

NESTING PEREGRINE FALCONS IN TEXAS, 1977

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INTRODUCTION

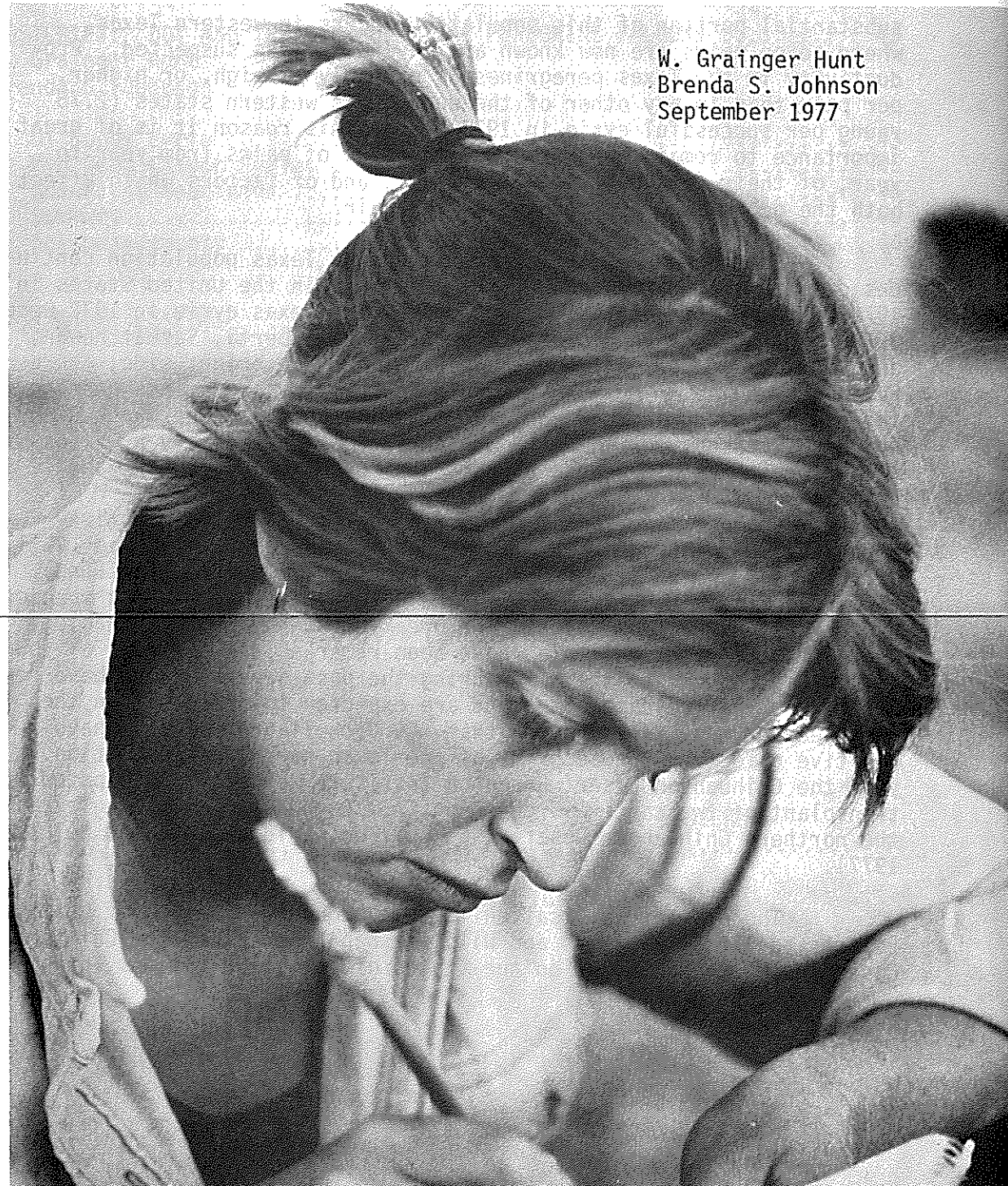
It is clear that the Chihuahuan Desert is one of the last areas in North America, south of Canada, where peregrine falcons (*Falco peregrinus anatum*) continue to breed and produce young. A substantial portion of this population occurs in western Texas, where seven pairs are now known and several others suspected. Productivity in the Texas peregrines is probably as high, or higher, per pair than in any other of the contiguous western states (2.75 young per successful eyrie in 1977). For this reason it is of great importance to remain abreast of the numbers of pairs from year to year, of their reproductive performance, and of factors which affect both the occurrence and success of the pair.

The depressive effect of DDT on the Texas population continues despite the virtual ban of the substance in the United States in 1972. Eggshell fragments collected from one Texas eyrie in 1977 were 25 percent thinner than pre-1947 shells from Alberta, Saskatchewan, and Montana (Anderson and Hickey 1972). On the bright side, there has been an encouraging increase in productivity by peregrines nesting on the Rio Grande during the past two breeding seasons (see pages 3 and 4). While the reasons for this are unclear, there is probably now less DDT pollution in the Rio Grande and its environs than five years ago.

Another important asset to the peregrine is the captive-breeding and reintroduction efforts being conducted by Tom Cade, Bill Burnham, and Jim Weaver of Cornell University (the Peregrine Fund). The project is aimed at restoring the peregrine as a breeding species to the eastern United States. The break-throughs in the technology needed to carry out this plan have been remarkable. A number of young falcons introduced to the wild during the past several years have returned to their release sites and are expected to breed within the next year or two. It is hoped that the Cornell program will have a positive effect on the security of the Texas peregrine population. This year the Chihuahuan Desert Research Institute workers participated in a transplant of two captive-bred young from Cornell to a failing eyrie in the northern Chihuahuan Desert (see Belardo, Fridriksson, and Belardo 1977).

The present publication is the second in a series of yearly reports to the Texas Parks and Wildlife Department from the Chihuahuan Desert Research Institute on the status of peregrine falcons in western

Texas. It represents, in the aggregate, the work of six people (full time) for a total of 364 person-days in the field. The report includes the results of an intensive study of eyries in the Big Bend National Park, the monitoring of other known eyries in Texas, and a search for new eyries in ten mountain ranges.



W. Grainger Hunt
Brenda S. Johnson
September 1977

PEREGRINE FALCONS IN THE BIG BEND NATIONAL PARK:

1977 BREEDING SEASON

By

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Laurie J. Schaetzel

This study, funded by the Texas Parks and Wildlife Department, was designed to observe peregrine behavior, and to record productivity of nesting peregrines in the Big Bend National Park, Brewster County, Texas. The report describes the breeding cycle of the peregrines along the Rio Grande and a search for an historical eyrie in the Chisos Mountains.

This is the first year for the Chihuahuan Desert Research Institute (CDRI) to intensively study peregrine behavior. Information on peregrine productivity in the Big Bend National Park is valuable in formulating an overall evaluation of the status of this endangered species in the Chihuahuan Desert. These observations of behavior will aid in interpreting the status of other wilderness eyries where the amount of information gathered is often limited by the remoteness of the site. Of significance in our study is that two river eyries produced young in 1977, the highest productivity ever recorded for these eyries.

The decline of the peregrine in North America and Great Britain (Hickey 1969, Herman 1971, Ratcliffe 1972, Enderson and Craig 1974, Porter and White 1973, Hunt 1974) has been caused by chlorinated hydrocarbons in the environment (e.g. Ratcliffe 1967, Cade, White and Haugh 1968, Anderson and Hickey 1972, Peakall 1976). There is reason to suspect the Texas peregrines are under similar environmental pressures. Applegate (1970) found high levels of DDT and its metabolites in various species of birds in Big Bend National Park. In the Presidio Basin, 40 miles upstream from Big Bend National Park, seven pounds per acre of DDT was applied to agricultural lands in 1968 (Applegate, Hanselka, and Culley 1971), and the use of DDT there probably continued through 1972 when the substance was virtually banned for use in the United States. The peregrine, at the top of the food chain, was probably contaminated through a diet of insectivorous birds and bats that derive their food from the aquatic environment from irrigated farmlands.

Hunt (1976) feels that, in view of the known rate of contamination, it is reasonable that the river eyries should have failed to produce. Indeed, from 1973 to 1976 only one of eleven river nestings

produced young (nine percent success). This is extremely low compared to the 78 percent success of Chihuahuan Desert mountain eyries.*

STUDY AREAS

We observed peregrine falcons in three river canyons of the Rio Grande and searched for peregrines in the Chisos Mountains in Big Bend National Park.

SANTA ELENA CANYON

One study area is located on the Sierra Ponce-Mesa de Anquilla horst, an uplifted fault block near the southwestern boundary of the park. This fault block is tilted toward the southwest and bounded on the north-east by the Terlingua fault zone. The escarpment, 460 m high, 32 km long, is parallel to the fault zone and overlooks Terlingua Creek. The Rio Grande has carved its way through the massive Lower Cretaceous limestones that make up the fault block to form the 29 km long Santa Elena Canyon.

Giant reed (*Arundo donax*), common reed (*Phragmites communis*), and salt cedar (*Tamarix gallica*) form a dense growth along the river's edge. Willow (*Salix* spp.), mesquite (*Prosopis* spp.), acacia (*Acacia* spp.), tree tobacco (*Nicotiana glauca*), and several cacti dominate the outer reaches of the floodplain. A diverse and abundant bird population is associated with the floodplain belt, and north of this lies a vast expanse of shrub desert containing creosote bush (*Larrea tridentata*), ocotillo (*Fouquieria splendens*), lechuguilla (*Agave lecheguilla*), yucca (*Yucca* spp.), prickly-pear (*Opuntia* spp.), and other cacti. The mesa highlands contain grassland vegetation including sotol (*Dasylirion leiophyllum*), chinograss (*Bouteloua breviseta*), lechuguilla, and a wide variety of yucca and cacti.

MARISCAL CANYON

Mariscal Canyon, another canyon of the Rio Grande, is carved through Mariscal Mountain, a long anticlinal fold (Maxwell 1968). The canyon of exposed massive Lower Cretaceous limestones is 12 km long and 500 m deep.

* Hunt's more recent evaluations find only seven positive failures of river nests during 1973-76.

Numerous hollows in the cliff faces provide excellent nest sites for raptors. The topography in Mariscal Canyon is varied with shear walls, terraced rims and a dissecting cross-canyon breaking the uniformity.

Vegetation inside the canyon is sparse. Sand and silt bars support small colonies of common and giant reed, mesquite, seepwillow (*Baccharis glutinosa*), acacia, and various grasses. The variety and numbers of birds inside the canyon are fewer than are found in the broad floodplains outside the canyon. The slopes of the canyon walls are dominated by an assortment of succulents, primarily false agave (*Hechtia scariosa*), lechuguilla, candelilla (*Euphorbia antisyphilitica*), and prickly-pear, with hairy resurrection plants (*Selaginella pilifesa*) forming a ground cover.

BOQUILLAS CANYON

Our third study area, Boquillas Canyon, which is 35 km long and averages 450-500 m in depth, has also been carved through the same Cretaceous limestones, here exposed in the Sierra Del Carmen. Boquillas has the most varied topography of the three canyons. Sections of the canyon have vertical walls that rise 175-300 m above the river while the remainder consists of long slopes terraced with cliffs that extend several kilometers from the river's edge. Numerous deeply-eroded arroyos enter Boquillas Canyon. Vegetation is similar to that described for Mariscal. Unlike Santa Elena and Mariscal, Boquillas has an extensive interior floodplain. Abundance of birds inside the canyon is much greater than inside the other two canyons (see Appendix I). Grazing occurs all along the river, which limits the growth of vegetation in the floodplains and likely limits the numbers of birds that would otherwise utilize the area.

CHISOS MOUNTAINS

Our fourth study area, the Chisos Mountains, is the southernmost montane area in the United States (Wauer 1973). Elevations exceed 2,390 m. The rock in the Chisos, mainly igneous, includes extensive lava flows, (Casa Grande, South Rim), and intrusions (Vernon Bailey Peak-Pulliam Ridge) that have been uplifted and eroded (Maxwell 1968). Cliffs suitable for peregrines are numerous.

Vegetation varies with altitude. The foothills are primarily a sotol-chinograss association, interspersed with ocotillo, guayacan (*Porlieria angustifolia*), agave, and leatherstem (*Jatropha dioica*).

The pinyon (*Pinus* spp.)-juniper (*Juniperous* spp.)-oak (*Quercus* spp.) woodlands start at the upper edges of the foothills and cover most of the higher peaks and mesas. Arizona cypress (*Cyprusus arizonica*) can be found in a few highland canyons. Cacti, agave, sumac, (*Rhus* spp.), Texas madrone (*Arbutus texana*), and other woodland understory plants are found in the highlands.

Many species of birds nest in the Chisos. As many as 40 bird species pass through during peak migration in spring (species can number more than 80 during migration peaks near the river) (Wauer 1973).

Water is limited in the mountains. A few springs (e.g. Cat-tail Falls) run all year and pools of water in rocky gorges may provide water requirements for the mountain fauna and for peregrines. It is possible that lack of "undisturbed" water is a primary limiting factor for peregrines in the Chisos (see Appendix II, for cliff and eyrie characteristics and Appendix III for nesting raptors in each study area).

