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BREEDING BIOLOGY OF THE CRESTED CARACARA IN THE CAPE REGION OF BAJA CALIFORNIA, MEXICO

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Abstract.—The breeding biology of the Crested Caracara (*Caracara plancus*) was studied during the 1990 and 1991 breeding seasons in Baja California Sur, Mexico. Sixteen nests were monitored in 1990 and six in 1991. The breeding season extended from February–August. Caracaras were more abundant during the post-fledging period (October–November) when up to 1.2 birds/km were registered in road surveys. The cardon cactus (*Pachycereus pringlei*) was the most used structure for nesting (76% of nests), although other tree-like structures were also used. Nest material consisted mainly of twigs of rama parda (*Ruellia peninsularis*), coralvine (*Antigonon leptopus*), and condalia (*Condalia globosa*). Nesting success estimated using the Mayfield method was 0.75 and 0.38 in 1990 and 1991, respectively. Mean (±SD) productivity was 2.2 ± 0.4 and 1.8 ± 0.7 fledglings per successful nest in 1990 and 1991, respectively. Five second clutches were registered. The productivity of the Cape region Crested Caracara population was similar to that reported for caracaras in Texas but higher than in Arizona.

BIOLOGÍA REPRODUCTIVA DEL CARACARA EN LA REGIÓN DEL CABO DE BAJA CALIFORNIA, MÉXICO

Sinopsis.—En la región árido-tropical de Baja California Sur, en la región del Cabo, estudiamos la biología reproductiva de *Caracara plancus,* siguiendo 1.2 nidos en 1990 y seis en 1991. La reproducción se realiza entre febrero y agosto. La máxima abundancia se registra entre octubre y noviembre, correspondiendo con el período de independencia de los jóvenes. *C. plancus* utilizó más frecuentemente cardones (*Pachycereus pringlei*) para colocar sus nidos (76%), aunque puede utilizar otras estructuras arbóreas para anidar. Los nidos se contruyeron con ramillas de *Ruellia peninsularis, Antigonum leptopus* y *Condalia globosa.* El éxito reproductivo de acuerdo a los estimados del método de Mayfield fue de 0.75 y 0.38 para 1990 y 1991, y la productividad de 2.2 ± 0.4 y 1.8 ± 0.7 jóvenes/nido exitoso en 1990 y 1991, respectivamente. Se hicieron 5 registros de segundas puestas en esta población. La productividad de *C. plancus* en la región del Cabo fue similar a la reportada para Texas, pero superior a la de Arizona. El elevado éxito de *C. plancus* parece relacionarse a la alta diponibilidad de cardones apropiados para anidar y probablemente a las fuentes de alimento que el hombre le provee (carroña, cultivos y desperdicios).

The Crested Caracara (*Caracara plancus*) has a limited distribution in North America (Florida, Texas, and southern Arizona), but is present through Mexico south to Tierra del Fuego (del Hoyo et al. 1994, Howell and Webb 1995). In spite of this wide distribution, little is known of its breeding biology, nest characteristics, and reproductive performance (see Dickinson and Arnold 1996, Ellis et al. 1988, Kilham 1979, Levy 1988, Mader 1981, Paradiso 1987).

In Baja California, caracaras are found throughout the peninsula, but are most common in the Cape region of the southern tip (Rodríguez-Estrella et al. 1990, Wilbur 1987). Habitat changes due to increased human activity have occurred along the peninsula over the last decade, especially in the Cape region. Low human density and low precipitation in

the peninsula had precluded habitat destruction, but increasing tourism and changes in traditional land-use practices (i.e., agriculture and small-scale ranching) may be affecting the nesting habitat of bird species (Massey and Palacios 1994), including the Crested Caracara. Information is lacking on the status and productivity of the Crested Caracara (and other raptors) to evaluate the potential effects of habitat alterations. Therefore, the purpose of this paper is to quantify the status, breeding biology, nest characteristics, and productivity of the Crested Caracara in a well-preserved natural area where traditional human activities also occur.

