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Winter ecology of the gray vireo *Vireo vicinior* in Sonora, Mexico

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The University of Arizona, 1987

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**WINTER ECOLOGY OF THE GRAY VIREO *VIREO VICINIOR*
IN SONORA, MEXICO**

by
John Marshall Bates

**A Thesis Submitted to the Faculty of the
DEPARTMENT OF ECOLOGY AND EVOLUTIONARY BIOLOGY
In Partial Fulfillment of the Requirements
For the Degree of
MASTER OF SCIENCE
in the Graduate College
THE UNIVERSITY OF ARIZONA**

1987

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19 November 1987
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TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS	iii
LIST OF ILLUSTRATIONS	v
LIST OF TABLES.....	vi
ABSTRACT	vii
1. INTRODUCTION.....	1
2. STUDY SITES AND METHODS	4
3. RESULTS	11
Banding Data and Population Structure	11
Banding Data	11
Sex Determination.....	14
Wintering First-year Birds	14
Movements by Banded Birds	15
Unbanded Birds on the Study Sites	16
Weight Changes Across the Winter	16
Winter Vocalizations.....	19
Territoriality and Trespassing	22
Evidence for Territoriality.....	22
Evidence for Trespassing	24
Foraging and Interspecific Interactions.....	27
Plant Use by Vireos	27
<i>Bursera</i> and Gray Vireos.....	28
Interspecific Interactions	35
4. DISCUSSION	37
The Winter Distribution of Sexes.....	37
Why Defend Winter Territories?.....	37
Trespassing	38
The Effect of Gray Vireo Density on Their Winter Behavior.. ..	39
Frugivory in the Winter.....	39
Competition Among Plants for Dispersers in the Lobos Area.....	40
5. CONCLUSION.....	42
6. APPENDIX I. Plants of Cerro Prieto and San Lorenzo	43
7. APPENDIX II. Birds of Cerro Prieto and San Lorenzo.....	44
8. LITERATURE CITED.....	45

LIST OF ILLUSTRATIONS

Figure	Page
1. The Winter Range of the Gray Vireo.....	3
2. Five Years of Rainfall Data from Puerto Libertad.....	5
3. Map of the San Lorenzo Study Site.....	6
4. Map of the Cerro Prieto Study Site.....	7
5. Mean Weights of Gray Vireos Vireos Across the Winter.....	18
6. Vocalizations per Hour Heard on Each Visit to the Study Sites During the winter of 1986/87.....	20
7. Counts of <i>Bursera microphylla</i> Berries from Flagged Branches at San Lorenzo.....	29
8. Counts of <i>B. hindsiana</i> Berries from Flagged Branches at San Lorenzo.....	30
9. Counts of <i>B. microphylla</i> Berries from Flagged Branches at Cerro Prieto.....	31
10. Counts of <i>B. hindsiana</i> Berries from Flagged Branches at Cerro Prieto.....	32

LIST OF TABLES

Table		Page
1.	Results of Banding on the Study Sites (Five Winters)	12
2.	Captures and Sightings of Marked Birds for the Winters of 1985/86 and 1986/87.....	13
3.	Territory Sizes of Nine Marked Birds	23

ABSTRACT

A marked population of wintering Gray Vireos (*Vireo vicinior*) was studied for two seasons (1985-1986 and 1986-1987) on two study sites near Puerto Lobos, Sonora, Mexico. Eleven of the 15 individuals banded in the first winter returned to the same areas in the following winter. Territories were defended throughout the winter and averaged 0.9 ha in size (N= 9). Territorial interactions occurred frequently along boundaries as neighbors trespassed to forage on each others' territories. All birds appeared to defend individual territories. First year birds appeared to occupy marginal territories on the periphery of the best habitats. Fruit from the elephant tree, *Bursera microphylla*, became a dominant part of the vireos' diet as winter progressed and the fruit ripened. The importance of *B. microphylla* to the vireos' winter diet and the high degree of overlap between the winter range of the vireos and the distribution of the plant suggested a mutualistic interaction between them. Gray Vireos acted as the primary dispersers for the plant.

CHAPTER 1

INTRODUCTION

For north temperate zone insectivorous birds that migrate south for the nonbreeding season, little is known about basic demography and behavioral adaptations for resource acquisition in the winter. Numerous studies report territoriality in wintering passerines (see citations in Keast and Morton 1980; and Greenberg 1986). However, in a recent review of the literature on avian competition in the nonbreeding season, Greenberg (1986) notes that only a few studies have been carried out on territorial wintering birds over the entire winter season (Schwartz 1964; Myers et al. 1979; Rappole and Warner 1980; Greenberg 1984). Despite only a few detailed studies, Greenberg suggests that territoriality is probably the norm among small insectivorous passerines in winter. This study addresses aspects of territoriality and foraging behavior for Gray Vireos (*Vireo vicinior*) wintering along the coast of Sonora, Mexico. Data I present here, collected over two years on an individually marked group of wintering Gray Vireos, indicate that the vireos are strongly territorial and highly frugivorous during the nonbreeding season.

Several of the eleven North American migrant species of the genus *Vireo* have been the subject of detailed ecological studies on their breeding grounds (Barlow 1962; Williamson 1971; James 1976; Barlow and Rice 1977; Rice 1978); however, most information about vireos in winter is restricted to geographic distribution and habitat selection (Barlow 1980; but see Tramer and Kemp 1980). The Gray Vireo is the most locally distributed North American member of the subgenus *Lanivireo* which includes Solitary (*V. solitarius*), Hutton's

(*V. huttoni*), and Yellow-throated Vireos (*V. flavifrons*) (A. O. U. 1983). The species breeds in open pinyon pine and juniper woodland and in the ecotone between this habitat and several types of lower elevation chaparral habitats from western Oklahoma to California and Baja California; and from southern Nevada and Utah to southern Arizona, southwestern Texas and Northern Coahuila, Mexico. Birds migrate south from this range in September to winter primarily in the deserts surrounding the Gulf of California (Figure 1). A small population has also been found wintering in the Chisos Mountains of Texas (Barlow and Wauer 1971). Birds do not leave their wintering grounds until the end of April. Thus, seven months of the year are spent in a desert region which receives as little as 100 mm of rainfall annually.

One initial purpose of this study was to determine if there were territorial pairs of Gray Vireos on the wintering ground as observations of this species (S. M. Russell and J. C. Barlow Pers. Comm.) and several other passerines (Zahavi 1971; Morton 1980b; Greenberg and Gradwohl 1980) suggest the presence of winter pair bonds. Winter pair bonds could affect some traditional notions of mate selection on the breeding grounds should they be maintained into the following breeding season. In addition to looking at territorial activity and patterns, I collected data on foraging behavior. My observations of a color-banded population of Gray Vireos through the winters of 1985-1986 and 1986-1987 in Sonora, Mexico suggest that Gray Vireos are not paired, but that birds do show some interesting behavioral patterns that are different from those reported for other territorial migrant passerines on their wintering grounds.

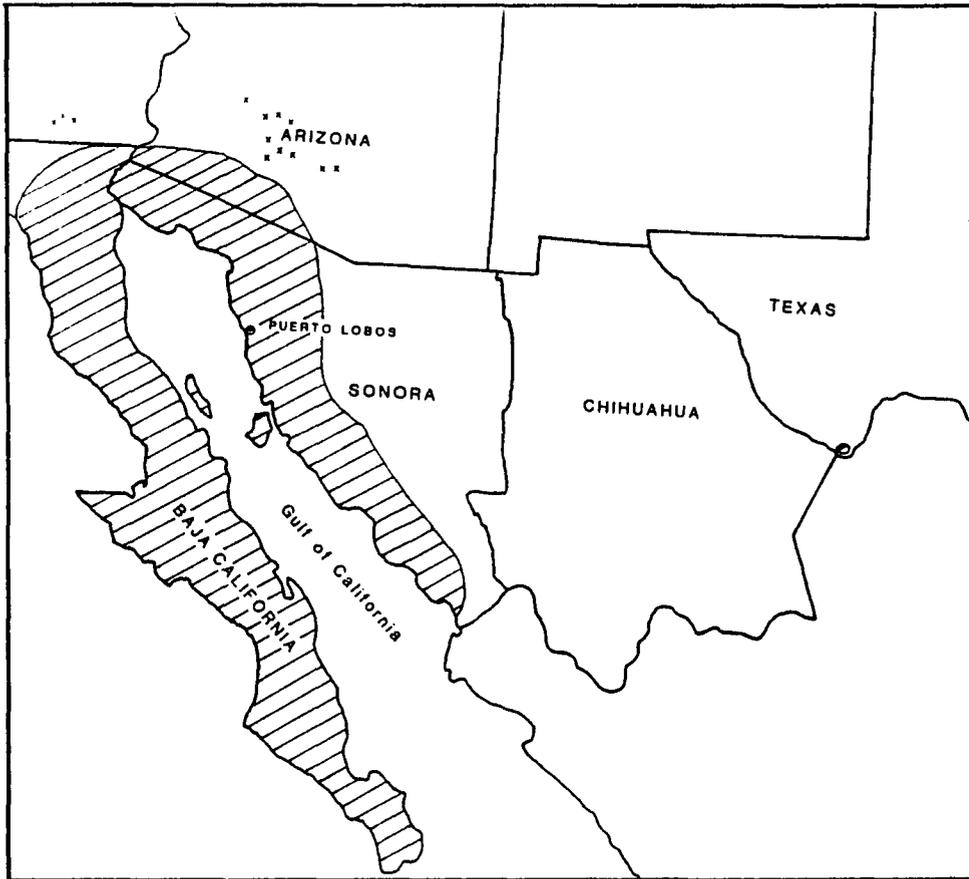


Figure 1. The Winter Range of the Gray Vireo.

