted that the whiter base to the flight feathers of an immature Black-backed Wagtail may be apparent in the field. His experience with an immature Black-backed (Bolinas, California, November 1995) bore this out. When that bird stretched out its wing, and in flight, the bases of the remiges showed as a broad white band on the upperwing, suggesting the whiter-winged look of an adult Black-backed. The underwings of both species, however, look bright white, because the inner webs of the remiges are white on all birds.

Thus an immature wagtail with a white wing panel connected to a wedge of white on the secondaries is a Black-backed. Note, however, that this pattern is approached closely by some adult female Swinhoe’s White Wagtails. Two white wingbars and a dusky bar at the base of the secondaries are typical of immature Swinhoe’s. Our field experience indicates that the angle and intensity of light can make it difficult to distinguish between wing patterns 4c and 4d, even between 4b and 4d (Figure 4); photographs can be particularly misleading in this respect, given the potential for the angle of light to cause illusions (e.g., making wingbars appear solid or vice versa), and prolonged critical observation in a variety of light conditions is the best method of evaluating wing pattern.

**Outermost Rectrix Pattern**

We divided the pattern of the outermost rectrix into “black” and “white” (Figure 6). Birds with only a few very inconspicuous gray flecks on the feather (probably not visible in the field) were classified as white. In the field, this pattern on the inner web of the outer rectrices can be seen on the underside of the closed tail.

Most Black-backed Wagtails (*n* = 73) had all-white outer rectrices, but a few immatures (*n* = 5) had a dark pattern similar to the Swinhoe’s White Wagtail’s. Most Swinhoe’s (*n* = 133) had dark on the outer rectrix, often more extensive than on Black-backed Wagtails with a dark area, but three adults had white outer rectrices.

Thus, while there is a slight overlap in this feature, all-white outer rectrices on an immature wagtail indicate the Black-backed, a conspicuous black area the Swinhoe’s.

**Other Characters**

Although adults of both species may show a faint yellow or buffy tinge on the face, and immatures often lack yellow tones, a distinct yellow wash on the face suggests the immature Black-backed (and see Wild Bird Society of Japan 1982). Immature Swinhoe’s may show a faint yellowish wash on its face but not as bold as on the Black-backed. This yellow can be particularly noticeable in the autumn (through early November, at least) but may fade by midwinter.

The Black-backed Wagtail averages larger billed than Swinhoe’s, and males average longer billed than females. Although the sexual difference in mean length is only about 1 mm (Howell 1989), it may parallel the useful difference between Hammond’s (*Empidonax hammondii*) and Dusky (*E. oberholseri*) flycatchers. Two immature Black-backed Wagtails in California
(October 1989, November 1995; e.g., Figure 1) showed strikingly long and stout bills, appearing well outside the range of Swinhoe’s.

From specimens and limited field experience it appears that winter adults have all-dark bills while immatures often have a pale fleshy or orange-yellow base to the lower mandible (cf. Figure 1). If so, this could help greatly with ageing White Wagtails and in distinguishing between the adult Swinhoe’s and immature Black-backed. An immature male Black-backed Wagtail that spent January to April 1996 in California showed a distinct pale base to its lower mandible in February; by mid March the paler basal area was dull and hard to see, and by early April the bill appeared all black. More field observations are needed to evaluate the usefulness and timing of this character and whether or not bill color varies seasonally in adult wagtails.

Photographs of vagrants in California show an apparent difference in face pattern: the thicker dark eyestripes of Black-backed Wagtails tend to encompass the eye, while the narrower dark eyestripes of Swinhoe’s leave the eye more distinct. Specimens do not show such a striking difference, but face pattern is often distorted on dried skins.

The black chest bib of winter wagtails averages broader in adults than in immatures and broader in males than in females. Immature male Black-backed Wagtails may have bibs almost as broad, but perhaps not as clean-cut, as on adult male White Wagtails.

As in alternate plumage (Howell 1989), basic-plumaged Black-backed Wagtails typically have a white shaft to their fourth (from inner) rectrix; in Swinhoe’s this feather is typically all dark but may have an indistinct whitish streak on the shaft. Some immature Black-backed Wagtails,
however, have the fourth rectrix all dark (Howell 1989). Exceptional views, preferably supported by photographs, are needed for this character to be used in the field.

Hybrids

Kishchinski and Lobkov (1979) reported that where the ranges of Swinhoe’s White Wagtail (ocularis) and Black-backed Wagtail (lugens) overlap on the Kamchatka Peninsula, interbreeding is “restricted and infrequent,” and on St. Lawrence Island, Alaska, vagrant Black-backed Wagtails have paired up with the local Swinhoe’s (Badyaev et al. 1996). Nazarenko (1968) reported that M. lugens and M. alba leucopsis nest side by side with limited interbreeding in northeastern China, while leucopsis interbreeds freely with baicalensis, which interbreeds with ocularis. Recent range expansion by lugens, however, has brought about widespread hybridization between it and leucopsis in southern Japan, where these two forms have recently come into contact (Alstrom et al. in press), and species limits within this complex remain far from resolved.

The specter of possible hybridization between Swinhoe’s White and Black-backed wagtails was always a consideration when we found troublesome specimens. The two differ primarily in wing pattern and back color, with the adult female Black-backed being intermediate between the adult male Black-backed and Swinhoe’s. Intermediate-plumaged specimens labeled male could be missexed females, and some immatures might show only partial development of adult characters. Observers in North America should always consider the possibility of a hybrid when confronted with a vagrant White/Black-backed Wagtail that does not show the full characters of one species or the other.

Status in Western North America

Through the winter of 1995/96 there were 46 accepted records (involving 42 birds) of the White and Black-backed wagtails from western North America, south of Alaska: 9 (representing 6 individuals) of the White, 14 (13) of the Black-backed, and 23 unidentified to species (including six we consider as White, and one probable Black-backed) (Table 3). Critical analysis and discussion of all records is beyond the scope of this paper, and we encourage persons whose conclusions differ significantly from ours to publish their findings. We have supplied detailed comments to the California Bird Records Committee concerning all unidentified White/Black-backed Wagtails from that state.

Morlan (1981) concluded that the Black-backed Wagtail may be more likely to occur in western North America than the White, in part because at that time there were three documented records of the former, only one of the latter. Although this is still mirrored in the accepted records to date (Table 3), we believe that the bias toward the Black-backed reflects the ease with which adults are identified and that the true ratio may be nearer 50:50, or perhaps even in favor of the White.

Although records are few, some patterns may be emerging. Adult Black-backed Wagtails have occurred from late July to late September and in May
## Table 3  Records of White and Black-backed Wagtails in Western North America South of Alaska, through Winter 1995/96

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Source</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Wagtail</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Jan 1882</td>
<td>La Paz, BCS, Mexico</td>
<td>Howell and Webb (1995)</td>
<td>Specimen lost (imm.)</td>
</tr>
<tr>
<td>10 Oct 1974</td>
<td>SE Farallon I., San Francisco Co., CA</td>
<td>Binford (1985)</td>
<td>Immature&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>9-11 Oct 1978</td>
<td>Goleta, Santa Barbara Co., CA</td>
<td>Binford (1985)</td>
<td>Immature&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>9 Oct 1983</td>
<td>Arroyo de la Cruz, San Luis Obispo Co., CA</td>
<td>Roberson (1986)</td>
<td>Adult (probable male)</td>
</tr>
<tr>
<td>26 Apr 1984</td>
<td>Ocean Park, Pacific Co., WA</td>
<td>B. Tweit (in litt.)</td>
<td></td>
</tr>
<tr>
<td>14 Jan–7 May 1984</td>
<td>Crockett I., Lake Co., WA</td>
<td>Tweit and Skreltz (1996)</td>
<td>Imm. molted into alt. plumage</td>
</tr>
<tr>
<td>7 Nov–3 Dec 1990</td>
<td>Pajaro R. mouth, Santa Cruz/Monterey Co., CA</td>
<td>Unpubl. CBRC data</td>
<td>Immature male&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>8 Nov 1990–9 Mar 1991</td>
<td>Saticoy, Ventura Co., CA</td>
<td>Unpubl. CBRC data</td>
<td>Immature&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Black-backed Wagtail</td>
<td></td>
<td>Heindel and Garrett (1995)</td>
<td>Considered same as Oxnard bird</td>
</tr>
<tr>
<td>22 May 1980</td>
<td>Tiburon, Marin Co., CA</td>
<td>Binford (1985)</td>
<td>Adult male</td>
</tr>
<tr>
<td>18 Apr 1982</td>
<td>Vancouver, B.C.</td>
<td>Campbell et al. (19XX)</td>
<td></td>
</tr>
<tr>
<td>2 Aug–7 Sep 1987</td>
<td>Port Hueneme, Ventura Co., CA</td>
<td>Pyle and McCaskie (1992)</td>
<td>Adult (female&lt;sup&gt;a&lt;/sup&gt;), molted during stay</td>
</tr>
<tr>
<td>1 Oct 1989</td>
<td>Rodeo Lagoon, Marin Co., CA</td>
<td>Unpubl. CBRC data</td>
<td>Imm. (probable male&lt;sup&gt;a&lt;/sup&gt;)</td>
</tr>
<tr>
<td>6–7 Sep 1994</td>
<td>Crescent City, Del Norte Co., CA</td>
<td>Howell and Pyle (1997)</td>
<td>Adult (probable male)</td>
</tr>
<tr>
<td>Date</td>
<td>Location</td>
<td>Remarks</td>
<td></td>
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<td>------------</td>
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<tr>
<td>25 Jan-12 Apr 1996</td>
<td>Dana Point, Orange Co., CA</td>
<td>Unpubl. CBRC data</td>
<td></td>
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<tr>
<td>8-9 Nov 1981</td>
<td>Seattle, King Co., WA</td>
<td>B. Tweit (in litt.)</td>
<td></td>
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<tr>
<td>8 Nov 1984</td>
<td>Cabo San Lucas, BCS, Mexico</td>
<td>Wilbur (1987)</td>
<td></td>
</tr>
<tr>
<td>7-10 Oct 1985</td>
<td>Grand Canyon (S rim) sewer ponds, Coconino Co., AZ</td>
<td>Stejskal and Witzeman (1986)</td>
<td></td>
</tr>
<tr>
<td>3-11 Dec 1989</td>
<td>Pajaro R. mouth, Santa Cruz/ Monterey Co., CA</td>
<td>Unpubl. CBRC data</td>
<td></td>
</tr>
<tr>
<td>30 Apr 1990</td>
<td>Keystone, Island Co., WA</td>
<td>Description inadequate for specific identification</td>
<td></td>
</tr>
<tr>
<td>21 Dec 1990-19 Jan 1991</td>
<td>Moss Landing, Monterey Co., CA</td>
<td>Description inadequate for specific identification</td>
<td></td>
</tr>
<tr>
<td>1-3 Sep 1994</td>
<td>Eel R. Wildlife Mgmt. Area, Humboldt Co., CA</td>
<td>Description inadequate for specific identification</td>
<td></td>
</tr>
<tr>
<td>30 Apr-7 May 1996</td>
<td>Triangle I., B.C.</td>
<td>Description inadequate for specific identification</td>
<td></td>
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</tbody>
</table>

*Species identification from our evaluation of documentation in CBRC files.*
(and perhaps early June), immatures from early October to early November. There is a well-documented winter record (January to April) of an immature Black-backed Wagtail from southern California and another winter record (February to March), reportedly of a Black-backed, from Oregon.

Adult White Wagtails have been found wintering in California and Baja California from October or November to February or early March. Immatures have been found in winter during December and January (perhaps reflecting Christmas Bird count coverage rather than true arrival?) but then have seemed to vanish, other than one bird in Washington that remained from January to early May. Migrating immature and adult White Wagtails have occurred from October through early November (with adults averaging earlier than immatures) and in April.

Thus adult Black-backeds have occurred earlier in fall and later in spring than all White Wagtails, whereas most midwinter birds have been White. Interestingly, adult Black-backeds have been found more often away from the coast, unlike White Wagtails and immature Black-backeds, which have been mainly coastal.

SUMMARY

Identification of wagtails cannot be simplified and requires critical study of several features. Most identification problems are between the immature Black-backed and adult female and immature male Swinhoe’s White. Figure 7 shows typical basic plumages of each. Variation within species is gradual, and many immatures, particularly of the White, cannot be sexed in the field.

All adult Black-backed Wagtails are identified by their mostly white primaries and secondaries. Even though the white flight feathers of the Black-backed may not be immediately apparent on a perched bird, study of the folded wing will reveal useful clues. Diagnostic features are the continuous pure white panel from the median coverts to secondaries, white bases (at least) of all primaries, and some white on the alula and primary coverts. Many individuals (particularly males) show blackish smudges on the back or entirely white outer webs of the tertials, both of which are diagnostic.

Immature female (and many immature male) Swinhoe’s White Wagtails are equally distinctive, with relatively narrow white wingbars and dark-based secondaries; all plumages of the Black-backed show far more white on the wing coverts and secondaries. These dull immatures also tend to have an all-gray crown, brownish wings, and a narrow blackish bib.

Other plumages—adult and some immature male White and immature Black-backed—are more difficult to distinguish. Check for contrast in pattern and wear within the greater coverts or between the greater and median coverts, and look at forehead pattern and the color of the lower mandible as clues of age.

The characters typical of Swinhoe’s White Wagtail in adult basic and first basic plumage and the Black-backed Wagtail in first basic plumage are summarized in Table 4.
Figure 7. Basic-plumaged Black-backed (left) and Swinhoe’s White (right) wagtails. Top to bottom: adult male, adult female, immature male, immature female.

*Painting by David A. Sibley*
## Table 4 Proposed Identification Characters for Adult and Immature Swinhoe’s White Wagtail and Immature Black-backed Wagtail in Winter

<table>
<thead>
<tr>
<th></th>
<th>Forehead</th>
<th>Crown</th>
<th>Lower Rump</th>
<th>Wings</th>
<th>Bill</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adult White Wagtail</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Male  white</td>
<td>45–100% black;</td>
<td>dark gray,</td>
<td>solid or broken</td>
<td>medium,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>most have</td>
<td>contrast with</td>
<td>white panel;</td>
<td>dark</td>
<td></td>
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<tr>
<td></td>
<td>all-black caps</td>
<td>blue-gray back</td>
<td>remiges distinctly</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>not marked</td>
<td>edged white</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female white to whitish</td>
<td>0–70% black,</td>
<td>dark gray,</td>
<td>bold white bars</td>
<td>small, dark</td>
<td></td>
</tr>
<tr>
<td></td>
<td>variable</td>
<td>contrast averages less than in male</td>
<td>to broken panel; remiges</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>narrowly edged</td>
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<td></td>
<td></td>
<td></td>
<td>white at base</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Immature White Wagtail</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male  dusky to white</td>
<td>0–50% black,</td>
<td>gray, little or</td>
<td>broad to narrow</td>
<td>medium,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>most have</td>
<td>no contrast</td>
<td>white bars; remiges</td>
<td>pale base</td>
<td></td>
</tr>
<tr>
<td></td>
<td>little black</td>
<td>with gray back</td>
<td>narrowly</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>edged whitish at base</td>
<td></td>
<td></td>
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<tr>
<td>Female dusky to whitish</td>
<td>0–10% black</td>
<td>gray, as in male</td>
<td>narrow to broad</td>
<td>small, pale</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>white bars; poorly contrasting</td>
<td>base</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>white edges to remiges narrow</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>at base</td>
<td></td>
<td></td>
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<tr>
<td><strong>Immature Black-backed</strong></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Male  white to whitish</td>
<td>0–100% black;</td>
<td>black, in strong</td>
<td>solid to broken</td>
<td>large, pale</td>
<td></td>
</tr>
<tr>
<td></td>
<td>most have</td>
<td>contrast to gray back</td>
<td>white panel; bold white edges</td>
<td>base</td>
<td></td>
</tr>
<tr>
<td></td>
<td>much black</td>
<td></td>
<td>to remiges widen</td>
<td>at base of feathers and show in flight</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>as broad band</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female dusky to white</td>
<td>0–100% black;</td>
<td>dark gray,</td>
<td>broad white</td>
<td>medium,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>most have</td>
<td>often little contrast with</td>
<td>medium,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>some black</td>
<td>back</td>
<td>white base</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>base panel; white bases to remiges</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>average less than in male</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Forehead and crown color can change over the winter (see text and Tables 1 and 2).

*Bill color may change over winter; more study needed.

**ACKNOWLEDGMENTS**

We thank personnel at the American Museum of Natural History, the Museum of Comparative Zoology (Harvard University), the Academy of Natural Sciences, Philadelphia, the National Museum of Natural History, the Museum of Vertebrate Zoology (University of California, Berkeley), and the California Academy of Sciences who
allowed us to examine specimens in their care. The owners of Moonglow Dairy, Moss Landing, California, allowed us access to their land when a controversial wagtail was present there (January 1991), and Maya Decker kindly provided excellent videos of a Black-backed Wagtail that wintered in California (January to April 1996). Michael A. Patten arranged for us to review California Bird Records Committee files, including extensive notes by David Bell. Patten (California), Harry B. Nehls (Oregon), and Bill Tweit (Washington) were most helpful in our compilation of records of west coast wagtails. Per Alström, Mike Carter, Jon Dunn, Paul Lehman, Joseph Morlan, and Peter Pyle improved the manuscript with their comments. This is contribution 121 of the California Bird Records Committee.

LITERATURE CITED


WHITE AND BLACK-BACKED WAGTAILS IN BASIC PLUMAGE


Accepted 1 May 1998
ARIZONA BIRD COMMITTEE REPORT, 1974–1996: PART 1 (NONPASSEERINES)

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The Arizona Bird Committee (ABC hereafter) was organized by Steven M. Speich in 1972, with the original members being Russell P. Balda, Bill Harrison, Gale Monson, Stephen M. Russell, Steven M. Speich, and Robert A. Witzeman. Through the 1980s, as original members retired from the committee, new members were elected; these included Doug Danforth, Kenn Kaufman, G. Scott Mills, Gary H. Rosenberg, Will Russell, David Stejskal, Scott B. Terril, and Carl Tomoff. In 1986, the number of members was raised from six to eight. In 1996, term limits were adopted, with members rotating off for a minimum of one year. New members are nominated and elected for a four-year term by the existing committee at its annual meeting. New members elected as of 1996 are Chris Benesh, Troy Corman, Roy Jones, Dave Krueper, and Chuck LaRue. The current committee (July 1998) consists of these five plus Kenn Kaufman, Will Russell, and Dave Stejskal. Janet Witzeman served as secretary of the ABC from 1972 to 1996 and continues to serve as assistant secretary. Gary H. Rosenberg was elected secretary in 1996 and continues to serve in that position in a nonvoting capacity.

This report covers the period from 1974 through 1996. Two previous reports by the ABC have been published (Speich and Parker 1973; Speich and Witzeman 1975). The ABC sincerely regrets not publishing reports on a timely basis and hopes to do better in that regard in the future. Since 1974, no fewer than 46 species have been added to the Arizona list, 21 of which are included in the present nonpasserine portion of the report (the remainder will be published in a second part covering the passerines). The following species were accepted as first state records: Yellow-billed Loon, Red-necked Grebe, Laysan Albatross, Least Storm-Petrel, Garganey, Tufted Duck, Harlequin Duck, Black Scoter, Swallow-tailed Kite, Northern Jaçana, Hudsonian Godwit, White-rumped Sandpiper, Ruff, Long-tailed Jaeger, Mew Gull, Glaucous Gull, Elegant Tern, Black Skimmer, Ruddy Ground-Dove, Cinnamon Hummingbird, and Eared Trogon. Most of these reports have been previously published in American Birds or National Audubon Society Field Notes (Am. Birds/NASFN hereafter), but this is the first time the ABC has reviewed and endorsed these records. More than 1000 reports have been reviewed by the ABC since 1974; original reports and photos are housed in a file in the ornithology collection at the University of Arizona in Tucson. As is likely for most records committees, numerous reports of many species have not been submitted to or reviewed by the ABC but have been published in Am. Birds/NASFN. A summary of records outstanding follows each account. It is the hope and intent of the ABC to solicit documentation for as many of these as possible. Most records prior to 1972, as published in previous scholarly ornithological works (Phillips et al. 1964; Monson and Phillips 1981), have not been evaluated by the ABC. We have noted when
a species has been removed from our review list (as indicated by an asterisk in the ABC’s Field Checklist of the Birds of Arizona; Rosenberg and Stejskal 1994), and we have noted when sketch details are still requested for inclusion of reports in Field Notes (noted by a diamond in the Checklist).

Each record listed below includes a locality, county (abbreviation: see below), date (span normally as published in Am. Birds/NASFN), and initial observer if known. Additional observers who submitted reports and photographs are also listed. All records are sight records unless noted otherwise with a symbol for a photograph, sound recording, or specimen. It has not been customary for the ABC to review individuals returning for multiple years, but these dates are normally included within the accounts.

The ABC would like to re-emphasize a few aspects of documentation of rarities, some of which were noted by Howell and Pyle (1997), particularly with regard to what the committee is looking for when reviewing records. A few basics are very much appreciated: reports need to be written clearly and legibly; date, locality, when first found (if known), initial observer (if known), and observer writing the report are essential, though often omitted; photos should be clearly labeled. First state records are generally not accepted without some form of physical documentation (photo, recording, or specimen), although a few exceptions have been made with multiple-observer sightings (e.g., Least Storm-Petrel, Swallow-tailed Kite). The committee encourages observers to write descriptions before referring to reference material. Descriptions should encompass not only as full a description of the bird as possible, including any aspect of the bird’s behavior (e.g., voice, tail-bobbing), but circumstances regarding the sighting (e.g., weather, lighting conditions, optical equipment, and distance to bird) as well. A crude sketch (you do not need to be an artist) of the bird is an excellent means to conveying important plumage information. Lack of acceptance is generally not an indication of belief or disbelief of a particular report by the ABC but more often a determination that the documentation reviewed by the committee did not definitively substantiate the record. The ABC will gladly reevaluate a record if additional material (additional write-ups, photos, etc.) is submitted. Historically, a record that received two or more negative votes by the committee was not accepted. The ABC’s current policy is similar, but a record that receives two “dissenting” votes, either positive or negative, is circulated for a second round of votes. If at the conclusion of the second round it still receives at least two negative votes, it is not accepted.

The ABC’s abbreviations for counties in Arizona are as follows: APA, Apache; COS, Cochise; COC, Coconino; Gil, Gila; GRA, Graham; GRE, Greenlee; LAP, La Paz; MAR, Maricopa; MOH, Mohave; NAV, Navajo; PIM, Pima; PIN, Pinal; SCR, Santa Cruz; YAV, Yavapai; YUM, Yuma. Other nonstandard abbreviations commonly used in this report include B.T.A., Boyce Thompson Arboretum; F.M.I.R., Fort McDowell Indian Reservation; L.C.R., Little Colorado River; L.C.R.V., Lower Colorado River Valley; N.I.R., Navajo Indian Reservation; ph., photograph; P.A.P., Pinal Air Park; P.R.D., Painted Rock Dam; S.P.R., San Pedro River; S.T.P., sewage treatment plant.
RECORDS ACCEPTED

RED-THROATED LOON Gavia stellata. Single individuals were seen at Bill Williams Arm, L. Havasu, MOH, 29 Mar–2 Apr 1978 (ph. KVR), at P.R.D., MAR, 26 Nov 1978 (ST), at L. Havasu, MOH, 23 Dec 1980–21 Feb 1981 (MK; ph. JW2), at Willow L., YAV, 27–28 May 1984 (BT), two individuals were at L. Havasu, MOH, 8 Feb 1986 (WCH, CBa), and was one at the Hassayampa R. Preserve, MAR, 17 Nov 1996 (ph. MST). At least one additional record has been published in Am. Birds/ NASFN but not reviewed by the ABC. Three additional records were published by Monson and Phillips (1981).

YELLOW-BILLED LOON Gavia adamsii. The first record for Arizona was of one at P.R.D., MAR, 15 Jan–11 Feb 1984 (DS); ph. JWz; see Witzeman et al. 1997:135). Another individual was at L. Havasu City, MOH, 24 Dec 1989–14 Mar 1990 (ph. PS; ph. KB; see Am. Birds 44:302). These two are the only Arizona records.

LEAST GREBE Tachybaptus dominicus. Single individuals were at Guevavi Ranch, SCR, 16–23 Dec 1976 (RNd), at Quitobaquito, Organ Pipe Cactus N. M., PIM, 13 Oct 1976–30 Nov 1978 (TPt; ph. RWz), and at Picacho Res., PIN, first reported in mid-Dec 1994, relocated 10–14 Feb 1995 (NB; ph. DE, JiB). These three, along with those previously published by Monson and Phillips (1981), bring the total number of acceptable records to eight.

HORNED GREBE Podiceps auritus. Prior to 1975, this species was on the review list with accepted reports from Bonita, GRA, 6 Oct 1974 (DDa) and Nogales, SCR, 1–3 Nov 1975 (PN). Currently it is a rare but regular visitor in fall and winter to the L.C.R.V. and casual at those seasons elsewhere in the state, with numerous reports listed by Monson and Phillips (1981). Sketch details are still requested for reports’ inclusion in Field Notes.

RED-NECKED GREBE Podiceps grisegena. The first state record was from L. Havasu, MOH, 23 Mar 1981 (CRo; ph. MK; Figure 1; Rosenberg et al. 1991). Other individuals were at L. Mohave, MOH, 28 Jan 1984 (MK), Roosevelt Lake, GIL, 17 Feb 1988 (DDr), L. Havasu, MOH, 22–23 Feb 1992 (TC), Kayenta, NAV, 21 Sep 1994 (CTL), and L. Pleasant, YAV, 21 Mar 1996 (TLi). These represent all of the acceptable Arizona sightings.

LAYSAN ALBATROSS Diomedea immutabilis. Truly outstanding for the desert Southwest were an individual picked up alive at Yuma, YUM, 14 May 1981 (MH; ph. GMC; Figure 2) and transported to Sea World (and eventually released) in San Diego, and another found dead there 18 Jul 1988 (ph. TPP). These represent the only two accepted records from Arizona. As pointed out by Rosenberg et al. (1991), there are other inland records for southern California; neither Arizona record appears to be the result of any storm.

SOOTY SHEARWATER Puffinus griseus. The only record of this typically pelagic species for Arizona is of one found dead near Welton, YUM, 6 Jun 1971 (RQ; *UA); although this record has been published previously (Monson and Phillips 1981), it had not been reviewed by the ABC.

LEAST STORM-PETREL Oceanodroma microsoma. Two individuals were at Davis Dam, L. Mohave, MOH, 12–17 Sep 1976 (WP, CLw), following Tropical Storm Kathleen, and one was at Patagonia L., SCR, 24 Aug–5 Sep 1992 (Deo, PK). Both these records have been accepted by the ABC, but there remains no physical documentation of this species’ occurrence in Arizona.

WHITE-TAILED TROPICBIRD Phaethon lepturus. One was found exhausted in Scottsdale, MAR, 22 Aug 1980 after a tropical depression hit the Texas coast and

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swept inland toward Arizona (PR; *Smithsonian). This is the only Arizona record of this pelagic species. As this individual appears to have been brought to Arizona by way of the Gulf of Mexico, one must question the identification of the specimen as the Pacific race P. l. dorothea (G. E. Watson in Monson and Phillips 1981).

RED-BILLED TROPICBIRD Phaethon aethereus. Single birds were found alive at Wingfield Mesa, YAV, 7 Apr 1984 (ph. Klm; *UA; see Am. Birds 38:943) and in Tucson, PIM, 29 Jun 1990 (ph. JHo; see Am. Birds 44:1165). Two additional published records (Monson and Phillips 1981), plus one of a bird picked up in Green Valley, PIM, 22 May 1992 and brought to a rehabilitation center (ph. GM), bringing the total number of acceptable records in Arizona to five.

BLUE-FOOTED BOOBY Sula nebouxii. Single birds were found on Hwy. 89 at Cameron, COC, 27 Jul 1993 (CVC; *UA), at Canyon L., MAR, 14–20 Sep 1996 (ph. SGn), and at Laveen, MAR, 25 Sep–19 Oct 1996 (ph. TC, JdB, GR; Figure 3). Other than those prior to 1974 cited by Monson and Phillips (1981), three additional records have been published in Am. Birds/NASFN but not submitted to the ABC.

BROWN BOOBY Sula leucogaster. One was at L. Havasu, MOH, 19 Aug–Dec 1977 (GMo; ph. RWz; see Am. Birds 32:240), one was at Yuma, YUM, 12 Sep 1990 (DCr; ph. BHe; see Am. Birds 45:135), one was near Phoenix, MAR, 14 Sep–11 Oct 1990 (DF, ph. TG. GR; see Witzeman et al. 1997:135 and Am. Birds 45:175), and one was near Hillside, YAV, 21–26 Oct 1991 (MP, EHt). Only one additional post-1974 record (1990) has been published in Am. Birds but not reviewed by the ABC.

NEOTROPIC CORMORANT Phalacrocorax brasilianus. Accepted reports are of one at Patagonia L., SCR, 28 Feb 1976 (JVR), one at Parker Canyon L., SCR, 21 Oct 1976 (BY), one at Patagonia L., SCR, 24 Oct 1976 (BY), one at Cibola N.W.R., YUM, 27 Jan–24 Feb 1978 (HA), two at San Benardino Ranch, COS, 5 Mar 1978 (DDa), and one at Mittry L., YUM, 14 Dec 1978-9-Jan 1980 (KVR). Since the late 1970s, this species has been considered a rare but regular visitor to lakes and ponds in southern Arizona and has been dropped from the ABC review list.

MAGNIFICENT FRIGATEBIRD Fregata magnificens. One at Yuma, YUM, 26 July 1973 (ph. HGd), one at P.R.D., MAR, 13 July–Aug 27 1974 (RB), one at Davis Dam, MOH, 17 Sep 1976 (ph. CLw), at least six at P.R.D., MAR, 22 Jul–9 Aug 1979 (ph. JWz; see Am. Birds 33:887), one at Grand Canyon, COC, 7–8 Oct 1985 (ph. BDd), one at L. Havasu, MOH, 22 Jul 1990 (ph. RWz), one at Picacho Res., PIN, 20 Aug 1990 (RMo), and one along the upper S.P.R., COS, 21 Jun 1996 (PG). Only scattered reports have been reviewed by the ABC since the mid-1970s; even though there are now more than 50 reports of this species for Arizona, the ABC is retaining it as a review species, particularly because the Great Frigatebird (Fregata minor) is a possible vagrant to Arizona.

LITTLE BLUE HERON Egretta caerulea. Accepted individuals include one at Scottsdale, MAR, 13 Apr 1977 (DCh), one at Guevavi Ranch, SCR, 5 June 1977 (CMc), one at Peck’s L., YAV, 3 May 1992 (MSO), one at P.R.D., MAR, 24 Jul–18 Aug 1993 (ph. JJ), and two at P.R.D., MAR, 22 Jul 1995 (PM). This species has only sporadically been reviewed; there are now more than 40 records for Arizona, and it is no longer considered a review species. Sketch details are still requested for reports' inclusion in Field Notes.

TRICOLORED HERON Egretta tricolor. Accepted records are of one at L. Mary, COC, 2 Nov 1975 (ph. CBf), one at Aravaipa Canyon, PIN, 28 Jul 1977 (jSc), one at Guevavi Ranch, SCR, 29 Oct 1977 (GMa), one at Willcox, COS, 27 May–3 Jun 1978 (GBe), one at Green Valley, PIM, 1 Nov 1987 (DG), one in Tucson, PIM, 29 Jul 1988 (CdW), one at Palominas, COS, 24 Aug–1 Sep 1988 (TC, ph. DKr), and one at Willcox, COS, 27 May 1989 (DPe). As with the previous species, Tricolored Heron
is a rare but almost annual visitor to Arizona that has been only sporadically reviewed by the committee; there are now nearly 40 records for the state, and it is no longer considered a review species. Sketch details are still requested for reports' inclusion in Field Notes.

**REDDISH EGRET** *Egretta rufescens*. Single individuals were at Ahwatukee, MAR, 14–18 Jul 1980 (PB; ph. ST, RWz; see Witzeman et al. 1997:136 and Am. Birds 34:919), P.R.D., MAR, 10 Oct 1988 (Sgn), and Snyder Hill S.T.P. w. of Tucson, PIM, 7–18 Aug 1996 (ph. MSf). Three records prior to 1974 were published by Monson and Phillips (1981), bringing the total number of records to six.

**YELLOW-CROWNED NIGHT-HERON** *Nyctanassa violacea*. One was at Dudleyville, lower S.P.R., PIN, 8 May–16 Jun 1984 (OS; ph. GMo). There were only two prior records for the state (Monson and Phillips 1981; Speich and Witzeman 1975). One additional record (May 1992) has been published in *Am. Birds*, but not reviewed by the ABC.

**WHITE IBIS** *Eudocimus albus*. Accepted records are of 6–10 at Horseshoe Dam, Verde R., MAR, 3–14 May 1977 (BCa; ph. DTs; see Witzeman et al. 1997:137 and Am. Birds 31:1032), one at Picacho Res., PIN, 22 Jun–14 Sep 1986 (JP), and four flying along the Santa Cruz R., Tucson, PIM, 1 Aug 1988 (RPe). There were only two published reports prior to 1974 (Monson and Phillips 1981); one report (June 1977) has not been reviewed by the ABC.

**ROSEATE SPOONBILL** *Ajaia ajaja*. Accepted records are of one from Deadhorse Ranch, Cottonwood, YAV, 10–11 May 1992 (ph. Cta; see Am. Birds 46:458), one from Nogales, SCR, 22–23 Jul 1996 (LVW), and one from Roosevelt L., PIN, 19–24 Sep 1996 (BST, ph. GGa). At least 20 individuals, at six localities (mostly in the L.C.R.V.), invaded during the summer of 1977, but no reports were submitted to or reviewed by the ABC.

**WOOD STORK** *Mycteria americana*. One at Patagonia, SCR, 30 Jul 1975 (WBs), one at Willow Cr. Res, YAV, 23 Jun–5 Jul 1987 (BTh), one at P.R.D., MAR, 24–25 Jul 1993 (CBA; ph. RJ), and one at P.R.D., MAR, 9–20 Jul 1994 (DKa). This species was not reviewed by the ABC through the 1980s, when there were at least 13 reports totaling 60 individuals. Since 1989, the only reports are those listed above, plus one additional report (Jun 1996) published in NASFN, so the Wood Stork will be considered a review species.

**FULVOUS WHISTLING-DUCK** *Dendrocygna bicolor*. One was at Kino Springs, Nogales, SCR, 28 Apr–15 May 1990 (DP) and another at the Phoenix Zoo, MAR, 26 Oct 1993 (ph. Jj; see Witzeman et al. 1997:137). Since 1975, no fewer than eight records have been published in Am. Birds/NASFN that were never reviewed by the ABC.

**ROSS' GOOSE** *Chen rossii*. Records submitted and accepted in 1975 are of one at Nogales, SCR, 16 Nov 1975 (PN), one at Wilcox, COS, 21 Nov 1975 (DDa), and one at Ariteca, PIM, 7 Dec 1975 (PN). Prior to 1975, this species was considered much rarer than it is today. Since 1975 there have been more than 100 records for Arizona, so Ross' Goose is no longer considered a review species.

**BRANT** *Branta bernicla*. Single birds were at Arlington, MAR, 6 Jan 1975 (TSj), along the L.C.R. n. of Ehrenberg, LAP, 14 Apr 1978 (ph. KVR), along the Verde R., F.M. I.R., MAR, 11–14 Dec 1991 (PBb; ph. TC), and at Sun Lakes, Chandler, MAR, 7–18 Jan 1992 (ph. MSc). Four additional records (Feb 1979, Dec 1981, May 1990, and May 1993) have been published in Am. Birds but not reviewed by the ABC.

**GARGANEY** *Anas querquedula*. The only two accepted records for Arizona are of males at Buenos Aires N.W.R., PIM, 8–12 Apr 1988 (SR; ph. RWz; Figure 4) and
one Tucson, PIM, 21–29 Mar 1992 (ph. GH). One additional record (May 1991) was published in Am. Birds but not reviewed by the ABC.

**EURASIAN WIGEON** *Anas penelope*. One at Papago Park, Phoenix, MAR, 1 Feb 1979 (ph. KVR), one at Ganado L., APA, 6 Oct 1979 (RPI), one at Parker, LAP, 20–28 Mar 1981 (KVR), one at Sierra Vista, COS, 17 Oct 1987 (JEp), one at Willcox, COS, 14–28 Apr 1990 (JHo), one at the confluence of the Salt and Verde Rivers, MAR, 16 Dec 1991 (DP), and one at the Phoenix Zoo, MAR, 6 Nov 1992 (RJ). Since 1979, there have been more than 50 reports (some of which represent individuals returning multiple years), virtually all of which are of males. The ABC no longer solicits details for male Eurasian Wigeons but still would like to review all reports of females. Although impossible to prove, the probability that all or most of these records represent escapes from captivity is low.


**GREATER SCAUP** *Aythya marila*. One at Willcox, COS, 1 Nov 1975 (PN), one at Phoenix, MAR, 3 Jan 1976 (PN), one at Phoenix, MAR, 24 Dec 1976 (VT), and one at Lake Havasu City, MOH, 21 Dec 1984 (ph. KVR). These records represent just a few of the many sightings in Arizona since 1974. The Greater Scaup is now recognized as a rare but regular migrant and winter visitor to the Colorado River Valley, but it is still casual and irregularly reported away from there, particularly in the southeastern portion of the state. Sketch details are still required for reports included in *Field Notes*.

**HARLEQUIN DUCK** *Histrionicus histrionicus*. One at Arthur Pack Regional Park, n.w. Tucson, PIM, 3 Dec 1995 (ph. MSr; see NASFN 50:90) represents the first and only record of this species from Arizona. This species had been long overdue in Arizona, especially after one was found at Puerto Peñasco, Sonora, Mexico, 60 miles south of the Arizona border, 26 Mar–9 Apr 1977 (Kaufman and Witzeman 1979).

**OLDSQUAW** *Clangula hyemalis*. One at Willcox, COS, 1 Nov 1975 (PN), one at Nogales, SCR, 16 Nov 1975 (PN), one at Davis Dam, MOH, 28 Oct 1976 (BY), one at Nogales, SCR, 13 Nov 1977 (CMr), one at upper L. Mary, COC, 30 Nov 1978 (JC), one at Gila Farms Pond, Chandler, MAR, 13 Dec 1983 (DSr), one at Avondale, MAR, 13–19 Dec 1984 (RBr; ph. GR), one at Watson L., YAV, 14 Jan–4 Apr 1987 (BTh), one found dead at Snyder Hill S.T.P., PIM, 1 Dec 1991 (JHi; *UA), and one at Parker Dam, LAP, 27 Nov 1992 (SF). Since 1974, no fewer than an additional 20 reports have been published in Am. Birds/NASFN but not reviewed by the ABC. As there are more than 40 records for the state and its occurrence is nearly annual, the Oldsquaw will no longer be considered a review species. Sketch details are still requested for reports to be included in *Field Notes*.

**BLACK SCOTER** *Melanitta nigra*. Accepted records include one at Tucson, PIM, 3–4 Nov 1975 (PN), three at Phoenix, MAR, 4–11 Nov 1975 (SD; ph. JWz; see Witzeman et al. 1997:139), one at upper L. Mary, COC, 28–30 Nov 1980 (GR, RPI), one at Parker Dam, LAP, 9 Jan–1 Apr 1981 (ph. MK; see Am. Birds 35:324), and one male shot at Mormon L., COC, 14 Nov 1984 (*UA). One additional sighting listed (Dec 1978) by Monson and Phillips (1981) has not been reviewed by the ABC.

**SURF SCOTER** *Melanitta perspicillata*. One at Chandler, MAR, 26 Oct 1975 (RBR), one at Sierra Vista, COS, 1 Nov 1975 (PN), a total of 39 individuals at Chandler and Phoenix, MAR, 28 Nov 1975 (ST; ph. RWz; see Witzeman et al. 1997:139), one at Willcox, COS, 16 May 1976 (ph. JWz), one at Ashurst L., COC, 5 Nov 1978 (RPI),
one collected at Lee’s Ferry, COC, 20 Oct 1984 (DWh; *UA), and one at Marana, PIM, 3 Dec 1995 (ph. MST). These represent just a few of the nearly 60 reports received since 1974. The Surf Scoter is now recognized as a rare but regular migrant and winter visitor statewide and is no longer considered a review species. Sketch details are still requested for a report to be included in Field Notes.

WHITE-WINGED SCOTER Melanitta fusca. Records reviewed and accepted by the ABC are of one at Nelson Res., APA, 24–26 Nov 1977 (ph. DDa), one at upper L. Mary, COC, 28–30 Nov 1978 (JC), two at Lake Havasu City, MOH, 9 Jan–12 Mar 1981 (ph. MK; see Am. Birds 35:324), one at Parker Dam, LAP, 11 Nov–23 Dec 1984 (ph. KVR; see Am. Birds 39:195), and one at L. Havasu, MOH, 2 Mar 1991 (CBA). They represent just a few of the nearly 30 reports published in Am. Birds/NASFN since 1974. Although not nearly as expected as the Surf Scoter, the White-winged is still recognized as nearly annual in the state and is removed as a review species. Sketch details are still requested for reports’ inclusion in Field Notes.

BARROW’S GOLDFENEYE Bucephala islandica. Accepted records are of 57 individuals at Davis Dam, MOH, 5 Dec 1974–20 Feb 1975 (ph. CLw), one at Willow L., YAV, 22 Mar 1977 (HGa), and several below Parker Dam, LAP, 31 Jan 1979 (KVR). Since first found wintering along the Colorado River in 1973, this species has been recognized as a rare but regular annual winter visitor there; Barrow’s Goldeneye will remain a review species for all records away from the Colorado River drainage, for which there are about ten published records in Am. Birds/NASFN that have not been reviewed by the ABC.

SWALLOW-TAILED KITE Elanoides forficatus. One accepted record of one soaring with Mississippi Kites along the lower San Pedro R. near Dudleyville, PIN, 2–3 Aug 1980 (EB, RF). Although there is no physical documentation of this species in Arizona, the ABC has accepted this report as the first and only record for the state.

WHITE-TAILED KITE Elanus leucurus. One 22 mi. s.w. Robles Jct., PIM, 11 Aug 1978 (DE), one near Madera Canyon, PIM, 22 Aug 1979 (RHu), one along the upper S.P.R., COS, 27 Oct 1979 (POB), up to five at the Pinal Air Park pecan grove, PIM, 19 Jun 1982 (SL), one at Green Valley, PIM, 1 June 1984 (DG), and one at Organ Pipe Cactus N.M., PIM, 17 Oct 1984 (ph. ?). This species has been recognized as a rare though irregularly reported permanent resident throughout southern Arizona since 1978, with the first confirmed breeding records in 1983 (Gatz et al. 1987), and is no longer considered a review species.

MISSISSIPPI KITE Ictinia mississippiensis. One in s.w. Phoenix, MAR, 16 Jun 1974 (RNi), and one at F.M.I.R., Verde R., MAR, 25 Jun 1975 (KK). In the mid-1970s the distribution of this species in Arizona was poorly understood; it is now recognized as a fairly common summer resident along the lower S.P.R., with records scattered throughout the state. Sketch details are still required for inclusion of reports in Field Notes of all records away from known nesting areas in the state.

NORTHERN HARRIER Circus cyaneus. One found nesting near Bouse, LAP, 27 Apr 1980 (ph. BM) represents the only definitive nesting record for the state.

RED-SHOULDERED HAWK Buteo lineatus. Accepted records are of one at the s.e. end of the Catalina Mts. near Redington Pass outside Tucson, PIM, 20 Dec 1975–Aug 1976 (RC; ph. RGl), one at Parker, LAP, 24 Nov 1989–10 Feb 1990 (PL), one at the Phoenix Zoo, MAR, 1–15 Dec 1989 (ph. RJ), one 16 mi. s. Chino Valley, YAV, 9 Jan 1990 (MCo), one at Littlefield, MOH, 22 Nov 1990 (PL), one at Picacho Res, PIN, 5 Aug 1992 (GHe), and one at Arivaca Cienega, PIM, 12 Jan 1994 (WA). There has been one published account of this species attempting nesting in Arizona, at Mittry L., L.C.R.V., in 1970 (Ginski 1982). These are only eight of the nearly 30 reports published in Am. Birds/NASFN since 1974; although the frequency of
reports of this species suggests that it may be almost annual in occurrence, the ABC retains the Red-shouldered Hawk on its review list because of possible confusion with similar species.

BROAD-WINGED HAWK *Buteo platypterus*. Records accepted by the ABC are of one collected at Tucson, PIM, 7 Jan 1965 (MWh; *UA), one at Ramsey Canyon, COS, 11 April 1976 (DSz), one at Cave Creek Canyon, COS, 14 Apr 1977 (WS), one along the upper S.P.R., COS, 27 Jul 1987 (TC), one at Ramsey Canyon, COS, 19 May 1988 (GR, JK), one along the upper S.P.R., COS, 18 Sep 1988 (DKr), one below Bartlett Dam, Verde R., MAR, 13 Feb 1992 (LA), one found dead at West Turkey Cr., Chiricahua Mts., COS, 25 Feb 1994 (NSn; *UA), and one at Barfoot Lookout, Chiricahua Mts., COS, 6 Aug 1995 (PM). There have been more 20 other reports published in Am. Birds/NASFN since 1974. Because of possible confusion between this species and similar species, the Broad-winged Hawk will remain on the ABC review list.

CRESTED CARACARA *Caracara plancus*. Records accepted by the ABC away from known breeding areas are of one at San Bernardino Ranch, COS, 10 Nov 1979 (DDs), one at Santa Maria Valley, YAV, 7 Jan 1981 (BMa), one in the Sulphur Springs Valley near Elfrida, COS, 6 Nov 1982 (AMo), and one in n.e. Phoenix, MAR, 6–23 Dec 1991 (ph. BVP). These represent just a few of the many extralimital records of this species in southern Arizona published in Am. Birds/NASFN since 1974. Sketch details are requested for inclusion of such reports in Field Notes.

BLACK RAIL *Laterallus jamaicensis*. One male was found dead at Mittry L., YUM, 2 May 1981 (DTO; *UA); this species is locally “common” in summer along a short stretch of the L.C.R.V. (Monson and Phillips 1981), with a few unsubstantiated sight records from southeastern Arizona. The Black Rail remains a review species for all reports away from the L.C.R.V.

PURPLE GALLINULE *Porphyra martinica*. One at Willcox, COS, 7 Aug 1975 (DP), one at Sabino Canyon, PIM, 11 Sep 1976 (PN), one at Lehner Ranch near Palominas, COS, 1 Jun 1981 (EL; ph. KVR; Am. Birds 35:967), one at Cook’s L., PIN, 15 Jul 1983 (KLe; ph. MOB), one at Gila Farms Pond, MAR, 1 Aug 1991 (SM), and one at Picacho Res., PIN, 8–14 Aug 1993 (BJR). Two additional records were published in Am. Birds (Jul 1993; Sep 1993) but not reviewed by the ABC.

AMERICAN GOLDEN-PLOVER *Pluvialis dominica*. Records accepted by the ABC as at least an unidentifiable golden-plover are of single birds in s.w. Phoenix, MAR, 24–25 Oct 1974 (SD), 27 Aug–7 Sep 1975 (ST), 18 Oct–15 Nov 1975 (SH), and 11–24 Oct 1982 (ph. RWz; see Am. Birds 37:209), one at Parker, LAP, 6 May 1978 (KVR), one in s.w. Phoenix, MAR, one at Willcox, COS, 23 May 1983 (ph. RT), one at Many Farms L., APA, 14 Sep 1985 (BJa), one at Tucson, PIM, 14 Oct 1986 (JP), one at Canado L., APA, 1 Oct 1989 (JSA), and one at Willcox, COS, 10–16 Sep 1992 (PH). One specimen obtained at Kayenta, NAV, 10 May 1984 (CTL; *UA) is clearly dominica. We presume that all of the Arizona reports are more likely of dominica than fulva, but most of the details and photos submitted in the past are inadequate for positive determination.

NORTHERN JACANA *Jacana spinosa*. Two accepted records for Arizona: one was at Kino Springs, then Guevavi Ranch, Nogales, SCR, 7 Jun 1985–3 Jan 1986 (R. & EH; ph. EHp, PL, BZ; see Am. Birds 39:946), and one was at Mittry L., L.C.R.V., YUM, 6–30 Jun 1986 (ph. CCo).

SOLITARY SANDPIPER *Tringa solitaria*. One winter record was reviewed and accepted by the ABC, of one in s.w. Phoenix, MAR, 15 Dec 1986 (DS)).

WANDERING TATTLER *Heteroscelus incanus*. The only accepted state record for this species is of one in s.w. Phoenix, MAR, 18 Sep–9 Oct 1971 (BB; ph. RWz;
see Witzeman et al. 1997:140); the documentation of this sighting has been published (Witzeman 1972) but had not been reviewed by the ABC.

**UPLAND SANDPIPER** *Bartramia longicauda*. One was at Snyder Hill S.T.P., PIM, 25 Sep 1988 (DSj), and one was at Buenos Aires N.W.R., PIM, 9 May 1989 (DSj). Since 1974, one additional record has been published in Am. Birds (Oct 1974) but not reviewed by the ABC.

**WHIMBREL** *Numenius phaeopus*. One was in s.w. Phoenix, MAR, 19 May 1977 (RBt), one was at Imperial N.W.R., YUM, 13 Jul 1978 (ph. KVR; see Am. Birds 32:1195), one was at Poston, LAP, 2 Aug 1978 (ph. KVR), one was at P.R.D., MAR, 14 Jun 1980 (ph. KVR), and one was s. of Cashion, MAR, 24 Mar 1983 (ph. KVR). These records are just a few of the nearly 50 reports published in Am. Birds/NASFN since 1974. Although this species is no longer on our state review list, sketch details are still requested for reports away from the L.C.R.V.

**HUDSONIAN GODWIT** *Limosa haemastica*. One at Willcox, COS, 14–16 May 1976 (Bjo; ph. JWz; see Am. Birds 30:873) provided Arizona's first record. Another was there 24–27 May 1986 (DKi; ph. M. Stowe), three were there 17–22 May 1988 (KK; ph. DW), one was there 13 May 1996 (MSt; ph RJ), and one was at Gila Bend S.T.P., MAR, 18 May 1996 (ph. CBa). These represent all of Arizona's accepted records.

**RUDDY TURNSTONE** *Arenaria interpres*. Early records include one at Sierra Vista, COS, 6–11 Sep 1975 (TLa), one in s.w. Phoenix, MAR, 7–9 Sep 1975 (RNt), and one at Nogales, SCR, 10 Apr 1977 (CMt). There have been nearly 30 records published in Am. Birds/NASFN since 1974 that have not been reviewed by the ABC. We have dropped the species from our review list, but sketch details are still requested for inclusion of reports in *Field Notes*.

**RED KNOT** *Calidris canutus*. Early records reviewed by the ABC include one at Chandler, MAR, 31 Aug–7 Sep 1975 (RBt), one at s.w. Phoenix, MAR, 6 Sep 1975 (RBt), one at Willcox, COS, 10 Sep 1975 (PN), and two at Granado L., APA, 22–23 Sep 1979 (GR; ph. KVR). The total number of reports from Arizona is more than 35. We have dropped the Red Knot from our review list, but sketch details are still requested for inclusion of reports in *Field Notes*.

**SEMIPALMATED SANDPIPER** *Calidris pusilla*. Early reports reviewed by the ABC include one at Tucson, PIM, 17 Aug 1975 (PN), one at Lake Havasu, MOH, 31 Aug 1980 (ph. KVR; see Am. Birds 35:212), and one at Sierra Vista, COS, 27 Aug–2 Sep 1987 (TC). At Willcox, COS, single birds were seen 20 Apr 1985 (BDa), 20 Jul 1985 (BP), and 2 Aug 1988 (GR). In s.w. Phoenix, MAR, there was one on 23 Sep 1985 (DSj), 13 Sep 1986 (DSj), and 7 May 1987 (DSj), and three 30 Aug–4 Sep 1987 (DSj). We now recognize that this species is a rare but regular migrant (at least 100 reports since 1974) and no longer include it on the review list.

**WHITE-RUMPED SANDPIPER** *Calidris fuscicollis*. One at Willcox, COS, 4 Jun 1977 (ph. DDa) provided Arizona's first state record. One at Many Farms L., APA, 25 May 1987 (ph. CBa; see Am. Birds 41:380), ones at Willcox, COS, 23–24 June 1990 (SM; ph. JHo; see Am. Birds 44:1167) and 6 Jun 1996 (A. & NMC), and one at Buenos Aires N.W.R., PIM, 13 May 1993 (LW) represent the remainder of Arizona's accepted records.

**SHARP-TAILED SANDPIPER** *Calidris acuminata*. One was in s.w. Phoenix, MAR, 18 Oct 1985 (DSj). There is only one other accepted Arizona record (Monson and Phillips 1981).

**RUDD PHILOROMACHUS pugnax**. The first Arizona record was from s.w. Phoenix, MAR, 10 Nov 1974–Feb 17 1975 (RNt, DDa; ph. JWz; see Witzeman et al. 1997:140 and
Am. Birds 29:100). One in s.w. Phoenix, MAR, 18–20 Oct 1985 (DSj) and one at Tucson, PIM, 13 Oct 1986 (BSu) constitute the only other accepted records.

RED PHALAROPE Phalaropus fulicarius. Two northern Arizona reports were reviewed by the ABC: one at Becker L., Springville, APA, 5 Oct 1978 (ST), and one at Ganado L., APA, 24 May 1986 (ph. CBa; see Am. Birds 40:507). There have been at least 50 reports published in Am. Birds/NASFN since 1974. The Red Phalarope is no longer considered a review species, but sketch details are still requested for inclusion of reports in Field Notes.

POMARINE JAEGGER Stercorarius pomerinus. One record of an adult at Lake Pleasant, MAR, 7–10 Jun 1985 (RBr). There are two records prior to 1974 (Monson and Phillips 1981) and one published in Am. Birds (Oct 1985) that has not been reviewed by the ABC.

PARASITIC JAEGGER Stercorarius parasiticus. One was at Davis Dam, MOH, 17 Sep 1976 (CLw), one was found dead n. of Gila Bend, MAR, 1 Sep 1984 (ph. DTO; *UA), and one was at Mormon L., COC, 7–10 Sep 1994 (DSj, CDB). Five additional reports (Aug 1977, 2 Sep 1977, Sep 1980, and Sep 1981), mostly from Lake Havasu, have been published in Am. Birds but not reviewed by the ABC.

LONG-TAILED JAEGGER Stercorarius longicaudus. One immature at Phoenix, MAR, 7–20 Sep 1970, thought for many years to be a Parasitic, was reevaluated and determined to be a Long-tailed (ph. RWz; Figure 5; see Witzeman et al. 1997:141). Two adults and one immature were at L. Havasu, MOH, 4–5 Sep 1977 (ph. RWz; see Am. Birds 32:241), another immature thought to be a different individual was at L. Havasu, MOH, 14 Sep 1977 (ph. SC; see Rosenberg et al. 1991: 187), one immature was found dead n. of Sierra Vista, COS, 3 Sep 1989 (DHa; *UA), one adult was found dead n. of Lupton, APA, 18 Sep 1992 (Lee fide TH; *UA), one immature was found dead 8 mi. s. of Ash Fork, YAV, 28 Aug 1996 (JPe; ph. PW), and one was at Mormon L., COC, 21–23 Sep 1996 (MSJ, JC). One additional record (Sep 1980) has been published in Am. Birds but not reviewed by the ABC.

JAEGGER SP. Stercorarius sp. One was at P.R.D., MAR, 23 Aug 1980 (RBr), one was at Willcox, COS, 5 Sep 1992 (MSt), one was at Watson L., Prescott, YAV, 16 Nov 1993 (TSJ), and one was at Gilbert, MAR, 5 Sep 1994 (JoB). Details submitted to the ABC were not sufficient to identify these individuals to species.


HEERMANN’S GULL Larus heermanni. Only scattered reports have been reviewed, of one at Tucson, PIM, 2 Nov 1974 (DSz), one at Picacho Res., PIN, 11 Oct 1975 (RBr), one at Prescott, YAV, 20 Mar 1987 (BTh), and one in s.w. Phoenix, MAR, 10 Apr 1994 (CBA). There have been more than 40 records of this gull published in Am. Birds/NASFN since 1975, and it is no longer considered a state review species. Sketch details are still requested for inclusion of reports in Field Notes.

MEW GULL Larus canus. Accepted records are of one adult and two first-winter birds at Davis Dam, MOH, 19–20 Mar 1979 (ph. BW), with one second-winter individual there 31 Mar–17 Apr 1979 (ph. BW; see Rosenberg et al. 1991: 189), one at Lake Havasu City, MOH, 25 Feb–9 Mar 1991 (JK; ph. CBA, JHe; see Am. Birds 45:300), one at Katherine’s Landing, L. Mohave, MOH, 28–31 Mar 1992 (JFJ), one at L. Havasu City, MOH, 4–5 Mar 1995 (CBA; ph. RJ; Figure 6), one at P.R.D., MAR,
9 Jan–6 Feb 1996 (DSj; ph RWz; see Witzeman et al. 1997:141), and one at Wahweep Marina, L. Powell, COC, 30 Nov to at least 21 Dec 1996 (ph. TC, GR; see NASFN 51:96). These are the only reports from Arizona.

THAYER’S GULL Larus thayeri. One found dead n. of Bowie, COS, 1 Dec 1968 (DZ; *UA: Monson and Phillips 1981) was originally identified as this species, but because of heavy plumage wear, the ABC is reluctant to endorse this record. Two first-year birds were at Davis Dam, MOH, 12 Dec 1974–18 Feb 1975 (CLw, SB), up to three first-winter were at Davis Dam, MOH, 17 Jan 1976 (KK, ph. JWz), one first-winter was at L. Mary, COC, 30 Nov–1 Dec 1980 (RPI, KVR; *UA), one first-winter was at Parker Dam, LAP, 30 Dec 1989 (TC), and one was at P.R.D., MAR, 1 Jan–15 Feb 1996 (SB; ph. RWz; see Witzeman et al. 1997:142). Two additional old records of specimens were listed by Monson and Phillips (1981), bringing the total number of state records to seven. One additional report published in Am. Birds (Nov 1989–Feb 1990) has not been reviewed by the ABC.

GLAUCOUS-WINGED GULL Larus glaucescens. Accepted records are of one first-winter bird collected at Imperial N.W.R., YUM, 17 Nov 1956 (GMO; *UA), one at Davis Dam, MOH, 12 Dec 1974–18 Feb 1975 (CLw, SB), one at Davis Dam, MOH, 17 Jan 1976 (KK; ph. JWz), and one on L. Havasu, MOH, 30 Oct 1981 (MK). One additional specimen was listed by Monson and Phillips (1981), bringing the total number of accepted records from Arizona to five.

GLAUCOUS GULL Larus hyperboreus. Arizona’s first record was of a first-winter bird found at Scottsdale, MAR, 17 Nov–4 Dec 1988 (BK; ph. TG, GR; Figure 7; see Witzeman et al. 1997:142 and Am. Birds 43:25). Another first-winter bird was at P.R.D., MAR, 24 Dec 1993–1 Jan 1994 (CBn; ph. CBA). One additional record from Yuma (Dec 1992) has yet to be evaluated by the ABC. These represent the only Arizona records.

BLACK-LEGGED KITTIWAKE Rissa tridactyla. Accepted records are of one at Davis Dam, MOH, 17–20 Feb 1975 (CLw), one to five individuals at P.R.D., MAR, 16–30 Nov 1980 (GR, JWz; ph. KVR), one found dead along Hwy. 83 n. of Sonoita, PIM, 16 Nov 1980 (GBr; *UA), two below Parker Dam, LAP, 21 Dec 1980–6 Feb 1981 (ph. KVR; see Rosenberg et al. 1991: 192), one at Willcox, COS, 30 Apr–2 May 1989 (ph. EFI), one at Kayenta, NAV, 1–8 Dec 1990 (ph. CTL; see Am. Birds 45:300), and one along the Gila R. near Buckeye, MAR, 29 Dec 1993 (JWz, MCh). Six additional records have been published in Am. Birds since 1975 (Dec 1975, Feb 1976, Nov 1978, Nov 1980, Mar 1982, Dec 1984).

SABINE’S GULL Xema sabini. Early records reviewed by the ABC include one at Chandler, MAR, 4 Nov 1974 (RBr), two at Nogales, SCR, 21 Sep 1975 (PN), and one at Chandler, MAR, 24 Sep 1975 (RBr). There have been at least 75 reports of this gull since 1975, and it is no longer considered a review species. Sketch details are still appreciated for reports’ inclusion in Field Notes.

ELEGANT TERN Sterna elegans. One adult at P.R.D., MAR, 30 May 1988 (RF; ph. DSj; CBA; see Witzeman et al. 1997:143 and Am. Birds 42:373) provided Arizona’s first record. Other accepted reports are of two at Tucson, PIM, 24 May 1990 (JPa), and one at Snyder Hill S.T.P., PIM, 7–9 Jul 1990 (ph. GR; see Am. Birds 44:1213). One additional record of four individuals at Tucson, PIM, 15 May 1981 (ph. SG0) has yet to be evaluated by the ABC. These are the only reports from Arizona.

ARCTIC TERN Sterna paradisaea. Accepted records are of one collected at Tucson, PIM, 4 Sep 1965 (WBI; *UA), another collected at n.w. Tucson, PIM, 4 Oct 1968 (DBu; *UA), and one adult at Tucson, PIM, 18 May 1982 (KK). Two additional records published in Am. Birds (Sep 1981, Sep 1993) have not been reviewed by the ABC.
LEAST TERN Sterna antillarum. Three at P.R.D., MAR, 8–10 Jul 1974 (ph. RWZ), one along the L.C.R.V. near Cibola, LAP, 18–20 Jun 1980 (RMT), up to two at Picacho Res., PIN, 21–29 Jun 1986 (PTa), one at Willcox, COS, 27 May 1988 (DSj), one in Tucson, PIM, 21–23 Apr 1990 (CDB), one at Snyder Hill S.T.P., PIM, 7–8 May 1990 (GR, JHo), one in s.w. Phoenix, MAR, 14 Jun 1990 (JHe), one at Picacho Res., PIN, 9–21 May 1992 (NBo, MSc), one at Gilbert, MAR, 21 May 1992 (ph. CBa), and one at the Arivaca Genega, PIM, 11 Apr 1993 (TU). The status of this species in Arizona has certainly changed within the last decade; it has become essentially annual in small numbers, particularly in May and June, with no fewer than 20 reports since 1990. The Least Tern is no longer considered a review species, but sketch details are still appreciated for inclusion of reports in Field Notes.

BLACK SKIMMER Rynchops niger. One seen independently by two observers at different localities n. of Yuma, YUM, 12 June 1977 (SSi; ph. JD), one at Lake Havasu, MOH, 1–4 Sep 1977 (DR; ph. RWZ, KVR; see Rosenberg et al. 1991: 196), two at Willcox, COS, 4 Aug 1984 (JPe), one there 15 May 1996 (GR, ph. MSt), and one at P.R.D., MAR, 14 Jul 1993 (GR, GM, DSj, KK; ph.GR; Figure 9). One additional report (Aug 1979) has been published in Am. Birds but not reviewed by the ABC. These represent the only acceptable records from Arizona.

RUDDY GROUND-DOVE Columbina talpacoti. Since the first reports of two males in s.w. Phoenix 21 Oct 1981 (ph. KVR), the following records have been reviewed by the ABC and accepted: one male at Green Valley, PIM, 17 Nov–27 Dec 1983 (ph. DG), two males there 22 Nov 1987–15 Apr 1988 (ph. DG), one male at Lukeville, PIM, 2–3 Jan 1989 (ph. JG; Figure 10), one male and one female at Guevavi Ranch, Nogales, SCR, 15 Jan–19 Feb 1989 (ph. B2), one male along the Hassayampa R. near Wickenburg, MAR, 4 Oct 1989 (TC), one male along the Salt R. above Roosevelt L., GIL, 21 Nov 1989 (TG), one at Tucson, PIM, 29 Nov 1989 (CdW), three males, and two females at F.M. I.R., MAR, 18 Dec 1989–17 Feb 1990 (DSj), one male at Lukeville, PIM, 3 Apr 1990 (SGI), one along the upper S.P.R., COS, 22 Oct–30 Nov 1990 (DKr), one at Patagonia L., SCR, 15 Dec 1990 (RBa), one to two along the upper S.P.R., COS, 15 Dec 1990–25 Feb 1991 (DKr), one male at Camp Verde, YAV, 10 Jun 1991 (ph. CVa), one female in s.w. Phoenix, MAR, 8 Feb 1992 (TC), two to three at the P.A.P pecan grove, PIM, 4 Nov 1992 (GJa), one female at Maricopa, PIN, 7 Nov 1992 (RJ), up to four at Patagonia, SCR, 12 Nov–early Apr 1993 (Ido), one male at Gila Farms Pond, Chandler, MAR, 21 Nov 1992 (TC), a pair with fledgling at Hassayampa R. Preserve, Wickenburg, MAR, 15–19 May 1993 (GH), one male and one female at Paloma Ranch, MAR, 12 Nov 1994, with the female remaining until 20 Jan 1995 (TC, PL), one male and one female along the upper S.P.R., COS, 17 Dec 1994 (DTr), one female at the P.A.P pecan grove, PIM, 13 Nov 1994–16 Feb 1995 (GH, CDB; ph. 7), and one male at Lukeville, PIM, 18 Apr 1996 (JoB). These records represent a fair percentage of the nearly 100 individuals reported during the past ten years. This species is no longer considered on our review list, but sketch details are still requested for inclusion of reports (particularly of females) in Field Notes.

BLACK-BILLED CUCKOO Coccyzus erythropthalmus. The only record accepted by the ABC is from Portal, COS, 3 Oct 1984 (JA). One additional record (Jul 1985) has been published in Am. Birds but has not been reviewed. There remains no physical documentation for this species in the state.

GROOVE-BILLED ANI Crotophaga sulcirostris. Records accepted are of one along the Colorado R. in the Grand Canyon, COC, 3 Jul 1975 (ph. GP), one s. of Patagonia, SCR, 20 Jun 1976 (ph. Cho), one at Chandler, MAR, Jul 1 1977 (RBt), one in s.w. Phoenix, MAR, 20 Dec 1978 (DSj), one along the upper S.P.R., COS, 8 Aug 1994 (AAn), one along the Verde R. e. of Phoenix, MAR, 2 Oct 1994 (ph. PM),
and one at the P.A.P. pecan grove, PIM, 9–16 Oct 1994 (TSd; Figure 8). These represent only a few of the more than 20 reports since 1975; this species is still casual (not annual) in the state and will remain on the review list.

BLACK SWIFT Cypseloides niger. The committee has tentatively accepted two records, one at Cave Creek Canyon, COS, 27 Aug 1977 (DW), and one at Ganado L., APA, 28 Sep 1986 (DSj). These represent two of the nearly 20 reports from Arizona, many of which have been rejected by the ABC (see below) because there still remains no physical documentation for the state. All Black Swift records from Arizona will be reevaluated once a photograph or specimen is obtained.

CHIMNEY SWIFT Chaetura pelagica. Small numbers of this species were found sporadically at Tucson, PIM, through much of the 1970s and 1980s, and no fewer than nine additional records have been published in Am. Birds/NASFN since 1975, but none has been reviewed by the ABC.

WHITE-EARED HUMMINGBIRD Hylocharis leucotis. A scattering of records has been reviewed by the committee, including ones at Portal, COS, 26–31 May 1979 (WS) and 27 Jul–1 Sep 1984 (WS) and one at Cave Creek Canyon, COS, 3 Aug 1986 (CDa). This species has proven to be a rare but regular summer visitor in the canyons of southeastern Arizona (Ramsey, Carr, Cave Creek, and Madera in particular; see photo of nest in NASFN 50:979), with more than 90 acceptable reports since 1975. None of these are away from the oak or pine zone at elevations of at least 5000 feet; this species will remain on the review list for all reports away from that zone.

BERYLLINE HUMMINGBIRD Amazilia beryllina. Records reviewed and accepted by the ABC are of one at Carr Canyon, COS, 31 Jul–7 Aug 1981 (RL), one at Ramsey Canyon, COS, 22–27 Jun 1982 (JEp), one at Ramsey Canyon, COS, 8–19 Jul 1983 (EFz), one at Madera Canyon, SCR, 17 Jul into Aug 1983 (DGa), one female with nest and young at Chiricahua N.M., COS, 18 Aug–15 Sep 1984 (WH), one at Cave Creek Canyon, COS, 29–30 Jun 1985 (ph. BZ), one at Rustler Park, COS, 18 Jul 1985 (BP), one in Huachuca Canyon, COS, 22 Apr 1986 (TSg), one in Madera Canyon, SCR, 1 Aug 1986 (MSu), two banded in Ramsey Canyon, COS, 21 Jul 1987 (SSu), with the banded female showing up at Madera Canyon, SCR, 1 Aug 1987 (BTw), one with nest and eggs, along with a male at Ramsey Canyon. COS, 21 Jun–31 Aug 1991 (ph. CMo), one at Portal, COS, 4 May–11 Jun 1992 (ph. BZ, GR), and one in Cave Creek Canyon, COS, 15 Jul 1995 (MCa). About fifteen additional records have been published in Am. Birds/NASFN since 1975 but have not been reviewed by the ABC. Virtually all of the acceptable records are from a narrow elevational range in the oak zone (5000–6000 feet). The first documented nesting records for the United States were in Cave Creek Canyon in the Chiricahua Mts. in 1976 and in Ramsey Canyon in 1978 (Anderson and Monson 1981).

CINNAMON HUMMINGBIRD Amazilia rutila. There is one record, representing the first acceptable record for Arizona and the United States, of one found at Patagonia, SCR, 21–23 Jul 1992 (DKi; ph. EWi).

PLAIN-CAPPED STARThROAT Heliomaster constantii. One at Phoenix, MAR, 17 Oct–28 Nov 1978 (JY; ph. GMe; see Witzeman 1979), one at Madera Canyon, SCR, 17 Jul–6 Sep 1982 (RNe, CBa), one at Sycamore Canyon, SCR, 26 Jun 1983 (JSa), one at Cave Creek Canyon, COS, 20 May 1987 (RS), one at Portal, COS, 21 Aug–2 Sep 1987 (DSj), one at Coronado N.M., COS, 13 Jun–14 Jul 1989 (CHA), one at Sabino Canyon, PIM, 2 Sep 1989 (JK, WRu), one in Stump Canyon, COS, 10 Sep 1990 (ph. DSo; see Am. Birds 45:136), and one in Portal, COS, 23 Jul–3 Oct 1992 (EHT). Arizona's first record was from Nogales, Sep 1969 (Harrison 1976). About nine additional records have been published in Am. Birds/NASFN but not reviewed by the ABC.
LUCIFER HUMMINGBIRD Callithrix lucifer. Ones at Portal, COS, 9 Sep–6 Oct 1976 (SSp) and 27–29 Apr 1977 (SSp), one at Coronado N. M., COS, 15–17 Aug 1977 (DDa), one at Bisbee, COS, 6 Oct 1977 (DDa), one in lower Sabino Canyon, PIM, 6 May 1979 (SSa), one in Sycamore Canyon, SCR, 12 Jun 1979 (RWo), one in Chino Canyon, PIM, 9 Apr 1982 (CEd), and one at Ramsey Canyon, COS, 2–9 May 1992 (AGr) represent but a fraction of the more than 100 reports since 1975. This species is no longer on our review list, but sketch details, particularly for females, are still requested for inclusion of reports in Field Notes.

CALLIOPE HUMMINGBIRD Stellula calliope. One winter record for Arizona was accepted by the ABC, of a female or immature at Ramsey Canyon, COS, 7 Jan 1982 (ph. RBw; see Am. Birds 36:319).

ELEGANT TROGON Trogon elegans. One extralimital record was reviewed and accepted, of one at Carefree, MAR, 30 Jun 1989 (ph. LO). It is the northernmost and westernmost record of the species.