STUDY AREA

We studied Crested Caracaras in the Cape region of Baja California (109°60′–111°45′W, 25°45′N), in an area 70 km south La Paz dominated by sarcocaulescent scrub vegetation. This vegetation type, the westernmost dry tropical community in North America, is characterized by cardon (*Pachycereus pringlei, P. pecten*), dagger cactus (*Stenocereus gummosus*), mesquite (*Prosopis articulata*), palo verde (*Cercidium microphyllum*), Adam's tree (*Fouquieria diguetii*), plum tree (*Cyrtocarpa edulis*), copal (*Bursera* spp.), lomboy (*Jatropha cinerea*) and cholla (*Opuntia cholla*) (León de la Luz et al. 1996, Wiggins 1980). Topographically, the area consists of plains and small hills dissected by flat dry streams (arroyos). The elevation of the area ranges from 0–250 m. This zone is characterized by mean annual precipitation of 150.6 mm, a winter rainy season, and a mean annual temperature between 22.1–23.4 C. Most nests were located on private ranches and communal properties (ejidos). Cattle ranching and agriculture are the principal human activities in the study area.

METHODS

Caracaras were censused from February–November, 1990 and 1991, to estimate the timing of the breeding season and to locate territories and nests. Active searches were made in a vehicle along main and secondary roads (Fuller and Mosher 1987), using binoculars (10 × 40) to check age of birds and potential nesting structures. Ages (juveniles < 1-yr old and adults) were determined using plumage characteristics (Clark and Wheeler 1987).

Nest location.—To locate breeding pairs, we plotted all individuals recorded during monthly surveys on 1:20,000 quadrangle topographic maps. Potential breeding territories were then delineated. We searched for nests within a radius of 100–150 m from the points where pairs were most frequently recorded. In February, we searched for pairs involved in courtship activity or copulation, and plotted their locations on maps. In March and April, we looked for nests in these areas. Finally, we queried local people for information on historical caracara nesting sites.

Breeding chronology and productivity.—We considered nests to be active if they contained eggs or chicks. We intended to count the number of eggs per nest, but ceased these visitations when we determined that caracaras delayed several minutes before returning after our visits. Human

disturbance near a ranch headquarters apparently caused the abandonment of two nests during incubation. After eggs hatched, we visited the nests every 7–10 d except near fledging, when we checked them more frequently to determine the day of fledging. A nest was considered to be successful if fledglings were observed around the nests.

We used the Mayfield method (Mayfield 1961, 1975; Steenhof and Kochert 1982) to estimate weekly nest survival probability or the probability of successful breeding attempts. These probabilities were compared between years using a *Z*-test (Hensler and Nichols 1981). Productivity was calculated as the number of fledglings per successful nest. We compared productivity between years using a *t*-test (Zar 1974). Because we did not find differences in the productivity between years ($t = 0.26$, df = 20, $P = 0.79$), we pooled all data when we compared the productivity of this and other caracara breeding populations (Arizona, Levy 1988; Texas, Dickinson 1990) also using *t*-tests. The number of nests used to estimate weekly nest survival and productivity may be different because the data we obtained from some nests did not contain the information needed to estimate weekly nest survival but could be useful to estimate productivity.

Breeding chronology was estimated by taking into account the incubation period of 28–30 d (Bent 1937), the estimated age of chicks using plumage characteristics described by Bent (1937), and by observations at nests where downy chicks (1–2-days old) were found and to which we recorded time of fledging. We used only the nests from which we had enough data in 1990 ($n = 11$).

Nest characteristics.—We recorded the species, height, and crown cover of the vegetation supporting each nest. Crown cover was considered to be the total extent of the crown of nest trees and was calculated according to the formula of an ellipse ($C = 2.5\pi d_1 \cdot d_2$; where d_1 is the largest crown diameter and d_2 the diameter perpendicular to d_1). We also measured height of the nest above ground and identified nest material. We measured the characteristics of 23 confirmed Crested Caracara nests.

