NESTING ECOLOGY AND DIET OF SWAINSON'S HAWK IN THE CHIHUAHUAN DESERT, SOUTH-CENTRAL NEW MEXICO

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N M S U

NESTING ECOLOGY AND DIET OF SWAINSON'S HAWK IN THE CHIHUAHUAN DESERT, SOUTH-CENTRAL NEW MEXICO

BY

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ABSTRACT

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This thesis reports the density, reporductive chronology, nesting success, and diet of Swainson's Hawk (Buteo swainsoni) in the Chihuahuan Desert grasslands of south-central New Mexico during 1974 and 1975.

Swainson's Hawks arrived in the first two weeks of April and estab-lished nests primarily in yuccas. The average density for both years was one pair per 9.45 km^2. The mean laying date for 1974 was

May 5 and was May 6 in 1975. The mean hatching date for both years was June 11. Clutch sizes ranged from two to four eggs with the average clutch size for the combined years being 2.8 eggs. This compares to a range of 1.8 to 2.3 reported in other portions of its range. The mean number of nestlings for both years combined was 2.5 per nest compared to 1.3 through 2.3 in other studies.

The combined mean number of fledglings per nest was 1.6. This fledging rate is similar to other studies.

Gullet samples were taken from the young of eight nests in 1974 and six in 1975. A total of 522 prey items were identified in these samples; items represented 21 different species, which is the greatest variety of prey reported for Swainson's Hawk. Prey items most frequently taken were the western whiptail lizard (Cnemidophorus tigris) (28 %), Texas horned lizard (Phrynosoma cornutum) (19 %), and the spotted ground squirrel (Spermophilus spilosoma) (14 %). When the biomass of prey is considered, the importance of the prey species changes. Lagomorphs (Lepus and Sylvilagus) were the most important in biomass (36 %), with the spotted ground squirrel ranking second, (19%), and the bannertailed kangaroo rat (Dipodomys spectabilis) third contributing 15% of the total biomass.

Ground squirrels and lagmorphs were also important mammalian prey in other studies. Reptiles, which were an important class of prey in this study, were not important in other studies. Another difference in prey items was the total lack of insects taken in this study.

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Swainson's Hawk (*Buteo swainsoni*) is described as a hawk of the plains. It has been reported to feed primarily on small rodents and fledgling birds (Cameron 1908, Bowles and Decker 1934, McAtee 1935, Olendorff 1973, Dunkle 1977). These hawks are also known to feed on large numbers of insects during certain times of the year (Cameron 1913, Taylor 1946, White 1966, Smith and Murphy 1973, Dunkle 1977).

The most extensive published works on Swainson's Hawks are those by Olendorff (1973) in prairie habitat in northern Colorado and by Dunkle (1977) on the Laramie Plains in Wyoming.

In the Chihuahuan Desert grasslands of southern New Mexico, the Swainson's Hawk is the most numerous breeding raptor. This and the fact that it has never been studied in the warm desert biome prompted this study of the food habits and nesting ecology. In 1974 and 1975 when this study was being performed, the U.S. International Biological Program (IBP) was studying the desert and desert-grassland ecosystems in south-central New Mexico, which enabled me to utilize data on prey and their general relative abundances.

STUDY AREA

This investigation was conducted on the USDA Jornada Experimental Range, 40 km NNE of Las Cruces, Dona Ana County, New Mexico (Figure 1). The study area was approximately 143 km^2 of Chihuahuan Desert grassland-scrub with flat to gently rolling terrain and swale areas where water collects after heavy rainfalls. The soil in most of the study area is sandy loam with the rest of the area being a calcareous fine sandy loam (Buffington and Herbel 1965).

Dominant woody plant species in the area are mesquite (Prosopis glandulosa), which occurs sparsely over the area except in dune areas where it grows in dense low clumps; tarbush (Flourensia cernua), which occurs in a limited southern portion of the study area; and yucca (Yucca elata), which occurs throughout the study area in varying density, including small groups or single plants. Mesa dropseed (Sporobolus flexuosus), black grama (Bouteloua eriopoda), hairy grama (Bouteloua hirsuta), and red three-awn (Aristida oligantha) are the major grasses occurring throughout the study area (Buffington and Herbel 1965).