As is discussed in the section on Gray Vireos and *Bursera*, the main part of the range overlaps completely with the distribution of *B. microphylla* with the exception of the sites in California and Arizona marked by "x's" (*B. microphylla* distributional data courtesy of R. B. Turner). Only in what appears to be a small isolated area in the Chisos Mountains, Texas does the vireo's winter range fall outside the plant's distribution.

CHAPTER 2

STUDY SITES AND METHODS

The two study sites, Arroyo San Lorenzo (Lat. 30° 17',Long. 112° 48') and Cerro Prieto (Lat. 30° 19',Long. 112° 48') are located to the south and north of the small fishing village of Puerto Lobos, Sonora, Mexico, on the eastern shore of the Gulf of California. Average rainfall for the area is approximately 100 mm per year falling primarily in the late summer and winter. It is not unusual for several months to pass without measurable rainfall. Rainfall data (courtesy of R. B. Turner) by month from January, 1979 to December of 1984 taken at a weather station at Puerto Libertad 30 km south of Puerto Lobos are shown in Figure 2. Rainfall can be very localized in the region so that actual amounts falling at Puerto Lobos may be somewhat different than at Puerto Libertad.

The 10 ha main study area at San Lorenzo is roughly one kilometer long and about 100 m wide (Figure 3). It is the main drainage from a group of hills several kilometers east of the coast. A large alluvial fan covered with teddy bear cholla (*Opuntia biglovii*) runs along much of the north edge of the site and steep canyon walls border much of the southern side. Searches conducted both upstream and downstream from the area revealed vireos in densities similar to those on the site. There are small sparsely vegetated side canyons to the north and south and several vireos maintained territories there also. The much smaller Cerro Prieto site (4 ha) (Figure 4) occupies a shallow drainage running along the base of an isolated volcanic hill into coastal dunes about 1 km from the coast. Except for the upper

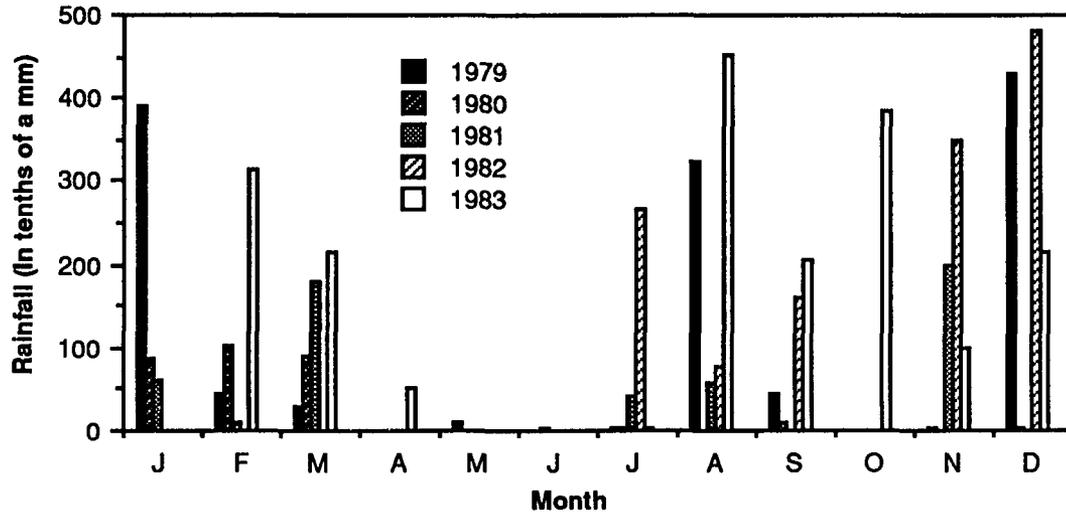


Figure 2. Five Years of Rainfall Data from Puerto Libertad.

Note that the amount of rainfall in any month can vary greatly between years but that the periods with most rain are in the late summer and winter.

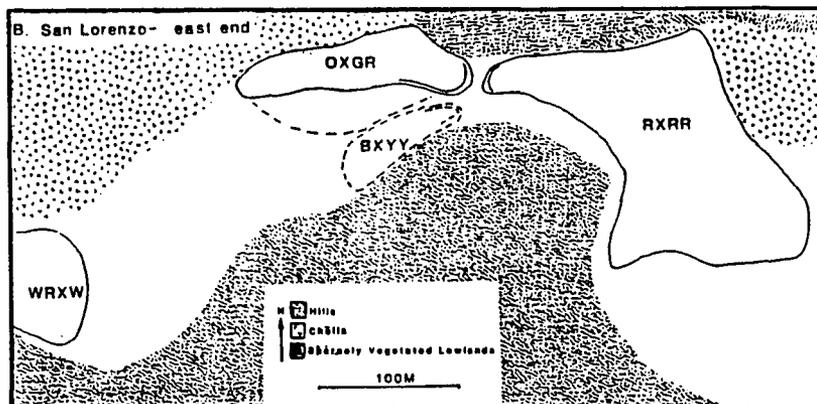
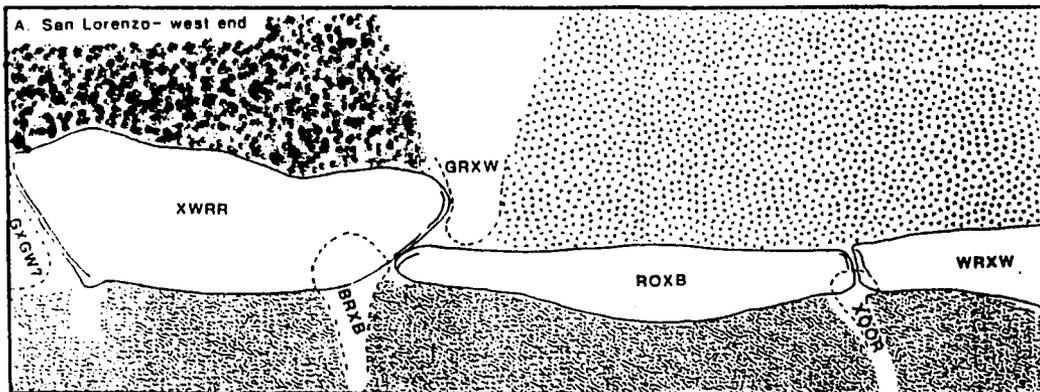


Figure 3. Map of the San Lorenzo Study site.

The site has been cut into two halves. The unshaded areas represent more densely vegetated arroyos favored by the vireos. Territories of marked birds are shown. Double lines where territories abut represent areas where encounters between neighboring individuals were frequent. Dotted lines indicate where I could not establish territorial boundaries.

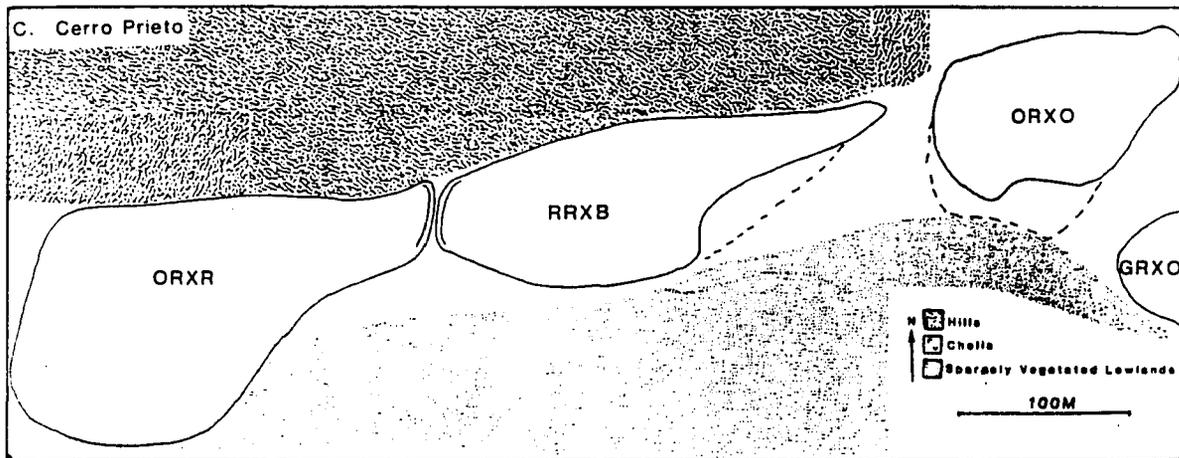


Figure 4. Map of the Cerro Prieto Study Site.

The legend is the same as for Figure 3.

part of the drainage to the east, the only vireo territories in the area were on the study site. While these study sites are about ten kilometers apart, they have very similar vegetation and fauna and for most aspects of the study they have been considered together.

