California Condor: activity patterns and age composition in a foraging area

"Accurate determination . . . must await more exact techniques for identifying individuals"

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CALIFORNIA CONDORS (*Gymnogyps californianus*), once distributed from at least the Columbia River south to Baja California, now occupy primarily the rugged chaparral-covered mountains north of Los Angeles, California, and an area of foothill woodlands and grasslands surrounding the southern San Joaquin Valley (Wilbur 1978). The mountains are used for nesting, the grasslands for foraging. Recent alarm over the continuing decline of the species has drawn widespread concern and attention from conservationists and professional biologists. Life history and ecology of the species have been described by Koford (1953) and Wilbur (1978), but quantifiable data have in general been limited to reports of high counts (Miller *et al.* 1965), results of annual surveys (Mallette and Borneman 1966; Mallette *et al.* 1967; Sibley *et al.* 1968, 1969; and others), or summaries of suspected population trends over several years, based upon both high counts and surveys (Wilbur *et al.* 1972, Wilbur 1976). No recent quantifiable information is available on activity patterns of foraging condors.

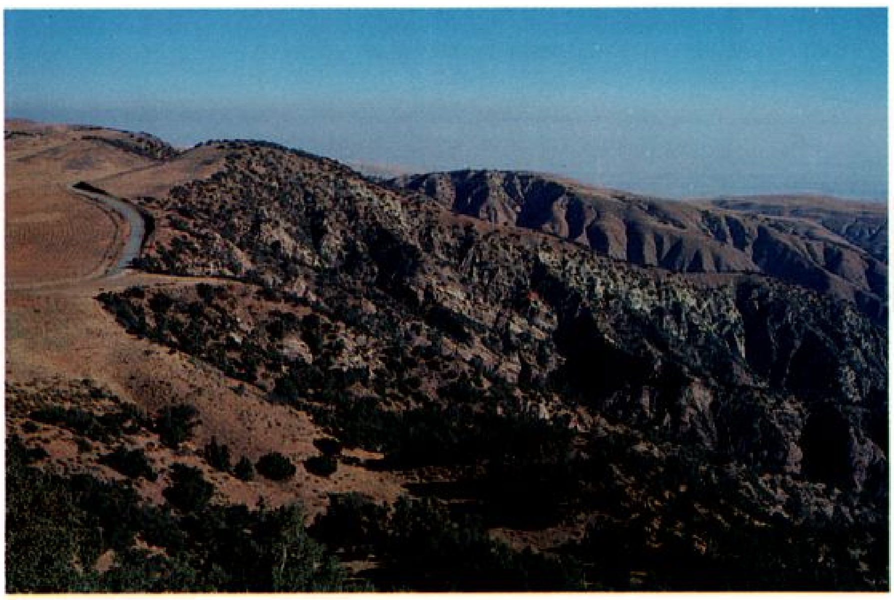
We monitored condor activity in a heavily-used foraging area for 33 consecutive days in August and September, 1981. Our data include observations on daily activity patterns, group sizes, and an estimate of the age composition of the segment of the population using this area.

STUDY AREA AND METHODS

OUR OBSERVATION SITE was in the foothill grassland habitat of southern Kern County, within an area designated as the ". . . central and most important part . . ." of condor foraging range by Miller *et al.* (1965:12). The continued importance of this area had become apparent through repeated observations (by EVJ, GMW, DAC and others) of low-flying, presumably foraging condors in the immediate vicinity for several years. In fact, condors have been seen in the area every month of the year, with greatest concentrations from August through October.

We established our observation site at an elevation of 1400 m, overlooking the grasslands. The view from the observation point was best to the north and northeast, looking across the foothills and the southern San Joaquin Valley. Prevailing winds blew from the north, creating updrafts along the foothills. The grasslands were dissected by steep canyons, some over 300 m deep. Visibility to the southeast was also good, but to the south, southwest, west, and northwest was partially obstructed by surrounding hills. Previous observations, however, revealed that most condor activity occurred over the foothill grasslands to the north and northeast.