EARED TROGON Euplectilis neoxenus. Up to four at Cave Creek Canyon, COS, 23 Oct–2 Dec 1977 (KI; ph. RT) provided the first Arizona and United States record for this species. Additional reports from there include one 11 Aug–22 Oct 1979 (AMc), one 22 Aug and again 1 Oct 1982 (JVO), one 22 Oct 1985 (ph. KLa), one 21–22 Jun 1989 (RM), one 7 May 1990 (L & MB), and one to two 22 Jun into early Aug 1991 (JWh). Away from Cave Creek Canyon accepted reports are of one at Ramsey Canyon, COS, 1–3 Dec 1977 (BJo), one at Carr Canyon, COS, 9 Aug 1989 (DSi), one in Rock Creek Canyon, w. side of the Chiricahua Mts., COS, 7 Oct 1990 (LC), one in Gardner Canyon, Santa Rita Mts., SCR, 19 Aug 1991 (TC), one along Hospital Ridge, Mogollon Rim, COC, 12 Jun 1992 (EMU), one at Parker Creek, Sierra Ancha, GIL, 17 Jun 1992 (THi), one near Rustler Park, COS, 8 Jun 1994 (BCo), and one along Christopher Creek near Payson, COC, 27 Oct–11 Nov 1995 (BC; ph. RD; see NASFN 50:91). One pair, and an additional male, were at upper Ramsey Canyon, COS, beginning 6 Aug 1991 (ph. GR see Am. Birds 46:168), with at least one male and the female remaining there the entire winter of 1991–92. The “pair” was seen again 24 May through the fall 1992 (SMi et al.), with the single male remaining through 1995, being seen sporadically in various canyons in the Huachuca Mts., including Sawmill Canyon 8 May 1995 (JWA). About seven additional reports, five of which are from Cave Creek Canyon, were published in Am. Birds/NASFN but not reviewed by the ABC.

GREEN KINGFISHER Chloroceryle americana. Early records reviewed by the committee include one at Patagonia, SCR, 21 Jul 1975 (WRi), one at St. David, COS, 9 Oct 1976 (JBe), and one at Patagonia, SCR, 18–20 Sep 1976 (RMd, BY). Since 1975, there have been nearly 120 reports from scattered localities in s.e. Arizona. Nesting was confirmed along the upper S.P.R. in 1988 and is suspected but not confirmed along Sonora Creek near Patagonia. This species has been dropped from the review list.

RED-HEADED WOODPECKER Melanerpes erythrocephalus. With the apparent disappearance of a specimen reported collected in 1894 (Monson and Phillips 1981), one at Ash Canyon, Huachuca Mts., COS, 15 Feb–11 Mar 1974 (DDa) represents the first documented Arizona record. Subsequently, one was at Portal, COS, 19 Oct 1990 (RMd; ph. RWz; see Am. Birds 45:136), and at Continental, PIM, 21 Nov 1991–10 May 1992 (MHa, BJJo; ph. SGN, GR; see Am. Birds 46:132). One additional record (Aug 1996) was published in NASFN but has not been reviewed by the ABC. Two additional records were listed by Monson and Phillips (1981).

YELLOW-BELLED SAPSUCKER Sphyrapicus varius. The only reports to be reviewed by the committee are of one from the upper S.P.R., COS, 2 Nov 1986 (DKr) and one from the B.T.A., PIN, 1 Dec 1991–7 Mar 1992 (PL). There have been more
than 40 reports of this species since 1975, and we have dropped it from our review list, but sketch details are still requested for inclusion of reports in Field Notes.

RED-BREASTED SAPSUCKER Sphyrapicus ruber. The only record reviewed by the committee was of one from Oak Creek Canyon, COC, 11 Dec 1989 (AE). There have been more than 30 reports of this species since the early 1980s; because some of those reported as Red-breasted have turned out to be apparent hybrids with Red-naped Sapsucker, sketch details are still requested for inclusion of sightings in Field Notes.

DOWNY WOODPECKER Picoides pubescens. The only extralimit record accepted was one from s.w. Phoenix, MAR, 2-15 Jan 1976 (RBr, KK). The ABC still would like to review records away from known breeding areas in northern Arizona.

RECORDS NOT ACCEPTED

RED-THROATED LOON Gavia stellata. The description of one reported at Willow Creek Res., YAV, 11 May 1986 was unconvincing.

LEAST GREBE Tachybaptus dominicus. The details of a bird observed at Peña Blanca L., SCR, 5 Jan 1985 were too brief for the committee to accept the record. Reports of this species from the Sierra Vista S.T.P., COS, 7 Apr 1986, and Snyder Hill S.T.P., PIM, 3 Sep 1986 do not rule out Eared Grebes with yellow eyes.

HORNED GREBE Podiceps auritus. A report from Phoenix, MAR, 22 Oct 1975 was not detailed enough.

BRANDT’S CORMORANT Phalacrocorax penicillatus. An intriguing report of an immature bird at Patagonia L., SCR, 3 June 1976, by two very experienced observers from California, was not accepted as a first state record by the committee. Although the observers described the bird meticulously, the descriptions were not written until well after the sighting, then not submitted to the ABC for more than seven years. The committee decided that although the identification might have been correct, this species can not be added to the state list without some form of physical documentation.

FULVOUS WHISTLING-DUCK Dendrocygna bicolor. A report of one adult at Watson L., YAV, 30 May 1984 was submitted with virtually no description.

BRANT Branta bernicla. The details supplied for one at Luna L., APA, 13 Feb 1982 were not complete enough.

AMERICAN BLACK DUCK Anas rubripes. One photographed at the Phoenix Zoo, MAR, 1 Feb 1980 was considered a possible escaped aviary bird. Another was reported from Kayenta, NAV, 30 Nov 1990, but the description was too brief and did not rule out the Mottled Duck.

GREATER SCAUP Aythya marila. A description of a female-plumaged bird from Phoenix, MAR, 22 Dec 1974 was not detailed enough.

MASKED DUCK Oxyura dominica. A strange looking duck seen on the Colorado R. 3 mi. s. of Parker Dam, LAP, 8 Dec 1977 was tentatively identified as this species, but the descriptions of plumage, habitat, and behavior strongly suggest that this individual was not a Masked Duck, and without a photo or specimen, its true identity will remain a mystery.

MISSISSIPPI KITE Ictinia mississippiensis. A bird briefly observed at Nogales, SCR, 19 Dec 1987 was not documented well enough to substantiate a first winter record for Arizona.
RED-SHOULDERED HAWK *Buteo lineatus*. The following reports were not sufficient to eliminate confusing species such as the Gray and Broad-winged Hawks: one at Cook's L., PIN, 1 Sep 1980, one at Cottonwood, YAV, 5 Dec 1989, one at Kino Springs, SCR, 11 Mar 1990, one at Portal, COS, 20 Apr 1990, and one at Yuma, YUM, 16 Dec 1990.

SHORT-TAILED HAWK *Buteo brachyurus*. Three reports of this species have been received, one from Rustler Park, Chiricahua Mts., COS, 7 Aug 1985, one from Sawmill Canyon, Huachuca Mts., COS, 21 Jul 1988, and one from near Paradise, COS, 7 Mar 1990. It is the opinion of the committee that each report was probably correct, but each was insufficient to support a first state record without some additional form of physical evidence. Once the Short-tailed Hawk is adequately documented in Arizona, each of these sightings will be re-evaluated. The Sawmill Canyon sighting was not intended to be submitted as a first state record but is included here for completeness.

SWAINSON'S HAWK *Buteo swainsoni*. A winter sighting at Nogales, SCR, 14 Dec 1974 was considered not detailed enough to accept; there are no records of healthy birds from Arizona during winter (Monson and Phillips 1981).

WHITE-TAILED HAWK *Buteo albicaudatus*. It is difficult to ascertain the true historical status of this species in Arizona, mainly because sight records from the 1950s and 1960s (Monson and Phillips 1981) lack any corroborating evidence. The ABC is hesitant to accept sight records of White-tailed Hawks without photographic evidence, as the last definitive records of this species in Arizona were in the 1890s. The following reports were not accepted by the committee for a variety of reasons, mainly that the descriptions were incomplete and did not rule out for certain other confusing species: one 20 mi. w. of Willcox, COS, 19 May 1974, one at Chandler, MAR, 27 Nov 1975, one near Ramsey Canyon, COS, 14 Apr 1977, and one at Tucson, PIM, 9 Apr 1980.

APLOMADO FALCON *Falco femoralis*. According to Monson and Phillips (1981) there have been only two credible sightings of this falcon in Arizona since 1910, the last in 1940. Because of this historical status, and because of the variation in plumage of the Prairie Falcon and juvenile Swainson's Hawk, the ABC has adopted a very conservative and cautious view of Aplomado reports. No fewer than ten have been submitted to the committee since 1974: one below Madera Canyon, PIM, 2 Feb 1974, one there 22 Nov 1980, one e. of Palominas, COS, 18 Aug 1974, one from Bisbee, COS, 19 Jul 1980, ones from the San Rafael Valley, SCR, 18 Sep 1980, 18 Aug 1988, and 6 Jan 1991, one from near Apache, COS, 5 Jan 1981, one from near Montezuma Pass, COS, 19 Jun 1984, and one in Sycamore Canyon, SCR, 24 Aug 1985. Without exception, all of the details submitted were insufficient to support the identification. The 1988 San Rafael Valley sighting was documented with photographs that ruled out the Aplomado Falcon and suggested a Prairie.

BLUE GROUSE *Dendragapus obscurus*. Although this species is resident in northern Arizona in the White Mountains and on the Kaibab Plateau, its presence in southern Arizona has not been documented. A brief observation, and even more brief description, of a large, dark, blue-gray bird flying away "that looked like a Blue Grouse" near Onion Saddle, Chiricahua Mts., COS, 21 May 1979 are insufficient for acceptance.

WHITE-TAILED PTARMIGAN *Lagopus leucurus*. A very brief report of four birds "chicken-sized, all white wings, brown backs, white on the tails" seen for five minutes at the top of the San Francisco Peaks at the Arizona Snow Bowl, COC, 15 Sep 1979 was not accepted as a first state record, but what were these birds?

BLACK RAIL *Laterallus jamaicensis*. A description of a brief observation of a small rail thought to be this species at Willcox, COS, 18 Apr 1977 was not convincing.
WHOOPING CRANE Grus americana. An adult at Willcox, COS, 8 Feb 1989 was most likely identified correctly but was doubtless a stray from the introduced population that winters along the Rio Grande R. in New Mexico and, therefore, the species should not be added to the state list.

DOUBLE-STRIPED THICK-KNEE Burhinus bistriatus. A somewhat tame individual on a golf course in Yuma, YUM, beginning 16 Nov 1989 was certainly this species but eventually proven to be a bird transplanted from Guatemala (see Rosenberg 1991).

AMERICAN GOLDEN-PLOVER Pluvialis dominica. One report of an adult in breeding plumage at Willcox, COS, 29 May 1984 was probably correct, but the description was not detailed enough to identify the bird to species, so was therefore, not accepted as either the American or Pacific. Another individual reported there 3 May 1986 was not accepted as either species because the description was too brief.

BLACK OYSTERCATCHER Haematopus bachmani. A flock of twelve individuals was reported at the mouth of the Bill Williams R., LAP, 28 Aug 1981. Although the description is of all-black “shorebirds” with red bills, aspects of the very brief details, such as flight and behavior, are wrong for oystercatchers.

WANDERING TATTLER Heteroscelus incanus. Details in two reports, one from Peoria, MAR, 13 Oct 1974, the other from Patagonia, SCR, 24 Apr 1985, were unconvincing.

UPLAND SANDPIPER Bartramia longicauda. One reported at Tucson, PIM, 4 Sep 1982 was not accepted because the descriptions were not detailed enough, and contained aspects, such as a description of flight, that were wrong for this species.

HUDSONIAN GODWIT Limosa haemastica. A report of one near Portal, COS, 6 Nov 1987 is very intriguing, but the description is inadequate to support the identification. One member suggested that perhaps the bird was a Black-tailed Godwit, given the late date.

RED KNOT Calidris canutus. The description of a sandpiper at Watson L., YAV, 15 Sep 1987 was not detailed enough to rule out several other species.


TEMMINCK’S STINT Calidris temminckii. A “worn and ratty” peep thought to be this species was reported from Snyder Hill S.T.P., PIM, 13 Aug 1984, but no photo was obtained, and the description had far too little detail for acceptance.

LAUGHING GULL Larus atricilla. The following reports were inadequate for acceptance: one from Patagonia L., SCR, 13 May 1986 and ones from Willcox, COS, 18 Jul 1975 and 15 and 25 Jun 1988. Although at least a couple of these were probably Laughing Gulls, in each case a Franklin’s Gull in first alternate plumage was not completely eliminated.

HEERMANN’S GULL Larus heermanni. One reported from Willcox, COS, 25 Oct 1987 was probably correct, but details submitted were too sketchy.

HERRING GULL Larus argentatus. A report of four from P.R.D., MAR, 13 Jul 1974 was not convincing, particularly given the summer date.

WESTERN GULL Larus occidentalis. Two reports were submitted, one from below Madera Canyon, PIM, 5 Aug 1980, the other from Willow Creek Res., YAV, 2 May 1986. Unfortunately, neither bird was photographed, and neither description is
detailed enough to determine species. There is only one Arizona record for the Western Gull (Monson and Phillips 1981) and no record for any other dark-mantled species.

GLAUCOUS-WINGED GULL Larus glaucescens. One report of an immature bird flying down the Colorado River near Gibola, LAP, 19 Nov 1982 was not detailed enough, given the scarcity of this species in Arizona.

GULL-BILLED TERN Sterna nilotica. One reported from Willow L., YAV, 4 Jul 1985 was fairly well described by one of the observers, but because of the paucity of records for Arizona, no photos being supplied with the documentation, and only one of the seven observers supplying details, the committee decided not to accept what was likely the third record of this species in the state.

ELEGANT TERN Sterna elegans. Two reports of this species predating the first documented record for the state were received, one from Tucson, PIM, 25 Sep 1977, another from Patagonia L., SCR, 25 Jul 1986. Neither description is detailed enough to rule out other confusing tern species.

ARCTIC TERN Sterna paradisaea. Two reports insufficiently detailed to support this species were submitted, of one in Scottsdale, MAR, 16 May 1975, the other on L. Havasu, MOH, 4 Sep 1981.

LEAST TERN Sterna antillarum. One reported from Tucson, PIM, 1 May 1974 lacked sufficient details for acceptance, and one reported at Willow L. Res., YAV, was not accepted because it was identified at a distance of 2000 feet solely on the basis of its appearing slightly smaller than a Black Tern perched nearby on a branch. Has anyone ever seen a Least Tern perched in a tree?

BLACK SKIMMER Rynchops niger. One report of this species from Martinez L., YUM, 16 May 1989 was likely correct, but the description was inadequate in substantiating the record.

WHITE-TIPPED DOVE Leptotila verreauxii. One individual reported from a wash s. of Arivaca, PIM, 7 Jul 1993 was not seen or described well enough to substantiate a first Arizona record.

BLACK-BILLED CUCKOO Coccyzus erythropthalmus. A brief description from the Santa Cruz R. n. of Nogales, SCR, 17 Jul 1983 did not rule out a young Yellow-billed Cuckoo.

ELF OWL Micrathene whitneyi. One winter report of at least three individuals heard only at Lukeville, PIM, 31 Dec 1980 was not accepted because of the variation in small owls' vocalizations and because the birds were not seen.

BUFF-COLLARED NIGHTJAR Caprimulgus ridgwayi. Calls heard at dawn at Pipe Springs N. M., MOH, 23 May 1976 were most likely the dawn song of a Cassin's Kingbird.

BLACK SWIFT Cypseloides niger. The following reports were not accepted: one at Martinez L., YUM, 1 Oct 1975, one 10 mi. s. of Ehrenberg, LAP, 9 May 1977, one in Oak Creek Canyon, COC, 31 Aug 1979, one n.w. of Wickenburg, MAR, 11 May 1980, one in Cave Creek Canyon, COS, 31 Mar 1981, one in Madera Canyon, SCR, 27 Apr 1981, one s. of Alpine, APA, 17 Jun 1981, one at Ganado L., APA, 28 Sep 1986, one at Hereford, COS, 22 Sep 1988, one at Yuma, YUM, 18 May 1989, and another at Cave Creek Canyon, COS, 27 Jul 1989. At least some of these records are certainly correct, but as there is no physical documentation of this species in Arizona and because of the difficulty in distinguishing the Black Swift from other Cypseloides swifts, descriptions of these individuals were not detailed enough for acceptance.
CHIMNEY SWIFT *Chaetura pelagica*. A report of one at Phoenix, MAR, 4 May 1975 was not detailed enough to rule out Vaux's Swift.

WHITE-EARED HUMMINGBIRD *Hylocharis leucotis*. Details were insufficient to support the following reports: one from Portal, COS, 3 Aug 1976, one from Mt. Lemmon, PIM, 15 Aug 1977, one from Patagonia, SCR, 20 Aug 1983, and one from Ramsey Canyon, COS, 14 May 1985.

FORK-TAILED EMERALD *Chlorostilbon canivetii*. A bird reported as this species at Ramsey Canyon, COS, 30 Jun 1989 was likely a molting Broad-billed Hummingbird.

PLAIN-CAPPED STARTHROAT *Heliotomaster constantii*. One reported at Cave Creek Canyon, COS, 6 Oct 1987 was not described well enough, and details of one reported from Patagonia, SCR, 22 Jul 1990 suggested a "funny" Anna's Hummingbird.

LUCIFER HUMMINGBIRD *Calothorax lucifer*. Details submitted to the committee were insufficient in substantiating the following reports: one from Patagonia, SCR, 20 May 1977, one from Cave Creek Canyon, COS, 23 Jun 1982, one from Portal, COS, 2 Jun 1985, and one from Molino Basin, PIM, 23 Jun 1987.

BLACK-CHINNED HUMMINGBIRD *Archilochus alexandri*. One winter report from Tucson, PIM, 22 Dec 1977 was reviewed and not accepted by the committee because the details did not rule out other confusing female hummingbirds.

EARED TROGON *Euptilotis neoxenus*. Insufficient details were provided to substantiate the following reports: in Cave Creek Canyon, COS, one male seen flying across road from car 15 Oct 1977, more than a week before the first U.S. record was
Figure 2. An amazing addition to the Arizona list was this Laysan Albatross picked up on a street in Yuma 14 May 1981. It was later brought to Sea World in San Diego.

*Photo by Guy McCaskie*

Figure 3. Always out of place in the Southwest, this Blue-footed Booby frequented a golf course pond outside of Phoenix 25 September–19 October 1996.

*Photo by Gary H. Rosenberg*
documented, 26 May 1986, 1 Sep 1987, and 8 Sep 1988, and 21 Jun 1989 (last viewed without optics). One was also reported in Scheelite Canyon, COS, 6 Aug 1984 (viewed without optics), and one was poorly described from the Huachuca Mts., COS, 21 May 1989.

GREEN KINGFISHER Chlorocyrtle americana. One extralimitial report of an individual along the Colorado R. at Topock, MOH, 25 Mar 1988 was not accepted by the committee because the details lacked any actual description of the bird other than noting what appeared to be "green" upper parts.

GOLDEN-FRONTED WOODPECKER Melanerpes aurifrons. A bird thought to be this species was photographed at Sedona, YAV, 12 Mar 1990, but the photo reveals the bird to be a Gila Woodpecker (M. uropygialis) with some yellow on the forehead.

NUTTALL'S WOODPECKER Picoides nuttalii. Two reports, one from the Arizona–Sonora Desert Museum, PIM, 22 Apr 1979, the other from Portal, COS, 4 May 1985, failed to rule out the resident Ladder-backed Woodpecker. There is concern that a specimen from Phoenix collected in 1901 (Monson and Phillips 1981), the one published record of this species from Arizona, was actually mislabeled.

WHITE-HEADED WOODPECKER Picoides albolarvatus. An amazing woodpecker with a white head was described from Rose Canyon L., Mt. Lemmon, PIM, 3 Jun 1983, but given the distribution and movements of this normally sedentary species, the ABC was unable to accept this potential first state record without physical documentation.

CONTRIBUTORS

Figure 4. This first Garganey for Arizona was at Buenos Aires National Wildlife Refuge 10 April 1988.

Photo by Robert Witzeman


ACKNOWLEDGMENTS

We are grateful to the hundreds of observers over the past two decades who have taken the time to write up their sightings and submit documentation to the ABC. We thank Steve Russell and Tom Huels for allowing the committee to store its files at the Bird Collection at the University of Arizona. Gale Monson was instrumental in maintaining a photo file of Arizona records and was gracious enough to review a draft of this manuscript. Philip Unitt and Troy Corman also contributed greatly to the improvement of the manuscript.

LITERATURE CITED


Figure 5. This immature jaeger at Lake Havasu 4 September 1977, originally identified as a Pomarine, was finally accepted as a Long-tailed.

*Photo by Robert Witzeman*


Figure 6. Arizona's fifth Mew Gull at Lake Havasu City, 4 March 1995.

Photo by C. Babbitt

Figure 7. Arizona's long-awaited first Glaucous Gull, at Scottsdale 17 November–4 December 1988.

Photo by Gary H. Rosenberg
Figure 8. Groove-billed Ani at the Pinal Air Park pecan grove 9-26 October 1994.  

Photo by Gary H. Rosenberg


Accepted 18 April 1998
Figure 9. Black Skimmer at Painted Rock Reservoir, 14 July 1993.

*Photo by Gary H. Rosenberg*

Figure 10. Female Ruddy Ground-Dove at Lukeville 3 April 1990. Nearly 100 individuals have been found in Arizona since 1981.

*Photo by James Gallagher*
NOTES

POSSIBLE PREDATION OF A SPOTTED OWL BY A BARRED OWL

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The Barred Owl (Strix varia) has rapidly expanded its range into the western United States in the past century, moving westward across the northern Rocky Mountains and thence southward from the Pacific Northwest into California (Dark et al. 1998). Concern over adverse effects on the threatened Northern Spotted Owl (Strix occidentalis caurina) by invading Barred Owls has been raised because of the two species' ecological similarities (Taylor and Forsman 1976, Hamer 1988, Dunbar et al. 1991). Among the concerns are competition for habitat and prey (Hamer 1988), the Barred Owl's more flexible habitat selection (Dunbar et al. 1991), behavioral dominance (Hamer 1988, pers. obs.), and hybridization (Hamer et al. 1994, Dark et al. 1998). To this litany of potential negative interactions between the two species we add the possibility of predation of the Spotted by the Barred.

On 11 May 1997 at approximately 14:30 Leskiw found a freshly (blood fresh and wet) killed Spotted Owl along a trail in Redwood National Park, Humboldt Co., California. Two sets of feathers were found within 60 m of the body. The owl was decapitated, but the head could not be located. Additionally, what appeared to be several Spotted Owl feathers were seen in a tree 4 m above the ground. Finally, the ground litter was disturbed in a 2-m radius around the carcass, suggesting a struggle had occurred. Leskiw left the area and returned at approximately 15:30. When he returned to the kill site at 15:45, a Barred Owl spontaneously hooted nearby. He could not see the bird because of the dense understory. He played a tape of Barred Owl calls. The Barred Owl responded and changed its location twice but still could not be seen. He then imitated a Spotted Owl contact whistle (see Gutiérrez et al. 1995 for call description). The Barred Owl immediately flew in and landed 5 m from him. After several minutes it changed its location to 10 m up slope. At this point Leskiw could see whitish-brown mottled feathers clinging to the Barred Owl's left talons. He left the area while the Barred Owl continued to hoot an announcement series (i.e., "who cooks for you, who cooks for you all") and issue a nasal crying sound. A second Barred Owl was heard in the possibility about this time.

Gutiérrez necropsied the Spotted Owl. The bird's head had been removed by disarticulation of the cervical vertebrae. The muscle from the left side of the bird's breast, side, and wing were eaten. All of this trauma occurred without a single broken or crushed bone as would be typical following mammalian predation or scavenging. No primary, secondary, or contour feathers were plucked in accipitrine fashion. Puncture wounds in the left side of the body had penetrated the chest and abdominal cavity, lacerating the lungs, liver, and heart. Lacerations on internal organs were thin and longitudinal, indicating talons, not teeth. Similarly, no ribs were broken from the side punctures. Four distinct punctures on the upper back and left side formed a pattern more similar to the arrangement of owl talons than of Accipiter talons. The diameters of the two most distinct puncture wounds were each 4.2 mm (the maximum diameter of the dead Spotted Owl's talons was 4.2 mm), similar to the diameter of a Barred Owl talon.

The dead Spotted Owl had been banded as an adult on 7 July 1993, 14.45 km north of the kill site. Neither it nor a possible mate had been detected subsequently, up
to the end in 1996 of a banding study conducted by Gutiérrez, suggesting it was a nonterritorial “floater.” The habitat at the kill site was old-growth redwood (Sequoia sempervirens) forest.

These lines of circumstantial evidence combine to suggest that a Barred Owl indeed killed and partially consumed this Spotted Owl. We could not discern whether the predation was the result of a territorial interaction or an actual foraging event, but clearly much of the Spotted Owl was eaten by the predator. Regardless, our observation suggests that adult Spotted Owls are vulnerable to predation by Barred Owls given the right circumstances. Thus, the Barred Owl’s range expansion takes on another negative dimension with respect to the threatened Spotted Owl.

We thank Howard Sakai and Richard Tanner for checking their records for Goshawk and Great Horned Owl sightings in Redwood National Park. Peter Carlson, Eric Forsman, Alan Franklin, and Mark Seamans read an earlier draft of this paper. Susan Petersen provided confirmation to Leskiw’s observations.

LITERATURE CITED


Accepted 12 May 1998
NOTES

NOCTURNAL CHICK PROVISIONING BY BLACK SWIFTS

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The Black Swift, Cypseloides niger, is the single North American breeding species in the Cypseloidinae, a mostly tropical New World subfamily of swifts (Apodidae). Members of this subfamily have the well-known habit of nesting on damp, dark rock surfaces near or behind waterfalls (Knorr 1961, Collins 1968, Marin and Stiles 1992). Unlike other western swifts, Black Swifts bring food back to their single chicks only after intervals of several hours and possibly only once a day (Michael 1927). Food for the chick is carried in a large compacted mass in the esophagus rather than as a smaller bolus transported in the mouth as in Vaux’s Swift, Chaetura vauxi (Chaeturinae; Bull and Beckwith 1993), and the White-throated Swift, Aeronautes saxatalis (Apodinae; Collins pers. obs.). The large mass of esophageal food can be fed to a chick over a short time (3–8 minutes), as previously noted (Grant 1966, Collins 1998). Adult Black Swifts collected at nocturnal roosts with large quantities of insect food in their esophagus (Collins and Landy 1968) suggest that their single chick may be provisioned in increments over several hours, including well after dark. At Lawlor Falls, a Black Swift nesting colony in the San Jacinto Mountains of southern California (Foerster 1987, Foerster and Collins 1990), Peterson photographed nocturnal provisioning of chicks. On 8 and 9 August 1987, he set up a camera to photograph a Black Swift nest containing a half grown chick; photographs were taken automatically every 2 minutes from 20:00 to 03:00 Pacific Daylight Time. The pictures show an adult on the nest from 20:36 to 20:42, during which time the chick was fed at least twice (Figure 1). What appeared to be the same adult reappeared on the nest from 21:38 to 21:44 and again fed the chick at approximately 21:42. This was 58–60 minutes after the initial feeding and at least 45 minutes after full darkness. The earlier observations of adults roosting at night with food in the esophagus (Collins and Landy 1968) suggest that such nocturnal provisioning bouts may not be unusual in the Black Swift and possibly other cypseloidine swifts. As discussed by Collins (1998), transport of large quantities of food in the esophagus and feeding of chicks only after long intervals may permit cypseloidine swifts to exploit greater foraging ranges and specialize on patchily distributed but calorically dense swarming insects, such as winged ants and termites, recorded as prominent food items of these swifts (Collins and Landy 1968, Foerster 1987).

Some other diurnal birds, such as the storm-petrels and small alcids, also feed their chicks nocturnally. In these cases nocturnal feeding is most likely related to predator avoidance by the adults. Cypseloidine swifts consume swarming insects, some of which are more abundant near dusk. Their nocturnal feeding of chicks is thus more a product of near-dusk foraging and late return to the nest with a large quantity of food, which can be incrementally fed to the chick over several hours.

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Figure 1. Black Swift chick being fed by adult on nest at Lawlor Falls at dusk (20:28 P.D.T.)

Photo by B. Moose Peterson.


Accepted 6 April 1998


PRESIDENT'S MESSAGE

From a well-attended meeting in the Imperial Valley in August 1997, the Western Field Ornithologists will shift gears climatically and biogeographically to meet 1–4 October 1998 in Arcata, Humboldt County, California. Ron LeValley is heading up the local committee, and Dave Shuford is putting together the scientific program. I'm sure those who attended the Imperial Valley meeting will join me in thanking Roger Higson and those who assisted him in hosting a unique and productive WFO meeting. At the 1997 meeting three WFO Directors whose terms had expired were re-elected: Dan Gibson, Tim Manolis, and Dave Shuford; Lucie Clark was elected by the Directors to be the new Recording Secretary. We also agreed to form more aggressive and effective committees to take care of WFO business and strive to implement new initiatives. In an attempt to attract students of ornithology to the organization, we have initiated a student membership rate. We are finalizing plans to hold our 1999 meeting in Anchorage, Alaska, and we have been invited to meet along the Kern River in Kernville, California, for WFO's 30th birthday in 2000.

Limited space here allows me to list only two of the various initiatives of the directors, officers, and other active participants of WFO. Most importantly, WFO's web site is now up and running; the URL for this site, which doubles as the site for the California Bird Records Committee, is www.wfo-cbrc.org Many thanks to Peter LaTourrette, David Blue, and Joe Moran for their hard work on this site. I also want to mention that a new Publications Committee, in tandem with Phil Unitt and his tremendous editorial team, is working hard to initiate a series of WFO Monographs, with plans, for example, for a monograph on the birds of the Salton Sea to follow in part from a series of excellent presentations on that topic at our 1997 meeting.

Our organization has always had an interest in the Salton Sea; the first two volumes of California Birds included three papers dealing, at least in part, with the Sea, and there have been many more since. The WFO Directors, simultaneously heartened and concerned by the current political interest in the future of the Sea, have adopted the resolution below; the American Ornithologists’ Union and other major ornithological societies followed suit by adopting a similar resolution, based upon ours, at the April 1998 North American Ornithological Conference.

RESOLUTION IN SUPPORT OF THE SALTON SEA AS SIGNIFICANT WILDLIFE HABITAT

WHEREAS the Salton Sea, the third largest interior saline lake in North America, formed by accidental water diversions from the Colorado River into southeastern California in 1905–6 and presently maintained by inflows of water imported for agricultural purposes, agricultural runoff, and freshwater river flows, has long been recognized as providing significant wetland habitat for a highly diverse array of migratory and breeding waterbird populations, and

WHEREAS recent surveys have revealed populations of up to 1.5 million Eared Grebes in midwinter (Jehl 1988), up to half of California’s wintering White-faced Ibis (Shuford et al. 1996), and regional significance as an integral component of the Pacific Flyway for tens of thousands of migratory shorebirds (Page et al. 1992), waterfowl, and American White Pelicans, as well as significant breeding colonies of Double-crested Cormorants and Caspian Terns (K. Molina unpubl. data), nearly 40% of the nesting Black Skimmers (Collins and Garrett 1996), and by far the larger of only two breeding populations of Gull-billed Terns in western North America (Parnell et al. 1995), and

WHEREAS the Salton Sea has been documented to be of significant value as avian habitat from the time of its formation (for example, see early studies reported by Grinnell 1908, Dawson 1923, Pemberton 1927, Miller and van Rossem 1929), and
PRESIDENT'S MESSAGE

has retained this significance in the subsequent nine decades, with the Sea and its surrounding agricultural lands remaining a renowned birdwatching locality of national significance with over 350 species recorded and immense numbers of breeding, migrant, and wintering birds, in addition to unique post-breeding use by a variety of subtropical waterbirds, and

WHEREAS the Salton Sea represents a complex mosaic of habitats and land-use types, from saline lake waters to brackish and freshwater deltas resulting from both natural and imported (agricultural) water sources, and of state and federal wildlife refuges, agricultural areas, and geothermal developments, all with equally complex interactions and often competing interests, and

WHEREAS the state of California and surrounding regions have experienced significant losses of wetlands (Johnson and Jehl 1994), including coastal wetlands, interior wetlands (most notably the Colorado River delta and Tulare Lake basin), and interior saline lakes such as Owens Lake (Jehl 1994), making the Salton Sea, despite its "artificial" genesis, especially unique and important as de facto mitigation on a regional if not continental scale, and

WHEREAS significant colonies of ground-nesting colonial waterbirds and ardeids, as well as of the recently established Brown Pelican, have thrived during the 1990s, likely due in large measure to decreased levels of human recreational uses of key portions of the Salton Sea (Molina 1996), and

WHEREAS the Salton Sea has experienced high levels of eutrophication, salinization, and contamination, resulting in diminished water quality and recently culminating in large-scale mortalities of birds and fish, and

WHEREAS freshwater sources for the Salton Sea are currently under threat from planned diversions to coastal urban regions of California, and

WHEREAS current attempts by government agencies, nongovernmental organizations, private concerns, and lawmakers to "save" the Salton Sea are gaining momentum,

THEREFORE BE IT RESOLVED that the WESTERN FIELD ORNITHOLOGISTS recognize the significance of the Salton Sea to wildlife and supports rehabilitation and conservation efforts for the Salton Sea that are responsive to the needs of wildlife and based on sound and thorough biological data; that recognize the importance of freshwater, delta, brackish, saline, and agricultural habitats at the Salton Sea; that improve water quality and guarantee continued adequate sources of freshwater; that stress the critical need for protection and isolation of waterbird colonies from human and other disturbance; and that seek to minimize threats to wildlife potentially resulting from urban and recreational development.

LITERATURE CITED

PRESIDENT’S MESSAGE


Kimball L. Garrett

FEATURED PHOTO

FIELD SEPARATION OF BISHOPS (EUPLECTES) FROM NORTH AMERICAN EMBERIZIDS

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Any puzzlement readers might feel over the identity of the bird on the back cover only serves to strengthen the point I have chosen to illustrate. This species’ non-descript sparrowlike appearance has caused field identification problems through much of California in recent years. Its unfamiliarity stems from its absence from North American field guides and avifaunal works and is symbolic of the increasing naturalized populations of non-native bird species that now thrive in many human-altered habitats in California.

Bishops and widowbirds of the genus Euplectes are native to sub-Saharan Africa but have been introduced into several other regions of the world (Long 1981). Little is known of the history of establishment of the Orange Bishop (Euplectes franciscanus, also known as the Northern Red Bishop) in California; individuals or small groups were noted in urban and suburban habitats of coastal southern California by the late 1970s (pers. obs.). High rates of importation, along with ongoing modifications of lowland habitats, have promoted a burgeoning population of this species in coastal California. Flocks of 50 to 100 bishops are now routinely noted in some flood-control basins near Los Angeles (W. S. Smithson pers. comm.). The female or basic-plumaged male Orange Bishop shown here was photographed at the Sepulveda Wildlife Area, Los Angeles Co., California, on 9 December 1995.

Western Birds 29:231-232, 1998
The male Orange Bishop in alternate plumage can be confused only with the closely related Red Bishop (E. orix), but females and basic-plumaged males are much trickier. Johnson and Horner (1986), Craig (1992), and Zimmerman et al. (1996) treated the identification of this species, but only with respect to similar bishop species. In North America there is a simpler hurdle to overcome: distinguishing bishops from native granivores. The streaked upperparts, lateral crown stripes, and finely streaked buff-washed breast bring to mind certain of our *Ammodramus* sparrows and even the much larger Bobolink (*Dolichonyx oryzivorus*). Although none of these species closely resembles a bishop, birders may be tempted to seek a “default” identification from the collection of species illustrated in their field guides.

North American birders encountering a dull, streaky bishop should take note of several characters. First, the tail is short and the rectrices are rather broad and blunt, unlike the narrower, “spiked” rectrices of *Ammodramus* sparrows and the Bobolink. The short tail is often flicked open—occasionally when the bird is at rest and frequently if agitated. The bill is rather heavy and wholly pinkish (unlike *Ammodramus* sparrows). Finally, the tertials, wing coverts, scapulars and back feathers have simple dark centers and narrow pale fringes, lacking the complex internal and subterminal markings found on many of these feathers in our grassland sparrows and Bobolinks. Male bishops are larger than females (Craig and Manson 1981). The identification references noted above provide details on distinguishing several similar small species of *Euplectes*.

In the increasingly human-dominated landscapes of much of North America, birders will need to be aware of identification pitfalls posed by exotics; mastering the bishops is a good place to start!

**LITERATURE CITED**


BOOK REVIEWS


Human knowledge becomes ever more specialized, a trend reflected among ornithological field guides by numerous recent publications treating families or similar taxa rather than all birds of a given region. The North American warblers, with their beauty and popularity, stand out as an obvious choice for such a guide. No two authors are better suited to present one than Dunn and Garrett. A Field Guide to the Warblers of North America (hereafter “Warblers”) stands out among these family treatments because of the two authors’ balanced and extensive experience with this group. With many other guides of this nature, I have had the feeling that authors with good organizational and writing skills picked their subjects out of a hat. Not so with Warblers.

Jon Dunn has birded intensely since childhood and has gained a wider knowledge of North American birds than anyone I have met. These skills resulted in his being the top consultant for National Geographic’s outstanding field guide to North American birds. Kimball Garrett, of the Natural History Museum of Los Angeles County, is also an active field ornithologist with more knowledge of the avifauna of southern California than anyone. They have teamed again to produce a book of extraordinary value to both the birder and the ornithologist, one that is not simply a regurgitation of published information but a trove of personal knowledge gained from vast field experience with warblers and (as evidenced by the length of the acknowledgments) extensive connections with both the birding and the ornithological communities.

The book covers the 60 warbler species recorded in Baja California and North America north of mainland Mexico. A 42-page introduction addresses the natural history and identification of warblers, including taxonomy, hybridization, plumages and molts, habitats, foraging and food, vocalizations, behavior, breeding biology, and conservation. As is typical of the entire book, the writing style in these sections is informative and easy on the eye. Most subjects are referenced to a bibliography, leading readers to additional information.

I found the section on molts to be good, especially in comparison to other single-family guides, some of which ignore altogether this important aspect of bird identification. I applaud the authors for using the Humphrey–Parkes molt-and-plumage terminology, which is slowly gaining acceptance over earlier systems; however, they also use the terms “first spring male,” “fall adult female,” etc., defining plumages in a seasonal context, contrary to the Humphrey–Parkes system. The authors have explained their reasoning and, given the broad range of potential users of Warblers, seem justified in using these terms. It is perhaps illogical to expect beginning birders to be comfortable with the nonintuitive Humphrey–Parkes plumage terminology.

The plates are broadly appealing, although the images are somewhat variable in quality. Most are excellent—I especially like those of the genus Dendroica—while for some species, such as the Ovenbird and Virginia’s, Worm-eating, and Wilson’s warblers, the images are somewhat flat and grainy. Production of the plates during the first printing may have resulted in some of this, as it certainly has for the unnaturally olive looks to the female Black-throated Blue and Oporornis warblers. This apparently has been improved during later printings. What I like the most about the plates is the number of plumages depicted, ranging up to 23 (for the Yellow Warbler) and averaging 5.9 per species. An understanding of intraspecific variation (due to seasonal changes, geographic variation, and age/sex-related differences) is integral to field identification, and the plates, text, and photos in Warblers cover this variation extremely well.
BOOK REVIEWS

It is in the species accounts, comprising nearly 500 pages, that the knowledge and background of the authors become evident. Each account has a brief summary and description characterizing the species, followed by sections covering similar species, voice, behavior, habitat, distribution, status and conservation, subspecies, taxonomic relationships, plumages and molts, and references listed by subject. Each of these sections is extremely thorough, and almost every account contains some interesting tidbit of information not generally known or easily pulled from the literature. Just a few examples include a detailed chronology of the Bachman’s Warbler’s demise, including an assessment of every record since the 1950s, a thorough summary of how the ranges of the Golden-winged and Blue-winged warblers, and the frequency of their hybrids, have ebbed and flowed in correspondence with human-induced habitat changes, the similarity of a hybrid Black-throated Green × Townsend’s Warbler to a pure Townsend’s, that much of the key habitat of the Golden-cheeked Warbler was destroyed by landowners in anticipation of its listing as an endangered species, that the Black-and-white Warbler continues to be placed in the awkwardly named genus Mniotilta rather than Dendroica because the rules of nomenclature dictate that the earlier name Mniotilta take priority if they are lumped, a detailed account of how tail-bobbing in the two waterthrushes differs, and that, through 1995, there were 31 records of the Red-faced Warbler in six states outside of Arizona and New Mexico. Additionally the range maps, put together by Sue A. Tackett and Larry O. Rosche, are excellent, in many accounts giving detail to the county level within states. I came away from the species accounts sensing that everything known about each species was there.

It is the job of the reviewer to point out discrepancies and inconsistencies, of which I struggled to find a few. While the taxonomic information is valuable, the numerous indications that certain taxa should possibly be considered closely related (or not) to other taxa seemed a bit haphazard and unreferenced. For example, in an introductory section on warbler genera it is strongly suggested that the Ovenbird be split from Seturus (the waterthrushes), while on the following page it is suggested that the Fantailed Warbler (Euthlypis), a distinct creature to me, be merged with Basileuterus. Likewise, I might argue against the idea that “a close relationship between the waterthrushes and Dendroica is suggested” by a single reported hybrid. Besides being inconsistent, none of these opinions is referenced, leaving me to wonder how valid they actually are. In the American Redstart account is the statement that “much needs to be learned about the exact nature of the prealternate molt in this species.” In fact, more is known about this molt in American Redstart than in any of the other warblers. A general statement about our lack of knowledge of prealternate molts in most warblers would have been of greater value. Finally, without looking hard at all, I noticed several errors in the citations and two (one would have been preferable) bibliographies: DeSante and Pyle “1987” (p. 36) should have been 1986; Hall “1983” under the Yellow-throated Warbler should have been 1993; Howell, “S. W.” (p. 636) should be Howell, S. N. G., and so on. That these were located without effort makes me wonder how many other errors there are in the citations.

Nonetheless, these few grievances do not come close to outweighing the many benefits of Warblers, a must for all birders and ornithologists.

Peter Pyle


Published in North America by Princeton University Press, this book comes from the Helm stable that brought us such classics as Seabirds (Harrison 1983) and Shorebirds (Hayman et al. 1986), with which it shares a similar format (brief
BOOK REVIEWS

introductory chapters followed by color plates with short, facing-page texts and distribution maps, and thence by species accounts). Unfortunately, the similarities largely end there. This volume covers 145 species of a group traditionally classified as the Sylviidae, the Old World warblers. All species known to breed in the Palearctic and southern Asia are included, although, strangely, the African Reed Warbler Acrocephalus baeticatus? avicenniae population of the Red Sea area was excluded. Baker makes a valiant one-man attempt to treat an enormous subject, but the task evidently was too great to generate another classic.

The quality of the color plates is inconsistent, falling short of the standard expected from modern bird-identification literature. The plates do not capture the true shape and structure of many species, and the subtle plumage tones that make Old World warblers so appealing (and perplexing) are often absent. Above all, the omission of many field-separable subspecies compromises the value of the plates for identification.

The taxonomy of palearctic warblers is presently undergoing considerable reevaluation. While acknowledging this fact, Baker proceeds to use it as an excuse for making "no rigourous attempt" (p. 12) at a modern assessment of specific, generic, or even family relationships. Remarkably, the dust jacket states that this book "brings up to date the latest thinking on taxonomic treatment (of warblers)," an assertion that is both misleading and at odds with the book's content. By circumventing the critical subject of taxonomy, the otherwise reasonable species accounts are severely undermined. In one example among many, the Phylloscopus warbler taxa chloronotus and kansuensis are lumped with Pallas' Leaf Warbler, P. proregulus, despite widely accepted published data strongly indicating that both are valid species (cf. Ibis 134:329–334; Bull. Br. Ornithol. Club 117:177–193).

The distribution information appears to be largely accurate, but a cursory check revealed several mapping errors (e.g., Marmora's Warbler is mapped for Menorca despite a {correct} contrary statement in the text). It was disappointing to find that the distribution sections of the species accounts gave no information on vagrant occurrences. In addition, about 25 distribution maps in the review copy were printed too faintly to be legible.

This book serves as a general introduction to palearctic and Asian warblers but falls well short of being a comprehensive identification guide. North American birders seeking state-of-the-art information on species such as the Arctic, Dusky, and Lanceolated warblers should probably look elsewhere.

Jon R. King
Wing Your Way to
Western Field Ornithologists’
23RD ANNUAL MEETING

ARCATA, HUMBOLDT COUNTY, CALIFORNIA

1–4 October 1998

at the Quality Inn on Guintoli Lane at Highways 101 and 299 (800-221-2222 or 707-822-0409). The hotel is offering a special rate of $44 per room for those reserving before 20 September. Please mention that you are with the Western Field Ornithologists meeting when you make your reservation. Other accommodations/camping available.

Tentative Schedule of Events

Thursday evening, 1 October: Welcome; registration; WFO board meeting; presentation “Birding behind the Redwood Curtain: The Story of North Coast Rarities,” by Ron LeValley.

Friday morning, 2 October: Field trips (6:00–11:00 AM). Target species include the Black-capped Chickadee, Gray Jay, Red Crossbill, shorebirds, migrant passerines, and possibilities such as the Sharp-tailed Sandpiper and vagrants.

Friday afternoon: Scientific presentations (1:00–5:30 PM)

Friday evening: California Bird Records Committee presentation by Guy McCaskie; Identification panel chaired by Kimball Garrett

Saturday morning, 3 October: Field trips (6:00–11:00 AM)

Saturday afternoon: Scientific presentations, posters, and art show (1:00–6:30 PM)

Saturday evening: Annual banquet; “Parallels in Latitude: Comparing the Avifaunas of Western North America and Western South America,” by Steve Howell and Sophie Webb

Sunday, 4 October: Del Norte County field trip (6:00 AM–4:00 PM)

Field trip destinations: Mad River County Park and Patrick’s Point (seabirds, migrant passerines); Fairhaven (north spit Humboldt Bay and Arcata Bottoms (vagrants, loons, migrant grassland species); Ferndale and Eel River Wildlife Area (vagrants, migrants, shorebirds, Gray Jay); Crescent City and Smith River mouth, Del Norte County (Sunday only—seabirds, shorebirds, migrants, Black-capped Chickadee). Transportation in vans available Friday and Saturday.

Registration brochure coming soon. For more information, contact WFO Conference, c/o Mad River Biologists, P. O. Box 3020, McKinleyville, CA 95519

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Quarterly Journal of Western Field Ornithologists

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The California Bird Records Committee of Western Field Ornithologists recently revised its 10-column Field List of California Birds (June 1996). The last list covered 578 accepted species; the new list covers 592 species. Please send orders to WFO, c/o Dori Myers, Treasurer, 6011 Saddletree Lane, Yorba Linda, CA 92886. California addresses please add 7.75% sales tax.

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BIOLOGY OF THE CALIFORNIA GNATCATCHER: FILLING IN THE GAPS

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Interest in the coastal populations of the Black-tailed Gnatcatcher (Polioptila melanura) first diffused outside of the ornithological community in 1978. Notable for its odd vocalizations, localized distribution, and co-occurrence with a vegetation then known as "inland sage scrub" (Thorne 1976), the coastal subspecies of the Black-tailed Gnatcatcher (P. m. californica) was judged by environmental planners to be sensitive because of its small range and vulnerability to habitat conversion (M. U. Evans pers. comm.). Therefore, it warranted discussion in reviews of development projects written in response to the California Environmental Quality Act. Discussions of the bird's sensitivity, however, rapidly intensified as it became apparent that the subspecies inhabited some of the most developable lands of coastal California. Conservation of the subspecies soon became synonymous with broader goal of conserving coastal scrub vegetation, which by 1980 was considered one of the most rapidly disappearing vegetation types in California (Westman 1981). In the late 1980s, Phillips (1986:xxvi and 75, 1991:25–26) and Atwood (1988) elevated the subspecies, with its relatives in Baja California, to the level of a species, the California Gnatcatcher (P. californica), restricted in the U.S. to the coastal sage scrub vegetation type and its variations (Westman 1981, O'Leary 1990, White and Padley 1997). Although the California Gnatcatcher was originally described as a species by William Brewster in 1881, its reapprreciation as such a century later almost guaranteed that southern California would experience an endangered-species conflict involving billions of dollars of real-estate development. Because of extensive habitat loss (due to conversion to urban, suburban, and agricultural development; Westman 1981, O'Leary 1990) and associated decline in the species' population (e.g., Atwood 1993), the U.S. Fish and
Wildlife Service listed the California Gnatcatcher as a “threatened” species under the Endangered Species Act (ESA) in March 1993 (USFWS 1993). The USFWS went on to state that the species probably warranted “endangered” status but that ongoing conservation planning (“Natural Communities Conservation Plan”; Calif. Dept. Fish & Game 1993) reduced the level of threat.

In anticipation of (and subsequent to) the federal listing of the gnatcatcher under the ESA, local, state and federal agencies, as well as conservationists and developers, began collecting information and data to support policy decisions and permits required under the act. Unlike previous conflicts over endangered birds, which occurred primarily on federal lands and were investigated by teams of agency and resource-industry scientists [e.g., the Northern Spotted Owl (Strix occidentalis caurina); Murphy and Noon 1992, Gutiérrez et al. 1996], that over the gnatcatcher represented a new model of conflict over private land, where scientists would be contracted for research by a bewildering array of public agencies, corporations, and private individuals.

Most of this information-gathering activity focused on the fine-scale details of gnatcatcher distribution, particularly the identification of occupied and unoccupied habitat. Ancillary to these distributional studies, data were also gathered on local movements, breeding biology (particularly reproductive success), habitat association, and territory sizes. Much of the information amassed for management and conservation decisions, however, was recorded only in unpublished reports, or even simply buried in an individual’s field notebook. Mechanisms for objective review of the information used in policy decisions did not exist. Although thousands of hours of research effort had been expended on the California Gnatcatcher, few peer-reviewed papers describing this work were published. Administrative functions, such as issuance of permits, continued in absence of published information, but conservation science suffered. Researchers had few avenues of communication, no one could build off the established work of others, and mechanisms for identifying reliable data went unused. Thus the need for a symposium on the biology of the California Gnatcatcher, and perhaps a new manner of looking at endangered-species research, arose from the chaos created when so many researchers plunged into so many studies in such a short period.

We organized this symposium for the purpose of bringing gnatcatcher researchers together and lobbying for the publication of the large body of data generated on the species. The California Gnatcatcher Symposium, held 15–16 September 1995 on the campus of the University of California, Riverside, drew 160 participants from academia, biological consulting businesses, and government agencies. We asked the participants to present existing data and analyses and to help us identify the current status of scientifically based knowledge on the species. Our hope for the symposium proceedings was to move as much of this knowledge as possible from the “gray” literature into the peer-reviewed (and more widely accessible) mainstream. The papers contained in this issue of Western Birds represent a major portion of the realization of that goal. In further support of that goal, we were successful in making a collection of previously unpublished reports available through the auspices of the Van Tyne Memorial Library, curated by
the Wilson Ornithological Society, at the Museum of Zoology at the University of Michigan. Although these reports have not undergone peer review, they contain valuable data; each is cited in one or more of the papers in this volume as appropriate.

At the symposium 45 oral and poster papers were presented, representing most aspects of California Gnatcatcher biology. Although many were explicitly conservation or management oriented, that focus was not a criterion for inclusion on the program. From these 45, 22 appear in this collection; we are aware of at least seven other presentations, portions or all of which have appeared or are currently in review in other professional journals. Publication of these proceedings would not have been possible without the generous support of Ogden Environmental Services, LSA Associates, the Metropolitan Water District of Southern California, the Riverside County Habitat Conservation Agency, and the University of California.

From these papers we can distill several facts about the California Gnatcatcher. For example, at a regional or landscape scale, the distribution of the species appears largely constrained by the distribution of coastal sage scrub vegetation; however, at more local scales birds may be found in (and perhaps depend on) additional vegetation types, depending on the particular local mosaic. Because individuals and pairs can be found in patches of suitable habitat quite isolated from the nearest population of any consequence, the power of dispersal of this nonmigratory species may be substantial. It is quite clear that gnatcatchers in southern California occupy a fragmented landscape and are governed by metapopulation dynamics. Territory sizes are highly variable, increasing significantly as one moves inland from the coast, and in general are much larger on average than those of other passerines of comparable body mass. They are persistent nesters, constructing as many ten nests within a breeding season. However, nests are frequently abandoned before eggs are laid, so that the number of clutches is usually less than the number of nests built by a pair. Clutch size is variable, and much of the variation seems related to variation in weather, particularly precipitation. Although California Gnatcatchers serve as frequent hosts to the Brown-headed Cowbird (Molothrus ater), they also suffer a high rate of nest predation, which seems to exert the greatest control over reproductive success.

Nevertheless, numerous gaps in our knowledge of gnatcatcher biology remain. For example, we lack certainty about the birds' mating system and criteria for mate choice; although they appear socially monogamous, they also demonstrate behaviors that clearly suggest a potential for extra-pair copulations for both sexes. While mating systems are of academic interest to behavioral ecologists, they are also relevant to conservation biologists because of the implications they may have for genetic structuring of populations and effective population size. Likewise, although there have been several investigations of gnatcatcher genetics with a goal of elucidating taxonomic relationships, we are currently unaware of any studies examining the genetics of populations or demes. In addition to providing information on effective population size, properly done molecular studies also assess gene flow, genetic traces of the connections among subpopulations distrib-
uted over a fragmented landscape. Because gnatcatchers nest persistently, their reproductive effort can be high; although there is a rich body of life-history theory that deals with trade-offs among aspects of reproduction, none has been systematically applied to the California Gnatcatcher. And although clutch size varies from year to year, it also varies from pair to pair at a site within a year; it is not known if this variation reflects differences in territory quality or differences in the quality of individuals. Indeed, we do not know how reproductive success varies with standard measures of habitat.

From a conservation and management perspective, our greatest concerns about knowledge gaps pertain to issues of landscape ecology and metapopulation dynamics. For example, it is evident that gnatcatchers must disperse through "unsuitable" habitat (i.e., habitat not suitable for territory establishment and subsequent reproduction); however, we have only a few tantalizing details about the actual paths taken or vegetation types used. We also have hints that there may be spatial correlation in temporal fluctuations in abundance, but the strength and spatial extent of this correlation throughout the region (which is critical to estimating metapopulation persistence) is unknown. Perhaps most important, we currently lack the ability to generalize source and sink subpopulations among the many disjunct assemblages of occupied habitat, which is critical if efforts to preserve the species in the region are to be successful. Ultimately, the natural dynamic cycles of gnatcatcher habitat have been disrupted by invasive, non-native grasses; increased frequency of fire in habitat preserves may radically alter the dynamics of gnatcatcher populations across the mosaic of remaining habitat.

Taken together, filling in these gaps will help answer what Atwood (pers. comm.) identified as the four principal questions that need to be answered for effective conservation planning in the region:

1. How long does it take habitat disturbed by fire or created by restoration to achieve the point where it can support successfully breeding gnatcatchers?
2. How do dispersal patterns affect the genetic and demographic connectivity of subpopulations?
3. What drives long-term large-scale patterns of variation in demography?
4. How can we identify, and perhaps rank, good-quality habitat over large spatial scales?

We hope that this symposium and the research it summarized and generated will be a major contribution to answering these questions.

ACKNOWLEDGMENTS

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LITERATURE CITED


CALIFORNIA GNATCATCHER
territorial behavior

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To conserve and manage endangered and threatened species effectively requires an understanding of their overall distribution as well as a more detailed understanding of individuals' use of space. Nonmigratory birds' use of an area in the breeding season may differ from their use of it in the nonbreeding season. Amid ever-increasing pressure to develop, determining if habitat is occupied is crucial to planning preserves. Knowledge of typical territorial behavior can be important in designing survey methods for determining population densities and in ensuring the conservation of habitat necessary for breeding and overwintering.

We studied the ecology of 57 pairs of the California Gnatcatcher (Polioptila californica) in southwestern San Diego County from 1989 to 1992 (see Grishaver et al. 1998, Preston et al. 1998). Currently, there is little published information on the species' territory size and territorial behavior. This paper describes the gnatcatchers' unusually large territory and various aspects of males' and females' territorial behavior.

materials and methods

study area

We studied California Gnatcatchers at two sites in the unincorporated Rancho San Diego area of southwestern San Diego County (32° 40' N, 117° W), approximately 19-23 km inland from the coast and 21 km north of the U.S.-Mexican border. Elevations range from 90 to 370 m above mean sea level. At the 1200-ha Rancho San Diego site, along the Sweetwater River in Jamacha Valley, the study extended from November 1988 to August 1991. At the 111-ha Amber Ridge site, 2.5 km to the northeast, it extended from November 1988 to July 1992. We did not collect data sufficient for analysis at Amber Ridge between July 1989 and September 1990 when over half of the site was graded for development. Approximately 65 ha were retained in open space. Both sites are dominated by coastal sage scrub (Mooney 1977, Westman 1981).

field methods

In November 1988, we mist-netted and banded adult California Gnatcatchers with U. S. Fish and Wildlife Service aluminum bands and unique combinations of color bands. Throughout the remainder of the study, we banded additional juvenile and adult gnatcatchers opportunistically. Nestlings were banded at an age of 9 or 10 days.
CALIFORNIA GNATCATCHER TERRITORIAL BEHAVIOR

We recorded the number of pairs, the identity of individuals within a pair, and any changes in pair composition. Individual mortality and immigration of new birds into the study areas were also noted. We visited each territory an average of 12 to 16 times during the nonbreeding (1 September–28 February) and breeding (1 March–31 August) seasons. We used tape-recorded vocalizations to elicit responses from a resident pair only if extended searching failed to reveal one or both members of the pair. If a tape was used, we waited 5–10 minutes prior to beginning data collection to allow the gnatcatchers to resume their normal activities. We determined the breeding status of each pair during each observation period.

We collected territory/home-range data by following each resident individual or pair and mapping its location every 30 seconds on an aerial photograph (photo scales 1:3300 and 1:4800). A repeating timer indicated the beginning of each 30-second interval. We recorded when none, one, or both gnatcatchers were in view, and then calculated the proportion of time each individual was in view or out of sight during the observation period.

We defined a territorial dispute as any aggressive intraspecific behavior directed at an intruding nonresident individual. Territorial disputes typically entailed mewing, scolding, bill clicking, and aggressive display postures directed toward the intruding gnatcatcher(s) by one or both members of the resident pair. Disputes often resulted in pursuit and sometimes in an attack on the intruding bird(s) by the resident bird(s). For each observed territorial dispute, we recorded the identity of all participants, their age and sex, and the beginning and ending locations of the dispute.

Data Analysis

The size and configuration of each pair's territory/home range were calculated by combining all mapped locations for each pair for each breeding and nonbreeding season. A minimum convex polygon, indicating the extent of the territory/home range, was hand-drawn around the outermost locations in a conservative connect-the-dots manner without any buffer area. Territory/home-range size was determined by hand-planimetering the perimeter of the polygon and using a computer to calculate its area.

We defined the home range as the entire area used by a pair and the territory as the area actively defended by the pair through aggressive, agonistic interactions. Paired t tests were used to determine if there were significant differences between the sizes of breeding territories and home ranges. The area observed to be used by the birds during any particular period of time is a subset of the home range. Thus, use areas determined during a restricted period may underestimate the true home range. To assess the point at which each pair had been sampled sufficiently to represent its true home range, we plotted area used versus cumulative field effort (number of hours and number of days of observation). Initial search effort, periods when both gnatcatchers disappeared from view and could not be quickly relocated, and brief nest checks were not included in calculation of field effort. The rate of increase in territory size was calculated for each observation day and averaged for each pair over the entire breeding season. Average rates of increase for individual pairs (ha/observation day) were
CALIFORNIA GNATcatcher TERRITORIAL BEHAVIOR

averaged for all pairs to yield an overall average rate of increase in territory size per observation day. The average rates of increase between successive nest attempts, during the fledging phase, and during the post-breeding phase were compared with the overall mean rate of increase to determine if territory-delineation rates were higher during these intervals. At the Rancho San Diego site we also kept records of the amount of time a subset of established pairs wandered outside of their territories of the previous breeding season during the 1989–1990 and 1990–1991 nonbreeding seasons.

We categorized territorial disputes by the age and sex of all participants and compiled disputes according to the age of the intruder for each month of the year. Locations where territorial disputes originated and terminated were added to the maps showing territory boundaries (see above). We also measured the distance from the ending location of the dispute to the nearest territory boundary.

We plotted average territory sizes obtained from other studies of the California Gnatcatcher against distance from the coast. By means of SAS software (SAS 1996), we used a Pearson’s correlation to determine if there was a significant relationship between territory size and distance from the coast.

RESULTS
Field Effort

We delineated breeding territories and/or nonbreeding home ranges for 57 pairs of the California Gnatcatcher. For 16 of these pairs, one or both individuals were observed in two consecutive breeding and/or nonbreeding seasons. Our total field effort averaged 16.0 [standard error (SE) ± 1.6] visits to a territory to collect territory/home-range data during the breeding season, 12.8 (± 0.9) visits during the nonbreeding season. Observation periods were of variable duration (range 15–275 minutes). Excluding the nonbreeding seasons at the Amber Ridge site, we observed each pair an average of 70.2 minutes per territory visit. Individual breeding-season and nonbreeding-season observation periods averaged 57 to 86 minutes per territory visit. During the nonbreeding seasons at Amber Ridge, field effort was substantially lower with an average of 44 minutes of observation per visit.

 Territory and Home-Range Size

Data for both sites and all years combined, the mean size of a gnatcatcher’s breeding territory was 8.1 ha (SE ± 0.5, n = 45 pairs). There was no significant difference in territory size between the two study areas (7.8 ± 0.7 ha, n = 30 pairs at Rancho San Diego versus 8.7 ± 0.8 ha, n = 15 pairs at Amber Ridge), although there was variability from year to year (Figure 1). Nonbreeding home ranges at both sites averaged 12.4 ha (SE ± 1.1, n = 51 pairs). At Rancho San Diego nonbreeding home ranges (mean = 14.0 ha, SE ± 1.2, n = 41 pairs) were over twice as large as at Amber Ridge (mean = 5.8 ha, SE ± 0.4, n = 10 pairs). This may be attributed partially to a lower level of effort at Amber Ridge during the nonbreeding season for both
number of visits and observation-period duration (see below). At Rancho San Diego, the mean difference in home-range size between the breeding and nonbreeding seasons for pairs for which both areas were estimated was 7.2 ± 1.5 ha, an average proportional increase of 78% (SE ± 16.2%, n = 18). This mean difference was significant (paired t test, n = 18 pairs, P = 0.005).

We obtained average territory sizes from other studies of the California Gnatcatcher and found a significant correlation (P < 0.001) between territory size and distance from the coast (Figure 2).

Population Dynamics

We observed fluctuations in the number of pairs at both sites over the course of the two studies. Numbers at both sites were higher during the nonbreeding periods owing to postbreeding immigration of juveniles and to relatively high weather-related mortality during January and February just before the breeding season. At one site in the Rancho San Diego study area we observed a 50% reduction in the number of pairs over one year, despite substantial immigration and settlement of juveniles on the site. The primary cause of mortality was severe cold, wet weather from December to February. There were also year-to-year differences in population densities that appeared associated with weather conditions such as cold rains and extended
drought. Our study extended over the last two years (1989–1990) of a five-year drought and one year (1992) of above-average rainfall.

Over half of the Amber Ridge site was graded for development in the fall of 1989, resulting in a decrease in the gnatcatcher population in adjacent undeveloped habitat. The population gradually increased, however, in this remaining habitat during the two years following grading.

**Territory Size and Level of Field Effort**

Our estimate of the size of a California Gnatcatcher territory increased as the level of field effort increased (Figure 3). The average rate of increase for 18 territories was 0.3 ha (SE ± 0.04) per day of observation. This rate of increase was not linear for all territories, as some followed a stair-step pattern. Since gnatcatchers often focus their activity around their nests (Atwood et al. 1998a), during the breeding season they often use different parts of their territory selectively. We found that the rate of increase between the termination of a nesting attempt and the beginning of another attempt was 25% higher than the rate of increase during a nest attempt.

Field observations suggested that prior to leaving the natal territory and becoming independent, fledglings were led around the perimeter of the

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**Figure 2.** California Gnatcatcher territory size versus distance from the coast in southern California; $r^2 = 0.628; P < 0.001$. Average territory sizes obtained from the following sources: this study, R. A. Erickson (pers. comm.) for coastal Orange County, S. Taylor (pers. comm.) for Marine Corps Air Station Miramar, Mock et al. (unpubl. data) for Miramar and southwest Poway, Sweetwater Environmental Biologists (1986), RECON (1987), Impact Sciences, Inc. (1990), Bontrager (1991), McMillen et al. (1991), MBA (1993), Mooney Associates (1994), Atwood et al. (1998a).
estimates of California Gnatcatcher breeding-territory size \((n = 19)\) as a function of observation effort.

Figure 3. Estimates of California Gnatcatcher breeding-territory size \((n = 19)\) as a function of observation effort.

territory by the adults. Therefore, we expected that the rate of increase in the delineated territory would be higher late in the fledgling stage. We found that the rate of increase in delineated territory was 25% higher (0.4 ha/observation period, \(n = 24\) periods) when pairs had older fledglings (fledged for 14 or more days). The rate of increase was also higher (0.6 ha/observation day) for pairs that had completed nesting prior to the end of the breeding season. Typically we saw this expansion of territory in a subset of the pairs beginning in late June or July. This increased territory growth most likely reflects the beginning of the expansion of the home range in the nonbreeding season.

The observed size of 12 of 18 (66.7%) territories increased on the last visit of the breeding season (average increase on the last observation day was 0.3 ha). The average territory size delineated after eight visits was 5.4 (SE ± 0.6) ha. When data from all visits (mean = 18.2 visits, range 9–34 visits/territory) were included, the territory averaged 8.6 ha (SE ± 0.9), 59% larger than the same territories delineated with eight visits (paired t test, mean difference = 3.2 ha, \(P < 0.006, n = 18\)). The eight-visit dataset represented only a portion of the complete breeding season for most of the pairs, and the average territory may have been larger if the eight visits had been more evenly spaced throughout the entire breeding season.

During the nonbreeding season, 11 pairs of California Gnatcatchers spent substantial portions of their time wandering outside of their established...
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Figure 4. Mean (± standard error) percentage of time California Gnatcatchers wandered outside of defended territories in the nonbreeding season at Rancho San Diego. Number of hours of observation and number of pairs specified for each month.

territory into neighboring territories or into undefended habitat (Figure 4). This expansion of their home range peaked in December with an average of 62.1% (SE ± 11.2%) of their time spent outside of their defended territory.

Throughout the breeding and nonbreeding seasons territory boundaries as determined by patterns of spatial use and the locations of territorial displays were relatively fixed. Existing boundaries could be somewhat altered during the postbreeding season, however, through immigration and territory establishment by juveniles. Occasionally pairs of first-year birds were able to insert a territory between large existing territories. Weather-related mortality in late winter was also associated with adjustments to territory boundaries. Typically, territories adjacent to a vacated territory expanded to include all or part of the vacated territory.

Territorial Behavior

Despite wandering outside of their territory during the nonbreeding season, gnatcatchers defended territory boundaries throughout the year (Figure 5). Territorial disputes involving an adult intruder accounted for 53.5% of 129 observed disputes, those involving juvenile intruders 42.6%, intruders of unknown age or sex 3.9%. Territorial disputes with adult intruders were distributed equally between the nonbreeding and breeding seasons, with some monthly variation. Because of the high level of extrater- ritorial wandering and trespassing into occupied habitat during the nonbreeding season, it might be expected that the frequency of territorial disputes then would be higher. During the nonbreeding season, however,
territory holders spent a large proportion of time wandering outside of their own defended territories, so intrusion of neighboring pairs into their territory often went undetected. Quiet and secretive behavior by gnatcatchers intruding into neighboring territories, coupled with their evasive behavior when encountering territory holders, may also account for a lower-than-expected number of territorial disputes during the nonbreeding season. Disputes involving juvenile intruders peaked in the late spring and early summer as juveniles dispersed through occupied habitat and began establishing their own territories. By November, disputes with juveniles ceased as juveniles established their own territories by October. The lack of juvenile intruders after late fall may also be attributed to the difficulty in differentiating between first-year and older birds after this time of the year.

Adult male gnatcatchers were involved in the majority of territorial interactions, acting alone or with the female as a defender of their territory, in 87.6% of the disputes. The female was involved as a defender (alone or with her mate) in 50.4% of disputes. The male was the sole defender in 49.6% of disputes, while the female was the sole defender in 12.4%. Males defended their territories primarily against other males, juveniles (unknown sex), and pairs. Rarely did the male chase out a lone female. Females most often chased other females or juveniles (unknown sex) out of their territory and rarely chased out lone males. Adult males were intruders in 42.6% of the disputes, adult females were intruders in 20.9%. The remainder of disputes involved juveniles of undetermined sex or unidentified birds.
Territorial chases typically were terminated by a resident pair near their territory boundary (as determined independently by territorial delineation). In 74% of 115 territorial disputes, aggressive chases terminated within 30 m of the resident pair's current breeding-season territory boundary or, in the nonbreeding season, the previous breeding season's boundary. This percentage includes disputes that terminated both inside and outside of the territory. Of the remaining territorial disputes, 17.4% ended between 30 and 60 m from the territory boundary, and 8.7% ended greater than 60 m from it.

Two established pairs meeting at a boundary between adjacent territories often sat on high perches (e.g., Malosma laurina or Baccharis sarothroides) and scolded, clicked their bills, and engaged in defensive postures such as tail fanning and pumping, without actual contact or a prolonged chase. After a few minutes these disputes usually dissipated and the participants returned to their own territories. If an intruder crossed over a territory boundary it was most likely scolded and then aggressively attacked and/or chased out of the territory by the resident gnatcatcher(s). The resident male typically did most of the active chasing and aggressive behaviors with the female following at a distance or remaining behind and not actively participating. The female was not as actively involved as the male in aggressive interactions beyond initial scolding. If an intruder was a lone adult female, however, the resident female took the lead in chasing the intruding female out of the territory.

We observed a number of instances where a gnatcatcher had lost its mate or was temporarily separated from its mate. In these cases, the lone resident would usually scold any intruders, including prospective mates. In the absence of pursuit by a resident of the same sex, however, intruders of the opposite sex refused to leave. The intruder typically stayed close, giving frequent contact notes. Usually the lone resident would eventually begin foraging with the prospective mate. If the lone resident was unpaired, it often accepted the intruder as its mate within a few days. If the resident was only temporarily separated from its mate, however, the return of its mate would result in the chasing of the intruder out of the territory. Males that were unpaired or had lost their mates spent extensive time vocalizing and searching. If after a day or so they failed to find their mate, they tried to attract another female to their territory by persistently vocalizing and patrolling their territory. Unpaired males would also leave their territory to look for mates in adjacent habitat. One established male lost his mate late in the breeding season and remained unpaired through the following February, when he relocated nearly 4 km from his established territory and bred at the new territory with a new mate.

California Gnatcatchers use areas of marginal habitat, such as riparian edges or weedy areas, for foraging during the winter (this study, Campbell et al. 1998). These areas are not inhabited during the breeding season but are used by gnatcatchers wandering outside of defended territory boundaries in the nonbreeding season. Because these are not defended areas, gnatcatchers sometimes gather there in small groups and forage together without territorial behavior. Members of these groups even remain in contact with one another while foraging by exchanging contact notes. We observed as many as five individuals (a juvenile, female, and three males) foraging together in undefended habitat during the nonbreeding season.
DISCUSSION

Territory Size and Density

California Gnatcatcher populations can vary considerably from year to year (this study, Atwood 1998b, Erickson and Miner 1998). Population levels may be altered over the short term by factors such as weather (e.g., drought, floods; this study, Erickson and Miner 1998), adjacent grading or clearing of habitat (this study), or fire (Atwood et al. 1998c). Other characteristics of a site may influence population levels over the long term, such as climate (Mock 1998), elevation (Atwood and Bolsinger 1992), composition of the vegetation communities (Weaver 1998), and distance from the coast (this study). California Gnatcatcher occupancy of an area can vary over time. During our study, some areas of suitable habitat were unoccupied during years of low population density and became occupied as the population increased.

