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Central Valley Bird Club
c/o Frances Oliver
1817 Songbird Place
Lodi, CA 95240

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The *Central Valley Bird Club Bulletin* welcomes the contribution of articles, notes, and news of research and publications on the avifauna of California's Central Valley. Of particular interest is original information that addresses bird status, distribution, ecology, and conservation. Contribution of high quality photographs and artwork are also welcomed. Potential contributors are encouraged to contact the editor.

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Establishing a Nest Box Program for the American Kestrel at the Merced Vernal Pools and Grassland Reserve

Christopher W. Swarth, Natural Reserve System, Merced Vernal Pools and Grassland Reserve, University of California, Merced, California 95343. cswarth@ucmerced.edu

Maria Camila Vega, Natural Reserve System, Merced Vernal Pools and Grassland Reserve, University of California, Merced, California 95343

Steve Simmons, 2499 5th Ave. Merced, California 95340

The American Kestrel (*Falco sparverius*) is found across most of North America where it forages in open landscapes dominated by short vegetation. It is the most numerous falconiform species in North America (Smallwood and Bird 2002, Pandolfino et al. 2011). Kestrels are obligate secondary cavity nesters that use holes in trees excavated by woodpeckers or other natural or man-made cavities (Smallwood and Bird 2002). Data from the US Geological Survey's Breeding Bird Survey, the National Audubon Society's Christmas Bird Count, numerous nest box monitoring programs, and migratory raptor counts all indicate long-term declines in this species (Smallwood and Bird 2002, Smallwood et al. 2009). In California, kestrels also have declined (Beedy and Pandolfino 2013) probably in part because of loss of suitable nesting trees. Fortunately, kestrels readily adopt man-made nesting boxes, which substitute for natural cavities. To stabilize or increase North American kestrel populations, nest boxes have been erected and monitored by many individuals and organizations, such as the American Kestrel Partnership of the Peregrine Fund (http://kestrel.peregrinefund.org/).

In spring 2014, the University of California's (UC's) Merced Vernal Pools and Grassland Reserve (Merced Natural Reserve) initiated a nest box project to expand the American Kestrel nesting population and to monitor its breeding success. Kestrels are common nesting birds in eastern Merced County and they forage over the Reserve grasslands where they were observed on 45 of 105 bird surveys conducted between January 2013 and August 2014 (Swarth unpubl. data). Prior to the initiation of this project there were no indications, however, that they nested within the Reserve.

In February and March 2014, a team of UC Merced undergraduate students fabricated and erected ten wooden nest boxes within the Reserve. The boxes were placed on existing fence posts and monitored in May and June 2014. Objectives of the study were to:

- determine if kestrels would adopt nest boxes
- measure nesting productivity in the boxes,
- band the kestrel chicks and any adults that could be captured, for long-term monitoring, and
- provide a hands-on research experience for students.

STUDY AREA

The Merced Natural Reserve is adjacent to and northeast of the UC Merced campus, Merced County, California. The Reserve consists of 2,656 ha (6,563 ac) of rolling grasslands and thousands of small vernal pools that were protected as mitigation for construction of the campus. The Reserve was designated in January 2014 as part of the University of California Natural Reserve System and will be managed for research and education.

Elevation varies from 85 to 177 m (280-580 ft). Aquatic habitats are mostly seasonal and ephemeral and include Black Rascal Creek, thousands of vernal pools, and ten cattle stock ponds, as well as the Le Grand irrigation canal along the Reserve's southwestern edge. The grasslands are dominated by a variety of introduced European grasses. Common forbs are filaree (*Erodium botrys*), tarweed (*Holocarpha virgata*), vinegarweed (*Trichostoma lanceolatum*), and Fitch's tarweed (*Hemizonia fitchii*). A few willow trees (*Salix* sp.) occur along the canal and around some of the stock ponds; these, along with a single Eucalyptus, are the only trees in the study area. Dairy cattle graze the Reserve between November and May. Many kilometers of barbed wire fence divide the lands into grazing units, and the fence posts provide perch sites for kestrels. Grasshoppers were observed in swarms throughout the grasslands in June and July, indicating that these prey insects were plentiful during our study.

Average annual precipitation (100% as rain) measured at the Merced Municipal Airport 14.5 km (9 mi) southwest of our study area is 320 mm (12.6 in.) (NOAA, National Climatic Data Center). For the period 1 October 2013 to 31 July 2014, rainfall was only 40% of the annual average.

