

## Activity and population characteristics of Andean Condors in southern Chile

Actividad y características poblacionales de los Cóndores Andinos en el sur de Chile

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### ABSTRACT

Data were collected on general activity patterns and population characteristics of free-ranging Andean Condors *Vultur gryphus* in Torres del Paine National Park, Chile from July 1992 to June 1994 during 3,680 h of observation. Seasonal differences were evident in relative abundance and activity patterns. The mean number of condors sighted/ observation significantly higher in fall-winter than in spring-summer. There was a significant decrease from spring-summer to fall-winter in the percentage of observations during which we sighted solitary condors and a significant increase in the number of groups of condors. In addition, mean monthly maximum group size was significantly larger in fall-winter than spring-summer. The sex ratio (males:females) of juveniles was significantly skewed in favor of females, and that of adults was significantly skewed in favor of males. The significantly different adult:juvenile ratio of condors visiting the park could have resulted from differences in distribution and habitat use and/or low breeding rates. Differential juvenile mortality and dispersal could also have produced skewed age and sex ratios, but more research is needed. Condor activity seemed related to wind speed. The greatest proportion of condors was observed flying in calm and low winds and less frequently in moderate to very strong winds. Temperature seemed to have an important effect on aerial activity because the greatest proportion of condors was sighted flying and soaring on warm days. Temperature and wind speed were weakly correlated.

**Key Words:** Andean Condor, activity, Patagonia, sex ratio.

### RESUMEN

Se recolectaron datos sobre los patrones generales de actividad y características de la población del Cóndor Andino *Vultur gryphus*. El estudio se realizó en el Parque Nacional Torres del Paine, Chile, entre julio 1992 y junio de 1994, totalizando 3680 horas de observación. Durante el estudio fueron evidentes diferencias estacionales en los patrones de actividad y abundancia relativa de estas aves. El número promedio de cóndores por observación durante el otoño y el invierno fue significativamente diferente al promedio observado durante la primavera y el verano. Hubo una disminución significativa desde la primavera - verano hacia el otoño - invierno en el porcentaje de observaciones de cóndores solitarios y también hubo un aumento significativo en el número de grupos de cóndores. El promedio mensual máximo del tamaño de grupo fue significativamente más alto en el otoño - invierno que en la primavera - verano. La proporción entre los sexos (machos:hembras) en la población juvenil favoreció significativamente a las hembras, mientras que en la población adulta favoreció a los machos. Esta diferencia en la proporción entre cóndores adultos y juveniles posiblemente está relacionada con diferencias en la distribución y el uso de hábitat y/o bajas tasas de reproducción. Diferencias en las tasas de mortalidad juvenil al igual que diferencias en las tasas de dispersión también pudieron contribuir a las diferencias en proporciones entre los sexos y las edades, pero se necesitan más investigaciones al respecto. La actividad de los cóndores en el parque pareció ser dependiente de la fuerza del viento. Observamos mayores cantidades de cóndores durante días con vientos de intensidades bajas y menos durante días con vientos de intensidades altas. La temperatura ambiental también pareció influir en la actividad aérea de los cóndores; fue más común observar a estas aves volar durante los días con temperaturas más cálidas. Hubo una correlación débil entre la intensidad del viento y la temperatura ambiental.

**Palabras clave:** Cóndor Andino, patrones de actividad, Patagonia, proporción sexual.

## INTRODUCTION

The Andean Condor *Vultur gryphus*, Linnaeus 1785, has been valuable in developing techniques for rearing the endangered California Condor *Gymnogyps californianus* in captivity (Wallace & Temple 1987), yet is prone to local extirpation along populated coastal areas of South America (McGahan 1972, Temple & Wallace 1989). Despite its endangered status, there have been few studies addressing the ecology of this species throughout its native South American range from Mérida, Venezuela, through the Andes south to the main island of Tierra del Fuego (Fjeldsa & Krabbe 1990). The only methodological studies have been conducted in Peru and Colombia (McGahan 1972, Temple & Wallace 1989, Wallace & Temple 1987, 1988), but there are anecdotal observations from Ecuador (Wiggins 1945), Venezuela (Calchi & Vilorio 1991), northern Chile (Peterson 1958), southern Argentina (Adams 1907), and Peru (Pennycuik & Scholey 1982).