California Gnatcatcher territories range from an average of less than 1 ha to the relatively large territories of 8+ ha we observed in our study. The territory sizes we recorded were unusually large relative to the body mass of the species in comparison to those of other passerines (Figure 6). In our study individual breeding-season territories ranged from 2.83 to 18.5 ha, considerably larger than recorded in most other studies. There may be several reasons for such large territories in our study areas. In coastal southern California there appears to be a trend of increasing territory size with increasing distance from the coast (Figure 2). Habitats may vary in the resources they offer gnatcatchers, so that habitat quality may be higher along the coast than farther inland. The composition of the vegetation at more mesic coastal sites and more arid inland sites differ (Weaver 1998). Habitat quality defined in terms of food resources or vegetation physiognomy and composition has been shown to affect territory size in some passerines (Schoener 1968, Davies 1978, Wiens et al. 1985, Smith and Shugart 1987, Haggerty 1998). Territories near the coast may also be constrained by development and a lack of suitable habitat. The number of pairs inhabiting a site may influence territory size. The five-year drought ending in 1991 may have resulted in larger territories at our sites. When habitat is abundant and population densities are relatively low, gnatcatchers appear to be able to defend much larger areas without interfering with their normal reproductive activities (Grishaver et al. 1998). Population densities have also been shown to be related to territory size in some birds (Krebs 1971, Morse 1976, Wiens et al. 1985, Smith and Shugart 1987).

Bontrager (1991) noticed an 82% increase in home-range size during the nonbreeding season, similar to our increase of 78%. This extra-territorial wandering appears to have two functions. California Gnatcatchers wandering into neighboring territories are able to assess the status of the neighboring territory holders. Gnatcatchers are short-lived birds and may benefit by being able to determine the pairing status of potential mates in case their current mate should die. We observed gnatcatchers expand their own territory into neighboring territories with the death of one or both members of the neighboring pair. Thus by assessing the status of other territories around their own, gnatcatchers have the opportunity to acquire resources.
and information (e.g., more habitat, potential mates). A second function of extra-territorial wandering is the use of nondefended habitat for supplemental foraging during winter when food resources are likely limited (this study, Campbell et al. 1998). This foraging, often in edge or riparian habitats, may be important in the overwinter survival of gnatcatchers in drier and colder inland sage scrub.

Fluctuations in population levels, territory size, amount of habitat occupied, and habitat requirements between the breeding and nonbreeding seasons have important implications for the conservation and management of the California Gnatcatcher. In many cases planning decisions for proposed development projects are based on the number of gnatcatchers detected during multiple visits to the site during the breeding season. Information on use of nonbreeding habitat has only begun to be considered. Attempts are often made to define habitat use through the delineation of territories. There is substantial debate, however, over methods for delineating occupied habitat through territory mapping, often with the aid of computer modeling (Anderson 1982, Atwood et al. 1998a, Hansteen et al. 1997). Using the same data
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set, different computer programs yield different estimates of territory size (Worton 1989, Call et al. 1992, Hansteen et al. 1997). The amount and temporal distribution of data-collection effort also affect estimates of territory size (Figure 4; Anderson 1982, Atwood et al. 1998a).

There is also disagreement over the interval between data points necessary to achieve statistical independence of each point (Anderson 1982, Hansteen et al. 1998). The 30-second interval used in this study does not afford such independence. In another study of gnatcatcher territories in coastal San Diego, we recorded the birds’ locations at 1- and 5-minute intervals and found that territories defined from locations recorded at only the 5-minute intervals were substantially smaller (Spencer and Mock unpublished data). This result is similar to that from other home-range studies (Anderson 1982, Call et al. 1992, Hansteen et al. 1997). The need is for territory-delineation techniques that fully document the home range used by a pair while maximizing the statistical independence of data points. It is important, however, that biologically relevant observations not be ignored for the sake of meeting strict statistical criteria.

Atwood et al. (1998a) recommended that standard methods for determining gnatcatcher territory size and configuration be developed. Such standardization is important for comparing results of various studies so we may gain a better understanding of how territories vary in time and space. Determining territory size and configuration should take into account that gnatcatchers’ use of space varies through time. They tend to maintain fairly constant territory boundaries throughout the year, however, even with this variation. Territory boundaries appear to change primarily in response to local changes in population densities resulting from juveniles’ immigration and adults’ mortality. Because of fluctuations in habitat occupancy, population densities, and territory sizes over time, we should move away from depending almost exclusively on territory delineations and population estimates in making land-use decisions. Development of habitat-suitability models that adequately evaluate habitat quality and long-term viability could minimize decision making based on information that varies significantly from year to year (e.g., population density and territory size).

Territorial Behavior

In our study paired male and female gnatcatchers jointly defended territories year round. We observed each sex defending its territory primarily against adults of the same sex. This behavior may be important in maintaining the integrity of the pair by minimizing the intruder’s competition for a mate (Gowaty et al. 1989, Slagsvold 1993, Meek and Robertson 1994). It may be a means for a territory holder’s recognizing its mate or for an intruder’s determining that a territory holder is unpaired. This pattern of territorial behavior may also be important in a resident’s preventing its mate from engaging in extra-pair copulations. Alternatively, by tolerating intruders of the opposite sex, territory-holders can solicit extra-pair copulations. Extra-pair matings are considered to be an important part of the mating strategies of many apparently monogamous passerine species (Birkhead and Möller 1992). Although, we did not observe any extra-pair copulations, we did observe a male entering another male’s territory, quietly visiting the

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active nest. He approached the nest very closely, avoiding detection by the resident male. This observation, combined with territorial defense aimed at the same sex, could indicate that California Gnatcatchers engage in extra-pair matings. Similar behavior is seen in species known to participate in extra-pair copulations (Gowaty et al. 1989, Slagsvold 1993, Meek and Robertson 1994). Breeding-season aggression between resident females and intruding females has also been attributed to preventing conspecific brood-parasitism (Hobson and Sealy 1990).

The male is the most active in territorial defense, but the female also plays an active if less intensive role (e.g., scolding but not chasing). The female's participation contrasts with the situation in many other passerine species, in which the male is the sole defender of the territory (Davies 1978, Welty 1982, Hunt et al. 1995). The female California Gnatcatcher's significant role in territorial defense may be attributed partially to year-round defense of a territory unusually large relative to body size. Female participation may be required to maintain a large territory successfully and thereby ensure acquisition of resources necessary for survival and successful reproduction.

SUMMARY

We studied the territorial behavior of 57 pairs of the California Gnatcatchers at two sites in southwestern San Diego County from 1989 to 1992. At our sites pairs defended unusually large year-round territories. Breeding-season territories averaged 8.1 ha (SE ± 0.5, n = 45). During the nonbreeding season, gnatcatchers wandered into adjacent territories and unoccupied habitat, using a home range that was typically 78% (SE ± 16.2) larger than their breeding territory. The number and duration of these forays peaked in December, when the birds spent an average of 62% of their time away from their defended area. Despite the increase in forays outside of established territories during the nonbreeding season, pairs continued to defend and sometimes to expand their previous breeding-season territories. Disputes involving adult intruders were equally distributed between breeding and nonbreeding seasons. Juvenile intruders accounted for 42.6% of all territorial disputes. Female gnaticatchers, in contrast to many other passerine species, actively participate in territorial defense and were involved in 50% of all territorial disputes. Over 70% of disputes terminated within 30 m of the boundaries of the breeding-season territory, regardless of season. Knowledge of California Gnatcatcher territory size and territorial behavior is important in designing preserves and in developing practical survey methods for assessing population densities of this threatened species.

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CALIFORNIA GNATCATCHER TERRITORIAL BEHAVIOR


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CALIFORNIA GNATCATCHER
VOCALIZATION BEHAVIOR

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Some passerine songs and calls have fairly specific functions (Kroodsma 1981, Catchpole 1982, Merila and Sorjonen 1994). Other songs or calls may have more than one function with the meaning varying with the context in which the song or call is given and received (Lein 1981, Catchpole 1982, Howes-Jones 1985, Nelson and Croner 1991, Slagsvold et al. 1994). Characteristics of the repertoire and singing behavior, such as switching from one song to another, shifting song frequencies, song flights, song rate, tempo, volume, complexity, and length, can convey information on the motivation of the singer (Hill and Lein 1987, Radesater et al. 1987, Highsmith 1989, Stacey 1989, Schnase et al. 1991, Aweida 1995, Byers 1995, Ritchison 1995). Birds’ vocalizations can function to attract mates, establish and defend territories, maintain pair bonds, attract females for extra-pair copulations, stimulate a female’s reproductive condition, coordinate nest exchanges, and convey information about the presence or absence of potential predators (Kroodsma 1981, Catchpole 1982, Ritchison 1991, 1995, Neudorf and Tarof 1998).

We investigated the vocalization behavior of the California Gnatcatcher (Polioptila californica) to determine the function of the various calls made by males and females. In this species the male does not sing a complex song as in many other passerines. We also investigated the annual cycle in vocalization rates and in the percentage of pairs detectable during surveys. Vocalizations play an important role in the detection of gnatcatchers by observers and thus are important in identifying occupied habitat.

Atwood (1988) used sound spectrograms to characterize gnatcatcher vocalizations in his comparison of the California and Black-tailed (P. melanura). To date, however, there has been no detailed description of California Gnatcatcher vocalization behavior. We studied over 50 pairs of California Gnatcatchers in southwestern San Diego County from 1989 to 1992 (Grishaver et al. 1998, Preston et al. 1998). This paper examines the vocalization behavior of 21 of these pairs.

MATERIALS AND METHODS

Study Area

We studied California Gnatcatchers at two sites in the unincorporated Rancho San Diego area of southwestern San Diego County (32° 40’ N, 117° W). The two sites are located approximately 19–23 km inland from the coast and 21 km north of the U.S.–Mexican border. Elevations range from
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90 to 370 m above mean sea level. At the 1200-ha Rancho San Diego site along the Sweetwater River our study extended from November 1988 to August 1991. At the 111-ha Amber Ridge site, 2.5 km to the northeast, it extended from November 1988 to July 1992. Both sites are dominated by coastal sage scrub (Mooney 1977, Westman 1981).

Field Methods

Our methods, including banding each individual with a unique combination of colors, are detailed in Preston et al. (1998). We visited each territory an average of 12 times during the nonbreeding season (1 September–28 February) and 16 times during the breeding season (1 March–31 August). Between 1 September 1989 and 31 July 1991, two observers noted all vocalizations of a subset of pairs in the two study areas, simultaneously with our observations for studies of territoriality, time budgets, and breeding biology. We recorded the frequency of different vocalizations given by males and females. Notes were also made indicating when birds were out of hearing range or when the identity of the vocalizing bird could not be determined. Intervals when the pair appeared separated (out of vocal contact with one another) were also noted. We categorized vocalizations on the basis of descriptions by Atwood (1988). Vocalizations included the mew (Atwood Type I), scold (modified Atwood Type I), churr (Atwood Type II), alarm (Atwood Type V), and warbling (Atwood Type VI). We also recorded contact notes (not described by Atwood), which are quiet, short buzzes given by both male and female when close together.

To calculate the monthly detectability of resident gnatcatchers at the Amber Ridge site between October 1990 and July 1992, we recorded the time spent in each occupied territory searching for resident pairs.

Data Analysis

We summarized, by observation period, the frequency of each type of vocalization for an established pair of gnatcatchers. We did not include data from unpaired birds or birds believed to be in the process of establishing their territories. The frequency of a pair’s vocalizations was divided by the number of minutes one or both of the pair were within the range of the observer’s hearing and was expressed as an hourly rate. Monthly means and standard errors were calculated for each type of vocalization and for each stage of the nesting cycle. The pre-nest-building stage was the 2-week period preceding the first signs of nest building for each pair at the beginning of the breeding season. Nest building was the period when birds were observed constructing a nest. Egg laying was the period between the end of nest building and the beginning of incubation. Incubation started when birds were first observed sitting on eggs. The brooding stage began with hatching of the first egg and ended when parents no longer brooded their young, typically when the nestlings were 9 days old. The older-nestling stage extended from then until the chicks fledged, usually at an age of 14 days. The fledgling period began when the first nestling had left the nest and continued, in the absence of another nesting attempt, until the fledglings left their natal territory. If the adults began construction of another nest while still attending fledglings, the
stage was classified as nest building since most observations were near the nest, typically some distance away from the fledglings. The eighth stage of the nesting cycle was the nonbreeding period.

Using the methods described above, we calculated separate hourly vocalization rates for males and females. We calculated the mean and standard error of vocalization rates for each type of call for both males and females by month and by stage of the nesting cycle. To look at the effect of time of day on vocalization rate, we categorized vocalizations as early morning (0600–0959) or late morning/.mid-day (1000–1359). Observations after 1400 were insufficient to be included in the statistical analysis. We compared differences between males and females by analysis-of-variance tests after log transforming vocalization rates by month and by stage of the nesting cycle. We also compared vocalization rates for the two daily time periods.

Monthly percent detectability was calculated by totaling our number of visits to all territories in the study area in which we detected one or both of the pair. This total was divided by the total number of visits to all established territories for that month. A visit was defined as “no detection” if we spent >30 minutes within an established territory and did not locate that pair. Visits to territories with known nests were excluded from this analysis, since gnatcatchers were almost always detected if the active nest location was known, artificially inflating the measure of detectability.

RESULTS

Vocalization Behavior

Between 1989 and 1991, we recorded 327 hours of vocalizations during 241 observation periods of 21 gnatcatcher pairs at the two study sites. The number of hours of data collection per pair averaged 15.6 (standard error ± 3.9, range 1.1–70.5). This measure of field effort excludes any periods when both members of a pair were outside of the observer’s hearing range. Data-collection levels were similar for males (310.2 hours) and females (297.2 hours).

We tallied 50,347 vocalizations during the study. Mews constituted 52.2% of all vocalizations, contact notes 31.6%, churrs 11.9%, scolds 3.3%, and other vocalizations 1.1%. The mean monthly rate of vocalizations peaked in February with 237.6 vocalizations/hour and was lowest in June with 67.4 vocalizations/hour (Figure 1). The monthly patterns for different types of vocalizations were similar except for churrs, which were most frequent from January through June.

Mean vocalization rates varied with stage of nesting, with highest rates before nest building and lowest rates while eggs and young were in the nest (Figure 2). Churrs were highest during the early stages of breeding, whereas mews peaked at later stages of the nesting cycle. Contact notes were lowest when the nest was active and the male and female were often separated by relatively great distances (e.g., one bird was foraging while the other was tending the nest).

Male and female gnatcatchers shared all calls except the churr, given only by males. Males called significantly more frequently than females from February through June \( (P < 0.005) \) (Figure 3). Merging vocalization rates for
the entire year also yielded a significant difference between males and females \((P < 0.001)\). In 9 of the 20 pairs with observations sufficient for this comparison, the males’ and females’ vocalization rates differed significantly. For all but one of these pairs, the male’s rate was greater than the female’s.

Except during the fledgling stage males’ and females’ vocalization rates differed significantly during all stages of the nesting cycle (Figure 4). The difference at the fledgling stage appears not significant only because observations at this stage were too few \((n = 8\) observation periods each for males and females). Conversely, the sample size for the nonbreeding period was the largest \((n = 141\) observation periods each for males and females), and even though the difference in vocalization rates appears small it was significant.

There was no significant difference in vocalization rates between the early morning \((0600-0900)\) and middle of the day \((1000-1300)\).

**Detectability**

On the basis of repeated surveys of nine territories between 1 October 1990 and 31 July 1992 at Amber Ridge, the gnatcatchers’ detectability was lowest from October to February (Figure 5). There were two replicates for all months except August and September. There may be some bias in detectability over the course of the study due to the two observers’ increasing familiarity with the population. Some pairs were easier to detect than others. Monthly detectability of any one pair varied from 20 to 100%.
Figure 2. Mean rates of California Gnatcatcher vocalization types during each stage of the nesting cycle. Twenty-one pairs were observed for 327 hours at the Amber Ridge and Rancho San Diego study sites. The number of observation periods is listed above each stage of the nesting cycle.

DISCUSSION

Vocalization Behavior

California Gnatcatchers emit several unique calls (Atwood 1988) but lack a longer, more complex vocalization characteristic of the songs of males of many passerine species. The division between calls and songs, however, is rather arbitrary and artificial (Catchpole 1982). We consider gnatcatcher calls to encompass functions similar to those of typical passerine songs.

From our observations and the descriptions of vocalizations by Atwood (1988), it appears that some gnatcatcher calls have very specific functions. We heard alarm calls consistently when a potential predator or human approached the gnatcatcher or its nest too closely. Churrs, restricted to males, are important in mate attraction, facilitation of nesting, and pair-bond maintenance. The contexts in which this call was heard and the seasonal pattern of churr rates (Figures 1 and 2) are consistent with other studies that have found certain vocalizations to have similar functions in other passerines (Howes-Jones 1985, Kroodsma 1981, Staicer 1989, Merila and Sorjonen 1994, Ritchison 1995). The rate of churring is highest during the pre-nesting and early nesting periods, relatively low in the nonbreeding and later breeding stages. The male initiates and plays a dominant role in nest building (Grishaver et al. 1998). Churrs are an important component of nest-building behavior and may entice the female to the nest site. Churrs during the pre-
breeding stage may stimulate the female into reproductive condition. Churrs were also associated with periods when the male and female became separated, especially during the earlier phases of the nesting cycle (from pre-nesting to incubation). This call was also frequently heard during pair formation, although we quantified vocalizations only for established pairs. In one case a newly unpaired male left his territory at the start of the breeding season and entered the territory of a female who had also lost her mate. The male churred extremely often over several days and appeared to be trying to lead the female back to his territory. The fact that the male was not defending his own territory while churring extensively and was unpaired and attempting to attract a mate suggests that churrs function primarily in mate attraction and not in territorial defense. The California Gnatcatcher may indulge in extra-pair copulations (Preston et al. 1998). If so, churrs may also function to attract females for such copulations, although we did not document this.

The mew call appears to be used in a variety of situations. Atwood (1988) described it as important in territorial advertisement and in interactions between the sexes. The contexts in which we observed gnatcatchers mewing support Atwood’s interpretation of multiple functions for this call. California Gnatcatchers mew often throughout the year (Figures 1 and 2), consistent
CALIFORNIA GNATCATCHER VOCALIZATION BEHAVIOR

![Graph](image)

**Figure 4.** Mean (± standard error) rates of total vocalizations for male and female California Gnatcatchers during each stage of the breeding cycle. Twenty-one pairs were observed at the Amber Ridge and Rancho San Diego study sites. Females were observed for a total of 297.2 hours, males for 310.2 hours. The number of observation periods for each sex is listed in parentheses below each month (male/female). * difference between the sexes is significant (P < 0.005, analysis of variance).

with the call's functioning to maintain pair bonds and territories year round. Atwood also attributed a scolding function to the mew. In our study we recorded this scolding call separately because we could distinguish it easily and because of the specific scolding context in which it was used. This scolding type of mew was used by territory holders in interactions with intruding gnatcatchers and in mobbing potential nest predators. It was also used when members of a pair came together after short-term separations. Because of the variability in the mew call, it is likely that variations in its rate, duration, frequency, pitch, and volume relay specific information.

To determine the functions of various gnatcatcher calls definitively will require further spectrographic analysis of the various subtleties of the calls, more quantification of the context of each call, and of the behavioral responses of receivers of these calls.

**Detectability**

The study at Amber Ridge indicates pairs were most detectable from March to September (Figure 5). Best and Petersen (1982, 1985) found that the detectability of two other arid shrubland passerines, the Sage (Amphispiza belli) and Brewer's (Spizella breweri) Sparrows, varied with the stage of the nesting cycle. The Sage Sparrow's detectability was relatively low (25-80%) with some fluctuation according to breeding stage,
CALIFORNIA GNATCATCHER VOCALIZATION BEHAVIOR

Figure 5. Mean (± standard error) rates of monthly percent detectability of California Gnatcatchers in occupied territories at the Amber Ridge study site. Sample sizes are listed in parentheses below each month as number of visits to all territories/number of territories.

whereas Brewer’s Sparrow varied pronouncedly in detectability, being highly detectable (100%) during the early breeding season and dramatically less detectable (30–60%) after pairing.

Our study suggests that the California Gnatcatcher’s detectability ($P_d$) varies between 70% and 90% from December through September. Detectability is lowest in October and November (52–57%). Therefore, the probability ($P_m$) of missing a gnatcatcher present at a site diminishes greatly with each successive visit. A maximum value of $P_m$ at 5% requires five visits for a $P_d$ of 50%. $P_d$ values greater than 70% require only three visits for the 5% $P_m$ threshold to be met. Therefore three to five visits are adequate in most months of the year in areas with relatively large gnatcatcher populations. In areas where $P_d$ may be lower, however, such as near the limits of the gnatcatcher’s range, additional visits might be necessary.

The pattern of detectability of the gnatcatchers at Amber Ridge differed somewhat from the pattern of variation in vocalization rates (Figures 1 and 5). Gnatcatchers emit easily detectable calls (e.g., mews and churrs) at the highest rate between August and March. Since vocalizations are the primary means of detecting gnatcatchers, we expect that gnatcatchers are more detectable during these months. The slightly lowered detectability at Amber Ridge from October to February (52% to 78%) may be partially explained by the birds’ high rate of extra-territorial wandering between November and January (Preston et al. 1998). As we became familiar with each territory, we
may have biased our efforts in areas where we expected to find gnatcatchers. Gnatcatchers outside of their defended territory call less frequently than when they are in their territory. Simpson (1985) documented the same pattern in the Carolina Wren (Thryothorus ludovicianus). Resident birds wandering into territories of neighboring pairs or into supplemental foraging areas not defended by any birds may not be detected by an observer using a taped recording to elicit territorial behavior.

It is important to note that we directed substantial effort toward following each pair during the breeding season and to finding all nests. As a result, we spent more time looking for hard-to-detect pairs during the breeding season than during the nonbreeding season. This increase may have contributed to higher detectability during the breeding season than would have been expected from vocalization patterns. The majority of nests were found at the nest-building stage (Grishaver et al. 1998), when gnatcatchers are relatively conspicuous and vocal (Figure 2). Subsequent observations at known nests were not used to determine detectability (see Methods). This precluded the inclusion of many observations from the incubation, brooding, and nestling stages of the nesting cycle when gnatcatchers are substantially less vocal, hence detectability in the breeding season may have been overestimated. Our experience in locating and following California Gnatcatchers suggests that gnatcatchers are more difficult to detect during the egg-laying, incubation, and early nestling stages. At these times adults are significantly quieter (Figure 2) and more secretive, especially near the nest. Detection rates by observers unfamiliar with a gnatcatcher pair during the breeding season would probably be lower than suggested by this analysis.

While California Gnatcatchers do not sing complex songs, they do have a variety of calls that appear to have specific functions. The pattern of these calls and the behavior of the birds during the annual cycle can influence their detectability during surveys, with important consequences for survey methods and determination of population densities.

SUMMARY

We collected vocalization data on 21 pairs of California Gnatcatchers throughout the annual cycle to describe their seasonal pattern of vocalizing and to determine the functions of multiple call types. By understanding their vocalization behavior, we can improve our survey methods for assessing densities of this threatened species. Vocalization rates were highest from August through March (the non-breeding, pre-nesting, nest-building, and fledgling stages of the breeding cycle) and lowest from April to June (especially during the egg-laying, incubation, and nestling phases). Males were significantly more vocal than females from February to June. The percentage of pairs detected during regular surveys varied by month, being lowest during October and November.

ACKNOWLEDGMENTS

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LITERATURE CITED


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FACTORS AFFECTING ESTIMATES OF CALIFORNIA GNATCATCHER TERRITORY SIZE

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Efforts to conserve the California Gnatcatcher (*Polioptila californica*) have generally focused on maintaining large, viable tracts of coastal sage scrub habitat through regional land-use planning, rather than on delineation and protection of specific areas used by individual pairs (Atwood and Noss 1994, Reid and Murphy 1995). Nonetheless, determination of the territory or home-range boundaries of particular pairs of gnatcatchers is sometimes an issue of management and regulatory concern. For instance, property owners who prepare habitat-conservation plans under Section 10(a) of the Endangered Species Act usually base mitigation proposals on the level of gnatcatcher “take” expected to result from the proposed project (Bean et al. 1991). Because this species inhabits some of the most expensive real estate in the United States, determining the number of pairs likely to be affected by a proposed development—and the amount of mitigation that may be required—can easily have major financial implications. Furthermore, estimates of gnatcatcher territory or home-range sizes have been suggested as possible indices of habitat quality (Atwood 1993). Because population-viability models frequently determine carrying capacity from classification of habitat quality (Akçakaya and Atwood 1997), the comparability of territory-size estimates obtained by different researchers using various techniques is an important issue that may influence regional conservation planning.

Published information concerning the home-range or territory sizes of California Gnatcatchers is limited (Atwood 1993), and statements made in various unpublished reports and planning documents have in some cases been cited so frequently that the preliminary nature of the original comments seems often to have been forgotten. It is not the intent of this paper to critique the results of other studies or even to summarize information on territory sizes presented to date. Instead, our focus here is to use data from the Palos Verdes Peninsula to assess factors that may influence the analysis of gnatcatcher home-range or territory sizes and to propose some general approaches to this topic that would enhance our ability to synthesize information being generated by various ongoing studies.

METHODS

During 1993 and 1994 we mapped the use areas (here we make no effort to distinguish the terms use area, home range, or territory) of 26 breeding pairs of the California Gnatcatcher on the Palos Verdes Peninsula, Los Angeles County, California. Observations were recorded on 7.5-minute-series USGS topographic maps enlarged to a scale of approximately 1 inch = 500 feet. Although vocal and visual registrations of both sexes were used, the majority of our data reflect locations of the more easily observed males. If both birds of a pair were recorded simultaneously, only the male's position

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was used in the analysis. When a pair rotated nest-attending duties during an observation, the bird that earlier had been attending the nest became the focal individual for the duration of the observation. Although locations of fledglings were mapped similarly, they were not included in the following analyses.

Playbacks of tape-recorded vocalizations or "spishing" were only rarely used to relocate birds that had temporarily disappeared from view. Observations were generally made from distances greater than 50 m to reduce the possibility that normal behavior might be influenced by the researcher. Thirteen (50%) of the observed pairs included at least one uniquely color-banded bird. Behavioral details and information concerning reproductive status were recorded during each visit, as well as during supplemental visits when specific locations were not mapped.

Pairs were visited on varying numbers of dates from late February through early August, with most observations being made during the mid-morning hours (Table 1). On each date we attempted to obtain at least 10 observations spaced at 5-minute intervals; points recorded at shorter intervals were excluded. In reality, gaps between successive observations were often longer than 5 minutes, and on some days it proved impossible to obtain the desired 10 data points given our project's time constraints.

As an initial step toward reducing potential bias, thought to be especially likely when a pair's secretive behavior on a given date might force an observer to establish visual contact by waiting for the birds' appearance near a previously identified nest, prior to analysis we restricted the data as follows. First, dates represented by fewer than five points were excluded. Second, observation periods were not allowed to include gaps longer than 60 minutes; points isolated by such gaps were excluded. Third, on dates when locations were mapped during morning and afternoon hours, and where both visits met the preceding criteria, the afternoon records were excluded. Finally, after imposing these limitations, we restricted the sample size again, removing dates represented by fewer than five points. The resulting data are summarized in Table 1.

We entered the locations in a computer and converted them to UTM coordinates by using the ArclInfo geographic-information system. Analysis was performed by means of the CALHOME home-range-analysis program developed by the U.S. Forest Service and California Department of Fish and Game (Kie et al. 1994, Larkin and Halkin 1994). As provided by CALHOME, we applied the adaptive-kernel method of Worton (1989), the harmonic-mean method of Dixon and Chapman (1980), and the minimum-convex-polygon method of Mohr (1947) to various data subsets described below. Except when evaluating the effects of different grid densities (see below), we used a 25-m grid-cell size for both adaptive-kernel and harmonic-mean analyses. For both of these nonparametric methods of estimating use area we calculated the 75% and 90% point-distribution contours, constructing the minimum convex polygon containing 100% of the observation points.

We tested the assumption that successive data points were independent by using observations from 20 randomly selected dates, representing 14 different pairs of gnatcatchers. Following the approach outlined by Swihart and Slade (1985), we calculated Schoener's ratio for observations obtained
Table 1 Data Used in Analyses of California Gnatcatcher Use Areas

<table>
<thead>
<tr>
<th>Pair</th>
<th>Days studied⁵</th>
<th>Date range</th>
<th>Modal time of visits</th>
<th>Number of nests⁶</th>
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<td>3</td>
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<td>23 Mar-25 May 1994</td>
<td>08:25</td>
<td>(1)</td>
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</tbody>
</table>

⁵Total number of dates used in analysis after data restrictions. See Methods for further discussion.
⁶Number of nests initiated during indicated observation period. Values in parentheses represent minimum counts; others are believed to represent the total number of nests begun. See Methods for further discussion.

on each date at approximately 5- and 10-minute intervals. Calculation of eccentricity values was based on CALHOME plots of each data subset and the bivariate normal method of Jennrich and Turner (1969). We used critical values as determined at $P = 0.25$ for a bivariate normal distribution (Swihart and Slade 1985).

To examine four potential practical approaches to the problem of dependence of successive observations, we used CALHOME to calculate the 90% and 75% adaptive-kernel contours on four distinct subsets of our data (created after application of the exclusions described above). At one extreme we included all records available from each date regardless of their temporal spacing or daily differences in sample sizes (ALL_OBS). Next, we ensured uniformity of sample sizes among dates by randomly selecting five observations per date; no concern was given to the temporal spacing of the selected points (5RANDOM). Third, we systematically selected three observations per date, with each point separated from the preceding point by an interval of $\geq 20$ minutes (20MIN_3). Last, at the cost of reducing sample size, we
randomly selected one observation point per day (1RANDOM) as our best effort to ensure data independence. Effects of grid-cell density were examined by comparing results based on a fixed 25-m grid-cell size with those obtained through CALHOME's default setting of a 30-cell by 30-cell grid scaled to each data set.

Finally, use-area boundaries (based on the adaptive-kernel method, 75% and 90% contours) were calculated from observations limited to those during 16 complete nesting cycles known to have resulted in the successful fledging of young. We defined the duration of each phase of the breeding cycle as follows: nest-building, 6 days; egg-laying, 4 days; incubation, 14 days; nestling care, 16 days; fledgling period preceding dispersal from natal territory, 21 days (Atwood 1993). The approximate schedule of each successful nest was extrapolated from dates of observed nest building, egg laying, hatching, or fledging, or from the estimated age of nestlings on a given date. In other words, for each successful nest, we established an approximately 60-day window that we estimated to encompass a single, entire breeding cycle, and used observations within that period as the basis for our analysis of use area. This idealized schedule is not meant to be interpreted rigidly; we recognize that the timing of different gnatcatcher nesting attempts may show substantial variation. Nonetheless, for our purposes here, we used this approach to reduce the possible confounding effects that gross differences in sampling duration might have on our results.

RESULTS

Independence of Data Points

Of 20 randomly selected dates in which all successive observations were used [mean time between observations 7.5 minutes, standard deviation (SD) 3.9], the null hypothesis of data independence was rejected in 14 instances (70%) (Table 2) according to the criteria of Swihart and Slade (1985). When alternating observations were used, increasing the mean time between points to 13.5 minutes (SD 5.8), the number of samples with dependent successive records decreased to 9 (45%) (Table 2). Thus, while longer intervals reduced the degree of dependence of successive observations, the improvement was far from complete.

Because of limitations in our sample sizes, we were unable to examine the effect that further increases in the length of time separating observation points might have had on data independence. Consequently, we did not identify a minimum interval at which successive observations would meet the assumptions of data independence required by standard methods of statistically analyzing animals' use areas.

Data Subsets with Varying Levels of Observation Independence

We found no significant differences among estimates of gnatcatcher use areas based on adaptive-kernel analysis (90% point contour) of four different subsets of the data (P > 0.10, Kruskal–Wallis test), where observations were assumed to range from highly intercorrelated (ALL_OBS) to independent (1RANDOM) (Figure 1). Harmonic-mean estimates (90% point contour) and 100% minimum convex polygons did differ significantly (P < 0.01, Kruskal-
FACTORS AFFECTING ESTIMATES OF GNATCATCHER TERRITORY SIZE

Table 2 Evaluation of Independence of Successive Locations of California Gnatcatchers Recorded at Approximately 5- and 10-Minute Intervals on 20 Randomly Selected Dates

<table>
<thead>
<tr>
<th>Pair</th>
<th>Date</th>
<th>5-Minute minimum</th>
<th>10-Minute minimum</th>
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<td></td>
<td></td>
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<td>(n^b)</td>
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<td>30 Jun 1993</td>
<td>5 10</td>
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</tr>
<tr>
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<td>30 Mar 1993</td>
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<td>1.38(^e)</td>
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<td>1.23</td>
</tr>
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<td>14 Apr 1993</td>
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</tr>
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</tr>
</tbody>
</table>

\(^a\) Mean time (minutes) between successive observations, using all points obtained at minimum intervals of 5 minutes.
\(^b\) Number of observation points separated by indicated minimum interval (number of pairs of successive observations = \(n - 1\)).
\(^c\) Schoener's ratio, mean squared distance between successive observations/mean squared distance from center of activity.
\(^d\) Mean time (minutes) between successive observations, using alternate points obtained at minimum intervals of 10 minutes.

Wallis test) among the four data subsets, with both methods yielding progressively smaller use-area estimates as sample sizes were reduced by increasingly stringent efforts to achieve data independence (Figure 1).

Different Analytic Methods

We found significant differences (\(P < 0.01\), paired \(t\) test) between estimates of gnatcatcher use areas based on adaptive-kernel and harmonic-mean methods using both the 90% and 75% point contours (Table 3). Estimates based on the harmonic mean were, on average, approximately 13% smaller than those obtained by the adaptive-kernel method at both contour levels. Similarly, results based on the 90% adaptive kernel and 90%
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harmonic mean were significantly smaller than those provided by the 100% minimum convex polygon \((P < 0.01\), paired \(t\) test); however, the magnitude of these expected differences, especially with the adaptive-kernel method, was relatively minor \([90\%\) adaptive kernel = 85\% (mean) of minimum convex polygon; 90\% harmonic mean = 75\% (mean) of minimum convex polygon\]. In 7 (28\%) of 25 instances the 90\% adaptive-kernel method estimated use areas that exceeded the 100\% minimum convex polygon; in only two instances (8\%) did the 90\% harmonic-mean method predict use-area boundaries greater than the minimum convex polygon. All methods yielded approximately comparable coefficients of variation (Table 3).

Variation in Grid-Cell Density

We found no significant differences between use-area estimates derived from CALHOME’s default setting (a 30-cell by 30-cell grid scaled to each data set) and a fixed 25-m grid-cell size for either the adaptive-kernel \((P > 0.10\), paired \(t\) test) or harmonic-mean \((P = 0.10\), paired \(t\) test) methods.

Differences in Duration of Sampling

Estimates of gnatcatcher use areas based on observations during 16 successful nesting attempts (nest building through departure of fledglings from natal territory) were significantly smaller than estimates of areas used by these same pairs throughout the entire breeding season \((P < 0.01\), paired \(t\) test; Table 4). Within each successful nesting attempt, the number of sampling dates influenced both minimum-convex-polygon (100\%) and adap-
FACTORS AFFECTING ESTIMATES OF GNATCATCHER TERRITORY SIZE

Table 3 Estimates of California Gnatcatcher Use Areas Based on Three Methods of Data Analysis

<table>
<thead>
<tr>
<th>Pair</th>
<th>n⁵</th>
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<th>Harmonic mean</th>
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⁵Sample size based on data subset consisting of observations separated by intervals of >20 min. See Methods for further discussion.

tive-kernel (90%) estimates of use-area size (Figure 2). Estimates of use area based on the minimum-convex-polygon method showed incremental increases even after 8 days of sampling. Although the sample size is small (n = 10 successful nests represented by at least 10 sample dates), estimates of use areas based on the adaptive-kernel method appeared to equilibrate more quickly, with only a 5% difference in mean estimates obtained from 6 as opposed to 10 days of sampling effort (Figure 2).

On the Palos Verdes Peninsula, California Gnatcatcher territory sizes during single successful nesting attempts varied from 0.6 to 2.5 ha (mean 1.52 ha, SD 0.60) (Table 4).
FACTORS AFFECTING ESTIMATES OF GNATCATCHER TERRITORY SIZE

Table 4 Areas Used by California Gnatcatchers while Nesting\textsuperscript{a} and over Entire Breeding Season

<table>
<thead>
<tr>
<th>Pair</th>
<th>Successful cycle</th>
<th>Entire season</th>
<th>Use-area estimate (ha)\textsuperscript{b}</th>
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\textsuperscript{a}Based on observations during single, successful nesting attempts (nest building through dispersal of fledglings).

\textsuperscript{b}Based on adaptive-kernel method (90\% point contour), 25-m grid cells.

DISCUSSION

Size estimates of California Gnatcatcher use areas can be influenced by differences in methods of both data collection and data analysis. From observations of breeding birds on the Palos Verdes Peninsula, we found that localities recorded at intervals of 10 minutes or less were often spatially correlated and therefore likely to violate the assumption of data independence inherent to most statistical models of animal use areas (Swihart and Slade 1985). Duration of the data-collection period may also influence use-area estimates. Areas used during a single successful nesting cycle (nest building through fledging) were smaller than estimates of areas used by the same pairs throughout the entire breeding season. Even within a single nesting cycle, the number of visits to a site may influence estimates of use area. The results presented here, based on the adaptive-kernel method provided by CALHOME, suggest that at least six visits are needed before there is any evident stabilization of use-area estimates. Further study regarding the minimum number of visits required to estimate the boundaries of gnatcatcher use areas accurately is warranted.

Various quantitative methods may also yield different estimates of California Gnatcatcher use areas; Lawson and Rodgers (1997) even found that different software packages produced variable results for the same home-range estimator. Using CALHOME, we obtained significant differences
Figure 2. Minimum-convex-polygon and adaptive-kernel estimates of California Gnatcatcher use areas by number of sampling dates. Estimates expressed as percentage of value derived from data collected on 10 dates. Error bars, 2 standard errors.

between estimates of use areas based on two nonparametric, probabilistic methods (adaptive kernel and harmonic mean), as well as between values derived by either of these methods and those obtained by the minimum-convex-polygon approach. Furthermore, results from both the adaptive-kernel and harmonic-mean methods may be affected by the dimensions of the grid cells applied in the analysis; Kie et al. (1994) noted that the adaptive-kernel model is less sensitive to the effects of different grid-cell sizes than the harmonic mean. These authors concluded that “we do not recommend the harmonic-mean method of home-range analysis. It has been shown to be an improper form of the statistical method of kernel estimation.”

Since the early 1990s several studies of California Gnatcatcher territory or home-range size have been presented in unpublished reports, usually in the context of environmental reviews required for approval of a development. Many of these preliminary documents have lacked detailed descriptions of field and analytic techniques, making it difficult to compare the results of different studies. Compounding this problem is the fact that work aimed at satisfying regulatory requirements, in which all movements of a pair throughout an entire year might legitimately be considered of interest, are fundamentally different from studies focused on examining whether territory size is correlated with some measure of habitat quality. The spread of home-range sizes reported during a single breeding season, from 1 ha (this study) to over 15 ha (ERCE, unpubl. data cited by Atwood 1993), suggests to us a degree of variability exceeding what we would expect solely on the basis of habitat differences. At least some of this variation may reflect differing methods of data collection and analysis.
Consequently, we caution against confident assertions about the area required for California Gnatcatcher territories or home ranges. While we believe that use-area boundaries may be effectively identified by experienced workers without use of computer models or concern over issues such as data independence, and that such delineations may be adequate (or even superior) for use in management or regulatory decisions, we do not think that subjectively mapped polygons will yield data that permit testing hypotheses about the possible relationship between habitat quality and gnatcatcher territory size. Without more rigorously collected data and more careful descriptions of the methods used to analyze such information, our understanding of the California Gnatcatcher’s home-range requirements will remain confused and uncertain.

Finally, we advise that care be taken in attempts to delineate boundaries of gnatcatcher use areas in documents intended for nonscientific audiences. Such presentations may easily be misinterpreted as implying a degree of territory permanence that ignores seasonal and annual variability and a level of certainty in placement of lines on a map that exceeds what was actually observed in the field. Instead, we suggest that the dynamic nature of California Gnatcatcher home ranges and breeding territories requires that land-use planners and regulatory authorities consider all areas of coastal sage scrub near sites recently occupied by the species to be of potential conservation value.

**SUMMARY**

Estimates of California Gnatcatcher territory size may be influenced by differences in data collection and analyses. Recording localities of birds at intervals of 10 minutes or less frequently violated the assumption of data independence basic to most statistical models of animal use areas. The number of dates on which observations were collected also influenced estimates of use area. We compared the results of two nonparametric methods of predicting animal home ranges (adaptive kernel and harmonic mean) with each other, and with results obtained by the nonprobabilistic approach of calculating the minimum convex polygon. We recommend that studies of gnatcatcher territory size (1) be based on observations at intervals of not less than 20 minutes, (2) include observations on at least six dates within a sampling window beginning with nest building and ending within 3 weeks of fledging, and (3) present results derived from a variety of objective, quantitative models, including the adaptive-kernel, harmonic-mean, and minimum-convex-polygon methods. Reports describing such studies should also detail the methods used in obtaining and analyzing data, including, for studies during the breeding season, information about the number of nesting attempts during the period of data collection.

**ACKNOWLEDGMENTS**

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FACTORS AFFECTING ESTIMATES OF GNATCATCHER TERRITORY SIZE

Manomet Center for Conservation Sciences, and an anonymous donor. Jack Cameron, Barbara Courtois, Lynda Luttrel, Nancy Nicolai, Tim Overbey, and Mike Walther all contributed important field assistance. The Environmental Systems Research Institute, Inc. (ESRI), provided a geographic-information system in the form of ArcInfo software; Stacie Grove patiently explained how to make it work. Amy Curry digitized many of the thousands of data points used in this analysis. Barbara and Sarah Atwood encouraged the senior author during his travels to southern California.

This research was conducted under U.S. Fish and Wildlife Service endangered species recovery permit PRT-800922, U.S. Fish and Wildlife Service master bird-banding permit 09996, California scientific-collecting permits, and a California Department of Fish and Game memorandum of understanding dated 25 August 1992 (as amended).

LITERATURE CITED


Accepted 6 July 1998
MOLT AND PLUMAGE VARIATION BY AGE AND SEX IN THE CALIFORNIA AND BLACK-TAILED GNATCATCHERS

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PHILIP UNITT, San Diego Natural History Museum, P. O. Box 1390, San Diego, California 92112

Despite much recent interest in the systematics and demography of the California Gnatcatcher (Poliopitla californica) (Atwood 1988, 1991, Phillips 1991, Mellink and Rea 1994), the molts and plumages of this species have not been described in detail, though treated briefly by Swarth (1902), Ridgway (1904), Woods (1949), and Dunn and Garrett (1987). According to these references, the first prebasic molt is partial, including the body feathers but not the flight feathers (here defined as the primaries, primary coverts, secondaries, and rectrices), subsequent prebasic molts are complete, and a limited prealternate molt includes the crown feathers, at least in males. Females and most but not all basic-plumaged males lack substantial black in the crown, whereas alternate-plumaged males have black crowns. Though females are browner on the back, flanks, and undertail coverts than males, most published sources report that the sexes are only subtly differentiated, if at all. Except for the juvenal plumage, no plumage differences by age have been confirmed.

Long ago, Swarth (1902) pointed out that basic-plumaged male but not female California Gnatcatchers have short black streaks over their eyes. This character, in the California and/or Black-tailed (P. melanura) Gnatcatcher, has been cited by some subsequent references (Woods 1949, Dunn and Garrett 1987, Howell 1987) but overlooked by others (Ridgway 1904, Oberholser 1974, Pyle et al. 1987). Swarth's hypotheses that this black streak is found in males of first basic as well as definitive basic plumage and that basic-plumaged birds with black in the crown are older males have not been confirmed. Dunn and Garrett (1987) further suggested that females have less white in the outer rectrices than do males, and Howell (1987) indicated that basic-plumaged male Black-tailed Gnatcatchers sometimes have a black mask. None of these sources, however, presented any specific data supporting their observations. A critical examination of the California and Black-tailed Gnatcatchers' plumages and molts is thus appropriate.

METHODS

Pyle examined all specimens of the California Gnatcatcher at the San Diego Natural History Museum (SDNHM; n = 115), Natural History Museum of Los Angeles County (LACM; n = 96), California Academy of Sciences (CAS; n = 48), Museum of Vertebrate Zoology, University of California (MVZ; n = 236), and Western Foundation of Vertebrate Zoology (WFVZ; n = 12) and all specimens of the Black-tailed Gnatcatcher at SDNHM, CAS, MVZ, and WFVZ (n = 212). The examination covered all
subspecies of both gnatcatchers from all parts of their ranges (see Atwood 1988, Phillips 1991, Mellink and Rea 1994).

On each specimen Pyle noted color and condition of the flight feathers, color of the nape and back, color of the lower underparts, and occurrence, location, and percentage of black or blackish in the crown. Our findings allowed us to determine the age, as first-year or older (hereafter "adult"), of almost all specimens. We found 21 (3.1%) postjuvenile specimens that we believe to have been missexed. This proportion of missexed specimens is typical of passerines in North American specimen collections (Parkes 1989, Pyle pers. obs.). Terminology of molts and plumages follows Humphrey and Parkes (1959).

Unitt prepared as study skins 40 specimens of the California Gnatcatcher collected by Eric Mellink in northwestern Baja California in January, February, and December 1991, the specimens on which the description of P. c. atwoodi was largely based (Mellink and Rea 1994). He described the extent of molt of each specimen on its label. These specimens constitute the basis of our analysis of the California Gnatcatcher's prealternate molt.

RESULTS AND DISCUSSION

Molt

Examination of prepared specimens confirmed most of what has been published on molt in gnatcatchers, and indicated that the extent of molts is similar in both species. The prebasic molt extends from late July to September. The first prebasic molt includes all lesser and median coverts, all or most greater coverts, up to five consecutive inner secondaries (including the tertials), and zero to all six pairs of rectrices. Twenty first-year (October-January) specimens at CAS and MVZ were examined specifically for extent of molt. Of these, 14 had replaced all the greater coverts; the remaining six had retained one to three juvenile outer coverts. The mean number of inner secondaries replaced was 2.8 (range 0–5); only one bird had not replaced at least one tertial. The mean number of rectrices replaced was 2.4, with eight specimens retaining all juvenile rectrices, six having replaced just the central pair, and two having replaced all six pairs.

Fifty-four specimens had been collected during their adult prebasic molt, and, except for the possible retention of a few primary coverts in some birds (see below), this molt appears complete.

The prealternate molt of the California Gnatcatcher is more extensive than previous literature suggests. Of the 35 specimens collected by Mellink between 16 January and 27 February, 30 were growing at least one new feather on the body. In 28, the molt included feathers other than the crown, and in 26, enough feathers were being replaced that counting the growing feathers individually was impractical. The 21 specimens collected between 16 and 30 January included six that were not molting at all and nine that were replacing only the crown, chin, and/or five or fewer contour feathers elsewhere on the body. The remaining six of this subset were replacing most of the crown, throat, upper breast, back, and scapulars. In none did the molt include the belly, and in only one did it extend to the rump. In two collected on 7 February
the molt included the crown, back, rump, and throat but not the lower breast or belly. By contrast, of the 12 collected from 19 to 27 February, four were molting all tracts of contour feathers, including the belly, and the other eight were molting at least some part of the body posterior of the neck. One of the 12 was replacing the innermost secondaries on both wings.

None of the five specimens collected from 6 to 8 December was molting. It appears from our examinations that gnatcatchers do not have a presupplemental molt as in some other passerines (Thompson and Leu 1994).

From these observations, we suggest the following as the normal course of prealternate molt in the California Gnatcatcher. In mid or late January the molt begins on the crown and chin. From there it spreads posteriorly, though not uniformly, but eventually it encompasses all or almost all of the contour feathers. Of the contour feathers, only those on the belly are possibly not replaced by all individuals. None of the wing and tail feathers are replaced except for the innermost secondaries (tertials) in a few individuals. This was corroborated by older specimens as well: of 143 alternate-plumaged birds at CAS and MVZ, 11% of first-year birds and 24% of adults had replaced from one to three inner secondaries. In a more intensively examined sample of 40 specimens in alternate plumage, 20 in their first spring and 20 older adults, 35% had replaced one or two inner greater coverts and three specimens (one first-year and two older adults) had replaced one or two central rectrices. The proportions of birds with replaced feathers and numbers of renewed feathers were roughly equal in the two age classes.

The molt extends through the end of February, and in some individuals may overlap the beginning of the breeding season: a male collected on 7 February had the testes enlarging, and a female collected on 27 February, still growing a few forehead, chin, nape, and back feathers, had the largest ova enlarging with yolk and was developing a brood patch. Between the sexes, no difference in molt is evident. The 25 January/February females include four not molting, four molting all tracts of contour feathers, and the rest representing stages in between. The 10 males range from one not molting to two replacing the crown, neck, back, throat, upper breast, and scapulars. Inner secondaries had been replaced in a similar proportion of both female and male specimens examined.

Plumage Variation by Sex

Except for juveniles (see below), both California and Black-tailed Gnatcatchers are easily sexed at any time of year. Specimen examination confirms that all males in alternate plumage have black crowns, all males in both first basic and adult basic plumage have a distinct blackish streak above the eye (Figure 1A, B), and that all females in all plumages typically lack black or dusky in the crown. First-year males appear to have, on average, less of this streak than adults (Figure 1A, B), but the age groups overlap in this feature. In addition to this black streak, varying proportions of basic-plumaged adult males retain some blackish in the crown or forehead (Figure 1C), which can be used for sexing. Among males, this feature varies with age (see below).
We also confirmed that, in both species, females have more brown in the backs than males. In females, the brown of the back contrasts with the gray crown, whereas in males the crown and back are virtually conolorous, having, at most, a light brownish wash to both the back and the nape. In spring, both sexes have grayer backs than in fall, possibly because of greater wear while the birds are nesting. This sex-specific difference reaches its maximum in the northern populations of the California Gnatcatcher, *californica* and *atwoodi*, in which there is no overlap between females and males (compare figures 3 and 5 in Melink and Rea 1994). In *pontillis* and *margaritae*, and in the Black-tailed Gnatcatcher, this distinction is less pronounced, especially in spring. On any given date, the sexes can be reliably distinguished by upperpart color, although the brownest males in fall may overlap with the grayest females in spring.

The sexual differences in the color of the flanks and undertail coverts are less pronounced than that of the back. Although there is slight overlap between the buffiest males and the whitest females, even in *californica* and *atwoodi*, this feature could be used as a secondary aid in sexing. We could not confirm that males have more white in the outer rectrices than females (Dunn and Garrett 1987). Any average age/sex-related differences in this character is largely masked by individual and wear-related variation. Of 169 basic-plumaged male specimens examined, only two adult California Gnatcatchers (MVZ 39279 and MVZ 39282, both collected in Claremont, California), had black in the auriculurs (i.e., a “mask”) as described by Howell (1987). This feature appears to be rare or anomalous, a conclusion now concurred with by Howell (pers. comm.), who has seen only two Black-tailed Gnatcatchers in Mexico with black in the auriculurs.

**Age Determination**

Forty-one juveniles were in the collections we studied, 34 of which had sex designations on the labels. In juvemal plumage, both males and females are washed pale brown over the crown and nape, as previously described (Oberholser 1974, Pyle et al. 1987). Juvenile males tend to have heads less brownish than those of juvenile females, but this difference is slight and probably not useful for sexing single individuals in the field. Juvenile males with at least one black feather behind the eye, presumably renewed first basic feathers, were collected as early as 14 June (MVZ 59736); such birds
could be reliably sexed males. On the other hand, juveniles without black behind the eye, sexed as males, were collected as late as 28 July (MVZ 3250), indicating that juvenile females probably should not be sexed by the lack of a black eye streak until at least mid-August.

We found several criteria that, when combined, can be used to age all male and most female gnatcatchers. Because the first prebasic molt does not include most of the flight feathers, differences in color and abrasion result between low-quality juvenal feathers, grown in the nest, and higher-quality adult feathers, replaced in the late summer. These differences become more pronounced with feather age, so that by spring, the juvenal flight feathers of one-year-old birds are very faded and abraded in comparison to those of adults. If a first-year bird has replaced some inner secondaries or rectrices during its first prebasic molt, the two generations of feathers will contrast.

The most useful age criterion appears to be the color and condition of the outer six or more primary coverts (Figure 2). In fall, juvenal primary coverts are narrow, pointed, and brownish black with a thin edge of gray or brown, whereas those of the adult plumage are broader, more truncate, and duskier.

**Figure 2.** Primary-covert wear and color patterns by age in the California and Black-tailed gnatcatchers. In fall, first-year birds have narrow coverts with thin gray edging, which quickly wears off, leaving the coverts brown and abraded by spring. Adult coverts are broader, with broader gray edging in fall, wearing to thinner gray edging by spring.
centered with broader and fresher gray (male) or brownish-gray (female) edging. The color of the edging typically matches that of the back, as varying by taxon and sex, and tends to be thinner or less distinct in females than in males. By spring, the coverts of first-year birds have lost all traces of edging and are very brown and abraded, while those of adults are brownish black with thinner edging, resembling juvenile coverts in fall. At both seasons these retained juvenile primary coverts (and on some birds the outer one to three greater coverts) contrast in wear with the replaced first basic greater coverts (see Jenni and Winkler 1994 and Pyle 1997a,b for full treatments of these contrasts and their use in age determination in passerines). The primary coverts of adult females may lose the edging in spring (during incubation?) and can be difficult to distinguish from the retained juvenile coverts of first-year birds. Otherwise, the condition of the primary coverts can be used to age most gnatchatchers.

Specimen examination confirmed the suggestion by Pyle et al. (1987) that rectrix shape and condition are not as useful in determining the age of gnatchatchers as in other passerines, including kinglets. (This tends to be true of all passerines with long, graduated tails and rounded rectrices.) Nevertheless, the juvenile rectrices of first-year gnatchatchers in spring tend to be browner and more abraded at the tip than those of adults, sufficiently so that in comparison with a series of specimens the age class of most birds was evident, in agreement with that specified by their primary coverts. Since many individuals replace at least the central pair of rectrices and most replace at least one inner secondary during their first prebasic molt, the contrast between fresher adult feathers and more abraded juvenile feathers is useful in age determination. Note that these contrasts indicate first-year birds only from September through January, as the variability in the extent of prealternate molt means that both age classes may show them in alternate plumage. Because a few individuals replace all rectrices during the first prebasic molt, a uniformly fresh tail does not specify an adult, though a comparatively worn tail does specify a first-year bird. First-year birds that replace the entire tail invariably replace at least the three tertials and so can be aged by contrasts among the inner secondaries.

At least 29 adult gnatchatchers, past their second prebasic molt, had what appeared to be two generations of primary coverts. Contrastingly newer coverts included the second, third, and/or fourth feathers from the outside (Figure 2), and these patterns were either symmetrical in both wings or differed by one feather. Replacement patterns did not correspond with that of the primaries, these being uniformly worn in all cases. These birds, collected between 12 October and 30 May, represented both sexes and all subspecies examined. Examples include SDNHM 13790 (P. c. margaritae, collected 22 October), LACM 12775 (P. c. californica, 29 November), CAS 41770 (P. m. lucida, 3 February), and MVZ 3726 (P. c. californica, 13 April).

The contrast between new and old coverts was easier to detect in fresh fall specimens than in worn spring ones and in males than in females, so we may have missed some birds, particularly spring females, with this pattern. Accounting for this, we estimate that 5-10% of adult-plumaged birds had partly replaced primary coverts. The older coverts do not seem as brown or worn as juvenile coverts are in spring, so it appears that this contrast does not
result from an incomplete second prebasic molt, as in woodpeckers (Pyle and Howell 1995). The most logical explanation is that the replacement of newer feathers during the adult prebasic molt had been suspended, resulting in the slight contrast with the feathers replaced earlier. A similar pattern was noted in a small proportion of adult House Finches (Carpodacus mexicanus) by Michener and Michener (1940). More study is needed of this interesting replacement pattern.

As mentioned above, some basic-plumaged male Black-tailed and California gnatcatchers have black or blackish in the crown besides the small eye streak (Figure 1C). Using the condition of flight feathers (especially primary coverts) to assign age classes, we found that black in the crown occurs in some (but not all) adult males but not in first-year males (n = 47), confirming Swarth’s (1902) conjecture that black in the crown might be found in “old” males only.

In the California Gnatcatcher, blackish in the crown (additional to the streak behind the eye) occurred in 64 of 89 (72%) males in adult basic plumage collected from September through January. The amount of black in the crown ranged from one feather (1%) to 70%; the mean was 14% of all 89 specimens and 20% of birds that had blackish. Fewer male Black-tailed Gnatcatchers in adult basic plumage had blackish in the crown additional to the eye streak (16 of 41; 39%), and the amount of blackish averaged less (4% of all 41 and 11% of those that had blackish). These proportions of black in the crown appear to be similar among subspecies of both species, with a consistent difference between the two species.

In basic-plumaged males with black crowns, the black tends to be flatter and duller than the glossy black of the alternate plumage. Thus, basic-plumaged males of the California and Black-tailed gnatcatchers with blackish in the crowns (Figure 1C) are past their second prebasic molt and can be aged as adults, whereas those without black in the crown, however large the black streak above the eye, should be aged only by the flight feathers. Birds in late January and February need to be checked for molt in the crown, as some first-year birds are growing black alternate crown feathers at this time.

Males in first alternate plumage appear to have duller crowns than adults, on average, sometimes with a few grayish feathers in an otherwise fully black crown, but this difference is slight and not useful on its own for determining the age of single individuals.

The age classes of birds are best determined with a synthesis of all characters. Shape, pattern, and wear of the primary coverts (Figure 2) and outer greater coverts, combined with crown color (Figure 1; especially in californica) and color, wear, and contrasts of the rectrices, should reveal the age of almost all male and most female gnatcatchers. Characters of a few birds may be contradictory, e.g., LACM 22888, a male collected on 7 December, which had 20% black (stain?) in the crown but flight feathers resembling those of first-year birds. It is also possible that some very old females might obtain male characteristics, e.g., black in the crown, as occurs rarely in other passerines. Birds showing contradictory features should not be aged or sexed by plumage. Pyle (1997b) summarized age determination of gnatcatchers and other passerines by these criteria.
Molt, Age, and Sex in the Blue-gray Gnatcatcher

Cursory examination of 390 specimens of the Blue-gray Gnatcatcher (*P. caerulea*) indicates that this species' molts resemble those of the California and Black-tailed gnatcatchers. A higher proportion (63%) of alternate-plumaged Blue-gray Gnatcatchers had replaced inner secondaries during the prealternate molt. Most basic-plumaged males do not have black on the forehead and are indistinguishable from females by head plumage; however, females are browner on the back than males, especially in western populations (*P. c. obscura*), and this is probably more useful for sexing than is generally recognized (Pyle et al. 1987, Ellison 1992). Otherwise, molt patterns (including partial replacement of primary coverts in some birds) and criteria for age and sex determinations appear to be similar to those of California and Black-tailed Gnatcatchers.

SUMMARY

Juvenile California and Black-tailed Gnatcatchers are easily distinguished from adult birds by their loose-textured plumage. The sexes of juveniles resemble each other closely, both having a pale brown wash to the upperparts, though males may average slightly grayer on the head and nape than females.

During the first prebasic molt (August–September) the birds replace all of their contour feathers, up to five inner secondaries, and no to all rectrices, but none of their primaries or primary coverts. In the basic plumage, the females are readily distinguished by their browner backs, flanks, and undertail coverts, the difference from males varying by taxon, reaching its greatest in the darkest subspecies, *P. c. californica*. In first basic plumage all males have a small black streak above the eye but none have black on the rest of the crown.

During the prealternate molt (January–March) the birds replace all of their contour feathers (except possibly the belly in some individuals) but none of their primaries or primary coverts. Some birds replace up to three inner secondaries on each wing and, very rarely, the central one or two pairs of rectrices. The alternate plumage may be slightly grayer than the basic plumage, but it wears and fades rapidly since the birds begin nesting as soon as they acquire it. A few one-year-old males may have one or more gray feathers in the otherwise black crown but most attain fully black crowns.

During the adult prebasic molt (late July–September) the birds replace their entire plumage. A few individuals may retain up to three primary coverts for an unknown period. Again, all males have a small black streak above the eye, and some (more in the California Gnatcatcher, fewer in the Black-tailed) have varying numbers of dull black feathers on the rest of the crown.

The contour feathers of the first basic and first alternate plumages are similar to those of the adult basic and adult alternate plumages. But the retention of more worn and faded juvenile flight feathers, especially the primary coverts, allows almost all one-year-old birds to be distinguished until their second prebasic molt. First-year birds have browner primary coverts
with narrow pale edges that wear away quickly; adults have duskier coverts with broader edges that persist in many males and some females through the spring.

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LITERATURE CITED


CALIFORNIA GNATCATCHER MOLTS AND PLUMAGES


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HAS BROOD PARASITISM SELECTED FOR EARLIER NESTING IN THE CALIFORNIA GNATCATCHER?

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Reconstructing past selective pressures can be a daunting task, as data are often sparse, unreliable, or inconsistently gathered. Nevertheless, museum collections provide an impressive but all too often untapped resource. Data housed in such collections provide an important window to the past and allow us to identify and explore changes in the ecology of a species or a community (Reznick et al. 1994, Smith et al. 1995, Schaffer et al. 1998). With respect to avian breeding biology, a wealth of data resides on egg-data cards, most of which are associated with egg-sets and nests collected during the heyday of ornithology in the late 19th and early 20th centuries. Although egg-set cards are not without their biases and flaws (McNair 1987), they remain useful, bearing information that can be gathered and analyzed, with great potential for increasing our understanding of avian breeding biology.

We used virtually all available egg-set data to construct a picture of the historical breeding biology of the California Gnatcatcher (Polioptila californica). In particular, we were interested in examining changes in clutch size and clutch-completion date over the past 100 years. Whereas our results for clutch size differed not and those for clutch-completion date differed little from those of other studies (e.g., Atwood 1990, 1993), we uncovered an apparent shift toward earlier clutch completion subsequent to the establishment of the brood-parasitic Brown-headed Cowbird (Molothrus ater) within the range of the gnatcatcher. We therefore hypothesize that cowbird parasitism has selected for earlier nesting in the California Gnatcatcher.

METHODS

We examined all available egg-set data (n = 117) from five California collections: the Western Foundation of Vertebrate Zoology, Camarillo (WFVZ), San Bernardino County Museum, Redlands (SBCM), Museum of Vertebrate Zoology, University of California, Berkeley (MVZ), Santa Barbara Museum of Natural History, Santa Barbara (SBMNH), and the San Diego Natural History Museum, San Diego (SDNHM). The majority of these cards represented sets collected in California; only six are for Baja California.

We did not use four cards because they contained questionable information. Two cards from Ventura County (WFVZ 43088, WFVZ 92163) were said to be from nests in an “apricot tree” and in “pasture land,” respectively. From these thumbnail habitat descriptions, these nests were more likely of the Blue-gray Gnatcatcher (P. caerulea). A set attributed to P. melanura [i.e., P. californica] from San Luis Obispo County (MVZ 10484) pertains to the Blue-gray Gnatcatcher because the California Gnatcatcher is unknown north of Ventura County (Atwood 1980, 1988). A card from Baja California
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(WFVZ uncatalogued, 20 May 1928) likely pertained to an incomplete clutch (there was only one egg in the nest). Another card from Baja California (WFVZ 103856) lacked a collection date but was used in the analysis of clutch size. Thus the number of egg-set cards usable for analysis of clutch-completion date was 112. Three nests contained Brown-headed Cowbird eggs, so we excluded them from clutch-size analyses, leaving \( n = 109 \) for that study.

Unless the card specified the exact date of laying, we estimated the clutch's completion date from its collection date and stage of incubation. The California Gnatcatcher's incubation period is about 14 days from the laying of the last egg (see Woods 1949). We used a correction similar to Koenig's (1984) to estimate clutch-completion date (Table 1; Patten and Campbell 1994). A majority of historical egg sets were collected within the first few days of the final egg's being laid (McNair 1987, L. F. Kiff pers. comm.), so we considered the incubation stage to be between "fresh" and "slight" if incubation information was not available (e.g., if nothing was indicated on the card); that is, we subtracted one day from the collection date for those few cases.

We calculated clutch-completion date and clutch size as simple means, and regressed clutch-completion date against year of collection. Clutch size was regressed (in separate tests) against clutch-completion date and against year of collection. In further regression analyses against clutch-completion date we used 1920 as a dividing point because, although an exact date cannot be set, this was approximately the year when the Brown-headed Cowbird became an established breeder in cismontane southern California (Laymon 1987, Rothstein 1994). We compared mean clutch-completion dates before and after 1920 by means of Mann-Whitney \( U \) tests with \( \alpha = 0.10 \). Analysis of variance (ANOVA) was used to compare mean clutch size across various studies. Statistical tests were performed with BMDP statistical software (1990 version for personal computers).

RESULTS

Mean clutch completion for California Gnatcatcher nestings was 5 May (standard deviation (SD) 22.57, \( n = 112 \)), with roughly two-thirds of pairs

<table>
<thead>
<tr>
<th>Incubation stage (from the data card)</th>
<th>Estimated clutch-completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh, just begun</td>
<td>collection date</td>
</tr>
<tr>
<td>Slight, started, begun, trace</td>
<td>collection date minus 2 days</td>
</tr>
<tr>
<td>Well begun, embryo taking shape</td>
<td>collection date minus 5 days</td>
</tr>
<tr>
<td>About half</td>
<td>collection date minus 9 days</td>
</tr>
<tr>
<td>Advanced, far advanced</td>
<td>collection date minus 12 days</td>
</tr>
</tbody>
</table>

*From Patten and Campbell (1994). Incubation time for the California Gnatcatcher is assumed to be 14 days. See the text for treatment of cards lacking incubation data.
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completing their clutches between 13 April and 28 May (the mean ± one standard deviation). We define the nesting season as the time between commencement of nest building and fledging of young. Nest construction generally begins about three weeks prior to egg laying, incubation lasts 14 days, and young fledge between 9 and 15 days after hatching, with smaller broods requiring less time to fledge (Woods 1949). Average fledging time is probably 13–14 days; thus, the peak historical nesting season for the California Gnatcatcher extended from 23 March to 26 June. The earliest clutch-completion date was 22 March, indicating nesting commenced as early as about 1 March. The latest clutch-completion date was 10 July, indicating fledging as late as about 7 August. Mean clutch size was 3.85 (SD 0.49, \( n = 110 \), mode = 4). Clutch size did not decrease over the season \( (r = -0.019, \text{ not significant}) \) nor did clutch size decrease over the years represented in this study (1883 to 1959; \( r = -0.053, \text{ not significant} \)).

By contrast, a negative correlation of clutch-completion date with year of collection was significant (Figure 1; \( r = -0.21, \text{ } P < 0.03 \)). Even with the 1959 record excluded—it could be considered a late outlier (the next latest

![Figure 1. Estimated clutch-completion date vs. year of collection (\( r = -0.21, \text{ } P < 0.03 \)).](image-url)
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Figure 2. Estimated clutch-completion date vs. year of collection for egg sets collected from 1883 through 1920, inclusive (r = -0.06, P > 0.60, n = 54).

collection was in 1945)—the negative relationship persists (r = -0.17, P < 0.08). With the data set divided by the year 1920, clutch-completion date from 1883 through 1919 was not significantly correlated with year of collection (Figure 2; r = -0.06, P > 0.60, n = 54) but that from 1920 through 1959 was (Figure 3; r = -0.23, P < 0.08, n = 58).

The mean clutch-completion date from 1883 through 1920 was 10 May (SD 24.52), whereas from 1921 through 1959 it was 1 May (SD 19.86). These means differ significantly (U = 1885, P < 0.07) and, coupled with the strong negative correlation between clutch completion date and year of collection, the difference suggests a shift toward earlier clutches after 1920 (i.e., after the Brown-headed Cowbird became established in cismontane southern California). Nest-card data do not alter the nesting period described by Atwood (1988, 1990, 1993) and extended by Patten and Campbell (1994). Likewise, clutch sizes from the museum egg sets were strictly comparable (ANOVA, \( F_{3,222} = 1.30, P > 0.25 \)) to previously published means of 3.84 (SD 0.57, n = 61; Atwood 1988), 3.67 (SD 0.61, n = 27; Roach 1989), and 3.88 (SD 0.23, n = 33; Bontrager 1991).
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Figure 3. Estimated clutch-completion date vs. year of collection for egg sets collected after 1920, the approximate year in which Brown-headed Cowbirds became established in cismontane southern California (Laymon 1987, Rothstein 1994; $r = -0.23$, $P < 0.08$, $n = 58$).

Three California Gnatcatcher nests in our data set were parasitized by Brown-headed Cowbirds. All three were collected between 25 and 30 May in the years 1929 to 1933. We calculated the mean laying date for Brown-headed Cowbird to be 22 May (SD = 18.77, $n = 256$; data from Norris 1947, Berger 1951), indicating a primary laying period from 3 May through 10 June, a finding consistent with other studies (Payne 1973, Verner and Ritter 1983, Kiff and Irwin 1987). Note that all three parasitized nests fall within this window. Our analyses of clutch-completion date excluded these parasitized nests, although there is no a priori reason to assume that parasitism affects anything other than clutch size for a given nest. With all cases included, we calculated the same negative trend both for all data ($r = -0.23$, $P < 0.02$) and for post-1920 data ($r = -0.23$, $P < 0.10$, $n = 54$). Furthermore, mean clutch-completion date for post-1920 nests was earlier (30 April) and means of pre-1920 and post-1920 nests differed significantly ($U = 1840$, $P = 0.03$).
DISCUSSION

Museum egg-set data are subject to several potential biases and limitations. Nest searches by egg collectors were usually not random through the year or across habitats. Collectors were not distributed randomly and tended to search more heavily close to home. Their searches were generally intended to maximize the number of nests found, either across or within species. Still, mean clutch sizes in egg-set data are usually not seriously biased (McNair 1987). Whereas early dates are well represented, late dates tend to be poorly represented. Species that regularly nest late may be under-represented and have data skewed to one end of the nesting season. Because California Gnatcatcher eggs were collected at a fairly even rate for 60 years and throughout the species’ California range, we feel that biases in these data are minimal, giving no reason to expect biases to shift through time.

Published extreme historical nesting dates for the California Gnatcatcher are from 10 April to 30 May in western Riverside County (Hanna 1934) and from 28 March to 12 July throughout the species’ range (Bendire 1888, Woods 1949). More general accounts based on historical data paint a comparable portrait: in Los Angeles County the nesting season was reported as “late March to early July” with the “best month” being April (Kiff and Irwin 1987), rangewide as “late February through July,” with the mean date for nest initiation being 5 May (Atwood 1988, 1990, 1993). Our results are generally comparable to these previous studies, although mean dates for the most thorough analyses (by Atwood) differ markedly, for we estimated a date of 5 May for mean clutch completion, whereas his 5 May date was for mean nest initiation. Assuming three weeks between nest initiation and egg laying (see above), we calculated a mean nest-initiation date of about 15 April. Two recent studies slightly expanded the early portion of the nesting window, with the breeding season extending from the last two weeks of February through the first week of July at a San Diego County site (Roach 1989) and nest construction as early as 26 February with “all nest activity ... concluded by mid-July” at an Orange County site (Bontrager 1991). Furthermore, the late end of the breeding season has been extended to late August (Patten and Campbell 1994).