Cattle are generally present in the study area from late April or May to mid-November, and are moved to lowlands below 600 m during the winter months. Calving normally occurs from mid-September to early November, but Epizootic Bovine Abortion, sometimes called "foothill disease" by the local ranchers, causes abortions and premature births as early as late July. In addition to livestock carcasses, an ongoing coyote control program provides a supplemental carcass supply of 50 to 100 or more each year. Thus food for condors is abundant during the summer and



Typical habitat in a heavily used foraging area of condors being monitored in the study. Photo/ D.A. Clendenen.

fall, including uneaten afterbirth from cattle, aborted fetuses, cows that die in labor, coyotes, and deer carcasses and entrails from hunting season, in addition to normal wildlife mortality (deer, rabbits, ground squirrels, etc.). The seasonality of condor abundance in the area (Fig. 1) appears to be primarily a direct reflection of the chronology of cattle abortions and births.

At least one observer was present at the observation point from 0900 hrs to 1800 hrs PDT daily from August 19 through September 20, 1981, a total of 33 days. Observers were equipped with 7 × 35 mm or 7 × 50 mm binoculars, a 30 × spotting telescope, field notebooks, and data sheets containing a condor outline on which an individual's conspicuous molt pattern could be diagrammed. The following information was recorded for every condor sighted: time and location of first detection; direction of travel; number of individuals if more than one; behavior; and time and location of loss of visual contact. If the birds were close enough, and/or light conditions permitted, the following information was also obtained: head color; condition of the wing linings (underwing coverts); extent and intensity of the wing bar across the dorsal surface (tips of upper, greater secondary coverts); and any discernible molt, including gaps in secondaries and short or missing primaries and rectrices.

On each occasion that one or more condors was observed, we attempted to determine group size in the following manner. A single bird seen when no other condors could be located anywhere in our field of view was recorded as alone, as were single birds more than approximately one-half kilometer from the nearest condor or condors and obviously not interacting with them. If two or more birds were soaring in the same updraft, interacting socially (*e.g.*, chasing), or obviously following each other, we recorded them as a group. Usually such individuals stayed within approximately one half-kilometer of each other. If after we had observed a group for several minutes a lone individual joined it, we recorded the lone bird and both the original and augmented group size (*e.g.*, 1, 3; 4). If a group split up and birds disappeared in different directions, we recorded both the initial group size and the size of the groups into which it divided (*e.g.*, 4; 2, 2). Our intent was not to make any predictions about long-term social arrangements, but simply to determine if condors were more likely to forage singly or in groups, *i.e.*, whether their distribution over the foraging area was random or clumped.

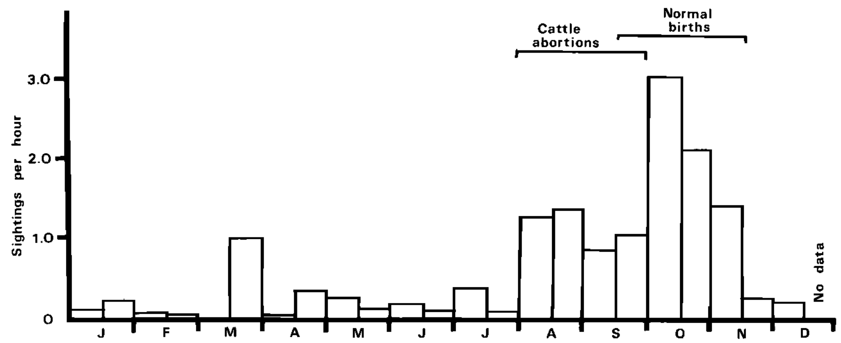


Fig. 1. Annual condor activity in the study area by half-month intervals, based on observations from August 19, 1980, to April 28, 1982. The number of hours of observation for each interval ranges from 6 to 141. The apparent peak in March is an artifact of small sample size.