The Puerto Lobos area is part of Lower Colorado River Valley subdivision of the Sonoran Desert Scrub biome (Brown 1982), but the arroyos (washes) where the study sites are located share vegetational features with Central Gulf Coast flora found further to the south. These arroyos are dominated by "stem succulents," including two species of elephant tree (*Bursera hindsiana* and *B. microphylla*), and two species of columnar cacti (*Pachycereus pringlei* and *Lophocereus schottii*). Also common in the arroyos are jojoba (*Simmondsia chinensis*), limber bush (*Jatropha cuneata*), and ironwood (*Olneya tesota*). The surrounding hillsides are sparsely vegetated, primarily by creosotebush (*Larrea tridentata*) and white brittlebush (*Encelia farinosa*). A more complete listing of the common perennial plant species in the area is given in Appendix 1.

Despite the unavailability of fresh water and the high summer temperatures, the area supports about thirty permanent or semipermanent resident bird species (Appendix 2). In addition, numerous species pass through during migration. Over 90 species of land birds were recorded on the sites during the two year period.

Field work was conducted on three to six day trips to the study areas. While this limited the amount of work possible on a given trip, I was able to follow the birds during the entire winter season. Sixteen trips were made between January 1986 and April 1987. Four of the trips were made during the winter of 1985-1986; the other twelve were made during the winter of 1986-1987.

Between January 11 and April 6, 1986, I spent eight full days and 8 half days on the

study sites. Full days refer to days where most daylight hours were spent on the study sites. On half days, the morning or late afternoon hours were spent on the sites but not both. The goal was to color-band as many Gray Vireos in the area as possible. During the winter of 1986-1987 (September- April), 25 entire days and 22 half days (296 total hours) were spent primarily gathering data on the movements and other behaviors of individually marked birds. Mist netting in this second season was done on an irregular basis, usually to catch unbanded birds seen in certain areas; it also provided information on the movements of previously banded birds on the study sites. All captured vireos were weighed and measured and banded with a unique three color-band combination and a U.S.F.W. Service aluminum band. Individual birds can therefore be referred to by their color combination such as OXGO for an individual with orange and aluminum bands on the left leg and green and orange bands on the right leg. Fecal material was collected from eight captured birds and later examined for insect parts and fruit material to assess diets. Laparotomies were performed on two individuals in March of 1987.

I made maps of each study area by establishing transects with stakes placed every thirty meters through each study area. Plants and other features could then be located relative to one another by pacing their perpendicular distance off the transect and noting the point on the map. When birds were observed, they were identified by color-band combination and followed as long as possible. Data were collected on movements and other behaviors such as foraging and vocalizing. The height of the birds in the vegetation was estimated and recorded. Also, their general position on the study area was noted and their movements placed on the study site maps. I determined territorial boundaries of the birds by collating all movements of each bird. Data taken in the field were often dictated onto a cassette recorder

and later transcribed into a field notebook.

I also collected data on fruit disappearance from the two species of elephant tree, *B. microphylla* and *B. hindsiana*. Both species produce fruits with fibrous outer coverings surrounding seeds wholly or partially encased in a bright orange fleshy aril. These seeds are dispersed by birds that consume them for the fleshy aril.

Single branches on 14 different trees of each species were marked and the number of berries they bore was censused on each trip to the sites. Caloric content of the arils of each species was measured using a Phillipson Oxygen Microbomb Calorimeter (Gentry Instruments Inc.). Calculations of the caloric content per gram of aril for each species were done following the procedure of Phillipson (1964).

CHAPTER 3

RESULTS

Banding Data and Population Structure

Banding Data

From January through April, 1986, fifteen birds were color-banded on the two study sites. Eleven of these birds (73%) returned in the winter of 1986-1987 to the same areas where they had been initially captured. Stephen M. Russell has banded birds in the spring on the San Lorenzo study site beginning in March of 1983. Over the course of the five winters beginning with 1982-1983, 41 vireos have been banded and released. Three of the birds captured in March of 1983 were color-banded with the 1985-1986 group. Two of these birds were back for the winter of 1986-1987. These birds were therefore at least five years old when they moved north at the end of the 1986-1987 winter. Table 1 lists the capture records for both study sites.

Table 2 contains the capture and sighting data by date for the color-banded birds during the two winters of the study and provides information on the structure of the population. Some individuals were encountered only once or a few times and other birds were seen repeatedly. During the 1986-1987 winter, eight of the 17 banded birds on the sites early in the season were observed on at least five of the 11 trips (Table 2). On some trips, an individual was not positively identified by color-band combination, but vocalizations were heard within the bird's territory. No color-marked bird was detected on each of the

Table 1. Results of Banding on the Study Sites (Five Winters)

Color-Band	Band # *	82/83	83/84	84/85	85/86	86/87
BXY	744	3/31	4/7		**	3/21
XRRB	749	3/31		1/4	1/12	
	750	4/1				
	751	4/1				
	755	4/1				
	756	4/1				
	758	4/1				
RXRR	762	4/1	4/7		1/11	**
	769	4/2	4/7			
	770	4/2				
	776	4/2	4/7			
	777	4/2				
	778	4/2				
	621		4/7			
	622		4/7	1/5		
	625		4/7			
	798		4/8			
XOOR	805		4/8		1/12	**
GXGG	701				1/12	
WRXW	704				1/12	**
BRXB	707				1/13	**
ROXB	708				1/13	**
WXGG	712				2/28	2/28
ORXR	713				2/28	**
ORXO	724				3/2	11/12
RRXB	727				3/19	**
BRXW	718				3/1	
WXGW	719				2/28	
GRXO	725				3/2	10/4

* Last three numbers of U. S. F. W. Service band

** The individual was seen but not netted

Table 2. Captures and sightings of marked birds for the winter of 1986-1987. N= captured in a net. S= seen only. ?= vocalizations heard or a sighting made in an appropriate area, but positive identification of the individual was not made. S. L.= San Lorenzo, C. P.= Cerro Prieto The dates at the head of the columns are the first date (month/day) of each trip.

		Winter 1986-1987									
Color-Comb.	9/25	10/2	10/25	11/10	11/28	12/11	1/2	1/12	2/27	3/18	4/4
S. L.											
RXRR	S	S	S	S	S	S	?		S		
BRXB		S	N								
WRXW		S	S	S	S	S	?				S
XOOR		S	?								
WXGG									N		
OXGO		N									
WXGB		N		?		?					
OXGR	?		N		S	S/N	S	S	S/N	N	?
GRXW		?	?	N						N	
XWRR	-	--	?	?	N	S	S	?	S		S
BXYY			?	?	S		?	S	S	N	S
GXGW*								N	?		
YXYG*									N		
ORXW*									N		
C.P.											
ORXO	S			S/N							
RRXB	S	?	?	S	S	S	S		S		
ORXR		S	S	S	?	S	S	?	S	?	S
GRXO			S								S
WWBX	N										S
WRXW*							N				N

* These birds were banded off of the main study sites in the main arroyos and therefore they may hold territories in these areas.

11 trips due to the often secretive behavior of the species during the nonbreeding season and to the departure of some individuals prior to April 2, when the last visit to the sites was made. The territories of the eight most frequently observed birds will be discussed in the section on territoriality.

Using all the banding data beginning in 1983, 52% (15 of 29) of the birds returned the winter following banding. This figure probably includes some birds that were migrating through the study areas when captured and is therefore conservative. The 73% return rate for birds banded in 1985-1986 is more accurate. The two rates are very similar to those found in other studies of wintering insectivores. Price (1981) reported a 52% return rate (13 of 25) for all Greenish Warblers (*Phylloscopus trochiloides*) he studied and a 67% return rate (10 of 15) for birds returning to undisturbed habitat. Nesbit and Medway (1972) reported a 63% return rate for Eastern Great Reed Warblers (*Arcocephalus orientalis*).

Sex Determination

Gray Vireos are monomorphic, and there appears to be a bimodal distribution in wing lengths in ten specimens in the University of Arizona collection. Male wing length averages greater than 65 mm (mean= 66.4 mm, range 65-67 mm, N= 5) and female wing length averages less than 65 mm (mean 64.3 mm, range 63-65 mm, N= 5). however there is enough overlap in these measurements that variation in wear of the primaries and other factors may make many birds unidentifiable as to sex.

Wintering First-year Birds.

Observations on three birds indicate that first-year birds generally end winter in areas on the periphery of the best habitats. In a study of a large winter population of semi-territorial

Eastern Great Reed Warblers (Nisbet and Medway 1972) there was a high rate of disappearance for juveniles early in the winter. In the present study, only one vireo (OXGO) first netted by early October (in the 1986-1987 winter) was not seen again; another (WXGB) was seen in October and November but not afterwards. Three other birds caught in the central portion of the study areas for the first time early in the fall of 1986 were seen again in February or March of 1987. Only one of these three birds (OXGR) was seen throughout the winter. This bird was able to defend a small portion of the main arroyo at San Lorenzo for most of the winter and was able to expand its territory to include more of the arroyo as the winter progressed (see Figure 3). WWBX was caught for the first time on the eastern side of the Cerro Prieto site in late September and not seen again until early April. The reappearance of WWBX in April occurred on a territory of a bird that appeared to have already migrated from the study area and I think WWBX spent the winter in marginal habitat northeast of the study site. GRXW, a female by laparotomy, was also not seen for more than three months after banding. She may have had a territory in a sparsely vegetated side canyon to the north of the San Lorenzo site (see Figure 3).