In southern Chile, including Torres del Paine National Park, the Andean Condor is likely a key scavenger in this ecosystem (Venegas 1993). As the Chilean Patagonia becomes increasingly developed and populated, however, there is potential for increased human-condor interactions. McGahan (1972) and Temple & Wallace (1989) established that condor mortality rises when there is frequent contact with humans. With the potential for elevated condor mortality, it is important to possess updated information regarding relative abundance, activity patterns, and general population characteristics (Venegas 1993). The objective of this study was to describe for the first time activity, seasonal relative abundance, and general population characteristics of Andean Condors from the southern fringe of their distribution

## METHOD

*Study area*

The study was conducted from July 1992 to June 1994 in Torres del Paine National Park (51°3' S, 72°55' W), located in the eastern foothills of the Andean mountain range in southern Chile. The study area was a 60-km<sup>2</sup> "peninsula" ranging from 200-400 m in elevation bordered by large lakes to the north, south, and west, and the Goic sheep ranch to the east. The landscape was open, with rolling hills, and vegetation was rarely > 1 m high. Grasses *Festuca gracillana*, *Anarthrophyllum patagonium* and shrubs *Mulinum*

*spinsum*, *Senecio patagonicus*, and *Berberis buxifolia* dominated this pre-Andean steppe (Pisano 1974). Meteorological conditions varied. Summer (December-February) was marked by relatively high winds, rain, and relatively warm daily temperatures. In contrast, winter (June-August) was relatively dry, colder, and less windy. Spring (September-November) and fall (March-May) were intermediate in temperature and precipitation.

*Sampling data*

We recorded data from 0830-1800 during the spring, summer, and fall, and from 1000-1600 during winter because of the decreased photoperiod. One to three observers were in the field year-round an average of 18 days/month for a total of 3,680 h of observation and recorded information whenever a condor was sighted. We observed condors with 8X binoculars and 20X spotting scopes. We easily distinguished condors from other raptors in the area, such as the Black-chested Buzzard-Eagle *Geranoaetus melanoleucus*, Chimango Caracara *Milvago chimango*, Crested Caracara *Polyborus plancus*, and the White Throated Caracara *Phalcoboenus albogularis* from distances as far away as 5-6 km. We aged birds from distances up to 2 km and classified them according to the color of their wing secondaries and neck collars (modified from McGahan 1972): black or brown in juveniles (<1 year old), grey in subadults (considered as juveniles for statistical analysis) (1-6 years old), and white in adults (>6 years old). Accurately sexing birds was more problematic and sex was generally determined from 100-500 m. Males were differentiated from females by the presence of a caruncle on the head. With the intention of minimizing error associated with sexing juveniles, we analyzed only the data collected by R. Sarno, who was present for the duration of the study. The caruncle of juvenile males is between 3-5 cm high (nearly adult size) when they begin flying at six months of age (Wayne Schulenburg, personal communication, San Diego Zoo; Don Sterner, personal communication, San Diego Wild Animal Park), making them easily distinguishable from juvenile females. In addition, we collected data on solitary condors and groups of condors (all individuals within 0.5 km were included in the same group), activity, time of day, temperature, and wind speed. Activity was recorded as flying (flapping wings), soaring (airborne without flapping wings), resting, and feeding. Days were characterized by temperature as cold (< 1 °C), cool (1 -9 °C), warm (10 -20 °C), and hot (>