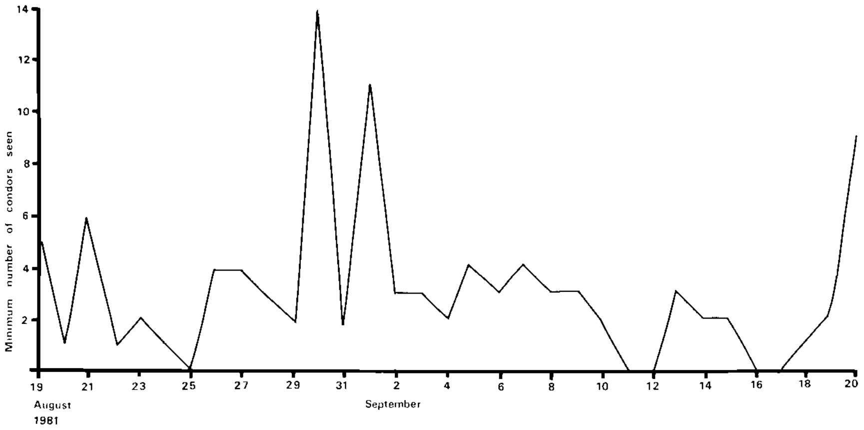


Fig. 2. Minimum daily numbers of condors in the study area throughout the survey period

Using known distances to landmarks, we were able to estimate distances at which we first sighted birds, closest approaches, and distances at which birds were lost behind hills or simply faded from view in the haze. All observers were experienced at condor identification in the field, and were capable of distinguishing condors from Golden Eagles (*Aquila chrysaetos*) and other raptors at distances exceeding 7 km. Most condors were first sighted when 4 to 7 km away by the observer scanning the grasslands, horizon, and sky with binoculars. Once located, condors were viewed with the telescope until they disappeared from view, either down canyons, behind hills, or gliding away at distances of 9 to 13 km.

RESULTS

One or more condors were seen on 28 of the 33 days (Fig. 2). We have presented minimum numbers of condors in the area for each day, based on group size, times and directions of detection and loss, and individuals recognizable by combinations of plumage pattern, head color, and/ or molt. On three of the five days with no sightings, weather was clear and warm, there were severe thunderstorms on the other two. The typical weather pattern during the study involved clear, calm mornings; a light breeze picking up from the north by 1000 hrs; little or no cloud cover; haze over the San Joaquin Valley becoming thick and low by about noon, and temperatures ranging from approximately 15° to 32° C. Condors were seen before 0930 hrs on only three mornings, all of which were unusually windy, with a steady north or northeast breeze blowing up the canyons.

The first observation occurred before 1300 hrs on 26 of the 28 days on which condors were sighted (Fig. 3), and usually (19 days) before 1130 hrs. Observations of flying condors (Fig. 4) were concentrated between the hours of 1000 and 1400, and declined sharply after 1700 hrs Of the 297 hours we spent at the observation site, we had one or more condors under observation for 23 hrs 05 min, or 7.8% of the time. Length of sightings ranged from less than a minute to 60 min; an average sighting had a duration of 11 min, and there was an average of 4.5 sightings on the days when condors were observed. For the entire 33-day period, the number of sightings per day ranged from 0 to 17, with 2 or more sightings on 25 of 28 days (89 3%).

The distribution of occurrences of various group sizes is presented in Table 1. In order to compare these data with a Poisson distribution, which is a theoretical distribution of randomly-occurring rare events (Sokal and Rohlf 1969), the zero value was calculated by dividing the total observation time that condors were not in sight by the duration of an average sighting, yielding a hypothetical number of "nil" sightings The observed and expected frequencies were then compared using chi-squared analysis (Steel and Torrie 1960). Condor group sizes were not distributed according to a Poisson distribution ($p < .005$). There were too few observations of single birds, and too many of zeros and of 2 or more, indicating that the birds tended to aggregate. Average group size was 1.95, essentially 2.