Movements by Banded Birds

Several non-first year birds were sighted on only a few occasions, a pattern that represents usual movements for some members of the population. GRXO, a returning bird at Cerro Prieto in 1986-1987, was seen in late October but not again until early April. Like WWBX described above, the reappearance of this bird was associated with the departure of one or more of the territorial birds (RRXB and perhaps ORXO) on the east side of the Cerro Prieto site. GRXO probably held a territory further to the east throughout the winter (Fig. 4). Another returning bird at the San Lorenzo site, XOOD, was seen early in the the winter of 1986-1987

but not after that (Table 2). This bird was originally banded in April of 1984. Its absence after the initial sighting in 1986-1987 may mean the bird had left the area, although its territory was not well defined and seemed to primarily be in a side canyon to the south of the main arroyo (Fig. 3). It is possible that the bird was able to escape detection for the rest of the winter in this area.

The appearance of WXGG in a net in the center of the San Lorenzo site on 28 February, 1987 is not easily explained. The bird had been first banded on 28 February, 1986 and not observed between captures. The bird may have been a floater that had gone undetected throughout the first part of the 1986-1987 winter, but I think this is unlikely since this was one of the most closely watched sections of the study site.

Two birds, BRXB and ORXO, among the eleven that returned to the study sites for the winter of 1986-1987, having reestablished their territories, were both subsequently captured off their territories. After being recaptured, neither was positively seen again. In BRXB's case, the bird may have lost its territory as a consequence of losing several secondaries in the net. Whether ORXO abandoned its territory or changed its behavior after being recaptured is not clear.

Unbanded Birds on the Study Sites

Early in the winter, unbanded birds may be expected as first year birds arrive and territories are established. Once territories are established unbanded birds should become less frequent. Only five sightings of unbanded birds on the main study areas were recorded from November to May, 1987. These sightings are thought to represent four individuals, perhaps young birds seeking unoccupied areas, or trespassing birds from territories off the study sites. One unbanded bird appeared to have set up a territory to the west of ORXR on

the extreme western edge of the Cerro Prieto site (Fig. 4). It was first seen in mid-January and again in early March but not afterwards. No influx of unbanded vireos was observed in the spring. In Northern Waterthrushes (*Seiurus noveboracensis*) (Schwartz 1964) and Greenish Warblers (Price 1981), individuals that had wintered further south began migrating north through areas with wintering populations before the local wintering individuals had departed.

Weight Changes Across the Winter

Data on weights taken from all Gray Vireos Russell and I captured are shown in Figure 5, grouped to provide sufficient samples throughout the winter. The mean weight of April birds was higher than that of birds which had just arrived in September and October, although there is no appearance of subcutaneous fat in vireos netted prior to Spring migration. Mean winter weight drops to a low in February and rises through March into April when the vireos migrate north. Price (1981) found the same pattern in weights of territorial Greenish Warblers wintering in India as did Pearson (1971) for Willow Warblers (*P. trochilus*) wintering in Uganda.

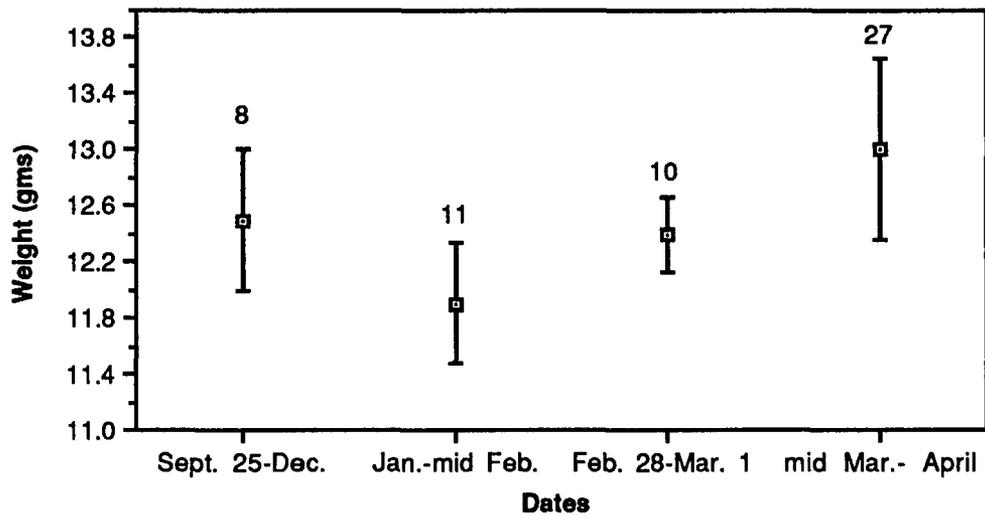


Figure 5. Mean Weights of Gray Vireos in the Winter.

The bars represent one standard deviation. Data include all birds captured between 1983-1987. Note that birds lose weight from time they arrive through mid-February but then increase to an average weight that is higher than their early weight shortly before spring migration.

Winter Vocalizations

Gray Vireos employ three types of vocalizations on their wintering grounds: trills, songs and scolds. The proportions of these vocalizations that are given are different from those in the breeding season. The most commonly given vocalization on the wintering grounds is a trill peculiar to the species (Barlow and Wauer 1971). All birds appear to use trills throughout the winter whereas it is rarely heard on the breeding grounds. It serves in territorial disputes and as a general location call directed at conspecifics. Trills vary in intensity and length which may reflect use in different behavioral situations. Long, low intensity trills are often given when a bird is on the edge of its territory with no other birds apparent in the immediate area. Shorter, high intensity trills are often given in response to a tape or at the outset of a chase between two birds.

During more intense territorial disputes, some birds will sing and bouts of singing may last for over 20 minutes. The usual song consists of slow short phrases that are characteristic of the subgenus *Lanivireo*. Several individuals occasionally sang a faster squeaky version of this song during territorial interactions. The only bird that I have heard give this song type in the breeding season was a copulating male in the Santa Catalina Mountains of southern Arizona. The third type of vocalization is a short harsh scolding note which is also given by other members of the genus. Scolds are often given in series of several hundred by birds on my study areas and are usually directed interspecifically. Vireos attracted by an imitation of a Western Screech-Owl would usually scold.

Although there is some fluctuation, vocal activity decreases as the winter progresses (Fig. 6). The low numbers heard on the October 2 trip are puzzling, however, the decrease in trills seen through the winter is probably due to the stabilization of territorial boundaries. A similar decrease in vocalizations

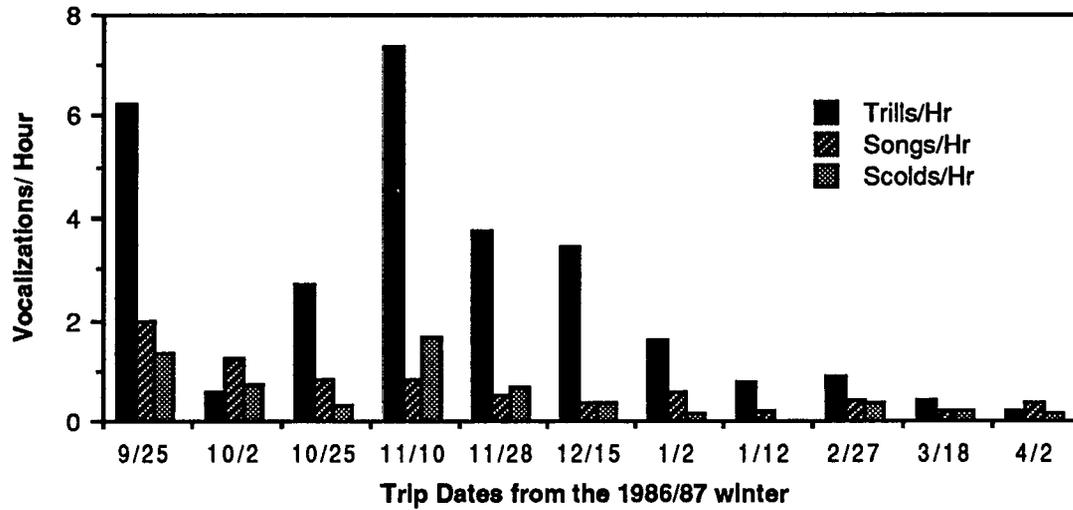


Figure 6. Vocalizations Heard per Hour on Each Visit to the Study Sites in the Winter of 1986/87.

The number of trills drops off as winter progresses presumably because territorial boundaries stabilize.

through the winter has been reported for Greenish Warblers (Price 1981) and this was also thought to be due to greater stabilization of territories later in the season. For the vireos, trills and other vocalizations never ceased completely because trespassing by individuals continued even after territories were well established.

Territoriality and Trespassing

Evidence for Territoriality

There are several lines of evidence indicating that Gray Vireos are territorial on their wintering grounds. First, there is long term site fidelity both within and between winter seasons. All 11 color-banded birds returning in the winter of 1986-1987 occupied the same areas where they were banded in the winter of 1985-1986. Second, over the course of the winter, the identity of a vocalizing bird in a given area was highly predictable. Third, neighboring birds were frequently seen in disputes that occurred in the same areas throughout the winter (Figs. 2,3) For instance, from the hillside to the north of the boundary between ORXR and RRXB's territories I could watch disputes between these two birds(Fig. 4). Disputes appeared to start when one bird was detected on another's territory. One bird would give a trill that would be answered by the other. If the trills were close together along the boundary, one bird would usually move away from the boundary soon after the incident. The birds were not consistent in their roles in these encounters and on occasion one or both birds would begin to sing. Similar types of interactions were given where the territories of RXRR, OXGR, and BXYY came together (Fig. 3). This area was near my camp at San Lorenzo where trilling and occasionally singing could be heard from two to three birds on adjacent territories throughout the winter. Pairs of trills given by one bird and then another such as described above were heard while in many parts of the study sites.