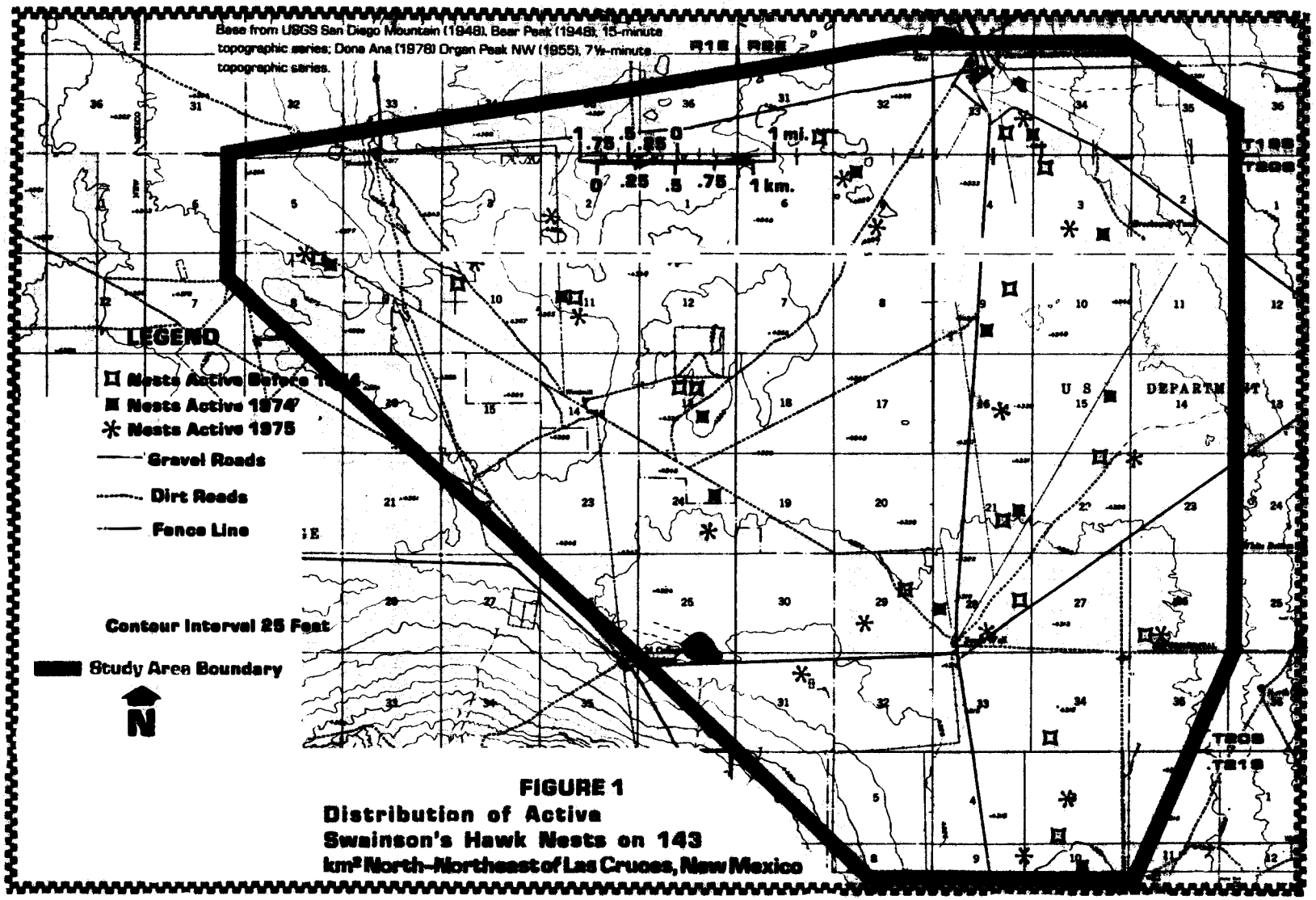

FIGURE 1
Distribution of Active Swainson's Hawk Nests on 143 km² North-Northeast of Las Cruces, New Mexico

METHODS

Nesting

Searches for nests were conducted during the winter of 1973. Swainson's Hawks were known to nest mainly in yuccas and occasionally in tall mesquites in this region; therefore, I checked all tall (2 m or greater) yuccas and mesquites for nests. After this, the locations of all old nests and potential nest sites were recorded on a study area map. In the spring of both years of this study, I checked the previously located nests for reuse and also located new nests which were then recorded on a study area map.