RESULTS

Caracaras were most abundant in October–November when we registered up to 1.2 birds/km in both years (Fig. 1). Solitary adults were present throughout the year. Juveniles were seen more often in the post-fledging period (September and November). Pairs were more abundant from September–April of both years.

Breeding chronology and productivity.—Caracaras in the Cape region were observed conducting courtship activities in mid-February. Pairs spent most of their time flying together and changing perches. Perches were usually the most elevated branches of cardons (7–9 m height) at the site. After short flights, copulation took place on one of the cardon branches. Copulation lasted 3–5 s ($n = 20$ observations). After mating, the male usually rested in a cardon close to the female where they spent up to 70 min without activity nor allopreening ($n = 3$ pairs).

We estimated the breeding chronology of 11 nesting pairs. The breed-

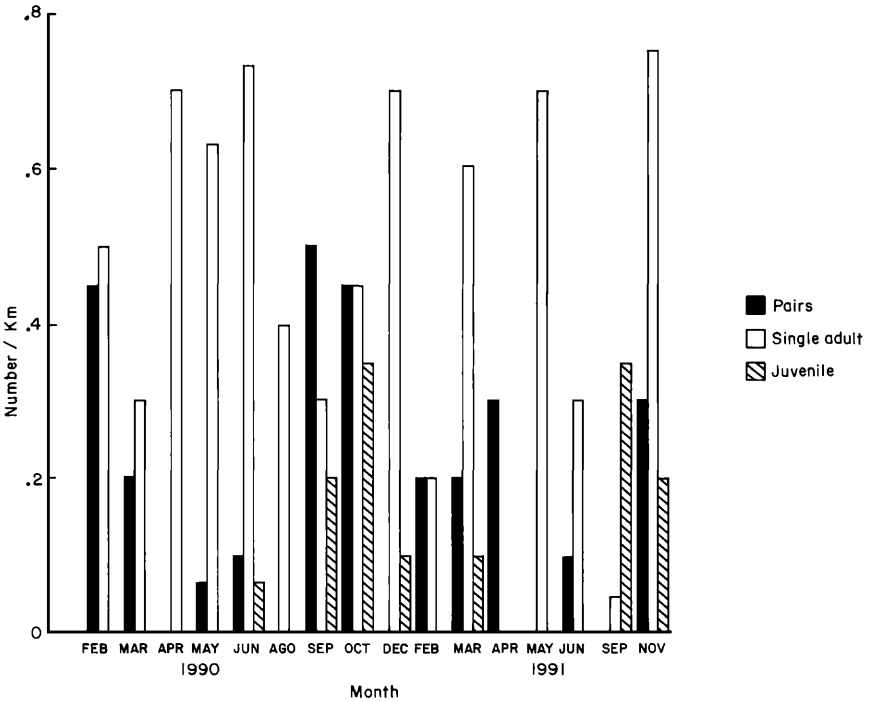

FIGURE 1. Mean number of single adults, juveniles, and pairs of Crested Caracaras per km of surveyed transects in the Cape region, Baja California, 1990–1991.

ing season extended from February–August. Eggs were laid between March and June, although probable second clutches were also found in August (Fig. 2). Fledglings were mostly observed from June–August, but we also recorded fledglings in October–November.

We recorded five probable second clutches in the Cape region. In 1990, two nests that had successfully fledged young in the month of June were observed again in August with incubating birds. In September, these nests were successful again. Additionally, adults of one of these nests successfully raised a second brood in 1991, 1993, and 1994. Productivity was not different between first and second cltuches of the same nests. Although adults were not marked, we believe the same adults raised the second broods in all cases because plumage patterns of adults were distinctive.