Territory sizes for Gray Vireos, determined by mapping birds' movements onto study site maps, averaged 1.0 ha (Table 3). This was a large winter territory for a bird this size (wt.= 12.3 gms.); it was similar to the size of some breeding territories I have measured for this

Table 3. Territory Sizes of Nine Marked Birds

Color band comb.	Territory Size (ha)
ROXB	1.1
WRXW	0.6
OXGR	0.6
XWRR	1.3
BXYY	0.3
RRXB	1.1
ORXR	1.4
ORXO	0.7
RXRR	1.0
Mean=	1.0

species in Arizona, but smaller than the 2.4 to 8 ha breeding territories reported for the species in central Arizona and Texas, (Barlow 1978). Data on territory size of other vireos on their wintering grounds are unavailable, but Gray Vireo winter territories were much larger than for migrants wintering in the tropics. Rappole and Warner (1980) report that the average wintering Hooded Warbler (*Wilsonia citrina*), and Wood Thrush (*Hylocichla mustelina*) territories are only 0.25 ha. Large winter territories of Gray Vireos were probably associated with a lower resource density in these deserts than in tropical forest.

Not all territorial boundaries for most individuals were well defined but at least three (XWRR, ROXB, and RRXB) interacted frequently with color-banded neighbors on either side. The distribution of densely vegetated habitat in the arroyos caused territories to be arranged in a linear fashion. Thus, some of the boundaries for each bird abutted unsuitable habitat such as the cholla dominated fan to the north of the San Lorenzo site. Birds rarely if ever ventured into these areas.

Evidence of Trespassing.

Nonterritorial or floating birds have been noted in several species of birds during both the breeding and nonbreeding seasons (Smith 1978; Rappole and Warner 1980). In a study of Hooded Warblers (*Wilsonia citrina*) wintering in Mexico, Rappole and Warner (1980) cite three reasons why they thought there were a substantial number of nonterritorial individuals or floaters on their sites in southern Mexico: 1) these individuals were captured throughout the winter on other birds' territories; 2) these individuals took over territories of occupants given the opportunity; 3) movement and other behavior of these individuals were very different from those of territory owners.

Rappole and Warner do not exclude the possibility that these "nonterritorial birds" are

not simply trespassing birds from neighboring territories. While there were several Gray Vireos on my two study sites that might have been floaters based on their low yet widely spaced incidence of detection during the study, some of these were observed early in the winter (September and October) and may have been first year birds that were unable to obtain a territory in the area and therefore moved on. As described earlier, unbanded birds were rarely seen on the main study sites; yet, I often observed color-banded individuals that had crossed into a neighbor's territory. On two occasions, I caught color-banded birds whose territories were known, in nets set up in the middle of territories adjacent to their own.

Trespassing did not seem to be a one-way interaction; birds adjacent to one another would frequently enter each other's territory. When a bird reached the edge of its territory it would often continue foraging silently into the next territory until it was detected. Birds moved as much as 70 meters into neighbors' territories. This behavior occurred throughout the winter. The trespassing events did not seem attributable to ill-defined boundaries. Once a territorial bird detected the neighboring invader there would be a chase and then the two birds would display, often countersinging, across an open area. This would often be the same area, with the birds even occupying the same two bushes in different encounters. I have observed the same behavior in individuals wintering in similar habitat in the Sierra Pinta Mountains of southwestern Arizona 150 km north of Puerto Lobos.

While the following evidence is circumstantial, it suggests that for Gray Vireos, neighbors and not floaters benefit from the disappearance of a territorial bird. On 4 October, 1986, RRXB, a territory holder on the western edge of the San Lorenzo site, was caught 70 meters off its territory along with an unbanded bird (banded as OXGO). RRXB lost several secondaries in the net and while it flew off ably after release, it was not seen again (nor was

OXGO). During the next month, I saw an unbanded bird on several occasions in part of the territory formerly occupied by RRXB in interaction with another unbanded bird that always remained in an area to the north. On 29 November, I erected nets in the area where these birds had been and within an hour, captured two unbanded birds. The one caught on RRXB's territory was banded as XWRR. I followed XWRR frequently during the subsequent months, and in addition to using the area on RRXB's former territory, the bird also occupied an extensive area to the west. RRXB had always occupied the side canyon to the south and was never seen to the west in the main arroyo. However, I had heard trills in that direction from another bird. I think that XWRR had been RRXB's neighbor to the west who incorporated at least a portion of RRXB's territory into its own upon RRXB's disappearance. As a result, XWRR had one of the larger territories in the study (Table 3).

Rappole's observation that the behavior of a "floater" was different than that of a territorial owner also holds for territorial Gray Vireos crossing on to a neighbor's territory. The only time I heard a bird vocalize on a neighbor's territory was in early April when the neighbor had already left the study area. On most occasions, the trespassing birds were silent and foraged inconspicuously in the densest vegetation available. My observations of Gray Vireos indicate that most aggressive interactions in the winter, even ones involving long chases, result from the detection of a trespassing neighbor and not of a nonterritorial bird.

Foraging and Interspecific Interactions

Plant Use by Vireos

Members of the Family Vireonidae are typical insectivores (Chapin 1925). Several species eat large quantities of fruit during the nonbreeding season (Chapin 1925; Morton 1977). The relatively large bill and gape compared to many parulids and other small insectivorous passerines are ideal for handling small berries in addition to large-bodied insects. Although insectivorous in the breeding season (Chapman 1925; Barlow 1978), Gray Vireos also consumed substantial amounts of fruit in the nonbreeding season.

For much of a typical day during the winter, the vireos moved slowly throughout their territories and foraged for insects in a variety of plants. Birds followed for at least fifteen minutes (mean observation= 32 minutes; N=26) visited an average of 4.4 species of plants and 7.8 individual plants. This is probably an underestimate of both species and individual plants visited because the density of the vegetation made it impossible for me to view the birds continuously. Also, vegetation on the study sites grows in large interwoven clumps with up to six woody perennial plant species growing together, so that a bird perched on one species might actually be gleaning insects off another species. With the exception of cacti, the birds were observed in all common woody perennial plant species greater than 0.5 m in height. Data on the percentage of vireo observations that were made in each plant species are shown in Appendix 1. Forty-two percent of the individual plants in which Gray Vireos were observed were one of the two species of *Bursera* trees.

Gray Vireos foraged for insects primarily in the lowest meter of vegetation inside the outer layer. This is not the case when an individual is searching through a *Bursera microphylla* tree for berries; then it often foraged in peripheral twigs at higher levels where fruit was most abundant. Even when searching for fruit, a bird will often pluck a berry and fly down to consume it in the adjacent dense vegetation before resuming the search.

Bursera and Gray Vireos.

The two species of elephant tree in the genus *Bursera* (Burseraceae) that occur in the Puerto Lobos area produce leaves and fruit during the winter. The family is widely distributed in the tropics and the aril covered seeds of many species are eaten and dispersed by birds (Foster 1982; Trainer and Will 1984; Grant 1986). The two species in the Puerto Lobos region are also bird dispersed. Unripe fruits have fibrous red or purple coverings which split as the fruit ripen to expose bright, orange arils covering the seeds. It is the aril, which is analogous to the pulp of other fruits, that induces most birds to eat the fruits. I observed Gray Vireos consuming the fruit of only one of these species: *B. microphylla*. Even though the vireos were not observed eating *B. hindsiana* fruit, I have included data collected on the availability of fruits of this species. The data on *B. hindsiana* show that the species has a contrasting strategy for attracting dispersers compared to *B. microphylla*. Given the recent number of studies on the competition for avian dispersers among plants (Herrera 1984, 1985; Wheelwright 1986), it is worthwhile to consider the larger winter frugivore community of which Gray Vireos are a part.