Table 1. Observed and expected frequencies of various group sizes of California Condors. For calculation of the zero value, see text.

Group size	*Observed frequency*	*Expected frequency (Poisson)*
0	1495	1348.92
1	100	304.10
2	48	34.27
3	27	
4	12	
5	2	
6	2	2.70
7	1	
8	1	
9	1	
10	1	

When condors approached close enough, or when lighting conditions were optimal, we were able to assign head color to one of three classes: solid gray or dark; dull orange or grayish-orange; and clear, bright orange. The first category probably includes birds aged 3-4 years or less (Koford 1953; Todd 1974). Between the ages of 3 and 4 years there is a "ring-necked" stage (Verner 1978), wherein the head begins to change to adult color, starting on the neck. Although we have seen a photograph of a ring-necked bird taken from our observation point in July, 1981, we were unable to identify any of the gray-headed birds we saw as ring-necks. The ring on the photographed bird was so narrow that it would have taken a very close encounter to detect. Thus some of our gray-headed birds may in fact have been ring-necks. Birds with what appeared to be a clear, bright orange head color were probably 5½ or more years old. Our weakest field aging category was the one wherein head color was dull or grayish orange. Koford (1953) mentions that he was told that 2 captive condors underwent head color change between 4 and 6 years of age. Todd (1974) states that the captive at the Los Angeles Zoo (Topa Topa) began showing head color change at age 4 years, and was completely orange-headed by the time it was just over 6 years old. We at least tentatively suggest that the birds we designated as intermediate in head color may have been birds in the 3½ to 5½ year old category, and we termed them subadults, as distinguished from gray-headed juveniles. The Condor Research Center (1982) designates as subadults ". . . birds with orange heads, but lacking full adult feather patterns." We chose to rely only on head color because we have seen condor wing linings, which were quite gray, mottled, or dusky at close range, appear snow white at greater distances. Furthermore, the extent and intensity of the wing bar across the dorsal surface of the secon-

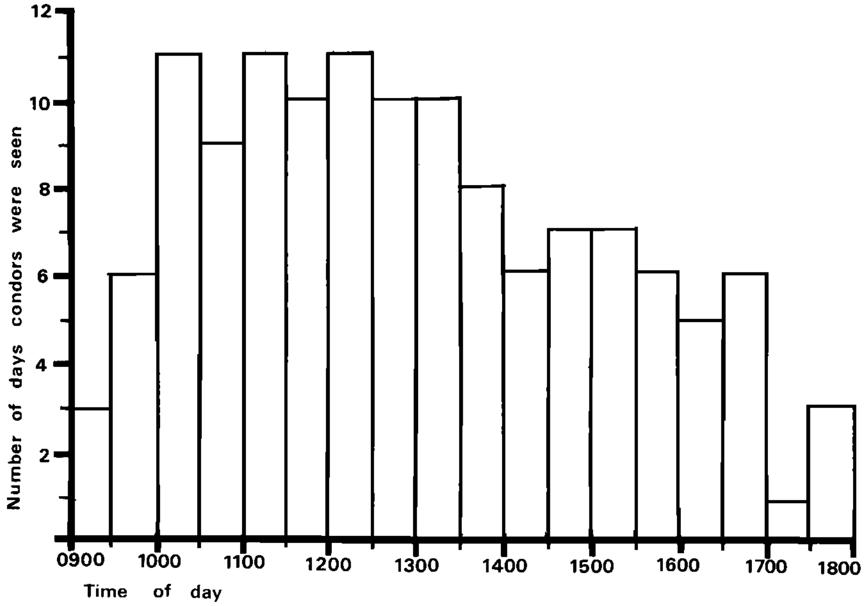


Fig. 3. Time of first condor sighting for the 28 days on which condors were observed.