Historically, brood parasitism of the California Gnatcatcher by cowbirds has been recorded infrequently (Hanna 1934, Friedmann et al. 1977, Friedmann and Kiff 1985), although it has been suggested that parasitism may be responsible for the species’ “decline or absence in some areas where suitable habitat remains” (Atwood 1980). Currently, cowbird parasitism plays a major role in gnatcatcher nest failure, at least locally (Braden et al. 1997), and probably for quite some time. Our data suggest that cowbird parasitism may have altered the California Gnatcatcher’s breeding biology, selecting for earlier nesting. Recent late-season nesting records (Patten and Campbell 1994) may indicate an overall protraction of its nesting period. Most pairs of gnatcatchers have at least two broods each season and, given the early commencement of gnatcatcher nesting and the comparatively late laying of the Brown-headed Cowbird, we suspect that the majority of gnatcatcher nests parasitized by cowbirds hold at least the second clutch of the season. Assuming a shift toward earlier nesting is heritable, we hypoth-
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esize that California Gnatcatchers that fledge their first brood before the onset of cowbird parasitism are more fit, i.e., leave more progeny.

Selection over so short a time, while apparently not common, has been demonstrated in Darwin’s finches and guppies (Gibbs and Grant 1987, Reznick et al. 1990, Weiner 1995). Smith et al. (1995) described selection in response to altered food sources within the past century affecting bill length in the liwi (Vestiaria coccinea). That a shift toward earlier gnatcatcher nesting is a selective response is difficult to corroborate, although predicting such a response is reasonable given that lower nesting success of some hosts is correlated with synchronous laying of host and cowbird eggs (McGeen 1971). As noted above, egg collectors could unwittingly but substantially bias data they gathered, but it seems unlikely that bias toward collecting early-season egg sets would take place only after 1920. Data sets both before and after 1920 are close to equal in size, so we doubt that sample sizes are responsible for the apparent pattern in post-1920 data. Egg-set data for other species nesting in cismontane southern California could test this hypothesis, with both common hosts such as the Song Sparrow (Melospiza melodia), where the same pattern would be predicted, and uncommon hosts such as the Wrentit (Chamaea fasciata), where the pattern would not be predicted.

It is impossible to prove, from available information, whether the proximate cause of the earlier mean nesting date is earlier nest initiation, a decrease in the incidence of multiple brooding, or both. We favor the first possibility, as currently the gnatcatcher’s nesting season is at least as long as it was earlier this century. In either case, but particularly if fewer birds are attempting multiple brooding, other ultimate causes are possible, especially a decrease in resource quality or availability (e.g., habitat degradation). Such a decrease might cause fewer nesting attempts per season or could even affect the seasonality of nest predation through its effects on other species or on vegetative cover.

SUMMARY

We used virtually all available nest cards for the California Gnatcatcher \((n = 112)\) to analyze historical patterns of its nesting schedule and clutch size. Year of collection ranged from 1883 to 1959, with the majority from 1885 to 1940. Mean clutch size was 3.85, with a mode of four. Clutch-completion dates extended from 23 March to 26 June, with a mean of 5 May. The mean clutch-completion date has become progressively earlier, particularly since 1920. This shift corresponds to the appearance of the brood-parasitic Brown-headed Cowbird within the range of the gnatcatcher.

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HAS BROOD PARASITISM SELECTED FOR EARLIER NESTING?


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BREEDING BEHAVIOR OF THE CALIFORNIA GNATCATCHER IN SOUTHWESTERN SAN DIEGO COUNTY, CALIFORNIA

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We intensively studied various aspects of habitat use, breeding biology, home-range requirements and dispersal patterns of a population of the California Gnatcatcher (Polioptila californica) in southwestern San Diego County from 1989 to 1992. When this field effort was initiated, few quantitative demographic studies of the species were available to aid in making informed decisions regarding the conservation and management of this species (Atwood 1993). In this paper, we detail our observations of the gnatcatcher’s breeding behavior and nesting success. Other analyses are reported in several companion papers (Preston et al. 1998a, b, Bailey and Mock 1998).

METHODS

We studied California Gnatcatchers on approximately 842 ha of coastal sage scrub near the Sweetwater River in the unincorporated community of Rancho San Diego in southwestern San Diego County (32° 40' N, 117° W). Rancho San Diego is approximately 21 km from the Pacific coast and 21 km north of the United States–Mexico border. Elevation varies from 92 to 366 m above mean sea level. The slope gradient varies widely, from flat river floodplain to slopes greater than 50%. There were two primary study areas within 3 km of each other. We collected data on breeding biology at the larger study area (1200 ha) from 1989 to 1991, from the second smaller, more easterly study area (111 ha) from 1989 to 1992. Over half of the smaller study area was graded for development in the fall of 1989, eliminating the gnatcatchers from most of the shallow slopes that previously supported them.

We banded 318 California Gnatcatchers from 1988 to 1992. Of these, 218 were adults, juveniles, or fledglings caught in mist nets and 100 were nestlings from 33 nests. Birds were banded with unique combinations of a single USFWS metal band and one or two plastic color bands. The seams of the color bands were sealed with acetone to prevent them from opening. The smallest color bands commercially available (AC Hughes size XF) are slightly too large for gnatcatchers. After some initial problems with band slippage, especially in very young birds, we reduced the band size slightly according to the procedure described by Thomas (1983). No further problems were noted.

Most nests (75%) were found while they were being built. Territories of color-banded gnatcatchers were visited two to three times each week during
the breeding season. Nest checks were conducted so as to minimize nest predation associated with the observer (Martin and Geupel 1993). Nest checks were infrequent and timed to determine nesting stage (e.g., eggs laid or eggs hatching) and when nestlings were of an age suitable for banding. We determined the fate of each nest found. Mayfield estimates of daily nest survival were calculated for the different phases of the nesting cycle for each year and for the entire study period (Mayfield 1961, 1975).

After each nest attempt was completed, we recorded the species of plant in which the nest was located, measured the dimensions of each nest (depth and width of the inner cup, length and width of the entire nest, distance from the nest to the nearest opening in the host plant, distance from the ground to the nest rim), and height, width, breadth of the host plant. We measured the distances from the host plant to the nearest neighboring shrubs on the east, west, north, and south. Nest locations were plotted on a topographic map, then digitized into a geographic-information system (GIS) from which percent slope was determined for each nest location.

We observed behavior at the nest with binoculars from a distance of at least 10 m. We defined rounds of nest building as periods of work broken by intervals of less than 10 minutes. The number of trips made to the nest by each member of the pair was recorded. We defined a shift of incubation or brooding as the complete interval that an individual spent on the nest. We always determined the duration of incubation shifts for pairs of consecutive shifts between which the sexes exchanged roles. Observations of nesting behavior were usually made for periods lasting 1 hour or more. The number of trips to feed nestlings was recorded for each parent. Postfledging young were considered fledglings until they left their natal territory, juveniles thereafter. Parental care of fledglings was documented for all intensively monitored pairs. We recorded the date when juveniles immigrating into the study area established territories and banded these birds shortly after their initial detection.

We sampled vegetation structure and composition within gnatcatcher territories by means of 130 belt transects of 60 m². Each transect sampled an area 30 m long and 2 m wide. At least three transects were positioned within a territory, but larger territories often had additional transects. Transects were placed within each territory to sample representative vegetation within the territory. Each transect paralleled the vertical aspect of the slope. Information recorded included species, height, width, and length of each shrub rooted within the belt. Area of each shrub was calculated as if it were an ellipse \([0.5 \text{ length}] \times [0.5 \text{ width}] \times \pi\). Relative cover of each species was calculated as (total area for a species/total area of all species) \times 100\%.

Daily temperature and precipitation records from 1988 through 1992 from one of the study sites and approximately 8 km away in La Mesa were obtained from the San Diego County Department of Flood Control.

All descriptive statistics are expressed as the mean ± standard error (SE) and sample size (n). Statistical tests for preferences in nest-site selection relative to percent slope and host-plant species followed Bonferroni’s inequality test described by Neu et al. (1974). Comparisons between unsuccessful and successful nests are made with a t test or Z test for
proportions with continuity correction (Zar 1984). We did chi-squared analyses for the Mayfield nest-survival estimates to test for differences between years and nesting stages, as well as initial survival of dependent juvenile gnatcatchers. The level of significance for all statistical tests was set at $\alpha = 0.05$.

RESULTS

Nest Placement and Nest Sites

We documented 134 nesting attempts over four breeding seasons (1989–1992). Of these nest attempts, 101 (75.4%) were detected during nest building or egg laying, 18 (13.4%) during incubation, 7 (5.2%) with nestlings, and 8 (6.0%) post-fledging. California Gnatcatcher nests are built from grasses and various bark fibers. The cup is lined with fine grasses, fur, feathers, and downy flower parts such as those of *Baccharis sarothroides*. Nest measurements were not obtained from all nests studied because often predators destroyed nests or gnatcatchers took material from old nests to build subsequent nests. Dimensions of intact nests (in cm; mean ± SE): outer length 6.8 ± 0.22 (n = 57); cup depth 3.6 ± 0.07 (n = 67); outer diameter 6.2 ± 0.07 (n = 74); inner-cup diameter 3.8 ± 0.07 (n = 62).

Within a breeding season, patterns of nest dispersion within a pair's territory varied. Some pairs clumped nesting attempts within a small area of their territory, often associated with a drainage, whereas other pairs distributed nests widely throughout their entire territory. Nest placement within the host shrub ranged from 30 to 292 cm above the ground (mean 82.1 ± 2.9 cm, n = 101). Nests were placed within the shrub an average of 16.4 ± 1.4 cm (n = 75) from the nearest outside edge of the shrub. The mean height of shrubs supporting gnatcatcher nests was 135 ± 3.6 cm (n = 103), and the diameter of host shrubs averaged 197 ± 11.7 cm (n = 73). Mean distances between the nest shrub and neighboring shrubs ranged from 153 to 176 cm, indicating that the surroundings of the nest shrub could be characterized as relatively open sage scrub. Plant species were selected for nest support as a function of their relative availability (Table 1). There was no significant preference or avoidance of any plant species for nesting relative to its dominance within the study areas (Neu test of proportions, $P > 0.05$). The smaller study area supported less cover of *Artemisia* and *Malosma* and more *Viguiera* and *Baccharis* than the larger study area (Table 1).

Nesting Behavior and Phenology

Both male and female gnatcatchers participated in all stages of the nesting cycle, although each sex allocates its effort differently (Figure 1). Males selected the nest site and did most of the nest building and nestling feeding, while females spent more time incubating eggs and brooding nestlings. The time spent during each stage of the cycle was documented for 23 pairs monitored through the entire breeding season (Figure 2). The birds nested persistently and were involved in some aspect of the breeding cycle for most of the breeding season.
Table 1 Plant Species Supporting California Gnatcatcher Nests and Relative Plant Dominance at Rancho San Diego

<table>
<thead>
<tr>
<th>Plant species</th>
<th>Area 1</th>
<th>Area 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Relative dominance (mean ± SE)</td>
<td>% Nests (n = 84)</td>
</tr>
<tr>
<td>Artemisia californica, California sagebrush</td>
<td>37.6 ± 2.3</td>
<td>35.7</td>
</tr>
<tr>
<td>Eriogonum fasciculatum, Flat-top buckwheat</td>
<td>28.4 ± 2.4</td>
<td>30.9</td>
</tr>
<tr>
<td>Malosma laurina, Laurel sumac</td>
<td>15.7 ± 1.9</td>
<td>10.7</td>
</tr>
<tr>
<td>Rhamnus crocea, Redberry</td>
<td>2.6 ± 0.5</td>
<td>4.8</td>
</tr>
<tr>
<td>Baccharis sarothroides, Broom baccharis</td>
<td>0.6 ± 0.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Gutierrezia californica, California matchweed</td>
<td>0.6 ± 0.1</td>
<td>0</td>
</tr>
<tr>
<td>Viguiera laciniata, San Diego sunflower</td>
<td>a</td>
<td>1.2</td>
</tr>
<tr>
<td>Salvia apiana, White sage</td>
<td>a</td>
<td>7.1</td>
</tr>
<tr>
<td>Brickellia californica, California brickellbush</td>
<td>a</td>
<td>0</td>
</tr>
<tr>
<td>Adolphia californica, California spinebush</td>
<td>a</td>
<td>2.4</td>
</tr>
<tr>
<td>Simmondsia chinensis, Jojoba</td>
<td>a</td>
<td>2.4</td>
</tr>
<tr>
<td>Hazardia squarrosa, Sawtooth goldenbush</td>
<td>a</td>
<td>1.2</td>
</tr>
<tr>
<td>Adenostoma fasciculatum, Chamise</td>
<td>a</td>
<td>1.2</td>
</tr>
<tr>
<td>Xylococcus bicolor, Mission manzanita</td>
<td>a</td>
<td>1.2</td>
</tr>
</tbody>
</table>

*Relative dominance less than 0.6 for area 1 and less than 4.5 for area 2.

Figure 1. Allocation of effort by sex at each stage of the breeding cycle of the California Gnatcatcher.
Nest Building

California Gnatcatchers began to molt into breeding plumage in February (Figure 3). The timing of the appearance of the males’ black caps varied from year to year and appeared to depend on the amount and timing of winter precipitation. Over the four years studied, the molt began six to seven weeks after the first significant rain (>12 mm) in December. Nest building began two to four weeks after apparent completion of the molt. Nesting attempts were usually initiated between early March and mid-June with the largest number of nests started in April and May. The length of the breeding season from earliest nest building to the latest fledging (excluding the postfledging period) ranged from 102 (1990) to 173 days (1991; mean 121.3 ± 17.3 days, n = 4 years).

Male gnatcatchers appeared to select the nest site and have the dominant role in nest construction. Frequently, while a pair was foraging together, the male abruptly stopped foraging and flew to a shrub that was later used as a new nest site. The male vocalized persistently until the female joined him. The male began bringing nesting material to the site and formed the nest disc in a fork of the shrub. During the female’s first few visits to the nest site.
she did not bring in any nesting material but eventually began providing material and shaping the cup. The male allocated more time to nest building than did the female at all stages of nest construction except for lining the nest (Figure 4). The average number of nest visits per hour during nest building was 22.7 ± 2.3 for males and 12.7 ± 1.4 for females (paired t test: \( P = 0.001, n = 9 \) pairs).

Gnatcatchers often raised more than one brood. Early and late in the breeding season initiation of nest building often did not lead to egg laying. The average number of nesting attempts per pair per breeding season ranged from 3.3 to 7.3 (\( n = 4 \) seasons); one pair attempted to nest 10 times within a single breeding season in 1992 (Table 2). The number of nesting attempts in 1992 was higher than in the other three years (7.3 vs. 4.0–4.7 attempts per pair). A nest can be constructed in as few as 4 days, but the length of time between nest initiation and egg laying decreased as the season progressed. Although the nest appeared complete after 5 or 6 days, the female, and occasionally the male, visited the nest regularly to supplement the lining. For nests initiated in March, the interval between nest initiation and laying of the first egg averaged 10.9 days (± 0.69, \( n = 12 \)). Nests initiated in April required an average of 7.0 ± 0.25 days (\( n = 11 \)), those in May or June, 5.2 ± 0.19 days (\( n = 14 \)). In an unusual case in 1990, a pair spent 30 days building their first nest of the season before finally laying. Several March rain storms washed away neighbors’ nests, but this pair’s nest survived undamaged.

Egg Laying

The first clutches were initiated in late March (earliest date: 22 March 1989; Figure 3). Egg laying appeared to be delayed in wetter years when a
number of early nests were destroyed by rain storms. Initiation of the last clutch of the season varied more from year to year, with egg laying ceasing from late May in 1992 to late July in 1991.

California Gnatcatchers typically lay clutches of three or four eggs (mean clutch size $3.61 \pm 0.06$, $n = 69$). Clutch size varied significantly by year and may have been influenced by precipitation. In 1989, the fourth year of a drought, only 38% of the clutches contained four eggs ($n = 24$). In the following three years more rain fell and an average of 74% of the nests contained four eggs ($n = 45$ clutches). No complete clutches had less than three eggs. One five-egg clutch was the result of partial predation of a four-egg clutch, followed by laying of three-egg replacement clutch in the same nest. This was the only observed instance of partial predation followed by additional laying. The average number of eggs laid per female in one breeding season was $8.8 \pm 0.55$ ($n = 23$), the maximum 15.

Incubation

Gnatcatchers begin incubation with the penultimate egg, and eggs hatch after 14 days (mean incubation period $14.3 \pm 0.13$ days, $n = 25$). Both
### Table 2 California Gnatcatcher Breeding Success at Rancho San Diego, 1989–1992

<table>
<thead>
<tr>
<th></th>
<th>1989</th>
<th>1990</th>
<th>1991</th>
<th>1992</th>
<th>All years combined</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Percentage of pairs successful</strong></td>
<td>70.8%</td>
<td>59.1%</td>
<td>100.0%</td>
<td>60.0%</td>
<td>70.0%</td>
</tr>
<tr>
<td></td>
<td>(24)</td>
<td>(22)</td>
<td>(9)</td>
<td>(5)</td>
<td>(60)</td>
</tr>
<tr>
<td><strong>Number of nests built per pair per complete season</strong></td>
<td>3.25 ± 0.62</td>
<td>3.5 ± 0.60</td>
<td>4.3 ± 0.60</td>
<td>7.3 ± 1.8</td>
<td>4.2 ± 0.84</td>
</tr>
<tr>
<td></td>
<td>(8)</td>
<td>(6)</td>
<td>(7)</td>
<td>(4)</td>
<td>(25)</td>
</tr>
<tr>
<td><strong>Number of eggs per complete clutch</strong></td>
<td>3.38 ± 0.10</td>
<td>3.72 ± 0.11</td>
<td>3.67 ± 0.13</td>
<td>3.83 ± 0.11</td>
<td>3.61 ± 0.06</td>
</tr>
<tr>
<td></td>
<td>(24)</td>
<td>(18)</td>
<td>(15)</td>
<td>(12)</td>
<td>(69)</td>
</tr>
<tr>
<td><strong>Hatching rate (%)</strong></td>
<td>61.1%</td>
<td>72.7%</td>
<td>75.0%</td>
<td>31.0%</td>
<td>62.0%</td>
</tr>
<tr>
<td><strong>No. eggs hatched/no. laid</strong></td>
<td>52/85</td>
<td>48/66</td>
<td>39/52</td>
<td>13/42</td>
<td>152/245</td>
</tr>
<tr>
<td><strong>Number of fledglings per successful pair</strong></td>
<td>2.9 ± 0.14</td>
<td>2.8 ± 0.41</td>
<td>4.4 ± 1.16</td>
<td>2.7 ± 0.88</td>
<td>3.5 ± 0.20</td>
</tr>
<tr>
<td></td>
<td>(17)</td>
<td>(13)</td>
<td>(8)</td>
<td>(3)</td>
<td>(41)</td>
</tr>
<tr>
<td><strong>Fledging rate (%)</strong></td>
<td>76.9%</td>
<td>64.6%</td>
<td>97.4%</td>
<td>53.8%</td>
<td>76.3%</td>
</tr>
<tr>
<td><strong>No. fledged/no. hatched</strong></td>
<td>40/52</td>
<td>31/48</td>
<td>38/39</td>
<td>7/13</td>
<td>116/152</td>
</tr>
<tr>
<td><strong>Percentage of successful pairs attempting a second brood</strong></td>
<td>50.0%</td>
<td>57.1%</td>
<td>55.6%</td>
<td>33.3%</td>
<td>51.9%</td>
</tr>
<tr>
<td></td>
<td>(8)</td>
<td>(7)</td>
<td>(9)</td>
<td>(3)</td>
<td>(27)</td>
</tr>
<tr>
<td><strong>Percentage of successful pairs raising multiple broods</strong></td>
<td>25.0%</td>
<td>28.6%</td>
<td>22.2%</td>
<td>33.3%</td>
<td>25.9%</td>
</tr>
<tr>
<td></td>
<td>(8)</td>
<td>(7)</td>
<td>(9)</td>
<td>(3)</td>
<td>(27)</td>
</tr>
<tr>
<td><strong>Estimated number of fledglings per pair</strong></td>
<td>2.1</td>
<td>1.6</td>
<td>4.4</td>
<td>1.6</td>
<td>2.4</td>
</tr>
</tbody>
</table>

---

aFigures are means plus or minus standard error, with sample size (n) in parentheses.

bIncludes only pairs that survived through July and all of whose unsuccessful nests were believed to have been located.

cAssumes no successful nests went undetected, so estimate is conservative (potential underestimate).
members of the pair incubated, the female longer (Figure 1). The average duration of an incubation shift was 35.9 ± 2.4 minutes for females and 22.8 ± 1.4 minutes for males (paired t test, \( P < 0.001, n = 46 \) paired comparisons). Females appeared to control the duration of the incubation shift. Males would approach the nest several times before females relinquished their position, whereas males invariably vacated the nest as soon as the female approached. We did not attempt to observe incubation behavior at night; however, Woods (1928) and C. Reynolds (pers. comm.) reported that females are on the nest then.

Nestlings

Nestlings remained in the nest 10 to 15 days (mean 13.3 ± 0.29 days, \( n = 23 \) nests). Table 3 details development of nestlings. For the first 4 days following hatching, the pair brooded the nest nearly continuously. Brooding decreased as the nestlings became better insulated and required more

<table>
<thead>
<tr>
<th>Age</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>Nestlings are tiny (egg sized). Body is pink and “skinny.” The head is dark, eyes are closed.</td>
</tr>
<tr>
<td>Day 2</td>
<td>Nestlings are slightly plumper and darker. They hold their heads up and open their mouths when the nest moves. There are small bumps along the edges of the wings where primaries and secondaries will come in.</td>
</tr>
<tr>
<td>Day 3</td>
<td>Body is becoming darker. Pin-feather nubs are visible on the back. No nubs are visible on top of the head. Pin feathers are emerging on edges of the wings. Eyes are still closed.</td>
</tr>
<tr>
<td>Day 4</td>
<td>Pin feathers are visible in rows on head and body.</td>
</tr>
<tr>
<td>Day 5</td>
<td>Pin feathers have elongated; pink skin is visible between rows. Eyes are still closed.</td>
</tr>
<tr>
<td>Day 6</td>
<td>Eyes are open. Pin feathers are beginning to cover large areas of the back.</td>
</tr>
<tr>
<td>Day 7</td>
<td>Rows of pin feathers are visible on the top of the head. Feathers on the body are in sheaths and bare skin shows between the rows.</td>
</tr>
<tr>
<td>Day 8</td>
<td>All feathers are still in sheaths. The tail is about 6 mm long. Birds may be banded at this age with cut-down bands. Nestlings chirp when handled.</td>
</tr>
<tr>
<td>Day 9</td>
<td>The tips of the primaries and the body feathers are unsheathed. The head looks feathered. Banding is optimum today. Birds return easily to nest.</td>
</tr>
<tr>
<td>Day 10</td>
<td>All feathers are losing sheaths; 50–75% are out of sheaths. The body is beginning to look downy. Not much bare skin shows, except ventrally. Broods of four are not easily returned to the nest; the last bird replaced often will not stay in nest and may induce others to fledge.</td>
</tr>
<tr>
<td>Day 11</td>
<td>All feathers are out of sheaths. Nestlings have short tails and a yellow gape. They hop out of the nest if disturbed and do not stay in the nest if replaced.</td>
</tr>
<tr>
<td>Day 12</td>
<td>Nestlings hop out of the nest if approached. They do not stay in nest if replaced. Survival as fledglings at this age is very good. The main problem with banding at this age is that it is very difficult to handle the birds. They pop out and escape before a hand can be placed over the nest.</td>
</tr>
<tr>
<td>Day 13</td>
<td>If approached, the nestlings hop out of the nest and fly a short distance.</td>
</tr>
<tr>
<td>Day 14</td>
<td>If the nest is approached, the nestlings fly out, with initial unrehearsed flights of over 10 feet.</td>
</tr>
</tbody>
</table>
frequent feeding. Nestlings were brooded 89% of the time for the first two
days, 66% of the time by day 7, and not brooded at all by day 11 (n = 31
hours of observation of 9 pairs). Females brooded more than males (60.7% versus 39.3% of the total brooding time; Figure 1), a division of labor similar
to that observed during the incubation period.

Both males and females fed the nestlings, but males brought food more
frequently. In 34 hours of observation of 9 pairs, we found that the male
made 62.2% of the trips to the nest, the female 37.8% (Figure 1). Nestling-
feeding rates increased with nestling age (Figure 5). When the female was
brooding, males often brought food to the nest, gave it to the female, and
she fed the nestlings. Females were never observed bringing food to
brooding males. We did not document the type of food the parents brought
but did observe that the size of prey increased as the young grew. Initially the
parents brought food so small that it was barely visible in their beaks. Older
young were fed larger insects and caterpillars; these were consumed whole.

Fledglings

Parents cared for fledglings for 21 to 35 days (mean 24.5 ± 1.0, n = 21
broods) after fledging before excluding them from their territory. During the
first week the brood stayed close together, often lined up next to each other
on a single branch near the nest. They flew short distances toward the
parents if called. During the second week, fledglings begged for food more
loudly and occasionally flew toward an approaching parent. They still
remained close to their siblings, usually perched in the same bush. They did
not appear to feed themselves, but searching behavior was emerging. By the second week, fledglings began to mew when separated from the family group, but the majority of their vocalizations were begging notes. By the third week out of the nest, fledglings began to feed themselves, although they continued to beg for food from their parents. The family ranged widely in the parents’ territory. By the end of the third week, the family groups spent much of their time at the boundaries of their territory, and by the end of the fourth week, parents chased their fledglings out of the territory, scolding at them and clicking their bills. The length of the fledgling period was dependent on whether the pair initiated another nesting attempt. Early in the breeding season, the parents typically began a subsequent nest within three weeks after the first brood fledged. They continued to feed the fledglings during the early stages of the new nest, but the fledglings were generally expelled from the territory by the fourth week. At the end of the season, however, fledglings remained in the parents’ territory for up to five weeks.

We determined the interval between nest attempts in 40 instances. For 29 pairs whose nest was destroyed before young were fledged, a new nest was begun within one day following the destruction. For pairs nesting successfully, the timing of a second nesting attempt depended on the number of young fledged. For two pairs successfully fledging four young, a new nest was begun an average of 20.5 ± 0.05 days after the first nest. The next nest was begun 16 days later for both pairs that fledged three young. The six pairs fledging two young began new nests an average of 12.8 ± 1.14 days later.

In one case, we monitored a pair that fledged only one young from a partially depredated nest. This pair began a new nest only six days later. They fed the fledgling while nest-building, even allowing it to sit in the same bush as the new nest. During egg laying and incubation it was kept some distance away and the male alone fed it. It was not excluded from the parent’s territory until the new clutch hatched. Parents with a larger number of fledglings often flew great distances between the new nest and the first fledglings. In all cases, the first young were excluded from the territory by the time the subsequent clutch hatched.

Of 77 fledglings from 25 closely monitored nests, the greatest mortality (13%) occurred in the first week after fledging. About 79% of these fledglings survived for three weeks and became independent. During the first three weeks of the fledgling period larger broods were more susceptible to mortality than smaller broods ($\chi^2 = 6.04$, df = 2, $P = 0.049$). For broods with one or two fledglings, survival to three weeks of age was 94.1% ($n = 17$ fledglings from 11 broods). Broods with three fledglings had a survivorship of 88.9% ($n = 27$ fledglings from 9 broods). The remaining broods had four fledglings, and half of these experienced some mortality, for a survival rate of 71.2% ($n = 52$ fledglings from 13 broods).

Nesting Success

Average annual breeding success ranged from 1.6 to 4.4 fledglings per pair over four seasons (Table 2). About 70% of the 60 pairs monitored raised at least one fledgling each season (range 60–100%). Over half of the successful pairs attempted to raise more than one brood, and a quarter of
these fledged two broods; one pair raised three broods. About 33.6% of 134 nesting attempts with known outcomes produced fledglings (Figure 6). Approximately 43% of these nests failed because of predation, while 12% were abandoned, most prior to completion of the nest and before egg laying. Predation varied from 31% in 1991 to 50% in 1989. Seven clutches suffered partial predation, and four of these the pair continued to incubate. During the nestling stage three nests suffered partial predation, but all of these eventually fledged at least one young.

From the condition of the nest and its contents following predation, we attempted to categorize the likely predator (Best and Stauffer 1980). Nests left intact were most likely the victims of snakes or small rodents, whereas nests completely torn apart were more likely attacked by larger mammalian predators. Snakes swallow eggs whole and are therefore less likely to leave broken shells in or near the nest as may rodents or predatory birds. Nests with linings slightly pulled up and nests with punctured eggs may have been disturbed by avian predators. We also observed instances of mice taking over gnatcatcher nests and filling them with their own nesting material.

On the basis of these criteria, we believe snakes were the most common predator (32.8%; Figure 7). We observed snakes to be abundant and diverse in the study area [e.g., California whipsnake (Masticophis lateralis), gopher snake (Pituophis melanoleucus), and common kingsnake (Lampropeltis getulus)], as is typical in coastal sage scrub (T. Case pers comm.). The second important group of likely predators was mid-sized mammals (29.3%), including the California ground squirrel (Spermophilus beecheyi), opossum (Didelphis virginiana), raccoon (Procyon lotor), coyote (Canis latrans),

![Figure 6. Fates of California Gnatcatcher nests at Rancho San Diego, 1989–1992; n = 134 nests.](image-url)
gray fox (*Urocyon cinereoargenteus*), and bobcat (*Lynx rufus*). There were numerous potential avian predators [e.g., Western Scrub Jay (*Aphelocoma californica*) and Greater Roadrunner (*Geococcyx californianus*)], which appeared to account for at least 20% of the nest predation.

Brown-headed Cowbirds (*Molothrus ater*) parasitized three nests of two adjacent pairs in 1991. In one parasitized nest, the gnatcatcher eggs failed to hatch and the pair reared the cowbird to fledgling size before we removed it. The second parasitized nest failed because of predation, and the third was successful after we removed the cowbird egg during early incubation. During the four years of the study, cowbirds were trapped along the nearby Sweetwater River, which may have minimized cowbird parasitism of gnatcatcher nests. All three incidents of cowbird parasitism occurred in 1991, when gnatcatchers laid later in the summer than in other years.

We calculated Mayfield estimates for daily survival during each stage of the nest cycle for each year and for the entire study (Table 4). We calculated nest survival with and without the nest-building phase included (Table 5). There was significant annual variation in nest success ($\chi^2 = 29.1, \text{ df} = 3, P < 0.001$). Nest survival was highest in 1989 and 1991, particularly low in 1992 if nest building is included in the estimate. Nest survival also varied significantly with stage of the nesting cycle ($\chi^2 = 30.9, \text{ df} = 3, P < 0.001$). Nest failure was highest during nest building. Although the daily survival rate during egg laying was relatively low, this phase lasted only two days, making the overall survivorship during egg laying relatively high in comparison to the
Table 4 Estimated Daily Survival Rates of California Gnatcatcher Nests at Rancho San Diego, 1989-1992

<table>
<thead>
<tr>
<th>Year</th>
<th>Nest building</th>
<th>Egg laying</th>
<th>Incubation</th>
<th>Nestling</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>0.907 ± 0.028</td>
<td>0.909 ± 0.061</td>
<td>0.970 ± 0.012</td>
<td>0.981 ± 0.011</td>
</tr>
<tr>
<td>1990</td>
<td>0.943 ± 0.021</td>
<td>0.963 ± 0.036</td>
<td>0.942 ± 0.017</td>
<td>0.963 ± 0.018</td>
</tr>
<tr>
<td>1991</td>
<td>0.917 ± 0.024</td>
<td>0.842 ± 0.083</td>
<td>0.973 ± 0.012</td>
<td>1.000 ± 0.083</td>
</tr>
<tr>
<td>1992</td>
<td>0.841 ± 0.034</td>
<td>1.000 ± 0.258</td>
<td>0.938 ± 0.023</td>
<td>0.963 ± 0.026</td>
</tr>
<tr>
<td>All years</td>
<td>0.903 ± 0.014</td>
<td>0.928 ± 0.028</td>
<td>0.957 ± 0.008</td>
<td>0.981 ± 0.006</td>
</tr>
</tbody>
</table>

*Mean plus or minus standard error.

incubation (14 days) and nestling (13 days) phases. Daily survival during incubation was substantially lower than during the nestling stage.

One third of the nests produced at least one fledgling (Figure 6). Of the 89 nests that failed, 52% were lost during the nest-building stage, primarily because of rain damage and abandonment. Failure after egg laying we attributed largely to predation, occasionally to infertility, death or injury of adults, trampling, or cowbird parasitism. Over 31% of failed nests were lost during the incubation stage, 10% during the nestling stage, and 7% during egg laying. Nest abandonment prior to egg laying was frequent (11% of all nesting attempts) and tended to occur early and late in the season. About 50% of the abandoned nests were observed in 1992, the year with 120% of normal rainfall. In addition to abandoned nests, we also found five nests with visible rain damage early in the 1992 breeding season. Abandonment in 1992 was also attributable to a truncated laying season, ending in late May. Nest building continued into the third week of June 1992, but no eggs were laid.

Nests initiated in May were significantly more likely to be successful than those begun in February or March, and nests started in February were significantly less likely to be successful than those initiated in April (P < 0.05, Z test for proportions, n = 133 nests; Figure 8). Over 80% of all successful

Table 5 Probability of a California Gnatcatcher Nest Surviving Each Stage of the Nesting Cycle at Rancho San Diego, 1989-1992

<table>
<thead>
<tr>
<th>Year</th>
<th>Nest building</th>
<th>Egg laying</th>
<th>Incubation</th>
<th>Nestling</th>
<th>Nest building to fledging</th>
<th>Egg laying to fledging</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>0.555</td>
<td>0.826</td>
<td>0.657</td>
<td>0.784</td>
<td>0.235</td>
<td>0.433</td>
</tr>
<tr>
<td>1990</td>
<td>0.701</td>
<td>0.927</td>
<td>0.434</td>
<td>0.612</td>
<td>0.171</td>
<td>0.231</td>
</tr>
<tr>
<td>1991</td>
<td>0.593</td>
<td>0.709</td>
<td>0.680</td>
<td>1.000</td>
<td>0.233</td>
<td>0.516</td>
</tr>
<tr>
<td>1992</td>
<td>0.369</td>
<td>1.000</td>
<td>0.408</td>
<td>0.612</td>
<td>0.034</td>
<td>0.230</td>
</tr>
<tr>
<td>All years</td>
<td>0.542</td>
<td>0.861</td>
<td>0.541</td>
<td>0.777</td>
<td>0.155</td>
<td>0.348</td>
</tr>
</tbody>
</table>
nesting attempts were completed in May and June. Cause of nest failure varied by month. All losses of nests due to rain \((n = 8)\) occurred in March. Predation was highest during May \((34.6\%)\) of all depredated nests, followed by April \((29.1\%)\), June \((21.8\%)\), March \((10.9\%)\), and July \((3.6\%)\). Over 36% of abandoned nests were deserted in June, 28.6% of nests in March, and 28.6% in April.

Although California Gnatcatchers apparently did not prefer nesting in any particular shrub species \((\text{Neu test of proportions, } P > 0.05; \text{ Table 1})\), the species of nest-host plant appeared to influence nest success \((\text{Figure 9})\). Nests in California sagebrush \((\text{Artemisia californica})\) were significantly more likely to be successful than those in flat-topped buckwheat \((\text{Eriogonum fasciculatum})\) or San Diego sunflower \((\text{Viguiera laciniata})\) \((P < 0.05, \text{ two-tailed } Z \text{ test for proportions with continuity correction})\). Nests placed in relatively scarce shrubs \((\text{e.g., Baccharis sarothroides, Rhamnus crocea, and Brickellia californica})\) were significantly more likely to be successful than nests in San Diego sunflower.

The height or diameter of the nest shrub did not significantly influence nest success. The placement of the nest within the shrub, however, did, in that nests placed at an intermediate height from the ground were more likely to be successful. The success of nests less than 70 cm above the ground \((20.7\%, n = 29)\) was significantly lower \((P < 0.02, \text{ } Z \text{ test for proportions})\) than that of nests 70 to 90 cm high \((45.0\%, n = 40)\). The success of nests
CALIFORNIA GNATCATCHER BREEDING BEHAVIOR

Figure 9. California Gnatcatcher nesting success by host-plant species; \( n = 130 \) nests. Comparisons lacking common letter are statistically different (Z test, \( P < 0.05 \)). ARCA, Artemisia californica; ERFA, Eriogonum fasciculatum; MALA, Malosma laurina; SAAP, Salvia apiana; VILA, Viguiera laciniata.

placed higher than 90 cm from the ground did not vary significantly from that of lower nests (28.1%, \( n = 32 \)).

Although California Gnatcatchers showed no significant preference for nesting on steeper or shallower slopes, slope had a significant influence on nesting success. Nests were more likely to be successful on shallow slopes (<19.9% slope) than on steeper slopes (\( P < 0.05 \), Z test for proportions).

DISCUSSION

Nesting Behavior

The California Gnatcatcher is a very persistent nest builder, with up to 10 nesting attempts within a breeding season. Nearly 70% of the pairs monitored successfully produced fledglings each season. About a quarter of the breeding pairs raised two or more broods, although annual variation in the environment, such as drought in 1989 and 1990, is a likely key factor limiting multiple brooding. Unlike many temperate-zone passerines, the California Gnatcatcher has a relatively long nesting season. In 1991 the first nest building was observed on 6 March, the latest nest fledging young on 25 August. Fledglings remained in their natal territory and were dependent on their parents well into September. Woods (1928) and Patten and Campbell (1994) have also reported late-nesting gnatcatchers.
High rates of nest failure account for the high number of nesting attempts by the California Gnatcatcher. It appears to be more persistent in renesting than ecologically similar species in shrubby habitats (Ellison 1998). The Blue-gray Gnatcatcher (*Polioptila caerulea*) may make up to seven nesting attempts and raise up to two broods per season (Root 1969). The ecologically similar Wrentit (*Chamaea fasciata*) makes fewer nesting attempts (up to four), but a similar proportion (20%) of pairs successfully raise two broods (Geupel and DeSante 1990). The differences in renesting effort between the gnatcatchers and Wrentit could be due to the Wrentit's slightly longer nesting period and relatively long dependent-fledgling period (up to 70 days; Erickson 1938, Geupel and DeSante 1990). In addition, the Wrentit studies were conducted in northern California, where the species' reproductive effort could differ from that farther south.

Male California Gnatcatchers participate more in all phases of the nesting cycle (Figure 1) than do many other male passerines, especially in nest building and feeding of young (Silver et al. 1985, Møller 1986). The Blue-gray Gnatcatcher and Wrentit resemble the California Gnatcatcher in the male's providing substantial assistance to the female in nest building, incubation, brooding, and feeding of young (Root 1969, Geupel and DeSante 1990, Ellison 1996). The male Blue-gray, like the male California, often chooses potential nest sites, initiates nest construction, and engages in substantial nest building, especially in renesting attempts, whereas female gnatcatchers of both species are typically responsible for adding the lining and final shaping of the nest cup (Root 1969, Ellison 1996).

Nest Success

Like ours, other studies have shown substantial variation from year to year and from site to site in the California Gnatcatcher's reproductive output. Annual reproductive success in our study ranged from 1.6 to 4.4 fledglings per pair. On the Palos Verdes Peninsula, Los Angeles County, the corresponding range was 2.3–3.9 fledglings per pair (Atwood et al. 1998), in Orange County, 3.4–5.7 (Woehler et al. 1995). From one-year studies, Andros and Schroeder (1995) and Galvin (1998) each reported 2.4 fledglings per pair. Atwood et al. (1998) reported average breeding productivity ranging from 2.3 to 2.6 in Orange County. P. Galvin (pers. comm.) reported annual production exceeding 5.3 fledglings per pair for two consecutive years on his Orange County plot. In Riverside County, the average number of fledglings per pair was 1.9 over 3 years (Braden et al. 1997b).

Notably, the two studies located well away from the coast—Rancho San Diego (this study) and Riverside County (Braden et al. 1997b)—measured the lowest annual productivity (less than two fledglings per pair in some years). Mock (1998) postulated a coastal vs. interior dichotomy in habitat quality and population density due to the difference in climate. Coastal areas are influenced by the more favorable maritime conditions, which presumably allow for higher population densities and productivity. This study and Bontrager (1991) are the only available data gathered during extended drought, highlighting the sensitivity of the California Gnatcatcher's breeding success and survival to weather variations (Mock 1998).
Causes of Nest Failure

Predation was the most common cause of nest failure in our study (Figure 6), responsible for the loss of 43.3% of all nests (range 31-50% each year), a level in the middle of the range reported for other shrub-nesting passerines (Rotenberry and Wiens 1989, Martin 1993, Miller and Knight 1993). For 17 shrub-nesting species (Table 6), the average predation rate was slightly higher, 47%. In three recent studies of the California Gnatcatcher, even higher rates were observed: in Orange County, 50% (Bontrager et al. 1995), in Riverside County, 54.2% (Braden et al. 1997a), in San Diego County, 68% (Sockman 1997). In Riverside County Ellison (1998) also

<table>
<thead>
<tr>
<th>Species</th>
<th>Incubation period (days)</th>
<th>Nestling period (days)</th>
<th>Percent success</th>
<th>Percent predation</th>
<th>No. broods per season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue-gray Gnatcatcher</td>
<td>15.0</td>
<td>12.5</td>
<td>24.4</td>
<td>–</td>
<td>2.0</td>
</tr>
<tr>
<td>(Polioptila caerulea)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wrentit (Chamaea fasciata)</td>
<td>15.5</td>
<td>15.5</td>
<td>50.4</td>
<td>–</td>
<td>1.5</td>
</tr>
<tr>
<td>Northern Mockingbird</td>
<td>12.2</td>
<td>12.0</td>
<td>49.7</td>
<td>47.1</td>
<td>2.5</td>
</tr>
<tr>
<td>(Mimus polyglottos)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sage Thrasher</td>
<td>15.0</td>
<td>12.3</td>
<td>45.0</td>
<td>–</td>
<td>2.0</td>
</tr>
<tr>
<td>(Oreoscoptes montanus)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown Thrasher</td>
<td>13.1</td>
<td>11.3</td>
<td>43.5</td>
<td>29.0</td>
<td>2.0</td>
</tr>
<tr>
<td>(Toxostoma rufum)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curve-billed Thrasher</td>
<td>14.0</td>
<td>14.0</td>
<td>43.8</td>
<td>40.2</td>
<td>2.5</td>
</tr>
<tr>
<td>(T. curvirostre)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow-breasted Chat</td>
<td>11.0</td>
<td>8.0</td>
<td>19.7</td>
<td>66.9</td>
<td>2.0</td>
</tr>
<tr>
<td>(Icteria virens)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Indigo Bunting</td>
<td>12.5</td>
<td>9.5</td>
<td>36.4</td>
<td>54.0</td>
<td>3.0</td>
</tr>
<tr>
<td>(Passerina cyanea)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Painted Bunting (P. ciris)</td>
<td>11.5</td>
<td>13.0</td>
<td>58.8</td>
<td>35.3</td>
<td>3.0</td>
</tr>
<tr>
<td>Green-tailed Towhee</td>
<td>12.0</td>
<td>12.0</td>
<td>22.0</td>
<td>78.0</td>
<td>2.0</td>
</tr>
<tr>
<td>(Pipilo chlorurus)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rufous-sided Towhee</td>
<td>12.5</td>
<td>11.0</td>
<td>48.1</td>
<td>51.9</td>
<td>2.0</td>
</tr>
<tr>
<td>(P. erythrophthalmus)</td>
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<tr>
<td>Abert’s Towhee (P. aberti)</td>
<td>–</td>
<td>12.5</td>
<td>27.5</td>
<td>63.8</td>
<td>–</td>
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<tr>
<td>Brewer’s Sparrow</td>
<td>13.0</td>
<td>8.5</td>
<td>79.5</td>
<td>20.5</td>
<td>–</td>
</tr>
<tr>
<td>(Spizella breweri)</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Sage Sparrow</td>
<td>14.2</td>
<td>10.0</td>
<td>56.4</td>
<td>43.2</td>
<td>2.0</td>
</tr>
<tr>
<td>(Amphispiza belli)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White-crowned Sparrow</td>
<td>12.6</td>
<td>10.0</td>
<td>37.4</td>
<td>51.1</td>
<td>2.5</td>
</tr>
<tr>
<td>(Zonotrichia leucophrus)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Goldfinch</td>
<td>12.3</td>
<td>13.5</td>
<td>45.0</td>
<td>46.6</td>
<td>2.0</td>
</tr>
<tr>
<td>(Carduelis tristis)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median from all studies</td>
<td>12.6</td>
<td>12.0</td>
<td>44.4</td>
<td>47.1</td>
<td>2.0</td>
</tr>
<tr>
<td>California Gnatcatcher</td>
<td>14.3</td>
<td>13.3</td>
<td>32.3</td>
<td>47.3</td>
<td>1.2</td>
</tr>
</tbody>
</table>

*Data from Martin (1993).
documented substantially higher nest-predation rates (range 56.5–62.1%) among four species of sparrows nesting in sage scrub, with significant annual differences in some species. In our study area we found evidence of a wide range and abundance of potential nest predators, especially snakes, raccoons, and corvids, often associated with high nest-predation rates (Rotenberry and Wiens 1989, Miller and Knight 1993).

California Gnatcatchers had their lowest daily nest-survival rates during the nest-building and egg-laying stages (Table 4). Based on Mayfield estimates, the chance that a nest in our study area would be successful was 34.8% if the nest-building stage was not included in the estimate (Table 5). Because of abandonment and losses due to rain, however, if nest survival prior to nest completion was factored in, nests had only a 15.5% chance of surviving to fledging (yearly range 3.5–23.5%). Since many investigators do not include the nest-building stage in their nest-survival estimates, our study may be best compared to others with the 34.8%.

Expected survival during incubation was also very low (Table 5). Sockman (1997) found significantly higher nest predation during egg laying during one of the two years of his study. In contrast, Ellison (1998) found nest failure among sage-scrub sparrows to be highest during the nestling stage. During our study, about 23% of gnatcatcher nests failed from causes other than predation (Figure 6), a high proportion in comparison to studies of 17 other shrub-nesting passerine species (mean 7.2%; Martin 1993). Our results, however, resemble those from other studies of the California Gnatcatcher. Braden et al. (1997a) reported 22.6% of nests abandoned and 5.4% lost to weather or infertility. Sockman (1997) estimated a probability of 19.9% that a nest would fail because of abandonment. This higher rate of nest abandonment prior to egg laying in the California Gnatcatcher may be partially the result of weather (this study, Braden et al. 1997).

With an extended breeding season, a female’s nutrient reserves may be insufficient for egg laying at the beginning and end of the season when most nest abandonment was observed and when food is likely to be scarce. Since male gnatcatchers are the primary nest builders, the female may not always be physiologically prepared to lay eggs when the first nest is near completion. An extreme example was one pair that initiated nest building on 6 March and began egg laying 5 April, a 30-day interval between nest initiation and the first egg. The last nesting attempts of the season are also frequently abandoned prior to nest completion, most likely because of a decline in food availability late in the season that may preclude continued egg laying (Lack 1968, Drent and Daan 1980, King and Murphy 1985, Martin 1987, Daan et al. 1988, Carey 1996). The intensity of nest monitoring in our study might also have resulted in a higher detectability of nest abandonment. We found most nests (75%) during the nest building, when the birds’ behavior is quite conspicuous.

Nest parasitism by the Brown-headed Cowbird does not appear to be a significant factor in the success of California Gnatcatcher nests at two sites studied in San Diego County (this study, Sockman 1997). In Riverside County, however, Braden et al. (1997a) documented a higher incidence of nest parasitism (31.5%), although it was overshadowed by the even more substantial effects of nest predation. Severe brood parasitism appears to be
restricted to only a few locations (D. Bontrager, M. Fugagli pers comm.). Gnatcatcher populations have benefited from cowbird-control programs (Braden et al. 1997a). We identified several factors associated with the nesting success of California Gnatcatchers, including timing of nest initiation, nest host plant, nest height, and steepness of the slope on which the nest was placed. Early and late nests were less successful than nests initiated in April and May (Figure 8). In over 80% of successful nests the young fledged during May and June, the middle of the fledging period. Although predation of nests was highest from April to June, the large numbers of active nests during this period and the high rates of nest failure due to a variety of causes during the early and late months meant that success was still greater for these mid-season nests. At the beginning of the breeding season predation, nest destruction by storms, and abandonment prior to egg laying caused most nest failures. Late in the breeding season, however, the two major causes of nest failure were nest abandonment prior to egg laying and predation. Other studies have also shown that timing of nest initiation affects nest success in some species, primarily because of changes in the abundance of nest predators (Schaub et al. 1992, Filliater et al. 1994).

Although gnatcatchers did not prefer particular shrubs for nesting, we found that the choice of nest shrub did affect nest success (Figure 9), contrary to the findings of Sockman (1997) at Marine Corps Air Station Miramar in central San Diego County. The difference may be due to the two sites’ plant-species composition differing substantially. Nesting gnatcatchers at Miramar make extensive use of broom baccharis (*Baccharis sarothroides*) (J. O’Leary, pers. comm.), a shrub species not found commonly at Rancho San Diego (<1% relative dominance). We were not able to distinguish between the contribution of shrub species and other habitat variables, such as steepness of slope, to the likelihood of nest success. In our study, *Viguiera laciniata*, the shrub associated with lowest nest success, grows primarily on the drier, steeper south-facing slopes in areas of sparse vegetation. Gnatcatchers nesting in *Viguiera* had reduced success, but this could be due to the smaller, sparser structure of this shrub or to some factor associated with slope.

Although the size of the nest shrub did not affect nesting success significantly, it is possible that nests built in *Artemisia californica* are less visible because of this shrub’s leaf density being higher than that of *Eriogonum fasciculatum* or *Viguiera laciniata*. We did not measure shrub structure, but among all our nests, those placed toward the middle of the shrub were more successful than nests closer to the ground or to the edges. This is consistent with the findings of Sockman (1997), who reported that nests located in the middle third of the bush were more successful, and implies that concealment of the nest is a factor in reducing nest failure. Several other studies have shown that nest concealment is important in reducing nest failure in passerines (e.g., Martin and Roper 1988, Holway 1991, Norment 1993, Ellison 1998), although for some species it may not be important (e.g., Howlett and Stutchberry 1996, Filliater et al. 1994). Nests can be concealed at the level of a single shrub but also at a larger scale involving the surrounding patch of habitat (Martin and Roper 1988,
Knopf and Sedgwick 1992). We examined nest success primarily at the nest site; however, habitat characteristics at this larger scale may also be important. Mean distances between the nest shrub and adjacent shrubs ranged from 1.5 to 1.8 m, suggesting relatively open habitat. Braden et al. (1997b) found that gnatcatchers’ nests tend to be more successful and productive when the birds’ territories support more grass and forb cover and fewer perennials yet also that the structure of the perennial vegetation is also correlated with nesting success, higher in mature coastal sage scrub.

SUMMARY

We studied the nesting biology of the California Gnatcatcher in southwestern San Diego County from 1989 to 1992. We banded a total of 318 individuals and monitored 134 nests. Gnatcatchers molt into breeding plumage in February and begin nest building two to four weeks after molt. Males select the nest site and are the primary nest builders. Females assist in nest construction and do most of the nest lining. A nest can be constructed in as little as 4 days, but nests built early in the season were worked on for an average of 11 days before eggs were laid. Gnatcatchers are persistent nesters, which is highly adaptable in a habitat that supports many potential nest predators. New nests are begun one day after nest predation and between 6 and 20 days after a brood is fledged, depending on the number of surviving fledglings. Up to 10 nests have been built by a pair in a season. About 75% of all eggs are laid in April and May. The majority of clutches contained 3 eggs in the driest year and 4 eggs in years with more rainfall. The female is the primary incubator and brooder, but the male makes almost twice as many feeding trips to the nestlings. Nestlings fledged at 13 days of age and remained with their parents 3 to 5 weeks. Selection of nest host plant had significant consequences on subsequent nest survival. Landscape-level conditions of the nest site, such as slope gradient, may also affect nest success.

ACKNOWLEDGMENTS

Field observers contributing to this study included Eric Bailey, David King, John Lovio, Ann Kreager, and John Konecny. Graphics and GIS support was provided by the San Diego office of Ogden Environmental and Energy Services. Funding for this study was provided by Home Capital Development Corporation, the Weingarten, Siegel, Fletcher Group, Inc., Skyline Wesleyan Church, and Ogden Environmental and Energy Services. Review of the manuscript was provided by John Rotenberry and Philip Unitt. The authors are grateful to all of the above individuals and organizations for their contributions to this study.

LITERATURE CITED


CALIFORNIA GNATCATCHER BREEDING BEHAVIOR


Accepted 7 July 1998
BREEDING AND DISPERsal BIOLOGY OF THE CALIFORNIA GNATCATCHER IN CENTRAL ORANGE COUNTY

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The California Gnatcatcher (*Polioptila californica*) is a persistent nester, attempting up to seven nests after repeated failures (Bontrager 1991). I collected data on the dispersal and breeding biology of the gnatcatcher, particularly relating to nesting success and nest location, in Orange County, California. Dispersal patterns can broadly be classified as breeding dispersal, "the movement of individuals, which have reproduced, between successive breeding sites" and natal dispersal, "the movement an animal takes from its point of origin to the place where it reproduces or would have reproduced if it had survived and found a mate" (Howard 1960, Greenwood 1980). Natal dispersal is the primary means by which genetic diversity and interpopulation movements are maintained in nonmigratory, territorial birds, especially those occupying a highly fragmented landscape. Natal dispersal is therefore an important aspect of the biology of the California Gnatcatcher, yet few studies have investigated it (G. Braden unpubl. data, Atwood 1993, Bailey and Mock 1998).

STUDY AREAS AND METHODS

My main study site, Siphon Reservoir, is located in central Orange County, in the foothills of the Anaheim Hills (Figure 1). The site comprises 53 ha of coastal sage scrub surrounding the reservoir, dominated by California sagebrush (*Artemisia californica*) and California buckwheat (*Eriogonum fasciculatum*), with white sage (*Salvia apiana*), black sage (*Salvia mellifera*), brittlebush (*Encelia californica*), and prickly pear cactus (*Opuntia littoralis*) also common (from visual estimates; no quantitative vegetation sampling conducted). The sage scrub is divided into two continuous sections, one to the east and one to the west of the reservoir; the sections are connected via a thin strip of riparian vegetation dominated by willows (*Salix* spp.) and mulefat (*Baccharis salicifolia*). Small areas dominated by grasses and mustard (*Brassica* spp.) are interspersed among the coastal sage scrub. The study site is surrounded by orange groves, nurseries, and other agricultural land. The nearest patch of sage scrub lies approximately 1 km to the northeast.

In addition to the main study site at Siphon Reservoir, I surveyed four other areas for gnatcatchers: Rattlesnake Reservoir, Bee Canyon, Peter’s Canyon, and Gypsum Canyon, as part of the dispersal aspect of this study (Figure 1). The size and vegetation composition of each of these areas are similar to that at Siphon Reservoir, all being dominated by California sagebrush and California buckwheat (from visual estimates). At Gypsum Canyon, however, the ground cover is somewhat reduced by cattle grazing.

I established the number and location of breeding pairs of gnatcatchers at the main study site in March, following standard survey protocol. Breeding
territories were visited once or twice a week from late March to the end of the breeding season (late July). Nests were visited once per week and monitored for the onset of egg laying, clutch size, nest parasitism, number of nestlings, and number of fledglings. I attempted to locate all nests, including those abandoned prior to egg laying. Although some unsuccessful nesting attempts went undetected, I believe all nesting attempts that resulted in fledglings were located. Nestlings were banded at 8 or 14 days of age. Juveniles were captured with mist nets and banded toward the end of the breeding season, as were several adults. Nest-site characteristics were recorded after gnatcatchers were finished with the nest, after either nest failure or successful fledging of chicks.
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I selected sites for the dispersal surveys along a transect running from the main study site (the banding site) toward Highway 91 (Figure 1) in such a way as to represent all distances along the dispersal curve adequately. Each of the selected study sites covered the same area and was vegetated (from visual assessment) like the main study site. The selection of the study sites was complicated by the location of suitable gnatcatcher habitat and by the requirement for not selecting sites separated from the banding site by large areas of developed land. The main study site covered distances from 0 to 1.5 km from the banding site; Bee Canyon is 2.2 km from the banding site (from the center of both sites), Rattlesnake Reservoir at 2.9 km, Peter’s Canyon at 7.3 km, and Gypsum Canyon at 16.4 km.

I surveyed for dispersal at each of the five study sites in November and December. Each site was surveyed nine times to ensure that all banded birds were located. Biologists were rotated from site to site to reduce observer bias. Every effort was made to ensure that each site was surveyed for the same length of time. Dispersal distances were calculated as straight-line distances from the site where the bird was banded to the site where it was relocated; mean distances were used in cases of multiple resightings. Dispersal angles were calculated for each observation relative to true north, banding location, and site of relocation; the first angle was used in cases of multiple resightings. The results were tested for a significant direction of mean dispersal.

RESULTS

I located 24 pairs of California Gnatcatchers at the main study site. No unpaired individuals were detected. These pairs were spaced uniformly through the available habitat with no large areas of unoccupied coastal sage scrub. Although I did not map territories during the study, enough data on the birds’ locations were collected to define the centers of activity for each of the 24 pairs. All of the gnatcatchers, except for one pair, appeared to remain in the same area throughout the breeding season, although there were some shifts in centers of activity associated with new nest locations. One pair appeared to move to a small area of unoccupied coastal sage scrub adjacent to a second pair after its first nest failed. Because no gnatcatchers were banded at the start of the study, however, these observations cannot be confirmed.

Breeding behavior (in the form of pair bonding and nest-site searching) was first observed in early March, and most pairs had built their first nests by early April. The first chicks hatched on 10 April, and the first chicks fledged on 24 April. Many of the early successful breeders had fledglings by early May. The gnatcatchers continued their breeding cycle throughout May and June, but most pairs had stopped new nesting attempts by early July. The last new nests built were located in the first week of July, and the last chicks fledged on 21 July.

Seventeen of the 24 pairs (71%) nested successfully. Clutch size ranged from three to five with a mean of 3.94 (standard deviation (SD) 0.34); in total 134 eggs were laid. Eighty-five chicks hatched, of which 74 fledged successfully. The population as a whole had a mean of 3.1 fledglings per pair.
Of the 46 nests located during the breeding season, 21 (45.6%) successfully produced fledglings. Of the 25 unsuccessful nests, 13 (28%) were abandoned or destroyed before eggs were laid, 9 (20%) were depredated with eggs, and 3 (7%) were depredated with chicks. Of the nine nests lost at the egg stage, five were depredated by snakes and four were completely destroyed. Four of the nests lost during the nest-building stage were also completely destroyed, while the others were abandoned. During the breeding season, gnatcatchers were observed aggressively mobbing Greater Roadrunners (Geococcyx californianus), Western Scrub Jays ( Aphelocoma californica), and Cactus Wrens (Campylorhynchus brunneckapillus), suggesting that they recognized these species as potential nest predators or destroyers. Other potential nest predators observed in the study site include the American Crow (Corvus brachyrhynchos), Common Raven (C. corax), coyote (Canis latrans), bobcat (Lynx rufus), gopher snake (Pituophis melanoleucus), and common kingsnake ( Lampropeltis getulus).

No evidence of brood parasitism by the Brown-headed Cowbird ( Molothrus ater) on the California Gnatcatcher was observed at the main study site, where an intensive cowbird-trapping program was conducted throughout the study.

There were marked differences in the nesting success of individual pairs of gnatcatchers. Four pairs of gnatcatchers (17% of total) raised two broods, 13 pairs (54%) raised one brood, and six pairs (19%) did not raise any broods. Two pairs each raised eight fledglings from their two nesting attempts, while three pairs did not raise any fledglings from three or four nesting attempts. It was unknown whether the differences in breeding success were related to breeding experience, nest or territory location, habitat quality, differences in reproductive fitness between the pairs, or accidents.

The nesting substrates used by gnatcatchers at the main study site were California sagebrush, 23 nests (56.1%); California buckwheat, 11 nests (26.8%); brittlebush, 4 nests (9.8%); white sage, 1 nest (2.4%); black sage, 1 nest (2.4%) and prickly pear cactus, 1 nest (2.4%). The numbers of these nests that were successful were California sagebrush, 8 nests (42.1%); California buckwheat, 7 nests (36.8%); brittlebush, 2 nests (10.5%); white sage, 1 nest (5.3%); black sage, 1 nest (5.3%) and prickly pear cactus, no nests. Although nesting success for nests built in California buckwheat was greater than for those built in California sagebrush or brittlebush, it was not significantly so ($\chi^2$ test, $P > 0.05$).

Nest height ranged from 0.3 to 1.4 m above the ground (mean 0.61 m, SD 0.25 m) and from 0.08 to 1.10 m below the top of the canopy (mean 0.25 m, SD 0.19 m). There were no significant differences in nest height above the ground or in height below the canopy between successful and unsuccessful nests (Student's $t$ test, $P > 0.05$).

Nest location ranged from 0.3 to 97.6 m to the edge of the shrub canopy (mean 3.1 m, SD 4.8 m) and from 0.3 to 121.9 m to the edge of the coastal sage scrub habitat (mean 21.0 m, SD 39.5 m). There were no significant differences between successful and unsuccessful nests in nest location relative to the distance to the edge of the shrub canopy or the edge of the coastal sage scrub (Student's $t$ test, $P > 0.05$).
Fifteen banded gnatcatchers were located during the dispersal surveys, three of which had been banded as adults, 12 as nestlings or juveniles. For adults, this gave a resighting rate of 75% (3 of 4 banded adults relocated), for juveniles, 32% (12 of 38). Gnatcatchers mist-netted and banded as juveniles were much more likely to be resighted than those banded as nestlings. Seven of the 10 (70%) gnatcatchers banded as juveniles were relocated, while only 5 of the 31 (16%) banded as nestlings were relocated.

Of the 12 banded juvenile gnatcatchers that were relocated, all but one were recorded at the main study site (the banding site). The other banded gnatcatcher was located at Peter’s Canyon. The mean dispersal distance of juvenile gnatcatchers was 1.05 km (SD 2.06 km, range 0.01–7.55 km), but this figure was skewed by the one individual that dispersed 7.55 km. This individual excluded, the mean dispersal distance was only 0.46 km (SD 0.25, range 0.01–0.80 km). Most of the juvenile gnatcatchers dispersed between 0.3 and 0.8 km from their nests (Figure 2). The mean dispersal distance of gnatcatchers mist-netted and banded as juveniles (mean 0.19, SD 0.19, range 0.01–0.41) was much lower than of those banded as nestlings (mean 0.58, SD 0.25, range 0.24–0.80, not including the outlier), indicating that many of the juvenile gnatcatchers caught in the mist nets may have already undergone some dispersal. Even if this is so, clearly most of the juveniles did not disperse far from their natal area. Dispersal direction was

![Figure 2. Cumulative percentage of dispersed young California Gnatcatchers relative to distance from banding area.](image-url)
not significant ($\chi^2$ test, $P > 0.05$), indicating that juveniles dispersed in a random direction after leaving their natal territory.

The banded gnatcatchers exhibited a range of behaviors relating to dispersal and home-range establishment. Of the 12 relocated juveniles, six had paired and established home ranges. Interestingly, four of the five males relocated were paired, only two of the seven females. Throughout the dispersal surveys gnatcatchers were observed most frequently in coastal sage scrub; however, they were also observed regularly in riparian and grassland areas, especially those adjacent to coastal sage scrub. Although no quantitative data were collected, gnatcatchers appeared to use these habitat types more frequently during the nonbreeding season than during the breeding season (see also Campbell et al. 1998).

Survey rates (defined as the mean acres surveyed per minute per biologist) were used to assess if each site was surveyed with equal effort. Despite conscious efforts to maintain equal effort there were significant differences in survey rates between sites (Duncan's multiple-rank range test, $F = 11.1$, $P < 0.01$). Mean survey rates for Gypsum Canyon (0.308 acres/min/biologist) were significantly higher than for other sites, rates for Siphon Reservoir (0.200) were significantly lower. Mean survey rates at Bee Canyon (0.241), Rattlesnake Reservoir (0.254), and Peter’s Canyon (0.240) were not significantly different from each other. Many factors affect survey rates, including weather, topography, habitat type, and the number of gnatcatchers located, especially the number of banded gnatcatchers. During this study, surveys were generally quickest at Gypsum Canyon, as the habitat there was very open, with much less ground cover than at the other sites and because there were fewer gnatcatchers there. Surveys took longer at Siphon Reservoir mainly because of the large number of banded gnatcatchers. Observers generally took less than 5 minutes to determine if a located gnatcatcher was unbanded; however, it frequently took up to half an hour to record the band combination of the banded birds. These differences in mean survey rates probably did not affect the results since all areas were surveyed nine times and there was little probability of detecting new birds after six or seven surveys (Figure 3).

Throughout the dispersal surveys many of the banded gnatcatchers were relocated on more than one occasion. On the basis of data from Siphon Reservoir (the only site where more than one banded gnatcatcher was located), the mean probability of detecting one of the banded gnatcatchers was 0.38. This probability was calculated by dividing the mean number of banded birds recorded during each survey by the total number of banded birds present at the site (it is assumed that all banded birds at the site were located). With this probability of detection, probability theory implies that it takes seven surveys to locate 95% of the banded birds.

Another way of determining the minimum number of surveys required to detect all banded gnatcatchers is to plot the cumulative number of new sightings against the number of surveys performed. This plot indicates that just four surveys were required to detect 93% of the banded birds, and all banded birds were recorded after five surveys (Figure 3).
Figure 3. Cumulative number of new banded California Gnatcatchers located during each survey.

DISCUSSION

The main study site at Siphon Reservoir contained a relatively high number of gnatcatcher pairs (24) for 53 ha of suitable habitat. Although home ranges or territories were not mapped in this study, the mean home range for the gnatcatchers can be estimated by dividing the total available habitat by the number of pairs present, giving a mean home range of 2.2 ha. The calculation is valid under the assumptions that gnatcatchers do maintain home ranges, that these home ranges do not overlap, that all available habitat was used, and that the pairs were not using areas beyond the study site. Many other studies have indicated that gnatcatchers do maintain and defend territories (Bontrager 1991, Atwood 1993). My observations at Siphon Reservoir indicate that the breeding gnatcatcher pairs used all of the available habitat and never left the site. Estimates of the California Gnatcatcher's home range vary widely, from as little as 1 or 2 ha (Tattersall 1988, Atwood 1993) to as much as 9.3 ha (Preston et al. 1998). Preston et al. (1998) found a correlation between territory size and distance inland, with the larger territories inland. My estimates are consistent with other estimates for coastal sites.

Nesting success at Siphon Reservoir was relatively high. Seventeen of the 24 pairs (74%) successfully raised fledglings, compared to only 42% in
Rancho Mission Viejo (Bontrager 1991), 58% at Lake Mathews (J. and J. Griffith unpubl. data), and 65% at Rancho San Diego (P. Mock unpubl. data). The 74 chicks fledged represent a mean of 3.1 fledglings per pair, again comparing favorably with results from other studies, 1.4–3.8 fledglings/pair at Riverside (Braden et al. 1997), 2.99 fledglings/pair at Palos Verdes (J. Atwood unpubl. data), 4.65 fledglings/pair at UCI Reserve (E. Woehler unpubl. data), and 0.78 fledglings/nest in San Diego (Sockman 1997).

California sagebrush and California buckwheat were the most commonly used nesting substrates, accounting for over 80% of all known nest sites at Siphon Reservoir. Other studies also found these to be the most commonly used substrates (Atwood 1993, Bontrager 1991, Roach 1989). It is not known whether the preferences for California sagebrush and California buckwheat as a nesting substrate reflect a preference for these plants or the fact they are the two most abundant species in the coastal sage scrub. Most studies, including this one, have found that gnatcatchers nest more frequently in California sagebrush than in California buckwheat. I found nesting success to be higher in California buckwheat than in California sagebrush, but the difference was not significant ($P > 0.05$).

At Siphon Reservoir, the mean nest height was 0.61 m above the ground, slightly lower than recorded in most other studies: 1.04 m in southern California (Atwood 1993); 0.66 m at Rancho San Diego (Roach 1989); 0.87 m near Perris (Tattersall 1988); 0.86 m at Palos Verdes (J. Atwood unpubl. data). The mean distance of the nest below the canopy (0.25 m) was also slightly less: 1 m near Rancho San Diego (Roach 1989); 0.45 m at UCI Reserve (J. Simonsen unpubl. data); 0.42 m at Palos Verdes (J. Atwood unpubl. data).

The mean dispersal distance of juvenile gnatcatchers banded at Siphon Reservoir was 1.05 km, significantly lower than the means of 2.04 km at Riverside (G. Braden unpubl. data) and 2.4 km at Palos Verdes (J. Atwood unpubl. data). The mean dispersal distance at Siphon Reservoir might be an underestimate since some of the relocated banded birds were not banded as nestlings but as fledglings and may have already undergone some dispersal when they were banded in mid July. Other biases in the data set, including small sample size and the fact that not all suitable habitat within the potential dispersal range could be surveyed, make direct comparisons problematic. However, the general dispersal pattern (most of the juveniles staying close to their natal areas and a few dispersing a long distance) is similar to that observed elsewhere (J. Atwood, G. Braden unpubl. data, Bailey and Mock 1998).

These data indicate that gnatcatchers can and do disperse long distances dispersal across unfavorable habitat but that the frequency of these events is low. More typically, gnatcatchers disperse short distances through contiguous coastal sage scrub. As coastal sage scrub becomes more fragmented and gnatcatcher populations more isolated, short-distance dispersal will become more difficult and the long-distance dispersal may not be sufficient to maintain genetic diversity and interpopulation movement.

Of the 12 banded juvenile gnatcatchers that were relocated, all but one were recorded at the main study site (the banding site). That so many young
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birds were recorded at the main study site might indicate that the population there was not at saturation level or that its rate of turnover was high. Since the surveys were conducted during the winter, however, I do not know if these birds were able to establish territories and breed successfully in the study area.

My data indicate that six surveys are sufficient to detect over 95% of gnatcatchers at any site. This is an important consideration for both presence/absence surveys and where complete censuses are required.

Because of the impracticality of surveying all potential habitat for banded gnatcatchers, most dispersal studies probably underestimate dispersal distance. Isolated occurrences (Bailey and Mock 1998) and sightings of banded birds (G. Braden pers. comm.) confirm long-distance dispersal. The question, then, is not if gnatcatchers can disperse long distances but the frequency of long-distance dispersal.

SUMMARY

I conducted an intensive study of the breeding and dispersal biology of the California Gnatcatcher at five locations in central Orange County in 1995. Twenty-four pairs of gnatcatchers attempted nesting at the main study site, Siphon Reservoir. Seventeen (71%) nested successfully. A total of 134 eggs was recorded, from which 85 chicks hatched and 74 chicks fledged. Twenty-one of the 46 nests located (45%) were successful. Twenty-eight percent of the nests were abandoned before eggs were laid, 20% were depredated while eggs were in the nest, and 7% were depredated while chicks were in the nest. There was no incidence of brood parasitism by the Brown-headed Cowbird. Mean number of fledglings per pair was 3.1. There were marked differences in nesting success between individual pairs; several pairs raised two broods. The majority of gnatcatchers built their nests in Artemisia californica (56.1%) or Eriogonum fasciculatum (26.8%). Mean nest height above the ground was 0.61 m, and mean distance of the nest below the canopy 0.25 m. Mean distance from nests to the nearest edge of the shrub canopy was 3.1 m, mean distance to the edge of the coastal sage scrub habitat 21.0 m. There were no significant differences for any of these measurements between successful and unsuccessful nests. Fifteen of the 45 individually color-banded gnatcatchers were relocated during the dispersal surveys, three banded as adults, 12 banded as young. Mean dispersal distance of juveniles was 1.05 km (SD 2.06 km), although this was heavily skewed by one individual that moved 7.55 km. This bird excluded, the mean dispersal distance was just 0.46 km (SD 0.25). Juveniles dispersed in random directions after leaving their natal territories.