20 °C), and wind speed as calm (0-8 km/h), low (9- 24 km/h), moderate (25-48 km/h), strong (49-64 km/h), and very strong (>64 km/h). We estimated and agreed upon temperature and wind speed. Because we soon departed from the field on rainy days, nor entered the field in such weather, we cannot comment on condor activity during such conditions. Because of the lack of statistical significance between fall-winter and spring-summer we combined data for seasonal (fall-winter versus spring-summer) comparisons to increase sample size, on the number of condors sighted/

observation, the proportion of sightings of solitary condors and groups of condors, and mean maximum group size. We adjusted all analyses involving the number of condors sighted/observation or per hour for the number of observers in the field at that time. The spacing of observers in the field made it possible to determine when we had redundant sightings. When this occurred, we used only the minimum number of condors sighted.

We used chi-square goodness of fit, t-tests, Pearson correlation, and standard ANOVA techniques to analyze activity, number of observations in which condors were sighted alone or in groups (2-9, 10-19, 20-27, relationship between wind speed and temperature, and the proportion of adults:juveniles and males:females (SAS Institute, Inc. 1989).

## RESULTS

The mean number of condors sighted/observation was significantly higher in fall-winter (mean = 2.42, SD = 4.21, n = 189) than in spring-summer (mean = 1.56, SD = 1.86, n = 167,  $t = 2.4$ ,  $df = 354$ ,  $P = 0.008$ , Fig.1). From spring-summer to fall-winter there was a significant decrease in the proportion of observations during which we sighted solitary condors ( $\chi^2 = 13.5$ ,  $df = 1$ ,  $P < 0.001$ ), and a significant increase in groups of condors ( $\chi^2 = 14.0$ ,  $df = 3$ ,  $P = 0.003$ , Fig. 2). In

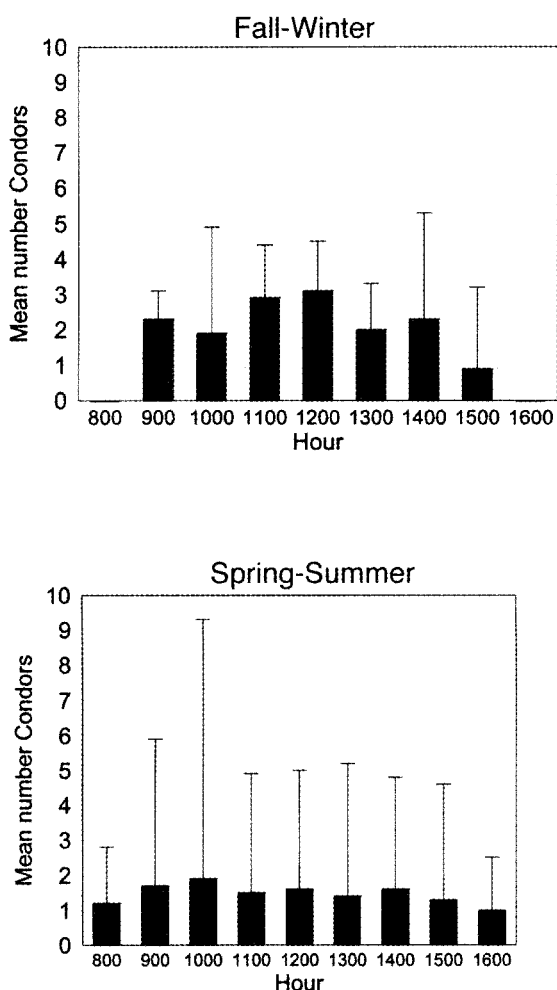


Fig. 1. Mean number of Andean Condors observed/hr/ observer during fall-winter and spring-summer in Torres del Paine National Park, Chile from June 1992 to July 1994. Extended lines indicate standard error.

Número promedio de Cóndores Andinos observados /hr/ observador en otoño - invierno y primavera - verano en el Parque Nacional Torres del Paine, Chile entre junio 1992 y julio 1994. Las líneas extendidas indican error estándar.