METHODS

Research was conducted during the period 22 March through 17 June. A total of 154 researcher-days were spent in the field. We used seven and one-half minute USGS topographical maps to record eyries as well as to determine promising areas where we could search for new eyries in the Chisos Mountains and along the river. We made five trips through both Mariscal and Boquillas Canyons in a canoe. At Santa Elena, making observations involved a hike from the road. For 30 researcher-days we made backpack trips to survey accessible cliffs in the Chisos Mountains, often bushwacking off the trails to gain a high vantage point. Upon sighting historic or prospective nesting cliffs we stopped and often stayed overnight to determine raptor occupancy. Observations were mostly in the mornings and evenings for up to seven hours per sitting, averaging four hours per sitting, occasionally lasting a full day. One to eight days per trip were spent at each peregrine eyrie (average: 3.5 days). We used a 20 and 40 power spotting scope and seven power binoculars. Normally we were able to identify the male and female by noting molted primaries, size difference, and a characteristic orange overwash on the female's breast. It was often difficult to sex the birds at very tall and/or distant cliffs. See Johnson (1976a) for further details regarding methods used by CDRI researchers for peregrine falcon surveys.

RESULTS

BREEDING BEHAVIOR AT EYRIES

For a number of reasons the reproductive behavior of peregrine falcons has become a matter of interest. The peregrine has a complicated ecology, is highly territorial, and its behavior is thought to be affected by the presence of bodily contaminants such as DDT (see Peakall 1976 for review). During extensive eyrie searches conducted by CDRI in the past four years, the researchers have often found it necessary to restrict number of visits at the more remote eyries to one or two per season. It is therefore important to learn to evaluate the different behavioral patterns occurring at various stages in the breeding cycle in order to determine if the parents are incubating, feeding young, and so forth.

I. Santa Elena Canyon

Nesting Chronology

By knowing the date the young flew from the nest we were able to estimate the chronological order of events of the breeding cycle. To determine these dates, we used an average of 33 days incubation period based on the 32-34 day period for Utah peregrines. However, there is controversy on the length of the incubation period; for a complete discussion, see Porter and White (1973). Nelson and Myres (1976) gives a 42 day brooding period for the Peale's falcon, which we also used. Hunt and Johnson (pers. comm.) observed courtship at Santa Elena on 21 February. Eggs were (probably) laid the last week of February, hatched around 28 March, and three young fledged on 8 May. We located the Santa Elena eyrie during the brooding stage; thus, we were not able to observe incubation.

The nesting ledge is located ca. 62 m (measured) below the top of the escarpment. The cliff itself is 186 m (measured) in height and comprises the upper tier of the 460 m (estimated) escarpment. The view from the eyrie, fulfilling the peregrine's requirement for a "gulf of air," is stupendous, commanding many square miles of airspace and floodplain.

The nest site itself was unique in that it consisted of a cave (to the observers' left), where the eggs were laid, connected by a 10-m-long enclosed tunnel to an open ledge about 11 m in length and 1-2 m wide. All of the area described was utilized by the adults and young, and all

was protected by overhanging rock from rain. The nest cave was found to be 1.2 m wide, 1.5 m high, extending 2.8 m into the cliff face, narrowing to 0.6 by 0.9 m in the back. A large pack rat nest was found in the rear of the cave and it contained prey remains from the peregrines' diet, cactus, and other plunder. Parenthetically, we regard the life-style of this pack rat as quite amazing, but not at all enviable. Morning sun shown on the substrate of the nest, but after mid-morning the birds were in deep shade.

Brooding

Parental Attentiveness. During our first observations at Santa Elena 12-16 April, the chicks were about 15 days old. We observed the adults visiting the eyrie twenty times during these days. Visits lasted four minutes to one hour. Twice an adult perched on the edge of the eyrie for about one-half hour. The bird was not brooding but was attentive to the chicks. In addition, twice, an adult remained in the eyrie until dark. We believe that the bird remained there during the night to brood the young.

Late in the brooding stage, from 29 April to 5 May, we did not see the adults in the eyrie except for feedings.

Feeding. During our first observations at Santa Elena the chicks were fed by the adults. Later, when the chicks were 33-38 days old the chicks were 78 percent self-fed (eleven times). In three other cases, the adult remained and fed the young for an average of ten minutes. Enderson, Temple, and Schwartz (1973) found that feeding generally takes ten minutes for Alaskan peregrines. On 3 May a feathered (unplucked) bird was given directly to the young at Santa Elena.

We never saw the nestlings fight over food. In one case, an eyass ran to the adult female who had arrived with food. The eyass grabbed the food and ate while the others looked on.

Nestling Behavior. On 29 April we saw two of the three young peregrines at the entrance of the eyrie for the first time. They were approximately 33 days old. The chicks were downy-grey except for dark feathers outlining the tails and wings. During the next five days the feathers grew rapidly. By 5 May (39 days old) the chicks were over 50 percent feathered. Hal Flanders (pers. comm.) noticed similar growth occurring during the final week of the nestling stage in prairie falcons (*Falco mexicanus*).

The chicks frequently stretched and exercised their wings and were seen in all parts of the eyrie. At the ledge (to the observers' right) they ran down a long sloped rock as they practiced flying. Frank Deckert, park naturalist, (field notes) saw the young preening each other.

Fledging

One male and two female young flew from the Santa Elena eyrie on the morning of 8 May. Their attempts to land on ledges were clumsy and unsuccessful. All three eventually landed on a boulder at the base of the 186 m cliff and resided there for the next four days (Belardo, Fridriksson, and Belardo, notes).

Post Fledging

Steve Belardo, Frid Fridriksson, and Betsy Belardo observed peregrine activity at the Santa Elena site from 8 May through 12 May. The following sections are taken from their notes unless otherwise specified.

Parental Attentiveness. While the fledglings stood on the boulder, the adults appeared to be "checking" on their offspring. For example, the male adult circled above the cliff and then stooped straight down to within six meters of the youngsters. He circled back up and landed on the cliff top. A second time, an adult landed on the boulder and walked down to the ground where the young frequently went to avoid direct sun. Then the adult flew toward the top of the cliff.

Feeding. During observations, 8-12 May, the adults brought food to the chicks on the boulder thirteen times. The male was seen bringing food only once. All three chicks ran to the male. One youngster took the prey from his talons and ran away with it, then the male flew. Two of the young birds peacefully ate together as the female arrived and fed the third. The young birds were fed beak-to-beak five times by the female. Once, when the female brought food to the youngsters one chick tried to pull the food away from her. The adult braced herself, tugged the prey from the young bird and began tearing off pieces, feeding the youngsters herself. The two chicks took turns eating, begging between turns.

The young fed themselves six times. On one occasion two of them had a tug-of-war with the food. The winner turned aside to eat without further interference. At other times siblings approached a chick who had food, whereupon the eater sometimes mantled the food.

Two times a young peregrine flew below the adult male and clumsily took prey from him. One of these prey transfers occurred while the female was feeding the other two young.

How long the parents continued to provide food for the young is not known. After the birds left the boulder it was not possible to determine if or when food was brought except when a food transfer occurred in the air.

Fledgling Behavior. While at the base of the eyrie cliff, the activity of the young was similar to that observed while they were in the eyrie; the young stretched their wings and ran up and down the boulder while flapping. Occasionally they flew 5 to 15 m, but returned to the boulder. They pounced on rocks and tumbled over as if to practice catching prey. Two times they gently preened each other. On two nights, half an hour before dark, the three young huddled together on the boulder. We speculate that they spent the nights together for warmth and protection.

On 11 May, the three young flew from the boulder. One returned and was supplied food from the parents for three more days. The other young were very active, frequently flying with their parents. They commonly perched in huge caves. On 13 and 14 May, all five peregrines, young and adults, were seen flying over the floodplain (Chuck Kowaleski, field notes). We returned to the cliff on 1 and 8 June. The young and adults were still present. The young flew together along the cliff, chasing a turkey vulture (*Cathartes aura*) once. They often flew more than 1.5 km away from the eyrie cliff. The birds stooped, tail chased, and dived at each other almost constantly.

Other Notable Behavior

Perching. The adults had favorite perches on their nesting cliff. Early in brooding they perched in the eyrie doorway and in the connected adjacent hole. Later, when the eyasses were older, the adults rarely perched at or near the eyrie. Instead, they regularly perched at two locations near the top of the nesting cliff. On three occasions, we saw the male perch on a small tree at one ledge for up to 35 minutes; the female perched within three meters of the male twice. After the young flew from the eyrie we did not notice the adults perching repeatedly at any location.

Caching. On 13 April we observed an adult visiting several caves in quick succession, remaining for up to two minutes as if looking for cached food. On 1 May we saw behavior which again indicated that this pair cached food. One of the adults perched for five seconds in a hole adjacent to the eyrie. It flew to the top of the cliff and immediately returned to the chicks with food in its talons. This adult was not observed hunting at the cliff top; thus, we believe the food was obtained from a cache.

II. Mariscal Canyon Eyrie

Nesting Chronology

We were not present for courtship and egg laying in Mariscal and, as with Santa Elena, have worked back from the date the eyasses flew from the nest to determine the approximate nesting chronology. The Mariscal peregrines were probably at their nesting cliff courting by mid-February. The eggs were probably laid during the first week of March and hatched about 8 April. On 19 and 20 May, two male peregrine chicks made their first flight. Their sex was determined by comparing their small size to the adult female during feeding.

Incubation

The Mariscal peregrines shared in incubation duties. In two days of observation we saw two types of incubation switches. In four cases, a peregrine flew to and entered the eyrie hole, followed a few seconds later by a falcon leaving the eyrie and flying to an often-used perch hole. In the second type (two cases) a peregrine first flew from the eyrie to the perch, where it disappeared inside the cavity. Immediately thereafter, a falcon flew from the perch to the eyrie. This may indicate that both incubating and non-incubating adults initiated nest switches. The possibility does exist, however, that some of these observations, instead of being exchanges, were movements of a single bird.

We observed two incubation periods that lasted 3.5 hours and four incubation periods that lasted between 1.75 and 2.8 hours. Both adults were seldom away from the nest simultaneously. Such times occurred only during food passes or incubation exchanges and lasted from ten seconds to five minutes. We were unable to correlate duration of incubation

with a given sex. Enderson, Temple and Schwartz (1973) found the male to incubate one-third of the time in Alaskan peregrines. (Of note is that a 20 hour photo period exists in that region).

Food was brought to the incubating bird two times per day, in the morning and in the evening, during our three day watch of incubation. Exceptions to this were two food passes that occurred only 45 minutes apart on the evening of 25 March. The male brought prey to the female in both transfers.

We saw an adult peregrine entering the eyrie at dusk on 19 March and assume the eggs were incubated by this one bird all night. It would be interesting to know if one sex always incubated at night.

Brooding

We made three trips to the Mariscal eyrie between the times the eggs hatched (ca. 8 April) and the young flew (19-20 May).

Parental Attentiveness. During a full day of observation on a mid-April trip when the chicks were approximately ten days old we never saw the male go to the eyrie. Enderson, Temple, and Schwartz (1973) found that visits by the male at Alaskan nests nearly ceased during and after hatching. The female was in the eyrie six times during the day's observation, staying from 11 to 30 minutes on three occasions.

During our trip of 5-7 May, when the chicks were 27-29 days old, we did not see the adults go to the eyrie except to feed the young. From 17-20 May, shortly before fledging, we saw only two instances of brooding (feeding beak-to-beak?): the male was in the eyrie two minutes and the female, twelve minutes (17 May).

Feeding. On 18 April we observed four food transfers in nine hours of observation. Twice the male passed prey to the female in flight near the eyrie. Two other times the female flew from the eyrie to accept prey from the male who perched up to 500 m away. On this day we saw the female feed her young two times. Both feedings were in the morning, about two hours apart, and lasted eleven and twelve minutes.

Enderson, Temple, and Schwartz (1973) found, that with Alaskan peregrines, no food transfers occurred between adults on the nesting ledge. Twice during 5-7 May we saw the male fly to the eyrie ledge with prey, followed by the female. The male dropped the prey at the eyrie entrance and immediately left, whereupon the female carried prey in to the young and fed them. There was evidence that the young were at least partially feeding themselves by 27 days of age.

When the young falcons were 40-42 days old they were regularly self-feeding. On three occasions peregrines carried prey to the eyrie and immediately left. We saw the eyasses take the prey and eat two times. Twice the adult female stayed with the chicks several minutes after bringing prey, suggesting that the young were still occasionally being fed. Similar to our early May observations, a food transfer occurred on the eyrie ledge on 17 May. The female, on this occasion, followed the male to the eyrie, took the prey, then flew from the nest. The male remained in the eyrie when the female was not present.

During three full days of observations in May, no more than four food transfers were seen per day, though three transfers occurred in less than two hours on the evening of 19 May. In the 1976 observations of Texas peregrine eyries, four prey items were brought to one eyrie in two hours time (Johnson 1976a), and at another eyrie 15 prey exchanges occurred in one day (Sumner Matteson, field notes). This contrasting data leads us to question whether prey transfers unobservable to us may have occurred behind canyon obstructions. Alternatively, the adults might have been caching and picking up prey. The number of young to be fed, the size of prey species, and the energy expended in capturing prey may all influence the number of prey that are needed.

Nestling Description and Behavior. We first saw the two young in the eyrie on 6 and 7 May. The eyasses, 27-29 days old, were downy-grey with dark feathers bordering the trailing edges of their wings and tail. Dark streaking was visible on their breasts, and dark feathers outlined their heads and eyes. The young falcons were at the eyrie entrance when the morning sun shone on them, flapping their wings, stretching, and vocalizing. Neither of the chicks were seen after 0915 on both days.