Study nests were examined every other day to determine the date of the first egg, the final clutch size, and the first hatching date. When the young in each nest were two days old, food habit data collec-tion was begun.

The nests were visited every other day to check on progress until laying was complete, every fourth day during most of the 37-day incubation period (Olendorff 1973), and every day near the end of incubation.

Diet Analysis

Eight nests were selected for study of food habits in 1974, and six nests in 1975, on the basis of their accessibility. After all

young in each nest were two days old, I began food habit data collec-tion, which included searching the nests and the ground below for food items. Daily gullet samples were taken from all young in each nest utilizing a technique described by Errington (1932). This gullet sampling technique consisted of physically inducing regurgitation of food from each nestling's proventriculus. These food items were analyzed to determine prey species, frequency, percent frequency, biomass, and percent biomass of prey in each nest. Collection of these data continued until the young in each nest fledged. This gullet sampling technique was used because it provided quantitative data on food items provided by the adults. Pellet analysis of Buteo species is only qualitative, because the digestive process in Buteos is very destructive of hollow bones of birds and reptiles (Errington 1932). Also, pellet analysis is an unsatisfactory technique because it entails many errors (Glading et al. 1943). In 1974, the samples were collected from each nestling daily between 08:00 and 12:00 MDT. In 1975, the samples were collected twice daily: once between 08:00 and 11:00 MDT and once between 18:00 and 21:00 MDT. All samples were separated by nest; they included prey remains from the nest as well as material on the ground below the nest. Samples from the young in each nest were placed in a bottle labeled with the date, nest number, and in 1975, time of day. The bottles were then filled with 90% ethanol to preserve the samples for later identification.

Gullet samples were analyzed as to species and age (mature/im-mature) in the case of mammals and birds. In most cases, sufficient

pelage, scales, feathers, or appendages were contained in each sample to identify the species. In cases where the sample was mainly muscle, with little fur, identification of hair was made as to species using techniques described by Moore et al. (1974).

Both biomass and frequency of occurrence of prey items taken were calculated for each species. Mammalian, reptilian, amphibian, and avian weights assigned for biomass computation were taken from the University of New Mexico Vertebrate Museum specimens and from Whitford (unpublished IBP data) (Appendix). Juvenile weights were assumed to be one-half those of adults.

POPULATION

Results

Density

The density of Swainson's Hawks nests was one pair per 11 km^2 in 1974, and one pair per 7.9 km^2 in 1975.

Reproductive Chronology

Adults arrived in the first two weeks of April in both 1974 and 1975. In 1974, the first one appeared on 4 April, and the last one was present on the site until 15 October 1974. In 1975, the first birds arrived on 1 April, and the last birds remained until 18 October.

Within two weeks of arrival, birds were seen soaring in pairs. In 1974, copulation was first noted on 28 April; in 1975, on 17 April. The first eggs were laid on 29 April 1974, and within 11 days, all nests had complete clutches; the mean laying date for all nests was 5 May. In 1975, the first eggs were laid on 3 May, and eight days later the other five nests had complete clutches; the mean laying date for all nests was 6 May. First hatching occurred in 1974 on 5 June, and on 6 June in 1975. The mean hatching date for both years was 11 June.

The nestling period lasted approximately 37 days; after fledging, young birds remained in the general vicinity of the nest for approxi-mately a week and then ventured farther from the nest and became in-creasingly more difficult to follow. Activity of the young between seven days after fledging and migration is not known. The entire nesting cycle from territory establishment and nest building to fledging was approximately three months long.

Nesting

In the winter nest search of 1973, 19 nests were found, all in yuccas. Of the 19, 8 were reused during 1974, along with 5 new nests, again all in yuccas. In 1975, 18 nests were found, 17 in yuccas and 1 in a mesquite tree. Of these 18 nestings, 2 reused 1974 nests; 2 pairs reused older nests; and the other 14 built new nests.