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LITERATURE CITED


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SIX YEARS OF SYNCHRONOUS CALIFORNIA GNATCATCHER POPULATION FLUCTUATIONS AT TWO LOCATIONS IN COASTAL ORANGE COUNTY, CALIFORNIA

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Bird populations and distributions are known to be influenced by environmental factors (e.g., Graber and Graber 1979, Cawthorne and Marchant 1980, Root 1988a,b,c, Arcese et al. 1992, Mehlman 1997). Nevertheless, "whether and how most animal populations are regulated remains one of the principal unanswered questions in ecology" (Rodenhouse et al. 1997). Another major gap in our understanding concerns the scale over which species' populations fluctuate (Holmes et al. 1986).

Atwood and Bolsinger (1992) analyzed the upper elevational limits of the California Gnatcatcher (Polioptila californica), but otherwise little has been published on environmental factors affecting this species. In particular, Atwood (1993) noted that data concerning annual survivorship had not yet been published. We compared the results of California Gnatcatcher surveys conducted at two locations in coastal southern California over the same 6-year period in the 1990s. A cursory examination of the data suggested that annual fluctuations in the number of breeding pairs were similar, presumably in response to similar environmental influences. A more thorough analysis and consideration of these issues is presented here.

STUDY AREAS

The coastal terrace at Crystal Cove State Park, between Newport Beach and Laguna Beach, Orange County, California, is described in more detail elsewhere (Miner et al. 1998). The study site lies between Pacific Coast Highway and the bluffs overlooking the Pacific Ocean in the vicinity of Pelican and Reef points. Total size of the study area is approximately 93 hectares; the elevation is approximately 20–40 meters. Habitat on the site is a mixture of coastal sage scrub and annual grassland. Dominant scrub species include California sagebrush (Artemisia californica; plant taxonomy and nomenclature follow Hickman 1993), California buckwheat (Eriogonum fasciculatum), California encelia (Encelia californica), black sage (Salvia mellifera), goldenbush (Isocoma menziesii), deerweed (Lotus scoparius), and coyote brush (Baccharis pilularis).

"Site 2" is also on the coast of Orange County, approximately 11 km away. It covers approximately 100 hectares and, like the Crystal Cove site, the terrain is mostly gentle. The elevation range is 0–35 meters. The habitat is a mixture of coastal sage scrub and annual grassland, with California
encelia strongly dominant over most of the site. Unlike Crystal Cove, Site 2 is located adjacent to a considerable expanse of wetland and ruderal habitat that may serve as a buffer and allow for a higher gnatcatcher population than would be possible at a site otherwise susceptible to seasonal desiccation (Campbell et al. 1998). Because of a combination of natural and unnatural features, the gnatcatcher populations at both sites are rather discrete, but movement in and out of both populations is known to occur.

METHODS

Gnatcatcher surveys at Crystal Cove began in 1991. Final estimates of nesting pairs each year were based on an analysis of all data collected during the breeding season (February through July), although not all areas necessarily received equal coverage. Color-banding of some birds greatly assisted in this process. In general, all areas were carefully surveyed at least twice with the occasional use of taped gnatcatcher vocalizations.

Sporadic gnatcatcher surveys were conducted at Site 2 in 1990 and 1991, but comprehensive coverage during the breeding season did not begin until the following year. Three complete surveys were conducted from March to May 1992 and in July/August 1997, with two surveys done in March/early April in each of the intervening years. As at Crystal Cove, taped gnatcatcher vocalizations were occasionally used during these surveys.

Because of the limitations of our coverage, our observations of single males (or females) were considered to represent pairs unless further visits gave us sufficient confidence that single birds were indeed unpaired. We acknowledge that these data may not represent completely accurate censuses of these areas, but we consider them to be careful estimates.

In order to assess the influence of weather on these gnatcatcher populations, we obtained temperature and rainfall data from Newport Beach Harbor and summed rainfall totals from November through February to obtain a cumulative seasonal amount for each season from 1990–1991 to 1996–1997. Similarly, we averaged monthly average temperature maxima and minima to obtain single seasonal averages for the same period. Long-term seasonal averages were derived from long-term monthly averages in the same fashion.

RESULTS

Our annual estimates of the number of nesting pairs at each site fluctuated rather synchronously from 1991 to 1997 (Figure 1; \( r = 0.759, P = 0.02 \)). Weather during the study period was generally milder than average, with lower maximum temperatures and, especially, higher minimum temperatures (Figure 2). Seasonal temperatures varied rather little, and no correlation with population size was found. Rainfall did vary (following a prolonged drought, the study period was generally wetter than average) and was inversely correlated with population size (\( r = -0.706, P = 0.025 \) at Crystal Cove; \( r = -0.429, P = 0.15 \) at Site 2).
DISCUSSION

The considerable variation in population size at these sites may seem unusual given the statement by Welty and Baptista (1988:405) that "the great majority of bird populations seem relatively constant in number except for seasonal fluctuations." Evidence is mounting, however, that annual population swings of this magnitude are common among passerines (e.g., Wiens 1989, DeSante 1990, Arcese et al. 1992). There is a large body of work concerning the variability of bird communities (e.g., Noon et al. 1985, Holmes et al. 1986, Böhning-Gaese et al. 1994), but it is usually difficult to tease out details on individual species from community discussions. Koenig (1998), using Breeding Bird Survey and Christmas Bird Count data, found little large-scale synchrony among California landbird populations, especially in resident species.

The general population trends documented here are similar to those shown during the same period on the Palos Verdes Peninsula, coastal Los Angeles County, and in the San Joaquin Hills of coastal Orange County.
Figure 2. Temperature and precipitation during the study period.

(Atwood et al. 1998a,b). Weather data presented here, coupled with demographic data gathered by Atwood et al. (1998b), are useful in attempting to explain these population trends.

Rainfall appears to be a mixed blessing for California Gnatcatchers and can be viewed in two ways. The inverse correlation shown in Figure 3 suggests that overwinter survivorship may be reduced in years of above-average rainfall (several days of continuous rain may decrease food availability; Holmes et al. 1986), limiting population levels in the nesting season to follow. This is precisely the pattern shown by Atwood et al. (1998b): survivorship was greatest prior to the population peaks in 1994 and 1996. Another view of Figure 3 suggests that above-average rainfall in this arid landscape allows for increased productivity and an increase in the nesting population the following year (cf. DeSante and Geupel 1987). Again, at least partial support has been provided by Atwood et al. (1988b), as reproductive success was greatest in 1993, one year prior to the population spike shown in Figure 3. Displacement of some birds by the October 1993 Laguna Canyon Fire, separated from the Crystal Cove study site by the width of Pacific Coast Highway, probably accentuated the 1994 peak at Crystal Cove, as suggested by Bontrager et al. (1995) and Atwood et al. (1998a).

Both of these phenomena have been proposed as major regulating factors in other passerines, and it is likely that the two interact with one another over time to influence gnatcatcher population levels. Sherry and Holmes (1993) noted that, in general, species mostly resident in the temperate zone tend to be limited mainly by winter mortality (e.g., Root 1988c, Arcese et al. 1992, Mehlman 1997), especially smaller species (Graber and Graber 1979, Cawthorne and Marchant 1980) such as the California Gnatcatcher. How-
ever, O'Connor (1991) stated that weather is usually considered merely as a transient influence on bird populations. A number of other authors (Nolan 1978, DeSante and Geupel 1987, Johnson and Geupel 1996, Chase et al. 1997) have emphasized productivity in determining population size, especially among migratory species.

Only additional data and analysis will clarify how these and other factors regulate California Gnatcatcher populations. No one factor is likely to account wholly for a given population level (Newton 1991). Our analysis does not consider the impact of minimum temperature or short-term severe weather, which may be more important than seasonal averages (Arcese et al. 1992, Atwood 1993, Mock 1998). Nor do we yet understand the potential effect of metapopulation dynamics on analyses such as ours. O'Connor (1991) suggested that when primary habitats are saturated, secondary habitats are often colonized, and when those are in turn colonized fully, further habitats come into use. Hence primary habitats will usually be saturated and vary little from year to year, but secondary habitats may vary substantially.

In conclusion, our data suggest that the synchrony observed is produced by common population responses to commonly experienced weather patterns, perhaps related to higher mortality in wetter years.

SUMMARY

Similar methods were used to estimate the breeding populations of the California Gnatcatcher at two large sites (ca. 100 ha) in coastal Orange County, California, from 1992 to 1997. Population fluctuations were highly correlated ($r = 0.759, P < 0.02$), and seasonal rainfall and population levels were inversely related. Demographic data obtained elsewhere suggest that increased rainfall may increase winter mortality, at the same time that it
increases productivity in the following nesting season. The potential for synchronous population fluctuations on a regional scale has obvious management implications. Permanent or long-term monitoring at selected sites may improve the reliability of interpretations of short-term data and assist in planning for potential population bottlenecks.

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CALIFORNIA GNATCATCHER POPULATION FLUCTUATIONS


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DISTRIBUTION AND POPULATION SIZE OF CALIFORNIA GNATCATCHERS ON THE PALOS VERDES PENINSULA, 1993–1997

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The potential effects of fragmentation of natural communities by urban development are dramatically evident on the Palos Verdes Peninsula of Los Angeles County, California. Because of the long history of agricultural and, more recently, intensive urban development of the Los Angeles basin, tracts of natural scrub habitat on the peninsula have become increasingly isolated and smaller since the mid-1900s (Fink 1966, Gales 1974). The populations of the California Gnatcatcher (Polioptila californica) nearest that on the peninsula occur in Los Angeles County near Montebello and in Orange County near Fullerton and Newport Beach, all approximately 45 km from the Palos Verdes Peninsula across the urbanized areas of greater Los Angeles. In fact, Palos Verdes exemplifies the situation that California's Natural Community Conservation Planning (NCCP) program is intended to avoid—small, disjunct islands of natural habitat surrounded by a vast, nearly continuous urban "ocean" (Calif. Dept. Fish & Game 1993). Long-term maintenance of viable natural communities in such a landscape poses an especially difficult conservation challenge.

Through preparation of land-use plans that address the ecological requirements of selected "target species" at a regional scale, the NCCP attempts to allow economic development while ensuring the protection of biologically viable tracts of natural habitat (Atwood and Noss 1994, Reid and Murphy 1995). Two songbirds, the California Gnatcatcher and Cactus Wren (Campylorhynchus brunneicapillus), have been selected throughout much of southern California as the primary flagship species for a test-case application of an NCCP to the coastal sage scrub (Calif. Dept. Fish & Game 1993, Atwood and Noss 1994, Reid and Murphy 1995). Despite the centrality of these species to this planning process, however, little is actually known of their behavioral ecology (Atwood 1993, Rea and Weaver 1990). Consequently, to obtain basic biological data required for effective conservation planning, in 1993 Manomet Center for Conservation Sciences began an ongoing study of gnatcatchers and wrens on the Palos Verdes Peninsula. Here we summarize some of the results of the first five years of this project, especially with regard to annual fluctuations in population size and use of natural habitats by gnatcatchers on the peninsula.

METHODS

Vegetation Analyses

Discrete units of natural vegetation on the Palos Verdes Peninsula were identified on plastic overlays affixed to color aerial photographs, scale 1 inch
= 1200 feet, dated 8 January 1992 and 19 April 1993. The minimum size of delineated polygons was approximately 0.2 ha. We inspected each vegetation unit in the field, either from nearby vantage points through binoculars or by visits to the sites. We adjusted polygon boundaries as appropriate, and visually estimated the percent cover of the following plant species or categories for each unit: (a) Artemisia californica, (b) Eriogonum spp. (including E. fasciculatum and E. cinereum), (c) Salvia spp. (including S. leucophylla and S. mellifera), (d) Opuntia littoralis, (e) Rhus integrifolia, (f) Opuntia prolifer, (g) Encelia californica, (h) Elymus condensatus, (i) Baccharis pilularis, (j) Foeniculum vulgare, (k) Salsola kali, (l) miscellaneous ornamental shrubs, (m) disturbed grassland, (n) riparian, and (o) bare ground. Vegetation data were entered in a geographic-information system by means of ArcInfo software.

Various classification systems have been applied to subassociations of coastal sage scrub (Munz 1970, Thorne 1976, Kirkpatrick and Hutchinson 1977, Westman 1981, DeSimone and Burk 1992, Jones and Stokes Associates, Inc. 1993). Here, we used a cluster analysis to identify major vegetation groupings, then prepared a dichotomous key reflecting these results (Table 1). Using this key, we then categorized each mapped polygon as one of four scrub subassociations (lemonadeberry scrub, sage-lemonadeberry scrub, sagebrush scrub, and cactus scrub) or two types of disturbed grassland (grassland-scrub ecotone and grassland). Residential areas, landscaped parks, playing fields, golf courses, shopping centers, roads, and ruderal areas with >50% cover by Eucalyptus, Acacia, or other ornamental species were considered to be developed. Polygons classified as the same subassociation and sharing a common boundary were subsequently merged to form larger units than originally had been mapped in the field. Area estimates for vegetation polygons, uncorrected for slope effects, were obtained through ArcInfo.

**Table 1** Key to Coastal Sage Scrub and Grassland Categories Used in Vegetation Mapping on the Palos Verdes Peninsula*

| A | Percent cover of Ac + Er + Sa + Op + En + Rh < 30% ............................................. B |
| A' | Percent cover of Ac + Er + Sa + Op + En + Rh ≥ 30% .................................................. |
| B | Percent cover of Ac + Er + Sa + Op + En + Rh < 15% .............................................. Grassland |
| B' | Percent cover of Ac + Er + Sa + Op + En + Rh ≥ 15% ........ Grassland-scrub ecotone |
| C | Percent cover of Rh ≥ percent cover of Ac + Er + Sa + Op + En ................................ Lemonadeberry scrub |
| C' | Percent cover of Rh < percent cover of Ac + Er + Sa + Op + En .................................. D |
| D | Percent cover of Sa + Rh ≥ percent cover of Ac + Er + Op + En ................................ Sage-lemonadeberry scrub |
| D' | Percent cover of Sa + Rh < percent cover of Ac + Er + Op + En ................................ E |
| E | Percent cover of Op ≥ 25% ......................................................................................... Cactus scrub |
| E' | Percent cover of Op < 25% ......................................................................................... Sagebrush scrub |

*Ac, Artemisia californica; Er, Eriogonum spp.; Sa, Salvia spp.; Op, Opuntia spp.; Rh, Rhus integrifolia; En, Encelia californica.*
Population Surveys

All major areas of natural habitat on the Palos Verdes Peninsula were surveyed for breeding California Gnatcatchers from February to June of each year of the study (1993–1997). Surveys were generally conducted before 11:00 and after 16:00, in weather deemed acceptable in terms of wind and temperature. Taped recordings of gnatcatcher calls were used to elicit responses. In areas where adjacent territories of unbanded birds posed potential confusion over the number of pairs actually present, teams of two to four biologists revisited the site to observe all birds in question simultaneously. Because of the limited amount of suitable habitat and our population estimates’ being based on observations of uniquely banded birds, the locations of simultaneously active nests, or simultaneous observations of unbanded birds, we feel confident in the accuracy of our results. There was no substantial change in survey effort or technique during the study. We recorded the locations of breeding pairs on 7.5-minute USGS topographic maps that were enlarged to a scale of approximately 1 inch = 500 feet, then digitized with ArcInfo.

RESULTS

Habitat Distribution

We located approximately 642 ha of coastal sage scrub on the Palos Verdes Peninsula (Figure 1), of which 170 ha (26%) consisted of fragments of less than 5 ha each. Only one area of scrub exceeded 100 ha; this single tract represented approximately 17% of the total coastal sage scrub remaining on the peninsula.

Sagebrush scrub represented 46% of the total coastal sage scrub on the Palos Verdes Peninsula (Table 2). The least common of the four major subassociations was cactus scrub, which made up only 6%. Approximately 198 ha of grassland–scrub ecotone, where coastal sage scrub plants represented 15–29% of the vegetation cover, and 829 ha of grassland occurred on the peninsula.

Approximately 59% of coastal sage scrub remaining on the Palos Verdes Peninsula was located within the jurisdiction of the city of Rancho Palos Verdes (Table 2). Even greater percentages of the total remaining amounts of sagebrush scrub (69%) and cactus scrub (81%) occurred within Rancho Palos Verdes city limits. Scrub in the cities of Palos Verdes Estates and Rolling Hills was classified predominantly as lemonadeberry scrub or sage–lemonadeberry scrub (Table 2).

Gnatcatcher Population Size and Distribution

We found 26 to 56 breeding pairs of the California Gnatcatcher during the 1993–1997 nesting seasons (Figure 2). The population was greatest (56 pairs) in 1994. From 1994 to 1995 the number of breeding pairs declined 54%, then increased 50% from 1995 to 1996. None of these population fluctuations was evidently related to changes in habitat availability, as the amount of coastal sage scrub on the peninsula did not vary significantly from
1993 to 1997. Most gnatcatchers on the peninsula were located in the city of Rancho Palos Verdes (Table 3).

In all years of our study the majority of pairs were located in polygons classified as sagebrush scrub (Table 3; Figure 3). In the absence of detailed territory mapping, however, plotting of locations must be somewhat arbitrary and therefore unlikely to fully reflect the habitat as the birds perceive it. We suggest that habitat preferences are better demonstrated by the broader landscape where pairs are found (Figure 3). For example, during 1997, 14 pairs were located in areas classified as "grassland" or "grassland-scrub ecotone," raising questions regarding precision of the mapped locations of these pairs and/or the vegetation classification of these polygons (Table 3). Habitat analysis at a larger scale, however, showed that virtually all of these pairs were located in areas containing large amounts of sagebrush scrub, grassland, and grassland-scrub ecotone (Figure 3). On the Palos Verdes...
Table 2  Extent (ha) of Principal Coastal Sage Scrub and Grassland Habitats on the Palos Verdes Peninsula, 1993–1997

<table>
<thead>
<tr>
<th>Vegetation type</th>
<th>Total area</th>
<th>Mean</th>
<th>SD</th>
<th>n</th>
<th>Max</th>
<th>RPV</th>
<th>PVE</th>
<th>RH</th>
<th>RHE</th>
<th>SP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sagebrush scrub</td>
<td>298</td>
<td>2.79</td>
<td>2.90</td>
<td>107</td>
<td>22.4</td>
<td>205</td>
<td>27</td>
<td>33</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>Cactus scrub</td>
<td>37</td>
<td>1.06</td>
<td>0.76</td>
<td>35</td>
<td>2.9</td>
<td>30</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sage-lemonadeberry</td>
<td>101</td>
<td>3.05</td>
<td>4.25</td>
<td>33</td>
<td>24.5</td>
<td>46</td>
<td>0</td>
<td>49</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Lemonadeberry scrub</td>
<td>206</td>
<td>4.91</td>
<td>6.23</td>
<td>42</td>
<td>26.7</td>
<td>97</td>
<td>42</td>
<td>61</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Grassland-scrub ecotone</td>
<td>198</td>
<td>2.28</td>
<td>2.42</td>
<td>87</td>
<td>15.9</td>
<td>135</td>
<td>25</td>
<td>24</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Grassland</td>
<td>829</td>
<td>6.74</td>
<td>12.77</td>
<td>123</td>
<td>69.3</td>
<td>579</td>
<td>57</td>
<td>41</td>
<td>58</td>
<td>94</td>
</tr>
</tbody>
</table>

aRPV, Rancho Palos Verdes; PVE, Palos Verdes Estates; RH, Rolling Hills; RHE, Rolling Hills Estates; SP, San Pedro.

Peninsula, as well as elsewhere in southern California (Atwood unpubl. data), California Gnatcatchers are more likely to occur in landscapes where coastal sage scrub is patchily distributed within a grassland matrix than in continuous tracts of scrub as often occur near chaparral.

Some apparently suitable habitat on the peninsula was unoccupied by breeding gnatcatchers throughout the study. We never found breeding pairs in

Figure 2. Annual variation in number of breeding pairs of California Gnatcatchers on the Palos Verdes Peninsula, 1993–1997.
approximately 427 ha of coastal sage scrub vegetation, including approximately 159 ha that were classified as sagebrush scrub (representing 53% of the total amount of this subassociation). Patch size effectively predicted presence or absence of gnatcatchers in polygons classified as sagebrush scrub ($P < 0.001$, logistic regression) (Figure 4). Patches of this subassociation with gnatcatchers were significantly larger than unoccupied areas (occupied: mean 4.07 ha, SD 3.88, $n = 39$, range 0.34–22.4 ha; unoccupied: mean 2.05 ha, SD 1.81, $n = 68$, range 0.18–10.48 ha; $P = 0.001$, Mann–Whitney U test). Patch size showed no significant relationship with gnatcatcher occupancy for polygons delineated as cactus scrub, sage–lemonadeberry scrub, or lemonadeberry scrub ($P > 0.10$, logistic regression) (Figure 4).

Of 34 patches of coastal sage scrub (all subassociations combined) used by breeding gnatcatchers during the study, 7 (21%) supported pairs during all 5 years, 3 (9%) during 4 of the years, 5 (15%) during 3 of the years, 9 (26%) during 2 of the years, and 10 (29%) during only a single breeding season. Patch size was a successful predictor of the consistency of occupancy by gnatcatchers ($P = 0.016$, logistic regression). There was a significant difference in area among patches occupied for one to five years ($P = 0.032$, Kruskal–Wallis test), with patches used for four or five years being substantially larger than patches occupied one, two, or three years (Figure 5).

During each year of the study, a large portion of the peninsula’s entire gnatcatcher population was concentrated in Agua Amarga Canyon, the vicinity of Edward’s Canyon (McCarrell’s Canyon), and near Klondike Canyon (Figure 6). These three localities, which included only about 33% of the area of coastal sage scrub (all subassociations) on the peninsula, supported from 41% to 58% (mean 46%) of the annual breeding population from 1993 to 1997.

**DISCUSSION**

Shaffer (1981), Gilpin and Soule (1986), and Hanski (1991) summarized major forces that may contribute to population extinction. “Deterministic”
extinctions may result from the removal of an essential resource, such as a specific habitat type on which an organism is dependent. "Stochastic" extinctions may result from normal, random perturbations, such as demographic, genetic, and environmental variations, as well as catastrophes. As noted by Gilpin and Soule (1986), "decay in one factor (such as population size) can exacerbate not only itself but also the behavior of other factors (such as inbreeding and fragmentation)."

Our results indicate that the population of California Gnatcatchers on the Palos Verdes Peninsula is characterized by a number of factors that place it at a high risk of extinction. Only about 30 breeding pairs of gnatcatchers now remain on the peninsula, and the surrounding megalopolis of Los Angeles makes immigration of birds from other portions of the species' range in southern California impossible or extremely unlikely. Furthermore, gnatcatchers remaining on the peninsula are distributed over a very fragmented landscape, with approximately 50% of the total breeding population concentrated in three relatively small areas that could easily be disrupted by development or fire. Soule (1986) suggested that extinction due to demographic stochasticity is a real threat for populations of 20 or fewer breeding females. On the Palos Verdes Peninsula factors not yet fully understood but most likely related to weather variations have caused one-year declines exceeding 50%.
Conservation of California Gnatcatchers in the Palos Verdes area will require careful protection of nearly all areas of currently occupied coastal sage scrub, especially in the Agua Amarga Canyon, Edward’s Canyon (McCarrell’s Canyon), and Klondike Canyon areas. Additional efforts should also focus on increasing the overall amount of sagebrush scrub through restoration, especially on lands adjacent to currently occupied habitat. However, given the Palos Verdes gnatcatcher population’s current highly threatened status, plans to mitigate loss of presently occupied habitat through long-term habitat restoration projects may not be realistic.

While conclusions regarding the gnatcatcher’s long-term status on the peninsula must await completion of further studies and planning, at this time we see no evidence suggesting that the Palos Verdes population is not severely threatened. Under present knowledge, it would certainly be foolhardy to base planning decisions elsewhere in coastal southern California on the mere fact that California Gnatcatchers now tenuously persist on the peninsula.

SUMMARY

The population of the California Gnatcatcher on the Palos Verdes Peninsula of Los Angeles County provides a unique opportunity for studying the species’ biology in a fragmented and highly isolated landscape. Annual surveys located 51, 56, 26, 39, and 38 breeding pairs from 1993 to 1997. Substantial areas of apparently suitable habitat were not used by breeding gnatcatchers. Approximately 50% of each year’s breeding pairs were concentrated in approximately 33% of the peninsula’s 642 ha of coastal sage scrub. Of discrete habitat patches occupied by breeding birds, only 21% were occupied during all 5 years. Patch size effectively predicted both the
Figure 5. Mean patch size and number of years of occupancy by California Gnatcatchers on the Palos Verdes Peninsula, 1993–1997. Error bars, 2 standard errors.

Our results suggest that the Palos Verdes population of California Gnatcatchers is at a high risk of extinction because of its small size, concentrated distribution, and isolation from other populations in Los Angeles and Orange counties.

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Figure 6. Principal locations of California Gnatcatchers on the Palos Verdes Peninsula, 1993-1997. Black areas, habitat that supported >5% of each year's total population; gray areas, other regions of coastal sage scrub. Area 1, Klondike Canyon and vicinity; area 2, Agua Amarga Canyon; area 3, Edward's (McCarrell's) Canyon and vicinity. Fine black lines, city boundaries.

LITERATURE CITED


Calif. Dept. Fish & Game. 1993. Southern California coastal sage scrub Natural Communities Conservation Plan: Scientific review panel conservation guidelines and documentation (order from Calif. Dept. Fish & Game, 1416 9th Street, Sacramento 95814).


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DISPERsal CApability OF THE CAliFOrniA GNATcatcher: A LANDSCAPE AnALYsis OF DISTRIBUTIOn DA TA

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Dispersal is the means by which genetic and demographic exchange between subpopulations maintains the viability of the regional metapopulation (Fahrig and Merriam 1985, Lacy 1987, Merriam 1991). Our paper describes potential limitations of existing data on dispersal of juvenile California Gnatcatchers (Polioptila californica) and provides a landscape analysis of distribution data from areas of fragmented habitat. This analysis suggests that the dispersal capability of the California Gnatcatcher may be underappreciated.

METHODS

We studied California Gnatcatchers on approximately 842 ha of coastal sage scrub near the Sweetwater River in the unincorporated community of Rancho San Diego in southwestern San Diego County (32° 40' N, 117° W). Rancho San Diego is approximately 21 km from the Pacific coast and 21 km north of the United States-Mexico border. There were two primary study areas within 2 km of each other. Gnatcatchers were color-banded at the larger study area (1200 ha) from 1989 to 1991 and at the second smaller (111 ha), more easterly, study area (111 ha) from 1989 to 1992. We banded a total of 100 juvenile California Gnatcatchers between 1988 and 1992; 28 individuals were resighted in subsequent years after having dispersed away from their banding locations. We compare this dispersal data to comparable data for the Palos Verdes Peninsula (Atwood et al. 1998).

We evaluate the landscape characteristics of five dispersals of juvenile gnatcatchers to isolated sage scrub fragments at Palos Verdes (Los Angeles County), Encinitas, Point Loma, and the South Park, and Chollas Creek neighborhoods in the city of San Diego. For each dispersal we measured the distance both as a straight line and along a parsimonious landscape route favoring natural vegetation and topography. Vegetation and sighting information were derived from databases for regional habitat-conservation-planning programs maintained by the San Diego Association of Governments and the city of Rancho Palos Verdes. Aerial photographs (1:24,000 scale) were used to interpret the types of highly human-modified habitats.

RESULTS

Dispersal of banded juvenile California Gnatcatchers has been studied at Rancho San Diego (Mock and Bolger 1992), the Palos Verdes Peninsula (Atwood et al. 1998), and Siphon Reservoir, Orange County (Galvin 1998). The first two studies have documented median straight-line dispersal distances
of less than 3 km (Figure 1), whereas the third reports an average dispersal distance of less than 500 m (excluding a single observation at 7.55 km). The dispersal curves for Palos Verdes and Rancho San Diego are similar, but these results likely underestimate the gnatcatcher's typical dispersal distance because of the limitations of a relatively small search area (Barrowclough 1978, Cunningham 1986, Payne 1990). The Palos Verdes Peninsula population is presumably a closed population with restricted options for dispersing birds; this population appears to be able to reach all habitat patches on the peninsula. Potential habitat for dispersing gnatcatchers at Palos Verdes is limited to a relatively small area (less than 900 ha of habitat), and the longest possible straight-line distance between the most distant sage scrub patches on the peninsula is less than 10 km.

Twenty-eight of the 100 juveniles banded during the Rancho San Diego study were detected within the two study areas or were reported by biologists at other nearby sites. The remaining banded juveniles either died or dispersed outside of the study area and remained undetected. Many of the resightings in the Rancho San Diego study occurred during the drought years of 1989 and 1990, when gnatcatcher population densities were relatively low and habitat was readily available near a juvenile's natal territory. Fifteen of 28 banded gnatcatchers resighted at Rancho San Diego dispersed more than one territory away from their banding location (Figure 2). Nine of these 15 gnatcatchers most likely passed through landscapes that were extensively human-modified (residential, disturbed habitats, golf course, busy roads such

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Figure 1. Dispersal-distance curves of California Gnatcatchers at Rancho San Diego (n = 28 individuals; Mock and Bolger 1992) and Palos Verdes (n = 76 individuals; Atwood et al. 1998).
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Figure 2. Straight-line dispersal routes for 15 California Gnatcatchers dispersing more than one territory away from their banding location at Rancho San Diego. Vegetation data from regional database. Cross-hatching, coastal sage scrub; vertical dashes, other natural vegetation; no pattern, developed areas; open triangles, California Gnatcatcher sightings.

as highways 54 and 94). Several survey reports have documented dispersal of juvenile California Gnatcatchers across highly man-modified landscapes (Atwood et al. 1998, Everett et al. 1993, Galvin 1998, J. Lovio pers. comm., D. Hunsaker pers. comm.). Recent detailed studies of fragmentation of sage scrub suggest that the gnatcatcher may be able to maintain itself within an archipelago of small patches of habitat (Lovio 1996).

Gnatcatcher occurrences in isolated habitat patches that have been fragmented for over 20 years also suggest dispersal across highly human-modified landscapes. Table 1 compares the straight-line dispersal distance and natural-landscape dispersal distance for the five examples. Figures 3 through 6 show general vegetation coverage of each dispersal location. The vegetation types shown are coastal sage scrub, other natural vegetation (e.g., chaparral, riparian habitats, and grasslands), and developed/agricultural land (highly human-modified landscapes). The types of highly human-modified landscapes crossed by dispersing gnatcatchers are also summarized in the table in order of relative abundance.

Palos Verdes

A banded juvenile California Gnatcatcher on the Palos Verdes Peninsula dispersed to the U.S. Navy Fuel Depot (Figure 3; Atwood et al. 1995). To reach the native vegetation at the fuel depot, the gnatcatcher had to traverse
### Table 1
Presumed California Gnatcatcher Dispersal Distances across Highly Human-modified Landscapes

<table>
<thead>
<tr>
<th>Location</th>
<th>Dispersal distance (km)</th>
<th>Distance across modified landscape (km)</th>
<th>Proportion modified landscape (%)</th>
<th>Type of modified landscape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straight-line route</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palos Verdes</td>
<td>3.18</td>
<td>2.27</td>
<td>71</td>
<td>Moderate-density residential, well vegetated</td>
</tr>
<tr>
<td>Encinitas</td>
<td>1.10</td>
<td>0.79</td>
<td>72</td>
<td>High-density residential, little vegetation</td>
</tr>
<tr>
<td>Point Loma</td>
<td>5.83</td>
<td>5.28</td>
<td>91</td>
<td>Moderate-to high-density residential and commercial, poorly to well vegetated</td>
</tr>
<tr>
<td>South Park, San Diego</td>
<td>1.81</td>
<td>1.10</td>
<td>61</td>
<td>High-density residential, little vegetation</td>
</tr>
<tr>
<td>Chollas Creek, San Diego</td>
<td>1.73</td>
<td>1.26</td>
<td>73</td>
<td>High-density residential, well vegetated</td>
</tr>
<tr>
<td>Mean</td>
<td>2.73</td>
<td>2.14</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>Natural-landscape route</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palos Verdes</td>
<td>4.15</td>
<td>1.48</td>
<td>36</td>
<td>Parklike open space, well vegetated</td>
</tr>
<tr>
<td>Encinitas</td>
<td>1.26</td>
<td>0.34</td>
<td>27</td>
<td>High-density residential, well vegetated</td>
</tr>
<tr>
<td>Point Loma</td>
<td>6.54</td>
<td>2.99</td>
<td>46</td>
<td>Concrete channel; moderate-to high-density residential, well vegetated</td>
</tr>
<tr>
<td>South Park, San Diego</td>
<td>2.99</td>
<td>0.39</td>
<td>13</td>
<td>High-density residential, little vegetation</td>
</tr>
<tr>
<td>Chollas Creek, San Diego</td>
<td>2.17</td>
<td>0.79</td>
<td>36</td>
<td>High-density residential, well vegetated</td>
</tr>
<tr>
<td>Mean</td>
<td>3.42</td>
<td>1.20</td>
<td>32</td>
<td></td>
</tr>
</tbody>
</table>

*Based on landscape analysis (see Figures 3, 4, 5, and 6).

Highly human-modified landscapes for at least 1.3 km (Table 1). This route crosses several well-vegetated residential lots, continues along a strip of coastal sage scrub and other natural vegetation, crosses a wooded estate, skirts Palos Verdes Reservoir, and crosses Green Hills Memorial Park to reach the Navy fuel depot. At least two additional individuals have been subsequently documented dispersing between isolated sage scrub patches through human-modified habitats (Atwood et al. 1998).

**Encinitas**

Bailey noted a dispersing gnatcatcher on 14 June 1993 in a small fragment (less than 4 ha) of chaparral and riparian habitat (Figure 4). We assume it to have been a first-year bird since no gnatcatchers inhabited the site during the previous breeding season (1992). The gnatcatcher was not resighted during two subsequent visits in June. The nearest source population is around San Elijo Lagoon. To reach the fragmented site from San Elijo
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Figure 3. Straight-line (dotted line) and presumed natural-landscape routes (solid line) of juvenile California Gnatcatcher dispersing through highly human-modified landscape at Palos Verdes (Atwood et al. 1995). Vegetation from regional database. Cross-hatching, coastal sage scrub; vertical dashes, other natural vegetation; no pattern, developed areas.

Lagoon, a gnatcatcher would have to traverse a high-density residential neighborhood for at least 0.55 km (Table 1). Many of the homes in this neighborhood are well vegetated with mature ornamental trees and shrubs.

Point Loma

A California Gnatcatcher detected during focused surveys of Point Loma in 1993 was considered to be a dispersing individual (Figure 5; Everett et al. 1993). There were two previous reports of California Gnatcatchers on Point Loma in 1990 and 1992. Two gnatcatchers were detected in August of 1990, but did not remain in the area. Breeding gnatcatchers apparently have not occupied Point Loma for at least three decades and perhaps for much longer (Everett et al. 1993). Everett et al. (1993) concluded that Point Loma currently does not support a breeding gnatcatcher population and is apparently isolated by distance from likely source populations. However, W. E. Haas (pers. comm.) noted a pair of gnatcatchers in the fall of 1995 near the 1993 sighting location.

The source population nearest Point Loma is in Tecolote Canyon near the University of San Diego (Figure 5). To reach the native vegetation on Point Loma from Tecolote Canyon, a gnatcatcher would have to traverse highly human-modified landscapes for at least 4.8 km (Table 1). This route would follow the Tecolote Creek concrete drainage ditch, open space around Mission Bay, the San Diego River channel, Famosa Slough, and the
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Figure 4. Straight-line (dashed line) and presumed natural-landscape routes (dotted line) of California Gnatcatcher detected in an isolated patch of coastal sage scrub in Encinitas (E. Bailey pers. obs.). Vegetation and gnatcatcher-locality data from regional database. Cross-hatching, coastal sage scrub; vertical dashes, other natural vegetation; no pattern, developed areas; open triangles, California Gnatcatcher sightings.

ridgeline of Point Loma, covered with moderate- to high-density residential neighborhoods having dense mature trees and shrubs. Two freeways and numerous major roads also would have been crossed.

South Park and Chollas Creek, San Diego

In November 1993 Bailey observed a pair of California Gnatcatchers along Home Avenue, east of Interstate 805 (Figure 6). In addition, two gnatcatchers were detected nearby in the fall of the same year adjacent to Interstate 15 near Highway 94 (RECON 1993). These patches of habitat have been fragmented for over 40 years, strongly suggesting gnatcatcher dispersal across highly human-modified landscapes (this assumes local extirpation followed by recolonization rather than the maintenance of a relict population). Nearby source populations are Chollas Community Park and Balboa Park, locations that are also habitat fragments. To reach the native vegetation at Home Avenue from Chollas Community Park, a gnatcatcher would have to traverse highly man-modified landscapes for at least 1.3 km (Table 1). This route crosses a well-vegetated high-density residential area, continues through coastal sage scrub along Chollas Creek, and crosses over a residential and commercial area to the Home Avenue site. To reach native vegetation near Interstate 15 from Balboa Park, a gnatcatcher would have to traverse highly
Figure 5. Straight-line (dashed line) and presumed natural-landscape route (dotted line) of California Gnatcatchers detected on Point Loma (Everett et al. 1993). Vegetation from regional database. Cross-hatching, coastal sage scrub patches; vertical dashes, other natural vegetation; no pattern, developed areas; open triangles, California Gnatcatcher sightings, with year of sighting.

human-modified landscapes for at least 0.63 km (Table 1). This route crosses both fragments of native vegetation in canyons and high-density residential areas with little vegetation. Subsequent effort by P. Unitt for the San Diego Bird Atlas has documented a pair nesting at the Interstate 15 site and three
DISPERAL CAPABILITY OF THE CALIFORNIA GNATCATHER

Figure 6. Straight-line (dashed line) and presumed natural-landscape route (dotted line) of California Gnatcatchers detected in central San Diego (E. Bailey pers. obs.) and Chollas Creek (RECON 1993). Vegetation and gnatcatcher-locality data from regional database. Cross hatching, coastal sage scrub; vertical dashes, other natural vegetation; no pattern, developed areas; open triangles, California Gnatcatcher sightings.

gnatcatcher territories within Chollas Canyon between Chollas Park and the Home Avenue site. These subsequent sightings suggest there is a large cluster of habitat islands within an otherwise urban landscape that appears to allow for demographic exchange of gnatcatchers between habitat fragments (P. Unitt pers. comm, Lovio 1996).

DISCUSSION

We conclude that existing banding studies likely underestimate the typical and maximum California Gnatcatcher dispersal distance and that California Gnatcatchers appear to be capable of dispersing relatively long distances across highly human-modified landscapes (0.5 to 5.0 km, assuming a natural-landscape route; Table 1). Gathering an unbiased sample of dispersal distances is likely to be impractical for relatively large landscapes, such as San Diego County (Barrowclough 1978, Cunningham 1986, Payne 1990). An exponential model fitted to the Rancho San Diego dispersal data predicts a maximal dispersal distance of less than 22 km for 95% of juveniles surviving to October. A circle with a 22-km radius encompasses over 1500 km² (150,000 ha). A thorough search of sage scrub within such a large area over a short time period in fall (before substantial winter mortality) would be a very costly endeavor. Some conservation biologists have recommended
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against extrapolating dispersal data beyond empirically derived maximum values (Brussard et al. 1993:16); however, this conservative interpretation of spatially limited and biased dispersal data will usually result in an underestimation of a species’ dispersal capability (Cunningham 1986) and ultimately lead to an overestimation of the metapopulation’s vulnerability to extinction.

Although not preferred in a preserve design, “stepping-stone” dispersal corridors may be the only remaining dispersal routes between some core gnatcatcher populations of significant conservation value. Such minimal corridors appear to exist in San Diego County (e.g., Lakeside and Oceanside) and are likely to be critical linkages between substantial populations of the California Gnatcatcher. There are also relatively large islands of gnatcatcher-occupied coastal sage scrub completely surrounded by man-modified landscapes (e.g., Twin Peaks and Van Dam Peak in Poway, Rattlesnake Mountain in Santee, Dictionary Hill west of Sweetwater Reservoir). These habitat fragments cumulatively support several hundred pairs, and their conservation value may be underestimated. Dispersal studies of banded gnatcatcher populations associated with presumed stepping-stone corridors and relatively large isolated patches of coastal sage scrub are recommended.

SUMMARY

In the California Gnatcatcher, dispersal of juveniles is the means by which genetic and demographic exchange between subpopulations maintains the viability of the regional metapopulation. Studies of banded individuals in southern San Diego County and at Palos Verdes in Los Angeles County have documented median dispersal distances of less than 3 km. These measures likely underestimate the gnatcatcher’s typical dispersal capacity because of the difficulty of detecting dispersed individuals in open populations and the opportunity for successful dispersal to maximum distances being truncated in small isolated patches of habitat. Spatially isolated occurrences of gnatcatchers suggest juveniles’ dispersal capability is greater than empirically documented with banded individuals. Juvenile California Gnatcatchers are apparently able to traverse highly man-modified landscapes for at least short distances. Underestimation of a species’ dispersal capability can lead to an overestimation of the metapopulation’s vulnerability to extinction. The conservation value of “stepping-stone” corridors and of relatively large patches of gnatcatcher-occupied coastal sage scrub surrounded by man-modified landscapes may be underestimated.

ACKNOWLEDGMENTS

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DISPERsal Capability of the California Gnatcatcher

LITERATURE CITED


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HISTORY AND STATUS OF THE CALIFORNIA GNATCATCHER IN SAN BERNARDINO COUNTY, CALIFORNIA

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Historically the California Gnatcatcher (Polioptila californica) ranged north to southwestern San Bernardino County, where it has now been nearly eliminated by urbanization. Since 1990 we have recorded the California Gnatcatcher at seven sites in southwestern San Bernardino County, including portions of Lytle Creek wash, the Santa Ana River wash, the southern slope of the San Gabriel Mountains, and the Jurupa Hills (Figure 1).

STUDY AREA AND METHODS

The San Bernardino Valley, centering approximately at 34°04' N, 117°17' W, lies at the south base of the Transverse Ranges (eastern San Gabriel and San Bernardino mountains). Elevation varies from 180 to 210 m on valley floors near Chino and gradually increases to about 360 to 420 m near San Bernardino and Redlands. The climate is Mediterranean with cool, wet winters and dry, warm summers. Annual sunshine is 70% to 80%. The

![Figure 1](image_url). Approximate locations of recent and historic California Gnatcatcher locations in the San Bernardino Valley.

Western Birds 29:361–365, 1998
average daily maximum temperature is approximately 33°C to 37°C in midsummer and 18°C in winter. Annual precipitation varies from 30.5 to 50.5 cm, of which approximately 90% falls from November to April (Woodruff and Brock 1980).

The predominant natural vegetation in the valley is Riversidean alluvial-fan sage scrub along washes and uplands, where it intergrades with chapparal at 600 to 700 m elevation. Other vegetation consists of a patchwork of Riversidean coastal sage scrub, valley grasslands, riparian woodlands, oak woodlands, and mixed hardwood forests with nearly closed canopies, which border the San Bernardino Valley on the north and east. The valley is extensively urbanized.

We compiled historical records for San Bernardino County California Gnatcatcher locations up to 1990 from the references in Atwood (1993). For more recent records we consulted other field biologists’ reports and the California Department of Fish and Game’s Natural Diversity Data Base. We collated these data with our 1994–1997 field surveys.

RESULTS

Atwood (1980) listed no locations for the California Gnatcatcher in San Bernardino County more recent than 1960. Later, Atwood (1993) noted a single bird observed in 1990 near the confluence of Cajon Wash and Lytle Creek Wash and one or two California Gnatcatchers reported during four San Bernardino Valley Christmas Bird Counts during the late 1960s and early 1970s (Klameth 1969, 1970, Cardiff 1971, 1973). He considered these reports “hypothetical” because of field-identification difficulties and suggested the California Gnatcatcher was extirpated from San Bernardino County while acknowledging that the Lytle Creek Wash area and the Jurupa Mountains (also known as the Jurupa Hills) could still contain California Gnatcatchers.

Recent records of the California Gnatcatcher in southwestern San Bernardino County are from the following seven localities.

1. Confluence Lytle Creek and Cajon Wash, where Douglas R. Willick and Ray Vizgirdas observed one on 6 September 1990 in mature alluvial sage scrub on a high, stabilized bench in the center of a wash. Elevation approximately 440 m. Associated plants buckwheat (Eriogonum fasciculatum), open chamise (Adenostoma fasciculatum), laurel sumac (Malosma laurina), Prunus, and Yucca whipplei. Soil Soboba stony loam sand, slope 2–9%. This site was destroyed in 1994 by gravel mining.

2. Sycamore Flat (at Lytle Creek), where Steven G. Nelson observed one on 16 March 1993 in Riversidean alluvial-fan sage scrub. Elevation approximately 600 m. Associated plants white sage (Salvia apiana) and deerweed (Lotus scoparius). Soil Soboba stony loam sand, slope 2–9%.

3. Etiwanda Fan (north Rancho Cucamonga) represents the densest concentration of white sage known in Riversidean alluvial-fan sage scrub (M. Meyer pers. comm.). Three records: 16 April 1994, when McKernan observed one female, 3 June 1994, when Russel B. Dunkin observed one adult male and female about 30 m from the previous site, and 17 June 1994, when Burns observed one adult male. Elevation approximately 580–
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700 m. Associated plants Salvia apiana, black sage (S. mellifera), Eriogonum fasciculatum, Adenostoma fasciculatum and Yucca whipplei. Soil Soboba stony loam sand, slopes 2-9%.


5. Jurupa Hills (Alder Avenue), where in spring 1994 Davis, McKeman, Gerald T. Braden, and Eugene Cardiff saw one adult male feeding a juvenile adjacent to Alder Avenue. In 1995, approximately 0.5 km west of Alder Avenue, five pairs were nesting in an area of approximately 40 hectares. Habitat Riversidean coastal sage scrub; elevation approximately 365 m (1994 site) to 550 m (1995 site). Associated plants Salvia apiana, S. mellifera, Artemisia californica, and Bromus madritensis ssp. rubens. Soil Cienega–rock outcrop complex.

6. Santa Ana River, east Highland (Figure 2), where on 28 June 1995 McKeman and Marnie S. Crook saw one juvenile in Riversidean alluvial-fan sage scrub. Elevation approximately 460 m. Associated plants Salvia apiana, Eriogonum fasciculatum, Lotus scoparius, and yerba santa (Eriodictyon trichocalyx). Soil Soboba stony loamy sand, slopes 2-9%.

Figure 2. Riversidean alluvial-fan sage scrub along the Santa Ana River (east Highland) where a juvenile California Gnatcatcher was seen in 1995.

Photo by Liam H. Davis and Robert L. McKeman
7. Rialto (north of Highland Avenue and east of Sierra Avenue), where in April and May 1997 Eugene A. Cardiff observed a single pair build two nests, both abandoned, in Riversidean alluvial-fan sage scrub. Elevation approximately 490 m. Associated plants Salvia mellifera, Artemisia californica, and Adenostoma fasciculatum. Soil Soboba gravelly loamy sand, slopes 0–9%.

DISCUSSION

The seven recent California Gnatcatcher locations in San Bernardino County are widely scattered in two subassociations of sage scrub: Riversidean coastal sage scrub and Riversidean alluvial-fan sage scrub (occurring both on uplands and washes). Alluvial-fan sage scrub, the predominant subassociation of coastal sage scrub in San Bernardino County, is designated as a “threatened” plant community by the California Department of Fish and Game (Keeler-Wolf 1993). More than 75% of this plant community has been extirpated from southern California (T. Keeler-Wolf pers. comm.).

We believe that the southern slope of the San Gabriel Mountains (Figure 1) could support nesting populations of the California Gnatcatcher, as implied by the three 1994 sightings on the Etiwanda Fan and the unsuccessful nesting in 1997 in north Rialto. The species was documented for Los Angeles County north of Claremont in 1994 along the alluvial fan (Calif. Dept. Fish & Game Natural Diversity Data Base). From north Claremont east through Etiwanda toward north Rialto, along the southern slope of the San Gabriel Mountains, extends approximately 30 km of Riversidean alluvial-fan sage scrub, most of which is not regularly surveyed for California Gnatcatchers.

Nesting is suspected or known at other locations in the San Bernardino Valley. The 1995 sighting in a wash along the Santa Ana River, east Highland, was of a juvenile. Most of the Jurupa Hills is not surveyed regularly.

Additional surveys are warranted, particularly for other nesting sites, throughout the larger contiguous pieces of coastal sage scrub in the San Bernardino Valley. Because focused surveys have not been conducted over approximately 95% of the valley, the current population of the California Gnatcatcher in San Bernardino County is unknown.

CONCLUSIONS

Some of our California Gnatcatcher sightings confirm Atwood’s suggestion (1993) that the species may still be found in the Lytle Creek wash area and the Jurupa Hills. The Jurupa Hills are now nearly isolated by urban development. It is not certain if the gnatcatcher’s nesting in the Jurupa Hills represents recent immigration or remnants of a historic population. Fifty years ago substantial numbers of the California Gnatcatcher occurred throughout the Jurupa Hills (E. A. Cardiff pers. comm.). Ground and aerial surveys reveal an interrupted corridor linking the Jurupa Hills with the sage scrub along the Santa Ana River to the east.

Protecting sage scrub is the obvious way to preserve the encroached northeastern periphery of the California Gnatcatcher’s range. Recovery of so severely decimated a population, however, may require attention to
adequate unoccupied habitat equal to that to conserving occupied habitat (Belovsky et al. 1994, Reed 1995).

SUMMARY

From 1990 to 1997 the California Gnatcatcher was recorded at seven locations in San Bernardino County, showing the species is not yet extirpated from that county, as formerly believed. The habitat at these sites is Riversidean coastal sage scrub or Riversidean alluvial-fan sage scrub, in both uplands and washes.

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LITERATURE CITED


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HISTORICAL DECLINE OF COASTAL SAGE SCRUB IN THE RIVERSIDE-PERRIS PLAIN, CALIFORNIA

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Californian coastal sage scrub (CSS), which consists of dense stands of soft-leaved drought-deciduous subshrubs 0.5–1.5 m tall, has been extensively cleared for agriculture and urbanization (Westman 1981). The state of California has initiated a regionally focused conservation-planning process for natural communities, including CSS, in southern California (O’Leary et al. 1992). To protect two endangered species of CSS, the Stephens’ Kangaroo Rat (Dipodomys stephensi) and the California Gnatcatcher (Polioptila californica), Riverside County has developed a habitat-conservation plan for CSS in the Riverside-Perris Plain, an area of rapid present and future urbanization. This has resulted in protection of CSS through purchase of private lands surrounding preexisting public lands, largely through political and economic incentives (Feldman 1995).

Few studies have examined the landscape-scale dynamics of surviving CSS, particularly in relation to the invasion of exotic annuals introduced from the Mediterranean basin and Middle East since the late 18th century. While it is widely reported that exotic annuals have displaced indigenous herbaceous ecosystems (McNaughton 1968, Gulmon 1977, Heady 1988, Drake and Mooney 1986, Huenneke et al. 1990, D’Antonio and Vitousek 1992), relationships between the spread of these annuals and the dynamics of shrubland communities are not well understood. O’Leary and Westman (1988) and O’Leary (1990) demonstrated that CSS has been reduced by frequent fire, grazing, and the invasion of exotic annuals, as well as air pollution. These trends have special importance for the endangered California Gnatcatcher, whose habitat requirements include dense stands of CSS with high shrub-species diversity (Atwood 1993). Planning efforts have not taken into account whether CSS is a static system.

From 1929 to 1934 the vegetation of California was inventoried by the Vegetation Type Map (VTM) Survey under the California Forest and Range Experiment Station (Minnich et al. 1995). During the survey, 78 plots of CSS were surveyed in the Riverside-Perris Plain. The objective of our study is to replicate the VTM for this area to quantify change of CSS over the past 60 years and to evaluate the role of exotics, specifically, whether the invasion of exotics is dependent on frequent burning or whether exotics promote frequent burning. The answer to this question affects whether management should focus on disturbance or the control of exotics. Addressing the question requires the examination of such processes associated in habitat change, including disturbance, grazing, competitive replacement, and air pollution.
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STUDY AREA

The Riverside-Perris Plain is a fault-bound alluvial basin with scattered small hills (elevation 600–1000 m) 80 km east of Los Angeles, California (Figure 1). Although the floor of the plain has been largely cultivated since ca. 1900, hillsides are covered with CSS dominated by Artemisia californica, Eriogonum fasciculatum, Salvia mellifera, S. apiana, and Encelia farinosa (plant names after Hickman 1993). The climate is Mediterranean with winter rain from frontal cyclones and summer drought. The rain shadow of the Santa Ana Mountains to the west leaves the plain with mean annual precipitation of 25 to 30 cm, falling mostly between November and April. The Santa Ana Mountains also isolate the basin from cooling sea breezes, resulting in maximum temperatures >35°C from June to September.

METHODS

We mapped CSS in the Riverside-Perris Plain from Kodak Type 2443 color positive transparencies taken from an aircraft in 1990 (scale 1:20,000), using a roll-film stereoscope with 3 and 8x magnification and a standard pocket stereoscope. CSS is recognized from the blue-gray color and low stature of subshrubs. We identified three types on the basis of cover: (1) dense coastal sage scrub (subshrubs forming contiguous stands), (2) mixed coastal sage scrub/exotic grassland (open stands of subshrubs with understory of exotic annuals), and (3) exotic grasslands (continuous exotic annuals

Figure 1. Coastal sage scrub in the Riverside-Perris Plain, with locations of California Vegetation Type Maps (VTM) plots.
with subshrub cover <20%). Boundary data were transferred onto 1:24,000 topographic sheets by means of a zoom transfer scope. The vegetation map and VTM data were entered into the Arc-Info geographic-information system installed on a Sun workstation. General methods are given in Minnich (1987).

We compiled data from VTM plots from original records. The plots consist of 20 field quadrats covering 0.005 acres (0.04 ha, on file at the Department of Environmental Science, Policy, and Management, University of California, Berkeley). Although VTM workers did not leave permanent markers, we believe that plots could be relocated within a radius of 100 m from localities given on manuscript maps (Minnich et al. 1995). We sampled each site three times, subjectively scattering replicate plots over an area of 1.0 ha, with each matching the slope and aspect conditions given on original field sheets. The three replicates were averaged to achieve one modern composite sample to be compared with original data. In each plot the dominant shrub species is identified for each 0.001 acre (ca. 2 m²). No species are recorded for individual quadrats lacking shrub cover. Eighty-two plots were visited in 1930, but four had been cleared for urbanization or fuelbreaks, leaving a total sample of 78 plots. Some change between 1930 and 1992 may be due to sampling error in relocation, but we believe that actual changes will emerge as a result of the large sample size.

RESULTS

Published VTM vegetation maps (Riverside, San Jacinto quadrangles; Weislander 1934, 1938) show that CSS covered ca. 74,950 ha, concentrated on hilly terrain of the Riverside–Perris Plain. Most stands were apparently dense, as only a few hills were shown as "semibarren." This is confirmed by aerial photographs taken in 1931, 1948, 1952, and 1962 (on file, Riverside County Department of Public Works). VTM field sheets disclose that most semibarren sites were recently burned. A few sites are too rocky to support dense cover. VTM vegetation maps give a hierarchical classification by life-form and species dominance (species ±20% cover). In the northern Riverside–Perris Plain, stands were dominated by Encelia farinosa on southern exposures, Eriogonum fasciculatum and Artemisia californica on northern exposures. Farther south, most stands comprised mixtures of Eriogonum fasciculatum, Artemisia californica, and Salvia mellifera. Monotypic stands of Eriogonum fasciculatum covered hillsides in the far south. Salvia mellifera was dominant in the Santa Ana Mountains and the badlands of the northeast. Other stands of S. mellifera were found in the central Riverside–Perris Plain in association with underlying Mesozoic basic intrusive rocks (gabbro basalts, Calif. Div. Mines 1969).

By 1990, only 30,118 ha or 40.1% of the stands mapped as CSS by VTM workers still existed as contiguous stands (Figure 1), with most occurring on outcrops of Mesozoic gabbro basalts in the south. Another 31,408 ha (41.9% of stands) were open CSS mixed with a continuous layer of exotic annual grasses. The remaining 13,424 ha (18.0%) were entirely converted to exotic grassland, with most conversions concentrated in valley edges and north-facing slopes. Cursory field observations indicate that pure
exotic grasslands and exotic grasslands mixed with CSS are dominated by *Bromus madritensis* ssp. rubens on southern exposures and *B. diandrus* on northern exposures. Other important species include *Avena barbata*, *Brassica geniculata*, *Schismus barbatus*, and *Erodium cicutarium*. *Brassica tournefortii*, native to the Sahara Desert, was introduced into the southern California deserts in 1927 and began invading hillsides near Riverside about 1987 (Minnich and Sanders in press). Time-series ground photographs in Riverside show that CSS declined largely after the 1950s (Figure 2).

Replicates of VTM plots revealed significant changes in shrub cover and species composition (Figure 3). VTM workers recorded 60 to 90% shrub cover at most sites. Field sheets show that three plots with <40% were each burned during the late 1920s. Most plots had two or three species with at least 20% cover, although some were dominated by one species, usually *Artemisia californica* on north-facing slopes, *Eriogonum fasciculatum* on flats or steep bluffs, *Encelia farinosa* on south-facing slopes in the north, or *Salvia mohlera* on gabbro basalts. Other species frequently recorded on VTM plots include *Lotus scoparius*, *Keckiella antirrhinoides*, *Malacothamnus fasciculata*, *Opuntia littoralis*, and *Bebbia juncea*.

Our replicates showed that shrub cover had declined to an average of 36% (Figure 3) and that dominance was usually restricted to a single species, according to VTM criteria. Plots with <30% shrub cover frequently had no dominant species. The cover of *Salvia apiana* decreased from 7.4 to 1.7%, that of *S. mohlera* from 13.9 to 6.1%, that of *Artemisia californica* from 17.7 to 6.1%, that of *Eriogonum fasciculatum* from 20.2 to 9.0%. Average cover of *Encelia farinosa* increased from 4.6 to 5.2%.

The change in total shrub cover varied greatly from site to site, ranging from stability (<5% losses) to total displacement of dense cover by annual grassland (>90% losses, Figure 4). Modal shrub loss was 40%. Among dominant species, *Artemisia californica* experienced the greatest loss, although on many plots its decline was <20%. Modal loss was 10–30% for all species except *Encelia farinosa*. The frequency of plots with shrub losses was far greater than of plots with gains.

Total shrub cover declined on most substrates (Figure 5). Modal declines were 50% on granitoid rocks and Pauba (Pliocene) and Pleistocene sandstones, 30–60% on Santiago Peak volcanics and the Jurassic Bedford Formation, 20% on gabbro basalts. The greatest losses were of *Artemisia californica* and *Eriogonum fasciculatum* on alluvium and *Salvia mohlera*, *Artemisia californica*, and *Eriogonum fasciculatum* on Santiago Peak volcanics and the Jurassic Bedford Formation. All species except *Encelia farinosa* experienced at least a 10% decline on granitoid rocks. Shrub losses have resulted in shifts in species composition on various rock units (Table 1). *Eriogonum fasciculatum* is no longer dominant on granitoid rocks, while on Santiago Peak volcanics and the Jurassic Bedford Formation *Artemisia californica/Eriogonum fasciculatum* codominance has shifted to monotypic dominance of *Eriogonum fasciculatum*. *Encelia farinosa* experienced relative gains to other species on all rock units.

The magnitude of total shrub loss correlates with the decline of individual species (Table 2). Plots with >35% cover losses are typically associated with
Figure 2. Coastal sage scrub on Picnic Hill, on the campus of the University of California, Riverside. A, 1917. Dense shrub cover of various sizes and shapes suggests a diverse species composition, mostly of *Artemisia californica*, *Eriogonum fasciculatum*, and *Salvia apiana*. Exotic annuals are absent. B, 1954. Contiguous shrub cover with comparable species diversity. C, 1992. Open stands surrounded by exotic annual grassland (mostly *Bromus diandrus*). Hill with water tank has small patches of *Encelia farinosa* on south-facing exposures. D, 1998. Dense cover of exotic grassland, the remaining shrubs having burned in a fire two years before. Patches of *Encelia farinosa* survive near the water tank.
large declines in *Artemisia californica* and *Eriogonum fasciculatum* and virtual disappearance of *Salvia apiana* and *S. mellifera*. *S. mellifera* was stable only in plots with <35% decline. All species except *S. apiana* were stable in plots having declines of <15%. *Encelia farinosa* was stable at all rates of stand-thinning.
Figure 4. Change in cover by species. Ac, Artemisia californica; Efr, Encelia farinosa; Efs, Eriogonum fasciculatum; Sa, Salvia apiana; Sm, Salvia mellifera.
The majority of VTM plots had burned within the previous 20 years. Chronosequences of plot replicates show that average shrub cover increased from 22% for 0–9 years after a fire to 48% for 30–39 years afterward (Figure 6). Stands last burned >40 years ago still had lower average cover (31%) than recorded in the original VTM survey. Postfire species composition compared against VTM data appears to be uniform through time, as all species seem to reestablish themselves early in succession (Table 3). Encelia farinosa reached mature cover in 10 years, Artemisia californica and Salvia apiana approached half of VTM values only after 20 years, Eriogonum fasciculatum reached VTM values in 20 to 40 years, and dense Salvia mellifera stands were found primarily in areas last burned >40 years ago.

Although stand-thinning may lead to a decline in shrub diversity, the numbers of species recorded in plot replicates are similar to those during the original survey, with two to five dominants occurring in 71% of plots in 1932, in 68% of plots in 1992. The cover of extirpated species reported in 1932, however, was consistently greater than for immigrating species seen today. The patterns of immigrations and extinctions vary by species (Table 4). Artemisia californica immigrated into more sites than it was extirpated from, but sites of extirpation had 42% cover in 1932 while immigrants produced only 5% cover in 1992. Eriogonum fasciculatum and Salvia mellifera were
### HISTORICAL DECLINE OF COASTAL SAGE SCRUB

#### Table 1 Change in Average Shrub Cover in the Riverside-Perris Plain by Substrate

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<sup>a</sup>Standard deviations in parentheses.

extirpated at twice as many sites as they immigrated to, and the 1932 cover of extirpated populations was twice that of 1992 immigrant populations. *S. apiana* died out at 42% of the original VTM plots, and new populations developed at only three localities. For *Encelia farinosa*, local immigrations were greater than extirpations, with an average cover of 5% for each.

Twenty-two plots (28.2% of the sample) had at least 10% cover of dead mature shrubs. High mortality was most common in plots last burned <40 years ago but also occurred in plots in early postfire succession (data not shown).

### DISCUSSION

Replication of 78 VTM quadrats in the Riverside-Perris Plain reveals significant stand-thinning over the past 60 years. At many sites, formerly dense shrub cover became open with a continuous layer of exotic annuals dominated by either *Bromus diandrus* or *B. madritensis*. Among dominant
HISTORICAL DECLINE OF COASTAL SAGE SCRUB

Table 2 Change in Average Cover by Species in the Riverside-Perris Plain Compared with Change in Total Shrub Cover

<table>
<thead>
<tr>
<th>Change in total shrub cover (%)</th>
<th>Year</th>
<th>Artemisia californica</th>
<th>Encelia farinosa</th>
<th>Eriogonum fasciculatum</th>
<th>Salvia apiana</th>
<th>Salvia mellifera</th>
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<tbody>
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<td>10.9</td>
<td>12.8</td>
<td>18</td>
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<tr>
<td></td>
<td>1992</td>
<td>3.3</td>
<td>4.4</td>
<td>2.8</td>
<td>0.6</td>
<td>0.5</td>
<td></td>
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<tr>
<td>-35 to -55</td>
<td>1932</td>
<td>23.1</td>
<td>6.0</td>
<td>17.7</td>
<td>6.0</td>
<td>13.7</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>1992</td>
<td>6.5</td>
<td>7.5</td>
<td>7.3</td>
<td>1.0</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>-15 to -35</td>
<td>1932</td>
<td>11.9</td>
<td>7.0</td>
<td>27.7</td>
<td>8.2</td>
<td>7.1</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>1992</td>
<td>7.0</td>
<td>6.3</td>
<td>13.7</td>
<td>1.3</td>
<td>6.4</td>
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</tr>
<tr>
<td>&gt; -15</td>
<td>1932</td>
<td>9.8</td>
<td>1.1</td>
<td>16.3</td>
<td>10.1</td>
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<td>12</td>
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<tr>
<td></td>
<td>1992</td>
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<td>2.2</td>
<td>23.2</td>
<td>6.2</td>
<td>18.3</td>
<td></td>
</tr>
</tbody>
</table>

*Standard deviations in parentheses.

shrub cover (1932) has been stable, while Eriogonum fasciculatum, Salvia apiana, S. mellifera, and Artemisia californica have decreased since the original survey. Artemisia californica experienced the greatest losses, perhaps because it was abundant on north-facing slopes now densely covered with exotic annual grassland. The decline of Eriogonum fasciculatum appears to be moderated by the high diversity of habitats it occupies, including flats and cliffs, where exotics are discouraged. Salvia mellifera losses were large except on gabbro basalts, and S. apiana has experienced both widespread declines and local extirpations. Dense CSS now persists mostly on steep, rocky slopes too porous for the establishment of annuals and on gabbro basalts (Figure 1).

Other broad-scale surveys of vegetation change in CSS give mixed results. From aerial photographs repeated in 1947 and 1989 near Santa Barbara, Callaway and Davis (1993) found that grassland was converted to coastal sage scrub but that Quercus agrifolia woodland was converted to grassland in the absence of fire because of suppression of the shrub layer. O’Leary and Westman (1988) found that CSS was more resilient under periodic fire along the coast in the Santa Monica Mountains than in the inland valleys of the Riverside-Perris Plain. Near Ramona in San Diego County, Bradbury (1974) found that CSS invaded chaparral in areas of chronic disturbance but found little change in CSS cover and species composition. In a vegetation-mapping survey from aerial photographs in 1928-36 and 1980, Freudenberger et al. (1987) found that grassland had increased in some
HISTORICAL DECLINE OF COASTAL SAGE SCRUB

Figure 6. Chronosequence of postfire shrub cover.

places of the Los Angeles Basin but that CSS replaced grassland in others. Seedling densities were high in CSS stands but low outside their boundaries.

CSS appears to be susceptible to profound change, even over short time scales, because of its extensive coexistence with invasive exotic annual grasses. Invasions of exotic annuals into CSS have been attributed to anthropogenic disturbance (Gulmon 1977, Freudenberger et al. 1987, Heady 1988, O'Leary and Westman 1988, O'Leary 1990). Since invasions are assumed to be closely associated with disturbance, it is argued that the degradation of CSS depends on excessive burning and overgrazing, which open up stands to penetration by exotics. CSS is able to resist biological invasions because the herbaceous vegetation (including exotics), which proliferates after a fire, is assumed to decline with the maturation of the shrub layer. Alternatively, the invasion by exotics into CSS may also be due to competitive replacement through processes such as competition for moisture and nutrients. Exotics may also shorten fire intervals by increasing the habitat's flammability (Drake and Mooney 1986, Huenneke and Mooney 1989, D'Antonio and Vitousek 1992).

Whether coastal sage scrub is degraded by disturbance or by exotic invasions requires the examination of three factors: (1) the successional dynamics of exotic herbaceous cover, (2) whether the invasion of exotics requires fire disturbance, grazing, or air pollution, and (3) whether anthropogenic ignition rates influence intervals of fire recurrence. Explanations of habitat change must also consider the history of invasion of exotics that compete directly with CSS.
Table 3 Change in Average Shrub Cover in the Riverside-Perris Plain Compared with Time Since Plot Last Burned

<table>
<thead>
<tr>
<th>Change in total shrub cover (%)</th>
<th>Year</th>
<th>Artemisia californica</th>
<th>Encelia farinosa</th>
<th>Eriogonum fasciculatum</th>
<th>Salvia apiana</th>
<th>Salvia mellifera</th>
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</table>

*Standard deviations in parentheses.

Land Clearing

The assertion that as much as 90% of CSS has been removed for urbanization and agriculture has been based on the assumption that fertile soils of the Los Angeles basin were largely covered by woody vegetation (Westman 1981, Freudenberger et al. 1987). Grasslands were presumed to be focused near Indian settlements and that frequent burning was required to maintain them (Timbrook et al. 1982). The record of indigenous vegetation in the coastal and interior valleys of California, however, is virtually nonexistent because exotic annuals introduced with Spanish colonization in 1769 were displacing native herbaceous cover before scientists first visited the region (Heady 1988). Accounts from the Portoló and Anza expeditions of 1769–1772 suggest that the Los Angeles Basin was covered by extensive herbaceous vegetation (Bolton 1927, 1930, Minnich 1988). In 1796 Juan Crespi and Junipero Serra described large areas of "pasture" in the plains of San Diego (Minnich and Franco-Vizcaino 1998). Hence estimates of CSS losses may be greatly exaggerated.

History of Invasions of Exotic Plants in California

An important question necessary to evaluating the role of disturbance versus competitive displacement is why the decline of CSS has occurred only during recent decades. Although European exotics have been present in California since Franciscan mission times in 1769, invasive species have
come in “waves” over the past two centuries (Heady 1988), and the ecological requirements of early arrivals were different from later ones, with divergent impacts on CSS.

The first exotics to spread extensively in southern California, notably, *Avena fatua*, *Brassica nigra*, and *Erodium cicutarium*, were introduced by Franciscan missionaries in 1769 or perhaps earlier as ballast from ships. These annuals quickly replaced indigenous herbaceous cover throughout California (Table 5; Heady 1988). For example, the U.S./Mexican boundary survey reports and the Pacific Railroad Surveys in the 1850s found that *Avena fatua*, *Brassica geniculata*, *Erodium cicutarium*, and *Trifolium* spp. were extensively naturalized in coastal southern California, including the San Bernardino Valley (Parry 1859, Minnich 1988). These surveys indicate, however, that exotic annuals were concentrated in bottomland habitats and disturbed places, as seen today, far from the CSS covering the foothills. Indigenous herbaceous vegetation was assumed to be perennial bunch grassland of *Nassella* spp., but historical descriptions, as well as phytolith and archaeological evidence, indicate that some herbaceous cover in southern California and neighboring northern Baja California may have consisted predominantly of forb fields (Bartolome et al. 1986, Bean and Lawton 1973, Timbrook et al. 1982, Minnich and Franco-Vizcaino 1998).

The second wave of exotic annuals, including mostly *Bromus* spp. and *Brassica* spp., did not reach the Riverside-Perris Plain until the early 20th century. In the San Bernardino Valley, the first records of *Bromus madritensis*, *B. diandrus*, and *Brassica geniculata* date to ca. 1890, when they were found mostly along roadsides and in waste places. These annuals gradually
expanded across valley lowlands only by 1920 (Parish 1913, 1920). In contrast with the first wave of exotics, they spread onto CSS-covered hillsides. They were later joined by still other taxa capable of invading CSS, including *Schismus barbatus* in the 1950s and *Brassica tournefortii* in the 1980s. The evaluation of dynamics in relation to fire, grazing, and air pollution must consider the history of proliferation of exotics.

**Fire**

Studies in California have shown that CSS is resilient under periodic fire, though most of its plants resprout poorly after being burned. Seedlings must establish themselves from a prefire seed cache (*Salvia apiana, S. mellifera*) or germinate from seed dispersed widely by wind (*Artemisia californica, Encelia farinosa, Eriogonum fasciculatum*). Resprouting species flower vigorously the first few years after a fire, providing nonrefractory seeds that germinate in subsequent years, leading to mixed-aged stands (Westman 1981). Recruitment and growth to maturity is extremely rapid (ca. 10–20 years) for most taxa (Westman 1982).

Disturbance-dependent models state that although early succession is characterized by abundant herb cover, the probability of recurring fire capable of breaching succession and inducing permanent vegetation change is averted by the limited persistence of indigenous herbs. Many herbs are specialized fire annuals that sprout from a dormant seed pool whose germination is stimulated by the heat of fire, charred wood, and light (Westman 1979, Keeley and Keeley 1984, O’Leary and Westman 1988). The decline of the herb layer improves the chances for the long intervals between fires compatible with the life-history traits of CSS species. However, there is uncertainty whether natives are fire annuals sensu stricto. Accounts by C. R. Orcutt and others of extensive flower fields before the second invasion of exotics (Minnich and Franco-Vizcaíno 1998) suggest that wildflowers may be more generalized, or germinate to cues of precipitation and temperature, like closely related desert wildflowers, as well as from fires.