On 17 May the eyasses were 38-40 days old and appeared fully feathered. From their behavior we expected them to jump from the ledge at any moment. Following are some excerpts from our field notes of 18 and 19 May.

- 18 May 0650 hrs. - Two young birds at entrance of eyrie; looking, flapping.
0807 hrs. - Sun on eyrie, one young stretching wings, flapping, both young then went inside.
0812 hrs. - One young at edge with back facing out, flapping.
0815 to
1000 hrs. - One young is on edge flapping, its body is hanging over the edge and it is about to fall off, but maintains its balance. The young are moving between the inside and the [outer] edge several times a minute. They are flapping most every time they come to the edge.
1230 hrs. - One young at edge. It began to flap and almost fell off ledge.
1230 to
1305 hrs. - Young remained at ledge.

- 1400 hrs. - No young visible for 15 minutes.
 1520 hrs. - First [time] we've seen the young for a long while. They watched the adults while they were flying by. The female flew almost into the eyrie where the two young were, but she stalled in the air and flew on. Immediately after, one young flapped its wings.
 1536 hrs. - They are spending a good deal of time at the edge, flapping their wings.
 1700 to
 1830 hrs. - [Young are] basically not visible but appeared [at edge] occasionally for a short period.
 1900 hrs. - One young at edge, flies back into eyrie many times.
 2100 hrs. - No sightings for 45 minutes - twilight.

19 May 0650 to

- 0735 hrs. - Young are constantly flapping wings [when] near the edge. They frequently go back into [the] eyrie and fly [out] to the edge where they catch the edge with [their] talons. [They] often face the eyrie while at the edge, flapping their wings, falling or losing their balance a little.

In summary, the eyasses (just before flying) were very active in the morning hours and were seen little during the hot afternoon. Their movements in the eyrie were often vigorous. One factor determining when first flight occurs may involve the chicks pushing their limits of flight and coordination within the eyrie until they fall out and at that point they fly*. Another influence may be enticement by the adults. This is illustrated in our notes (above) at 1520 hrs.

First Flights

First flights of the two chicks were 24 hours apart. From our notes:

- 19 May 0805 hrs. - One young flew. Saw it descending in a long 180° spiral, fast-uncoordinated wingflaps. It then landed [clumsily] on a rock [75 m below the eyrie].

The flight was a soaring descent with little control. The fledgling spent the following 24 hours perched mid-way down a large cliff. It moved

* After this writing, Belardo, Fridriksson and Belardo (1977) reported that in another eyrie a young actually lost its balance and fell from the nest. It then flew to a perch where it landed safely.

among several perches and flapped a great deal but made no attempt to fly. The flight of the second chick is described in our notes as follows:

- 20 May 0720 hrs. - Chick in eyrie flew straight across from eyrie. [It] perched for two minutes then [it] flew again (both times flapping all the while, seemed to be in good control) tried to perch above archway over eyrie [it] grabbed rock but there was no good ledge. [It] started sliding off so it flew again... to a pile of rocks against the cliff.

The fledgling of 19 May flew from its perch at the same instant the second eyass made its first flight; one chick's flight may have inspired the other's. Both made controlled flights and managed to perch high on the canyon walls, in contrast to the Santa Elena fledglings who spent four days on the talus below the cliff. The young Mariscal falcons made two or three short flights during the remainder of 20 May.

Post Fledging

Behavior of Flying Young. On 21 May the fledglings made numerous flights. They soared less frequently than the adults and made shorter flights, 200-600 m long. The fledglings were unskilled in choosing perch sites, often attempting to land on steep rock, resulting in their sliding off.

The chicks sometimes vocalized before and during feedings, probably depending on their degree of hunger. The most often used call was a high-pitched, tremulous "ch-e-e-e" or "kr-e-e-e"; a related "chip" or "ee-chip" was heard a few times but (we saw no behavior with which to associate the call). Several times we may have heard the chicks wailing similarly to the calls of the adults.

Feeding of Fledged Young. On 19 May both chicks received prey 22 minutes before the first chick flew. The chick remaining in the eyrie was brought food three other times that day, while the second youngster, who perched below the eyrie received no more food.

The female adult carried prey to the eyrie on 20 May, after the second young had flown. Seeing that no young were present, she then flew to one of the fledglings and fed him, beak-to-beak, eating some of the prey herself. When the fledgling was satisfied, the adult carried the prey remains away. The unfed youngster followed her, but perched short of where she had flown out of sight. Thirty minutes later the female brought a fully-feathered bird to the unfed fledgling. She left immediately; the chick plucked and ate the prey.

On 21 May a similar feeding occurred. The female received prey from the male. She flew to the eyrie, possibly checking to see if young were present. She then flew to one fledgling and gave it the prey. A moment later she flew to the second youngster and, as if acknowledging the chick's need for food, she immediately flew, returning three minutes later with prey. Because the female obtained prey in such a short period of time, we feel she must have utilized a cache site (see page 9 on caching).

Teaching the Young. On 21 May we first observed the parent birds flying with the young. In one instance, the female adult circled behind a fledgling, tail chasing the young bird. In another example, the female carried prey in her talons while she made passes at a fledgling. She plucked at the prey as she circled, showering the area with feathers. We feel the female was enticing the immature falcon to take prey in the air. The young bird followed the female, passing closely under her, but did not take the prey. The female gave the prey to the youngster when it perched.

Other Notable Behavior

Hole Hopping. It has been suggested (Whitacre 1976, Grainger Hunt and Brenda Johnson, pers. comm.) that "hole hopping," that is, flying from hole to hole by peregrine falcons during the nesting cycle is indicative of a broken clutch.

We saw four examples of one of the adult peregrines in Mariscal Canyon flying in and out of a series of holes within the nesting territory where young were present. On 18 April the adult female soared 90 m east of the eyrie and perched for 30 seconds on a small ledge. She flew to another ledge and perched for 30 seconds. This occurred four more times, all within an area of five meters. The female remained a few minutes then soared to the eyrie. On two other occasions, the "hole hopping" was followed by the adult flying to the eyrie. No vocalizations accompanied the "hole hopping" behavior by the Mariscal peregrines. Associated with the above behavior, the adult female carried objects from the eyrie six different times. Two of these objects were fully-feathered prey which had been brought to the young and apparently not accepted. We assume the other objects to be prey remains. On 19 May the Mariscal female flew to and from the eyrie with a fully-feathered bird. She carried the prey into a hole that we earlier associated with "hole hopping" and left without it, obviously caching the food. On 19 April the female flew from the eyrie to the same hole and back to the eyrie. On 5 May the male made five passes at the same hole, seemingly trying to grab something; he then stooped into the eyrie. The peregrines appeared to be collecting prey from cache in these last two examples.

On 20 May the female flew to three ledges within 50 m of each other. She stayed 30 seconds at the second ledge. On the third ledge she began eating prey that she found there. This is good indication that the "hole hopping" we observed was an adult looking for cached prey on closely situated ledges. The adults utilized at least three cache sites.

Wayne Nelson (pers. comm.) told us that during courtship a female peregrine goes from ledge to ledge, "hole hopping," looking for prospective scrapes. The ledges visited are usually spaced further apart and the times spent at each ledge are greater than in food caching.

Vocalizations, notably "ee-chip," usually accompany courtship behavior. Such behavior following incubation or late in the nesting cycle probably does imply that a clutch is broken, as was possibly the case in Boquillas Canyon (see page 17). In summary, "hole hopping" may occur in a variety of circumstances, not just those involving broken clutches.

Perching. Peregrines spend considerable time each day perching within their territory. During incubation only three perches were used with regularity. One perch overlooked the eyrie from 30 meters. The adults frequently used this perch before and after nest exchanges. A second perch was used several times as a feeding post.

With the onset of brooding several new perches were identified. The female often perched within 30-60 m of the eyrie; the male perched at a greater distance from the eyrie, sometimes as far as 0.5 km away. These observations suggest that the male defends the outer reaches of the territory while the female defends the core. Both adults frequently perched for periods of up to 2.5 hrs. Only twice in our observations (excluding food transfers) did both adults perch side by side.

Four times at dusk we saw the male fly across the canyon from the eyrie and enter a heavily whitewashed cavity. We believe this was his night roost. We never saw him leave at dawn and suspect he flew very early. Twice during brooding we saw the female fly toward the eyrie at dusk. We assume she spent her nights in or near the eyrie.

Bathing. Bathing is an important but seldom-observed behavior in wild peregrines (Cade 1960, see Belardo, Fridriksson, and Belardo 1977). On 7 May we found peregrine tracks at the river's edge 2.2 km downstream from the Mariscal eyrie. The tracks were on a shallow sandbar and led into the water. On 17 May at 1700 hours we saw the adult female standing at the river's edge ca. 0.7 km upstream of the eyrie. She flew at our approach. Her tracks, leading into the water, plus numerous sets of old tracks, confirm this shallow gravel and sandbar to be a commonly used bathing site. Cade (1960) speculates that gently sloping sand or gravel bars for bathing may be a habitat requirement for Alaskan peregrines.

Such sites are common along the Rio Grande and are always near Chihuahuan Desert river eyries (Hunt, Johnson, and Whitacre 1976).

III. Boquillas Canyon Eyrie

Observations

We made five trips through Boquillas Canyon in 1977. Active eyries had been seen in the canyon in 1974 and 1976, and two young were produced in 1976 (Johnson 1976b). This year the Boquillas eyrie seems to have failed.

Two peregrines (age class undetermined) frequented the 1976 nesting cliff during our first trip through the canyon, 28-30 March, 1977. We saw no indications of nesting behavior, e.g. incubation or food transfers. The peregrines were not attentive to any hole or ledge. One falcon flew to six different ledges, never returning to the same one. Near the cliff at noon on 28 March we saw two peregrines circling within 10 m of each other. One of these falcons flew to two holes and a ledge within 30 seconds while calling "ee-chip" (a courting call) several times. Meanwhile the other falcon flew out of sight. Vocalizations were frequent and lasted up to 22 minutes.

Three weeks later (20-23 April) we saw a single peregrine at the cliff. Similar to observations of the earlier trip, the bird perched at seven different holes and ledges for one to five minutes. Vocalization was much more frequent than in late March. On 20 April, from 1000 to 1600 hrs. we heard "ee-chips" and "krees" every 15 minutes. The peregrine defended the territory against turkey vultures five times, striking and tearing feathers from the back of one vulture. On 23 April, at 0545 hrs. (before dawn) we woke to "krees" of two peregrines. One seemed to be directly over our camp; the other, 0.25 km away at the cliff.

A peregrine was seen in the vicinity of the cliff on 8 May by Jim Liles, chief ranger of the Big Bend National Park, and by ourselves in the evening of 11 May. No peregrines were seen at the site on the last two trips in late May and mid-June, 1977.

Interpretation

The sightings of two peregrines flying together, the territorial defense of one, and the simultaneous vocalizations of two peregrines indicate that the cliff was being occupied by a pair from late March through

April. The peregrine at the cliff on 28 March vocalized "ee-chip" while perching at several ledges. During 20-23 April a peregrine at the cliff acted similarly except that vocalizations were more frequent. Joseph A. Hagar (in Bent 1938) states that "...several elements of courtship [are] the flight display, the shelf display, the coaxing 'wichew' note..." (the "wichew" is what we call "ee-chip"). Wayne Nelson (pers. comm.) told us that "ee-chip" vocalizations, while at different ledges, denote courtship. Wayne Nelson (pers. comm.) supports our belief that the Boquillas peregrines were courting. Furthermore, Nelson's observations off the coast of British Columbia (letter, 27 July 1977) indicate that elements of courtship behavior may be associated with nest failure:

"...one pair lost a week old youngster and went into some courtship behavior. Another pair lost their 2 young—died on ledge at about 35 days (biocides, possibly). They also did some ledge displaying—both cases involved single birds in ledge displays as I recall."

It is likely that the Boquillas pair attempted to nest and that nest failure occurred prior to our first visit (28 March). Similar to Nelson's observations, courtship behavior suggests an attempt to recycle. The vocalization and ledge displaying we observed three weeks later (20 April) may indicate that the birds established another nest which failed. While we cannot be sure that a second nesting did occur, we feel sure that the peregrines made at least one unsuccessful nesting attempt this year.

CHISOS MOUNTAINS

Nesting peregrine falcons have been recorded in the Chisos Mountains as early as 1901 by Vernon Bailey and H.C. Oberholser and in 1935 by G.M. Sutton (Oberholser and Kincaid 1974, Van Tyne and Sutton 1939, see review in Johnson 1976a). Recent observations indicate that peregrines may still be residing in the Chisos. Roland Wauer (Wauer 1973) reported the last known peregrine productivity in 1967. He saw two young and an adult. Johnson (1976a) reported some 41 person-days spent in the Chisos Mountains looking for peregrines in spring 1976. Although two individuals were seen (not together), no eyrie was found.

We observed only one peregrine in the Chisos Mountains this year. While we were on top of the east side of Toll Mountain, an adult flew by five times at eye level. As the falcon passed, it gazed at us.

We received two reports of sightings of falcons from Park Headquarters. On 29 April and 1 May hikers reported seeing falcons flying

near Toll Mountain and Casa Grande. Richard Horton, park employee, reported a peregrine near Boot Springs on 19 May.

This year's sightings indicate that at least one adult peregrine may reside in the Chisos Mountains. It is possible that a pair may be nesting on inaccessible cliffs where established hiking trails do not exist, i.e. Pulliam Ridge, Crown Mountain, Lost Mine Peak, Ward Mountain, and Cattail Canyon.