METHODS

Ten nest boxes were built of thick, rough-cut wood. Boxes measured 18 x 8 x 8 inches (46 x 20 x 20 cm) with a 3-inch (7.6 cm) opening. Boxes were filled with 2-3 inches (5-8 cm) of wood shavings and attached to metal poles. On 11 March, the poles and boxes were secured to wooden fence posts, spaced about 250 to 350 m apart. Nest boxes were mounted 2 to 3 m above the ground and were placed in the western portion of the Reserve, near 37° 22.761 N; 120° 24.651 W.

We monitored the nest boxes on four days in 2014: 14 May, 22 May, 5 June, and 9 June. During nest checks, we plugged the nest opening to prevent adults from leaving, and we captured and banded any adults present. Chicks

Table 1. American Kestrel egg and chick production, and number of adults banded or recaptured at the ten Merced Natural Reserve nest boxes in 2014. F=female; M=male.

Nest Box Number	Clutch Size	Number of Chicks Banded and Fledged	Adults Banded	Recaptures of Previously Banded Adults
KB1	5	5 (1F & 4M)	0	F (#1783-41440)
KB2	0	0	0	0
KB3	0	0	0	0
KB4	0	0	0	0
KB5	4	3 (2F & 1M)	F (#1783-96235)	0
KB6	2	0 (1 cold egg)	F (#1783-96245)	0
KB7	2	2	0	F (#1783-45362)
KB8	4	0 (Eggs gone)	0	F (#1783-46241)
KB9	0	0	0	0
KB10	5	5	F (#1783-96227) M (#1783-96226)	0
Total	22	15	4 (3F, 1 M)	3 (3 F)

were at least 11 days old when banded. All birds were banded on the right tarsus. We determined the sex of nestlings by primary feather color.

RESULTS

Kestrels began inspecting several of the nest boxes in mid-March, a few days after the boxes were installed. In an incidental check on 28 April, nest box KB1 had 5 chicks; several other nests had only eggs. By the second week of May, four nest boxes held chicks and one held eggs (Table 1). Ultimately six of ten nest boxes (60%) were occupied by adult kestrels and a total of 22 eggs were laid. Clutch size varied from 2 to 5 eggs and averaged 3.67. Two pairs laid five eggs. Two other pairs laid eggs but failed to produce any chicks. A total of 15 eggs hatched, resulting in a 68% hatching success rate (percent of eggs that hatched; Table 1). When nest boxes were checked on 9 June, no dead chicks were found, indicating that all 15 chicks had successfully fledged (100% fledging success).

Nesting productivity averaged 2.5 young fledged per occupied nest (15 young / 6 nesting pairs). The mean number of hatchlings per successful nest was 3.75. Two nests each fledged five young. Nesting success (percent of attempts resulting in at least one chick surviving to banding age) was 67% (Table 1).

We captured seven different adults: four previously unbanded birds (three females, one male) and three previously banded females (Table 1). The three previously-banded females had been banded as nestlings in 2012 (#1783-41440 and #1783-46241) and 2013 (#1783-45362) in nest boxes on the Flying M Ranch, 5.3 to 8.9 km from their capture locations in 2014 on the Merced Natural Reserve. The two 2012-banded females were not found nesting on the Flying M Ranch in 2013 (Simmons, unpub. data).

DISCUSSION

Our study demonstrates that American Kestrels can respond quickly when artificial nest sites are made available to them in areas where the sites are lacking. The nest occupancy rate in the first year after box placement at the Merced Natural Reserve was 60%. Although our report summarizes only a single season of study and includes a small number of nests, it is still useful to compare our results with those from other studies. In contrast to our results, the annual occupancy rate for nest boxes in an eight-year study (2005-2012) on the nearby Flying M Ranch (Merced County, CA) varied from 16% during the first year after placement to 73% by year 7 in 2012, and the average occupancy rate was 49% (Simmons, unpub. data). A 21-year study of American Kestrel breeding biology in southwestern Idaho reported an annual nest box occupancy rate of 48% (Steenhof and Peterson 2009). Others have found high levels of occupancy following introduction of nest boxes (Smallwood et al. 2009).

Bill Ralph initiated a kestrel nest box program in Madera County in 2014. He recorded a nest occupancy rate of only 23% (35 nesting attempts in 151 nest boxes), less than half of the 60% rate in our study. Of 138 eggs laid in the nest boxes, 38% (52 hatchlings) fledged, compared with our fledging rate of 68%. Nesting success (percent of attempts resulting in at least one chick surviving to banding age) was 49%, compared with our nesting success of 67% (Ralph, pers. comm.).