---

**Table 5** Approximate Arrival Dates of Exotic Annuals in California*

<table>
<thead>
<tr>
<th>Species</th>
<th>Year</th>
<th>Native range</th>
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<tr>
<td><em>Erodium cicutarium</em></td>
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<tr>
<td><em>Avena fatua</em></td>
<td>1769</td>
<td>Mediterranean Europe</td>
</tr>
<tr>
<td><em>Brassica nigra</em></td>
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<td>Mediterranean Europe</td>
</tr>
<tr>
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<td><em>Bromus madritensis ssp. rubens</em></td>
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<td><em>Bromus diandrus</em></td>
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<tr>
<td><em>Bromus tectorum</em></td>
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<td><em>Avena barbata</em></td>
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<td>Mediterranean Europe</td>
</tr>
<tr>
<td><em>Brassica geniculata</em></td>
<td>1880</td>
<td>Mediterranean Europe</td>
</tr>
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<td><em>Brassica tournefortii</em></td>
<td>1927</td>
<td>Northern Sahara Desert</td>
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<td><em>Schismus barbatus</em></td>
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### Table 6 Total and Native Biomass and Shrub Cover by Time Since Fire in the Box Springs Mountains, Riverside

<table>
<thead>
<tr>
<th>Site and year</th>
<th>Precipitation (cm)</th>
<th>Years since fire</th>
<th>Total Biomass (tons/ha)</th>
<th>Native Biomass (tons/ha)</th>
<th>Shrub cover (%)</th>
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*Data from transects taken annually at the end of spring growth flush between March and early May.*

*No data.*

Many forbs may decompose and their stems may fragment during summer drought because they lack the silica content critical to the curing and flammability of grasses (D’Antonio and Vitousek 1992).

Field sampling for herb cover in the Box Springs Mountains, near Riverside, from 1989 to 1995 (Table 6) shows that annuals form high biomass within the first growing season after fire, reducing bare zones for shrub establishment. Native annuals (mostly Phacelia distans, Cryptantha intermedia, and Emmenanthe penduliflora) proliferated after a spring...
burn at one site but were replaced within 5 years by a dense cover of exotic annuals (*Bromus madritensis*, *Avena barbata*, *Erodium cicutarium*, *Schismus barbatus*, *Brassica geniculata*, and *B. tournefortii*), further preventing the development of the bare zones necessary for shrub establishment. Succession after a summer burn in Box Springs Canyon was dominated by exotic annuals from the start. *Erodium cicutarium* and *Schismus barbatus* were dominant the first two years, *Bromus madritensis* and *Avena barbata* thereafter. The persistence of herbaceous biomass was associated with shrub cover of 5 to 12% after 4 or 5 years. Shrub cover decreased from 29 to 12% after 10 years at one site from the combined effects of drought and freeze mortality. At yet another site, exotic annuals produced 1.5–3.0 tons/ha for 12 years after fire until the shrub layer reached canopy closure (shrub cover increased from 27 to 44% between 1990 and 1995).

Some studies indicate that fire at intervals <5–10 years will likely eliminate sage scrub, leading to domination by nonnative grasses (Wells 1962, Kirkpatrick and Hutchinson 1980, Keeley 1981, Zedler et al. 1983, Malanson 1984, Freudenberg et al. 1987, O’Leary and Westman 1988), although others have come to the opposite conclusion (Griffin 1978, Davis et al. 1988, Callaway and Davis 1993). It has been argued that the invasion of exotics has been prompted by anthropogenic burning because the rarity of lightning at low elevations makes natural fire too rare (Keeley 1981). Prehistoric fire intervals in CSS are unknown. However, electromagnetically recorded lightning-detection rates in the region are 0.5 to 1.0 strikes per kilohectare per year, and a 2–4% success rate in the initiating fires (suppressed lightning fires/lightning detections), typical of the nearby mountains, yields a fire-establishment rate requiring suppression of 1 per kilohectare every 30 years (Minnich et al. 1993). Fires in grassland can be much larger than in sage scrub because grasslands constitute a fire hazard at the landscape scale regardless of their history. Hence relatively few ignitions can lead to extensive burning. In the Box Springs Mountains, exotic annuals supported fires in 1989, 1993, and 1995, with the biomass levels of ±1.5 tons/ha. Since this level of biomass was reached with annual precipitation as low as 16.4 cm, 65% percent of normal (Table 6), herbaceous fuel build-up may be sufficient to carry fire most years. Three sampling sites had burned two to four years within the seven-year sampling period. Similarly, frequent fires in San Diego County were encouraged by deliberate seeding of the inflammable exotic grass *Lolium multiflorum* (Zedler et al. 1983).

In the Riverside-Perris Plain, California Division of Forestry records (on file at Perris) and Landsat imagery (Minnich 1983) show that fires carried primarily by exotic annual grassland have been frequent and extensive over the past 40 years, with the majority of VTM plots having burned during the past 20 years. VTM replicate chronosequences show that all CSS dominants are capable of reestablishing themselves soon after a fire. Only *Encelia farinosa*, however, has achieved the cover values reported in the original survey, and often within 10 years after fire. Other shrubs had not reached VTM levels by 40 years.

The divergence in succession patterns by slope is seen on Box Springs Mountain (Table 7). South-facing slopes experience rapid establishment of
virtually monotypic stands of *Encelia farinosa*, with shrub cover increasing to 60% and shrub density to 9687 per hectare by 14 years after a fire. Although we observed low rates of resprouting in *Encelia farinosa* (±10%), as many as 11,000 seedlings/ha established themselves within a few years, apparently through long-range wind dispersal of seeds. Seedling establishment diminished with increasing shrub cover, especially after 5 years. The resilience of *E. farinosa* may be related both to its resprouting ability and to its preference for xeric southern exposures where herbaceous cover is limited. On north-facing slopes, CSS cover was ±2.2% and densities were ±500 stems/ha, even in stands as old as 12 years. *Eriogonum fasciculatum*, *Artemisia californica*, and *Salvia apiana*, which were mapped as dominants on these sites by the VTM survey, apparently were burned almost totally, and the establishment of seedlings of these species that must regrow from seeds is apparently limited by the dense cover of *Bromus diandrus*. Moreover, there is little evidence that canopy closure reduces herb cover. Hence another grass fire is a virtual certainty before the development of a shrub canopy. Postfire succession may also be further postponed by increasing lag times due to the need for long-range seed dispersal from increasingly scarce surviving populations.

These trends are similar to postfire successions in inland Riversidian sage scrub recorded in other studies (Kirkpatrick and Hutchinson 1980, O'Leary

**Table 7 Sequence of Postfire Succession of Coastal Sage Scrub in the Box Springs Mountains**

<table>
<thead>
<tr>
<th>Site</th>
<th>Years since fire</th>
<th>Cover (%)&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Stem density&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Seedling density&lt;sup&gt;d&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>En Ef Total</td>
<td>En Ef Ac Total</td>
<td>En Ef Ac Total</td>
</tr>
<tr>
<td>South-facing slopes&lt;sup&gt;g&lt;/sup&gt;</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Sug94S</td>
<td>1</td>
<td>24.2 0 24.2</td>
<td>2760 0 0 1760</td>
<td>11,000 0 0 11,000</td>
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<tr>
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<td>2</td>
<td>4.8 0 4.8</td>
<td>900 0 0 900</td>
<td>3000 0 0 3000</td>
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<tr>
<td>Sug88S</td>
<td>7</td>
<td>35.6 0 35.6</td>
<td>2297 100 0 2397</td>
<td>1000 0 0 1100</td>
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<tr>
<td>Sug83S</td>
<td>12</td>
<td>42.4 0 42.4</td>
<td>4386 0 0 4386</td>
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<tr>
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<td>35.4 0 35.4</td>
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<td>Sug81S</td>
<td>14</td>
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<td>14</td>
<td>0 0 0</td>
<td>160 20 20 200</td>
<td>0 0 0 0</td>
</tr>
</tbody>
</table>

<sup>a</sup>En, *Encelia farinosa*; Ef, *Eriogonum fasciculatum*; Ac, *Artemisia californica*.

<sup>b</sup>Based on 50-m line-intercept transects.

<sup>c</sup>Expressed as stems per hectare and based on 50-m point-center quarter transects.

<sup>d</sup>Expressed as seedlings per hectare and based on 1.8-m circle plots on 10 points of point-center quarter transects. Seedlings were <10 cm tall with no charred stems at the root axis that would indicate resprouting.

<sup>g</sup>Slope aspect divided hemispherically with northern exposures (clockwise) from 270° to 90° and southern exposures from 90° to 270°.
and Westman 1988) and contrast with the resilience of sage scrub near the coast (Malanson and O'Leary 1982, 1985, Malanson 1984, O'Leary and Westman 1988). Along the coast, sage scrub shrubs, even some of the same or closely related species (Artemisia californica, Salvia leucophylla, Eriogonum fasciculatum, and Encelia californica) resprout better. Seedling establishment began in the second growing season after fire from the fruiting of shrubs resprouting the first year.

Grazing

Thinning of CSS has been attributed to livestock grazing, which opens up the shrub canopy to invasion by exotic annuals, disseminates seeds, and reduces the ability of native forbs and perennial bunch grasses to compete with exotics (McBride 1974, Freudenberger et al. 1987, O'Leary and Westman 1988). Historically, grazing was heaviest during the late 19th century. Livestock grazing in the Riverside–Perris Plain consisted of winter sheep drives beginning in the 1860s, reaching a peak near 1900 (Minnich 1988). Evidence is seen in criss-crossing trails ("sheeptours") on hillsides. However, grazing declined by the early 20th century—before the widespread naturalization of "second wave" exotics, including Bromus spp., and before the decline in CSS—because the annual transhumance grazing cycle was interrupted by the prohibition of summer browsing in the mountains with the establishment of national forests of southern California (Lockmann 1981). During our resurvey only two plots were subject to intense sheep grazing (Arlington Mountain, Massacre Canyon). Exotic grasses at these sites were browsed to the ground, and shrub seedlings appear to be eliminated by domestic stock, recalling of the impacts of grazing by feral goats and sheep on the Channel Islands (Brumbaugh 1980, Minnich 1980, Van Vuren and Coblentz 1987). Alternatively, the proliferation of exotics in southern California's inland valleys suggests that these plants were able to occupy suitable undisturbed habitat. For example, there is evidence that "first wave" invasions preceded settlement in the Central Valley (Wester 1975, 1981). Livestock disturbance and agricultural clearing have only a short-term role in the spread of these weeds (Biswell 1956, Naveh 1967, Heady 1988, Sauer 1988, Huenneke and Mooney 1989, Huenneke et al. 1990, D'Antonio and Vitousek 1992).

Competitive Exclusion

Aerial photographs and VTM-quadrat replications reveal shrub losses in stands last burned >40 years ago. Hence, while fire and grazing may facilitate conversion of CSS to grass, the deterioration of CSS may be more fundamentally related to competitive exclusion, in which exotics themselves induce habitat changes. Means for this include resource competition, light absorption, water uptake, altered water-holding capacity, and nutrient uptake (D'Antonio and Vitousek 1992). Exotic grasslands may be inducing nutrient and moisture regimes that inhibit the establishment, growth, and persistence of native shrubs (Westman 1981, O'Leary and Westman 1988). In the Riverside–Perris Plain, three lines of evidence support the view that exotics outcompete CSS.
(1) High shrub mortality during the 1992 replicate survey. In 22 plots (28% of VTM plots) the cover of dead shrubs was greater than 10%. Mortality followed drought between 1984 and 1990, during which time the water demand of dense, shallow-rooted exotics may have limited the water reaching the shrubs' roots. Shrub mortality may be related to the ability of herbs to produce high biomass (high water demand) in winters with subnormal precipitation. Although herb biomass was <0.6 tons/ha in the drought year of 1990, annual productivity was 2.5 tons/ha in the dry years of 1989 and 1994 (Table 6) owing to well-distributed light rains. Mortality in old-growth stands may be related to the large canopy and leaf area (transpiration load) of the shrub layer. We observed little shrub mortality in plots with low annual cover, mostly on rocky outcrops and on gabbro basalts. Soils overlying gabbro basalts may contain toxic chemicals or be deficient in nutrients, adversely affecting both exotic and native annuals, like soils lacking vital nutrients at Jasper Ridge in central California (Huenneke et al. 1990).

(2) CSS/grassland ecotones follow slope lines independent of fire history. These trends indicate a pattern of variable recruitment rates with habitat change unrelated to disturbance (unpublished data).

(3) Dense, relatively diverse stands of CSS (Artemisia califomica, Eriogonum fasciculatum, Encelia farinosa) often grow on recent road cuts and are often immediately surrounded by dense grasslands on undisturbed soils. Apparently, the scraping of topsoils and exposure of coarser decomposed regolith with nutrient characteristics of the basement encourages the rapid invasion of coastal sage species. Colonization of road cuts by CSS, far removed from neighboring stands, also suggests that long-range seed dispersal is not limiting even with low resprouting rates (O'Leary and Westman 1988) because these shrubs have tiny seeds capable of wind dispersal. Perhaps the absence of Salvia mellifera and S. apiana in road cuts reflects their seeds' larger size (Hickman 1993) and limited dispersal abilities. Except at sites occupied by Encelia farinosa, patterns of CSS reestablishment after fire on the Riverside–Perris Plain are inconsistent with the view that weedy invaders are eliminated rapidly by shading from larger, longer-lived native species (Huston 1995).

Air Pollution

Two major air pollutants, ozone and nitrogen oxides, may affect CSS (Westman 1979, 1981, Allen et al. 1996, Padgett et al. in press). Figure 7 shows a north-to-south gradient in the CSS losses in the Riverside–Perris Plain. For example, most VTM plots near Riverside have <20% of former cover, whereas cover was nearly stable at several plots to the south. The concentration of air pollution in the region varies widely (Allen et al. 1996, Padgett et al. in press). During summer, thermal gradients produced by the combination of daytime heating of the land and cool air overlying the ocean draw the marine layer into the inland valleys, with vertical mixing limited by strong temperature inversions. Blockage of onshore marine air flow by the Santa Ana Mountains divides the air mass into more and less polluted halves, with polluted marine air moving into the north from the urbanized Los Angeles Basin and less polluted air entering the south from less populated
HISTORICAL DECLINE OF COASTAL SAGE SCRUB

coastal regions. The two air streams frequently converge near Perris, 15 km southeast of Riverside, yielding a discontinuity in air-pollution concentrations and visibility.

How specific air pollutants may influence CSS is unclear. In the greenhouse, Preston (1986) and Westman et al. (1986) found simulated ambient summer ozone concentrations to reduce the growth of well-watered CSS seedlings. They concluded that air pollution weakens the shrubs, lowering their resprouting ability. However, there is no baseline data on the sprouting ability of CSS in the Riverside-Perris Plain before air pollution. Alternatively, differences between coastal and inland sites in resprouting rates may reflect local genetic variability, as well as climatic differences, including higher humidity, lower rates of leaf fall, and more green foliage during the summer drought along the coast. Postfire successional response may also be related to climatic gradients. CSS resilience along coast may be related to higher shrub productivity sustained by warmer temperatures through the winter rainy season. Growth persists into late spring because of the cooler summer. In the Riverside-Perris Plain, cold winters limit productivity until March/April when warming temperatures combined with moist soils result in a brief flush of growth. Growth is terminated by high temperatures beginning usually in May. Air-pollution effects may also be limited because summer ozone concentrations do not reach high levels until after shrubs have experienced desiccation, stomatal closure, and leaf senescence (Allen et al. 1996, Padgett et al. in press).

Figure 7. Change in the cover of coastal sage scrub on VTM plots from 1932 to 1992.
Anthropogenic nitrogen deposition may alter the composition of soil microorganisms and encourage displacement of native forbs by nitrogen-demanding exotics. In the Central Valley of California, the invasion of exotics was encouraged by high nutrient availability, independent of physical disturbance (Huenneke et al. 1990). Hence, increased soil nitrogen may make CSS more susceptible to invasion by exotic plants. CSS may decline because of elevated nitrate plus ammonium levels in the soil and the air (Allen et al. 1996, Padgett et al. in press). Studies have yet to control for air pollution by examining the effects of exotics growing in areas of low pollution, such as the California deserts and coastal northern Baja California.

Alternatively, differences in CSS losses in the Riverside–Perris Plain may be related to substrate. Gabbro basalt, the substrate on which CSS is most stable, occurs over large areas in the southern basin but is virtually absent in the north. Granitic substrate is widespread in polluted areas north of Perris. Exotic annuals have also spread extensively into the CSS of northern Baja California, where air pollution is virtually absent (Minnich and Franco-Vizcaino 1998). Future research on the effects of air pollution should control for the role of substrate and changes in soil chemistry.

MANAGEMENT IMPLICATIONS

A fundamental question in the management of CSS is whether the present decline is due to anthropogenic disturbance or to competitive displacement by exotic annuals. Limited chronosequence sampling of shrub and herb cover in the Box Springs Mountains supports both models, depending on the site. Encelia farinosa recovers rapidly, with corresponding decreases in herbaceous cover, even with short intervals between fires, but this shrub is only locally abundant in the northern Riverside–Perris Plain. In contrast, stands dominated by Artemisia californica, Eriogonum fasciculatum, Salvia mellifera, and S. apiana recover poorly even with little disturbance. The widespread decline of CSS in the Riverside–Perris Plain independent of disturbance supports the competitive-displacement hypothesis. The future of the Riverside–Perris Plain may see the displacement of CSS by exotic annuals.

To protect species diversity, the Riverside County Habitat-Conservation Plan for the Riverside–Perris Plain has purchased primarily lands contiguous with preexisting public lands, including lakes Matthews, Perris, and Skinner (Feldman 1995). These measures may not serve to protect the California Gnatcatcher. The assumption in preserve design and land management of static CSS distributions, stand structure, and species diversity is refuted by our replication of the VTM. Therefore, critical examination this dynamic one-way process of CSS conversion to exotic annual grassland is needed in preserve selection. Otherwise, land-protection measures will result in grassland preserves with little CSS flora or fauna. Most CSS on public land is now experiencing stand-thinning and potential displacement by exotic annual grassland. The plain’s largest remaining dense CSS, on gabbro basalts, are less susceptible to grass invasion and have stable shrub communities but are in private ownership and endangered by urban development.
SUMMARY

Californian coastal sage scrub (CSS) has been extensively cleared for agriculture and urbanization. Few studies have examined the landscape-scale dynamics of surviving CSS, particularly in relation to invasive exotic annuals. From 1929 to 1934 the vegetation of California was inventoried by the Vegetation Type Map (VTM) Survey. We replicated the VTM to quantify the changes in the CSS in the Riverside–Perris Plain over the past 60 years. The cover of Encelia farinosa cover was stable, but that of Salvia apiana, S. mellifera, and Artemisia californica was reduced greatly. At many sites, former dense shrub cover had become open stands with a continuous layer of exotic annuals dominated by either Bromus diandrus or B. madritensis ssp. rubens. Encelia farinosa reestablished itself rapidly on south-facing slopes, but on north-facing slopes the dense cover of the exotic grass Bromus diandrus limited reestablishment of Eriogonum fasciculatum and Artemisia californica. CSS has declined under limited or no grazing pressure from livestock. Hence, while fire and grazing may facilitate CSS-to-grass conversion, in some cases the deterioration of CSS may be more fundamentally related to competitive exclusion. Exotics may alter nutrient and moisture regimes, inhibiting the establishment, growth, and survival of native shrubs. Our data refute the assumption that CSS is still a stable habitat in this area. Attempts to conserve the California Gnatcatcher by extending public lands in regions experiencing this type of habitat degradation may be insufficient and need to be reexamined.

LITERATURE CITED


HISTORICAL DECLINE OF COASTAL SAGE SCRUB


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Accepted 18 June 1998
COASTAL SAGE SCRUB VARIATIONS OF SAN DIEGO COUNTY AND THEIR INFLUENCE ON THE DISTRIBUTION OF THE CALIFORNIA GNATCATCHER

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The California Gnatcatcher is widely known to be strongly associated with coastal sage scrub, yet it does not occupy all stands of this highly variable vegetation type (Kirkpatrick and Hutchinson 1976, Westmann 1983, O'Leary 1990, Atwood 1993). Bontrager (1991) suggested that scrub dominated by *Salvia mellifera* is often not occupied by gnatcatchers, and that the species is similarly absent if "a major component of the area was large woody shrubs such as *Rhus integrifolia* and/or *Malosma laurina." Yet no careful studies that objectively evaluate the impacts of scrub-species composition on gnatcatcher distribution have been presented.

Variations in coastal sage scrub occur in recognizable patterns. Climate is the major factor influencing distribution of plant species, as seen in the replacement of dominant shrubs with increasing distance from the coast. Soil types also affect scrub vegetation, as indicated by isolated stands of certain shrubs, as well as the local dominance of shrubs with restricted ranges. Slope aspect affects the density of the vegetation and may foster the replacement of one scrub type by another. North- and east-facing slopes often support chaparral rather than coastal sage scrub. Chaparral also occurs frequently on ridgelines and mesas, even at low elevations. Coastal sage scrub is often naturally fragmented by rivers and streams. Scrub stands, then, occur within a mosaic of habitats, assuring a patchy distribution of the California Gnatcatcher.

In this paper, I describe the primary variations of coastal sage scrub in San Diego County. I show that the occurrence of the California Gnatcatcher in the northwestern portion of the county is strongly influenced by the type of scrub cover. I also comment on the suitability of scrub types elsewhere in the county as likely reserves for the gnatcatcher.

METHODS

I collected data on the distribution of the California Gnatcatcher while surveying coastal sage scrub birds at 84 locations in northwestern San Diego County. I had no prior knowledge of the presence or absence of the gnatcatcher at the time each site was originally selected for investigation. I surveyed areas from Camp Pendleton and Fallbrook south to Del Mar and Poway (Figure 1, Table 1). I collected most data from 1993 to 1995 but have also drawn on many earlier surveys and a few later surveys. With very few exceptions, I conducted bird surveys in the early morning at least twice during the breeding season. I made multiple visits to the vast majority of locations.

I completed a vegetation survey of all sites checked for gnatcatchers. To obtain a broader perspective of the distributional limits of coastal sage scrub...
Figure 1. Location of coastal sage scrub sites surveyed for gnatcatchers in San Diego County, California. Numbers are keyed to sites listed in Table 1.

divisions, I surveyed an additional 148 locations throughout the county. I assigned values to coastal sage scrub plants by using a cover-abundance scale devised by Braun-Blanquet (1932). Each shrub and succulent species present was noted as covering more than 75% of the area, 50–75% of the area, 25–50% of the area, 5–25% of the area, or as few or solitary individuals providing little cover. To simplify plant surveys, I considered herbs and grasses as a single category. A "dominant" species has a minimum coverage of 25%. More than one species could, therefore, qualify as a dominant. A "prominent" species is characteristic of a specific type of scrub but has a cover of less than 25%. Plant names follow Dawson (1966) for cacti and
## Table 1 Locations Surveyed for California Gnatcatchers and Vegetation Types in Northwestern San Diego County

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<th>Location</th>
<th>Subassociation</th>
<th>No. of pairs</th>
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</thead>
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<td>2</td>
</tr>
<tr>
<td>15. Fallbrook, SW Hwy. 395/Pala Mesa (south)</td>
<td>4^e</td>
<td>1</td>
</tr>
<tr>
<td>16. Fallbrook, SW Hwy. 395/Pala Mesa (north)</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>17. Fallbrook, NW Wilt/Foxglove</td>
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</tr>
<tr>
<td>18. Fallbrook, NW Wilt/Citrus</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>19. Fallbrook, SE Hwy. 395/Canonita</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>20. Fallbrook, NW Hwy. 395/Canonita</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>21. Fallbrook, SE Stewart Canyon/Pala Mesa Heights</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>22. Fallbrook, NW Mission/Las Vistas</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>23. Vista, SW Hwy. 76/E Vista Way</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>24. Vista, SE Old River/Gopher Canyon^d</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>25. Bonsall, SW Old River/Dentro de Lomas</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>26. Vista, SE Gopher Canyon/Sagewood</td>
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<td>27. Bonsall, SE Old River/Dentro de Lomas</td>
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<td>0</td>
</tr>
<tr>
<td>28. Bonsall, SW Old River/Lake Vista</td>
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<td>1</td>
</tr>
<tr>
<td>29. Bonsall, NE Camino del Rey/W Lilac</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>30. Bonsall, NW W Lilac/Camino del Cielo</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>31. Bonsall, NE W Lilac/Camino del Cielo</td>
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<td>3</td>
</tr>
<tr>
<td>32. Bonsall, NE Camino del Rey/Eagles Perch</td>
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<tr>
<td>33. Bonsall, NE Camino del Rey/La Reina</td>
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<td>34. Vista, SE Gopher Canyon/Twin Oaks Valley</td>
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<td>35. Escondido, NE Circle R/El Camino del Pinos</td>
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<tr>
<td>Buena Vista Creek</td>
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<td>36. Carlsbad, NW Seabury/Stockton</td>
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<td>37. Carlsbad, SW Tamarack/Milford</td>
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<td>38. Carlsbad, NE Tamarack/Elm</td>
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<td>Agua Hedionda Creek</td>
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<td>39. Carlsbad, SW Adams/Highland</td>
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<tr>
<td>40. Carlsbad, NW Park/Adams</td>
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<td>41. Carlsbad, NE Park/Adams</td>
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<td>1</td>
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<tr>
<td>42. Carlsbad, NW Neblina/ Horizon</td>
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</tr>
<tr>
<td>43. Carlsbad, SE Park/Valencia</td>
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<tr>
<td>44. Carlsbad, SE El Camino Real/Tamarack</td>
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<tr>
<td>45. Carlsbad, NE Harwich/Elm</td>
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<tr>
<td>46. Vista, NW Estrellita/Esplendido</td>
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(continued)
<table>
<thead>
<tr>
<th>Location</th>
<th>Subassociation</th>
<th>No. of pairs</th>
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<tbody>
<tr>
<td>San Marcos Creek</td>
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</tr>
<tr>
<td>47. Carlsbad, SW Batiquitos/Poinsettia &lt;sup&gt;1&lt;/sup&gt;</td>
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</tr>
<tr>
<td>48. Carlsbad, SE Gabbiano/Batiquitos &lt;sup&gt;d&lt;/sup&gt;</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>49. Encinitas, SW Saxony/La Costa</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>50. Encinitas, SE Saxony/La Costa</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>51. San Marcos, NE Santa Fe/Flores</td>
<td>1&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0</td>
</tr>
<tr>
<td>52. San Marcos, Palomar College, N of Comet Circle</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>53. San Marcos, SW Mission/Knoll</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>54. San Marcos, San Marcos Mountains, W of Twin Oaks Valley</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>55. San Marcos, NE Mission/Vineyard</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>56. San Marcos, NW Richland/Carmen Court</td>
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</tr>
<tr>
<td>Escondido Creek</td>
<td></td>
<td></td>
</tr>
<tr>
<td>57. Encinitas, SW Manchester/El Camino Real</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>58. Escondido, NW N Broadway/Jack Rabbit Acres</td>
<td>3&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0</td>
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<tr>
<td>San Dieguito River</td>
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<tr>
<td>59. San Diego, NW San Andres/Flower Hill &lt;sup&gt;d&lt;/sup&gt;</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>60. San Diego, NE Via de la Valle/San Andres</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>61. Rancho Santa Fe, SW Via de la Valle/Las Planideras</td>
<td>1&lt;sup&gt;e&lt;/sup&gt;</td>
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<tr>
<td>62. Escondido, Bernardo Mountain</td>
<td>5</td>
<td>19</td>
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<tr>
<td>63. Escondido, N of Lake Hodges, W of I-15</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>64. Escondido, NW Via Rancho/I-15&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5</td>
<td>12</td>
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<tr>
<td>65. Escondido, W of Kit Carson Park</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>66. Escondido, NE Bear Valley/El Dorado</td>
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<td>4</td>
</tr>
<tr>
<td>67. Escondido, N of Lake Hodges, S of Beethoven</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>68. Escondido, NE San Pasqual/Sunset Hills &lt;sup&gt;d&lt;/sup&gt;</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>69. Escondido, SW San Pasqual/Old Pasqual</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>70. San Diego, NW Hwy. 78/Cloverdale &lt;sup&gt;d&lt;/sup&gt;</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>71. San Diego, SW Cloverdale/Cloveridge</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>72. Escondido, SE Cloverdale/Rockwood</td>
<td>5&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0</td>
</tr>
<tr>
<td>73. Escondido, NE Cloverdale/Rockwood &lt;sup&gt;d&lt;/sup&gt;</td>
<td>5&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0</td>
</tr>
<tr>
<td>74. San Diego, San Pasqual Battlefield State Historic Park/San Diego Wild Animal Park</td>
<td>5</td>
<td>28</td>
</tr>
<tr>
<td>75. San Diego, NW W. Bernardo/Aguamiel</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>76. San Diego, S of Lake Hodges, W of W. Bernardo</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>77. San Diego, NE W. Bernardo/Andanza</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>78. San Diego, Battle Mountain&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3&lt;sup&gt;e&lt;/sup&gt;</td>
<td>1</td>
</tr>
<tr>
<td>79. San Diego, S of Escala/E of Colonades</td>
<td>6&lt;sup&gt;h&lt;/sup&gt;</td>
<td>2</td>
</tr>
<tr>
<td>80. San Diego, SE Highland Valley/Sycamore Creek, approx. 1 km E</td>
<td>6&lt;sup&gt;i&lt;/sup&gt;</td>
<td>0</td>
</tr>
<tr>
<td>81. San Diego, SE Bandy Canyon/Isabel Creek &lt;sup&gt;d&lt;/sup&gt;</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Los Peñasquitos Creek</td>
<td></td>
<td></td>
</tr>
<tr>
<td>82. San Diego, Torrey Pines State Park, So.</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>83. Poway, NW Camino del Norte/Pomerado &lt;sup&gt;d&lt;/sup&gt;</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>84. Poway, E of La Manda, W of Pomerado</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

<sup>1</sup>Locations are listed by watershed, coast to inland, north to south. Subassociation numbers are keyed to Figure 1.

<sup>2</sup>1, Encelia scrub; 2, Lemonadeberry scrub; 3, Black Sage scrub; 4, Sagebrush–White Sage scrub; 5, Buckwheat scrub; 6, assemblage of vegetation unique.

<sup>3</sup>Maximum number of males or pairs recorded at site.

<sup>4</sup>Seriously degraded or lost as coastal sage scrub as of 1998.

<sup>5</sup>A disturbed site (herb/grass cover >25%) in which the vegetation is most similar to the subassociation indicated.

<sup>6</sup>Two subsociations occur at this site, thus the double listing.

<sup>7</sup>Dominated by *Salvia mellifera*, the subshrubs Encelia californica and Artemisia californica are prominent. Area appears to be intermediate between subsociations 1 and 3.

<sup>8</sup>Dominated by *Artemisia californica*; *Keckiella antirrhinooides* is prominent on slopes.

<sup>9</sup>Dominated by *Eriogonum fasciculatum*; *Keckiella antirrhinooides* is prominent; high cover of herbs/grasses.

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Beauchamp (1986) for all other species, although I refer to Artemisia californica as California sagebrush rather than as coastal sagebrush.

Methods of classifying coastal sage scrub are quite diverse. Westman (1983), for example, identified two “associations” for the entire county. Each association incorporates a wide variety of scrub types. Others, such as Kirkpatrick and Hutchinson (1976), recognized scrub types based on the presence of certain key species. Similarly, the San Diego Association of Governments (SANDAG 1992) devised a listing agreed upon by biological consultants that uses the presence of characteristic but not necessarily dominant plants (H. Wier pers. comm.).

I classified coastal sage scrub by which shrubs provide the primary cover at a site. My names for the various divisions have been selected accordingly. Because of the pervasiveness of California sagebrush in nearly all stands, however, I have used the term “sagebrush” only with those divisions in which it is generally the only dominant. I refer to scrub variations as “subassociations” rather than associations, since the latter term is used for divisions of large geographically based floristic formations (Westman 1983).

Sizes of scrub stands are based on information provided by the San Diego County tax assessor’s office and vegetation maps compiled for the Multiple Habitats Conservation Program by Dudek, Inc. Sizes should be considered as approximate. Slope aspect was taken from U.S. Geological Survey 7.5’ topographic maps, and information on soil types is derived from maps of the U.S. Soil Conservation Commission (Bowman 1973).

RESULTS

General Overview

Coastal sage scrub occurs in two disjunct areas in San Diego County. Coastal variations, including all subassociations of the northwestern part of the county, are collectively referred to as the “Diegan Association” by Westman (1983). All county records of the California Gnatcatcher, to my knowledge, are limited to this generalized type of vegetation. The gnat¬catcher does occur at the easternmost extension of this scrub in Pamo Valley, 46 km from the coast (C. Edwards pers. comm.).

Inland scrub types, referred to as the “Riversidian Association” by Westman (1983), barely enter the county north and west of Oak Grove, over 60 km from the coast. I have observed the gnatcatcher in this scrub near Aguanga, Riverside County, but have not recorded it in nearby San Diego County.

Within San Diego County, coastal sage scrub has an elevational range from near sea level, as at Batiquitos Lagoon, to over 800 m above sea level on the south flank of Palomar Mountain and near Oak Grove just south of the Riverside County line. During my surveys, I recorded the gnatcatcher at elevations ranging from 3 m at several coastal lagoons to 540 m on Palomar Mountain.

Composition and Structure of Coastal Sage Scrub

I identified nearly 40 species of shrubs and succulents on sites dominated by variations of coastal sage scrub. Only one or two species of semi-deciduous
“subshrubs,” typically a meter or less in height, dominate most sites. Only rarely does the coverage of a single shrub species exceed 50%. “Emergent” shrubs 2–4 m in height are frequently prominent and occasionally dominant. Most are sumacs (Anacardiaceae).

Shrub canopies vary from nearly closed with essentially no ground cover, as seen in chaparral, to rather open, somewhat resembling desert scrub. Scrub stands in northwestern San Diego County with an herb/grass coverage >25% have a history of disturbance. Scrub growing on north- and east-facing slopes has a denser cover and a greater number of emergent shrubs than that found on slopes with a south- or west-facing aspect. No shrub or succulent species is a strict indicator for any one subassociation since none is limited to a single type of scrub.

Coastal Sage Scrub Subassociations of Northwestern San Diego County

I could readily classify the plant cover of most sites north of the San Diego River watershed into one of five different coastal sage scrub subassociations (Tables 1 and 2), including 71 of the 84 sites that I surveyed for coastal sage scrub birds. Ten additional sites have vegetation that is highly disturbed but still referable to one of the five subassociations. The remaining three sites possess unique vegetation.

My records indicate wide variations in gnatcatcher frequencies and densities between different scrub subassociations (Table 3). Regardless of the vegetation, however, I did not find this bird on any of the 13 sites of less than 3 ha that I surveyed. This, I believe, reflects the influence of small size and fragmented habitat on bird distribution, as noted by Soulé et al. (1988). These sites are omitted from Table 3.

In the descriptions that follow, I refer to other areas of San Diego County in which these scrub types can be found. I have listed only representative localities that I have personally surveyed.

*Encelia* scrub. This subassociation is dominated by California encelia (*Encelia californica*) and California sagebrush (*Artemisia californica*). It is easily recognized by the prominance of succulents such as coastal cholla (*Opuntia prolifera*), short coastal prickly-pear (*Opuntia littoralis*), and Mohave yucca (*Yucca schidigera*). It is found along the northern San Diego County coast south intermittently to the Mexican border. Although it is most characteristic of the immediate coast, it extends exceptionally as far as 13 km inland along river valleys where maritime influences are strong. Lemonadeberry (*Rhus integrifolia*) is the primary emergent shrub. Overall, the canopy is fairly low and has frequent breaks because the terrain where it grows is highly eroded. Slopes typically have a southern aspect. Encelia scrub exists almost exclusively on old marine terrace (sedimentary) formations. This scrub is now very fragmented but was probably never extensive.

Kirkpatrick and Hutchinson (1977) recognized this same scrub as the “*Encelia californica*—*Artemisia californica* association.” My classification incorporates the “southern coastal bluff scrub” of Holland (1986) and SANDAG (1992). Representative locations include the cliffs of Ysidora (Camp Pendleton), Agua Hedionda and Batiquitos lagoons (Carlsbad), and San Elio Lagoon (Encinitas).
## Table 2 Characteristic Plants of Coastal Sage Scrub Subassociations in San Diego County

<table>
<thead>
<tr>
<th>Species</th>
<th>Subassociation&lt;sup&gt;b&lt;/sup&gt;</th>
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</thead>
<tbody>
<tr>
<td><strong>Subshrubs</strong></td>
<td></td>
</tr>
<tr>
<td><em>Artemisia californica</em>, California Sagebrush</td>
<td>3 2 3 3 3 2 3 3 2</td>
</tr>
<tr>
<td><em>Encelia californica</em>, California Encelia</td>
<td>3 1 p p p 0 0 0 0</td>
</tr>
<tr>
<td><em>Eriogonum fasciculatum</em>, Flat-top Buckwheat</td>
<td>1 1 1 2 3 2 1 3 p</td>
</tr>
<tr>
<td><em>Keckiella antirrhinoidea</em>, Yellow Bush Penstemon</td>
<td>0 p 0 p p 0 0 0 3</td>
</tr>
<tr>
<td><em>Salvia apiana</em>, White Sage</td>
<td>p p p 2 1 p p 1 1</td>
</tr>
<tr>
<td><em>Salvia mellifera</em>, Black Sage</td>
<td>1 2 3 p p 0 0 0 p 0</td>
</tr>
<tr>
<td><em>Viguiera laciniata</em>, San Diego Sunflower</td>
<td>0 p 0 0 p 3 2 0 0</td>
</tr>
<tr>
<td><strong>Emergent Shrubs</strong></td>
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</tr>
<tr>
<td><em>Heteromeles arbutifolia</em>, Toyon</td>
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</tr>
<tr>
<td><em>Malosma laurina</em>, Laurel Sumac</td>
<td>1 1 2 2 1 1 p 3 2</td>
</tr>
<tr>
<td><em>Quercus berberidifolia</em>, Scrub Oak</td>
<td>0 0 p p p p 0 1 1</td>
</tr>
<tr>
<td><em>Rhus integrifolia</em>, Lemonadeberry</td>
<td>2 3 p&lt;sup&gt;2&lt;/sup&gt; 0 0 p 2 0</td>
</tr>
<tr>
<td><em>Sambucus mexicana</em>, Mexican Elderberry</td>
<td>p p p p 1 p p p 0</td>
</tr>
<tr>
<td><em>Simmondsia chinensis</em>, Jojoba</td>
<td>0 0 p 0 0 p 2 0 0</td>
</tr>
<tr>
<td><strong>Succulents</strong></td>
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<tr>
<td><em>Opuntia littoralis</em>, Short Coastal Prickly-Pear</td>
<td>1 p p 1 p&lt;sup&gt;d&lt;/sup&gt; 1 1 0 0</td>
</tr>
<tr>
<td><em>Opuntia oricola</em>, Tall Prickly-Pear</td>
<td>p p p p p&lt;sup&gt;g&lt;/sup&gt; p p 0 0</td>
</tr>
<tr>
<td><em>Opuntia prolifera</em>, Coastal Cholla</td>
<td>1 p p p p p 1 0 0</td>
</tr>
<tr>
<td><em>Yucca schidigera</em>, Mohave Yucca</td>
<td>1 1 p p p p 1 0 0</td>
</tr>
<tr>
<td><em>Yucca whipplei</em>, Our Lord’s Candle</td>
<td>p 0 1 p 1 p 0 1 0</td>
</tr>
<tr>
<td><strong>Herb/grass cover</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 1 1 2 2 2 2 2 1</td>
</tr>
<tr>
<td>No. of locations surveyed</td>
<td>10 8 51 31 60 10 10 5 5</td>
</tr>
</tbody>
</table>

<sup>a</sup>Cover listed for each species is the most frequently recorded for that subassociation. All dominant species have a minimum cover of 3 for any site assigned to a given subassociation. Bold-facing indicates 100% occurrence with a coverage of 3, 90% or more with a coverage of 2 or less. 3, 25-50% of total cover; 2, 5-25% of total cover; 1, less than 5% of total cover; p, scattered individuals present, occurs on less than half of sites.

<sup>b</sup>1. Encelia scrub; 2, Lemonadeberry scrub; 3, Black Sage scrub; 4, Sagebrush–White Sage scrub; 5, Buckwheat scrub; 6, Sunflower scrub; 7, Sagebrush–Sunflower scrub; 8, Laurel Sumac scrub; 9, Penstemon scrub.

<sup>2</sup>in coastal areas.

<sup>g</sup>in driest inland valleys.

<sup>d</sup>in driest inland valleys.

The median density of gnatcatchers in this scrub (Table 2) is the second highest that I recorded for any subassociation. Unpublished data by the U.S. Fish and Wildlife Service (L. Salata pers. comm.) indicate densities as high as 0.4 pairs/ha near the mouth of the Santa Margarita River on Camp Pendleton Marine Corps Base. Because of extensive development of the immediate coast, however, Camp Pendleton harbors the only significant remaining population (>20 pairs) of gnatcatchers within this scrub. It is unlikely to play an important role in the continued existence of this bird.
**Lemonadeberry scrub.** This scrub is characteristic of north- and east-facing slopes near the coast. It is readily recognized by the abundance of lemonadeberry, a tall sumac. This dominant shrub forms a closed canopy, resulting in a very sparse herb layer. Toyon (*Heteromeles arbutifolia*), which is widely distributed in chaparral, is often prominent. Black sage (*Salvia mellifera*) and California sagebrush are the most prominent subshrubs. Lemonadeberry scrub frequently merges with chamise or southern maritime chaparral. This scrub is quite limited in extent. It occurs as far as 17 km from the coast in southern San Diego County but rarely extends more than 1–2 km inland in the north. It is found on the same soil types as encelia scrub. SANDAG (1992) referred to this subassociation as “lemonadeberry-dominated scrub.” Representative locations include Agua Hedionda and Batiquitos lagoons (Carlsbad), Torrey Pines State Reserve (southern section), Tecolote Canyon (San Diego), and Long and Rice canyons (Chula Vista). I have no observations of the gnatcatcher within this scrub. The dominance of tall, evergreen shrubs strongly resembles chaparral, which is avoided by the gnatcatcher. Although it may function as a corridor for the dispersal of the gnatcatcher, I believe its overall value as a reserve is very low.

**Black sage scrub.** This scrub replaces the preceding two subassociations in mid and northern San Diego County as one proceeds a short distance inland. The habitat has a climate retaining a strong marine influence but is largely east of the summer “fog” belt. This scrub has a much darker appearance than other scrubs because of the dominance of *Salvia mellifera*. Black sage often constitutes much of the shrub cover on north- and east-facing slopes, usually with a prominent emergent shrub layer. California sagebrush is frequently a co-dominant, especially on south- and west-facing slopes. The canopy is largely closed, resulting in a poorly developed herb layer. Laurel sumac (*Malosma laurina*) is the most prominent emergent shrub, but lemonadeberry is numerous near the immediate coast. The structural aspect of this scrub is similar to chamise chaparral, with which it is often confused in aerial mapping of vegetation. Black sage scrub occurs as
COASTAL SAGE SCRUB VARIATIONS OF SAN DIEGO COUNTY

far as 30 km inland, occupying a much larger area than the preceding scrubs. It is found on soils derived from marine sedimentary deposits, as well as granodiorite. It becomes scarce south of the San Diego River watershed. Isolated stands grow on gabbro soils within areas that are primarily dominated by the next two subassociations, as seen at Red Hill and Monserrate Mountain near Fallbrook. Originally quite extensive, areas supporting black sage scrub are being rapidly urbanized.

This scrub corresponds to the “Salvia mellifera–Rhus laurina association” of Kirkpatrick and Hutchinson (1977). SANDAG (1992) refers to vegetation consisting primarily of Salvia mellifera as “black sage-dominated scrub,” while areas where California sagebrush is a co-dominant are placed in a rather inclusive “California sagebrush-dominated scrub.” Representative locations include Camp Pendleton Marine Corps Base (west of Morro Hill), the San Marcos Mountains (San Marcos, Vista), Merriam Mountains (San Marcos), Harmony Grove, Olivenhain, Los Peñasquitos Canyon (San Diego), and Sorrento Valley (San Diego).

I observed the gnatcatcher on less than half the sites I surveyed (Table 3). All sightings were confined to areas in which California sagebrush is a co-dominant. Such stands function as low-density reserves for the gnatcatcher, while areas overwhelmingly dominated by black sage are avoided.

Sagebrush–white sage scrub. This subassociation is characteristic of uplands and south-facing slopes primarily within the watersheds of the San Luis Rey and Santa Margarita rivers. Within its somewhat limited range in San Diego County, it typically separates black sage scrub from the following subassociation. California sagebrush is the dominant subshrub. White sage (Salvia apiana) has the second greatest cover and is frequently a co-dominant. The overall light coloration of the foliage is distinct among scrub associations. Laurel sumac is the chief emergent shrub. The canopy is often fairly closed, especially so on north- and east-facing slopes. It ranges from 19 to 43 km from the coast and grows on thin soils derived from granodiorite or granite alluvium. Much of this scrub has been converted to avocado groves. SANDAG (1992) merged this vegetation with “California sagebrush-dominated scrub.” The nearly complete replacement of black sage by white sage, though, makes it readily distinguishable from the previous scrub. Representative locations include uplands and south-facing slopes of De Luz, Fallbrook, Bonsall, Lilac, and Pauma Valley.

I found the gnatcatcher on less than one third of all sites surveyed (Table 2). In general, this scrub appears to be marginal habitat for the gnatcatcher.

Buckwheat scrub. This is the characteristic scrub of the hot inland valleys in the foothill zone of the county. Marine influences are slight. Flat-top buckwheat (Eriogonum fasciculatum) co-dominates with California sagebrush. The canopy is open with a well-developed cover of herbs and grasses. Laurel sumac is the principal emergent shrub, although Mexican elderberry (Sambucus mexicanus) is frequent, especially on south-facing slopes. Overall, emergent shrubs are less conspicuous than in the preceding subassociations. Prickly-pears (Opuntia spp.) are frequently prominent and may form large patches on south-facing slopes. Buckwheat scrub ranges primarily from 20 to 46 km from the coast and grows on thin soils derived from granodiorite or metasedimentary rock.
This scrub resembles the "Artemisia californica-Eriogonum fasciculatum-Salvia apiana association" of Kirkpatrick and Hutchinson (1977). SANDAG (1992) included much of this subassociation in "California sagebrush-dominated scrub," while areas with dense cactus patches are distinguished as "prickly pear-dominated scrub." My field surveys reflect no apparent difference in gnatcatcher distribution whether prickly pears are abundant or not. Since assigning many stands to one or the other is subjective, I do not feel that subdividing this scrub is well justified.

Areas covered exclusively with buckwheat or dominated by white sage are merely disturbed variations of this scrub, from the soil types, geography, and a history of fire or grazing at most sites with which I am familiar. SANDAG (1992) listed these seral stages separately as "buckwheat-dominated scrub" and "white sage-dominated scrub," respectively. Representative locations include eastern Bonsall, Bernardo Mountain and Mule Hill (Escondido), the San Diego Wild Animal Park, Lake Hodges, highlands surrounding Poway, Wildcat Canyon, and Lake Jennings.

Most significant populations of the gnatcatcher in northwestern San Diego County occur in buckwheat scrub. Densities are even higher than those of encelia scrub (Table 3). I found the bird at every site larger than 3 ha with the exception of one isolated stand in Vista surrounded by black sage scrub. My observations indicate that buckwheat scrub should be the primary focus of conservation efforts on behalf of the gnatcatcher in northwestern San Diego County.

Additional Coastal Sage Scrub Subassociations of San Diego County

A major change in scrub composition occurs within the watershed of the San Diego River. Black sage scrub is replaced on south- and west-facing slopes by San Diego sunflower (Viguiera laciniata), also called San Diego County viguiera. Black sage largely disappears south of the San Diego River watershed. Additional scrubs appear within the watersheds of the Sweetwater, Otay, and Tijuana rivers. Inland areas of the county support other, rather localized, subassociations. The total area of coverage of most subassociations listed below is too minimal to support major populations of the gnatcatcher, even if they are actually inhabited. Two subassociations, though, appear to serve as important reserves for the bird. As I have limited experience with the gnatcatcher in these regions, my comments are based partially on data collected by Mock (1993).

**Sunflower scrub.** This scrub is common within the watersheds of the San Diego, Sweetwater, and Otay rivers. San Diego sunflower is the dominant subshrub. Laurel sumac is the primary emergent shrub at most locations. Slope aspect is usually southern. This scrub has a low and rather open canopy and grows on thin soils derived from granodiorite, metasedimentary, and marine sedimentary rock. It ranges from 8 to 36 km inland from the coast. Much of this scrub is east of the summer "fog" belt. SANDAG (1992) referred to this as "San Diego County viguiera-dominated scrub." Representative areas include south-facing slopes in Mission Valley (San Diego), Mission Trails Regional Park (San Diego), Santee Lakes (Santee), Harbison Canyon, Dehesa Road, and the Jamul Mountains.
The replacement of black sage scrub by sunflower scrub appears to benefit the gnatcatcher in the eastern fringes of San Diego and its suburbs. Distribution maps of gnatcatcher sightings collected by Mock (1993) show a concentration of records near Mission Trails Regional Park, Santee, and El Cajon.

* Sagebrush–sunflower scrub. This scrub is found along the lower reaches of the Sweetwater, Otay, and Tijuana rivers and their tributaries. California sagebrush is the dominant subshrub. San Diego sunflower may be a co-dominant but more often provides the second greatest cover. Sagebrush–sunflower scrub resembles the previous subassociation, but laurel sumac is largely replaced by two other emergent shrubs, lemonadeberry and jojoba (*Simmondsia chinensis*). Succulents, such as Mohave yucca and coastal cholla, are also prominent. Marine influences are strong. This scrub occurs up to 17 km from the coast, primarily on slopes with a southern aspect. It grows mainly on soils derived from marine sedimentary deposits, but a few stands in the eastern part of its range are found on soils with a metavolcanic base. SANDAG (1992) referred to this as “jojoba scrub” and considered it to be a variation of maritime succulent scrub. Jojoba, though, is also abundant in a different variation of coastal sage scrub growing in southwestern Riverside County near Agua N. Representative locations include Sweetwater Dam (Bonita), Long and Rice canyons (Chula Vista), and the Otay River Valley east of Interstate 805.

Mock (1993) shows a large concentration of gnatcatcher sightings near Chula Vista where this is the dominant subassociation. Most sites are rapidly being fragmented by intense urbanization. Long-term prospects for the gnatcatcher in this scrub are not good.

* Munz’s sage scrub. This scrub is dominated by Munz’s sage (*Salvia munzii*), which occupies a restricted area within the Sweetwater and Otay river watersheds. This species resembles a short black sage, but the canopy is much more open. Westman (1983) lists Munz’s sage as one of the dominant shrubs of the scrublands of northwestern Baja California. Its range marks the edge of the summer “fog” belt. I surveyed only two sites where this subassociation occurs and have not included it in Table 2. Munz’s sage scrub grows on soils of marine sedimentary, metavolcanic, and metasedimentary origin. SANDAG (1992) recognized this as “Munz’s sage-dominated scrub”. Representative locations include Proctor Valley Road and Upper Otay Reservoir. The gnatcatcher is present in both of these areas. The small area dominated by this scrub and the rapid development of nearby localities preclude its serving as a major reserve.

* Laurel sumac scrub. This is a north- or east-slope complement to buckwheat scrub growing on steep terrain within the watershed of the San Diego River. Laurel sumac has a greater cover than either flat-top buckwheat or California sagebrush, which coexist with it. Scrub oak (*Quercus berberifolia*) is prominent. It occurs in inland areas 28–35 km from the coast. This scrub frequently merges with chaparral or oak woodland. SANDAG (1992) has listed this as “laurel sumac-dominated scrub”. Representative locations include the Highway 67 corridor between Poway and Lakeside, Wildcat Canyon, El Monte Road, and hills south of Interstate 8.
between Lakeside and El Cajon. I know of no records of the gnatcatcher from this scrub. Its resemblance to chaparral makes it an unlikely refuge.

**Penstemon scrub.** This association grows in a fairly limited area, primarily on steep north-facing slopes, within the San Luis Rey and San Dieguito river valleys, 32-40 km from the coast. Yellow bush penstemon (*Keckiellia antirrhinoideas*) is the dominant shrub. Laurel sumac is often prominent. The shrub canopy is usually closed. Penstemon scrub grows on soils derived from granodiorite and granite alluvium. SANDAG (1992) referred to this as “penstemon-dominated scrub.” Representative locations include the Rincon Indian Reservation, the San Luis Rey River valley east and west of Cole Grade Road, and north-facing slopes of the San Pasqual Valley, as near Santa Maria Creek. I know of no gnatcatcher observations from this scrub in San Diego County. Penstemon scrub is very difficult to survey, but its small extent and chaparral-like growth form do not indicate it is likely to harbor a major population of the gnatcatcher.

**Buckwheat-deerweed scrub.** This inland subassociation barely enters San Diego County north and west of Oak Grove near the Riverside County line, 60-64 km from the coast. It is dominated by flat-top buckwheat and deerweed (*Lotus scoparius*). Slope aspect is southern. Succulents are prominent, especially valley cholla (*Opuntia parryi*) and Mohave yucca. The shrub canopy is quite open with areas of bare soil. Sugarbush (*Rhus ovata*) is the primary emergent shrub within San Diego County. Jojoba is widespread in nearby areas of Riverside County, where this scrub is better developed. Buckwheat-deerweed scrub grows on soils underlain by granite alluvium. It was not listed by SANDAG. I have completed surveys of only two stands of this scrub in the county, but this is most of what occurs, and I have not included it in Table 2. I have no observations of the bird.

At a limited number of sites, coastal sage scrub does not fit neatly into any of the above categories. Some of these variations may represent distinct subassociations whose limited geographical range is due to specific edaphic conditions. One such example is dominated by California adolphia (*Adolphia californica*) and grows in dense thickets on clay soils (SANDAG 1992). Another may be the stunted scrub growing on the steep north and south slopes of Palomar Mountain. Other types are obviously at the fringes of their ranges. Scrubs typical of dry washes or extremely dry sites in southwestern Riverside County, for example, extend no more than a few hundred meters into San Diego County west of Oak Grove. The majority of sites that I surveyed that cannot not be included in one of the subassociations listed above have a high herb-grass cover (>25%). They are disturbed versions of the scrubs discussed above.

**DISCUSSION**

The California Gnatcatcher shows decided habitat preferences within the coastal sage scrub of northwestern San Diego County. The birds avoid areas dominated by tall shrubs and occur in low numbers in closed-canopy scrub even where subshrubs dominate. In sharp contrast, I recorded gnatcatchers on all sites larger than 8 ha dominated by encelia scrub or buckwheat scrub.
Mean densities of gnatcatchers in buckwheat scrub were nearly twice those in encelia scrub. No other subassociations had a mean density above zero. In northwestern San Diego County only one subassociation, buckwheat scrub, serves as a major reserve for this species. The distribution of the gnatcatcher in southern San Diego County is likely to parallel its occurrence in the northern part of the county. Records appear to be concentrated in areas dominated by open-canopy scrub. However, additional research or review of the diverse and scattered survey data is needed to determine which, if any, subassociation is preferred.

This paper could have been titled “Can we predict the presence of the California Gnatcatcher by looking at the plant cover?” I believe the answer is “yes.” While much of my findings are probably known intuitively by experienced field observers, intuition isn’t what land planners, reserve managers, and government agencies will find acceptable when making decisions in the political and land-acquisition arena. An easily understood, objectively based approach might be.

Knowledge of vegetation patterns can, at the least, allow biologists to point out potential inadequacies in “reserve planning.” For example, setting aside some closed-canopy scrubs appears to provide little in the way of suitable gnatcatcher habitat, although they may be valuable as corridors. I encourage other observers to look for relationships between shrub cover and where we are finding the California Gnatcatcher.

SUMMARY

Surveys of the California Gnatcatcher in northwestern San Diego County reveal distinct preferences in the type of coastal sage scrub that it inhabits. The gnatcatcher occurs in high frequencies and densities in scrub with an open or broken canopy. It is absent from scrub dominated by tall shrubs and occurs in low frequencies and densities in low scrub with a closed canopy.

ACKNOWLEDGEMENTS

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LITERATURE CITED


COASTAL SAGE SCRUB VARIATIONS OF SAN DIEGO COUNTY


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USE OF REFUGIA BY CALIFORNIA GNATCATCHERS DISPLACED BY HABITAT LOSS

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Because the California Gnatcatcher (*Polioptila californica*) is one of the focal species for conservation of coastal sage scrub being planned under the state of California’s Natural Community Conservation Planning (NCCP) program (Atwood and Noss 1994, Reid and Murphy 1995), the species’ response to large-scale loss of habitat is an important factor that may influence both the design of habitat reserves and development of future habitat-management strategies. For example, can birds that are displaced by habitat loss be expected to move successfully into adjacent areas of undisturbed habitat? Or is suitable gnatcatcher habitat generally “saturated” in terms of the number of breeding pairs it is able to support, implying that birds displaced by destruction of coastal sage scrub will not successfully establish themselves in neighboring refugia?

An opportunity to examine these questions was presented in late October 1993, when the Laguna fire burned approximately 5261 ha (13,000 acres) of coastal sage scrub, chaparral, and grassland in the San Joaquin Hills of coastal Orange County (Bontrager et al. 1995). Pre-fire surveys conducted by Jones and Stokes Associates and Ed Almanza and Associates in 1992 suggest that habitat occupied by approximately 127 pairs of gnatcatchers was destroyed or severely degraded by the burn (Bontrager et al. 1995). Because the burn took place soon after the 1993 breeding season, when the population is augmented by recently fledged juveniles, as many as 500 individual gnatcatchers may have been affected. Surveys during spring 1994 found only 12 pairs within the burned area, 9% of the pre-fire (1992) estimate (Bontrager et al. 1995). During surveys immediately after the fire in November and December 1993, several experienced observers felt that many of the gnatcatchers seen in nearby unburned habitat were behaving as though they might have been displaced from their territories as a result of the fire (Bontrager et al. 1995). Additional gnatcatchers near the San Joaquin Hills were displaced in January and February 1994, when habitat that supported approximately five to ten breeding pairs in 1993 was destroyed during construction of a segment of the San Joaquin Hills Transportation Corridor north of Newport Coast Drive (E. Woehler pers. comm.).

In this study we compare the 1993–1995 population estimates of breeding California Gnatcatchers in coastal Orange County around the periphery of the Laguna fire with estimates from control sites unaffected by the burn. In particular, we ask two questions: (1) did breeding populations in habitat refugia show an increase during 1994 that might be attributed to displacement of birds by the Laguna fire, and (2) did any such increased densities of birds in the habitat refugia persist into the 1995 breeding season?
USE OF REFUGIA BY DISPLACED CALIFORNIA GNATCATCHERS

METHODS

In the San Joaquin Hills within 2 km of the Laguna fire’s perimeter we identified five unburned refugia for which baseline (1993) population data were available (Figure 1; Table 1). Each site, which included variable amounts of coastal sage scrub, was isolated from other patches of scrub by a distance of at least 1 km. Under this operational definition, the sampling units referred to here differ slightly from those used by Bontrager et al.

Figure 1. Habitat refugia surrounding the 1993 Laguna fire, including pre-fire (1992) distribution of coastal sage scrub and breeding pairs of the California Gnatcatcher within the burn area. TR, Turtle Rock; SH, Sycamore Hills; NLL, North Laguna Laurel; UCI, UC Irvine Ecological Preserve; CC, Crystal Cove State Park.
USE OF REFUGIA BY DISPLACED CALIFORNIA GNATCATCHERS

Table 1 Refugia and Control Sites for Study of the Laguna Fire

<table>
<thead>
<tr>
<th>Location</th>
<th>Dominant vegetationa</th>
<th>Area (ha)b</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Refugia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crystal Cove State Park</td>
<td>Sagebrush scrub; quail brush scrub</td>
<td>101</td>
</tr>
<tr>
<td>North Laguna Laurel</td>
<td>Sagebrush scrub; sagebrush-black sage scrub; black sage scrub; scrub-chaparral ecotone</td>
<td>80</td>
</tr>
<tr>
<td>Sycamore Hills</td>
<td>Sagebrush–buckwheat scrub; sagebrush–black sage scrub; black sage scrub; scrub-chaparral ecotone</td>
<td>151</td>
</tr>
<tr>
<td>UCI Ecological Preserve</td>
<td>Sagebrush–buckwheat scrub; southern cactus scrub; sagebrush–grassland; ruderal</td>
<td>25</td>
</tr>
<tr>
<td>Turtle Rock</td>
<td>Sagebrush–buckwheat scrub; sagebrush scrub; coyote brush scrub; mixed sage scrub; ruderal; southern cactus scrub</td>
<td>159</td>
</tr>
<tr>
<td><strong>Control sites</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agua Amarga Canyon</td>
<td>Sagebrush scrub; sagebrush–buckwheat scrub; southern cactus scrub</td>
<td>82</td>
</tr>
<tr>
<td>U.S Navy Fuel Depot</td>
<td>Sagebrush scrub; ruderal</td>
<td>57</td>
</tr>
<tr>
<td>&quot;Location 2&quot;c</td>
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<td>100</td>
</tr>
<tr>
<td>&quot;Moratorium&quot; zone</td>
<td>Ruderal; sagebrush scrub; sagebrush–buckwheat scrub; southern cactus scrub; purple sage scrub; toyon–sumac chaparral; sage scrub–grassland ecotone</td>
<td>551</td>
</tr>
<tr>
<td>Ocean Trails</td>
<td>Southern cactus scrub; sagebrush–buckwheat scrub; ruderal; sagebrush scrub</td>
<td>114</td>
</tr>
<tr>
<td>Point Vicente</td>
<td>Sagebrush scrub; southern cactus scrub; ruderal</td>
<td>71</td>
</tr>
</tbody>
</table>

aVegetation categories based on Jones and Stokes Associates (1993).
bArea estimates approximate, and not limited to areas of coastal sage scrub vegetation.
cUnnamed location in coastal Orange County; see Erickson and Miner (1998).

(1995). Similarly, we identified six control sites on the Palos Verdes Peninsula, Los Angeles County (Atwood et al. 1998), and in coastal Orange County (Erickson and Miner 1998). Because these localities were far removed from the San Joaquin Hills and isolated by extensive areas of urban development, we used them to evaluate population changes in the habitat refugia that might have been associated with the Laguna fire.

Year-to-year consistency of survey methods and personnel was maintained within each study location. The estimated number of gnatcatcher pairs was based on cumulative observations made throughout each breeding season, often including the mapped locations of uniquely color-banded birds and simultaneously active nests.

RESULTS

The numbers of breeding pairs of California Gnatcatchers at five habitat refugia and six control sites are provided in Table 2. Estimates in the refugia for 1994 were significantly different from those for 1993 (P = 0.043, Wilcoxon signed-rank test); 1993 and 1994 estimates from the control sites did not differ significantly (P = 0.256). In 1994, all five refugia showed population increases ranging from 25% (Turtle Rock) to 105% (Crystal Cove.
Table 2 Number of Breeding Pairs of California Gnatcatchers at Refugia and Control Sites

<table>
<thead>
<tr>
<th>Location</th>
<th>Population estimate</th>
</tr>
</thead>
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<tr>
<td></td>
<td>1993</td>
</tr>
<tr>
<td>Refugia</td>
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<tr>
<td>North Laguna Laurel</td>
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<td>Sycamore Hills</td>
<td>10</td>
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<tr>
<td>UC Irvine Ecological Preservea</td>
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<tr>
<td>Crystal Cove State Park</td>
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<td>Turtle Rockb</td>
<td>51</td>
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<tr>
<td>Control sites</td>
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</tr>
<tr>
<td>Agua Amarga Canyon</td>
<td>8</td>
</tr>
<tr>
<td>U.S. Navy Fuel Depot</td>
<td>5</td>
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<tr>
<td>“Location 2c”</td>
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<tr>
<td>“Moratorium” zone</td>
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<tr>
<td>Ocean Trails</td>
<td>7</td>
</tr>
<tr>
<td>Point Vicente</td>
<td>3</td>
</tr>
</tbody>
</table>

aFide E. Woehler. Excludes (from all three years) one pair present during 1993 and 1994 but which disappeared before the 1995 breeding season, apparently as a result of construction associated with the San Joaquin Hills Transportation Corridor in December 1994.

bIncludes sites referred to by Bontrager et al. (1995) as Ridgeline, Sand Canyon Reservoir, Turtle Rock fragments, and Turtle Rock Reservoir.

cUnnamed location in coastal Orange County; see Erickson and Miner (1998).

State Park) (mean increase 59.6%, standard deviation 32.4). Among the control sites, from 1993 to 1994, the population increased at three, decreased at one, and did not change at two (Figure 2).

Populations at the control sites declined significantly from 1994 to 1995 ($P = 0.027$; Wilcoxon signed-rank test). Among the refugia there was no statistically significant change from 1994 to 1995 ($P = 0.138$; Wilcoxon signed-rank test), although numbers decreased at four of the five sites, including a decline of 49% at Crystal Cove State Park (Figure 2).

DISCUSSION

Increased numbers of California Gnatcatchers were found in unburned areas of coastal sage scrub immediately after a fire that burned over 5200 ha of coastal sage scrub, grassland, and chaparral (Bontrager et al. 1995). During the 1994 breeding season these unburned refugia supported significantly more breeding pairs than before the fire. Populations at the control sites distant from the Laguna fire did not increase significantly from 1993 to 1994.

In 1995, gnatcatcher populations declined at all of the control sites and at four of the five refugia. The single refugium where the population increased
USE OF REFUGIA BY DISPLACED CALIFORNIA GNATCATCHERS

Figure 2. Gnatcatcher population changes in the San Joaquin Hills habitat refugia and control sites, 1993-1995. Abbreviations for habitat refugia as in Figure 1. Control sites: AA, Agua Amarga Canyon; FD, U.S. Navy Fuel Depot; LOC2, unnamed location in coastal Orange Co. (Erickson and Miner 1998); MZ, “Moratorium” zone; OT, Ocean Trails; PV, Point Vicente.

from 1994 to 1995 (Sycamore Hills) may have received immigrants displaced by adjacent construction that began in June 1994 and destroyed occupied gnatcatcher habitat (D. Bontrager unpubl. data).

At the time of the Laguna fire (October 1993), we hypothesized that gnatcatcher densities in unburned refugia located near the fire’s perimeter might increase during the 1994 breeding season, but, if pre-fire occupancy of these areas was close to saturation level, populations within the refugia would revert approximately to their pre-fire levels by spring 1995. The observations reported here are consistent with the first part of this hypothesis, but we remain unsure if density-dependent factors contributed to the declines seen from 1994 to 1995. We believe that the evidence is strong that the increases observed in the refugia during 1994 were related to displacement of birds by the Laguna fire. Though the population declines seen from 1994 to 1995 are consistent with our prediction that density-dependent factors might have acted to restore gnatcatcher breeding densities in the refugia to their approximate pre-fire levels, the concurrent population declines at control sites confound this interpretation. If winter weather in 1994-1995 caused regional population declines (Erickson and Miner 1998), then any density-dependent effects in the habitat refugia might well have been obscured.

In experimental studies of the effect of forest fragmentation in the Amazon basin of Brazil, Bierregaard and Lovejoy (1989) documented short-term increases in densities of forest birds in habitat refugia adjacent to large-scale deforestation; after approximately 200 days, these elevated densities decreased to levels lower than those encountered prior to the displacement.
Darveau et al. (1995) found increased densities of forest birds along riparian corridors adjacent to recent clearcuts. Hagan et al. (1996) observed increased densities but reduced pairing success of Ovenbirds (*Seiurus aurocapillus*) in forest fragments adjacent to areas of recent lumbering and proposed that "an abrupt fluctuation of this magnitude caused by displaced individuals from lost habitat might impose behavioral pressures that destabilize some fragment[ed] bird populations." If correct, this hypothesis suggests that substantial synchronous loss of habitat might temporarily elevate the gnatcatcher's population levels within habitat refugia to a point where increased territorial interactions could reduce reproductive success. Thus, even though actual counts of breeding pairs might show short-term increases, density-dependent effects might ultimately cause population declines. Especially with a relatively short-lived species like the California Gnatcatcher which may, on average, have a life-time breeding expectancy of only one or two years (Atwood et al. 1998, Bontrager unpubl. data), such effects could have important ramifications for the dynamics of local populations.

These hypotheses suggest that extensive wildfires may damage gnatcatcher populations in unburned refugia as well as within the burn. Because fire is clearly one of the most important factors to consider in maintaining viable tracts of coastal sage scrub, understanding the relationships among burn extent, use of habitat refugia, and recolonization of recovering burned areas by sensitive species such as the California Gnatcatcher is important. Until these topics are better studied, we suggest that frequent small controlled burns within reserves of coastal sage scrub habitat are less likely to have long-term adverse effects on gnatcatcher populations than occasional large fires.

Population trends in the California Gnatcatcher are likely to be influenced by a variety of factors ranging from the effects of weather on reproductive success and survivorship to increased competition for resources caused by the immigration of birds displaced by habitat loss. Our understanding of how these and other factors interact to determine gnatcatcher population dynamics remains limited, yet the issue has critical implications for both the design and effective management of viable habitat reserves. Consequently, continuation of in-depth, long-term studies at various sites throughout the species' range in southern California remains an important objective for recovery.

**SUMMARY**

We analyzed annual estimates of the number of breeding pairs of California Gnatcatchers from 1993 to 1995 in five habitat refugia located adjacent to the October 1993 Laguna fire in coastal Orange County and at six control sites distant from the burn. Observations immediately after the fire suggested that many of the over 500 gnatcatchers whose habitat was burned were displaced rather than killed outright. During the 1994 breeding season counts in all habitat refugia were higher than during the previous year; among the control sites, there was no trend. These results suggest that gnatcatchers displaced by habitat loss may, at least in the short term, pack more densely into remaining areas of intact coastal sage scrub. Populations at both refugia and control sites decreased from 1994 to 1995, possibly as
USE OF REFUGIA BY DISPLACED CALIFORNIA GNATCATCHERS

a result of density-independent factors such as weather; we could not assess whether increased densities of breeding gnatcatchers in unburned refugia would have persisted over more extended periods of time.

ACKNOWLEDGMENTS

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LITERATURE CITED


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ENERGETIC CONSTRAINTS TO THE DISTRIBUTION AND ABUNDANCE OF THE CALIFORNIA GNATCATCHER

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The relation of physiology to distribution in terrestrial vertebrates is neither direct, simple, nor obvious—George Bartholomew, 1958

Year-to-year variations in temperature, precipitation, and food supply affect the survival and reproduction of organisms. Annual fluctuations in birth rate and survival are often expressions of this environmental variability. It is generally believed that the viability of most populations decreases with increasing environmental variation (Burgman et al. 1993). A long series of years in which survival and/or birth rate are low may threaten the existence of a population. In the absence of human-caused threats, environmental variation is probably the greatest threat to population viability (Dennis et al. 1991, Järvinen and Väsänen 1984, Stacey and Taper 1992, Virkkala 1991).

The traditional view is that survival of small birds is most influenced by a combination of precipitation and cold weather, being low when the two coincide (Gessaman and Worthen 1982, Lustick and Adams 1977). Winter is typically the time of year with the highest mortality (Ricklefs 1969, Gessaman and Worthen 1982). Empirical work has demonstrated a linkage between variation in weather, food resources, and songbird demography (e.g., Holmes et al. 1991, Martin 1987, Sullivan 1989). Some studies suggest a causal link between physiology and species distribution (e.g., Yarbrough 1971, Ketterson and King 1977, Weathers 1979, Weathers and van Riper 1982, Hayworth and Weathers 1984, Root 1988, Hinsley et al. 1993). Earlier researchers, however, considered behavioral and ecological factors to be more important than physiological factors in limiting a species' distribution (e.g., Bartholomew 1958, Sturkie 1965).