We visited 16 active nests in 1990, and visited 6 in 1991. Total estimated probability of nest success was 0.75 (SD = 0.10; 95% CI = 0.65–0.86; n = 14 breeding attempts) and 0.38 (SD = 0.22; CI = 0.17–0.61; n = 4) in 1990 and 1991, respectively (Table 1). These estimates did not differ between the two years (Z = 1.52, $P > 0.05$).

Nests generally produced two fledglings (Table 2). In 1990, 87% of nests used (n = 16) successfully fledged 31 young. Productivity was similar

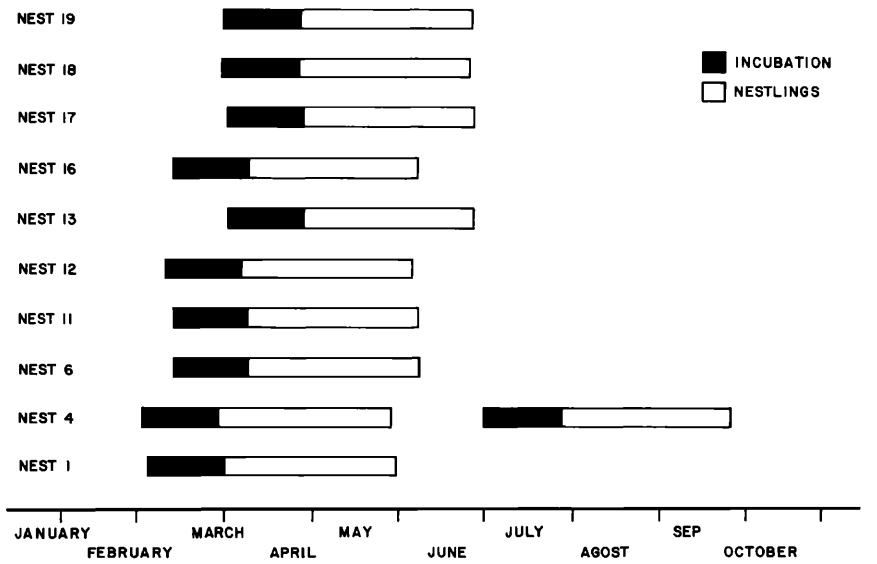

FIGURE 2. Breeding chronology of ten Crested Caracara pairs in the Cape region in 1990. This was the number of pairs which we were confident of the dates for every period. Nest 4 had a probable second clutch.

in 1990 and 1991 (Table 2; $t = 0.26$, df = 20, $P = 0.79$). Nests constructed on cardons produced 25 fledglings (2.3 young/nest; $n = 11$), while those on yucca produced 4 fledglings (2.0 young/nest; $n = 2$) and in palm, 2 fledglings ($n = 1$). The nest built in a palo verde tree was unsuccessful because of human disturbance. Nest re-use in 1990 was 84.6% ($n = 13$) and was 66% (4 of 6) in 1991.

TABLE 1. Nesting success (Mayfield method; $\bar{x} \pm SD$) of the Crested Caracara in the Cape region, Baja California Sur, Mexico, 1990–1991.

Mayfield estimate		Incubation	Nesting	Post-fledging	Overall
Total nests observed	1990	7 (6)[a]	11 (10)	12 (12)	—
	1991	2 (1)	4 (3)	3 (3)	—
Traditional success estimates	1990	0.85	0.90	1.00	—
	1991	0.50	0.75	1.00	—
Total observed weekly exposure	1990	25.5	67.5	96.0	—
	1991	8.0	20.0	24.0	—
Mayfield estimated weekly survival probabilities	1990	0.96 ± 0.03	0.98 ± 0.01	1.00	—
	1991	0.87 ± 0.11	0.95 ± 0.04	1.00	—
Probability of success for entire period	1990	0.85 ± 0.06	0.88 ± 0.03	1.00	0.75 ± 0.10
	1991	0.58 ± 0.15	0.66 ± 0.09	1.00	0.38 ± 0.21

[a] Number of successful nests in parentheses.