The most striking difference in fruit production between the elephant trees is that *B. hindsiana* berries appear and disappear within the period that *B. microphylla* is continually in fruit. In *B. hindsiana*, flowering and fruit set were occurring in the third week of September and virtually all fruit had been removed by mid-March. *B. microphylla* trees had completed fruit set by the first week of September and often half the crop was still on the trees in the first week of April. To measure rates of disappearance of fruits of both species, selected single branches on 14 trees at both sites were flagged and berry counts of the branches were made throughout the 1986-1987 field season, beginning on September 3 before any vireos or other migrant birds had arrived in the area. Counts of the branches were made throughout the winter (Figs. 7-10). There was also considerable variation in the numbers of fruits on individuals (some plants of both species produced no fruit); *B. microphylla* trees often had several thousand berries while the much larger

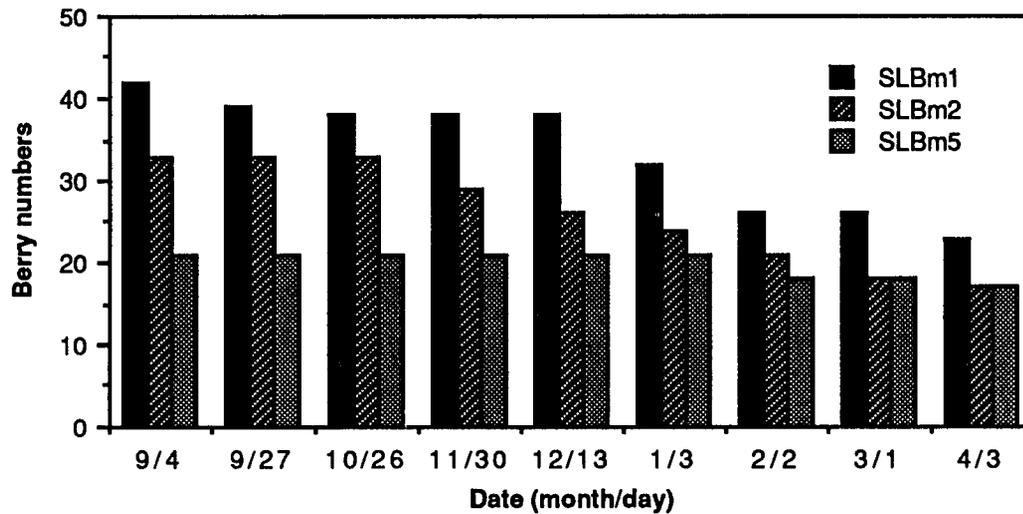


Figure 7. Counts of *Bursera microphylla* Berries on Flagged Branches at San Lorenzo.

Each flagged branch was on a different tree. Compare the numbers of berries left on these branches at the end of the winter with those shown in Figure 8. *B. microphylla* fruits do not begin to disappear from branches until late November when they first become ripe.

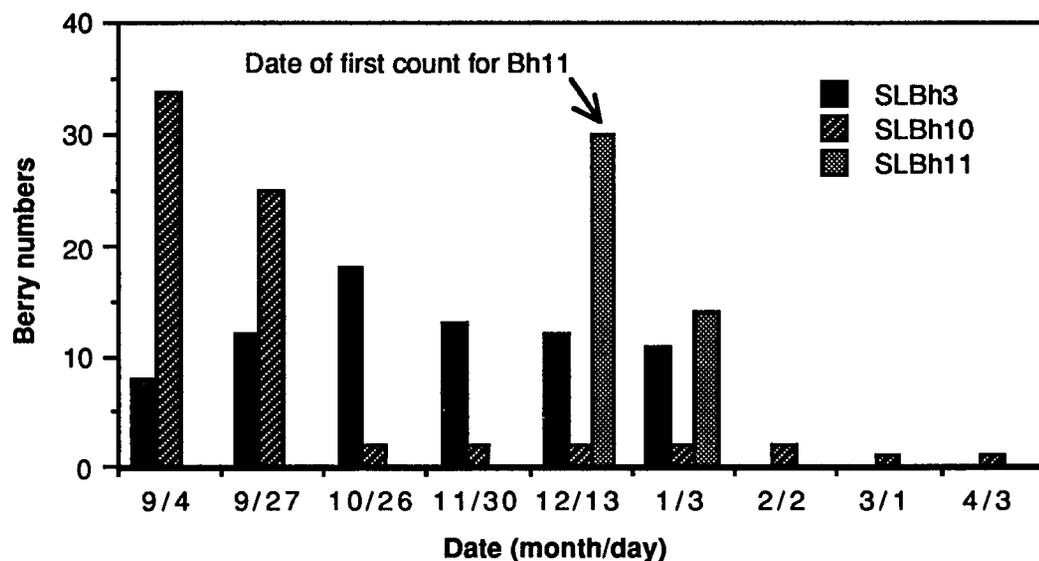


Figure 8. Counts of *Bursera hindsiana* Berries on Flagged Branches at San Lorenzo.

Each branch is from a different tree. All flagged branches with fruit on the site showed similar patterns of fruit disappearance. The increase in berries early in the season on SLBh3 is due to new fruit. The disappearance rate for these fruits are much greater than for those of *B. microphylla*. Branches with fruit later in the winter such as SLBh11 disappeared in the same manner. This disappearance is thought to be due primarily to avian consumers.

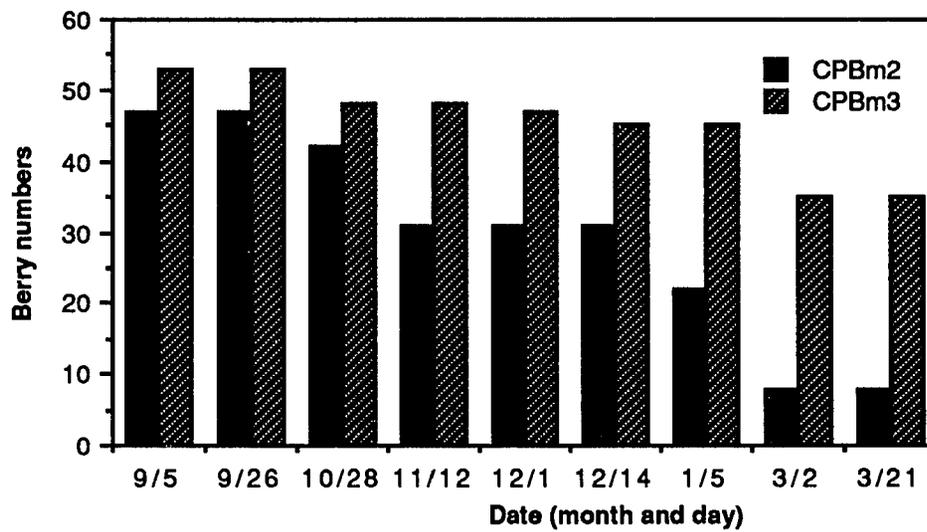


Figure 9. Counts of *B. microphylla* Berries on Flagged Branches at Cerro Prieto.

The disappearance of fruits is similar to what was shown in Figure 7. Other flagged branches on different trees on the sites showed similar patterns of fruit disappearance.

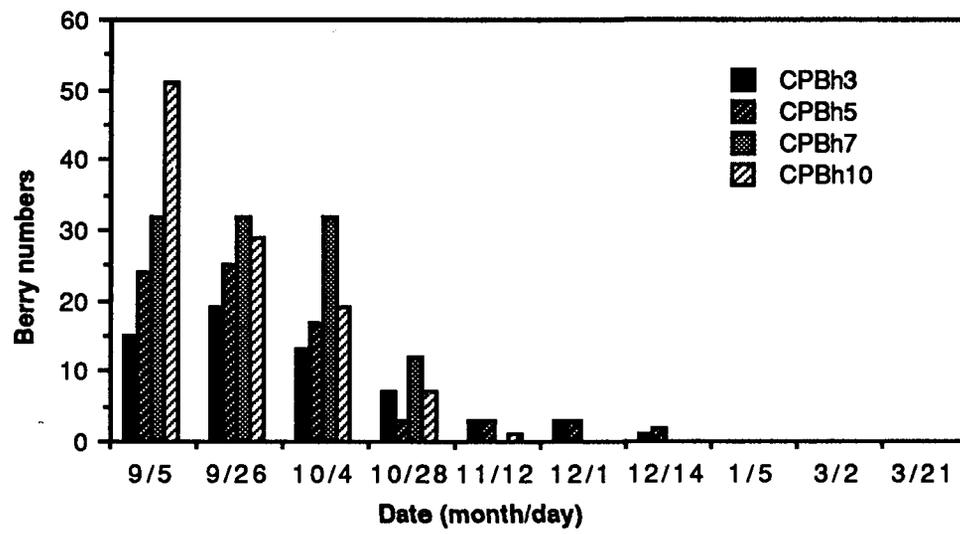


Figure 10. Counts of *B. hindsiana* Berries on Flagged Branches at Cerro Prieto.

As shown in Figure 8, these fruits disappear quickly after appearing on the plants.

B. hindsiana trees rarely had more than a thousand.

Average weight of a *B. hindsiana* aril (removed from the seed) is 31.2 mg (N= 6); average weight of a *B. microphylla* aril (removed from the seed) is 10.4 mg (N=11). The caloric content of arils from bomb calorimetry data was found to be 27.4 kJ/g (S. D.= 0.8; N=5 arils) for *B. hindsiana* and 32.8 kJ/g (S. D.= 1.3; N=7 arils) for *B. microphylla*. The value for *B. microphylla* is higher than any of the values reported for dry pulp of twenty plant species whose fruit are commonly eaten by fall migrants in Illinois (Johnson et al. 1985). Caloric content of dried pulp in that study was positively correlated with lipid content. Though no determinations of lipid content were performed for the *Bursera* fruits, it is likely that much of the high caloric content of these fruit is also due to lipids. Thus, these fruits are certainly a good source of energy for their consumers. This may be especially important in the spring when *B. microphylla* fruits are still available and birds are gaining weight in preparation for migration north.