The assumption that variation in climate can be a major factor influencing population viability is supported by analyses of the geographic limits of songbird distributions (Root 1988). Correlative evidence indicates that the winter distribution and abundance patterns of many bird species may be limited by their winter energy requirements. Root (1988) found that several species of songbirds appeared to be limited to areas where the January mean minimum temperature (JMMT) resulted in thermal compensation (i.e., thermoregulation plus basal requirements) less than 2.49 (standard error 0.07) times a species' basal metabolic requirement. The distribution-limiting isotherm is termed $T_a$.

The purpose of this paper is to evaluate the relevance of the Root model to the distribution and abundance of the California Gnatcatcher (Polioptila californica). Thousands of acres of otherwise apparently suitable coastal sage scrub (CSS) in the eastern portion of its range in California appear to support few gnatcatchers (Atwood and Bolsinger 1992, Mock 1993, D.
Padley, P. Unitt, B. Wagner, J. Newman pers. comm.), suggesting possible systematic differences in environmental conditions between coastal and inland areas that influence where gnatcatchers are able to persist. Substantial California Gnatcatcher mortality associated with cold, wet weather conditions has been documented (Mock and Bolger 1992).

METHODS

To evaluate the energetic-constraints hypothesis, I obtained historical climate data for weather stations throughout southern California (sources: National Climatic Data Center, North Carolina; Univ. Calif. Agricultural Extension Service 1970). I categorized weather-station locations shown in Figure 1 as to whether they were associated with the gnatcatcher's historical distribution [Atwood 1993, San Diego County regional geographic-information system (GIS) database, J. Newman, D. Padley pers. comm.]. Annual total precipitation and JMMT were evaluated relative to elevation and distance from the coast.

I calculated a predicted range of $T_{dm}$ from allometric equations in Root (1988), then compared my prediction with a detailed energetics model developed by Webster and Weathers (1990) for the Verdin (Auriparus flaviceps; mass 6 g) wintering in Riverside County. I adapted the model for the gnatcatcher by using temperature data from weather stations along the eastern boundary of the gnatcatcher's known distribution in San Diego County.

Figure 1. Distribution of weather stations within the southern California range of the California Gnatcatcher. Filled diamonds, locations with gnatcatcher populations; open circles, gnatcatchers absent.
RESULTS AND DISCUSSION

The current known distribution (Figure 1) and abundance of the California Gnatcatcher in California is concentrated along the coast in maritime-influenced areas of Orange and San Diego counties (Atwood 1993, county GIS databases). Much of the potentially suitable habitat in the peripheral portions of the documented range of the gnatcatcher has not been extensively surveyed; however, surveys of these areas typically have yielded relatively few new gnatcatcher sightings. For example, 1992 surveys of 2400 acres of CSS in Marron Valley, southeast of Otay Mountain, detected only three individuals and CSS around Gregory Mountain, east of Interstate 15 near Pala, also appears to be unoccupied (Ogden Environmental unpublished data).

Likewise, surveys in Riverside County suggest that CSS near Beaumont, Hemet, San Jacinto, and Sun City lacks substantial populations of the California Gnatcatcher (D. Padley, J. Newman pers. comm.). The interior valleys of Los Angeles County historically supported gnatcatchers, but populations are lacking in the Santa Monica Mountains and foothills of San Gabriel Mountains (Atwood 1993). Ventura County historically supported birds near Santa Paula, and there is a recent sighting of a single individual near Moorpark (Atwood 1993, C. A. Jones and R. S. Ramirez unpubl.).

Winter weather patterns within the range of the gnatcatcher are influenced by distance from the coast (maritime influence) and elevation, correlated factors (Figure 2). January mean minimum temperature is influenced significantly by both distance from the coast and elevation. Step-wise multiple regression of JMMT on distance and elevation showed that these factors account for a significant portion of the regression variance ($r^2 = 0.554$, $n = 52$, $F = 32.7$, $P < 0.0001$): $\text{JMMT} = 7.239 - 0.0043(\text{elevation}) - 0.0363(\text{distance})$.

Mean annual total precipitation (MATP) is primarily correlated with elevation ($r^2 = 0.279$, $n = 78$, $F = 29.4$, $P < 0.0001$): $\text{MATP} = 0.0211(\text{elevation}) + 32.849$. Distance from the coast is not a significant factor; however, inland areas tend to experience more days of precipitation ($r^2 = 0.661$, $n = 19$, $F = 36.04$, $P < 0.0001$): days precipitation $> 0.25 \text{ cm} = 0.048(\text{distance}) + 4.222$. This increased frequency of rain exposes gnatcatchers farther inland to more frequent thermal stress usually associated with the combination of cold temperatures and wet weather (Lustick and Adams 1977).

The apparent eastern limit of the California Gnatcatcher appears to coincide with a $T_{\text{d}}$ of 2.5°C (Figure 2), a value within the 95% confidence interval for the predicted $T_{\text{d}}$ derived from allometric equations developed by Root (1988). Ratios of resting metabolic rate to basal metabolic rate (RMR:BMR) calculated from the energetics model for the wintering Verdin suggest that California Gnatcatchers may be more sensitive to cold weather than most of the 14 species analyzed by Root (1988) (mean RMR:BMR 2.49, standard error 0.07, lower 95% confidence interval approximately 2.35). RMR:BMR for San Diego County areas lacking gnatcatchers mostly exceed 2.2 (Table 1). RMR:BMR for marginally occupied areas are between 2.10 and 2.15. Areas with substantial gnatcatcher occupation have ratios less than 2.10.

Overall, the eastern range limits of the California Gnatcatcher are generally consistent with the energetic-constraint hypothesis. Most CSS
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Figure 2. January mean minimum temperature and precipitation at weather stations where the January mean minimum temperature is less than 4.5°C. The energetics model predicts the California Gnatcatcher's occurrence only where Tdis > 2.5°C. Filled diamonds, locations with gnatcatcher populations; open circles, gnatcatchers absent.

above 450 m elevation does not appear to support substantial populations (Atwood and Bolsinger 1992; county GIS databases). Winter weather above this elevation is generally colder and wetter than below it. Annual overwinter survival of gnatcatchers at higher elevations is probably insufficient to sustain populations. One exception to this elevational limit is north of El Capitan Reservoir at the headwaters of the San Diego River (Figure 1), site of the most inland known population in San Diego County. The JMMT for this location is 5.1°C, well above the Tdis value of 2.5°C. Perhaps the San Diego River and El Capitan Reservoir have a moderating effect on JMMT in this area, allowing gnatcatchers to sustain themselves over the winter.

Root (1988) reported a Tdis of -1.1°C for the closely related Black-tailed Gnatcatcher (Polioptila melanura). The Black-tailed Gnatcatcher's distribution in western Arizona becomes restricted as elevation increases, especially above 600 m, despite apparently suitable habitat above this elevation (Hunter 1988, Rosenberg et al. 1991). The difference in elevational limits between the Black-tailed and California Gnatcatchers is reflected in their different values of Tdis. Black-tailed Gnatcatchers have also been documented as roosting communally in thermal refugia (e.g., Verdin nests) during winter, a behavioral adaptation enhancing over-winter survival (Walsberg 1990). California Gnatcatchers associated with the Cactus Wren (Campylorhynchus brunneicapillus) may also seek shelter in that species' covered nests when available.
Table 1 Calculated Ratios of Resting Metabolic Rate to Basal Metabolic Rate for the California Gnatcatcher along the Eastern Edge of Its Range in San Diego County

<table>
<thead>
<tr>
<th>Weather station location</th>
<th>Gnatcatcher population</th>
<th>January mean maximum temperature (°C)</th>
<th>January mean minimum temperature (°C)</th>
<th>Calculated RMR:BMR ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpine</td>
<td>No</td>
<td>17.3</td>
<td>3.3</td>
<td>2.15</td>
</tr>
<tr>
<td>Barrett Dam</td>
<td>No</td>
<td>17.4</td>
<td>0.9</td>
<td>2.22</td>
</tr>
<tr>
<td>Campo</td>
<td>No</td>
<td>15.8</td>
<td>1.6</td>
<td>2.27</td>
</tr>
<tr>
<td>Julian</td>
<td>No</td>
<td>12.7</td>
<td>2.0</td>
<td>2.38</td>
</tr>
<tr>
<td>Oak Grove</td>
<td>No</td>
<td>14.7</td>
<td>1.3</td>
<td>2.32</td>
</tr>
<tr>
<td>East El Cajon</td>
<td>Marginal</td>
<td>19.4</td>
<td>2.6</td>
<td>2.10</td>
</tr>
<tr>
<td>East Ramona</td>
<td>Marginal</td>
<td>18.4</td>
<td>2.6</td>
<td>2.14</td>
</tr>
<tr>
<td>Escondido</td>
<td>Marginal</td>
<td>18.5</td>
<td>2.6</td>
<td>2.13</td>
</tr>
<tr>
<td>Ramona</td>
<td>Marginal</td>
<td>17.2</td>
<td>3.7</td>
<td>2.15</td>
</tr>
<tr>
<td>El Cajon</td>
<td>Yes</td>
<td>18.7</td>
<td>5.5</td>
<td>2.04</td>
</tr>
<tr>
<td>El Capitan Dam</td>
<td>Yes</td>
<td>19.7</td>
<td>5.1</td>
<td>2.01</td>
</tr>
</tbody>
</table>

*aMarginal indicates areas with few gnatcatcher sightings. 
*bRatio of resting metabolic rate (RMR) to basal metabolic rate (BMR) calculated from energetics model for the Verdin in winter (Webster and Weathers 1990). Model assumed daytime and nighttime wind speeds of 8.0 and 0.8 km/hr, respectively.

There are a few weather stations with JMMT values greater than 2.5°C that currently do not have any nearby documented gnatcatcher populations (Alpine, San Jacinto, Beaumont, Newhall; Figure 2). This analysis suggests that gnatcatcher occupation of coastal sage scrub around these locations is not constrained by winter weather. Surveys of suitable habitat in these areas may reveal previously undocumented populations of the California Gnatcatcher.

The California Gnatcatcher appears to be lacking in the coastally situated Santa Monica Mountains and much of coastal Ventura County (Atwood 1993). Historically, gnatcatchers were known from near Santa Paula, and there is a recent sighting of a single individual near Moorpark (Atwood 1993, C. A. Jones and R. S. Ramirez unpubl.). From this analysis, the absence of gnatcatchers from the Santa Monica Mountains appears anomalous; the energetic-constraint hypothesis is not a likely explanation for the lack of gnatcatchers in the Santa Monica Mountains. This area supports substantial tracts of dense coastal sage scrub dominated by black and purple sage (Salvia mellifera and S. leucophylla; Westman 1981). Both of these species produce possibly insecticidal chemicals that may reduce insect densities, especially during droughts (Muller and Muller 1964, Muller and del Moral 1966, Tyson et al. 1974). Black-sage-dominated sage scrub has been reported as being less preferred by California Gnatcatchers (Bontrager 1991, Bontrager et al. 1995, Sweetwater Environmental Biologists 1994, Mock unpubl. data). The dominance of this less preferred subassociation may be one factor contributing to the gnatcatcher’s absence from this coastal area.

This research provides a preliminary test of the long-standing hypothesis within ecology that abiotic environmental factors, such as extreme weather, play a role in shaping a species’ distribution and abundance (Root 1988). It
provides a scientific basis for giving priority in habitat acquisition and habitat-management programs toward areas likely to support resilient gnatcatcher populations (Root and Schneider 1993). Coastal areas support the majority of documented gnatcatcher-occupied habitat and these areas have JMMT well above the $T_{d_{is}}$ value of 2.5°C.

Additional field surveys are recommended for areas where JMMT is less than 4.4°C to test the energetic-constraint hypothesis further. Laboratory studies documenting the physiological response of the California Gnatcatcher to temperature and wind are also needed if a detailed energetics model for this species is to be developed. Alternative hypotheses to explain the absence of gnatcatchers from the Santa Monica Mountains and coastal Ventura County need to be developed and evaluated.

SUMMARY

The California Gnatcatcher's current distribution appears to be limited to only a portion of the available coastal sage scrub. I evaluate the hypothesis that abiotic environmental factors (i.e., thermal environment and precipitation) are the primary forces constraining the species' distribution and abundance. Root (1988) proposed that distributions of small sedentary songbirds are limited to where the January mean minimum temperature results in a resting metabolism less than 2.49 times the species' basal metabolic requirement, defining a limiting isotherm $T_{d_{is}}$. The limiting $T_{d_{is}}$ for the California Gnatcatcher, based on a detailed energetic model for the Verdin, appears to be 2.5°C, within the 95% confidence interval of the Root model. The lack of gnatcatchers in the Santa Monica Mountains and coastal Ventura County is not consistent with the energetic-limitation hypothesis. These coastal areas are dominated by sage scrub subassociations believed to be less preferred by gnatcatchers.

ACKNOWLEDGMENTS

M. Webster graciously provided the Verdin energetics model program. Graphics and GIS support was provided by the San Diego office of Ogden Environmental and Energy Services. Funding for this study was provided by Ogden Environmental and Energy Services. Review of the manuscript was provided by C. Hunter, J. Rotenberry, P. Unitt, and an anonymous reviewer. I am grateful to all of the above individuals and organizations for their contributions to this study.

LITERATURE CITED


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CALIFORNIA GNATCATCHER USE OF HABITATS OTHER THAN COASTAL SAGE SCRUB: CONSERVATION AND MANAGEMENT IMPLICATIONS

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That California Gnatcatchers (Polioptila californica) within the United States are dependent on coastal sage scrub habitats is well established (Atwood 1993, USFWS 1991, 1993). Our effort in this paper is to look not at whether these habitats are necessary on a large scale, but rather to raise the question of whether they are always sufficient, at both local and larger scales.

Existing literature on these birds makes little mention of their occurrence outside of coastal sage scrub habitats. Some sources specifically state that the species is restricted to coastal sage scrub (Woods 1949, USFWS 1991). The earliest clear, published indication to the contrary was provided by Unitt (1984): "Elizabeth Copper (pers. comm.) suggests that the gnatcatchers leave the sage scrub for more humid habitats nearby in late summer when most sage scrub plants are dry and brown."

Throughout the species' U.S. range since 1990, we have found numerous instances of California Gnatcatchers making potentially significant use of habitats other than coastal sage scrub (hereafter, non-CSS). Many of these instances were noted without systematic study, but we also document systematic use of non-CSS by closely monitored birds over several years. We neither propose nor anticipate that the species is broadening its general habitat requirements, nor that in California the birds regularly nest independently of coastal sage scrub. We do believe that such use of non-CSS is frequent, at least in some situations, and potentially important to the long-term viability of U.S. populations.

METHODS AND RESULTS

We examined the literature on the California Gnatcatcher for discussions of non-CSS use and reviewed our own extensive combined field experience. Campbell, Erickson, and Patten have performed focused surveys or habitat assessments for the California Gnatcatcher at well over 200 sites since 1988, throughout most of the U.S. range of the species, and at all times of year. Haas has studied the species intensively at several sites in one portion of the range, over several years.

We found little published indication that the species is found outside of its typical habitat. An example is Woods' (1949) statement, "few landbirds confine themselves so rigidly to their characteristic habitat." Apart from
Unitt's (1984) reference mentioned above, we found no explicit discussions of whether the species' habitat preferences may vary seasonally or among various roles (e.g., during dispersal; for juveniles versus adults; during breeding versus nonbreeding). Some authors have noted use of non-CSS, but the potential importance of such use has never been addressed.

We present details of 51 occurrences of California Gnatcatchers using non-CSS for significant periods, many involving multiple birds (Table 1). These observations were not the result of systematic study at coastal sage scrub edge and thus may underestimate the occurrence of such behavior. Observations are ordered by county and grouped by month. Observations of only brief non-CSS habitat use or use of minor CSS habitat variations are not included. Plant nomenclature and taxonomy follow Hickman (1993).

We also present information from longer-term studies of California Gnatcatcher populations in San Diego County, data that complement Table 1. We have recorded substantial use of non-CSS habitat while monitoring gnatcatcher behavior at several locations including Mission Trails Regional Park, Lake Hodges, Sweetwater Reservoir and Dam, Fallbrook Naval Weapons Station, and Marine Corps (formerly Naval) Air Station Miramar. Three of these locations have been monitored for three years or more with color-banded birds. These data are based on standardized spot-mapping (Ralph et al. 1993) and include year-round data from most locations. Anecdotal observations of non-CSS use were made as well during those studies, but we present only graphic summaries of spot-mapping data over several months, as these data are not tested statistically.

At least one pair of California Gnatcatchers seasonally shifted in habitat from predominantly CSS habitat to non-CSS (in this case, cottonwood–willow riparian and willow scrub; Figure 1). In the case of some monitored pairs, the change appeared to be in part due to seasonal expansion of use areas.

Another pair showed an alternative (but not mutually exclusive) form of habitat shifting, from its breeding-season use area (high-quality coastal sage scrub) in the early morning to an alternative habitat (cottonwood–willow riparian; Figure 2) in the afternoon. It used non-CSS primarily along the habitat edge adjacent to the breeding territory.

During the cold, wet winter and spring of 1993 Haas observed three pairs engaging in a third type of shift (Figure 3). The study site covered 20 ha in San Diego County with sage scrub on slopes and in washes, chaparral on ridge tops and mesas. In March and April gnatcatchers used the chaparral, dominated by chamise (Adenostoma fasciculatum) and black sage (Salvia mellifera), not only for foraging but also for nest placement, building seven nests in chamise. Later in the year, when the sage scrub was no longer laden with dew in the early morning, two of the pairs placed their third or fourth nests there. At this time, all three pairs foraged extensively outside the chamise in sage scrub and chaparral broom (Baccharis sarothroides). Use of chamise chaparral by the California Gnatcatcher, even almost exclusive use year round by some individuals or pairs, has been recorded in several studies (T. Conkle pers. comm.).

Data from 1520 observations at two study sites (predominantly coastal sage scrub during the breeding season) show a definite increase from spring to summer in use of several types of non-CSS (including riparian and
Table 1 Observations of the California Gnatcatcher Using Habitats Other than Coastal Sage Scrub

<table>
<thead>
<tr>
<th>Location and use of non-CSS</th>
<th>Dominant plants or vegetation type</th>
<th>CSS proximity</th>
<th>Number, age, sex</th>
<th>Year</th>
<th>Observer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rancho Palos Verdes, Los Angeles Co.</td>
<td>Bx</td>
<td>&lt;200 m</td>
<td>4–5</td>
<td>1992</td>
<td>RAE</td>
</tr>
<tr>
<td>Jan–Mar</td>
<td>Bx</td>
<td>adjacent</td>
<td>1 pair, 2 juveniles</td>
<td>1992</td>
<td>KFC</td>
</tr>
<tr>
<td>Jun</td>
<td>Bx</td>
<td>&lt;200 m</td>
<td>4–5</td>
<td>1991</td>
<td>RAE</td>
</tr>
<tr>
<td>Sep–Dec</td>
<td>Bx</td>
<td>&lt;200 m</td>
<td>3–4</td>
<td>1991</td>
<td>RAE</td>
</tr>
<tr>
<td>Jan–Mar; regular</td>
<td>Bx, Al, Orn</td>
<td>&lt;100 m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Newport Beach, Orange Co.</td>
<td>Bs, Sx</td>
<td>&lt;100 m</td>
<td>1–2 pairs</td>
<td>1991</td>
<td>RAE</td>
</tr>
<tr>
<td>Mar–Apr; most of territory</td>
<td>Bs, Sx</td>
<td>&lt;100 m</td>
<td>2 pairs</td>
<td>1992</td>
<td>RAE</td>
</tr>
<tr>
<td>Mar–Apr; most of territory</td>
<td>Bs, Sx</td>
<td>&lt;100 m</td>
<td>2 pairs</td>
<td>1993</td>
<td>RAE</td>
</tr>
<tr>
<td>Mar–Apr; most of territory</td>
<td>Bs, Sx</td>
<td>&lt;100 m</td>
<td>2 pairs</td>
<td>1994</td>
<td>RAE</td>
</tr>
<tr>
<td>Mar–Apr; most of territory</td>
<td>Bs, Sx</td>
<td>&lt;100 m</td>
<td>1 pair</td>
<td>1996</td>
<td>RAE</td>
</tr>
<tr>
<td>Oct; seen once</td>
<td>Rud</td>
<td>&lt;150 m</td>
<td>2</td>
<td>1997</td>
<td>RAE</td>
</tr>
<tr>
<td>Oct–Nov</td>
<td>Rud</td>
<td>&lt;600 m</td>
<td>5</td>
<td>1990</td>
<td>RAE</td>
</tr>
<tr>
<td>Oct–Nov</td>
<td>Rud</td>
<td>&lt;600 m</td>
<td>5</td>
<td>1991</td>
<td>RAE</td>
</tr>
<tr>
<td>Irvine, Orange Co.</td>
<td>Bs</td>
<td>± 75 m</td>
<td>1–2 pairs</td>
<td>1991</td>
<td>RAE</td>
</tr>
<tr>
<td>nesting season; most of territory</td>
<td>Bs</td>
<td>± 75 m</td>
<td>1–2 pairs</td>
<td>1992</td>
<td>RAE</td>
</tr>
<tr>
<td>nesting season; most of territory</td>
<td>Bs</td>
<td>± 75 m</td>
<td>1–2 pairs</td>
<td>1993</td>
<td>RAE</td>
</tr>
<tr>
<td>nesting season; most of territory</td>
<td>Bs</td>
<td>± 75 m</td>
<td>1 pair</td>
<td>1994</td>
<td>RAE</td>
</tr>
<tr>
<td>nesting season; most of territory</td>
<td>Bs</td>
<td>± 75 m</td>
<td>1 pair</td>
<td>1996</td>
<td>RAE</td>
</tr>
<tr>
<td>nesting season; most of territory</td>
<td>Bs</td>
<td>± 75 m</td>
<td>male on territory</td>
<td>1997</td>
<td>RAE</td>
</tr>
<tr>
<td>nesting season; regular</td>
<td>Bx, Hi, AGr</td>
<td>adjacent</td>
<td>several pairs and their young</td>
<td>1992</td>
<td>RAE</td>
</tr>
<tr>
<td>nesting season; repeated</td>
<td>Bx, Hi, AGr</td>
<td>&lt;100 m</td>
<td>several pairs and their young</td>
<td>1993</td>
<td>RAE</td>
</tr>
<tr>
<td>nesting season; repeated</td>
<td>Bx, Hi, AGr</td>
<td>&lt;100 m</td>
<td>several pairs and their young</td>
<td>1994</td>
<td>RAE</td>
</tr>
<tr>
<td>nesting season; repeated</td>
<td>Bx, Hi, AGr</td>
<td>&lt;100 m</td>
<td>several pairs and their young</td>
<td>1995</td>
<td>RAE</td>
</tr>
<tr>
<td>nesting season; repeated</td>
<td>Bx, Hi, AGr</td>
<td>&lt;100 m</td>
<td>several pairs and their young</td>
<td>1996</td>
<td>RAE</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Location and use of non-CSS</th>
<th>Dominant plants or vegetation type</th>
<th>CSS proximity</th>
<th>Number, age, sex</th>
<th>Year</th>
<th>Observer</th>
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<tr>
<td>nesting season; repeated</td>
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<td>&lt;100 m</td>
<td>several pairs and their young</td>
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<td>RAE</td>
</tr>
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<td>nesting season; most of territory</td>
<td>Rud</td>
<td>&lt;250 m</td>
<td>1 pair</td>
<td>1996</td>
<td>RAE</td>
</tr>
<tr>
<td>nesting season; most of territory</td>
<td>Rud</td>
<td>&lt;250 m</td>
<td>2 pair; 1 successful</td>
<td>1997</td>
<td>RAE</td>
</tr>
<tr>
<td>Sep</td>
<td>Bx, Hi, Agr</td>
<td>&lt;250 m</td>
<td>3 juv.</td>
<td>1996</td>
<td>RAE</td>
</tr>
<tr>
<td>Sep-Oct</td>
<td>Bx, Hi, Agr</td>
<td>&lt;250 m</td>
<td>5-6, mostly juv.</td>
<td>1993</td>
<td>RAE</td>
</tr>
<tr>
<td>Sand Canyon Res., Orange Co.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May-Jun</td>
<td>Sx</td>
<td>&lt;100 m</td>
<td>1 pair and young</td>
<td>1995</td>
<td>RAE</td>
</tr>
<tr>
<td>Los Coyotes Hills, Orange Co.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May-Aug; postfledging</td>
<td>Bs, Rud</td>
<td>adjacent</td>
<td>5 pairs and young</td>
<td>1991</td>
<td>KFC</td>
</tr>
<tr>
<td>San Clemente, Orange Co.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan-Mar; regular</td>
<td>Bx, Al, Orn</td>
<td>&lt;100 m</td>
<td>3-4</td>
<td>1991</td>
<td>RAE</td>
</tr>
<tr>
<td>Jul; seen once</td>
<td>Bx, Rud</td>
<td>&lt;300 m</td>
<td>1 juvenile</td>
<td>1991</td>
<td>RAE</td>
</tr>
<tr>
<td>Sep-Dec; regular</td>
<td>Bx, Al, Orn</td>
<td>&lt;200 m</td>
<td>3-4</td>
<td>1990</td>
<td>RAE</td>
</tr>
<tr>
<td>Crystal Cove State Park, Orange Co.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug-Sep</td>
<td>Bx, Rud</td>
<td>&lt;200 m</td>
<td>5-6, mostly juv.</td>
<td>1993</td>
<td>RAE</td>
</tr>
<tr>
<td>Costa Mesa, Orange Co.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct-Nov</td>
<td>Rud</td>
<td>&lt;400 m</td>
<td>5</td>
<td>1990</td>
<td>RAE</td>
</tr>
<tr>
<td>Oct-Nov</td>
<td>Rud</td>
<td>&lt;400 m</td>
<td>5</td>
<td>1991</td>
<td>RAE</td>
</tr>
<tr>
<td>Laguna Niguel, Orange Co.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec; seen once</td>
<td>St</td>
<td>100+ m</td>
<td>2</td>
<td>1991</td>
<td>RAE</td>
</tr>
<tr>
<td>Lake Elsinore, Riverside Co.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May-June; nesting; not seen outside in 3 visits</td>
<td>Af</td>
<td>adjacent</td>
<td>1 pair</td>
<td>1995</td>
<td>KFC</td>
</tr>
<tr>
<td>S of L. Mathews, Riverside Co.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May-Jun; all of territory</td>
<td>Af</td>
<td>30 m</td>
<td>1 pair</td>
<td>1996</td>
<td>KFC</td>
</tr>
<tr>
<td>Jul-Aug</td>
<td>Sx, Sm</td>
<td>adjacent</td>
<td>3+</td>
<td>1995</td>
<td>KFC</td>
</tr>
<tr>
<td>Harrison Res., Riverside Co.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May-Jul; postnesting</td>
<td>low Rip</td>
<td>adjacent</td>
<td>1 pair, no young</td>
<td>1995</td>
<td>KFC</td>
</tr>
<tr>
<td>Location</td>
<td>Month</td>
<td>Habitat</td>
<td>Distance</td>
<td>Age</td>
<td>Year</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>-------</td>
<td>---------</td>
<td>----------</td>
<td>-----</td>
<td>------</td>
</tr>
<tr>
<td>Alberhill Cr., Riverside Co.</td>
<td>Jun</td>
<td>low Rip</td>
<td>50+ m</td>
<td>1 ad., 2 juv.</td>
<td>1992</td>
</tr>
<tr>
<td>Domenigoni Hills, Riverside Co.</td>
<td>Jun-Jul</td>
<td>Hi</td>
<td>adjacent</td>
<td>2 pairs and young</td>
<td>1995</td>
</tr>
<tr>
<td>Railroad Canyon, Riverside Co.</td>
<td>Jun-Jul</td>
<td>Sx, Pf</td>
<td>adjacent</td>
<td>1 pair, 3 young</td>
<td>1994</td>
</tr>
<tr>
<td>Railroad Canyon, Riverside Co.</td>
<td>Aug-Sep</td>
<td>Sx, Pf</td>
<td>adjacent</td>
<td>1 pair, 3 young</td>
<td>1995</td>
</tr>
<tr>
<td>W of L. Mathews, Riverside Co.</td>
<td>Jul</td>
<td>Bs</td>
<td>150+ m</td>
<td>1 male</td>
<td>1994</td>
</tr>
<tr>
<td>Good Hope, Riverside Co.</td>
<td>Sep</td>
<td>Bs</td>
<td>20 m</td>
<td>1 female, 1 juv.</td>
<td>1995</td>
</tr>
<tr>
<td>Cajalco Creek, Riverside Co.</td>
<td>Oct</td>
<td>low Rip</td>
<td>adjacent</td>
<td>2</td>
<td>1993</td>
</tr>
<tr>
<td>San Dieguito Cr., San Diego Co.</td>
<td>June</td>
<td>Hi, Im</td>
<td>± 50 m</td>
<td>1 pair, 3 young</td>
<td>1998</td>
</tr>
<tr>
<td>San Dieguito Cr., San Diego Co.</td>
<td>July</td>
<td>Tam</td>
<td>± 520 m</td>
<td>1 male</td>
<td>1998</td>
</tr>
<tr>
<td>Sweetwater Res., San Diego Co.</td>
<td>Nov</td>
<td>St</td>
<td>&gt;100 m</td>
<td>1 male</td>
<td>1994</td>
</tr>
<tr>
<td>Sweetwater Res., San Diego Co.</td>
<td>Nov</td>
<td>St</td>
<td>adjacent</td>
<td>2, male and female</td>
<td>1994</td>
</tr>
</tbody>
</table>

*Af, Adenostoma fasciculatum; Agr, annual grassland; Al, Atriplex lentiformis; Bs, Baccharis salicifolia; Bx, Brassica sp.; Hi, Hirschfeldia incana; Im, Isocoma menziesii; Om, ornamentals; Pl, Populus fremontii; Rip, riparian; Ru, ruderal (weedy); Sm, Sambucus mexicana; St, Salsola tragus; Sx, Salix sp., Tam, Tamarix sp.*
chaparral) and several plant species, especially Mexican elderberry (Sambucus mexicanus), willows (Salix spp.), coyote brush (Baccharis pilularis), and mulefat (B. salicifolia) (Figure 4). Not all pairs from which the data are drawn have access to non-CSS in or adjacent to their use areas.

DISCUSSION

California Gnatcatchers have been observed using non-CSS throughout the year. Given that there is some bias because much of our field work was during the breeding season, the highest rates of non-CSS use appear to be from May to November. Systematic variation in habitat use by time of day is possible (Figure 2).

The majority of our observations likely reflect short-distance movements, with gnatcatchers moving from territories located in coastal sage scrub to adjacent non-CSS. A few observations were of gnatcatchers whose nesting territories include or are located within non-CSS. We have no indication that the pattern is more prevalent coastally or inland, farther north or farther south, at higher or lower elevations, in smaller or larger patches of coastal sage scrub, among sink or source populations, or at the core or periphery of the species' U.S. range. Adults of both sexes, as well as juveniles, have been observed foraging in non-CSS for extended periods, although it appeared the birds most often engaged in such activity subsequent to nesting. Most non-
CSS use involves areas more mesic than coastal sage scrub, although some of the ruderal areas are only moderately so. An exception is the site on which Figure 3 is based, where gnatcatchers used chaparral adjacent to sage scrub. The sage scrub at this site may have been too cold and wet early in the spring, as the birds used it later. Mature woodland and forest appear to be visited only rarely. Perhaps a more consistent difference from coastal sage scrub is that the non-CSS used frequently has a somewhat greater average height and foliage density and is composed of plant species that are not summer-deciduous. Although many of our observations were of birds at the base of slopes covered with coastal sage scrub, we saw no indication that birds moved in response to degree of slope, aspect, hydrology, or from exposed to protected sites.

The edges of coastal sage scrub, scrub marginal or poor in certain resources, scrub heavily invaded by nonnative plant species, or where California Gnatcatchers in high density are adjacent to productive non-CSS may be the areas where use of alternative habitat is most common. Natural fragmentation of coastal sage scrub is relatively high (Mooney 1988) and increasing with human alteration of the landscape. Geographically, coastal sage scrub itself varies considerably in floristics and phenology (e.g., Kirkpatrick and Hutchinson 1977, White and Padley 1997), and the factors behind California Gnatcatcher use of non-CSS are likely affected by such variation. Annual variation in weather may play an important role, causing significant yearly variations in, for instance, insect abundance in coastal sage.

Figure 2. Morning-to-afternoon habitat shift of a pair of California Gnatcatchers in Mission Trails Regional Park, San Diego, July (J) to December (D) 1993. Data based on two 2-hour spot-mapping visits per month (n = 40 observations/month). Morning data (A) collected between 7 and 10 AM; afternoon data (P) collected between 2 and 5 PM. AM and PM data collected on same day. Solid bars, observations in coastal sage scrub; cross-hatched bars, observations in riparian habitat.
Figure 3. California Gnatcatcher use of chamise chaparral during breeding season, Marine Corps (formerly Naval) Air Station Miramar, San Diego. Shift in habitat in May corresponds to shift to nest placement in coastal sage scrub. Solid bars, observations in chamise chaparral; cross-hatched bars, observations in coastal sage and Baccharis scrub.

scrub in late spring and summer (e.g., Roach 1989), pushing birds out of coastal sage scrub or luring them into other habitats.

The California Gnatcatcher may parallel the riparian Least Bell’s Vireo (Vireo bellii pusillus), whose “use of non-riparian habitats, primarily areas of coastal sage scrub and chaparral vegetation, varied over the nesting cycle, and was related to territory location and habitat composition” (Kus and Miner 1989). These researchers revealed that at one site 23 pairs of Bell’s Vireos, 43% of those studied in one year, included nonriparian areas within their home range.

Four causes, which are not mutually exclusive, for the gnatcatcher’s use of non-CSS appear possible. In each case, fledglings are especially likely to be susceptible; the apparent peak period of non-CSS use in the species is from around the time birds are fledged to at least several months thereafter.

First, improved food resources may play a role. Coastal sage scrub is highly seasonal in plant growth and insect abundance (O’Leary 1989, Roach 1989, R. Redak unpubl. data). Although California Gnatcatchers appear to be well adapted to this habitat, it may be that at times of food stress, as a result of an unusual paucity of resources in the environment (e.g., drought and/or habitat degradation), more usual stress periods in the bird’s cycles (e.g., molt, juveniles’ foraging inefficiency combined with energy demands of fledglings), or a combination of these factors, individuals may receive significant benefit by
Figure 4. Shift in California Gnatcatcher habitat use from June to September at Mission Trails Regional Park and Lake Hodges, San Diego. Data based on 2-hour spot-mapping visits (10 pairs of gnatcatchers/site; 20 observations/pair/visit, n = 1520). Solid bars, observations in coastal sage scrub; cross-hatched bars, observations in riparian habitat.

foraging in non-CSS. Coastal sage scrub is summer-deciduous (Mooney 1988), unlike riparian habitats in the region, which remain green, dense, and mesic through summer (Holstein 1984). Comparing the close correlation of insect biomass and spring peaks of primary productivity in California upland vegetation, Holstein noted that comparable data for California riparian communities appear unavailable, but that the extremely high summer productivity of such communities undoubtedly induces similarly high summer peaks of insect biomass. These in turn attract insectivorous birds.

Second, gnatcatchers with non-CSS experience as juveniles may have higher survival rates during dispersal and other movements than those without such experience. Coastal sage scrub has always been relatively fragmented as well as subject to fires, and is becoming increasingly so (Mooney 1988, O’Leary 1989, Atwood 1993). Thus there is a potentially substantial and increasing selection pressure for success (i.e., finding resources and avoiding predation) during movement through non-CSS. Gnatcatchers that have been familiarized with such habitats, through foraging forays as juveniles led by parents, may have enhanced likelihood of survival later, and thus the behavioral trait of providing non-CSS habitat experience to young would increase as well.

Third, improved microclimate is another possible factor in non-CSS use. Temperature extremes can be an important factor regulating behavior and
small- and large-scale distribution in birds (e.g., Mugaas and King 1981, Barrows 1981). In a seasonally hot environment such as coastal sage scrub, it is reasonable to expect that fledglings may be susceptible to temperature peaks at the very time when shade and water are scarcest. Temporary movement of birds into more shaded habitats may allow them to avoid heat stress, as well as to seek water (whether directly or through food resources).

Fourth, a lowered predation rate for fledglings is yet another factor that may select for non-CSS use. With most songbirds, postfledging juveniles suffer relatively high predation. It is possible that predation rates on fledglings may be lower in non-CSS, such as willow riparian, where cover is more dense. If so, such habitats act as nurseries. An analog of this hypothesis may be found in the work of Evens and Page (1986), who studied predation on the Black Rail (Laterallus jamaicensis) during high tides in the San Francisco Bay area and concluded that vegetation peripheral to marshes may partly offset predation risk by providing rails with alternative cover at high tides. Rails in upland habitat adjacent to marshes during high tide were taken less often by avian predators than were those where cover peripheral to the marsh was lacking.

An additional factor that may add to the importance of non-CSS adjacent to coastal sage scrub is buffering. In addition to providing potentially direct benefits to gnatcatchers as discussed here, non-CSS may lower mortality within coastal sage scrub by lowering the incidence of predation from exotic species such as domestic cats and habitat loss from the many small fires set at the urban–wildland interface. Kelly and Rotenberry (1993) discussed the importance of buffering in reserve design and suggested methods for designing effective buffers. They did not explicitly address the effects or resource value of different kinds of habitats as buffers except in the context of “boundary permeability” for disturbance, and thus such functions are a potential additional value of buffers.

In addition to the potential advantages, however, inclusion or retention of non-CSS within or adjacent to areas being managed for the California Gnatcatcher may pose two distinct disadvantages: (1) frequency of brood parasitism by the Brown-headed Cowbird (Molothrus ater) and predation by a variety of predators may be higher with some adjacent habitats (e.g., low riparian) than with others (e.g., grassland), and (2) concerns regarding brush clearance for fire suppression along the urban–wildland interface may be aggravated when “nonhabitat” areas are being protected at the perceived cost of endangering human structures and lives. A tradeoff situation may exist. A nest located close to retained non-CSS may face a high risk of brood parasitism or predation but may make it easier for gnatcatchers to benefit from the non-CSS as well. As brood parasitism of the California Gnatcatcher appears to be rather patchy (Braden et al. 1997), proximity to non-CSS may result in very different conditions for birds in different places.

RECOMMENDATIONS

Determining the importance of non-CSS to the California Gnatcatcher’s survival will be a formidable task. Needed are studies addressing: (1) the
frequency and pattern with which non-CSS is used by pairs occupying territories adjacent to a variety of habitat types, (2) productivity of such pairs, and (3) survivorship of their offspring. Some of these issues could be addressed through minor adjustments to the methods and assumptions of ongoing and planned research projects.

Area-habitat relationships are the subject of much recent and ongoing research. It is important, however, to separate the broader issues of edge effects from the more focused issue addressed here. If non-CSS is available to a gnatcatcher, what are the costs and benefits of using it rather than adjacent coastal sage scrub? For example, does it allow birds to avoid other, potentially more costly behavior, such as maintaining a substantially larger territory composed of pure coastal sage scrub?

In the short term, management practices should include consideration of the potential importance of non-CSS located adjacent to coastal sage scrub inhabited by California Gnatcatchers. As Kus and Miner (1989) noted in examining use of nonriparian habitat by the Least Bell’s Vireo, “these observations suggest that planning boundaries intended to protect resources essential for breeding vireos should include upland areas bordering riparian habitats.”

Areas with moderate to high vegetative density that are not summer-deciduous but are adjacent to coastal sage scrub should be retained, especially habitats such as mulefat scrub, chaparral, and disturbed riparian. Gnatcatchers’ use of these habitats may be at least locally critical. We do not know how valuable such habitats are, but they are clearly more valuable than sites that are barren or regularly disturbed and are very likely less valuable than an equivalent area of high-quality sage scrub. The question that will arise repeatedly in management is where along that spectrum each patch of non-CSS in question lies. Probably some non-CSS is more valuable than some coastal sage scrub, if the quality of the latter is too poor, or other factors (e.g., patch size and shape; disturbance factors) are important.

Reserve design should reflect the need for landscape-level planning rather than treat habitats as isolates. For example, the value of a potential mitigation site is partly reflected in the presence of usable non-CSS, in addition to more traditional measures such as the quality and acreage of coastal sage scrub. The potential buffer from human impacts, as well as the alternative habitat resources, may spell the difference between a vital, long-term natural reserve and the dubious expediency of a simple acreage ratio. Finally, those performing impact analyses under the California Environmental Quality Act, National Environmental Policy Act, or other regulations should recognize that avoidance of impacts to coastal sage scrub alone is not a guarantee that impacts to gnatcatchers have been avoided. Removal of habitat up to, but not including, coastal sage scrub may well allow for persistence of gnatcatchers at a given site only if ideal conditions prevail indefinitely, an obviously unrealistic assumption.

It is critical for our understanding of what constitutes California Gnatcatcher habitat that definitions be drawn from actual use by the birds, not from scale-dependent abstractions such as “coastal sage scrub.” Failure to protect adjacent non-CSS adequately at the scales of both regional planning and particular sites may critically affect the species’ long-term viability. It
may be possible to save "the habitat" by artificially restricting our understanding of it and yet lose the species intended for protection.

SUMMARY

The California Gnatcatcher, while clearly dependent on coastal sage scrub within its U.S. range, regularly uses other habitats and shows seasonal and perhaps daily patterns in such use. Our data do not reveal patterns with regard to many possible environmental variables, such as geographic or topographic trends. There does appear to be some pattern of non-CSS use emphasizing shrubby or weedy habitats that are mesic and not summer-deciduous. Use of such habitats appears to be most frequent immediately upon fledging of young and continues through fall and winter, with smaller numbers of birds using such areas during the breeding season. Improved food resources, higher survival rates during juveniles' dispersal, fire avoidance, cooler microclimate during heat stress, and lower predation rates for juveniles may all be factors contributing to the gnatcatcher's use of alternative habitats. Non-CSS may also provide a buffer to human impacts on and natural variation in coastal sage scrub. Conversely, it may facilitate increased brood parasitism by cowbirds as well as predation at some sites.

The gnatcatcher's use of non-CSS habitats has implications for reserve design and management, restoration efforts, and environmental-impact analyses. The political ramifications of preserving non-CSS for gnatcatchers should be factored into planning and management decisions because of issues such as the perceived need of the human community for safety from wildfire. The importance of non-CSS to the California Gnatcatcher and other coastal sage scrub species should be examined through intermediate-term (8-15 yr) local studies of population dynamics and habitat use under a range of environmental conditions, addressing both productivity and survivorship.

ACKNOWLEDGMENTS

Anecdotal data (Table 1) are from the field work of Campbell, Erickson, and Patten; data from spot mapping are from the field work of Haas and Varanus Biological Services. We thank Elizabeth Copper for her early recognition of the use of alternative habitats by California Gnatcatchers. Brian E. Daniels was the first to point out to Campbell such a pattern of habitat use. Jonathan L. Atwood, Jutta C. Burger, Tricia A. Campbell, and John T. Rotenberry provided invaluable discussions, criticisms, and suggestions. We thank our clients for access to fascinating areas and permission to use the data, particularly the U.S. Marine Corps for use of data derived under contract at Marine Corps Air Station Miramar.

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GNATCATCHER USE OF HABITATS OTHER THAN COASTAL SAGE SCRUB


Accepted 23 July 1998

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AN EXAMPLE OF THE CALIFORNIA GNATCATCHER NESTING IN RESTORED COASTAL SAGE SCRUB


Creation of coastal sage scrub has become an important component of long-term management for the California Gnatcatcher (Polioptila californica) and other sensitive species in southern California. We describe successful gnatcatcher nesting in four-year-old restored coastal sage scrub in coastal Orange County, California, in 1995; the birds continued to nest there from 1996 to 1998. Our intent is to demonstrate that restored coastal sage scrub has been used by gnatcatchers, not to recommend specific restoration procedures.

In 1988, as a condition of residential development in Enclave VII in the Turtle Rock area of Irvine, the city's planning commission required 1:1 replacement of coastal sage scrub eliminated by construction, though it applied no standards for the replacement habitat's performance. In January 1989 LSA Associates, Inc., developed a revegetation plan (one-sheet drawing) that specified the conversion of 2.4 ha of annual (non-native) grassland to coastal sage scrub on specified open space dedicated to the city of Irvine. Dominant species on the site were wild oats (Avena fatua), ripgut grass (Bromus diandrus), foxtail chess (Bromus madritensis ssp. rubens), and artichoke thistle (Cynara cardunculus). [Plant taxonomy and nomenclature follow J. C. Hickman (ed.), 1993, The Jepson Manual: Higher Plants of California, Univ. of Calif. Press, Berkeley.] The site was approximately 250 m from the nearest patch of extant coastal sage scrub, on heavy clay soils with a southern exposure (Figure 1).

RESTORATION PROCEDURES

Preparation of the site consisted of treating annual grasses and artichoke with herbicide (Roundup at the dosage specified on the label), and disking the accessible portion of the site. The west end of the site consists of a draw that was too steep to disk. An accidental grass fire in that area, however, created an excellent seed bed that required no further preparation.

On 5 April 1991, immediately following the second application of herbicide, the seed specified in the plan (Table 1) was purchased and sown in the flatter portion of the site by means of a seed drill (Figure 2). On 8 April 1991, the part of the site that did not lend itself to being worked with farm equipment was hydroteeded with the same species mix at the same application rate, along with 600 pounds of wood-fiber mulch per hectare. Following seeding, five species of plants in one-gallon containers were planted on 10 and 11 April 1991 (Table 1). Because of the lack of normal winter rainfall and the lateness of the season, a temporary irrigation system was installed immediately following seeding and planting. The site was irrigated until July 1991.

Of the 11 species initially sown, only California encelia (Encelia californica) and bush monkey-flower (Mimulus aurantiacus) had grown to an
acceptable number of individuals by July 1991, and much of the site was occupied by annual grasses and other weeds, along with small seedlings of scrub species. Weeds and grasses were either pulled out, cut off, or treated with Roundup in the larger areas devoid of native vegetation.

Table 1 Plants Used in Restoration of Coastal Sage Scrub at Turtle Rock Enclave VII, Irvine, Orange County, California, April 1991

<table>
<thead>
<tr>
<th>Seed Mix</th>
<th>Container plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>California sagebrush</td>
<td>Toyon</td>
</tr>
<tr>
<td>California encelia</td>
<td>Prickly pear</td>
</tr>
<tr>
<td>California buckwheat</td>
<td>Lemonadeberry</td>
</tr>
<tr>
<td>Coastal goldenbush</td>
<td>Laurel sumac</td>
</tr>
<tr>
<td>Golden yarrow</td>
<td>Blue elderberry</td>
</tr>
<tr>
<td>Bladderpod</td>
<td>Heteromeles arbutifolia</td>
</tr>
<tr>
<td>Arroyo lupine</td>
<td>Opuntia littoralis</td>
</tr>
<tr>
<td>Bush monkeyflower</td>
<td>Rhus integrifolia</td>
</tr>
<tr>
<td>White sage</td>
<td>Malosma laurina</td>
</tr>
<tr>
<td>Black sage</td>
<td>Sambucus mexicana</td>
</tr>
<tr>
<td>Foxtail fescue</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Plants Used in Restoration of Coastal Sage Scrub at Turtle Rock Enclave VII, Irvine, Orange County, California, April 1991.
CALIFORNIA GNATCATCHER NESTING IN RESTORED SAGE SCRUB

Figure 2. Drilling seed following site preparation, March 1991. View to the east.  
*Photo by Gary Dow*

Figure 3. The site on 24 April 1995. View to the east.  
*Photo by Gary Dow*
Figure 4. Draw on the west end of the site, March 1994.

In June 1992, line-intercept transects showed 44% of the site to be covered with coastal sage scrub species, dominated by California encelia. The limited species diversity was due to the poor quality of the seed used by the contractor (proof of seed quality was not required, and it was later determined that seed of inferior quality was used). In addition, 3033 square meters of the site was found to be lacking coastal sage scrub vegetation. In January 1993, these open and weedy areas were supplemented with 2100 California sagebrush (Artemisia californica) plants grown in D-40 containers (deep-cell plant containers with diameters of 6.4 cm and depths of 25 cm).

In April 1993, the cover was estimated to be about the same as in June 1992, with California encelia still the dominant species. Annual grasses had diminished since June 1992, but California burclover (Medicago polymorpha), which had not been present previously, had overtopped all of the scrub species in some locations. The recently planted California sagebrush had grown well, with some plants 0.6 m high. The surviving original container plants were growing well, with some having achieved a height of 1.2 m and a crown diameter of 1.5 m.

By June 1994, the site appeared to have a full 70% cover, with small openings scattered throughout (Figure 3). The primary species remained California encelia, with lesser amounts of California buckwheat (Eriogonum fasciculatum), bush monkey-flower, California sagebrush, black sage (Salvia mellifera), golden yarrow (Eriophyllum confertiflorum), Mexican elderberry (Sambucus mexicana), lemonadeberry (Rhus integrifolia), and prickly pear (Opuntia littoralis), but in greater numbers than in previous years. The greatest species diversity occurred in the draw at the west end (Figure 4).
CALIFORNIA GNATCATCHER NESTING IN RESTORED SAGE SCRUB

CALIFORNIA GNATCATCHER OBSERVATIONS

Robert A. Hamilton first observed a pair of California Gnatcatchers on the restoration site on 13 December 1994, three years after it was planted. Erickson watched presumably these same birds carrying nesting material to a California encelia in the eastern half of the site on 24 April 1995, and on 21 June 1995 followed the pair as they tended three fledged young in the same area.

A biologist visited the site only once in 1996. On 12 April, David R. Bontrager found two pairs, one of which was tending a nest with four young. The nest was located in a California encelia near the east end of the site. Two pairs were present again in 1997 (Bontrager pers. comm.). The eastern pair successfully fledged two broods; the western pair's nesting attempts apparently failed. During preliminary surveys in 1998, Bontrager again found two pairs, one with a nest and eggs in the western ravine.

CONCLUSIONS

Although this project involved minimal effort, it produced usable nesting habitat for the California Gnatcatcher. Since completion of the initial plan in 1990, the gnatcatcher has been listed as threatened by the U.S. Fish and Wildlife Service, resulting in much more restoration of coastal sage scrub. More rigorous procedures for restoration are typical today, techniques that should provide better habitat than did this minimal effort.

SUMMARY

Creation of coastal sage scrub suitable for use by the California Gnatcatcher has become an important component of long-term management for this threatened species. In 1988, as partial compensation for a residential development in Irvine, the city's planning commission required 1:1 replacement of coastal sage scrub. A "revegetation" plan was developed in January 1989, requiring the establishment of 2.4 ha of coastal sage scrub in grassland nearby. Initial hydroseeding, drill seeding, and planting took place in April 1991, with supplemental seeding in September 1991 and additional planting in January 1993. Vegetation at the site is now dominated by California encelia (Encelia californica). One pair of California Gnatcatchers successfully nested at the site in its fourth year (1995), and at least two pairs have nested in each subsequent year (1996–1998).

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USE OF RESTORED COASTAL SAGE SCRUB HABITAT BY CALIFORNIA GNATCATCHERS IN A PARK SETTING

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Public lands are increasingly being relied upon to provide the natural open space necessary to conserve California’s rich natural heritage. Simple inclusion of land in parks is often assumed to provide the habitat and protective mechanisms required to ensure the long-term viability of natural populations. The conflicts inherent in administering these lands for public use while protecting all resources, however, are often not taken into consideration. Here we examine if one species, the California Gnatcatcher (*Polioptila californica*), is reproductively successful in a park with restored habitat near public facilities.

The California Department of Parks and Recreation purchased Crystal Cove State Park and began constructing facilities for public access in 1983. This park covers 1595 ha with approximately 5.1 km of coastline and is located in Orange County between the cities of Corona del Mar and Laguna Beach. At the time of acquisition, over 28 ha of the approximately 100-ha coastal terrace south of Pacific Coast Highway were devoid of vegetation and the severe compaction of the soils was accelerating bluff erosion. Remnants of the terrace’s original coastal sage scrub occurred only in the canyons dissecting the terrace and along the bluff face. These areas were dominated by California sagebrush (*Artemisia californica*), with lemonadeberry (*Rhus integrifolia*), coyote bush (*Baccharis pilularis*), black sage (*Salvia mellifera*), bladderpod (*Isomeris arborea*), and Mexican elderberry (*Sambucus mexicana*) commonly in association.

As part of a 4-year development plan, 20 ha of abandoned roads, trails, parking areas, and disturbed areas adjacent to new construction were revegetated with a mix of coastal sage scrub species in order to increase cover of the native plant community and reduce bluff erosion on the terrace. Consequently, many of the areas treated were linear in shape and adjacent to the newly built facilities. The revegetation efforts encompassed a variety of restoration techniques, including scarification, importation of topsoil, prescribed burning, hydroseeding (55 to 127 kg/ha), broadcast of seeds by hand (13 to 80 kg/ha), mulch and tackifier application, and container planting (24,175 plants total) (Hillyard and Black 1988). Success of each treatment combination was not uniform over the entire treatment area. Adverse soil conditions and competition from exotic plants appeared to affect the establishment of coastal sage scrub species substantially. Several sites were retreated with various combinations of methods between 1983 and 1987, making it difficult to attribute revegetation success at any one site to a specific set of treatments.

Since 1991, park biologists have surveyed for the California Gnatcatcher on the 100-ha coastal terrace south of Pacific Coast Highway, between
Pelican Hills Golf Course on the west and Muddy Creek on the east (Figure 1). Twelve pairs were observed within the study area in 1991, 14 pairs and 1 single male in 1992, 20-22 pairs in 1993 (Miner unpubl. data), and 41-44 pairs in 1994 (Hirsch and Wolf unpubl. data). The population increase from 1991 through 1993 was presumed to be due to the increase in available habitat on site and the lost of adjacent habitat to development. We presume the jump in the population from 1993 to 1994 to be largely a result of the 1993 Laguna Fire, which consumed most of the inland habitat in the San Joaquin Hills but not the coastal terrace (Atwood et al. 1998). Although fledglings were evident on site each year, it is unknown how much of the observed population increase was due to natural recruitment or to immigration from adjacent areas.

Regardless of the source of the increasing number of birds, the population of California Gnatcatchers is concentrated within the most highly visited portion of the park and is using restored habitat adjacent to areas heavily used by the public, such as park roads, trails, parking lots, and restrooms. There are five public parking lots, four of which are connected by a single access road parallel to the coast. A bike trail and five beach-access ramps serve pedestrians, bicyclists, and the park's safety and maintenance vehicles. Vegetation along these roads and trails is kept trimmed off the pavement edge. Two questions then arise: (1) are the gnatcatchers reproducing as

![Figure 1. Location of the Crystal Cove State Park study site on the Pacific coast of Orange County, California.](image-url)
CALIFORNIA GNATCATCHER USE OF RESTORED SAGE SCRUB

successfully in restored habitat as in nonrestored habitat, and (2) does the proximity of intensive public use negatively affect reproductive success?

METHODS

In 1995 surveys to identify individuals, pairs, and territories of California Gnatcatchers on the 100-ha coastal terrace of Crystal Cove State Park began on 25 February. The population density and resulting high level of territorial displays on the bluff tops of the park made locating the birds relatively easy. Researchers remained in areas of suitable habitat until the birds made themselves known either visually or by calling. In an effort to keep disturbance to a minimum, calling or "pishing" were used only on occasion when gnatcatchers were seemingly absent from patches of suitable habitat. Emphasis was placed on nonobtrusive observation throughout the breeding season.

Nest monitoring commenced 3 March and continued through 1 August. During this time, we limited ourselves to three and occasionally four visits per nesting attempt. Nests were located during the building phase from a distant observation point, then approached for the first time during incubation to document the number of eggs and any parasitism by the Brown-headed Cowbird (Molothrus ater). We revisited the nests after the adults began bringing insects to the nestlings to estimate the age and number of nestlings. Fifty nestlings were uniquely color-banded at 8 or 9 days of age. Nests were considered successful if the fledglings were seen during the first few days after leaving the nest.

We collected data on the nesting substrate, including host-plant species, after the nest was abandoned and no longer used as material for building the subsequent nest. In addition, we estimated the distance from each nest to the closest paved road or path. Using aerial photographs and acetate overlays, we mapped and compared gnatcatcher territories, nests, and previous restoration sites. For the purposes of this study, "restored" areas (Figure 2a) were defined as areas modified by means such as scarification, seeding, and planting to reestablish vegetative cover and included areas partially landscaped with nonnative species. Remnants of the original coastal sage scrub and scrub that regenerated naturally were considered "nonrestored" habitat (Figure 2b).

RESULTS

During the 1995 breeding season, 22 pairs and 3 single males were observed holding territories on the coastal terrace of Crystal Cove State Park. Eighteen (82%) of the pairs raised at least one young for a total of 73 fledglings and a mean of 3.32 fledglings per pair. Of the 91 nesting attempts observed in the study area during 1995, 22 (24%) were successful. A total of 69 (76%) nests failed. Of the failures, we attribute 43 (62%) to predation; 25 (36%) failed for undetermined reasons. We recorded one case of nest parasitism by a Brown-headed Cowbird, and that nest failed because of abandonment by the adults.

Nest success did not appear to be dependent on whether the nest was placed in restored or non-restored habitat. Nine of 42 nests (21%) placed in
restored areas and 13 of 49 (27%) nests placed in nonrestored areas were successful ($\chi^2 = 0.321$, d. f. = 1, $P > 0.05$).

Most of the territories contained a mix of restored and nonrestored habitat, and because of the complicated distribution of treated areas the actual portion of restored habitat in each territory was difficult to determine. However, of the five pairs whose territories were fully within restored
CALIFORNIA GNATCATCHER USE OF RESTORED SAGE SCRUB

habitat, four were successful in fledging at least one young from 5 of 16 nests, for a nest-success rate of 31%. Three pairs had territories fully within nonrestored habitat, and two of these were successful with 3 of 16 (19%) of the nests fledging at least one young.

Table 1 shows the frequency of plant species used for nest placement in restored and non-restored areas. California sagebrush and California encelia (Encelia californica) were the first and second most frequently used species for nest placement in both restored and nonrestored areas. A significant number of nests (19%) in the restored areas were placed in Brewer's saltbush (Atriplex lentiformis ssp. breweri). One territory was centered on a landscaped area, in which several of the large shrubs were nonnative, accounting for the placement of one nest in Australian bottlebrush (Melaleuca nesophila). Gnatcatchers built nests in a greater diversity of plants in the restored than in the nonrestored habitat.

Nest success also did not appear to be negatively affected by the proximity of the nest to actively used and maintained roads or trails (Figure 3). Thirteen percent of the nests were placed within 3 meters of a paved road or trail. Thirty-three percent of these were successful. While this success rate is higher than for those placed greater than 3 meters from a road or trail (23%), the difference was not significant ($\chi^2 = 0.632$, d. f. = 1, $P > 0.05$).

DISCUSSION

Population increases observed on the coastal terrace from 1991 to 1993 were likely due to suitable habitat, once restored, being available for California Gnatcatchers either recruited from the local breeding population or displaced by development of surrounding habitat. In the fall of 1993, the

Table 1 Plant Species Used for Nest Placement by California Gnatcatchers at Crystal Cove State Park in 1995*

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of nests</th>
<th>Percentage of total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Restored</td>
<td>Nonrestored</td>
</tr>
<tr>
<td>California sagebrush, Artemisia californica</td>
<td>14</td>
<td>27</td>
</tr>
<tr>
<td>California encelia, Encelia californica</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Brewer's saltbush, Atriplex lentiformis ssp. breweri</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>California buckwheat, Eriogonum fasciculatum</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Coastal goldenbush, Isocoma menziesii</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Coyote brush, Baccharis pilularis</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Black sage, Salvia mellifera</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Lemonadeberry, Rhus integrifolia</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Pink melaleuca, Melaleuca nesophila</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Prickly sow thistle, Sonchus asper</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>42</td>
<td>47</td>
</tr>
</tbody>
</table>

*See text for definition of plants considered "restored" and "nonrestored."
Laguna Fire consumed a large area of the San Joaquin Hills, including the inland portion of Crystal Cove State Park and other adjacent parklands. Subsequently, increases in the number of gnatcatchers within unburned refugia on the fire’s margins, including the Crystal Cove study site, were observed in 1994, presumably because of immigration of displaced birds (Atwood et al. 1998, Bontrager et al. 1995a). The population at the Crystal Cove study site doubled between 1993 and 1994, resulting in reduced and overlapping territories (Hirsch pers. obs.). In 1995, the number of California Gnatcatchers (22 pairs) were similar to that observed in 1993 (20–22 pairs). A possible explanation for the decline in 1995 is increased mortality due to the harsh, wet winter of 1994–1995. Similar population declines between 1994 and 1995 were observed for other gnatcatcher populations in Orange County (Erickson and Miner 1998, Atwood et al. 1998). Dispersal from the site in response to overcrowding is another possible explanation. Only a few gnatcatchers were observed within the burned area in 1995 and 1996, however (P. Galvin pers. comm., Griffith Wildlife Biology unpubl. data). Therefore, if gnatcatchers dispersed from Crystal Cove, most either relocated to remote unsurveyed sites or perished. Subsequent population estimates for the Crystal Cove terrace (29 pairs in 1996 and 25 pairs in 1997, Hirsch unpubl. data) and the fact that very little suitable habitat there goes unused by gnatcatchers indicate that the site may be near carrying capacity. However, habitat restoration on the terrace is continuing.

Vegetation restoration at Crystal Cove State Park has provided additional suitable habitat for California Gnatcatchers, as evidenced by the large proportion of pairs raising offspring from nests in restored areas. While we
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did not quantify the structure and diversity of restored vs. nonrestored habitat, it appears that the wider variety of plant species used for nest placement in the restored habitat generally reflects the availability in that habitat. Nevertheless, California sagebrush and California encelia were the primary nesting substrates used by the California Gnatcatcher in both the restored and nonrestored habitat.

It also appears that breeding success of California Gnatcatchers on the coastal terrace of Crystal Cove State Park is not being negatively affected by current management practices and levels of public use. Nest success in 1995 was independent of the distance of nests from human activity. In addition, the reproductive success at the Crystal Cove terrace (3.32 fledglings/pair, n = 22) was higher than that reported for the San Joaquin Hills area of Orange County in general in 1995 (2.7 fledglings/pair, n = 38, including 8 pairs from the Crystal Cove study site; Bontrager et al. 1995b).

As open space diminishes, public lands are being sought to provide additional recreational opportunities, as well as other land uses, in addition to preserving natural communities. Many of these lands are becoming isolated and are increasingly subjected to urban pressures, so that active management is necessary to assist or artificially continue natural processes. Meeting the challenge of managing park lands for the significant resources for which these lands were set aside requires empirical assessment of the effects of land use and management decisions on these resources. This study was an attempt to provide such an assessment of the effects of habitat restoration and recreation on the California Gnatcatcher population on the coastal terrace of Crystal Cove State Park.

SUMMARY

The California Department of Parks and Recreation initiated restoration of the native vegetation on the coastal terrace of Crystal Cove State Park as part of park development in 1983. As of 1995, 20 ha had been revegetated with coastal sage scrub. California Gnatcatchers increased from 12 pairs in 1991 to at least 41 in 1994, declining to 22 in 1995. Increase in available habitat on site and reduction of adjacent available habitat from development and fire presumably both contributed to the observed population increase. The decline in 1995 was likely due to an increase in winter mortality. Intensive monitoring in 1995 revealed that restored habitat was included in 19 of 22 territories and nests in restored areas were as likely to produce at least one young as nests in naturally generated scrub. Thirteen percent of the nests were placed within 3 meters of actively used roads or trails, and their success rate was similar to that of nests placed further from these high-use areas. Breeding success of California Gnatcatchers on the coastal terrace of Crystal Cove State Park appears not to be negatively affected by current management practices and levels of public use.

ACKNOWLEDGMENTS

We thank Dana Kamada, Amy Gorospe, David Bontrager, and Edward Almanza for sharing their data from the portion of the population they monitored under a
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LITERATURE CITED


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OCCURRENCE AND MANAGEMENT CONSIDERATIONS OF CALIFORNIA GNATCATCHERS ALONG SAN DIEGO COUNTY HIGHWAYS

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Being aware of sage scrub and California Gnatcatchers (Polioptila californica) along its highways, the California Department of Transportation (Caltrans), District 11, contracted with Regional Environmental Consultants (RECON) to identify potential habitat patches and survey for the gnatcatcher in these areas. The study could guide planning of highway improvements and routine maintenance to minimize or avoid effects on this threatened species. We present part of the results of that study. Our results suggest conservation-planning considerations for linear habitats along other highway and utility easements. In addition, we provide recommendations for further study of the California Gnatcatcher within such areas.

STUDY AREA AND METHODS

The study area included all interstate highways (I) and state routes (SR) within the known range of the species in San Diego County. Surveyed highways included I-5, I-8, I-15, I-805, I-905, SR-52, SR-54, SR-56, SR-67, SR-76, SR-78, SR-94, SR-125, and SR-163 (Figures 1a and 1b). We omitted highway segments currently under construction or being planned for improvement.

We identified a patch as potential California Gnatcatcher habitat if it covered at least 0.4 ha (1 acre) in size and contained greater than 10% native shrub cover. We defined a patch as an area of sage scrub or chaparral within the highway right-of-way that was not interrupted by more than approximately 400 meters of development (i.e., highway interchanges, road crossings, or residential/industrial/commercial structures) or nonnative vegetation. In addition, other land uses that might represent barriers to the gnatcatcher's movement, including highways of four lanes or greater and other areas of high traffic volume, were used to define the limits of a patch. For all surveyed patches along I-5, I-15, and I-805, the patch size was determined from Caltrans 600-scale aerial photography of highway rights-of-way. These were recorded to determine if patch size influenced the gnatcatcher's occurrence, with the premise that larger patches are more likely to support the species. We also noted whether there was contiguous habitat outside of the highway right-of-way or manufactured cut and/or filled slopes with restored native scrub.

Directed searches for the California Gnatcatchers focused primarily on I-5, I-15, and I-805, although portions of I-8, SR-52, and SR-78 were also covered. We surveyed up to a distance of approximately 400 meters from the highway or to the limit of the identified habitat patch, whichever was closer. The area that could be surveyed was limited by time and budget.
Figure 1. Study area and locations surveyed along highways for the California Gnatcatcher. (a), North portion; (b), south portion.
constraints; therefore, not all potential habitat along these highways was surveyed. Generally, we gave priority to areas where we judged the gnatcatcher most likely to occur. Although high-priority patches occur within rights-of-way along I-5 in Camp Pendleton Marine Corps Base and along I-15 in Marine Corps Air Station Miramar, no surveys were conducted in these areas as access to U.S. government property was not secured. Surveys were performed one to three times, as necessary. No subsequent surveys were performed if California Gnatcatchers were identified on the first or second survey. Therefore, our results represent occurrence only, not exact numbers.

Surveys were conducted by RECON biologists between April and December 1993 on 67 separate dates. Expected to be ineffective because of traffic noise, taped vocalizations of the California Gnatcatcher were generally not used during the surveys except downslope of highways, where ambient noise levels were much lower. All surveys were conducted on foot by observers moving slowly through potential habitat, searching for the species visually, and when possible listening for the bird’s distinctive calls. Surveys were performed generally between the hours of 0600 and 1200 under fair weather. Temperatures during the surveys ranged from approximately 10° to 32° C.

Prior to September 15 (the approximate date when males lose their black caps and juveniles assume their adult plumage), the sex of California Gnatcatchers was recorded. After this date, sex was considered unknown. Nesting, fledging, or noteworthy behavioral observations were also recorded.

RESULTS

We identified 187 habitat patches as possibly supporting California Gnatcatchers. Of these, 124 were contiguous with larger expanses of native scrub outside of highway rights-of-way, 63 were isolated. Of the 187, 57 were surveyed for the California Gnatcatcher. Forty-six (81%) of these were occupied, 11 were unoccupied. Four of 12 (33%) surveyed isolated patches were occupied, compared to 42 of 45 (93%) patches which were contiguous with more extensive habitat.

Size of the patch appeared to be an important factor in the presence of California Gnatcatchers. Of nine patches covering 8.1 ha (20 acres) or less, only four (44%) were occupied, whereas the species was observed in 38 of the 39 (97%) patches greater than 8.1 ha. The areas of seven additional patches were measured as below 8.1 ha, but because of limitations of the base maps we were unable to determine if additional adjacent habitat would increase these patches beyond 8.1 ha. Four of these seven were occupied.

One hundred eight occurrences of the California Gnatcatcher, comprising 243 individual birds, were recorded during the surveys. The generalized locations are shown on Figures 2a and 2b. The general locations of other known California Gnatcatchers from previous survey work adjacent to Caltrans District 11 highways are also shown (Caltrans and RECON unpubl. data).
Figure 2. Locations of California Gnatcatcher sightings along highways. Solid circles, occurrence identified during this study; open squares, other known occurrences. (a), North portion of study area; (b), south portion of study area.
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Five nests of the California Gnatcatcher were recorded during the study, two along I-5, three along I-15. Of these five, two were within revegetated coastal sage scrub on cut and filled slopes, three in natural sage scrub vegetation. The nests were at approximately 6, 15, 24, 61, and 88 meters from the edge of the highway. One additional nest, on a revegetated filled slope approximately 15 meters from I-5, was previously documented by RECON (1992, Technical analysis of potential noise effects on California Gnatcatcher habitat adjacent to future Orange Avenue, RECON, 4241 Jutland Dr., Suite 201, San Diego, CA 92117-3653).

The majority of California Gnatcatchers were observed within natural habitat adjacent to revegetated cut and filled slopes. Twenty-three observations, however, were made within revegetated areas, including the two observations of nests.

Surveyed cut and filled slopes, as well as other disturbed areas, were either seeded by Caltrans following highway construction or were revegetated through natural colonization. Most of these patches were covered sparsely with small native shrubs, primarily California buckwheat (Eriogonum fasciculatum) and/or California sagebrush (Artemisia californica); however, a few areas were densely vegetated. Most revegetated areas lacked large shrubs such as laurel sumac (Malosma laurina) or lemonadeberry (Rhus integrifolia). In most instances, the revegetated slopes augmented adjacent occupied habitat, adding to its overall value. In at least seven cases where gnatcatchers were present, however, the revegetated habitat along the highway was entirely constrained by urban or agricultural development.

CONCLUSIONS AND RECOMMENDATIONS

Because California Gnatcatchers use highway rights-of-way so extensively, additions, improvements, and maintenance should be implemented so as to avoid or minimize adverse effects to areas occupied or potentially occupied by the species. Additionally, these data support the usefulness to the California Gnatcatcher of native landscaping in highway revegetation. We recommended that native plant species, particularly those mimicking the vegetation composition and structure of typical California Gnatcatcher habitat, be used in highway landscaping where appropriate rather than traditional exotic landscape vegetation.

Our results suggest that California Gnatcatchers could use highway rights-of-way as dispersal corridors. From our observations of juveniles using these rights-of-way we suggest that maintenance of gnatcatcher habitat along highways, and its integration in future highway projects, will increase the chance of genetic exchange between core populations. Current regional conservation plans have generally not considered highway rights-of-way as potential habitat linkages, but our results suggest that they (and perhaps other linear utility easements, such as power-line corridors of similar configuration and plant composition) may be of significant value in linking populations of the California Gnatcatcher. The question merits further research, as do adverse effects possibly associated with highways, such as high noise levels, dust, light, direct mortality, etc. We mean not that the construction of new highways and utility easements is beneficial to the California Gnat-
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catcher, merely that given the remaining distribution and fragmentation of habitat suitable for the species, existing easements should be studied for their potential additional value to habitat preserves focused on the California Gnatcatcher.

SUMMARY

From April to December 1993 we surveyed potential California Gnatcatcher habitat along highways in San Diego County. California Gnatcatchers were found within 46 of the 57 patches of potential habitat surveyed. Twenty-three of these observations, including two of nesting, were on revegetated slopes. These data support the value of highway rights-of-way and possibly other utility easements to contribute to the limited remaining habitat for the California Gnatcatcher. Such areas may function as dispersal corridors.