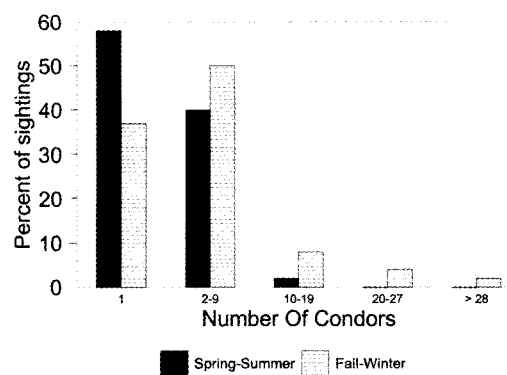


Fig. 2. The percentage of observations of solitary condors and groups of condors containing 2-9, 10-19, 20-27, and 28 individuals during spring-summer and fall-winter in Torres del Paine National Park, Chile from June 1992 to July 1994.

Porcentaje de observaciones de cóndores solitarios y en grupos que contienen 2-9, 10-19, 20-27, y 28 individuos en primavera - verano y otoño - invierno en el Parque Nacional Torres del Paine, Chile entre junio 1992 y julio 1994.

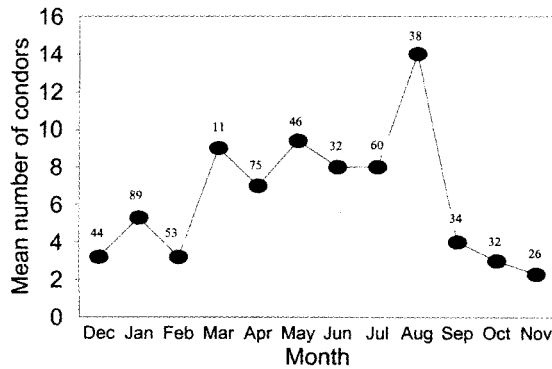


Fig. 3. Mean monthly maximum group size of Andean Condors in Torres del Paine Natinal Park, Chile from June 1992 to July 1994. Number above data point indicates sample size.

Promedio del tamaño máximo de grupo de Cóndores Andinos en el Parque Nacional Torres del Paine entre junio 1992 y julio 1994. El número sobre el punto indica el tamaño de muestra.

addition, mean maximum group size was significantly larger in fall-winter (mean = 9.2 condors/group, SD = 2.48) than in spring-summer (mean = 3.5 condors/group, SD = 1.04,  $t = 4.9$ ,  $df = 10$ ,  $P = 0.002$ , Fig. 3).

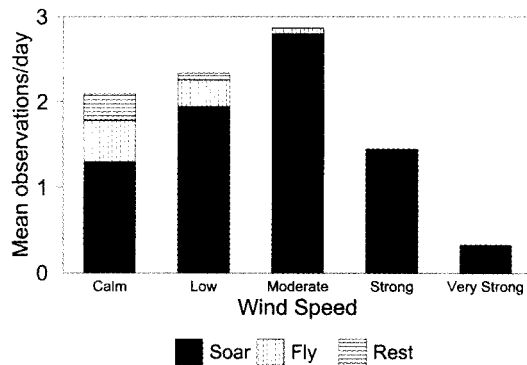


Fig. 4. Mean number of observations of Andean Condors/day soaring, flying, and resting per number of days categorized as calm (0-8 km/hr,  $n = 62$ ), low (9-24 km/hr,  $n = 61$ ), moderate (25-48 km/hr,  $n = 43$ ), strong (49-64 km/hr,  $n = 22$ ), and very strong (> 64 km/hr,  $n = 15$ ) wind days in Torres del Paine National Park, Chile from June 1992 to July 1994 ( $n =$  sample size of a particular day).

Número promedio de observaciones de Cóndores Andinos por día planeando, volando y descansando en relación al número de días con viento clasificado como tranquilo, bajo, moderado, fuerte, y muy fuerte en el Parque Nacional Torres del Paine, Chile entre junio 1992 y julio 1994.