OTHER PEREGRINE SIGHTINGS

Peregrine falcons were seen at locations 2.4 to 15.2 km away from known nesting cliffs along the river. The following is an account and discussion of each sighting.

On 23 May, Barbara Pettit, park interpreter, and George Howarth, park ranger, (pers. comm.), saw two adult falcons and an immature falcon at a river cliff. They reported that both adults attacked a black hawk (*Buteogallus anthracinus*), apparently in territorial defense. Tom Connors (pers. comm.), an experienced peregrine observer, identified a male and a female peregrine at the same location on 4 June. We believe these sightings constitute the finding of a new eyrie in the Big Bend National Park. For purposes of concealing its location in discussion, we code-named the eyrie "Lechuguilla."

In another area along the river we observed a peregrine soaring with a red-tailed hawk (*Buteo jamaicensis*). The 2-km-long cliffs near the sighting are tall and isolated and may indeed house peregrines. The floodplain there is a good source for avian prey.

Peregrines were seen four times over the floodplain near Rio Grande Village in the Big Bend National Park. The dates of the sightings were 8 May (2 sightings), 11 May, and 12 June. One was identified as an immature. The sex and age class of the other three were not determined. We cannot assume that these birds were from Boquillas Canyon, although such was quite possible. There is a rich supply of prey in this floodplain which must attract hunting peregrines.

At the end of a river canyon, on 15 May, a single peregrine stooped on two common ravens (*Corvus corax*) and two turkey vultures near

a cliff. The location is far from any known eyrie. At the same location on 25 May, two vocalizing peregrines were seen flying together. It is possible that these sightings were of a "new" pair, but such needs confirmation.

INTERACTIONS WITH OTHER RAPTORS

Turkey vultures were the most abundant raptorial birds in our study areas and the interactions were most numerous between this species and the peregrine. Nineteen attacks were observed, the peregrine actually striking the vulture in six attacks. Twice the peregrines tore feathers from the backs of the vultures. In contrast to this aggressive behavior, we also observed occasions of apparent compatibility. Four times turkey vultures flew within 15-20 m of the eyrie and were ignored by the peregrines. In one of these passes a peregrine perching in the eyrie entrance watched the vulture fly by. On four occasions one or both adult peregrines (showing no hostility) soared amidst a flock of turkey vultures, and once the pair of falcons hunted in and around a flock of vultures, perhaps hiding themselves among the vultures to surprise prey.

The stimulus causing peregrines to attack turkey vultures were often undetectable. We cite an example from our notes of 5 May:

2010 hrs. - Female adult ... landed 2-3 m [to the] right of [the] male. She remained 3-4 minutes, then took flight into a flock of six turkey vultures, chasing them all around. She struck several. It appeared she may have singled one or two birds out for she passed several without attacking them. It is interesting that while the male was perched alone, many turkey vultures passed him and he looked at them without going after them. The female is very territorial.

We can only speculate why the falcons chase some turkey vultures and not others. Aplomado falcons in Mexico often defend their food caches (John Langford and Dean Hector, pers. comm.) and it is reasonable that peregrines do also. The falcons may defend against a vulture flying toward (or looking at) cached prey. We have two records of a turkey vulture eating prey remains at a site where a peregrine falcon had recently fed. This is a good indication that turkey vultures would be attracted to cached prey lying on a ledge.

The fledgling peregrines at Santa Elena were first seen attacking turkey vultures on 2 June, 25 days after first flight. The fledglings were very active in tail-chasing and stooping on each other. Their flights at turkey vultures appeared to be no more than an extension of this activity. One young falcon left its siblings and flew 600 to 800 m out over the floodplain to attack a turkey vulture. The adults never traveled such a distance to make an attack.

Black vultures (*Coragyps atratus*) were seen in peregrine territories numerous times. Three times they were attacked by adults, and in two of these attacks, were struck five to six times. As with turkey vultures, some black vultures were attacked while others were not. Defense of a food cache may explain this selective aggression. We wonder if the peregrines may respond aggressively to subtle idiosyncrasies in the behavior of vultures or perhaps attack them in displacement behavior arising from other annoyances.

Common ravens have much the same habitat requirements as peregrines (Ratcliffe 1962) and were the second most abundantly observed raptorial birds of the Big Bend. Numerous individuals and pairs flew near peregrine territories but none were attacked by the resident peregrines.

We saw a peregrine stooping ten or more times on a nesting pair of ravens and two turkey vultures but this occurred over the cliff in which the ravens nested. Peregrines and ravens in England are known to nest simultaneously on the same cliff, aggressive interactions not being uncommon (Ratcliffe 1962).

Our most interesting accounts of territoriality occurred between peregrines and red-tailed hawks. Red-tailed hawks were seen copulating and performing nuptial flights 400 m from the Santa Elena peregrines. We presume the red-tails nested in the vicinity. They soared along the rim adjacent to or above the peregrine territory 16 times, never involving interaction with the peregrines.

One-thousand meters beyond the above-mentioned red-tailed hawk territory was a second red-tailed hawk territory. A peregrine passed through the territory on 10 April. From our notes:

1825 hrs. - [Peregrine] falcon soaring SE above rim. Red-tail soaring [above falcon]. As falcon approached red-tail, the latter folded its wings and stooped at the falcon, diving 100 m or more. The falcon was not seen after the stoop. The red-tail soared NW to vicinity above its eyrie.

Bond (1946) stated that the peregrine was the aggressor in all examples that he knew of of peregrine encounters with other raptors, with the exception of one example reported by Dixon in 1936 in which golden eagles (*Aquila chrysaetos*) drove off the peregrines. In the instance we

witnessed, the red-tailed hawk was nesting and was obviously defending its territory. The slogan "the home team always wins" gives meaning to a territorial principle illustrated here. At a later date the peregrine and red-tailed hawks were compatibly soaring together over the floodplains .5 km from the red-tailed hawk eyrie.

In Mariscal Canyon a red-tailed hawk passed within 100 m of the eyrie. Both male and female peregrines attacked the hawk in great fury, "keking" throughout the attack. They stooped on the red-tailed hawk eight or so times but never struck it. Each time the peregrines stooped, the red-tailed hawk turned upside down and bared its talons to the attacking birds. Both red-tailed hawks, golden eagles, and great horned owls (*Bubo virginianus*) are known to prey on large falcons when the falcons are at a disadvantage (e.g. on the ground) (Grainger Hunt, pers. comm.).

On 3 May an osprey (*Pandion haliaetus*) passed along the rim above the Santa Elena eyrie. An adult peregrine flew from the cliff and struck the osprey. The osprey turned away and retreated, whereby the peregrine returned to a perch. The osprey flew a short distance upwind of the cliff, then turned and soared swiftly past the eyrie cliff. As it passed over the peregrine, the latter looked up at the osprey, jumped from its perch and launched a swift attack. Two stoops were made at the osprey but no contact was made. The osprey tucked its wings close to its body and swiftly disappeared from sight. The peregrine again returned to its perch.

An immature golden eagle passed the Santa Elena eyrie on 13 May (Chuck Kowaleski, field notes), after the young had flown. An adult peregrine attacked the eagle, striking it twice on the back. The peregrine then chased the eagle 1,000 m or more from the eyrie. This is the longest distance we observed an adult peregrine chasing an intruder. Most attacks were under 300 m from the eyrie.

In Mariscal Canyon, our only study site where the adults could be easily sexed, the female was far more aggressive toward other raptors than the male. Of 22 attacks observed, only two were credited to the male. The pair cooperated in two or three attacks. All of these attacks occurred during the brooding stage. No attacks were seen in our three days of watching during incubation.

HUNTING

We observed the river peregrines hunting in the canyons and over the floodplains. Only three of nineteen observations (15.8 percent) of attempts to seize prey were successful. Rudebeck (1951) observed a 7.5 percent success rate in hunting peregrine falcons.

Hunting strategies of the peregrine in the Alaskan tundra consisted of "low, direct ground-effect flight, high direct flight, and soaring flight" (White, unpub. manuscript). In Sweden, almost all hunts were a variety of the stooping type (Rudebeck 1951). Hunt, Rogers, and Slowe (1975) describe a number of different hunting strategies employed by Arctic peregrines migrating along the Texas coast. Almost all of our sightings of peregrine attempts to catch prey involved stooping, but most of our observations were in the vertical canyons.

Examples of different modes of hunting seen at Santa Elena or Mariscal eyries follow:

1. 18 April, 1920 hrs. The peregrine pair soared among 12-15 turkey vultures. The female left the group and rapidly flew straight to the canyon wall. She made an unsuccessful attempt to catch a swallow. We observed this phenomenon of peregrines soaring with vultures a few other times. We feel that this is a way for the hunting peregrine to be less conspicuous to its prey.

2. 15 April, 0720 hrs. A peregrine flew along the rim of the cliff. The falcon turned 180° and suddenly tucked its wings and stooped towards a group of ten white-winged doves (*Zenaida asiatica*) over the floodplain. En route, it made one attempt to seize a small bird, but missed. Without hesitation it re-established the 45° angle stoop. The peregrine traveled approximately 0.5 km. As it flew into the flock it struck one of the doves. The dove fell and the peregrine turned and retrieved the prey before it fell into the vegetation.

3. 6 May, 1245 hrs. The female flew toward the eyrie. Instead of entering the eyrie she flew above it and briefly landed on a ledge below an overhang. A passerine flew off the same ledge. The peregrine chased after the small bird, made one attempt to seize it, then continued to chase it without further efforts to catch the bird.

4. 17 May, 2047 hrs. The female flew up against the canyon wall and attempted to pick something off the rock. Then she did a series of sharp turns. She was trying to catch a bat. We could not determine if she caught it.

5. 3 April, 0945 hrs. Cooperative hunting (from field notes): *Two peregrines [the pair] soaring above the [nesting] cliff. They soar and gain elevation. They slowly soar down the cliff—the male first, followed by the female. Then the male turned towards the floodplain in a stoop and [then] came out of it, [the stoop] (possible attempt to catch a bird). They regained elevation—both birds together now. The male and female flew over the floodplain. The male did a fast direct, vertical stoop,*

followed immediately by the female. The male swooped [upward] at the end of the stoop. I saw the bird it attempted to catch, but missed. [Then] the female caught the same bird! They flew along the lower rim below the [nesting] cliff, gained elevation. The female flew to the eyrie and landed; she walked back [inside]. I could see a chick flap its wings as it ran towards the female with prey. She left in ten seconds.

6. 28 March, 1850 hrs. A peregrine flew over the river from the Texas canyon wall. From above and behind, it rapidly approached a swallow sized bird. The first attempt to seize it was unsuccessful, but the falcon turned and repeated its attack and grabbed the bird in its talons. The falcon soared down to a boulder on a talus slope with its prey.

An unidentified lizard was brought to the fledged young at the Santa Elena eyrie (Belardo, Belardo, and Fridriksson, field notes). Johnson (1976) reported that an adult male peregrine nesting in Guadalupe Mountains National Park caught a Chihuahuan whiptail lizard (*Cnemidophorus exanquis*). We noticed lizards crawling at the entrance of the Mariscal eyrie.

The prey of the peregrine in the Big Bend and other parts of West Texas are covered in another section of this report (see page 31).

DISCUSSION

FOOD NICHE AND HABITAT REQUIREMENTS

The Big Bend National Park appears to have a vast number of "prime nesting cliffs," yet this region has a relatively small density of peregrines compared to pre-1947 populations in areas of cliffy habitat and more temperate climates. Bond (1946) found the populations of peregrines in the inter-mountain area to be primarily limited by climate and water, and to some extent, food supply. Before the decline of the Utah peregrine, Porter and White (1973) found both adequate food supply and large cliffs to be requisites for peregrines. The food supply in all cases was associated with a marsh or stream.

It is likely that the peregrine in Big Bend is limited to the Rio Grande canyons and the Chisos Mountains; the only areas which fulfill peregrine habitat requirements of water, abundance of prey species, and suitable nesting cliffs. A possible limitation in the Chisos Mountains is inadequate water caused by human alteration and disturbance of permanent water supplies.

Hunt (1976) feels the cliff environment of the mountain peregrine is an important element in the food niche of the bird, providing an expanse of air in which it captures prey isolated from cover. Indeed, we observed peregrines hunting in the airspace around their cliffs, but we feel that the floodplains outside of the canyon may also play an important role in providing prey for the peregrine. Inside both Santa Elena and Mariscal canyons, the walls rise nearly vertically from the river and only a few pockets of floodplain vegetation exist. Except for bats, swallows, and swifts, the numbers of potential prey species there are low.

Peregrines of Utah have been found to prefer cliffs with northern and eastern exposures (Porter and White 1973). Ratcliffe (1962) stated that:

"Varying opinions have been expressed on this subject, asserting that the birds prefer a site facing north and east either to receive morning sunlight or conversely, to give shade during hot weather. ...directional preference depends entirely upon the circumstance that in many regions most suitable cliffs happen to face between north and east."

Johnson (1976a) found no directional preference for peregrine eyries in western Texas. One eyrie in her 1976 sample faced due west with no protective overhang to shade the chicks.