The preference for yuccas was almost certainly due to the paucity of trees in the study area. The maximum height attained by yuccas in the study area was 5 m, whereas mesquite rarely grows taller than 2.5 m in the study area. As a result of the vegetation type and height, Swainson's Hawks nest heights in the study area were low: 2-4 m ($\bar{x}$ = 2.6).

Clutch Size

Mean size of the eight complete clutches in 1974 was 2.6 eggs, with two and three being minimum and maximum numbers (Table 1). In 1975, the mean size of the six complete clutches was 3.0, with extremes of two and four. The average clutch size for the combined years was 2.8 eggs.

Hatchability

Of the 21 eggs laid in 1974, 19 (90%) hatched, resulting in a mean of 2.4 nestlings per nest. In 1975, 18 eggs were laid and 15 (83%) hatched, resulting in a mean of 2.5 nestlings per nest. Thus, production of hatchlings was virtually identical in both years. In 1974, the probability of hatching (probability of hatching any egg laid) was 0.91. In 1975, the probability of hatching was 0.83. Failure to hatch was the major mortality factor during 1975, but was only slightly more important than mortality of nestlings. The overall probability of hatching for both years was 0.87.

Fledging Success

In 1974, fledging success on the study area was 1.3 young per nest or 48% of the total eggs laid. In 1975, the more productive year, 2.2 young fledged per nest, or 75% of the total eggs laid. The combined mean number of fledglings per nest was 1.6, 50% of the total

TABLE 1

Nesting Success of the Swainson's Hawk on 143 km NNE of Las Cruces, New Mexico

Nest Number	Clutch Size 1974	Clutch Size 1975	Number Hatched 1974	Number Hatched 1975	Percent Hatched 1974	Percent Hatched 1975	Number Fledged 1974	Number Fledged 1975	Percent Fledged 1974	Percent Fledged 1975
1	3	3	3	3	100	100	1	3	33	100
2	3	4	2	4	67	100	1	3	33	75
3	3	3	3	2	100	67	2	1	67	33
4	2	3	2	3	100	100	2	3	100	100
5	3	3	2	2	67	67	1	2	33	67
6	3	2	3	1	100	50	1	1	67	50
7	2		2		100		1		50	
8	2		2		100		1		50	
TOTALS	21	18	19	15	90	83	10	13	48	72
Avg.	2.6	3.0	2.4	2.5			1.3	2.2		

11 eggs laid.

In 1974, the probability of fledging of a nestling was 0.53. The overall probability of fledging, at egg laying, was 0.48; that is, approximately 50% of all eggs laid, hatched and fledged. In 1975, the comparable probability was 0.87. The overall probability of fledging at egg laying was 0.72; that is, approximately 75% of all eggs laid also hatched and fledged. The overall probability of fledging of a nestling for both years was 0.68. In both years of the study, the resultant probability of an egg hatching and proceeding through the nestling stage to fledge was 0.59.

Mortality

Factors involved in failure to hatch included eggs being infer-tile, cracked, pushed out of the nest, and apparently dehydrated. Specific causes of the loss of young were often difficult or impossi-ble to determine, but important known causes included young being crowded or blown out of the nest, retarded growth rate and subsequent mortality as a result of food monopolization by older nestmates, and fratricide (Pilz 1976, Pilz and Seibert 1978).

Comparison With Other Studies

In 1974, 13 active nests were found in the study area. Of these, 5 were new nests. In 1975, 18 active nests were found; 2 were 1974 nests, 2 were pre-1973 or 1973 nests, and the other 14 were new nests. Using the estimated home range diameter of 2.6 km, determined by

Craighead and Craighead (1956), each new 1975 nest was within this distance of the nearest old nest. This supports McCreary's (1939) hypothesis that Swainson's Hawks will build from one to three nests within their home range to which they return season after season and may utilize one for several years in succession.

The average density of Swainson's Hawks in my study area for the years 1974 and 1975 was one pair per 9.45 km^2. This density is one of the highest recorded in the literature. Craighead and Craighead (1956) found one pair per 6.2 km^2 near Jackson Hole, Wyoming. Dunkle (1977) found one pair per 6.7 km^2 near Laramie, Wyoming. Smith and Murphy (1973) found one pair per 166 km^2 in the eastern Great Basin of Utah, and Olendorff (1973) found one pair per 37 km^2 in northeastern Colorado.