The adult:juvenile (including subadults) ratio was significantly skewed in favor of adults (1.00:0.52,  $n = 1134$ ,  $c^2 = 109.3$ ,  $df = 1$ ,  $P < 0.0001$ ). The sex ratio of adult males:females was significantly skewed in favor of males (1.00:0.71,  $c^2 = 5.5$ ,  $n = 457$  (286 unsexed),  $df = 1$ ,  $P = 0.019$ ), and that of juveniles was skewed in favor of females (1.00:2.21,  $c^2 = 17.5$ ,  $n = 291$  (36 unsexed),  $df = 1$ ,  $P < 0.001$ ).

We observed the greatest proportion of condors flying in calm and low winds and less frequently in moderate to very strong winds ( $c^2 = 37.0$ ,  $df = 4$ ,  $P < 0.001$ ). Additionally, birds soared with greater frequency in calm to moderate winds, but with less frequency in strong and very strong winds ( $c^2 = 97.6$ ,  $df = 4$ ,  $P < 0.001$ ). We also observed condors resting more frequently in calm conditions and less frequently in all other winds ( $c^2 = 22.0$ ,  $df = 4$ ,  $P < 0.001$ , Fig. 4).

Temperature may have also influenced aerial activity because we sighted more birds flying ( $c^2 = 38.3$ ,  $df = 3$ ,  $P < 0.001$ ) and soaring ( $c^2 = 265.6$ ,  $df = 3$ ,  $P < 0.001$ ) on warm days. Additionally, we observed condors resting with equal frequency across all temperatures ( $c^2 = 7.2$ ,  $df = 3$ ,  $P = 0.07$ , Fig. 5). Wind speed and temperature were significantly correlated ( $r = 0.15$ ,  $P = 0.002$ ,  $n =$

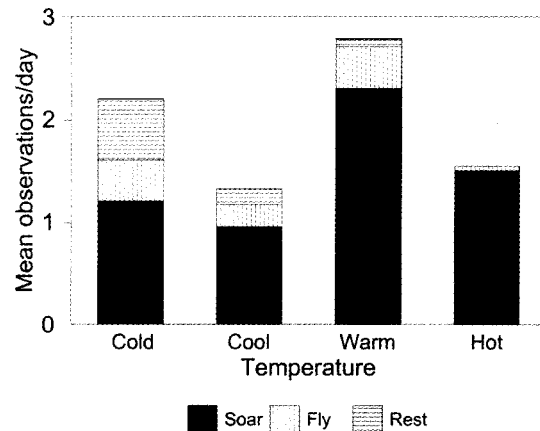


Fig. 5. Mean number of observations of Andean Condors/day soaring, flying, and resting per number of days categorized as cold (< 1° C,  $n = 10$ ), cool (1 - 9 °C,  $n = 60$ ), warm (10 a 20 °C,  $n = 109$ ), and hot (> 20 °C,  $n = 24$ ) days in Torres del Paine National Park, Chile from June 1992 to July 1994 ( $n =$  sample size of a particular day).

Número promedio de observaciones de Cóndores Andinos por día planeando, volando, y descansando en relación al número de días clasificados como fríos, tibios, calidos, y calientes en el Parque Nacional Torres del Paine, Chile entre junio 1992 y julio 1994.

411), but we discounted the biological importance of this relationship because of the low  $r$  value.

#### DISCUSSION

The high number and frequency of condors we observed suggests that this area could be an important feeding ground. Condors were likely attracted to the peninsula study area because of the open terrain and low vegetation (0.5 m) that likely made the abundance of large mammal carcasses easier to sight. Diets of some raptors in the park have been documented (Iriarte et al. 1990, Engh et al. in press), but condor food habits have not been studied. The most likely food source for condors was the year-round abundance of dead guanacos in the park and of dead domestic sheep and cattle just outside the park, because when we observed condors feeding ( $n = 3$ ), they were feeding on either guanaco or sheep carcasses. There were between 1200- 1800 guanacos on the peninsula (W. Franklin, unpublished data), and 5000 sheep and 200 cattle (J. Goic, personal communication) on the adjacent ranch during the study.