The eyries of Santa Elena and Mariscal canyons received sunlight for two to three morning hours and were shaded the remainder of each day by an overhang. The north-facing Boquillas cliff received less than an hour of morning sun. Wayne Nelson (pers. comm.) stated that during courtship, the female peregrine spends considerable time looking at potential scrape sites, and probably bases her selection on requirements of shade, as well as other needs. Mark Hitchcock (pers. comm.) informed us that in all eyries he observed in Mexico, the eyrie was shaded from sunlight a majority of the day either by directional exposure or by a protective overhang. More research is needed to determine if chosen cliff or eyrie exposures are functions of shade requirements. Sunlight may be important in stimulating vitamin production in the eyasses and in killing parasites (Grainger Hunt, pers. comm.). Wind currents may also be a factor in eyrie selection, influencing flight to and from the eyrie and possibly affecting fledgling mortality (see Johnson 1976a). Finally, eyries at lower altitudes (as in Big Bend National Park) may require more shading than cooler mountain sites.

HUMAN DISTURBANCES

Peregrines do not seem to be disturbed by activity below their cliffs but "frequent or prolonged visits by humans to the tops of an escarpment...may interrupt the breeding cycle and in some cases cause actual desertion of the eyrie" (Hickey 1942).

Many cliffs in the Chisos Mountains seem to be suitable for nesting peregrines (see Johnson 1976a for review). Hiking trails may in some cases discourage peregrines from nesting, especially the heavy hiking traffic of Easter time which coincides with the peregrine incubation period.

Human disturbance in the river canyons seems to be minimal. Rafters and canoeists usually spend most of their time in their boats. However, some of the river floaters are not harmless. Within two days we saw two parties of four and six men rafting in Boquillas Canyon with guns. We heard the first party shooting downstream from our camp in the evening. The next day we saw the second party shooting in the air at turkey vultures. We asked them to stop shooting, to which they complied only briefly. As they rounded a corner they all looked at the cliff as a peregrine started to "kree." Once they were out of sight around the corner they resumed shooting. Then we saw the peregrine over the river, where they were shooting. It continued to "kree" as it flew and landed on the cliff.

COMPARISON OF FLEDGING DATES

While peregrine pairs and/or nests were seen during the 1973-1975 surveys of the river, no young were seen. However, in 1976 a pair produced two young in Boquillas Canyon (Johnson 1976a). This year two river eyries produced a total of five young. A third eyrie failed to produce.

The chicks left the nests in early and mid-May this year. This is 23-25 days earlier than the approximate fledging dates (between 12-27 June) in Boquillas Canyon last year. We have no other river fledging dates for comparison since no young have been recorded on the river before 1976.

Over the past two years the eyasses of the Texas mountain eyries flew at an average date of 12 June (Johnson 1976a). The 1977 river peregrines flew a month earlier than the 1976 and 1977 mountain peregrines of the northern and eastern Chihuahuan Desert. Grainger Hunt (pers. comm.) suggested that the reason for the difference may be due to unseasonably heavy rains in the Big Bend National Park in December of 1976. The precipitation could have caused plants to seed early this year, providing food for, and allowing early nesting of principle peregrine prey (e.g. white-winged and mourning doves (*Zenaidura macroura*)). Hunt feels that peregrines may "key-in" on hormones produced by nesting prey species, or female peregrines may respond to increased numbers of prey transfers from males, etc.; thus, early nesting of prey may stimulate the reproductive cycle in the peregrine.

Our observations were substantiated this year by Francis Williams (pers. comm.), who regularly makes censuses of birds near Midland, Texas. She stated that there were fewer birds seen during this year's spring censuses and that there was no obvious peak migration. For example, she saw only one painted bunting (*Passerina ciris*) on surveys this year compared to a normal 20 in previous years. Francis believed the birds were able to migrate and nest earlier; thus, the regular censusing dates may have actually been "too late" this year. She attributes this phenomenon to the spring weather which was consistently smooth, that is, there were no big weather systems, fronts or late freezes. This allowed for the vegetation and insects to progress to maturity without interruption and did not delay the migratory birds.

Finally, Grainger Hunt (pers. comm.) suggests there may be a local adaptation or temperature thresholds for breeding early at hot climates and low elevations. If the fledging dates for 1977 river eyries are normal, the late fledging date for the 1976 Boquillas peregrines indicates that they broke their first clutch.

RECOMMENDATIONS

Our observations this year led us to the following recommendations for next year's peregrine study:

1. A winter survey should be conducted to determine if peregrines reside at or near their eyries in the Big Bend.
2. Studies should be continued on river eyries in Big Bend National Park, beginning in mid-February, to observe and determine the beginning of the breeding cycle and to obtain more behavioral information. All eyries should be closely monitored to record nest success or failure.
3. Peregrine sightings in the "new" locations discussed above strongly indicate the presence of new eyries. These should be examined next year. We continue to suspect a peregrine pair in the Chisos Mountains, as did Johnson (1976a). We recommend the use of helicopters for surveying distant or inaccessible cliffs in the Big Bend and lower canyons.
4. Studies of pesticides should be updated in Big Bend National Park to be compared with previous work by Applegate (1970). Applegate sampled soil, flora, and fauna from various areas in and near the Park. He found the Chisos Basin, Boquillas and Lajitas to have significant DDT and metabolite levels. For example, at Boquillas,

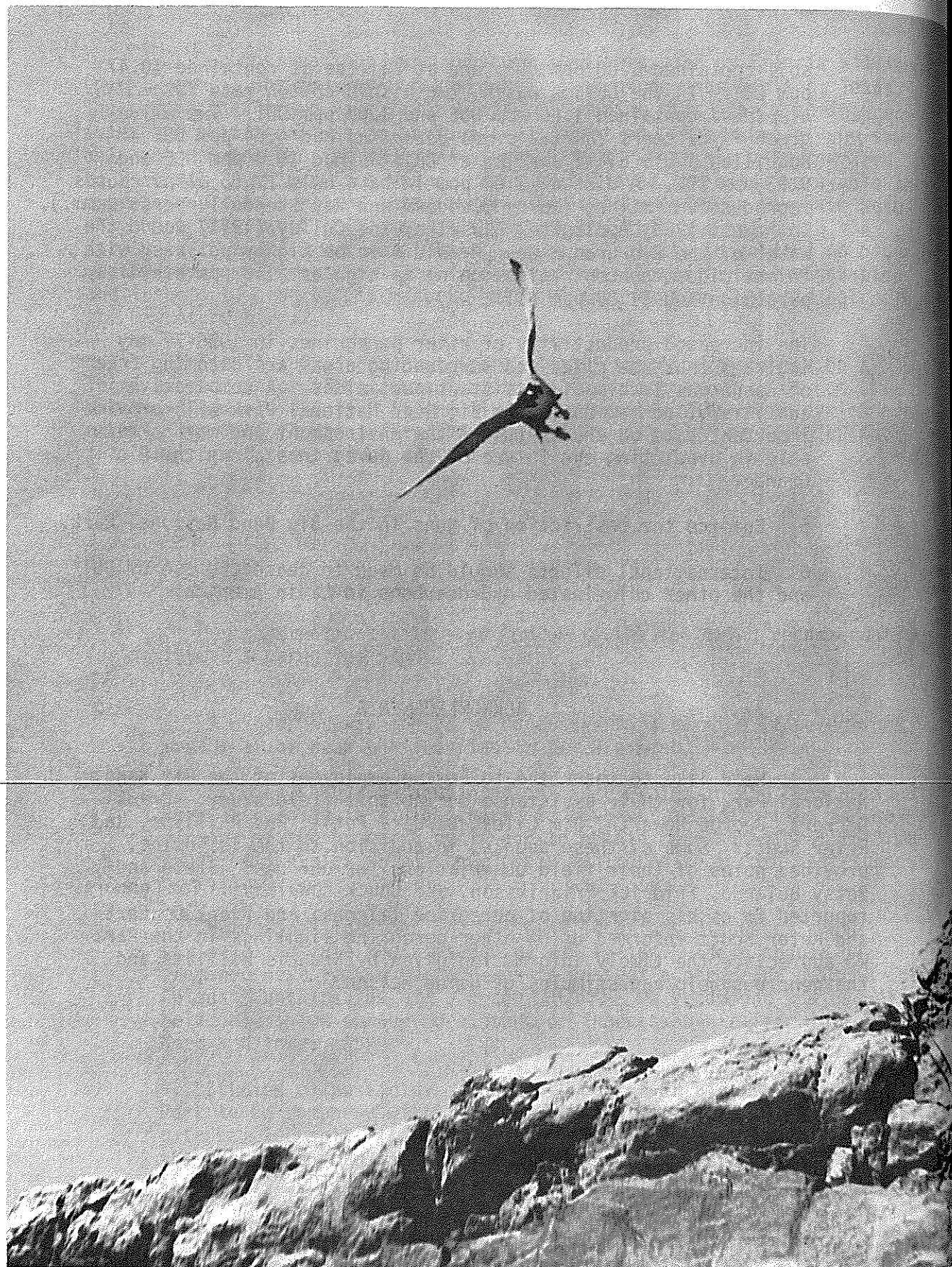
soil contained 1.00 ppm DDE, and at Lajitas it contained 10.47 ppm DDT. In the Chisos Basin, two hispid cotton rats (*Sigmodon hispidus*) contained 1.66 ppm DDE and 1.00 ppm DDT. Two olive-green flycatchers (*Nuttallornis borealis*) had 4.64 ppm DDE at Boquillas and a cliff swallow at Lajitas had 10.8 ppm DDE and 9.93 ppm TDE. A diet of 3.00 ppm in barn owls (*Tyto alba*) causes reproductive failure (Harry Olendorf and Ray Stendall, pers. comm.). In August 1965, Applegate, Hanselka, and Culley (1971) found the water of the Rio Grande near Presidio to be highly polluted with insecticides, concentrations being as high as 21.0 ppm ethyl parathion and 11.00 ppm DDT.

The increased productivity of river peregrines in 1976-77 may indicate that the river and surrounding areas are becoming free of dangerous levels of persistent pesticides. A comparative analysis of contamination in Big Bend National Park will provide important data on the status of the environment and may be valuable in predicting the future of the peregrines along the Rio Grande.

5. Enforce the restriction of guns in the Big Bend National Park.
6. International efforts should be made to cease the use of DDT and the other chlorinated hydrocarbons in Latin America.

ACKNOWLEDGMENTS

We'd like to thank the following employees of the Big Bend National Park for their assistance during this field study: Frank Deckert, George Howarth, Jim Liles, Barbara Petit, Bud Phillips, and Peter Scott. Some of these people, in addition to the following, provided notes of their field observations for our use: Steve and Betsy Belardo, Fridrick Fridriksson, and Chuck Kowaleski. Tom Connors reported to us his sighting of peregrine falcons, and Frank Deckert and Peter Scott informed us of other peregrine sightings in the Park. We appreciate the timely information given by Francis Williams and the generous help and stimulus of Wayne Nelson.



TEXAS PEREGRINE EYRIE SEARCH, 1977

By

Charles T. Kowaleski
Victor R. Wade

This field study, funded by the Texas Parks and Wildlife Department, was designed as a survey to locate new peregrine falcon (*Falco peregrinus anatum*) eyries and to attempt to relocate several historic eyries in western Texas. Two two-man teams (Team A and Team B) spent a total of 170 researcher-days in the field between 25 April and 18 June 1977. The teams traveled 8,226 kilometers and checked 126 cliffs in six mountain ranges in Texas. These included the Davis, Guadalupe, Chinati, and Eagle Mountains, and the Sierra Diablo and Sierra Vieja. Raptors seen during the study included eleven peregrine falcons, forty-two red-tailed hawks (*Buteo jamaicensis*), nineteen prairie falcons (*Falco mexicanus*), fifteen golden eagles (*Aquila chrysaetos*), fourteen American kestrels (*Falco sparverius*), nine Swainson's hawks (*Buteo swainsoni*), two great horned owls (*Bubo virginianus*), nine ravens (*Corvus corax*), and one burrowing owl (*Speotyto cunicularia*).

The peregrine falcon is an important part of the Chihuahuan Desert ecosystem. Not only is it a top-level carnivore that has likely shaped the evolution of numerous kinds of birds, but it is also an important indicator species showing rapid decline under pressures of environmental pollution by organochlorines (Reichel, Locke, and Prouty 1974, Ratcliffe 1972, Blus and others 1975, Walker and others 1973, Peakall and others 1975). As such, this species needs to be carefully monitored so that hidden but significant environmental changes may be detected and proper action taken.

The authors would like to thank the National Park Service for its cooperation, especially Gary Ahlstrand, Ann Farrel, Ron Kerbo, Gary King, and Roger Riesch. Thanks go to Dr. Ross Maxwell for furnishing information on the geology of the study areas, Mr. and Mrs. Delbert Mooney for their hospitality, and the following landowners or their managers who have cooperated by allowing us to survey the lands in their charge: Moody Bennett, Frosty Bowers, Cletis Davis, J.L. Douthit, Chuck Kierce, Tommy Lara, Wayne McBee, Tom Moore, Nelson Puett, Mack Spraul, and Buba Whitehead.

We would also like to thank John and Laurie Egbert, Lee York, and Roger Slothower for notes on their observations at the Ol' Buddy eyrie, and Steve Belardo, Fridrick Fridriksson, and Burnell Hill for their cliff work to collect prey remains. Lee York and John Melton assisted in the field work throughout most of the project, and their hard work is gratefully acknowledged.