Low nesting success in Ralph's study may have resulted from predation, from European starlings (*Sturnus vulgaris*) taking over nest boxes, or by high mortality possibly related to the drought (Ralph, pers. comm.). He suspected human disturbance caused abandonment of two nest boxes. Six nests that were started late (after 1 May) failed. Causes of egg loss in our study (5 eggs disappeared from two boxes) could be attributed to snakes, as we had seen several shed gopher snake (*Pituophis catenife*) skins in the area. Starlings are not common on the Reserve and none nested in our boxes.

Several factors, one general and one site-specific, may have contributed to the rapid and substantial response to nest boxes in our study area. Typically, many "floaters" (non-breeding birds without territories) that are excluded from nesting by older, more experienced birds are present in kestrel populations. Floaters will quickly adopt a breeding site and attract a mate when a new site becomes available (Penteriani et al. 2010).

The relatively high level of nest box occupancy in our study could also have resulted from the sudden loss of nesting boxes from the Flying M Ranch, located 5 to 10 km south of the Reserve. For many years, Steve Simmons maintained and monitored almost 200 kestrel nest boxes on this 6,070 ha (15,000-acre) ranch. In winter 2013-2014, however, new owners required that Simmons remove those boxes. As a result, an estimated 111 pairs of kestrels that bred at the Flying M Ranch in 2013 were forced to seek nesting sites elsewhere. At least three birds from that ranch nested at the Merced Natural Reserve.

Declines in kestrel population have been attributed to habitat loss and degradation, conditions that may be more pronounced along migratory routes or on wintering grounds than in the areas where kestrels nest (Smallwood et al. 2009). The widespread loss of suitable nesting trees evident in many areas is certainly an important factor. Our limited study suggests that providing nesting sites in a grassland-dominated habitat can be effective in enhancing nesting populations. The nest boxes resulted in the addition of a new species to the breeding avifauna of the Merced Natural Reserve and contributed locally to the conservation of this species. Additionally, the program provided field research and conservation experiences for UC Merced students. We will continue to monitor the nest boxes over the next few years and will consider increasing the number of boxes in the future.

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Use of Flooded Snags by Cavity-nesting Birds at Shasta Lake, California

Len Lindstrand III, North State Resources, Inc., 5000 Bechelli, Suite 203, Redding, CA 96002. lindstrand@nsrnet.com

Information regarding nest site and habitat characteristics of cavity nesting birds is widely available in the literature (Raphael and White 1984, Laudenslayer et al. 1999) and from other sources. Limited information is available, however, documenting cavity nesting birds using flooded snags in reservoirs or other flooded habitats, partly because trees are often removed from reservoir sites, particularly in California. Lack of tree clearing in a portion of Shasta Lake, California, created extensive areas of flooded snags within the reservoir drawdown zone, providing an opportunity to document cavity nesting bird use of this uncommon habitat.

STUDY AREA

Shasta Lake is 16 km north of Redding, Shasta County, California (Figure 1). The lake consists of five primary arms including Big Backbone and Squaw Creeks, and the Sacramento, McCloud, and Pit Rivers. Completed in 1945, Shasta Lake is California's largest reservoir with a maximum surface area of 121 km^2 and 676 km of shoreline. The full-pool elevation is 326 m and the surrounding terrain is moderate to steep. The local climate is Mediterranean, with an average annual precipitation of approximately 155 cm occurring primarily as rainfall. Average annual temperatures range from 10°C in winter to 32°C in summer.

During construction of Shasta Dam, clearing crews removed trees and other vegetation within much of the future reservoir area, presumably for timber use and to remove future obstructions to boating and reservoir operations. Crews worked from the dam site upriver to the confluence of Squaw Creek and the Pit River before their activities ceased due to the onset of World War II. Subsequent inundation of the new reservoir flooded the remaining 2,104 ha of forest in portions of the Squaw Creek arm and the entire Pit River arm (Figure 1), resulting in extensive stands of snags within the reservoir. Although many of the snags have fallen over time, most persist today.

The flooded forests consist primarily of conifers dominated by Douglas-fir (*Pseudotsuga menziesii*), with ponderosa pine (*Pinus ponderosa*) and occasional knobcone pine (*Pinus attenuata*). Dominant hardwoods include canyon live oak (*Quercus chrysolepis*), with occasional California black oak