The reproductive chronology of the Swainson's Hawk in southern New Mexico is very similar to that in other regions. Bowles and Decker (1934) reported that in Washington, nest building begins in mid-April, with May 15 being the average date of complete clutches. Craighead and Craighead (1956) noted that in Wyoming, nest building begins in mid-April with the earliest egg laying date being May 15. They found the earliest hatching date to be June 16 and the latest to be July 3. Smith and Murphy (1973) found Swainson's Hawks to arrive in Utah in early to mid-April; laying began as early as April 28 and continued to May 8, with May 5 as the average laying date. The earliest hatching date was May 27, with June 1 as the average.

Nest heights in southern New Mexico were lower ($\bar{x}$ = 2.6 m) than in more northern portions of the Swainson's Hawk's range. Sharp (1902), Bent (1937), Dunkle (1977), and Bowles and Decker (1934) found nests from 2 m to 23 m high. These other studies were all conducted in areas with tall trees and large shrubs that provided a greater variety of nest sites and heights.

Clutch sizes of Swainson's Hawks in southern New Mexico averaged 2.8 eggs for both years. This average is greater than found in several studies conducted in other portions of the breeding range. Smith and Murphy (1973) reported 2.2 eggs per nest in Utah. Craighead and Craighead (1956) noted a mean of 1.8 in Jackson Hole, Wyoming. Dunkle (1977) found a mean of 2.2 on the Laramie Plains, Wyoming. Finally, Olendorff (1973) found that Swainson's Hawks in northeastern Colorado had an average clutch of 2.3 eggs.

The overall probability of hatching for both years in southern New Mexico was 0.87. Smith and Murphy (1973) and Olendorff (1973) reported 100% hatchability, considerably greater than in this study, but the mean numbers of nestlings per nest (2.2 and 2.3, respectively) were similar. Craighead and Craighead (1956) reported only 71% hatchability and a mean of 1.3 nestlings per nest, considerably fewer than in the previously mentioned studies.

Swainson's Hawks in southern New Mexico fledged 1.6 young per nest, one of the highest fledging rates reported in the literature.

Elsewhere, Olendorff (1973) found a fledging success of 54% or 1.2 young per nest in northeastern Wyoming. Smith and Murphy (1973) reported the highest fledging success, 64% or 1.8 young per nest, in Utah, and Craighead and Craighead (1956) found the lowest fledging success, 42% or 0.8 young per nest in Jackson Hole, Wyoming. In this study, the probability of fledging at egg laying was 0.59.

Smith and Murphy's (1973) study revealed the highest overall probability of fledging at egg laying at 0.63. Olendorff (1973) reported an overall probability of fledging at egg laying of 0.51, whereas Craighead and Craighead (1956) reported the lowest overall probability of fledging of the four studies at 0.43.

DIET

Results

Because of the difficulty in differentiating between certain mammals, they were grouped into two categories: (1) lagomorphs, which included *Lepus californicus* and *Sylvilagus audubonii*, and (2) wood rats, which included *Neotoma albigula* and *N. micropus*.

In the analysis of prey items collected at eight nests during 1974 and six during 1975, I identified 21 species of prey. In 1974, 19 species and 258 individual prey items were identified (Table 2). This compares to 18 species and 294 individual prey items in the 1975 sample (Table 3). In 1975, 109 individual prey items occurred in the morning sample and 189 in the afternoon sample, indicating a greater hunting effort later in the day.

1974 Diet

Morning gullet sampling in 1974 resulted in the identification of seven mammal, eight reptile, three avian, and one (?) amphibian species (Table 2). Swainson's Hawks preyed most frequently on reptiles (55% of the prey items), which contributed 22% of the biomass, the second greatest amount. Mammals were the second most frequently taken prey item (42% of the prey items) but contributed the most prey biomass (79%). Birds contributed 2% of the prey items and 4% of the