METHODS AND MATERIALS

Aerial reconnaissance of the large cliffs of western Texas was made previously using a light plane and a helicopter (see Hunt 1974, 1975, Johnson 1976a). Likely appearing cliff areas were then surveyed from the ground in one of two ways. The first method, and the one most preferred, was to approach the cliff from the bottom, observing suspect cliff sites using 7x35 Bushnell Custom binoculars and a Bushnell Space-master II telescope with 20 and 40 power eyepieces. A spot was then chosen near the site with good visibility of as much of the cliff face as possible. Normally cliffs were watched for six hours in the morning or evening when raptors were most active. Upon sighting and identifying the raptor an effort was made to determine whether it was nesting on the cliff and, if so, where the eyrie was located. The second surveying method consisted of approaching the cliff from the top and attempting to get on an outjutting point of land. By using an overlook, two sections of cliff face could be watched simultaneously. Time was a limiting factor in the study due to the vast areas that needed to be covered during the relatively short nesting period. See Johnson (1976a) for further details regarding methods used by CDRI researchers for peregrine falcon surveys.

SURVEY RESULTS

Team A, composed of Charles Kowaleski and John Melton, surveyed northern Big Bend National Park and the Davis, Guadalupe, and Chinati Mountains. Team B, made up of Victor Wade and Lee York, surveyed the Sierra Diablo, Eagle Mountains, and Sierra Vieja in Texas and the Sierra del Cañon de Navarrete and Sierra de Pilares in Texas and adjacent Mexico. Team C (see pages 3-29 of this report) surveyed the Big Bend National Park, monitoring known eyries, and conducting a behavior study.

BIG BEND NATIONAL PARK - TEAM A

The only area of the Big Bend National Park surveyed by Team A was one cliff in the northern portion of the Park where peregrines had

been reported in 1975 (Tony Galuchi, pers. comm.). On 15 May Team A went down to check this report.

The cliffs in the area predominantly face northeast and southwest and range in height from 12 to 31 meters. The ridge upon which the cliffs are found is composed of limestone of the Glen Rose, del Carmen, and Santa Elena formations and ranges from 846 m above sea level at its base to 1,292 m near its peak. The dominant vegetation is a creosote bush (*Larrea tridentata*)-tarbush (*Flourensia cernua*) association with lesser amounts of sotol (*Dasylirion lelophyllum*), mesquite (*Prosopis* spp.), prickly pear (*Opuntia* spp.), and chino grama grass (*Bouteloua ramosa*). The nearest known water source is on the Black Gap Wildlife Management Area, eight km away. Possible prey species that were seen in the area were cañon wren (*Catherpes mexicanus*), mockingbird (*Mimus polyglottos*), brown towhee (*Pipilo fuscus*), and a variety of bats.

We camped overnight in a small canyon where the peregrines had been reported. The canyon was definitely atypical peregrine habitat. It consisted of low cliffs over a narrow canyon presumably far from a water source. When we arrived a pair of ravens were perched on the cliff reported to have been used by the peregrines. The ravens stayed there about 15 minutes before flying off to the south. During the remainder of our stay there we spotted a red-tailed hawk several times but no falcons. Grainger Hunt (pers. comm.) visited this canyon in 1975, saw no peregrines, but did find a pair of kestrels.

DAVIS MOUNTAINS - TEAM A

This study area is located ca. 20 km south of Toyahvale. The cliffs are composed of rhyolitic lavas and range in height from 10 to 200 meters. The cliffs predominantly face east or west and the elevation varies from 1,385 to 2,000 m above sea level. The dominant vegetation in the creek bottoms is oak (*Quercus* spp.) and maple (*Acer* spp.) with scattered stands of ponderosa pine (*Pinus ponderosa*). The slopes and tops are predominantly a grassland with dense stands of pinyon pine (*Pinus edulis*) and alligator juniper (*Juniperus deppeana*). There is permanent water (pools or small streams) in most of the canyon floors.

Possible prey species seen in this area included violet-green swallow (*Tachycineta thalassina*), mourning dove (*Zenaidura macroura*), canyon wren, Bewick's wren (*Thryomanes bewickii*), brown towhee, lesser nighthawk (*Chordeiles acutipennis*), evening grosbeak (*Hesperiphona vespertina*), black phoebe (*Sayornis nigricans*), Say's phoebe (*Sayornis saya*), vermillion flycatcher (*Pyrocephalus rubinus*), ash-throated flycatcher (*Myiarchus cinerascens*), mockingbird, Mexican jay (*Apelocoma*

ultramarina), brown-headed cowbird (*Molothrus ater*), common flicker (*Colaptes auratus*), acorn woodpecker (*Melanerpes formicivorus*) and western bluebird (*Siala mexicana*).

Team A surveyed the area from 18 May to 23 May, covering three of the major canyons. One was found to be devoid of raptors except for turkey vultures (*Cathartes aura*). Another canyon has a red-tailed hawk nest in a ponderosa pine. There was an adult in brooding position (probably incubating) on the nest both times we viewed it on 27 May. The third canyon had a prairie falcon eyrie. The team made two visits there, the first on 22 May. At 1345 hours a bird was observed flying from the cliff, it circled twice, made a "keeing" sound, and landed again on the cliff. At 1436 hours this falcon was joined by another prairie falcon, probably its mate, who flew in front of the cliff for several minutes before leaving. Neither bird entered an eyrie during our first visit there. The second visit to this cliff was on 28 May. We arrived under the cliff at 1100 hours and saw the prairie falcon at 1105. We watched the bird until 1500 hours. During that time it dove at a turkey vulture and a red-tailed hawk. The bird visited what we believe was the eyrie hole immediately after it dove at the red-tailed hawk. It entered the eyrie hole, disappearing from sight for eleven minutes, probably feeding young.

James Scudday reported a possible peregrine sighting in the Madera Canyon region of the northern Davis Mountains in late June of this year.

GUADALUPE MOUNTAINS - TEAM A

This area is located 104 km north of Van Horn. The cliffs are predominantly limestone of the Capitan Formation and range in height to 350 m. They are located at elevations between 1,515 and 2,636 m above sea level. The cliffs face predominantly southwest, east or north.

According to Warnock (1974), the vegetation in the bottom lands consists of creosote bush, tarbush, and mesquite. The vegetation on the lower slopes is mainly lechuguilla (*Agave lecheguilla*) and chinograma grass. The upper slopes have an abundance of sotol and mountain mahogany (*Cercocarpus montanus*). The top of the escarpment and northern slopes of the major canyons contain bigtooth maple (*Acer grandidentatum*), ponderosa pine (*Pinus ponderosa*), quaking aspen (*Populus tremuloides*), and Douglas fir (*Pseudotsuga menziesii*). A year-round source of water is the stream in McKittrick Canyon, and several small springs are found elsewhere.

Possible prey species seen below the two historic eyrie locations (Peregrine Palace and Lloyd's Ledge) include: mockingbird, common flicker, scrub jay, violet-green swallow, canyon wren, mourning dove, American kestrel, various species of tanagers and flycatchers.

We spent 31 May and 1 June checking the Peregrine Palace eyrie. There were four young peregrines well along in feather development in the eyrie. We expected the first one to fledge within a week and a half. An earlier team, composed of Steve and Betsy Belardo, noted the female incubating on 5 and 6 May.*

On 2 June we went to check the Lloyd's Ledge peregrine eyrie and the surrounding cliffs. At 1000 hours on 3 June we spotted an adult prairie falcon in the vicinity of Lloyd's Ledge. At one point this bird was seen chasing a violet-green swallow. The falcon was joined by another prairie falcon at 1010 hours and there was a possible prey transfer with one bird going back to the cliff. This would seem to indicate adults incubating or feeding young. An earlier team, checking the area on 3 and 4 May also reported finding a prairie falcon using the Lloyd's Ledge cliff (Steve and Betsy Belardo, field notes). One adult prairie falcon was seen on 4 June heading for a cliff southwest of Lloyd's Ledge. Close observation on 5 June located a second prairie falcon eyrie on the escarpment in a series of potholes near the top of the cliff face. Cries of adults and young birds were heard at 1030 hours. An adult was spotted at 1820 and 1930 in the vicinity of the cliff.

In summary, prairie falcons occupied the Lloyd's Ledge cliff in 1977 despite the fact that peregrines raised young there in 1975 and 1976 (see Hunt 1975, Johnson 1976a). It is probable that the Lloyd's Ledge pair had moved to an alternate site in 1977 as peregrines often do (see Ratcliffe 1962).

CHINATI MOUNTAINS - TEAM A

These mountains, located 24 km northwest of Presidio, run northwest to southeast. The major cliffs face west and south and range in height to 120 m. This mountain range attains 2,369 m above sea level and is made up of rhyolitic intrusions and lava ridges. The dominant trees in the streambeds are oaks and cottonwood (*Populus palmeri*). The slopes

* We checked the Peregrine Palace eyrie again on 6 June before going back to Alpine, Texas. At that time all four young were still in the nest.

are covered with mesquite, catclaw (*Mimosa biuncifera*), lechuguilla, and sotol. The top is predominantly an oak-juniper association. Water is found in many of the stream beds and in a number of locations appears to flow year-round.

Possible peregrine prey species seen in the area by both teams include Say's phoebe, black phoebe, mourning dove, white-winged dove (*Zenaida asiatica*), killdeer (*Charadrius vociferus*), mockingbird, canyon wren, summer and western tanagers, common grackle (*Quiscalus quiscula*), roadrunner (*Geococcyx californianus*), phainopepla (*Phainopepla nitens*), black-chinned sparrow (*Spizella atrogularis*), scaled quail (*Callipepla squamata*), pyrrhuloxia (*Pyrrhuloxia sinuata*), Scott's oriole (*Icterus parisorum*), ash-throated flycatcher, Cassin's kingbird (*Tyrannus vociferans*), and lesser goldfinch (*Spinus psaltria*).

Team A spent 9-13 June on the northern and western sides of the mountain range. On 10 June we found two red-tail nests, both were on west-facing cliffs approximately 30 m high. The first nest found contained two young, one of which had fledged and was flying well. The second nest had at least one young and possibly others that had already fledged. On the morning of 11 June we spotted two golden eagles flying eastward across Pinto Canyon. One of the birds was a young of the year, the other was a sub-adult as described by Lockhart (1976). The young eagle was struck by an adult red-tail as it flew over the red-tail's nest cliff. An adult golden eagle was seen late in the afternoon of 12 June circling some high cliffs in Dead Horse Canyon. Further examination of those cliffs on the morning of 13 June failed to reveal an eagle eyrie. Fourteen and fifteen June were spent in Pelillos Arroyo. We found a red-tail eyrie on 15 June on a northwest-facing cliff at 1130 hours. There was at least one fledged young, possibly more. At 1830 hours we spotted an adult golden eagle with both number one primaries missing, flying back and forth in front of a good-sized cliff. We spent 16-18 June checking San Antonio Canyon where we found two more red-tail eyries on the eastern side, probably the same two found by Wade and York on a 13 May survey of that canyon. No young could be seen, but the cliffs were extremely difficult to approach closely.

SIERRA DIABLO - TEAM B

The Sierra Diablo range is located 24 km north of Van Horn, Texas. It is a limestone formation that parallels the Culberson and Hudspeth county line for 50 km in a north-south direction. Cliff heights range from 92 to 130 m. The principal canyon is Victorio Canyon which extends westward into the mountains for 9 km. The high cliffs in this canyon face both north and south. Elevation of the study area ranges from 1,538 m to a high point of 2,061 m above sea level.

Two types of vegetation are found in this area, desert scrub and a piñon-oak-juniper association. The desert scrub consists of ocotillo (*Fouquieria splendens*), lechuguilla, mesquite, and prickly pear, and is found below the rim rock. Above the rim grow plant species such as oak, piñon pine, pinchot juniper (*Juniperus pinchotii*), yucca (*Yucca* spp.), cholla (*Opuntia* spp.), sotol, century plant (*Agave scabra*), lechuguilla, and prickly pear.

Available water in this area is almost absent. In the 1930's water flowed from two springs at the mouth of Victorio Canyon (Nelson Puett, land owner in the Sierra Diablo, pers. comm.). Peregrine falcons may have inhabited this area then, but the springs have ceased to flow. A small but hidden spring still exists at the south end of the mountains (Frosty Bowers, foreman of the Baylor Mountain Ranch, pers. comm.).

Bird species available as prey to falcons in the Sierra Diablo are pyrrhuloxia, loggerhead shrike (*Lanius ludovicianus*), brown towhee, violet-green swallow, Scott's oriole, rock wren (*Salpinctes obsoletus*), cañon wren, hepatic tanager, mockingbird, roadrunner, western meadow-lark, mourning dove, house finch (*Carpodacus mexicanus*), black-throated sparrow (*Amphispiza bilineata*), scaled quail, cactus wren (*Campylorhynchus brunneicapillus*), and scrub jay (*Aphelocoma coerulescens*). Brown towhees and scaled quail were most conspicuous.

Eighteen person-days were spent in a survey of this area from 2 June until 10 June 1977. The search, which included all east-facing cliffs of the Sierra Diablo as well as the cliffs of Victorio Canyon, revealed no peregrine falcon eyries. Territories of cliff-nesting raptors on the Sierra Diablo rim and in Victorio Canyon included three pairs of prairie falcons, one pair of golden eagles, two pairs of red-tails, and one pair of great horned owls. It is possible that with the proper water source this area could support one or two pairs of peregrines.