TABLE 2. Productivity ($\bar{x} \pm SD$) of the Crested Caracara in the Cape region, Baja California Sur, Mexico, 1990–1991.

Number	1990	1991	Both years
Nesting attempts	16	6	22
Successful nests	14	6	20
Fledglings	31	11	43
Fledglings/successful nest	2.2 ± 0.4	1.8 ± 0.7	2.1 ± 0.5
Fledglings/attempt	1.9 ± 0.9	1.8 ± 0.8	1.9 ± 0.8

Productivity at the Cape region (1.9 ± 0.8 fledglings/successful nest, n = 22) did not differ (t = 0.43, df = 24, P = 0.66) from that of a Texas population ($\bar{x}$ = 1.7 ± 0.5 fledglings/successful nest; n = 4; Dickinson 1990) but was higher (t = 2.29, df = 39, P = 0.02) than that of an Arizona population ($\bar{x}$ = 1.4 ± 0.6; n = 19; Levy 1988).

Nest characteristics.—We measured nest-tree characteristics at 23 nests. The nests were located mainly in valleys close to arroyos between 10–250 m elevation (Table 3). Most nests were on cardon (76.2%), but some pairs used other tree-like structures such as yucca (*Yucca valida,* 9.5%), palo fierro (*Olneya tesota*), palo verde, and palm (*Washingtonia robusta*) (4.8% each). Nests were located at least 4 m above the ground on cardons that were over 9 m in height (Table 3). Twigs of several species were used to build the nest, with rama parda (*Ruellia peninsularis*), coralvine (*Antigonon leptopus*), and condalia (*Condalia globosa*) being the most common (69%, 61% and 38% of 13 nests, respectively). Other plants used in construction were mesquite, yerba de la flecha (*Sapium biloculare*), tecote (*Viguiera tomentosa*), mistetloe (*Phoradendron* spp.), creosote bush (*Larrea divaricata*), palo colorado (*Colubrina glabra*), torote (*Bursera* spp.), thorn bush (*Lycium* sp), *Carlowrightia californica,* merremia (*Merremia*

TABLE 3. Nest-tree characteristics ($\bar{x} \pm SD$) of the Crested Caracara in the Cape region, Baja California Sur, Mexico. All measurements are in m except for crown cover which is in m^2.

Species	n	Total height (T_c)	Nest height (N_h)	N_h/T_c	Crown cover[a]	Nest material depth
Pachycereus pringlei[b]	18	9.7 ± 2.2	4.7 ± 0.8	0.5 ± 0.08	6.3 ± 4.5	0.72 ± 0.46
Yucca valida	2	6.0	4.2	0.71	4.71	0.4
Olneya tesota	1	4.5	4.0	0.89	6.59	0.3
Cercidium microphyllum	1	6.0	5.3	0.88	85.50	0.4
Washingtonia robusta	1	9.0	8.5	0.94	—[c]	—[c]

[a] Calculated according to the formula of an ellipse: $C = \pi \cdot 2.5 \cdot d_1 \cdot d_2$; where d_1 is the largest crown diameter and d_2 the diameter perpendicular to d_1.

[b] Only two nests were in *P. pecten.*

[c] Data not available.

aura), several grasses, and cardon fruits. Man-made material was commonly found as well (nylon cord, wire).

DISCUSSION

The Crested Caracara is a common resident in the Cape region of Baja California Sur. Caracara abundance varied by season. Highest counts were recorded during the post-fledging period, especially groups of adults with 1–3 juveniles (35.1%; n = 74 group observations). We observed what appeared to be family groups perched close to three nest areas as much as 2.5 months after fledging. In addition, groups of two adults with 2–3 juveniles were observed foraging together for carrion on roads, in henhouses, or for live prey from crop fields and ranches up to 5 mo after the average fledging date (Rodríguez-Estrella et al., unpubl. data). If these juveniles were still with their parents, the post-fledging dependency period in the Cape region would be longer than that reported for other populations (average 33 d in Texas; Dickinson and Arnold 1996). Further studies on the post-fledging period are needed using radio-telemetry.