TABLE 2

Diet of Nestling Swainson's Hawks in South-Central New Mexico, 1974

Prey Species	No. Indv.	% Indv.	Approx. Biomass (g)	% Biomass
Mammals				
Lagomorph species (juv)[a]	35	13	8,750	43
Dipodomys spectabilis	28	11	4,340	22
Dipodomys ordii Dipodomys merriami	28	11	1,188	6
	0	0	0	0
Spermophilus spilosoma	9	3	949	5
Neotoma species	2	1	265	1
Dipodomys species	4	2	317	2
Sigmodon hispidus	0	0	0	0
Unidentified mammal	2	1	--	--
Total Mammals	108	42	15,809	79
Reptiles				
Phrynosoma cornutum	66	25	2,468	12
Cnemidophorus tigris	60	23	1,044	5
Phrynosoma modestum	3	1	--	--
Cnemidophorus tesselatus	2	1	--	--
Crotaphytus wislizenii	2	1	--	--
Sceloporus magister Arizona elegans Masticophis flagellum	1	1	--	--
	5	2	375	2
	3	1	450	2
Total Reptiles	142	55	4,337	22
Birds				
Callipepla squamata (juv)	1	1	--	--
Icterus parisorum (juv)	2	1	--	--
Lanius ludovicanus (juv)	1	1	--	--
Unidentified bird (juv)	0	0	0	0
Total Birds	4	2	--	--
Amphibians				
Bufo species Total	4	2	--	--
Amphibians	4	2	--	--
TOTAL SAMPLE	258		20,146	--

a = Lepus californicus and Neotoma albigula and N.

b = Sylvilagus auduboni micropus

TABLE 3

Diet of Nestling Swainson's Hawks in South-Central New Mexico, 1975

Prey Species	No. Indv.	% Indv.	Approx. Biomass (g)	% Biomass
Mammals				
Lagomorph species (juv)[a]	26	9	6,500	30
Dipodomys spectabilis	12	4	2,015	9
Dipodomys ordii	8	3	340	2
Dipodomys merriami	1	1	--	--
Spermophilus spilosoma	65	22	6,852	32
Neotoma species	11	4	1,456	7
Dipodomys species Sigmodon hispidus Unidentified mammal	6	2	396	2
	2	1	221	--
	4	1	--	--
Total Mammals	135	45	17,780	82
Reptiles				
Phrynosoma cornutum	42	14	1,571	7
Cnemidophorus tigris	95	32	1,653	8
Phrynosoma modestum	1	1	--	--
Cnemidophorus tesselatus	2	1	--	--
Crotaphytus wislizenii	0	0	--	--
Sceloporus magister Arizona elegans Masticophis flagellum	1	1	--	--
	8	3	600	3
	2	1	300	1
Total Reptiles	151	53	4,124	19
Birds				
Callipepla squamata (juv)	4	1	--	--
Icterus parisorum (juv)	0	0	0	0
Lanius ludovicanus (juv)	0	0	0	0
Unidentified bird (juv)	4	1	--	--
Total Birds	8	2	--	--
Amphibians				
Bufo species	1	1	--	--
Total Amphibians	1	1	--	--
TOTAL SAMPLE	294		22,010	--

a = Lepus californicus and Sylvilagus auduboni b = Neotoma albigula and N. micropus

biomass. Amphibians also contributed 2% of the prey items and 4% of the biomass.

The most frequent prey was the Texas horned lizard (Phrynosoma cornutum), which comprised 25% of the total. The second most fre-quently taken prey was the western whiptail lizard (Cnemidophorus tigris), 23% of the total prey items. Lagomorphs contributed 13% of

the total prey items taken; they were the third most common prey items.

Lagomorphs contributed the greatest amount of biomass (45%) with the bannertailed kangaroo rat (Dipodomys spectabilis) contributing the second greatest amount of biomass (23%). The Texas horned lizard (P. cornutum) contributed only 13% of the total biomass (third largest amount of biomass) even though it was the most frequently taken prey species.

1975 Diet

During the AM and PM sampling regime in 1975, eight mammal, seven reptile, one avian, and one amphibian species were taken as prey (Table 3). Table 4 portrays the individual results of the AM and PM sampling periods. As in 1974, reptiles were the most frequently taken (53% of the prey items) and contributed 19% of the biomass.