ACKNOWLEDGMENTS

We thank the following biologists for assistance in the collection of field data: Terri Ayers, Christine Collier, Rick Eisenbart, Marianne Gallagher, Kimberly Miller, Jessa Netting, Bobbie Stephenson, and Julie Vanderwier. Additional thanks to Julie Vanderwier, Bobbie Stephenson, and Rick Eisenbart for preliminary review of the manuscript, as well as Harry Price and RECON for preparation of the figures. Finally, we thank Caltrans for funding the study as well as Caltrans biologists John Rieger and Gina Moran for their interest and input.

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IS THE CALIFORNIA GNATCATER A GOOD UMBRELLA SPECIES?

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Conservation of biodiversity is best attained by establishing habitat reserves that are designed for multiple species and sustain entire ecosystems (Noss 1983, Hunter et al. 1988, Scott et al. 1988, Brussard 1991). Most existing habitat reserves have been established primarily on the the basis of the ecological requirements of only one or a few species. This is a consequence of two basic limitations of the multiple-species approach to the design of habitat reserves: the single-species focus of the Endangered Species Act (ESA), and the lack of detailed autecological studies upon which multiple-species conservation decisions can be confidently based. Recent attempts to address conservation at the species and ecosystem levels simultaneously through habitat-based conservation planning and Section 10(a) of the ESA may be a feasible solution to the single-species focus of the ESA (Noss et al. 1997). However, we will always be faced with a lack of sufficient autecological data.

The concept of umbrella species has evolved in recent years in an attempt to overcome the single-species limitations of the existing legal framework and current level of ecological understanding. Fundamental to this concept is the assumption that preservation of the critical habitat of one species will also protect viable populations of other species that share that habitat (Murphy 1988, Simberloff 1988, Murphy et al. 1990, Noss 1990, Bean et al. 1991, Rohlf 1991, Noss et al. 1996). Testing of the effectiveness of each proposed reserve umbrella should be undertaken before a valid assessment of the protection provided other species under the umbrella can be made. After a thorough survey of the literature, however, Noss et al. (1996) could not find a single definitive study that evaluated the level of protection afforded other species of vertebrates within a proposed umbrella-species reserve.

Launer and Murphy (1994) investigated the effectiveness of a single-species-reserve umbrella to protect plants, and Berger (1997) evaluated the effectiveness of the Black Rhinoceros (Diceros bicornis) as an umbrella species in protecting six species of large herbivores. If species that are targets for reserve design are also to be used as umbrellas for conservation of greater biodiversity, then it is essential that we examine the broadest effects of reserve umbrellas to preserve species at all levels as well as important components of ecosystem structure and function. Noss et al. (1996) attempted a broad evaluation of the effectiveness of a reserve designed for large carnivores in Idaho to protect the wider diversity of vertebrates. As far as we are aware, however, our research is the first attempt to evaluate the effectiveness of an umbrella species in protecting a wide variety of plants and animals in numerous taxa and at many trophic levels.
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Determination of the precise level of protection afforded every other species contained within an umbrella requires detailed autecological studies and population-viability analyses of each species. Such a process would be excessively time-consuming and thus impractical in light of the rapid rate of species extinction (Diamond 1984, Gilpin 1987). Therefore, a methodological compromise is needed through which a reasonable estimate of the level of protection for each species in the reserve can be made. The purpose of this research is to apply one possible set of methods that require a relatively modest amount of time and data to determine the degree to which a single-species-reserve umbrella protects other species of concern. We hope that these or similar methods may be applied to current and future reserve-design efforts to improve estimates of other proposed umbrella species' effectiveness.

We selected the California Gnatcatcher (Polioptila californica) as the target for a single-species-reserve design and investigated how the umbrella of a California Gnatcatcher habitat reserve will protect populations of each of the other species evaluated in this study on the basis of the other species' ecological differences. Our general expectations of the effectiveness of the reserve umbrella are that species occurring in some habitats will be better protected than species occurring in other habitats, that species requiring smaller areas will be better protected than those requiring larger areas, that species at lower trophic levels will be better protected than those at higher levels, and that species that do not have specialized habitat requirements will be better protected than those with more exacting requirements.

METHODS

Our primary goal is to investigate the usefulness of our methods in evaluating the umbrella effects of a single-species reserve. The reserve we have designed and subsequently analyzed is hypothetical and not intended to be implemented on the basis of this design exercise. Our design was based on the best scientific data available at the time; however, several assumptions were made to simplify the number of issues that needed to be considered in designing the reserve: (1) planned future land uses were not considered, and therefore all existing habitat was assumed to be available for inclusion in the reserve; (2) the cost of land acquisition was not a factor in the reserve's delineation, and it was assumed that all land within the reserve could be acquired; (3) habitat within the reserve would be permanently protected from future development; and (4) all habitat within the study area that was not included in the final reserve design would not be protected and was not considered usable habitat for reserve species. We ignored the question of genetic stochasticity.

The gnatcatcher was chosen as the target species because it requires a relatively large area for a bird of its size. Therefore, it has greater potential to be an effective umbrella species. Furthermore, numerous studies associated with this and other conservation projects around the study area have resulted in good estimates of parameters for population modeling and the gnatcatcher's habitat requirements for reserve design. The study area (52,414 ha) was within a portion of the gnatcatcher's distribution in the Otay
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Figure 1. Location of hypothetical reserve designed to test the umbrella effect of the California Gnatcatcher.

region of southwestern San Diego County (Figure 1) and was selected because it contains several of the largest subpopulations in the United States as well as one of the largest contiguous patches of coastal sage scrub (CSS).

The two main tools used in designing a habitat reserve for the gnatcatcher are a geographic-information-system (GIS) database (Ogden 1993) and a metapopulation-simulation model (Akçakaya and Ferson 1992). Detailed descriptions of the reserve-design process and umbrella-evaluation method are contained in Fleury (1994). The important GIS coverages used for this analysis were vegetation communities, soils, slope, elevation, and locations of the gnatcatcher and sensitive plant species. The population parameters used for modeling the gnatcatcher in this study are based on best available data [see Mock (1993) and Ogden (1992)].

Coastal sage scrub is the primary habitat of the gnatcatcher in San Diego County and elsewhere in southern California (Anderson 1991, Atwood 1980, 1988, 1991, Braden et al. 1997). The CSS in the study area has been estimated to be able to support approximately one pair of gnatcatchers per 10 ha (Ogden 1992). On the bases of the distribution of CSS and gnatcatcher sightings over a 9-year period (1986 to 1994) the gnatcatchers in the study area appear to be distributed in 10 subpopulations (Mock 1993) and were modeled as such. Known dispersal distances for juveniles (Mock 1993) are greater than the distance between the two most distant subpopulations; therefore, the model allowed migration between all subpopulations.

The gnatcatcher reserve was designed to meet the following objectives: (1) to contain habitat sufficient to support a population of gnatcatchers for at least 200 years with 99% certainty, (2) to maintain contiguity with major areas of gnatcatcher habitat outside of the study area, (3) to follow accepted
principles of reserve design such as maintaining large contiguous areas, minimizing the perimeter-to-core-area ratio, and using naturally occurring boundaries, and (4) to exclude smaller isolated patches of habitat unless their inclusion is necessary for long-term population viability. The first objective of the reserve design (to support a viable population for at least 200 years with 99% certainty) is valid only within the hypothetical constructs of this exercise. If the assumptions we made to simplify the reserve-design process (see above) were relaxed, then this first objective would probably not be met. This is not a concern within the context of this study, which seeks to evaluate the umbrella effects of a hypothetical single-species reserve, but would be a problem if the results of our reserve design were implemented in the real world.

The reserve was designed simultaneously at the landscape level and at the population level. At the landscape level, the larger patches of high-quality gnatcatcher habitat were identified as reserve cores, and smaller fragmented patches that did not contribute to connectivity between large patches were excluded. Four key subpopulations were located in a line running from north to south through the center of the study area.

At the population level, the metapopulation-simulation model was run with these four subpopulations to determine the minimum viable population size necessary to meet the reserve’s goal of 99% certainty of population viability for 200 years under this metapopulation structure. Then linkage corridors were added to the core subpopulation centers to accommodate migration between the subpopulations and to maintain contiguity with the gnatcatcher populations to the north and south of the study area. A buffer of 50 m (based on Paton 1994) was added around the perimeter of the reserve to counteract edge effects (Wilcove 1985, Lovejoy et al. 1986, Temple 1987, Saunders et al. 1991, Alberts et al. 1993).

One hundred twenty species in the study area are listed as endangered, threatened, or declining on federal, state, or local lists (e.g., USFWS, California Department of Fish and Game, California Native Plant Society, Audubon Blue List, or county and city lists of species of concern). Some of these species are not sensitive over their whole range but are included because of their limited or declining occurrence in San Diego County or elsewhere. Forty of the 120 species were selected with a stratified random-sampling scheme to be analyzed for their level of protection under the umbrella. The stratification ensured that all major life-history groups were represented in the study (e.g., herbaceous plants, birds of prey, large mammalian carnivores, etc.). The area within the reserve was evaluated for the presence, quantity, quality, and spatial distribution of the habitat of each of the 40 species to determine how well the other species were protected within the reserve.

Several conditions must be met for a species to be well protected within the reserve. The habitat must be relatively cohesive, and there must be enough habitat to support a minimum population typically of at least several hundred individuals (although the number could be much higher depending on the life history of the species). If all habitat occurs in only one area, it is more vulnerable to catastrophes such as brush fire; optimally, therefore, the habitat should occur in several areas. Habitat patches must be connected so
that individuals can disperse from one patch to the next. We developed four criteria on the basis of these conditions to determine the level of protection the reserve umbrella provided for each species: (1) large unfragmented blocks of the species’ habitat must occur within the reserve, (2) species’ numbers within the reserve must be at least several hundred, (3) the large blocks of habitat must occur in at least three distinct areas, and (4) the habitat must be well connected relative to the species’ dispersal ability.

We categorized each species’ level of protection as “good,” “marginal,” or “poor.” If all four criteria were met, we considered the species well protected within the reserve; if only two or three criteria were met (depending on the species and circumstance), we considered the species marginally protected; and if zero, one, or in some cases two criteria were met, we considered the species poorly protected.

RESULTS

Approximately 11% of the 52,414-ha study area was contained within the gnatcatcher reserve (Figure 2). Seventy-three percent of the habitat in the reserve was CSS (4166 ha), of which 3370 ha was high-quality gnatcatcher habitat and, from an average density of one pair per 10 ha of high-quality habitat, was estimated to support a gnatcatcher population of 337 pairs. In addition to CSS, there was also chaparral, grassland, and open water covering from 5 to 10% of the reserve. Approximately 90% of our reserve area is also included within the reserve boundary of the final San Diego County Multiple Species Conservation Program (MSCP). Therefore, we believe that our reserve delineation is realistic, even though we did not consider other nonecological “real-world” constraints, such as the cost of land acquisition.

Fourteen of the 40 species analyzed (35%) were well protected by the reserve umbrella. Ten species (25%) were marginally protected, and 16

Figure 2. Distribution of hypothetical gnatcatcher reserve and habitat types in Otay region of San Diego County. Other habitat and land-use types within the reserve include grassland (6%), riparian wetland (3%), stands of Tecate cypress (Cupressus forbesii) (1%), disturbed habitat (1%), and developed (<1%).

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species (40%) were poorly protected (Table 1). Not surprisingly, the gnatcatcher is a good umbrella species for some species but not for others. It is more interesting, however, to examine the results for trends in level of protection for species grouped by the ecological factors (i.e., primary habitat, area requirements, trophic level, and need for rare and localized habitat types such as rock outcrops, or caves) relevant to determining each species’ level of protection. The 40 species selected from the original list of 120 sensitive species are listed in Table 2 along with their level of protection under the gnatcatcher-reserve umbrella and their primary habitat, area requirement, trophic level, and requirement for rare and localized habitat.

Table 1 Effect of Habitat, Area Requirement, Trophic Level, and Need for Rare and Localized Habitat Types on Level of Protection Afforded by a Reserved Designed for the California Gnatcatcher

<table>
<thead>
<tr>
<th>Category</th>
<th>Level of protection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Good (40%) Marginal (25%) Poor (40%)</td>
</tr>
<tr>
<td>All species (40)</td>
<td>14 (35%) 10 (25%) 16 (40%)</td>
</tr>
<tr>
<td>Coastal sage scrub species (22)</td>
<td></td>
</tr>
<tr>
<td>Primary habitat (CSS)</td>
<td>13 (59%) 3 (14%) 6 (27%)</td>
</tr>
<tr>
<td>Area requirement</td>
<td></td>
</tr>
<tr>
<td>&lt;2 ha (plants)</td>
<td>2 (50%) 1 (25%) 1 (25%)</td>
</tr>
<tr>
<td>&lt;2 ha (animals)</td>
<td>9 (82%) 1 (9%) 1 (9%)</td>
</tr>
<tr>
<td>2-10 ha</td>
<td>2 (67%) 1 (33%) 0 (0%)</td>
</tr>
<tr>
<td>&gt;10 ha</td>
<td>0 (0%) 0 (0%) 4 (100%)</td>
</tr>
<tr>
<td>Trophic level</td>
<td></td>
</tr>
<tr>
<td>Producer</td>
<td>2 (50%) 1 (25%) 1 (25%)</td>
</tr>
<tr>
<td>1° consumer</td>
<td>6 (75%) 1 (12.5%) 1 (12.5%)</td>
</tr>
<tr>
<td>2° consumer</td>
<td>5 (50%) 1 (10%) 4 (40%)</td>
</tr>
<tr>
<td>Need for rare and localized habitat types</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0 (0%) 0 (0%) 3 (100%)</td>
</tr>
<tr>
<td>No</td>
<td>13 (68%) 3 (16%) 3 (16%)</td>
</tr>
<tr>
<td>Non-CSS species (18)</td>
<td></td>
</tr>
<tr>
<td>Primary habitat (not CSS)</td>
<td>1 (6%) 7 (39%) 10 (55%)</td>
</tr>
<tr>
<td>Area requirement</td>
<td></td>
</tr>
<tr>
<td>&lt;2 ha (plants)</td>
<td>0 (0%) 3 (75%) 1 (25%)</td>
</tr>
<tr>
<td>&lt;2 ha (animals)</td>
<td>1 (14%) 3 (43%) 3 (43%)</td>
</tr>
<tr>
<td>2-10 ha</td>
<td>0 (0%) 1 (100%) 0 (0%)</td>
</tr>
<tr>
<td>&gt;10 ha</td>
<td>0 (0%) 0 (0%) 6 (100%)</td>
</tr>
<tr>
<td>Trophic level</td>
<td></td>
</tr>
<tr>
<td>Producer</td>
<td>0 (0%) 3 (75%) 1 (25%)</td>
</tr>
<tr>
<td>1° consumer</td>
<td>1 (25%) 1 (25%) 2 (50%)</td>
</tr>
<tr>
<td>2° consumer</td>
<td>0 (0%) 3 (43%) 4 (57%)</td>
</tr>
<tr>
<td>3° consumer</td>
<td>0 (0%) 0 (0%) 3 (100%)</td>
</tr>
<tr>
<td>Need for rare and localized habitat types</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1 (14%) 2 (29%) 4 (57%)</td>
</tr>
<tr>
<td>No</td>
<td>0 (0%) 5 (45%) 6 (55%)</td>
</tr>
</tbody>
</table>

*Figures are numbers of species.*
First, we examined level of protection by primary habitat. Of the 14 species classified as well protected, only one did not occur in CSS. Therefore, insufficiency of proper habitat appears to be the major factor in determining level of protection for non-CSS species. Nine of the 22 species occurring primarily in CSS, however, were categorized as marginally or poorly protected, suggesting that other factors were also important (Table 1). Because there is only one non-CSS species that was well protected, we focused the remainder of our analysis on the CSS species.

Next, we grouped animal species into three categories of area requirement (<2 ha, 2–10 ha, and >10 ha per individual) and looked at level of protection. Plants were analyzed separately because they use space so differently from animals. There are trends in all three animal categories and a weak trend for plants, suggesting that species that require 10 ha or less tended to be well protected and all species requiring greater than 10 ha were poorly protected (Table 1).

Next we examined level of protection by trophic level. Analyzing the results in terms of trophic level seems somewhat redundant because trophic level affects level of protection through area requirements (i.e., species at higher trophic levels generally require larger areas). Furthermore, trophic level may be confounded because many species forage at more than one trophic level. Although there were no tertiary consumers in CSS, there was a tendency for primary consumers and plants to be well protected (Table 1). There was no distinguishable trend for secondary consumers.

Finally, we grouped species by need for rare and localized habitat types. Examples of potentially rare and localized habitat types are larval host plants, vernal pools, cliffs, and caves. There were only two CSS species requiring rare and localized habitat types and both were poorly protected. At the same time, the majority of CSS species that did not require rare and localized habitat types were well protected (Table 1).

DISCUSSION

Our results indicate that a single-species reserve designed for the gnatcatcher is a good umbrella for some species but not for others, and that much of the patterning of species protection can be explained by species’ differences in ecological characteristics. Results of the single-species reserve-design effort are of obvious importance to the overall study’s results because they set the limits within which each of the other species may be evaluated. Although the basic question is whether the gnatcatcher-reserve umbrella protects populations of other species, the more interesting question is, why or why not?

Population size and distribution are two critical factors that determine viability of a population (Shaffer 1981, Shaffer 1985, Gilpin 1987, Soulé 1987). Many factors, including the four factors evaluated in this study (presence, abundance, distribution, and connectivity of habitat), can limit the size or distribution of a population.

Co-occurrence of species in the same habitat is the fundamental basis for the umbrella-species concept (Murphy 1988, Simberloff 1988, Murphy et al. 1990, Noss 1990, Bean et al. 1991, Rohlf 1991). However, as
Table 2 Level of Protection under the Gnatcatcher-Reserve Umbrella for 40 Selected Species

<table>
<thead>
<tr>
<th>Species</th>
<th>Level of protection</th>
<th>Number of criteria for protection met</th>
<th>Habitat&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Area requirement</th>
<th>Trophic level&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Need for rare or localized habitat types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Otay Mesa mint, <em>Pogogyne nudiuscula</em></td>
<td>Marginal</td>
<td>2</td>
<td>VP</td>
<td>&lt;2 ha</td>
<td>1&lt;sup&gt;0&lt;/sup&gt;P</td>
<td>Yes</td>
</tr>
<tr>
<td>San Diego ambrosia, <em>Ambrosia pumila</em></td>
<td>Poor</td>
<td>1</td>
<td>CSS, dist. CSS, dist. Chp</td>
<td>&lt;2 ha</td>
<td>1&lt;sup&gt;0&lt;/sup&gt;P</td>
<td>No</td>
</tr>
<tr>
<td>Orcutt's brodiaea, <em>Brodiaea orcuttii</em></td>
<td>Marginal</td>
<td>2</td>
<td>G, VP, seeps, wet meadows, streams</td>
<td>&lt;2 ha</td>
<td>1&lt;sup&gt;0&lt;/sup&gt;P</td>
<td>Yes</td>
</tr>
<tr>
<td>San Diego golden star, <em>Malilla clevelandii</em></td>
<td>Good</td>
<td>4</td>
<td>G, CSS, Chp (open)</td>
<td>&lt;2 ha</td>
<td>1&lt;sup&gt;0&lt;/sup&gt;P</td>
<td>No</td>
</tr>
<tr>
<td>Coast barrel cactus, <em>Ferocactus viridescens</em></td>
<td>Good</td>
<td>4</td>
<td>CSS</td>
<td>&lt;2 ha</td>
<td>1&lt;sup&gt;0&lt;/sup&gt;P</td>
<td>No</td>
</tr>
<tr>
<td>Palmer's ericameria, <em>Ericameria palmeri</em> ssp. <em>palmeri</em></td>
<td>Marginal</td>
<td>2</td>
<td>RS (edges), CSS</td>
<td>&lt;2 ha</td>
<td>1&lt;sup&gt;0&lt;/sup&gt;P</td>
<td>No</td>
</tr>
<tr>
<td>Otay manzanita, <em>Arctostaphylos otayensis</em></td>
<td>Poor</td>
<td>1</td>
<td>Chp</td>
<td>&lt;2 ha</td>
<td>1&lt;sup&gt;0&lt;/sup&gt;P</td>
<td>No</td>
</tr>
<tr>
<td>Tecate cypress, <em>Cupressus forbesii</em></td>
<td>Marginal</td>
<td>3</td>
<td>CF, Chp, drainages</td>
<td>&lt;2 ha</td>
<td>1&lt;sup&gt;0&lt;/sup&gt;P</td>
<td>No</td>
</tr>
<tr>
<td>Invertebrates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hermes copper butterfly, <em>Lycaena hermes</em></td>
<td>Good</td>
<td>4</td>
<td>CSS, Chp (open) (on <em>Rhamnus crocea</em>)</td>
<td>&lt;2 ha</td>
<td>1&lt;sup&gt;0&lt;/sup&gt;C</td>
<td>Yes</td>
</tr>
<tr>
<td>Quino checkerspot butterfly, <em>Euphrya editha quino</em></td>
<td>Marginal</td>
<td>4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>CSS, VP, NG</td>
<td>&lt;2 ha</td>
<td>1&lt;sup&gt;0&lt;/sup&gt;C</td>
<td>No</td>
</tr>
<tr>
<td>Thorne's hairstreak butterfly, <em>Mitoura thornei</em></td>
<td>Poor</td>
<td>1</td>
<td>CF (Tecate cypress)</td>
<td>&lt;2 ha</td>
<td>1&lt;sup&gt;0&lt;/sup&gt;C</td>
<td>Yes</td>
</tr>
<tr>
<td>Harbison's dun skipper, <em>Euphyes vestris harbisoni</em></td>
<td>Good</td>
<td>4</td>
<td>RW, RS, OW (on <em>Carex spissa</em>)</td>
<td>&lt;2 ha</td>
<td>1&lt;sup&gt;0&lt;/sup&gt;C</td>
<td>Yes</td>
</tr>
<tr>
<td>Riverside fairy shrimp, <em>Streptocephalus woottoni</em></td>
<td>Poor</td>
<td>0</td>
<td>VP</td>
<td>&lt;2 ha</td>
<td>1&lt;sup&gt;0&lt;/sup&gt;C</td>
<td>Yes</td>
</tr>
<tr>
<td>Amphibians and reptiles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>California red-legged frog, <em>Rana aurora draytonii</em></td>
<td>Marginal</td>
<td>4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>RA</td>
<td>&lt;2 ha</td>
<td>2&lt;sup&gt;0&lt;/sup&gt;C</td>
<td>No</td>
</tr>
<tr>
<td>Coronado skink, <em>Eumees skiltonianus interparietalis</em></td>
<td>Good</td>
<td>4</td>
<td>G, CSS, Chp (open)</td>
<td>&lt;2 ha</td>
<td>2&lt;sup&gt;0&lt;/sup&gt;C</td>
<td>No</td>
</tr>
<tr>
<td>Granite spiny lizard, <em>Sceloporus occidentalis</em></td>
<td>Poor</td>
<td>0</td>
<td>Chp, OW, with rocks formations</td>
<td>&lt;2 ha</td>
<td>2&lt;sup&gt;0&lt;/sup&gt;C</td>
<td>Yes</td>
</tr>
<tr>
<td>San Diego horned lizard, <em>Phrynosoma coronatum blainvillii</em></td>
<td>Good</td>
<td>4</td>
<td>CSS, Chp (open)</td>
<td>&lt;2 ha</td>
<td>2&lt;sup&gt;0&lt;/sup&gt;C</td>
<td>No</td>
</tr>
<tr>
<td>Orange-throated whiptail, <em>Cnemidophorus hyperythrus beldingi</em></td>
<td>Good</td>
<td>4</td>
<td>CSS, Chp, G</td>
<td>&lt;2 ha</td>
<td>2&lt;sup&gt;0&lt;/sup&gt;C</td>
<td>No</td>
</tr>
<tr>
<td>Birds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>San Diego Cactus Wren, <em>Campylorhynchus brunneicapillus sandiegensis</em></td>
<td>Poor</td>
<td>1</td>
<td>CSS (in <em>Opuntia</em> spp.)</td>
<td>&lt;2 ha</td>
<td>2&lt;sup&gt;0&lt;/sup&gt;C</td>
<td>Yes</td>
</tr>
<tr>
<td>Species</td>
<td>Distribution</td>
<td>Status</td>
<td>Occurrence</td>
<td>Habitat</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>---------------</td>
<td>--------</td>
<td>------------</td>
<td>---------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>Blue-gray Gnatcatcher, <em>Poliotila caerulea obscura</em></td>
<td>Marginal</td>
<td>4</td>
<td>OW, RW, CSS, Chp</td>
<td>2-10 ha</td>
<td>2°C</td>
<td>No</td>
</tr>
<tr>
<td>Tricolored Blackbird, <em>Agelaius tricolor</em></td>
<td>Marginal</td>
<td>3</td>
<td>FWM</td>
<td>&lt;2 ha</td>
<td>2°C</td>
<td>Yes</td>
</tr>
<tr>
<td>Canada Goose, <em>Branta canadensis moffitti</em></td>
<td>Marginal</td>
<td>4</td>
<td>AGF, G, FWM</td>
<td>&lt;2 ha</td>
<td>1°C</td>
<td>No</td>
</tr>
<tr>
<td>California Horned Lark, <em>Eremophila alpestris actia</em></td>
<td>Marginal</td>
<td>3</td>
<td>G (open), AGF</td>
<td>2-10 ha</td>
<td>2°C</td>
<td>No</td>
</tr>
<tr>
<td>Ferruginous Hawk, <em>Buteo regalis</em></td>
<td>Poor</td>
<td>1</td>
<td>G, AGF</td>
<td>&gt;10 ha</td>
<td>2°C</td>
<td>No</td>
</tr>
<tr>
<td>Sharp-shinned Hawk, <em>Accipiter striatus velox</em></td>
<td>Poor</td>
<td>1</td>
<td>All habitats</td>
<td>&gt;10 ha</td>
<td>3°C</td>
<td>No</td>
</tr>
<tr>
<td>Merlin, <em>Falco columbarius</em></td>
<td>Poor</td>
<td>1</td>
<td>G, AGF</td>
<td>&gt;10 ha</td>
<td>3°C</td>
<td>No</td>
</tr>
<tr>
<td>Long-eared Owl, <em>Asio otus wilsonianus</em></td>
<td>Poor</td>
<td>1</td>
<td>RW, OW, CF (near open scrub and G)</td>
<td>&gt;10 ha</td>
<td>2°C</td>
<td>No</td>
</tr>
<tr>
<td>Red-shouldered Hawk, <em>Buteo lineatus elegans</em></td>
<td>Poor</td>
<td>1</td>
<td>RW, OW, CF, urban</td>
<td>&gt;10 ha</td>
<td>3°C</td>
<td>No</td>
</tr>
</tbody>
</table>

### Mammals

<table>
<thead>
<tr>
<th>Species</th>
<th>Distribution</th>
<th>Status</th>
<th>Occurrence</th>
<th>Habitat</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Diego desert woodrat, <em>Neotoma lepida intermedia</em></td>
<td>Good</td>
<td>4</td>
<td>CSS, Chp</td>
<td>&lt;2 ha</td>
<td>1°C</td>
</tr>
<tr>
<td>Southern grasshopper mouse, <em>Onychomys torridus ramona</em></td>
<td>Good</td>
<td>4</td>
<td>CSS, Chp (open)</td>
<td>&lt;2 ha</td>
<td>2°C</td>
</tr>
<tr>
<td>Dusky-footed woodrat, <em>Chaetodipus californicus femoralis</em></td>
<td>Good</td>
<td>4</td>
<td>CSS, Chp, OW, CF</td>
<td>&lt;2 ha</td>
<td>C</td>
</tr>
<tr>
<td>Northwestern San Diego pocket mouse, <em>Chaetodipus fallax</em></td>
<td>Good</td>
<td>4</td>
<td>CSS, Chp (open)</td>
<td>&lt;2 ha</td>
<td>1°C</td>
</tr>
<tr>
<td>San Diego black-tailed jackrabbit, <em>Lepus californicus bennetti</em></td>
<td>Good</td>
<td>4</td>
<td>CSS, Chp (open)</td>
<td>&lt;2 ha</td>
<td>1°C</td>
</tr>
<tr>
<td>California mastiff bat, <em>Eumops perotis californicus</em></td>
<td>Poor</td>
<td>1</td>
<td>CC, MMStr., OW, CF</td>
<td>&gt;10 ha</td>
<td>2°C</td>
</tr>
<tr>
<td>Townsend's big-eared bat, <em>Corynorhinus townsendii townsendii</em></td>
<td>Poor</td>
<td>1</td>
<td>CC, MMStr. (near water), most native habitats</td>
<td>&gt;10 ha</td>
<td>2°C</td>
</tr>
<tr>
<td>Mexican long-tongued bat, <em>Choeronycteris mexicana</em></td>
<td>Poor</td>
<td>1</td>
<td>CC, MMStr., most native habitats</td>
<td>&gt;10 ha</td>
<td>1°C</td>
</tr>
<tr>
<td>Ringtail, <em>Bassariscus astutus octavus</em></td>
<td>Good</td>
<td>4</td>
<td>CSS, Chp, RW, RS</td>
<td>2-10 ha</td>
<td>2°C</td>
</tr>
<tr>
<td>Bobcat, <em>Lynx rufus californicus</em></td>
<td>Poor</td>
<td>1</td>
<td>All native habitats</td>
<td>&gt;10 ha</td>
<td>2°C</td>
</tr>
<tr>
<td>Mule deer, <em>Odocoileus hemionus fuliginatus</em></td>
<td>Good</td>
<td>4</td>
<td>CSS, Chp, RW, OW</td>
<td>2-10 ha</td>
<td>1°C</td>
</tr>
<tr>
<td>Mountain lion, <em>Puma concolor californica</em></td>
<td>Poor</td>
<td>1</td>
<td>CSS, Chp, RW, OW, CF</td>
<td>&gt;10 ha</td>
<td>2°C</td>
</tr>
</tbody>
</table>

*AGF, agricultural fields; CC, caves, crevices, mines; CF, coniferous forest; Chp, chaparral; CSS, coastal sage scrub; Dist., disturbed habitat; FWM, freshwater marsh; G, grassland; MMStr., man-made structures; NG, native grassland; OW, oak woodland; RA, aquatic riparian; RF, riparian forest; RS, riparian scrub; RW, riparian woodland; VP, vernal pool.

*1°C, primary consumer; 2°C, secondary consumer; 3°C, tertiary consumer.

*Habitat is intact but species is currently extirpated from reserve; therefore, criterion would be met only if species successfully recolonized or were successfully reintroduced.

*Species occurs within the reserve during winter only; therefore, the criterion is met during winter only.
demonstrated here, sharing of habitat is not the only determinant of the umbrella’s effectiveness. Indeed, only 59% of the species in this study that occur in CSS were considered well protected. For the other CSS species, other factors had an overriding effect. On the other hand, all but one non-CSS species were marginally or poorly protected, indicating that reserve umbrellas should be extended only to species that have habitat requirements very similar to those of the targeted umbrella species.

Often, when area requirements are discussed in the context of the umbrella-species concept they are discussed with respect to the requirement of the umbrella species itself (Shaffer 1981, Noss 1990), while the area requirements of other species are largely ignored. Ideally, the best umbrella species are those with vast area requirements, such as the mountain lion (*Puma concolor*) and grizzly bear (*Ursus arctos*), because the umbrella of these species’ reserves should protect almost all of the other species of that region (Noss et al. 1996). Implementing such a large habitat reserve would be immensely challenging because of economic as well as jurisdictional constraints and complexities (Bean et al. 1991). The area requirement of breeding gnatcatchers in our study area is approximately 10 ha per pair. Our analysis revealed that species requiring more than 10 ha per individual were not well preserved, indicating that species with area requirements much larger than that of the umbrella species are not likely to be well protected.

Trophic level may initially appear functionally similar to species’ area requirement, ranking wide-ranging carnivores high as umbrella species (Noss et al. 1996). However, trophic level may not be equally as useful as area requirement for most species. As previously mentioned, population size is one of two critical factors determining population viability. Population density (individuals/area) is the reciprocal of area requirement (area/individual). Population density, if extrapolated over the area of habitat, can be used to estimate population size, which is important in determining level of protection within a reserve.

There are at least three reasons why trophic level is not clearly related to population density or size. First, there is no direct relationship between trophic level and density. Species at the same trophic level may occur at very different densities (e.g., a bird as a secondary consumer feeding on insects versus a large carnivore as a secondary consumer feeding on herbivorous rodents and ungulates). Second, social behavior (coloniality) or mobility may allow species at higher trophic levels to occur at densities higher than expected (although increased local densities are likely to even out when averaged over larger areas). And third, a species may frequently forage at more than one trophic level by consuming a variety of foods. Therefore, it is possible that the weak relationship between trophic level and level of protection identified in this analysis is due predominantly to the correlation with the effect of area requirement.

The need for rare and localized habitat types was the bane of many species that otherwise would have been considered well protected in this study. Only 10% of the species requiring rare and localized habitat types were well protected within the reserve. Such habitat specialists are likely to be poorly protected by a single-species-reserve umbrella unless the umbrella species has similar specialized habitat requirements.
It is not possible to predict from these results which species are protected under the umbrella of a different single-species reserve. If different target species were chosen, the result would have undoubtedly been different. Likewise, had we chosen a different configuration for the gnatcatcher reserve our results probably would have differed. There are certain underlying ecological characteristics, however, that are likely to be common to most species that are protected and lacking in most species that are not, regardless of the particular single-species reserve. Specifically, we expect that species that share the same primary habitat as the umbrella species, that have area requirements equal to or less than the umbrella species, and that do not require rare and localized habitat types to be best protected under the reserve umbrella.

Why does this single-species-reserve umbrella protect the species it does? The simple answer is that the reserve encompasses enough habitat to support large enough populations of the well-protected species. It also encompassed habitats that were distributed widely enough to counter the detrimental effects of environmental stochasticity while being connected enough to allow dispersal throughout the habitat.

Although the umbrella-species concept has been briefly discussed many times in the conservation-biology literature (e.g., Murphy 1988, Simberloff 1988, Murphy et al. 1990, Noss 1990), these discussions typically have overlooked the many confounding factors that may restrict the ability of a reserve umbrella to protect a given species. One discussion that does address many of these problems is that of Mühlenberg et al. (1991), who acknowledged the problem of rare and localized habitat types also identified in this research. They recommended a hierarchical approach in which representative species with various area requirements and habitat characteristics are selected as target species. The initial reserve design is completed with the species with the largest area requirement functioning as the umbrella species. Then the design is modified using other target species with successively smaller area requirements and different habitat characteristics as additional umbrella species. Along with this hierarchical approach Mühlenberg et al. (1991) discussed a variety of additional important considerations and methods, from detailed population studies to population-viability simulations to policy strategies. Several of their recommended methods are analogous to those developed here and are being applied in multispecies conservation plans in the Southwest (e.g., San Diego County MSCP, California Natural Communities Conservation Planning (NCCP), and the Lower Colorado River MSCP).

Lambeck (1997) proposed an application of the umbrella-species concept to reserve design by identifying suites of focal species, each of which contributes different spatial and compositional attributes to the reserve. Lambeck's focal species are defined by limiting factors within the ecosystem. Species that are most limited by (i.e., have large) area requirements are used to define the minimum suitable area for that habitat type. The area-limited focal species are analogous to "traditional" umbrella species. Other focal species are added to the suite on the basis of other limiting factors and act as functional umbrellas for other components of the reserve. For example, dispersal-limited species are used to define the acceptable degree of connec-
tivity; resource-limited species (e.g., those requiring rare and localized habitat types) define essential habitat components; process-limited species (e.g., those depending on fire or flood) define the minimum level at which processes are managed. Lambeck's (1997) broader application of the umbrella-species concept includes structure and function in addition to the composition aspect of reserve design typically addressed by the umbrella-species concept.

Several multispecies habitat-conservation plans are currently under development and implementation in California and other states [e.g., Southern California Coastal Sage Scrub NCCP; Coachella Valley (California) MSHCP; Lower Colorado River MHCP (California, Arizona, and Nevada); Placer County (California) NCCP; Balcones Canyonlands (Texas) HCP; and Brevard County (Florida) HCP]. Although earlier habitat-conservation plans typically identified one or a few target species to function as umbrella species, recent regional HCP programs have significantly increased the number of species incorporated into the reserve-design process that may function as umbrella species (e.g., the San Diego County MSCP identified 97 nominal target species). The political context of habitat-conservation planning along with constraints of time and money, however, generally do not allow for rigorous scientific study to determine whether these species are the most effective basis to aid conservation-planning decisions (i.e., they may not be the best umbrella species)—a serious concern for some conservationists (Atwood and Noss 1994, Noss et al. 1996, Noss et al. 1997). As these reserve-design efforts continue, a species-by-species evaluation of the effectiveness of the reserve umbrella in protecting viable populations is a critical next step.

Fortunately, since this project's inception, the reactive single-species approach to reserve design has, to a significant extent, been replaced (at least conceptually) with a proactive ecosystem-level approach to conservation (Atwood and Noss 1994, Mantell 1994, Noss and Cooperrider 1994, Knight and Bates 1995). But multispecies and ecosystem-level projects are still limited by the amount of available ecological data and therefore must focus on a subset group of target species. These target species must function as umbrellas for the remaining species in the ecosystem. Therefore, the umbrella-species concept is still, and will likely always be, a necessary pragmatic approach for reserve design and management.

SUMMARY

In this case study of the umbrella-species concept, we analyzed the effectiveness of a reserve designed for a single species to protect a wide variety of other plants and animals that were not the target of the reserve design. We selected the California Gnatcatcher as the umbrella species and the Otay region of San Diego County as our study area. We then designed a hypothetical reserve based on the habitat requirements of the gnatcatcher alone. We assessed the level of protection this reserve provided 40 other sensitive plant and animal species occurring in the study area. The gnatcatcher functioned as a suitable umbrella species for less than half of the species we evaluated. Generally, the species best protected under the gnatcatcher-reserve umbrella were species that had area requirements equal...
to or less than the gnatcatcher's and habitat requirements similar to the gnatcatcher's, as well as species at lower trophic levels and species that were not habitat specialists. The methods developed in this study require a relatively modest amount of time and data to estimate the degree to which a single-species-reserve umbrella protects other species of concern and may be useful if applied in other single- and multiple-species conservation plans.

ACKNOWLEDGMENTS

We thank Pat Atchison, Tom McDowell, Andy Haines, and Debbie Turner who provided considerable GIS advice and technical support. Funding, GIS support, and computer-modeling facilities were provided by the San Diego office of Ogden Environmental and Energy Services. Additional financial support was provided by the San Diego State University Foundation. We also thank Reed Noss, J. Michael Scott, Michael Soulé, Arthur Getis, George Cox, Phil Pryde, J. Michael Reed, John Rotenberry, Peter Brussard, and Dennis Murphy for their helpful input to various stages of this project.

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IS THE CALIFORNIA GNATCATCHER A GOOD UMBRELLA SPECIES?


Accepted 4 August 1998
IS THE CALIFORNIA GNATCATCHER AN INDICATOR OF BIRD-SPECIES RICHNESS IN COASTAL SAGE SCRUB?

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In southern California, the California Gnatcatcher (Polioptila californica) is a resident year round in coastal sage scrub (Atwood 1993). This habitat, reduced to 10 to 30% of its former extent by conversion to human use, supports approximately 100 other animal and plant species considered rare, sensitive, threatened, or endangered by California or federal wildlife agencies (Atwood 1993, McCaull 1994). The legal protection given to the California Gnatcatcher has been important in driving efforts to protect coastal sage scrub from human development. The relative wealth of ecological information available for the California Gnatcatcher (Atwood 1993) makes this species attractive as a potential indicator of biodiversity in coastal sage scrub.

An indicator species has been defined as "an organism whose characteristics (e.g., presence or absence, population density, dispersion, reproductive success) are used as an index of attributes too difficult, inconvenient, or expensive to measure" (Landres et al. 1988). However, the use of an individual species as an indicator of biodiversity requires that there be a predictable relationship between the indicator and some attribute of biodiversity (Landres et al. 1988, Noss 1990). To begin to evaluate the California Gnatcatcher as a biodiversity indicator in coastal sage scrub habitat, we asked the question, are California Gnatcatchers found in areas of coastal sage scrub with high bird-species richness?

METHODS

As part of a larger project to explore the habitat associations of coastal sage scrub birds, in 1995 and 1996 we conducted point counts at 17 sites in San Diego, Orange, and Riverside counties (Figure 1). Within each site 4–20 points were located in coastal sage scrub, at least 50 meters from the nearest road or the edge of another habitat type, and with at least 150 meters between points. Birds were sampled by means of 5-minute unlimited-radius point counts (Ralph et al. 1995) conducted between sunrise and 10:00. In 1995, 128 points were sampled at 11 sites. Each point was visited once between 11 April and 10 May and again between 16 May and 16 June. In 1996, 155 points were sampled at 16 sites. One site, Dawson Canyon, was sampled in 1995 but not in 1996 because it had burned. First visits were conducted between 19 March and 1 May, second visits between 3 May and 25 May.

Our sampling was designed as an extensive survey of biodiversity across a large area rather than as an intensive effort to locate rare species. Therefore, our survey methods did not meet the specifications developed for intensive inventories of the California Gnatcatcher (Calif. Dept. Fish & Game 1993).
However, we feel our methods were appropriate for evaluating the suitability of the gnatcatcher as an indicator because a species that is very difficult to detect in an extensive survey of biodiversity is by definition less useful as an indicator. Furthermore, on the basis of personal communication with land managers, we are confident that we detected gnatcatchers at all study sites where they had been found with more intensive survey methods.

For all analyses the California Gnatcatcher was removed from the species list used to estimate species richness. Wide-ranging species, such as raptors, were not included in the analyses because their presence was rarely associated with individual points. We compared the number of species detected per point at two spatial scales, among sampling points and among sites, using data from two visits to all the points.
We used sampled randomization tests (Sokal and Rohlf 1995) to compare species richness at points where California Gnatcatchers were detected to the species richness expected at a random sample of points. We used this as an alternative to a parametric test because the number of points at which gnatcatchers were found was much smaller than the number of points at which they were not found. To compare the mean species richness among sites with and without gnatcatchers, we used a hierarchical analysis of variance with gnatcatcher presence/absence as one class variable and site (nested within gnatcatcher) as a second class variable. We conducted all site-level analyses using the average number of species detected per point to avoid making inappropriate comparisons of total species richness among sites containing different numbers of sampling points.

RESULTS

Point Scale

In 1995, California Gnatcatchers were detected at 18 of 128 points. The mean number of other bird species detected at points with gnatcatchers was 11.7, and this value was significantly higher than expected at a random sample of 18 points (mean 10.6, \( P < 0.05 \), one-tailed test). In 1996, gnatcatchers were detected at 19 of 155 points. The mean number of bird species detected at points with gnatcatchers, however, was 11.0, which did not differ significantly from the expected value (mean 11.8, \( P > 0.1 \)).

The 10 species most frequently detected at sampling points were the California Towhee (Pipilo crissalis), Spotted Towhee (Pipilo maculatus), Bewick's Wren (Thryomanes bewickii), Wrentit (Chamaea fasciata), Costa's Hummingbird (Calypte costae), Bushtit (Psaltriparus minimus), Rufous-crowned Sparrow (Amphiloia ruficeps), Mourning Dove (Zenaida macroura), California Quail (Callipepla californica), and California Thrasher (Toxostoma redivivum). These species were detected at over 50% of the sampling points in 1996.

Site Scale

In 1995, significantly more bird species were detected at points located within sites where gnatcatchers had been detected than at points in sites without gnatcatchers (\( F = 14.89, \ P < 0.001 \)). However, the difference in richness was small: the mean number of species at points with gnatcatchers was 11.0, at sites without gnatcatchers 9.5. This difference was significant even when significant differences in species richness among sites were accounted for (\( F = 3.26, \ P < 0.001 \); Figure 2). In 1996, there was no significant difference between mean species richness at sites with or without gnatcatchers (12.0 vs. 11.6; Figure 3).

DISCUSSION

Our results suggest that the California Gnatcatcher is not a particularly good indicator of bird-species richness in coastal sage scrub. Although gnatcatchers were found at points and sites with greater-than-expected
species richness in 1995, the differences were slight, and disappeared in our second year of sampling. The difference between the two years of the study may have been due to the increase in the number of sampling locations and to the more extensive geographical distribution of sampling locations in 1996. In 1996, California Gnatcatchers were detected at sites where the number of species per point was low, such as Kabian Park, as well as at more speciose sites, such as Limestone Canyon (Figure 3).
More generally, our results suggest that rare species cannot be assumed to be indicators of "hotspots" of species richness. Two recent studies have found little geographical correspondence between species richness and rarity (birds, liverworts, and aquatic plants, Prendergast et al. 1993; birds, Williams et al. 1996). In contrast, Debinski and Brussard (1994) did find an overlap between sites that support high species diversity and sites that support rare species of birds and butterflies.

To evaluate further the California Gnatcatcher as a biodiversity indicator in coastal sage scrub, future research should also investigate the relationship between gnatcatchers and species richness in other taxonomic groups. Because small mammals and plants have also been sampled in the same sites
CALIFORNIA GNATCATCHER AS AN INDICATOR SPECIES

as were used for the present study, we will be able to explore this relationship more in future analyses.

Several other bird species have been identified as "target species" or "species of concern" in coastal sage scrub (Calif Dept. Fish & Game 1993). These species, or others not considered to be in special need of conservation, may be of greater value than the California Gnatcatcher as indicators of species richness in coastal sage scrub. The value of other species remains to be explored.

SUMMARY

We evaluated whether the California Gnatcatcher is an indicator of species-rich bird communities in coastal sage scrub. Bird-species richness was estimated from point counts conducted in 1995 and 1996 at 17 sites in San Diego, Orange, and Riverside counties. Because California Gnatcatchers were detected at a small proportion of the points, we compared the species richness at points where California Gnatcatchers were detected to the species richness expected at randomly sampled points. Slightly more bird species were detected at points where California Gnatcatchers were also detected (mean 11.7 species) than at the random points (mean 10.6 species) in 1995. In 1996, however, there was no significant difference in species richness between points with gnatcatchers and random points. The results were similar when the mean species richness of sites with and without gnatcatchers were compared. This suggests that the California Gnatcatcher is not a particularly good indicator of bird-species richness in coastal sage scrub.

ACKNOWLEDGMENTS

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CALIFORNIA GNATCATCHER AS AN INDICATOR SPECIES


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NOTES

UNMATED MALE CALIFORNIA GNATCATCHER FEEDS FLEDGLING BUSHTITS

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There are numerous examples of interspecific feeding in birds (Skutch 1961, 1987, Shy 1982, Welty and Baptista 1988:362). Skutch (1960) described a female Tropical Gnatcatcher (Polioptila plumbea) in Costa Rica that neglected her mate's building a nest to tend to a brood of Golden-hooded Tanagers (Tangara larvata) in a nest nearby, but there are no published accounts of this sort of activity for the California Gnatcatcher (P. californica), except in relation to the brood-parasitic Brown-headed Cowbird (Molothrus ater; e.g., Braden et al. 1997). This note documents one such event.

The individual involved was part of a dense population of approximately 20 pairs or territories of California Gnatcatchers in the Bonita Reservoir area of Irvine, Orange County, California. The territory occupied by this individual was unusual in that more than 90% of it was made up of mulefat (Baccharis salicifolia) scrub, rather than the coastal sage scrub typical for the species (Atwood 1991; cf. Campbell et al. 1998). The territory was occupied in 1994 and 1996 (young fledged in 1996) but not in 1995 (LSA and Chambers Group unpubl. data).

In 1997, I heard two birds in this territory on 26 February, but otherwise I observed only a lone male on ten visits from 24 January through May. On 30 June and 21 July, presumably the same male appeared to be paired with a female that had been color-banded as a fledgling at the adjacent University of California, Irvine, Ecological Reserve on 10 April 1997 (D. R. Bontrager pers. comm.). Therefore I believe a single male occupied this territory alone until the arrival of the young female in June; I noted another lone male defending a territory in the same study area in the same year.

On the morning of 17 April 1997, I found the male gnatcatcher near the edge of the dense patch of mulefat. I watched the bird capture a prey item and drop out of sight into the vegetation as if to feed young. My pleasure at having detected successful nesting by a pair of gnatcatchers that I didn't even know existed turned to consternation as I realized the only other birds in the immediate vicinity were Bushtits (Psaltriparus minimus). Over the next several minutes I watched the gnatcatcher feed two or more receptive fledglings before the roving family group of Bushtits moved on. I detected no resistance to this supplemental feeding by any of the Bushtits, perhaps not surprising in a species well known for having helpers occasionally assist nesting pairs raise their young (Ervin 1977).

This example does not fit the generalization by Skutch (1961, 1987) and Welty and Baptista (1988:362) that the feeding of foster young of another species normally involves adults currently or recently engaged in reproduction. Shy (1982), however, summarized the potential benefits of young birds gaining experience in the rearing of young, even those unrelated to them. Because he was unmated, the gnatcatcher I discuss here was likely only a year old. In any case, perhaps those gnatcatcher surveyors who occasionally mistake Bushtits for their target species will find some solace in this account.

Michael A. Patten alerted me to Shy's important review, made helpful comments on the manuscript, and shared his more urban observation of an adult European Starling (Sturnus vulgaris) feeding a fledgling House Sparrow (Passer domesticus) in Huntington Beach, Orange County, on 30 May 1992.
LITERATURE CITED


Accepted 15 August 1998

A NEW SITE OF SYMPATRY OF THE CALIFORNIA AND BLACK-TAILED GNATCATCHERS IN THE UNITED STATES

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Within its current range in the United States, the California Gnatcatcher (Polioptila californica) frequents low scrub on the coastal side of the Peninsular and Transverse ranges in southwestern California. The closely related Black-tailed Gnatcatcher (Polioptila melanura) generally inhabits the Colorado and Mojave deserts within its range in southern California. Atwood (1988) discovered that both species coexist in limited areas of northeastern Baja California. This note reports a new site of sympatry of the two species on the U.S. side of the border.

I observed both gnatcatchers near the small community of Aguanga in southwestern Riverside County, California. Aguanga is located east of the city of Temecula within the coastal drainage of the Santa Margarita River. I found all gnatcatchers within 2 km of State Highway 371, between its intersection with Wilson Valley Road to the north and State Highway 79 to the south (Figure 1, Appendix). I believe my observations constitute the most inland records of a current established population of the California Gnatcatcher in southern California and the westernmost records of the Black-tailed Gnatcatcher.

I first noted the Black-tailed Gnatcatcher on 19 November 1995 with a pair in a draw 4.5 km north of the intersection of highways 79 and 371. I subsequently recorded this species in several draws immediately northwest of this intersection. The nearest previously known populations occur 45 km to the northeast in Deep Canyon.
south of Palm Springs, Riverside County (Weathers 1983) and approximately the same distance to the southeast near Ranchita, San Diego County (C. Edwards pers. comm.). I am unaware of additional records within a coastal drainage in California.

I first noted the California Gnatcatcher on 9 December 1995. I spotted two males in a draw just west of the initial observation of the Black-tailed Gnatcatcher. I have subsequently found the coastal species at nine additional locations. The nearest populations inhabit Lancaster Valley north of Radec (M. A. Patten pers. comm.), 2 to 3 km west of my closest observations. This species also occurs northeast of Vail Lake, 11 km west of Aguanga (Metropolitan Water District 1991) and above the Lake Skinner dam, 23 km northwest of Aguanga (Atwood 1990). Atwood (1990) considered the upper elevational limit for this species in the inland portion of its range to be 500 m. However, the Aguanga population occupies elevations ranging from 610 to 805 m.

A variety of shrublands dominate washes and all upland areas surrounding Aguanga. All my gnatcatcher observations were at sites dominated, at least in part, by coastal sage scrub. Flat-topped buckwheat (Eriogonum fasciculatum) provides the greatest cover. Other prominent species include the sugarbush (Rhus ovata), jojoba (Simmondsia chinensis), valley cholla (Opuntia parruyi), Mohave yucca (Yucca schidigera), and deerweed (Lotus scoparius).

Gnatcatchers occur to a lesser extent in several additional shrub habitats. One pair of Black-tailed Gnatcatchers included a mixed stand of redshank (Adenostoma sparsiflorum) and chamise (A. fasciculatum) within its territory. These shrubs are chaparral indicators. Two pairs of California Gnatcatchers included portions of dry washes within their territories. These spots are dominated by scale-broom (Lepidospartum squamatum) and wingscale (Atriplex canescens).

Many disjunct populations of plants associated with the Colorado Desert are also characteristic of Aguanga. They include thickets of honey mesquite (Prosopis glandulosa), and Anderson's desert thorn (Lycium andersonii). The territories of two Black-tailed Gnatcatchers and five California Gnatcatchers overlapped with this type of vegetation. True desert vegetation occurs no closer than the Palm Springs area and near Ranchita, as described above. Aguanga is separated from these areas by dense stands of chaparral and by montane coniferous forests from which both species are absent.

Both gnatcatchers appear to be locally distributed near Aguanga. Although vegetation appears appropriate, I have not recorded either gnatcatcher in shrublands immediately west of Aguanga nor to the east in Dameron Valley or near Oak Grove. In areas of sympatry in Baja California, Atwood (1988) observed the California Gnatcatcher in coastal sage scrub, while the Black-tailed Gnatcatcher inhabited nearby desert scrub vegetation. Distinct habitat preferences are less noticeable at Aguanga, as shown by the varied scrub habitats occupied by each species and by the presence of both gnatcatchers in two draws.

I confirmed breeding for each species in 1996. On 11 May, I observed a pair of Black-tailed Gnatcatchers feeding insects to a single fledgling (location 9, Figure 1). I noted a male California Gnatcatcher building a nest on 20 April, a pair feeding young on 11 May, and a pair with one fledged young on 18 May (locations 5, 11, and 7, Figure 1).

My only simultaneous observation was on 15 March 1996 when I "squeaked up" a male Black-tailed Gnatcatcher and a female California Gnatcatcher. Both birds perched in the same sugarbush 5 m from me. The two foraged fairly closely for a few minutes, then proceeded in separate directions. I have not observed any individuals showing obvious hybrid characteristics.

I thank Michael A. Patten for providing records of the California Gnatcatcher and for reviewing the manuscript.
NOTES

Figure 1. Sightings of Black-tailed and California Gnatcatchers near Aguanga, California. Numbers are keyed to the appendix.

LITERATURE CITED


APPENDIX. Gnatcatcher observations near Aguanga, California. Numbers are keyed to Figure 1. Abbreviations used: CSS, coastal sage scrub; CHP, chaparral; WSH, dry wash; MDT, mesquite-desert thorn thicket.

Location 1: nw 1/4, ne 1/4, sect. 22, T8S, R1E. Vegetation: CSS; SW-facing draw; California Gnatcatcher, male, 15 Jun 1996.

Location 2: nw 1/4, sw 1/4, sect. 14, T8S, R1E. Vegetation: CSS; S-facing draw; California Gnatcatcher, pair, 15 Jun 1996.

Location 3: nw 1/14, se 1/4, sect. 14, T8S, R1E. Vegetation: CSS; S-facing draw, California Gnatcatcher, two males, 9 Dec 1995.


Location 5: sw 1/4, sw 1/4, sect. 13, T8S, R1E. Vegetation: CSS, MDT; S-facing draw; California Gnatcatcher, male, 1 Jun 1996.

Location 6: sw 1/4, sw 1/4, sect. 13, T8S, R1E. Vegetation: CSS, WSH, MDT; S-facing draw/dry wash; California Gnatcatcher, male, 20 Apr 1996; California Gnatcatcher, female, 1 Jun 1996.

Location 7: se 1/4, nw 1/4, sect. 24, T8S, R1E. Vegetation: WSH; dry wash; California Gnatcatcher, pair, 9 Dec 1995; California Gnatcatcher, pair with one young, 18 May 1996.

Location 8: ne 1/4, sw 1/4, sect. 27, T8S, R1E. Vegetation: CSS, CHP, MDT; three adjacent S-facing draws; Black-tailed Gnatcatcher, male, 16 Apr 1996; Black-tailed Gnatcatcher, pair with one young, 11 May 1996.

Location 9: nw 1/4, se 1/4, sect. 27, T8S, R1E. Vegetation: CSS, MDT; S-facing draw; Black-tailed Gnatcatcher, male, 18 May 1996; California Gnatcatcher, female, 14 Jan 1996; California Gnatcatcher, male, 4 May 1996; California Gnatcatcher, pair, 18 May 1996; California Gnatcatcher, individual heard, 15 Jun 1996.

Location 10: nw 1/4, se 1/4, sect. 27, T8S, R1E. Vegetation: CSS, MDT; S-facing draw; California Gnatcatcher, male, 16 Apr 1996.

Location 11: se 1/4, se 1/4, sect. 27, T8S, R1E. Vegetation: CSS, MDT; S-facing draw; California Gnatcatcher, male, 4 May 1996; California Gnatcatcher, pair, 18 May 1996.

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BOOK REVIEWS


Two aspects of watching birds are that they move, and that their appearances can be highly variable. Even the best field guides, whether using paintings or photographs, are constrained by trying to cover everything via a limited number of two-dimensional, immobile images. Given such inherent restrictions, books can do a very good job—especially if one takes time to read the text! Nonetheless, the potential for video footage to show moving birds, and to portray more plumages that even a specialized field guide, suggests that the medium will become increasingly common in the field of bird identification. Producer John Vanderpoel has chosen one of the biggest nightmares in North American birding for the first in a series of videos aimed at helping observers identify problem groups of birds. The result is a success.

The video covers 13 species of “four-year” gulls (including the Yellow-footed) that have occurred in North America—all the regulars plus the Kelp and Yellow-legged, and some hybrids. An introductory section discusses gull topography (a useful pull-out card is provided with parts of a gull labeled clearly) and plumage development, and then from 5 to 15 minutes for each species follow. Jon Dunn, the narrator and co-writer (with Larry Rosche), speaks clearly and covers the geographical range and North American status of each species, followed by a discussion of structure and plumage for all species. Most age classes are shown (video was filmed in Siberia, Europe, and South America as well as North America), and footage of moving birds is interspersed frequently with still photographs that help illustrate various points. The quality of the footage ranges from excellent to good, and many birds in flight are “freeze-framed” to highlight wing patterns. The color definition of some pinks and yellows, however, is at times a little weak, e.g., the differences we are told to note between the greenish legs of the immature California Gull and the pinkish legs of the Ring-billed needed faith to discern. Overall, though, it is a dream come true for gull enthusiasts, although future productions might benefit from a few comments.

Large gulls have few if any peers in the field of identification headaches, and a lot of points need to be covered for any analytical to be remotely effective. Paradoxically, the sheer amount of information packed into 119 minutes may be both the strongest and weakest feature of this work. I found the pace and content so intense that I needed to break for a day or two after the fifth species! Images often seem to whiz by, and the sometimes hurried pace of the narration is not conducive to the prolonged and careful study so critical for appreciating subtle differences. I spent as much if not more time stopping and rewinding than simply watching. A second viewing was easier, but then, as with reading field guides, one probably isn’t expected to watch the whole video in one sitting. Nonetheless, more time with still photographs, or longer video of individual birds standing and maybe stretching their wings, would be preferable to lots of fast-moving images. Slower narration also might help; within sentences the narration is well-paced, even relaxed, but sentences follow one another so quick and fast that it can be hard to keep up with the flow of information. Background music accompanies some aesthetic flight video, and helps at times to calm the pace, although often it is inappropriate or extraneous. I could live with a bird video that lacked such touches. Similarly, the frequent and sometimes distracting spinning and fading of images might be a little overdone and unnecessary for an educational video.

One thing I urge be considered for future videos is that the date and location be provided for all cuts, with time to read the information and relate it to details of a bird’s plumage; such a step would immeasurably increase the value of the video as a tool for serious birders and even researchers.

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Beyond these concerns, there is not much to criticize. Gulls offer so much potential for discussion, and even heated argument, that I will refrain from trying to pick too many nits, and besides, I didn’t find many to pick. I would have preferred a longer introduction though, covering more aspects of gull identification. More emphasis might have been made of the amazing variation in plumage that gulls exhibit, or of the often striking size differences between the sexes (covered in passing in a few species accounts). Environmental variables, such as lighting and its effect on perception of gray tones (touched upon in some accounts), also could have had greater exposure.

In the introduction, the examples chosen to show differences in the gonydeal angle were, unfortunately, underwhelming, and while the narration talked about “primary projection” as primaries beyond the tertials, the on-screen pointers showed “primary projection” beyond the tail; this feature was also called “wingtip projection” in the video. A single, consistent definition might help. On several occasions the narration and images were not compatible, e.g., the “barely evident pale window” on the wings of the first-year California Gull shown looks barely different from the “prominent” window of the Herring Gull used for comparison. Closer attention to such discrepancies, of which there were several, might lessen rather than compound the feeling of bewilderment that some birding friends of mine have for gulls. Another cut at editing also might have removed phrases such as “with which it superficially resembles.”

In general, well-marked examples were chosen for each species. It would be hard at best, however, to distinguish one of the first-year Glaucous-winged Gulls from a Glaucous × Herring hybrid on the brief view available, and one of the still photos of a flying Kelp Gull looks like a Dolphin Gull (note the long tail, very broad white trailing edge to the wings, and apparently smoky gray head and dark bill). Mention might have been made of the regular occurrence of apparent Herring × Glaucous-winged gulls south to California and of their disturbing similarity to Thayer’s Gull. Indeed, the problem of hybrids, especially for west-coast observers, could have benefited from longer and less hurried treatment.

The overwhelming benefits of this video far outweigh any negative comments, though, and in particular I was impressed by how it makes manageable what might seem an almost impossible task: clearly covering the identification points of large gulls in North America. But before you feel too confident, the video ends with the very responsible caveat that not all gulls are identifiable!

This video was an ambitious undertaking, and it provides a wealth of information that seems certain to teach expert and beginner something new. I commend the producer and all involved for providing a highly educational tool. Anyone who looks at gulls, at any level, would do well to own this video, and to watch it many, many times.

Steve N. G. Howell


This new edition of Colin Harrison’s classic work, Nests, Eggs, and Nestlings of North American Birds (hereafter Nests), published originally in 1978 but out of print for several years, is a window onto the world of the nest. Paul Baicich has helped revise the guide, which covers all birds breeding north of the U.S.–Mexican border. As does the original, the second edition includes an introduction to breeding biology, an egg- and nestling-identification key, brief but detailed species accounts, color plates of nestlings painted by Philip Burton, and egg photos by F. Greenaway and Clark
BOOK REVIEWS

Sumida. Distributed throughout the text are black and white illustrations depicting nests and down patterns of chicks.

While the second edition retains most of the original baseline information, it offers revised and expanded details on breeding biology, brings the work more in line with present taxonomy, and adds species accounts for several rare or suspected breeders. Numerous black-and-white nest drawings by Terry O’Nele now accompany Andrew Burton’s original nest illustrations, and a selected bibliography has been added. The format is enlarged and of higher archival quality—the text is now printed on semigloss, acid-free paper, which I hope will prevent the yellowing that has afflicted my copy of the first edition.

Species accounts, preceded by family summaries, give more detailed information on nest type and placement and material used in nest construction. Egg descriptions remain the same, but nestlings are described in greater detail. The authors have also filled in some blanks regarding lengths of incubation and nestling periods. The new edition also elaborates on the roles played by male and female in nest construction, incubation, and feeding in some species, but I would like to see notes in greater depth on adults’ behavior at the nest.

Biologists will find useful additional information regarding the young birds’ age at major mile markers such as eyes opening, wing feathers breaking sheath, and independence. Nest also highlights many obvious gaps in knowledge and should encourage those monitoring nests to make detailed notes describing nestlings’ development by day.

The illustrations abstract the nest into its various components—egg, nest structure, nestling, and begging mouth. Forty-seven color plates of egg photos are an excellent aid to identification, though thier scale varies, in the case of wood warblers, within the plate, making size comparison difficult. The egg plates are now collected in the center of the guide rather than distributed throughout the species accounts, which works for comparing eggs, but I would still prefer to study the text and egg photos side by side.

Despite many additions, I am dissatisfied with the overall quality of the nest illustrations. A good number of the small cup nests lack physical context, being portrayed on a snippet of branch dangling in a lot of white space. These graphics therefore do little for the field biologist working to build a search image. While O’Nele’s nest figures possess a somewhat more dynamic quality than do Burton’s, her highly stylized illustrations are not very accurate. For example, the Lazuli Bunting’s nest is depicted as unlined, extremely exposed, and abnormally tattered around the rim, while the eggs in the cup are askew in a position I have never observed. A strange homogeneity pervades illustrations of shape and materials of many cup nests. Although I cannot recommend these illustrations for species-level identification, captions do illuminate some unique aspects of the nests represented.

Sixteen color plates of nestlings convey the diversity of appearances of birds fresh out of the egg, from the Turkey Vulture, with its black naked face peering out of a suit of woolly white down, to the scrawny and precariously perched Least Bittern, to the Brown-headed Cowbird chick lunging over the edge of a packed Red-eyed Vireo nest to grab the next morsel. These plates depict only a selection of nestlings, so for identification purposes one may find more useful the key to nestling mouth color and notes on gape color, skin color, and down patterns provided in the species accounts. I especially appreciate the comparative descriptions of down patterns in three families of cavity nesters—the titmice, creepers, and nuthatches. More line drawings of nestling development, though, such as that of the House Sparrow depicted in the introduction, would be welcome for native North American species.

This edition outlines various national nest-monitoring schemes and contacts for getting involved. Biologists and amateur naturalists seeking to apply their observation skills to the conservation of birds and their habitats may want to consider establishing nest-monitoring plots and participating in one of these nationally standardized data-
collection programs. Systematic nest monitoring can reveal a great deal about birds' life histories, including clutch size, number of nesting attempts made, and number of young birds produced per pair. Monitoring not only enables us to learn where and when birds nest locally, but also to investigate factors influencing productivity. We can then make comparisons among years, habitats, populations, and even between species nesting in temperate and tropical zones.

This book is not about recreational nest searching, nor is it meant for hobbyist egg or nest collectors. It will be of most use to field biologists and the increasing cadre of birders involved in breeding-bird atlases, as well as birders who wish to broaden their horizons. Enough new information has been added to warrant purchase of the revised edition, even if you own the first, and I would encourage environmental educators to incorporate this guide into their programs.

A caution to those using this book in conservation planning: geographic variation is not well addressed in the species accounts. The nest-site descriptions are somewhat like composite portraits, and one must really stretch the imagination to envision an actual nest site that might be encountered locally. Compare the Wilson's Warbler species account to that in the Marin County Breeding Bird Atlas (W. D. Shuford, 1993, Bushitt Books, Bolinas, CA): while Nests gives a very general account, the Marin Atlas compares birds nesting in coastal California and the Sierra Nevada, highlighting contrasts in the breeding biology of the two populations.

The sticky subject of subspecies (a topic barely addressed in this guide) further confounds the issue. For example, the nest description for Swainson's Thrush does not apply closely to sites that colleagues and I have documented for Catharus ustulatus oedicus in Marin County, California. The description offered in Nests seems better to reflect Swainson's Thrushes breeding in coniferous woodland than in coastal riparian habitat.

Other life-history information presented in the species accounts begs clarification. For instance, some accounts state that a species is known to be single- or double-brooded. The attempt to raise a second brood after one has fledged affects the net reproductive rate of a population and is clearly relevant to the conservation of healthy bird populations. But the occurrence of double-brooding may vary by year, subspecies, or bioregion, and claims of double-brooding should be placed in context—where and under what circumstances has it been observed for a species? The new edition of Nests calls the Warbling Vireo double-brooded; however, it is difficult to locate a published scientific reference describing this, although it has been observed on rare occasions by my colleagues in Marin County. Thus it would be unwise to generalize that Warbling Vireos are double-brooded across North America every year. This leads me to my main criticism of the book—expanded biological detail really demands inclusion of citations, and their omission seriously depreciates the value of this volume as a scientific tool.

Baich offers in the bibliography to respond to written requests for citations, and one is advised to use this guide in combination with the species accounts in the Birds of North America series (currently being produced by the Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union), which present facts well framed with locations, sample size, and references. For a western U.S. perspective, one can also check Hal Harrison's Western Birds' Nests in the Peterson Field Guide series.

I believe that biologist and general reader alike will benefit from this revision of Nests and, despite some of its shortcomings, I am relieved to see this book back in print, so that the information contained within is again widely accessible.

Stacy Small
FEATURED PHOTO

IDENTIFICATION AND MOLT OF HYBRID GLAUCOUS-WINGED GULLS

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Large white-headed gulls of the genus Larus hybridize frequently (Pierotti 1987). In particular, the Glaucous-winged Gull (L. glaucescens) hybridizes readily with other large gulls wherever they breed sympatrically: with the Western (L. occidentalis) along the Washington and northern Oregon coasts (Bell 1996 and references therein), with the Slaty-backed (L. schistisagus) on the east coast of Kamchatka (Firsova and Levada 1982) and on the Commander Islands (V. I. Grabovsky et al. unpublished data), with the Herring (L. argentatus smithsonianus) in southern Alaska (Williamson and Peyton 1963, Patten and Weisbrod 1974), and with the Glaucous (L. hyperboreus) in western Alaska (Strang 1977).

Probably nowhere else in the world do hybrids constitute such a large proportion of the total gull population as along the west coast of North America. Consequently, birders in this area have little choice but to familiarize themselves with the appearance and variability of hybrid gulls if the identification of scarce and vagrant gulls is to be attempted seriously. Unfortunately, current literature oversimplifies (or avoids) the relevant issues. For example, it is generally believed that Glaucous-winged x Western hybrids are much more abundant than Glaucous-winged x Herring hybrids in California (Grant 1986); while this may be true, we have found these hybrid combinations to be equally abundant at some northern California sites in winter. Our research suggests that Glaucous-winged x Herring hybrids have generally been overlooked, presumably identified either as Glaucous-winged x Western hybrids or as Thayer’s Gulls (Larus [glaucoides?] thayeri).

The featured photo on the back cover of this issue shows a hybrid first-year Glaucous-winged x Western Gull, photographed by King at Laguna Point, Mendocino County, California, on 27 November 1997. This bird arguably resembles a Glaucous-winged more than a Western Gull so may not be a first-generation hybrid. The following characters suggest this hybrid combination: The outer webs and tips of the primaries and the upper tail, so far as visible, are rather dark in comparison to the tertials and wing coverts; the dark grayish brown body plumage is more typical of a juvenile Western Gull; the freshly molted scapulars of the first basic plumage show prominent dark basal and subterminal bars, a pattern more typical of a Western (the Glaucous-winged in first basic plumage normally shows pale plain or finely marked scapulars); the bases of the outer greater coverts are plain brown (the Glaucous-winged often shows white spotting and wavy patterning across the bases of all the greater coverts); and the bill appears to be deep, possibly more similar in shape to the Western’s than to the Glaucous-winged’s.

One further characteristic warranting attention is the timing of the first prebasic molt. Western Gulls undergo this molt from October through December, while in the Glaucous-winged Gull this molt may be initiated at any time from late October to March (pers. obs.). Hybrids vary widely between the extremes of the two parent species in the schedule of their first prebasic molt; in general, however, even hybrids that most closely resemble the Western Gull apparently delay the molt, more closely resembling the Glaucous-winged Gull in this respect. The featured gull shows more first basic scapulars than are expected in November for a pure Glaucous-winged Gull but certainly many fewer than are typical for a first-winter Western Gull by that time of year (pers. obs.).
With the primaries (and other parts of in the plumage) so dark, and a wholly blackish short bulbous-tipped bill, the possibility of the featured bird’s being a Glaucous-winged × Glaucous hybrid is readily eliminated. Elimination of a hybrid with the Herring Gull is more problematic, as these can resemble Western Gull hybrids closely. Bill and head shape and bill coloration, however, are usually distinct, being more Herring-like than in the bird featured here. Hence the bill would be expected to show moderately extensive pink basally and to appear slimmer, with more parallel sides and a less bulbous tip, which combine to heighten the effect of a sloping forehead and more angular head shape. Furthermore, it is unlikely that the plumage of a Glaucous-winged × Herring hybrid would be so dark, and the bars on the first basic scapulars are perhaps darker and grayer than expected on a typical Glaucous-winged × Herring gull.

We thank Pierre Yésou for making the Grabovsky manuscript available. Doug Bell readily discussed issues relating to this note. This is contribution 853 of the Point Reyes Bird Observatory.

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