The cardon cactus was the nesting structure most often used by the Crested Caracara in the Cape region, although other plants are common in the area (mesquite, palo verde, palo fierro). Because most nests were in the middle portion of the cardons and because cardons with 10–30 branches were typically selected by caracaras to contruct their nests (Rodríguez-Estrella et al., unpubl. data), we suggest that certain cardons provide better shelter from solar radiation and that the arms of these giant cacti may permit the construction of bigger and long-lasting nests. In addition, the height of these cacti may offer protection against predators capable of clambing cardons (e.g., foxes, bobcat). Non-cliff nesting raptors may select nesting structures offering protection against ground predators (Travaini et al. 1994).

The breeding period of the Crested Caracara in Baja California Sur is similar to that reported for other caracara populations. Productivity is similar or higher than that reported for other North American populations. In addition, our finding of second clutches suggests that this phenomenon may be more common than previously believed in this species. Bent (1937) refers to "an exceptional case of two broods being raised". Dickinson and Arnold (1996) found two instances of second clutches in Texas (n = 8 nests). Replacement laying may occur if the first clutch is lost at an early stage or when food is unusually abundant (Newton 1979). The Crested Caracara in our study area feeds on carrion, invertebrates, and vertebrates (Rodríguez-Estrella and Rivera 1997), and it is often associated with areas where food is particularly abundant and predictable such as henhouses, cropfields, and garbage dumps (Rodríguez-Estrella 1996). We believe that because all caracara pairs successfully raised their first broods and productivity was high, second clutches at the Cape region may be related to a high food availability.

In our study area, nest success and high productivity of the Crested Caracara may be related to the availability of suitable nest supports and

human provided food sources (e.g., carrion, small mammals, and invertebrates associated with agriculture, and refuse) (Rodríguez-Estrella 1996). Caracaras seem to adapt well to moderate habitat changes (Rodríguez-Estrella 1996, Rodríguez-Estrella et al., in press). However, population declines are anticipated if severe habitat changes occur. Changes in land-management practices have caused rapid deforestation in many areas of the Cape region and elsewhere on Baja California peninsula. The rapid conversion of natural habitat to agriculture, urban development and mining in Baja California will diminish the amount of cardons and adequate nesting habitat. Although this species may use other tree-like structures, the decline of this raptor in southern United States appears to be related to loss of suitable habitat (Layne 1978, Levy 1988, Johnsgard 1990).

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LITERATURE CITED

BENT, A. C. 1937. Life histories of North American birds of prey, part 2. U.S. Nat. Mus. Bull. 170. 482 pp.

CLARK, W. S., AND B. K. WHEELER. 1987. A field guide of hawks of North America. Houghton Mifflin Co., Boston, Massachussetts. 198 pp.

DEL HOYO, J., A. ELLIOT, AND J. SARGATAL, eds. 1996. Handbook of birds of the world. Vol. 2. New World Vultures to Guineaxowl. Lynx Edicions, Barcelona, Spain.

DICKINSON, V. M. 1990. Breeding biology and behavior of the Crested Caracara in Texas. M.Sc. thesis, Texas A & M Univ., College Station, Texas.

———, AND K. A. ARNOLD. 1996. Breeding biology of the Crested Caracara in south Texas. Wilson Bull. 108:516–523.

ELLIS, D. H., D. G. SMITH, W. H. WHALEY, AND C. H. ELLIS. 1988. Crested Caracara, Pp. 119–126, *in* R. L. Glinski ed. Proc. Southwest Raptor Manage. Symp. and Worksh., 21–24 May 1986. Nat. Wildl. Fed. Washington, D.C.