TABLE 4

Diet of Nestling Swainson's Hawks in South-Central New Mexico During 1975 AM and PM Sampling Periods

Prey Species	No. Indv. AM	% Indv.	No. Indv. PM	% Indv.
Mammals				
Lagomorph species (juv)[a]	12	11	14	7
Dipodomys spectabilis	6	6	6	3
Dipodomys ordii *Dipodomys merriami*	5	5	3	2
Spermophilus spilosoma	0	0	1	1
Neotoma species[b] *Dipodomys* species *Sigmodon hispidus*	13	12	52	27
Unidentified mammal	2	2	9	5
	3	3	3	2
Total Mammals	1	1	1	1
	0	0	4	2
	42	40(31)[c]	93	49(69)
Reptiles				
Phrynosoma cornutum	11	11	31	16
Cnemidophorus tigris	42	40	53	28
Phrynosoma modestum	0	0	1	1
Cnemidophorus tesselatus	0	0	2	1
Crotaphytus wislizenii	0	0	0	0
Sceloporus magister *Arizona elegans* *Masticophis flagellum*	0	0	1	1
	4	4	4	2
	2	2	0	0
Total Reptiles	59	57(39)	92	48(61)
Birds				
Callipepla squamata (juv)	2	2	2	1
Icterus parisorum (juv)	0	0	0	0
Lanius ludovicanus (juv)	0	0	0	0
Unidentified bird (juv)	2	2	2	1
Total Birds	4	4	4	2
Amphibians				
Bufo species Total	0	0	1	1
Amphibians	0	0	1	1
TOTAL SAMPLE	105		190	

a = *Lepus californicus* and *Sylvilagus auduboni.*
b = *Neotoma albigula* and *N. micropus.*
c = Numbers in () represents the percent of each class of prey eaten in the AM or PM.

Mammals were again the greatest biomass contributor (81%). Birds and amphibians contributed 2% and less than 1% of the frequency respectively, and both contributed less than 1% of the total biomass.

Swainson' s Hawk adults provided more spotted ground squirrels (Spermophilus spilosoma) to their young in biomass (32%) than any other prey item. Lagomorphs (Lepus and Sylvilagus) constituted the second greatest biomass, 30% of total. The bannertailed kangaroo rat (D. spectabilis) comprised 9% of the total biomass of prey taken, making it the third most important prey item.

The most frequently taken prey items were reptiles. The western whiptail lizard (C. tigris) was taken as prey more often than any other prey item (33%), but contributed only 8% of the total biomass of prey. The next most frequently taken reptile was the Texas horned lizard (P. cornutum) (14%); it comprised 7% of the biomass.

From the 1975 data it can be seen that the afternoon sampling period produced the greatest variety of prey. This was probably due to two factors. First, collecting the gullet samples beginning at 08:00 MDT, during the months of June and July, permitted the adults to bring food to the nests for three to six hours (dawn to the time the gullet sample was collected). In the PM sampling period, the adults had from 10 to 13 hours to hunt and bring food to the nests. Second, two prey species are more active in the warmer periods of the day, making them more likely prey for adult Swainson's Hawks. These are

the spotted ground squirrel (S. spilosoma), and the western whiptail lizard (C. tigris).

From the combined results of the 1974 and 1975 (Table 5), prey items most frequently taken, in decreasing order of importance, were western whiptail lizard (C. tigris) (28%), Texas horned lizard (P. cornutum) (19%), and the spotted ground squirrel (S. spilosoma) (14%). When the biomass of prey is considered, the importance of the prey

species changes. Lagomorphs (Lepus and Sylvilagus) were the most im-portant in biomass (36%), with the spotted ground squirrel (S. spilosoma) ranking second, (19%), and third, the bannertailed kangaroo rat contributing 15% of the total biomass. Thus, even though reptiles were the most frequently taken prey (53%) compared to mammals (44%), birds (1%), and amphibians (1%), mammals contributed the most biomass
(81%).

Comparison With Other Studies

Swainson's Hawk in southern New Mexico utilized 19 prey species, the greatest variety reported. Smith and Murphy (1973) reported 15 prey species in Utah, while Olendorff (1973) found 16 prey species in northeastern Colorado.