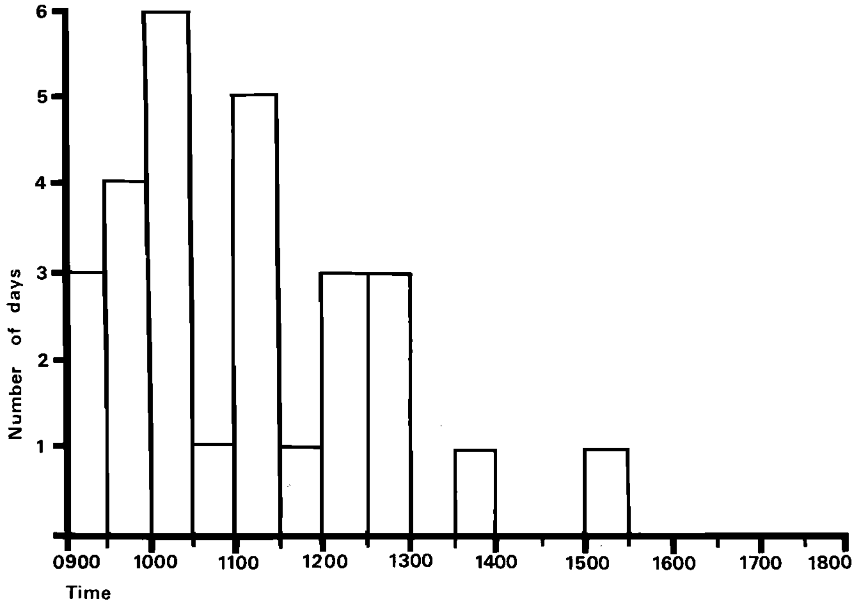
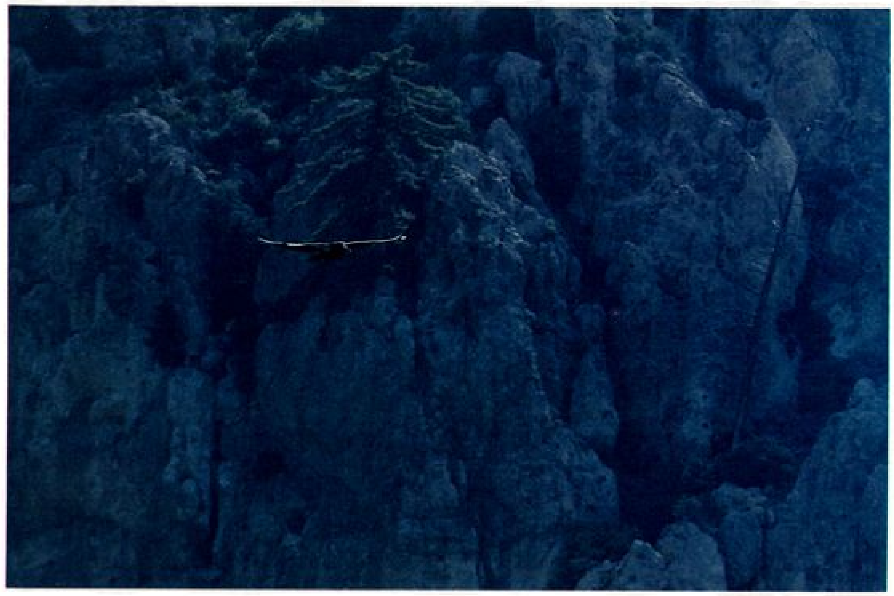


Fig. 4. Condor activity by half-hour intervals over the 33-day observation period.

daries varied considerably from bird to bird, even among adults, either because of molt, feather wear, or individual differences between birds. We recorded head color on a total of 105 occasions, and classified the sightings as 68 of adults (64.8%), 10 of subadults (9.5%), and 27 of juveniles (25.7%).