FULLER, M. R., AND A. MOSHER. 1987. Raptor survey techniques, Pp. 37–65, *in* B. A. Giron Pendelton, B. A. Millsap, K. W. Cline, and D. M. Bird, eds. Raptor management techniques manual. Sci. and Tech. Ser. No. 10, Natl. Wildl. Fed., Washington, D.C.

HENSLER, G. L., AND J. D. NICHOLS. 1981. The Mayfield method of estimating nesting success: a model, estimators and simulation results. Wilson Bull. 93:42–53.

HOWELL, S. N. G., AND S. WEBB. 1995. A guide to the birds of Mexico and Central America. Oxford Univ. Press, Oxford.

JOHNSGARD, P. A. 1990. Hawks, eagles and falcons of North America. Smithsonian Institution Press. Washington, D.C. 403 pp.

KILHAM, L. 1979. Caracara courtship behavior. Raptor Res. 13:17–19.

LAYNE, J. M. 1978. Threatened Audubons's Caracara. Pp. 34–35, *in* H. W. Kale, ed. Rare and endangered biota of Florida, Vol. 2 Birds. Gainsville Univ. Press, Florida.

LEÓN DE LA LUZ, J. L., R. B. CORIA, AND M. E. CRUZ. 1996. Fenología floral de una comunidad árido-tropical de Baja California Sur, México. Acta Botánica Mexicana 35:45–64.

LEVY, S. H. 1988. Status and distribution of the Crested Caracara *Polyborus plancus audubonii*

Cassin 1865 in Arizona. Technical Report. Arizona Game and Fish Department, Phoenix, Arizona.

MADER, W. J. 1981. Notes on nesting raptors in The Llanos of Venezuela. Condor 83:48–51.

MASSEY, B. W., AND E. PALACIOS. 1994. Avifauna of the wetlands of Baja California, Mexico: current status. Stud. Avian Biol. 15:45–57.

MAYFIELD, H. F. 1961. Nesting success calculated from exposure. Wilson Bull. 73:255–261.

———. 1975. Suggestions for calculating nest success. Wilson Bull. 87:456–466.

NEWTON, I. 1979. Population ecology of raptors. Buteo Books, Vermillion, South Dakota.

PARADISO, J. L. 1987. Threatened status for the Florida population of Audubon's Crested Caracara. U.S. Fish Wildl. Serv. Bull. 52:25229–25232.

RODRÍGUEZ-ESTRELLA, R. 1996. Response of Common Black Hawks and Crested Caracaras to human activities in Mexico. pp. 355–366, *in* D. M. Bird, D. Varland, and J. J. Negro eds. Raptors in human landscapes. Academic Press, London, United Kingdom.

———, AND L. B. R. RIVERA. 1997. Crested Caracara food habits in the Cape region of Baja California, Mexico. J. Raptor Research 31:228–233.

———, J. LLINAS, AND Y. MAYA. 1990. Crested Caracara (*Polyborus plancus*) in the Cape Region. J. Arizona-Nevada Acad. Sc. 25:13.

———, J. A. DONÁZAR, AND F. HIRALDO. In press. Raptors as indicators of environmental change in the scrub habitat of Baja California Sur, Mexico. Conserv. Biol.

STEENHOF, K., AND M. N. KOCHERT. 1982. An evaluation of methods used to estimate raptor nesting success. J. Wildl. Manage. 46:885–893.

TRAVAINI, A., J. A. DONAZAR, O. CEBALLOS, A. FUNES, A. RODRÍGUEZ, J. BUSTAMANTE, M. DELIBES, AND F. HIRALDO. 1994. Nest-site characteristics of four raptor species in the Argentinian Patagonia. Wilson Bull. 106:753–757.

WIGGINS, I. L. 1980. Flora of Baja California. Stanford Univ. Press, Stanford, California.

WILBUR, S. R. 1987. Birds of Baja California. Univ. Calif. Press, Berkeley, California.

ZAR, J. H. 1974. Biostatistical Analysis. Prentice Hall, Inc., Englewood Cliffs, New Jersey.

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