In Utah, Smith and Murphy (1973) also found mammals the most important prey class (99.3%) and lagomorph species to be the most important prey items. Dunkle (1977) found mammals to be the most

TABLE 5

Diet of Nestling Swainson's Hawks
in South-Central New Mexico During 1974 and 1975, Combined

Prey Species	No. Indv.	% Indv.	Approx. Biomass (GMS)	% Biomass
Mammals				
Lagomorph species (juv)[a]	61	11	15,250	36
Dipodomys spectabilis	41	7	6,355	15
Dipodomys ordii	36	7	1,528	4
Dipodomys merriami	1	1	--	--
Spermophilus spilosoma	74	14	7,801	19
Neotoma species[b]	13	2	1,721	4
Dipodomys species	9	2	713	2
Sigmodon hispidus	2	1	221	1
Unidentified mammal	7	1	--	--
Total Mammals	245	44	33,589	81
Reptiles				
Phrynosoma cornutum	108	19	4,039	10
Cnemidophorus tigris	155	28	2,697	6
Phrynosoma modestum	5	1	--	--
Cnemidophorus tesselatus	4	1	--	--
Crotaphytus wislizenii	2	1	--	--
Sceloporus magister	2	1	--	--
Arizona elegans	13	2	975	2
Masticophis flagellum	5	1	750	2
Total Reptiles	294	53	8,461	20
Birds				
Callipepla squamata (juv)	5	1	--	--
Icterus parisorum (juv)	2	1	--	--
Lanius ludovicanus (juv)	1	1	--	--
Unidentified bird (juv)	4	1	--	--
Total Birds	12	2	--	--
Amphibians				
Bufo species	5	1	--	--
Total Amphibians	5	1	--	--
TOTAL SAMPLE	553		42,050	

a = Lepus californicus and Sylvilagus auduboni
b = Netoma albigula and N. micropus

DISCUSSION

Population

Even though southern New Mexico is near the southern end of the Swainson's Hawk breeding range, the density was high compared to other portions of its range. These high densities are probably due in part to the grassland nature of this portion of the Chihuahuan Desert. Grassland habitat is the preferred breeding and wintering habitat of Swainson's Hawk. Due to the vegetational diversity in this portion of the Chihuahuan Desert, animal diversity also is high. As a result of this diversity, many prey species are available. This prey diversity provides the hawks with several alternate prey items and this, in part, also explains the high density in this area.

Clutch sizes were greater in this study than those in grassland areas in other western states. This regional difference and the dif-ference between years in this study could be explained by Lack's (1954) theory that an abundant prey base could affect the clutch size. That is, with an abundant, diverse prey base, the Swainson's Hawk responds physiologically and produces more eggs since there will be enough food for the extra young. This was found to be the case in several studies of owls (Rendall 1925; Schneider 1928; Schmaus 1938; Elton 1942; Moreau 1944; Schifferli 1949; Lack 1954. A second theory which could explain this larger clutch size is that of Cody (1966), who postulated that in unpredictable environments clutch sizes will be larger than those in predictable environments. The Chihuahuan Desert

is variable in temperature, rainfall, and probably prey numbers; however, the relatively high breeding density and nestling survival suggest a favorable food supply that accords better with the theory of Lack.

Diet

The diet of the Swainson's Hawk in the Chihuahuan Desert in southern New Mexico is somewhat different from that in other parts of its range. In this study, they relied mainly on mammals and reptiles as prey. Other studies showed mammals and birds to be the most important prey and insects to be frequently taken. This was not true of this study since there are few flocking avian species present on the study area during the breeding season; reptiles are probably utilized as the alternate prey items, as a result. It can be seen from Tables 2 and 4 that the importance of each prey item can change from year to year. This is probably due to fluctuations in the numbers of each prey species and not due to selective predation by Swainson's Hawk.

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APPENDIX

Weights of Prey Species Used in the Biomass Calculations

Species	Approx. Wt. Grams	Source
Mammals		
Lagomorph species (juv)	250	Whitford (Unpbl IBP Data)
Dipodomys spectabilis	155	"
Dipodomys ordii *Dipodomys merriami*	42	"
Spermophilus spilosoma	40	"
Neotoma species *Dipodomys* species *Sigmodon hispidus*	105	"
	132	"
	79	"
	110	"
Reptiles		
Phrynosoma cornutum	37	"
Cnemidophorus tigris Arizona *elegans* *Masticophis flagellum*	17	"
	75	Univ. N.M. Vert. Museum
	150	"

a = *Lepus californicus* and *Sylvilagus auduboni* b = *Neotoma albigula* and *N. micropus*