EAGLE MOUNTAINS - TEAM B

The Eagle Mountains run northwest to southwest for 15 km and are about 20 km northeast of the Rio Grande. The elevation ranges from 1,846 m to 2,097 m. Eight person-days from 28 through 31 May 1977, were expended surveying the northwestern section of this mountain range where the largest cliffs are found. Cliffs in this area are south- and west-facing and reach 90 m in height. They are composed of igneous rock formed by lava flows and intrusions.

The vegetation of this area is composed of desert scrub. The dominant plants are creosote, mesquite, and lechuguilla. Other species, which occur in fewer numbers but are important ecological indicators

are yucca, prickly pear, and sotol. The area is rugged and broken, with an abundance of creosote bush and lechuguilla.

Possible falcon prey species observed were brown towhee, house finch, mourning dove, scaled quail, mockingbird, western wood pewee (*Contopus sordidulus*), black-throated sparrow, cactus wren, Scott's oriole, cañon wren, cliff swallow (*Petrochelidon fulva*), and common nighthawk (*Chordeiles minor*).

Other than unavailable water in metal cattle tanks, (see Recommendations) the nearest source of water is the Rio Grande, which flows intermittently through the area to the south and west of these mountains.

Bird life is abundant on the river 18 km south of the Eagle Mountains. In 15 minutes, on 9 May 1977, over 40 ducks were counted in one of the oxbow lakes formed by the Rio Grande. White-winged doves inhabit the area by the thousands where the salt cedar (*Tamarix* spp.) grows (Hunt, Johnson, and Whitacre 1976). An abundance of bird life is probably important to falcons for hunting, and the available water is probably important to falcons for bathing in this desert region. On 9 May 1977 a peregrine falcon was seen at 0837 hrs. perched on a small hill overlooking the oxbow lake where the previously mentioned ducks were seen. In summary, ground reconnaissance revealed no peregrine eyries in the Eagle Mountains, but red-tailed hawk and other raptor nests were found. Further searching by helicopter disclosed the territory of a pair of prairie falcons but no peregrines (see Johnson, Hunt, and Wade 1977).

SIERRA VIEJA - TEAM B

From 19 to 23 May 1977 the Sierra Vieja rim was surveyed for unknown peregrine eyries for a total of eight person-days. This area lies 50 km west of Marfa, Texas. The Rio Grande is 16 km west of the rim. This west-facing rimrock outcrop is composed of rhyolitic welded tuff. The high point of this area is 2,000 m above sea level and the cliffs vary in height from 90 to 150 m.

The area above the cliffs is composed of chino grama grass, sotol, yucca, and some lechuguilla. Vegetation below the cliffs is desert scrub composed of creosote bush, ocotillo, and mesquite.

Water in this area is scarce. Several cattle tanks are near the cliffs and there is a seep in one of the canyons to the east which probably dries up during hot, dry spells.

Potential prey species identified on or below the Sierra Vieja rim were Scott's oriole, brown towhee, cañon wren, scaled quail, violet-green swallow, house finch, ash-throated flycatcher, white-throated swift (*Aeronautes saxatalis*), chipping sparrow (*Spizella passerina*), Say's phoebe, grey-headed junco (*Junco caniceps*), loggerhead shrike, mourning dove, scaled quail, rock wren, and cliff swallow.

No new peregrine eyrie was sighted on the Sierra Vieja rim, but the territories of other cliff-nesting raptors were found. These included three pairs of prairie falcons, two pairs of ravens, and two pairs of red-tailed hawks.

MEXICO - TEAM B

Two mountain ranges in Mexico along the Texas border were ground checked for peregrine falcons in connection with a study performed for the International Boundary and Water Commission. These included the Sierra del Cañon de Navarrete and Sierra de Pilares. These mountains are located within 20 km of the Rio Grande, downstream of El Paso. They parallel the river for 160 km.

Peregrines occupying these cliffs would utilize the Rio Grande and other hunting sites in Texas. Their offspring would probably help populate the Texas peregrine population in case of a decline.

Sierra del Cañon de Navarrete

Cliffs in the Sierra del Cañon de Navarrete were surveyed for a total of 20 person-days from 30 April to 5 May and again 15 June and 16 June 1977. This range is located 14 km west of Ruidosa, Texas, and 18 km south of the Rio Grande, facing westward and extending about 8 km. Three large canyons dissect these mountains, and all provide cliffs 80 to 90 m in height. Lava flows formed the igneous rock which makes up the mountains in this area. Elevations range from 1,692 m to 2,178 m above sea level.

Vegetation of the flats and canyon floors is mainly desert scrub, oak, creosote bush, mesquite, yucca, sotol, and prickly pear. Intermittent streams flow through the three canyons described.

These prey bird species were observed in the study area in the spring of 1977: common nighthawk, mourning dove, scaled quail, Cassin's kingbird, Gambel's quail (*Lophortyx gambelii*), house wren, brown towhee, cañon wren, summer tanager, white-winged dove, Say's phoebe, Scott's oriole, mockingbird, western meadowlark, and phainopepla.

Last year an adult male peregrine was seen flying toward the cliffs with a white-winged dove it had killed on the river (see Hunt, Johnson, and Whitacre 1976). This year a pair of prairie falcons occupied the largest and most suitable cliff, and there is a good possibility that in some years peregrines occupy this cliff. It is large and has holes for nesting, and water conditions are favorable. Other cliff-nesting raptors seen were three pairs of kestrels and one pair of ravens, but no peregrines were seen.

Sierra de Pilares

The area in Mexico between Ruidosa, Texas, and Lomas de Arena, Mexico, 16 km south of the Texas-Mexico boundary was checked on 14 and 15 May and again 24 through 26 May 1977. A total of ten person-days were spent searching this area. These east-facing cliffs extend intermittently for 70 km along the Rio Grande. The cliffs are lava flows reaching heights of 50 m. Elevations of this range vary from 1,692 to 2,013 m above sea level.

Vegetation of this area consists mainly of sotol, lechuguilla, mesquite, yucca, and creosote bush, all of which make up a desert scrub plant community. Possible falcon prey species noted in the Sierra de Pilares were common nighthawk, mourning dove, scaled quail, Gambel's quail, brown towhee, cañon wren, white-winged dove, Say's phoebe, Scott's oriole, and mockingbird.

No new nesting peregrines were found in this area, but a sighting of a peregrine falcon was reported to Team B by Ron Wilson, who was doing a bird census for the International Boundary and Water Commission. The sighting was made on 10 May 1977, approximately 32 km northwest of Candelaria, Texas, 48 km west of a sighting that Steve West (pers. comm.) made in May 1976 (see Hunt, Johnson, and Whitacre 1976).

OL' BUDDY EYRIE

The OL' Buddy peregrine eyrie was discovered in April 1976 by Grainger Hunt, Brenda Johnson, and Steven Belardo. The pair fledged one young in early June of that year. This year the pair was found to have

moved approximately one km down the cliff face to a new site (Steve Belardo, Frid Fridriksson, and Betsy Belardo, field notes). The pair obviously broke their first clutch as indicated by a prolonged incubation period and an extremely late fledging (mid-July) of the two young (a male and a female). Thickness of eggshell fragments collected in June 1977 below the eyrie averaged 0.271 mm (with membrane). This value is 25 percent thinner than pre-1947 eggs from Alberta, Saskatchewan and Montana reported by Anderson and Hickey (1972). In 1976, the OL' Buddy fragments were found to be 22.4 percent thinner than the pre-1947 shells.

Approximately 65 person-days were spent observing the OL' Buddy pair and their young in 1977. The work was supported by the International Boundary and Water Commission and will be reported separately to that agency.

SUMMARY

Two field teams (A and B) checked 126 cliffs in western Texas in 1977 as possible peregrine nesting sites (six mountain ranges in Texas and two in Mexico). A total of 123 raptors were seen during the survey, but no new peregrine eyries were found. Three historic peregrine sites were checked and two of these (OL' Buddy and Peregrine Palace) produced two and four young. Peregrines at the third eyrie, present and productive in both 1975 and 1976, were found to have been replaced by prairie falcons in 1977. It is suspected that this pair moved to an alternate, but unknown, site.

RECOMMENDATIONS

1. Peregrine Palace

For the past three years the Peregrine Palace eyrie has almost certainly been the most productive peregrine nest known in the 48 states—eleven young produced, for an average of 3.67 young per year. While we see no immediate danger to this eyrie, we urge careful attention to all matters affecting its continued survival. It is expected that visitor traffic will increase with a new development planned for the area. Should the delicate surrounding habitat be trampled, the carrying capacity for peregrines could conceivably be reduced. No one should be allowed above the cliff.

2. Further Research

- a. Early courtship should be observed to determine factors of competition (if any) for eyrie sites.
 - b. Post-fledging survival of young should be studied by continued observation to determine and evaluate mortality factors.
 - c. Areas searched for new eyries in spring 1978 should include (in order of priority) the Rio Grande (including the Lower Canyons), the Davis Mountains, and the Guadalupe Mountains. About 20-25 hours of helicopter time are needed.
 - d. All known eyries should be monitored for productivity and cause of failure if not successful.
 - e. The technology of water tanks for stock should be explored to determine if low cost modifications (acceptable to ranchers) could be made to allow for drinking and bathing by peregrines and their prey. Such might encourage the occupancy of new peregrine sites.
3. We in the United States have learned through regrettable circumstances of the harmful effects of DDT and other organochlorine insecticides. Most of these are now virtually banned for use in the U.S. We must communicate to our neighbors in Latin America our experience concerning the undesirability of these substances and help them find safe substitutes.

POSTSCRIPT:

DDT AND THE DIET OF TEXAS PEREGRINE FALCONS

Overwhelming evidence over much of the western hemisphere points to DDT as the principle cause of the dramatic peregrine falcon declines which have been occurring since the end of World War II. The most recent reviews of this phenomenon can be found in Peakall (1976) and Fyfe, Temple, and Cade (1976). In view of the tremendous amounts of DDT used on this continent, the fact that peregrines have survived in the Chihuahuan Desert and other parts of the west is a matter of amazement. The Desert's pastoral economy, its remoteness from agricultural centers, and its southern latitude, which reduces the peregrine's need to migrate, may all play a part in its continued occurrence here (see Hunt 1974).

Our data over the years on eggshell thinning in Texas peregrines and pesticide use in western Texas and adjacent Mexico indicate that DDT continues to threaten our peregrines (Hunt 1976, Johnson 1976a). The work of Howard Applegate and others in the Big Bend National Park and the Presidio Basin confirm that large amounts of DDT were applied up to the beginning of this decade (see Hunt 1975). Seven peregrine falcon nestings along the Rio Grande during the years 1973-75 failed to produce young.

OL' BUDDY EYRIE

Eggshell fragments from the Ol'Buddy eyrie last year were 20-24 percent thinner than pre-1947 eggshells from Alberta, Saskatchewan, and Montana collected by Anderson and Hickey (1972). (Unfortunately, we have no pre-1947 Chihuahuan Desert eggs with which to compare thickness). Eggshells produced by the same pair in 1977 were 21-25 percent thinner. Peregrine populations in other regions began to decline when eggshells reached the 18 percent thinning level. Despite the extraordinary thinness of the Ol' Buddy eggs, the pair produced one young in 1976 and two in 1977 (see Table 1). The eyrie overlooks an agricultural area in Texas and Mexico. A dessicated egg was obtained from the Ol' Buddy site in 1977, and the egg contained a few grams of dried yolk. This material was analyzed by Dr. Steve Herman of the Evergreen State College, Olympia, Washington, and was found to contain 780 ppm DDE (lipid weight). Table 2 shows our present knowledge of the food habits of the Ol' Buddy peregrines. As information accumulates on what this pair is eating, a clearer understanding of the source of contamination may be obtained.

TABLE 1. YOUNG PRODUCTION BY PEREGRINE FALCONS IN WESTERN TEXAS, 1975-1977.

Eyrie	Number of Young Produced			
	1975	1976	1977	1975-77 Total
Peregrine Palace	3	4	4	11
Lloyd's Ledge	1	3	?	4
Ol' Buddy	?	1	2	3
Santa Elena	0	0	3	2
Mariscal	0	0	2	2
Boquillas	0	2	0	2
Lechuguilla	?	?	(1?)	(1?)
Total number of young produced.	4	10	11	25
Mean number of young per successful eyrie.	2.00	2.50	2.75	2.50

TABLE 2. PREY REMAINS FOUND IN OR UNDER TEXAS PEREGRINE FALCON EYRIES.