Fruits of both species are taken by birds in ways similar to the types of handling noted by Trainer and Will (1984) for *B. simaruba* in Panama. Seven bird species and one mammal species (Harris' Ground Squirrel, *Ammospermophilus harrisi*) were observed taking *B. hindsiana* berries. Gila Woodpeckers (*Melanerpes uropygialis*), Cactus Wrens (*Campylorhynchus brunneicapillus*), Northern Mockingbirds (*Mimus polyglottos*) and Curve-billed Thrashers (*Toxostoma curvirostre*) swallowed whole ripe fruits. Only a Common Flicker (*Colaptes aurita*) was seen consuming whole unripe fruit. Verdins (*Auriparus flaviceps*) removed the aril, usually dropping the seed, and House Finches (*Carpodacus mexicanus*) ate arils and cracked the seeds. Many cracked *B. hindsiana* seeds were collected beneath cardon cacti, which are favorite perches of House Finches in the area. Gray Vireos were not observed taking *B. hindsiana* fruits. From data on gape width versus the diameter of the largest fruit eaten for a number of frugivorous species, Herrera (1985) found that gape width tends to be 1.0-2.5 mm larger than fruit diameter (but see Wheelwright 1985). Thus, with a mean diameter of 5.5 mm (N=6), *B. hindsiana* berries may be too large for Gray Vireos (average gape width 7.3 mm, N=10;

specimens from the University of Arizona) to swallow.

B. microphylla fruits with a mean fruit width of 4.7 mm (N=6) fall within the range of diameters that Gray Vireos can swallow whole. The species appears to depend heavily on these fruits for much of the winter. During the course of the study, fifteen bouts of berry-eating by vireos were observed; all berries taken were exposed arils with seeds, and as many as five were taken in one bout. On other occasions birds spent extended periods of time in *B. microphylla* trees apparently searching for berries, but I did not positively see them consume any. The fifteen observations represent berry-eating by at least nine different individuals. I saw a bird in the Sierra Pinta Mountains of southwestern Arizona consume a ripe *B. microphylla* berry on 17 December, 1986. All but two of these observations occurred after late November, which appears to be when fruits begin to ripen in numbers (see Figs. 9 and 10). Of seven fecal samples taken from netted birds during the winter of 1986-1987, only samples from a bird captured on 26 September were not stained orange from consumed arils. The six other samples were taken on 29 November, 5 January, 28 February, 1 March (2), and 21 March. The stomach contents of a bird that died in a mist net in April, 1986 contained seven *B. microphylla* seeds. The virtual absence of ripe fruit on any *B. microphylla* plants before late November and the paucity of observations of birds eating ripe fruits before that time (one bird consuming one fruit on 26 October and another bird eating one fruit on 11 November) suggest that the fruits were not eaten by the vireos in their first two months on the wintering grounds because most fruit were not yet ripe. Once the fruits become available, they make up an important part of the vireos' winter diet in the Puerto Lobos area.

I saw *B. microphylla* berries eaten by only three other species: House Finches, which eat the arils and crack the seeds; Black-throated Sparrows (*Amphispiza bilineata*), which swallow entire ripe fruits and probably crack seeds; and Ash-throated Flycatchers (*Myiarchus cinerascens*). Like the vireos, the flycatchers swallow whole fruits, the seeds of which are later either regurgitated or defecated and thereby dispersed (I saw neither species regurgitate the seeds, but suspect that vireos must regurgitate them due to their large size). Other bird species

undoubtedly eat the fruit to some extent. *B. microphylla* trees, unlike the larger *B. hindsiana*, are often the same height as the surrounding vegetation, making observation difficult. *B. microphylla* fruit was more numerous than *B. hindsiana* fruit on the study sites, but there were more ripe *B. hindsiana* fruit available at any given time.

Fig. 1 illustrates the range of *B. microphylla* and the winter range of the Gray Vireo. The amount of overlap is considerable and only in the Chisos Mountains of Texas does there seem to be a winter population of vireos outside the range of the plant (Barlow and Wauer 1971). Within the overlapping area, the vireos selected habitat in areas with *B. microphylla*. In the Lobos region and southwestern Arizona, the vireos were found in rocky canyons and arroyos and not in adjacent flats with taller equally dense vegetation that lack *B. microphylla*. They are one of the few wintering passerines on the islands in the Gulf of California (Case and Cody 1983) and occur throughout the lowlands of Baja California (S. Wilbur, Pers. Comm). *B. microphylla* is one of the dominant plants in all of these areas. Ash-throated Flycatchers may also be important to *B. microphylla* dispersal. They share much the same habitat preferences as Gray Vireos but have a much larger winter range. The flycatchers breed throughout this winter range. As half of the *B. microphylla* fruits were still on the trees in early April when the vireos departed, resident Ash-throated Flycatchers may consume some of these fruits as they ripen.

If *B. microphylla* fruits are as important to the winter diet of Gray Vireos as the previous data suggest, sites throughout the lowlands of Sonora with populations of fruiting *B. microphylla* should have wintering Gray Vireos, and the vireos should also be wintering in small numbers to the north and east of their currently recognized range in southwestern Arizona (Monson and Phillips 1981; see Fig. 1). For example, *B. microphylla* occurring in canyons in western Pima Co. should provide suitable resources for wintering vireos.

Presumably, fruit crops vary from year to year and may explain observed variations in vireo densities. At the end of the 1982-1983 winter, 13 Gray Vireos were banded on one quarter of the San Lorenzo site (S. M. Russell, Unpub. data). In the two years I made observations, this portion of the San Lorenzo site never had more than five birds. July of 1982 was the wettest on

record for Puerto Libertad (26.5 mm of rainfall, mean for the month over 13 years is 5.5 mm, data courtesy of R. B. Turner). Since July is the start of the flowering period for *B.microphylla* this rainfall may have greatly enhanced fruit set in the region that year explaining the higher densities of Gray Vireos present at the end of the winter.

Interspecific interactions.

There are three common bird species on the sites whose diets and foraging habits overlap those of the vireos: Verdin, Black-tailed Gnatcatcher (*Polioptila melanura*), and Ash-throated Flycatcher. Verdins and Black-tailed Gnatcatchers are permanent residents in the region. No actual interactions between vireos and these species were observed, although when the vireos began arriving in September and October, there was often a vireo in the vicinity of scolding gnatcatchers. Throughout the winter individuals of the three species foraged in close contact. Foraging habits of the three species differ. Verdins tended to forage high in the vegetation (at 2 m or greater) on the outer portions, and Black-tailed Gnatcatchers forage on the outer portions of the lower vegetation, whereas the vireos foraged inside the lower vegetation. Also, insect prey taken by the Verdins and gnatcatchers were probably smaller than those taken by vireos although there is likely to be overlap.

Ash-throated Flycatchers in the Puerto Lobos region during the winter may include resident and migrant individuals. They are more numerous than the vireos on the sites and frequently interact with them. On seven occasions, Ash-throated Flycatchers were seen chasing vireos. One instance ended with a vireo scolding from the middle of a 0.5 m tall jojoba bush (*Simmonsdsa chinensis*) with the flycatcher perched on top. The flycatcher left after about 30 seconds but the vireo remained in the bush for five minutes before resuming activity. The flycatchers were also attracted by recordings of Gray Vireo songs. These two species were the largest gleaning insectivores in the area, and both frequently foraged low in the vegetation. Both also fed on ripe *Bursera microphylla* berries, so competition for both these resources could explain the interspecific intolerance.

DISCUSSION

The Winter Distribution of Sexes

The distribution of wintering females remains in question. Of eight Gray Vireo specimens in the University of Arizona collection from Sonora, Mexico (all taken in an area 90 km south of Puerto Lobos), four are males and four are females. Barlow and Wauer (1971) also report collecting both males and females wintering in the Chisos Mountains, Texas. Thus, it does not appear that there is sexual segregation in the nonbreeding season on a large geographic scale as has been reported for some migrant passerines (Ketterson and Nolan, 1983).

Price (1981) found that both male and female Greenish Warblers (*Phylloscopus trochiloides*) wintering in India sang and held territories. Lynch et al. (1986) found that Hooded Warblers (*Wilsonia citrina*) wintering in southern Mexico were segregated by sex into different habitats. In this sexually dimorphic species, all females held territories but females with more male-like plumage characters occurred in more "male-like habitat". The behavior of wintering female Gray Vireos is probably more similar to that described by Price (1981) for the Greenish Warblers. J. C. Barlow (Pers. Comm.) has suggested that only male Gray Vireos respond by singing to playback of recorded songs. If this is true, then most of the individuals I was able to follow for extended periods of time were males (although no individuals on the study sites responded consistently to playbacks of recorded songs). Two birds (BXYY and WRXW), that were never heard singing despite being seen with some regularity throughout the study, may therefore have been females; these birds also had smaller territories than singing birds (see Table 3). A skewed sex ratio does not seem to exist in vireos wintering in the Puerto Lobos area, but more conclusive data on sexes are certainly desirable.

Why defend winter territories?

In the nonbreeding season, food is generally considered to represent a limiting resource (Fretwell 1980) and is therefore most often cited as the reason for territoriality at this time of year. Limited resources must be distributed in certain ways to be defensible (Mauer 1984).

Morton (1980) reports that two species of warbler (*Dendroica pennsylvanica* and *D. castanea*) wintering in Panama initially defend intraspecific territories where they forage for insects. At the start of the dry season, in January, these territories are abandoned and the birds move into mature forest to feed in groups on newly ripened fruit. Territorial behavior in wintering Gray Vireos did not change although the vireos also shifted to a largely frugivorous diet several months after they initially arrived on the wintering grounds. This may in part be due to the slow ripening of *B. microphylla* berries during the entire winter. The fruits may never be locally abundant enough for groups of vireos to exploit. It may also be that insects remain important enough to a vireo's diet that their defense is necessary even though *B. microphylla* fruit is available. Studies on Townsend's Solitaires (*Myiadestes townsendi*) (Salomonson and Balda 1977; Lederer 1977) show that this species is territorial when its winter food resources, in this case juniper berries, are defensible in a given area. The numbers of fruit from year to year determine whether the birds return to the same territories. *B. microphylla* fruit production coupled with continued consumption of insects each winter may represent the stabilizing force resulting in Gray Vireo winter territoriality.