The significant increase in the mean number of condors sighted / observation, combined with the significant increase in the percentage of observations that we sighted solitary condors and larger groups of condors in fall - winter, suggests an increase in local condor abundance during this period. Food availability may have influenced this increase. The mortality rate of juvenile guanacos increased during fall - winter (Sarno et al. 1999), and we suspect that adult guanaco mortality also increased during this period. In addition, domestic sheep mortality on adjacent ranches also rose during this interval because of increased puma *Felis concolor* predation (Iriarte et al. 1991). The increase in potential food for condors may have influenced immigration from other areas, thus increasing local abundance during the fall - winter.

The significantly skewed adult:juvenile ratio in Torres del Paine (1.00:0.52) is consistent with the ratio of adult:juvenile condors (1.00:0.35) reported by Temple and Wallace (1989) for two populations in Peru. Although it is not surprising that there are significantly more adults than juveniles, the reason is not clear. Age and or sex differences in population distribution, resulting from differential habitat use could exist. For example, Meretsky & Snyder (1992) suggested that immature California Condors visited an increasing number of feeding areas as they matured. Another possibility could be low breeding rates among adults. Wallace & Temple

(1987) discovered that in populations of condors in Peru, in which adults significantly outnumbered juveniles, adult condors were breeding less than every other year because of low food supply. Low food supply, however, does not seem likely to be a problem in Torres del Paine and the surrounding area.

The significantly skewed sex ratio (males:females) of juveniles (1.00:2.21) and adults (1.00:0.71) is puzzling. Sex differences in habitat use could exist. Other factors such as differential mortality and dispersal could also account for the skewed sex ratios. Because of the lack of published data on condor sex ratios, it is difficult to provide an insightful explanation. Because of the close proximity with which we determined juvenile sex, and the prominence of the caruncles of juvenile males, we are confident that the reported juvenile sex ratio accurately reflects the sex ratio of juvenile condors observed in Torres del Paine. The aerial activity of condors is most likely related to meteorological conditions. McGahan (1972) and Johnson et al. (1983) cited wind speed and updrafts as important factors for maintaining flight in Andean and California Condors because of the lift provided. We were surprised to find, however, that condors were least active in very strong winds ( $> 64$  km / hr). Our infrequent observations of condors resting in extremely windy conditions suggests their absence in the peninsula study area. It is possible that lack of stability during flight in very strong winds may have grounded condors. We were unaware of any communal roosts and found only two nests in the park. Perhaps under extremely windy conditions, condors remain on or near their nest or nightly roost. Temperature could have influenced aerial activity. We would have predicted more sightings of condors on hot days, given that the frequency and intensity of thermals probably increased. It is possible, however, that on hot days condors rode thermals so high that they were unable to observe them. While we frequently sighted condors circling over dead guanacos and sheep, we only observed them feeding on the ground three times. This may be related to condor behavior and the topography of the study area. Condors were highly vigilant on the ground and took flight almost immediately upon observing an approaching human from 200-300 m. Also, the large size of the study area combined with the open terrain likely decreased the probability that we would encounter feeding condors before they sighted us. Our results may not be representative of the condor population throughout the Patagonia because our study was limited to a relatively small area. Clearly, more research is necessary throughout

the region in order to better understand population structure and activity on a larger scale.

Because the Chilean Patagonia is increasingly being developed and populated, there is a potential for increased human - condor interactions. McGahan (1972) and Temple & Wallace (1989) established that condor mortality rises when there is frequent human contact. Conversely, much of the development in the Patagonia is in response to the burgeoning ecotourism market, an endeavor that should promote interest in and stewardship of the vulnerable Andean Condor.

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