Species	Eyrie Collected From	
	Ol' Buddy (1976,1977)	Santa Elena* (1977)
Duck (<i>Anas</i> sp.)		X
Sora Rail (<i>Porzana carolina</i>)	X	
Killdeer (<i>Charadrius vociferus</i>)	X	
Dowitcher (<i>Limnodromus</i> sp.)	X	
Dove (spp.)	X	
Rock Dove (<i>Columba livia</i>)	X	
White-winged Dove (<i>Zenaida asiatica</i>)	X	
Mourning Dove (<i>Zenaidura macroura</i>)	X	X
Common Nighthawk (<i>Chordeiles minor</i>)	X	
Lesser Nighthawk (<i>Chordeiles acutipennis</i>)	X	X
White-throated Swift (<i>Aeronautes saxatalis</i>)	X	
Ladder-backed Woodpecker (<i>Dendrocopos scalaris</i>)	X	
Horned Lark (<i>Eremophila alpestris</i>)	X	X
Swallow (sp.)	X	
Barn Swallow (<i>Hirundo rustica</i>)	X	
Cliff Swallow (<i>Petrochelidon pyrrhonota</i>)	X	
Wren (sp.)	X	
Cactus Wren (<i>Campylorhynchus brunneicapillum</i>)		X
Cañon Wren (<i>Catherpes mexicanus</i>)		X
Rock Wren (<i>Salpinctes obsoletus</i>)	X	

TABLE 2. Continued

Species	Eyrie Collected From	
	Ol' Buddy (1976,1977)	Santa Elena* (1977)
Mockingbird (<i>Mimus polyglottos</i>)	X	
Thrasher (<i>Toxostoma</i> sp.)	X	
Thrush (<i>Hylocichla</i> sp.)	X	
Loggerhead Shrike (<i>Lanius ludovicianus</i>)	X	
Meadowlark (sp.)	X	X
Blackbird (sp.)	X	
Brewer's Blackbird (<i>Euphagus cyanocephalus</i>)		X
Brown-headed Cowbird (<i>Molothrus ater</i>)	X	
Western Tanager (<i>Piranga ludoviciana</i>)	X	X
Black-headed Grosbeak (<i>Pheucticus melanocephalus</i>)	X	
Pyrrhuloxia (<i>Pyrrhuloxia sinuata</i>)		X
House Finch (<i>Carpodacus mexicanus</i>)	X	
Pine Siskin (<i>Spinus pinus</i>)	X	
Lesser Goldfinch (<i>Spinus psaltria</i>)	X	
Green-tailed Towhee (<i>Chlorura chlorura</i>)	X	X
Lark Bunting (<i>Calamospiza melanocorys</i>)	X	X
Rufous-crowned Sparrow (<i>Aimophila ruficeps</i>)	X	
Junco (spp.)	X	
Mexican Free-tailed Bat (<i>Tadarida brasiliensis</i>)	X	X
Whitetail Antelope Squirrel (<i>Ammospermophilus interpres</i>)	X	

* Data from Santa Elena eyrie are incomplete.

BIG BEND CANYON EYRIES

Productivity has been improving during the last two years at the eyries along the Rio Grande in the Big Bend National Park. Three broods have been produced for a total of eight young in 1976 and 1977. For the first time, in July 1977, we were able to obtain eggshell fragments and prey remains from one of these nests (see Tables 1 and 2). The fragments were from 4.7 to 16 percent thinner than peregrine eggs collected before the DDT era. We are hopeful that the Rio Grande peregrine are beginning to recover and we will continue to monitor their status during years to come.

GUADALUPE MOUNTAINS

There are two eyries known in the Guadalupe Mountains National Park: Peregrine Palace and Lloyd's Ledge. We have neither eggshells nor prey remains from either eyrie, but a nest in the nearby Lincoln National Forest of New Mexico contained shells which were approximately 18 percent thinner than the pre-1947 shells (Belardo, Fridriksson, and Belardo 1977). Although the peregrines at Lloyd's Ledge had been replaced by prairie falcons in 1977, the peregrines produced young in both 1975 and 1976. The Lloyd's Ledge pair have probably moved to another location within a few kilometers of the old site. The Peregrine Palace pair has produced a total of 11 young in three seasons, a phenomenally high rate of production. Other portions of the northern Chihuahuan Desert showed good peregrine productivity. Two eyries in the Gila National Forest fledged three and four young in 1977.

SUMMARY

Four of five eyries in Texas which were studied in 1977 produced a total of 11 young. In addition, a new eyrie (Lechuguilla) in the Big Bend National Park probably fledged at least one young. In summary, although eggshells remain thin, it is our impression that there has been a general improvement in the status of peregrine falcons nesting in Texas which is probably due to a gradual attrition of DDT residues in the environment.

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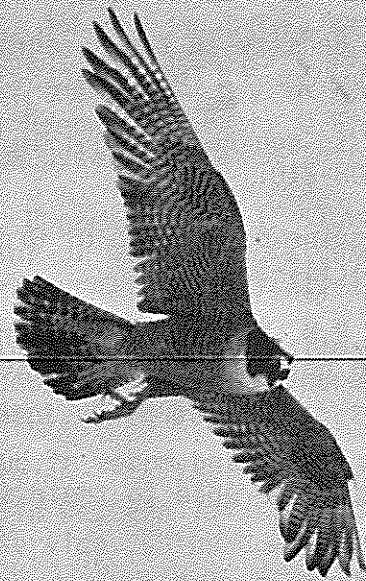
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(Hill and Schaetzel)

POTENTIAL PREY IN EACH STUDY AREA OF THE BIG BEND NATIONAL PARK

0 = Common in study area
X = Seen but not common

	Santa Elena Floodplains and Shrub desert	Mariscal Canyon	Exterior Mariscal Floodplain	Boquillas Canyon	Chisos Mountain
Mexican Duck (<i>Anas diazi</i>)	0		0		
American Wigeon (<i>Mareca americana</i>)	0		0		
Shoveler (<i>Spatula clypeata</i>)	0		0		
Blue-winged Teal (<i>Arus discors</i>)	0		0		
Scaled Quail (<i>Callipepla squamata</i>)	X				
Spotted Sandpiper (<i>Aetitus macularia</i>)	X	X	X	X	
Band-tailed Pigeon (<i>Columba fasciata</i>)					0
White-winged Dove (<i>Zenaida asiatica</i>)	X	0	X		0
Mourning Dove (<i>Zenaidura macroura</i>)	X		X		
Lesser Nighthawk (<i>Chordeiles acutipennis</i>)	X		X		
White-throated Swift (<i>Aeronautes saxatalis</i>)				X	X
Black-chinned Hummingbird (<i>Archilochus alexandri</i>)	X	X	X	X	X
Common Flicker (<i>Colaptes auratus</i>)					X
Ladder-backed Woodpecker (<i>Dendrocopos scalaris</i>)				X	X
Acorn Woodpecker (<i>Melanerpes formicivorus</i>)					X
Ash-throated Flycatcher (<i>Myiarchus cinerascens</i>)	X		X	X	
Black Phoebe (<i>Sayornis nigricans</i>)	X	X	X	X	
Cliff Swallow (<i>Petrochelidon pyrrhonota</i>)					X
Violet-green Swallow (<i>Tachycineta thalassina</i>)					
Rough-winged Swallow (<i>Stelgidopteryx ruficollis</i>)		X			
Mexican Jay (<i>Aphelocoma ultramarina</i>)					X
Black-crested Titmouse (<i>Parus atricristatus</i>)					X
Common Bushtit (<i>Psaltiriparus minimus</i>)					X
Black-eared Bushtit (<i>Psaltiriparus melanotis</i>)					X

APPENDIX I (Cont.)

POTENTIAL PREY (cont.)

	Santa Elena Floodplains and Shrub desert	Mariscal Canyon	Exterior Mariscal Floodplain	Boquillas Canyon	Chisos Mountain
0 = Common in study area					
X = Seen but not common					
White-breasted Nuthatch (<i>Sitta carolinensis</i>)	X		X	X	X
Cactus Wren (<i>Campylorhynchus brunneicapillus</i>)					
Rock Wren (<i>Salpinctes obsoletus</i>)	X	X	X	X	X
Cañon Wren (<i>Catherpes mexicanus</i>)	X		X		X
Mockingbird (<i>Mimus polyglottos</i>)	X				
Curved-billed Thrasher (<i>Toxostoma curvirostre</i>)					
Blue-gray Gnatcatcher (<i>Polioptila caerulea</i>)	X				X
Black-tailed Gnatcatcher (<i>Polioptila melanura</i>)	X				X
Bell's Vireo (<i>Vireo bellii</i>)	X	0	X	X	
Yellowthroat (<i>Geothlypis trichas</i>)	0		0	X	
Yellow-breasted Chat (<i>Icteria virens</i>)	X	0	X	X	
Brown-headed Cowbird (<i>Molothrus ater</i>)	X		X		
Scott's Oriole (<i>Icterus parisorum</i>)					0
Hooded Oriole (<i>Icterus cucullatus</i>)	0	0	0	X	
Summer Tanager (<i>Piranga rubra</i>)	X	0	X	X	0
Cardinal (<i>Richmondia cardinalis</i>)	X		0	0	0
Pyrrhuloxia (<i>Pyrrhuloxia sinuata</i>)	X				
Blue Grosbeak (<i>Guiraca caerulea</i>)	X		0	0	0
Painted Bunting (<i>Passerina ciris</i>)	0		0		
House Finch (<i>Carpodacus mexicanus</i>)				0	0
Rufus-sided Towhee (<i>Pipilo erythrophthalmus</i>)		0		0	X
Brown Towhee (<i>Pipilo fuscus</i>)	X				0
Black-throated Sparrow (<i>Amphispiza bilineata</i>)				0	0
Rufous-crowned Sparrow (<i>Aimophila ruficeps</i>)					
Black-chinned Sparrow (<i>Amphispiza atroquararis</i>)	X	X	X	X	0
Bat spp.					

APPENDIX II

(Hill and Schaetzel)

PHYSICAL CHARACTERISTICS OF PEREGRINE EYRIE CLIFFS IN THE BIG BEND NATIONAL PARK

Eyrie	Directional Exposure of Cliff	Cliff Height (Meters)	River to Rim Height (Meters)	Cliff Top Elevation* (Meters)	Directional Exposure of Eyrie	Distance of Eyrie Below Rim (Meters)
Santa Elena	NE	186	460	1,077	N-NE	60
Mariscal	S	350	425	923	W-SW	150
Boquillas	N	325	375	871	--	--

* Above Sea Level

NESTING RAPTORS IN EACH STUDY AREA OF THE BIG BEND NATIONAL PARK

	Possible nest	N = Known nest	Santa Elena	Mariscal	Boquillas	Chisos Mts.
Turkey Vulture (<i>Cathartes aura</i>)			P	P	P	P
Black Vulture (<i>Coragyps atratus</i>)			P	P	P	
Red-tailed Hawk (<i>Buteo jamaicensis</i>)			N, P	P	2N, P	N, P
Zone-tailed Hawk (<i>Buteo albonotatus</i>)					3N	P
Golden Eagle (<i>Aquila chrysaetos</i>)						P
American Kestrel (<i>Falco sparverius</i>)			P	N, 2P	4N, P	N, 2P
Peregrine Falcon (<i>Falco peregrinus</i>)			2N	N	N, P	P
Raven (<i>Corvus corax</i>)			N, 2P	2P	N, 3P	4P

APPENDIX III

APPENDIX IV

SUMMARY OF REPRODUCTIVE PERFORMANCE OF PEREGRINES IN WESTERN TEXAS, 1977
(updated from Johnson 1976a)

LOCATION	DATE	REPRODUCTIVE DATA
LLOYD's LEDGE	1975 May 27- June 14	Adult pair
	1975 June 16	At least 1 young, flying
	1976 April 17	Adult pair, incubating
	1976 June 10	3 large youngsters
	1977	Site occupied by prairie falcons
PEREGRINE PALACE	1970 May 26	Single adult seen at nest
	1971 through 1974	Adult pair, nesting
	1975 June 6	3 large youngsters (♀♀, ♂)
	1975 June 13	3 young flying
	1976 April 9	Adult pair, incubating
	1976 June 3, June 10	4 large youngsters
	1977 May 5, 6	Adult pair, incubating
	1977 June 1	4 large youngsters
OL' BUDDY	1976 April 10- April 11	Single adult
	1976 May 6	Adult pair, brooding young
	1976 May 25	Adult pair, feeding young
	1976 May 31	1 large youngster
	1977 April 20	Adult pair, incubating (broke first clutch, re-laid)
	1977 May-June	Adult pair, feeding 2 young (♀, ♂)
	1977 July 9	Young had flown from nest

APPENDIX IV cont.

SUMMARY OF REPRODUCTIVE PERFORMANCE OF PEREGRINES IN WESTERN TEXAS, 1977
(updated from Johnson 1976a)

LOCATION	DATE	REPRODUCTIVE DATA
BOQUILLAS	1973	Adult pair
	1974 July 3	Adult pair
	1975 Feb-June	Probably occupied, no young produced
	1976 April 25	Adult pair
	1976 June 12	Young, vocalizing
	1976 June 27	2 young, flying (♀ ♀)
	1977 March 28-May 11	Adult pair, no young produced
MARISCAL	1973 May	Adult pair, no young produced
	1974 April-June	Adult pair, no young produced
	1976 March-June	Adult pair, no young produced
	1976 April 25-June 14	Adult pair, no young produced
	1977 March	Adult pair, incubating
	1977 April 8-May 20	Adult pair, brooding young
SANTA ELENA	1977 May 6-7	2 downy youngsters (♂ ♂)
	1974	Adult pair
	1975 May 26	Adult pair, no young produced
	1976 April 26	Adult pair
	1976 June 12	Adult pair, probably no young produced
	1977 April 12-April 16	Adult pair, brooding young
	1977 April 29	3 downy youngsters (♀ ♀, ♂)

(Errata Sheet)

NESTING PEREGRINE FALCONS IN TEXAS, 1977.

Page	Line	
i	8	POSTSCRIPT
25	17	...whiptail lizard (<i>Cnemidophorus exanguis</i>).
31	23	...environmental pollution by...
43	1	POSTSCRIPT
45	9	...that the Rio Grande peregrines are beginning...
46	30	We greatly appreciate the work of <u>Dr. Steve Herman of The Evergreen State...</u>
47	17	2. <u>U.S. National Museum Bulletin 167:43-66.</u>
47	29	Auk 91(4):727-736.