Trespassing

Two hypotheses might explain the high frequency of trespassing observed. First, trespassing may allow a bird to obtain additional resources at little cost, without depleting the ones it defends. The other, is that trespassing may be a challenge to a neighboring bird, testing whether that neighbor is capable of defending its territory. Both hypotheses may apply to Gray Vireos. This may be especially true near the end of the winter, when birds were observed foraging and even singing on adjacent territories recently vacated by birds that had migrated north.

This trespassing behavior does not undermine the adaptive nature of territoriality. A cost of leaving a territory to trespass is that another bird may forage on the undefended resources of the trespasser. Earlier defense of a territory probably deters some usage of those resources by

another individual even without the physical presence of the defender.

Effects of Gray Vireo density on their winter behavior

My conclusions about Gray Vireo wintering behavior are made from data collected primarily in one field season. Numbers of wintering Gray Vireos in the Puerto Lobos region probably fluctuate from year to year. Evidence for this is that Russell was able in 1983 to band 13 birds in one fourth of the area of the San Lorenzo site, which had no more than 5 birds in the winters of 1985-1986 and 1986-1987. Higher densities of wintering birds may greatly influence behavior. Pairs and floaters (neither identified in this study) may only appear in denser wintering populations. A major weakness of this study was that vireos could not be confidently sexed. Females may be subordinate to males. In years of high population density, males may occupy all suitable habitat in which case females may occupy territories within those of males in a subordinate role, giving the appearance either of floating or perhaps being paired.

With the high rates of returning individuals, many first-year birds may be unable to obtain territories in quality habitat when the population is high; instead of existing as floaters, they appear to occupy territories on the edge of suitable habitat or move on to other areas. If this is the case, some juveniles may be expected to disappear early in the winter as was found by Nesbit and Medway (1972) for Eastern Great Reed Warblers (*Acrocephalus orientalis*). While no pairs and few if any floaters were found in the season I studied, interactions that at least resemble both situations occur and may be more common in some years. Additional study including the determination of the sex and age of more birds over several seasons would be required to investigate this properly.

Frugivory in the winter

In their shift to a largely frugivorous diet, Gray Vireos resemble the wintering Blackcaps (*Sylvia atricapilla*) studied by Herrera (1984) in southern Spain. The two species share aspects of plumage, morphology and behavior. Blackcaps are visually separable by sex. Both species occupy winter territories year after year and both sing frequently throughout the winter. Herrera

has suggested that a strong mutualistic relationship exists between Blackcaps and the plants whose fruit they consume and whose seeds they subsequently disperse. For Gray Vireos, a similar relationship exists with *Bursera microphylla*. This relationship may be even stronger than those described by Herrera in that the Blackcaps appear to eat a variety of fruit over a large geographic winter range, whereas Gray Vireos appear to concentrate on only *B. microphylla* and have a limited range in the winter. The vireos do occasionally eat other fruits; two mistletoe seeds (*Phoradendron californicum*) were found in one fecal sample from Lobos. The only other fleshy fruits produced on the sites during the winter are wolfberries (*Lycium sp.*) which are less common than the *Bursera* fruits. While they may be taken occasionally, I did not observe vireos eating them.

Competition among plants for avian dispersers in the Lobos area

Much of the discussion by Herrera (1984,1985) and others (Howe and Estabrook 1977) on the relationship between birds and the fruits centers on the notion that competition occurs between the different plant species for dispersers. In my study area, fruits of three of the four plant species producing fleshy fruits during the winter were taken predominantly by different species of birds. Northern Mockingbirds and Phainopeplas (*Phainopepla nitens*) vigorously defended mistletoe clumps. Northern Mockingbirds along with a variety of other large species were seen swallowing whole *B. hindsiana* berries. Observations of the consumption of *B. microphylla* berries were limited to Ash-throated Flycatchers and Gray Vireos. *Lycium* fruits did not appear until February and the few observations of birds consuming them were of House Finches and Northern Mockingbirds. On the surface, it appears that the few bird dispersed plant species in the Puerto Lobos area are well separated in terms of their dispersers.

B. microphylla and its fruit appear to exhibit the three attributes Howe and Estabrook (1977) deemed necessary for a plant to attract a specialized frugivore: 1) the fruits have a high energy content; 2) crop sizes at any given time are small (there were rarely more than one or two ripe fruits apparent on a tree at any time during the winter); and 3) the fruiting season of the plant

is long (Figure 7, 9). This is especially true compared to the phenology of *B. hindsiana* which produces fruit with a lower caloric content (although they are significantly larger in size) that is available for a much shorter period of time in greater numbers.

CONCLUSION

The results presented in this study suggest for Gray Vireos in the nonbreeding season: 1) Most and probably all birds defended individual territories throughout the winter and, if they returned, defended the same territories in successive winters; 2) Territories were individually held and there were no nonterritorial floating birds on the study sites in the winters I studied. Many birds frequently trespassed onto neighbors' territories when foraging and retreated quickly if detected; 3) Winter diet shifted to include large numbers of *Bursera microphylla* fruit in addition to insects; and 4) the phenology of *B. microphylla*, winter habitat selection by the vireos, and the large amount of overlap between the distribution of *B. microphylla* and the winter range of the vireos suggested that a mutualistic interaction may occur between the two species with the vireos being the primary disperser of the plant's seeds.

APPENDIX 1.

Plants of Cerro Prieto and Arroyo San Lorenzo. The first group are plants in which Gray Vireos were seen, with the percentage of the total Gray Vireo observations made in that plant species in parentheses.

Acacia greggi (1.0)
Bebbia sp. (2.0)
Bursera hindsiana (22.7)
B. microphylla (19.3)
Cercidium microphyllum (4.0)
Encelia farinosa (4.6)
Foqueria splendens (1.2)
Hyptis emoryi (5.4)
Jatropha cuneata (1.6)*
Justicia californica (0.6)
Larrea tridentata (3.4)
Lycium sp. (10.9)
Oleña tesota (7.4)
Opuntia biglovii (0.2)
Solanum hindsianum (0.2)
Simmondsia chinensis (9.3)
Stegnosperma halenifolium (0.4)
Unidentified (0.8)

*May include observations made in *Euphorbia misera*.

OTHERS

Ambrosia dumosa
Euphorbia misera
Ferocactus wislizenii
Lophocereus schottii

Pachycereus pringlei

APPENDIX 2

Common Land Birds of the Puerto Lobos Area. These species were seen on the study sites on almost every trip throughout the winter. P= permanent resident, M= migrant, W= winter resident.

Turkey Vulture (<i>Cathartes aura</i>) P,M	Verdin (<i>Auriparus flaviceps</i>) P
Red-tailed Hawk (<i>Buteo jamaicensis</i>) P	Canyon Wren (<i>Catherpes mexicanus</i>) P
Osprey (<i>Pandion haliaetus</i>) P	Rock Wren (<i>Salpinctes obsoletus</i>) P
American Kestrel (<i>Falco sparverius</i>) P	Black-tailed Gnatcatcher (<i>Polioptila melanura</i>) P
Gambel's Quail (<i>Lophotryx gambelii</i>) P	Northern Mockingbird (<i>Mimus polyglottos</i>) W, P?
Mourning Dove (<i>Zenaidura macroura</i>) P	Curve-billed Thrasher (<i>Toxostoma curvirostre</i>) P
Great Horned Owl (<i>Bubo virginianus</i>) P	Phainopepla (<i>Phainopepla nitens</i>) W
Costa's Hummingbird (<i>Calypte costae</i>) P	Loggerhead Shrike (<i>Lanius ludovicianus</i>) W
Common Flicker (<i>Colaptes auratus</i>) P,W	European Starling (<i>Sturnus vulgaris</i>) P
Gila Woodpecker (<i>Melanerpes uropygialis</i>) P	Gray Vireo (<i>Vireo vicinior</i>) W
Ladder-backed Woodpecker (<i>Picoides scalaris</i>) P	Northern Cardinal (<i>Cardinalis cardinalis</i>) P
Ash-throated Flycatcher (<i>Myiarchus cinerascens</i>) P,W	Green-tailed Towhee (<i>Pipilo chlorurus</i>) W
) W	Black-throated Sparrow (<i>Amphispiza bilineata</i>) P
Say's Phoebe (<i>Sayornis saya</i>) P	White-crowned Sparrow (<i>Zonotrichia leucophrys</i>)
Violet-green Swallow (<i>Tachycineta thalassina</i>) *	Brewer's Sparrow (<i>Spizella breweri</i>) W
W	Lincoln's Sparrow (<i>Melospiza lincolni</i>)
Common Raven (<i>Corvus corax</i>) P	House Finch (<i>Carpodacus mexicanus</i>) P
Cactus Wren (<i>Campylorhynchus brunneicapillus</i>) P	Lesser Goldfinch (<i>Carduelis psaltria</i>) P?

* - The swallows arrive to nest in small numbers in late February.

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