There were 10 observations of lone gray-headed individuals, 11 instances of a single gray-head with one or more orange-headed birds, 2 instances of 2 gray-heads with one or more orange-heads, and one instance of 2 gray-heads together. Thus in 24 observations we identified 10 gray-heads alone and 17 in the company of other condors. Of this total of 27 individual gray-head sightings, then, 37% (10 of 27) were of lone birds. Similarly, for orange-headed birds, there were 20 observations of lone birds and 28 instances of groups of 2 to 6 condors which included a total of 48 individual sightings of orange-headed birds. (In many cases head color could not be determined for some or even all members of a group.) Thus adults were observed alone on 29% (20 of 68) of our individual sightings. A chi-squared test (Steel and Torrie 1960) showed that juveniles were no more likely to appear alone or in groups than adults ($p > .05$).



DISCUSSION AND CONCLUSIONS

Day-to-day condor activity throughout the observation period (Fig. 2) showed no obvious pattern or predictability. Minimum numbers of birds in the area ranged from 0 to 14, and averaged 3.3 birds per day. The high count of 14 individuals was obtained on August 30, when there were three observers present. On that day 4 condors were observed soaring together, then 3 moved east and one north. The 3 joined a group of 7 about 8 km to the east, and that entire group continued eastward. All were lost in the distance, not behind hills, and our experience was that we could follow condors with a 30× telescope to 9 to 13 km, depending on air clarity. Eight minutes after we lost the bird that went north, and 2 minutes after we lost the 10 that went east, 4 more appeared from the northwest. We feel that this group might have included the bird we lost going north, but could not possibly have included any of the group of ten.

The times of first condor appearance and the daily activity patterns (Figs. 3 and 4) reflected the birds' reliance on updrafts for efficient soaring. While we had no equipment to measure actual wind velocity, it was noteworthy that sightings before 0930 hrs occurred only on days of unusually early winds. We think that the times of first observation were primarily a reflection of wind currents and updrafts rather than travel time from a distant roost, since a few birds occasionally spent the night roosting in a nearby canyon.

The frequencies of occurrence of various group sizes reflected condors' tendency to travel in pairs or possible family groups (2 adults and a juvenile flying together). The presence of food undoubtedly attracted several birds to a small area, and we could not rule out the possibility of birds following each other to feed. The data do show condors to be at least mildly social, occurring in groups of two or more birds more often than chance would predict. Although one might expect juveniles to be either more likely to be seen with other birds, especially if they follow their parents or associate in juvenile groups, or conversely, perhaps more likely to be seen alone because they are independent and as yet unpaired, our data do not show a sig-

California Condor in flight. Photo/Martha Lane Arnold.

nificant difference between them and adults in this regard.

One of our original goals was to attempt to identify individual birds by unique molt patterns. Most of the condors we observed showed conspicuous gaps in the secondaries, and some had short or missing primaries and/or rectrices. Because of the comparative ease with which we could see secondary gaps, we came to rely on these for individual identification. Primarily on this basis, we thought we had seen 8 different juveniles, 2 subadults, and at least 12 adults. Shortly after our observation period, however, staff from the Condor Research Center began photographing condors intensively, and discovered that secondary gaps of birds of known identity appeared and disappeared with confusing unpredictability (N. Snyder, *pers. comm.*). This may have to do with how the bird holds its feathers, or how the wind separates them, or may even be a result of bent feathers sometimes lying normally, and other times being bent by the wind to create transitory gaps. At any rate, the Condor Center staff have come to rely almost exclusively on primary molt patterns for individual identification (N. Snyder, *pers. comm.*) and thus we are disregarding all our tentative individual identification based on secondary gaps.

While it is tempting to apply our observed proportions of different age classes to current estimates of total population size, we are extremely hesitant to do so. There is no guarantee that the segment of the population we observed was a truly random sample of the entire population. Different age classes may not have visited the foraging area in the same proportion as they occurred in the population, and/or we may not have been able to identify age classes in correct proportion. Gray-headed birds at a distance may leave one in doubt as to whether the head was actually gray, or simply that the bird was too far or lighting too poor to determine actual head color. Accurate determination of condor population age composition must await development of more exact techniques for identifying individuals.

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