

THE SCRUB JAY IN ARIZONA :  
BEHAVIOR AND INTERACTIONS WITH OTHER JAYS

by

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STATEMENT BY AUTHOR

Introduction . . . . .

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## INTRODUCTION

The object of this study was to determine the form and the utility, if any, of flocking behavior in the life of the Scrub Jay (Cyanocitta coerulescens nevadae, genus in the sense of Amadon (1944) both in its impact upon the individual Scrub Jay, and in its encounters with similar flocks in the related species C. ultramarina arizonae and C. stelleri macrolopha, the Mexican Jay and the Steller's Jay.

The Scrub Jay is a resident of the chaparral of central Arizona and the juniper woodlands of northern Arizona. Occasional local breeding groups are found in small chaparral areas of southeastern Arizona and northeastern Sonora. The Mexican Jays are inhabitants of the pine-oak woodland of southeastern Arizona and northeastern Sonora as outlined by Marshall (1957). The Steller's Jay inhabits the pine and fir forests throughout the state. Little overlap occurs during the breeding season, although occasional contact may be found between the Scrub and Mexican Jays, and the Mexican and Steller's Jays. During the non-breeding seasons portions of these three jay populations disperse and come into contact in certain habitats.

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## METHODS

A primary study area of 100 acres was established during the spring of 1961 at Oracle, Pinal County, to study Scrub Jay flocking and breeding pair activities. Scrub Jays were trapped with mist nets at a feeding station or near nests and all marked with aluminum United States Fish and Wildlife Service leg bands plus two colored plastic coil bands so that individuals could be later identified. All banded birds were weighed when captured. Activities were mapped in a field note-book. A portable tape recorder was used to play calls within hearing of the nesting birds, thus testing their territorial aggressiveness. Other areas were visited during the fall and winter at which time jays were collected and are incorporated into the bird collection of the Department of Zoology, University of Arizona. Stomachs were stored in 70 per cent alcohol to be subsequently analyzed. All observations were recorded in the field note-book. Plants were collected in all areas and are deposited in my personal collection. Herbarium specimens were identified with the aid of the standard references, Kearney and Peebles (1951) and Benson and Darrow (1954). The areas visited, time spent, and approximate numbers of jays observed during this study are presented in Table 1. Field work began in September 1960 and was concluded in April 1962.

Table 1

Summary of areas visited, time spent, and  
approximate numbers of jays observed during the study

Area Studied	Days	Approximate number of birds observed		
		Scrub Jay	Mexican Jay	Steller's Jay
Jacobsen Canyon, Pinaleno Mts. Graham County	7	50	70	20
Box Canyon Road and Greaterville, Santa Rita Mts. Pima County	35	75	150	40
Gardner Canyon, Santa Rita Mts. Pima County	35	35	180	60
Control Road, Santa Catalina Mts. Pinal and Pima Counties	25	75	180	45
Hitchcock Hwy. Santa Catalina Mts. Pima County	31	50	65	15
Cananea, Sonora	5	45	150	20
12 miles North of Kirkland Junction, Yavapai County	3	35	0	0
Oracle Study Area, Santa Catalina Mts. Pinal County	60	60	0	0

## RESULTS

### The Jay Flocks in Fall and Winter

A study of closely related species in an area of overlap during the non-breeding season should be informative concerning degrees of interspecific tolerances and competition. If any competition were to arise, it might be manifested by chasing or fighting (Pitelka, 1951b). Obviously these congeneric jays are not competing during the breeding season for they nest in different habitats. But if they were to occur together in the same habitat at other times of the year, one might expect ecological and behavioral differences to be present which would continue to insure some sort of spatial or temporal separation of these congeners. The stippled area of Figure 1 represents the area in which the three species of jays overlapped during the non-breeding season.

#### Description of the Winter Study Areas

The distribution of jays is greatly influenced by vegetation type. The oak woods or encinal about the bases of the isolated mountains of Southeastern Arizona and Northeastern Sonora vary greatly in composition. Generally encinal envelops the hills from 4000 to 6000 feet, and it is within this area that Jays overlap during the fall and winter. Shreve (1915) subdivided encinal into closed encinal in the upper elevational range and open encinal in the lower range. The closed encinal is usually composed of a dense tall stand of evergreen oaks, but

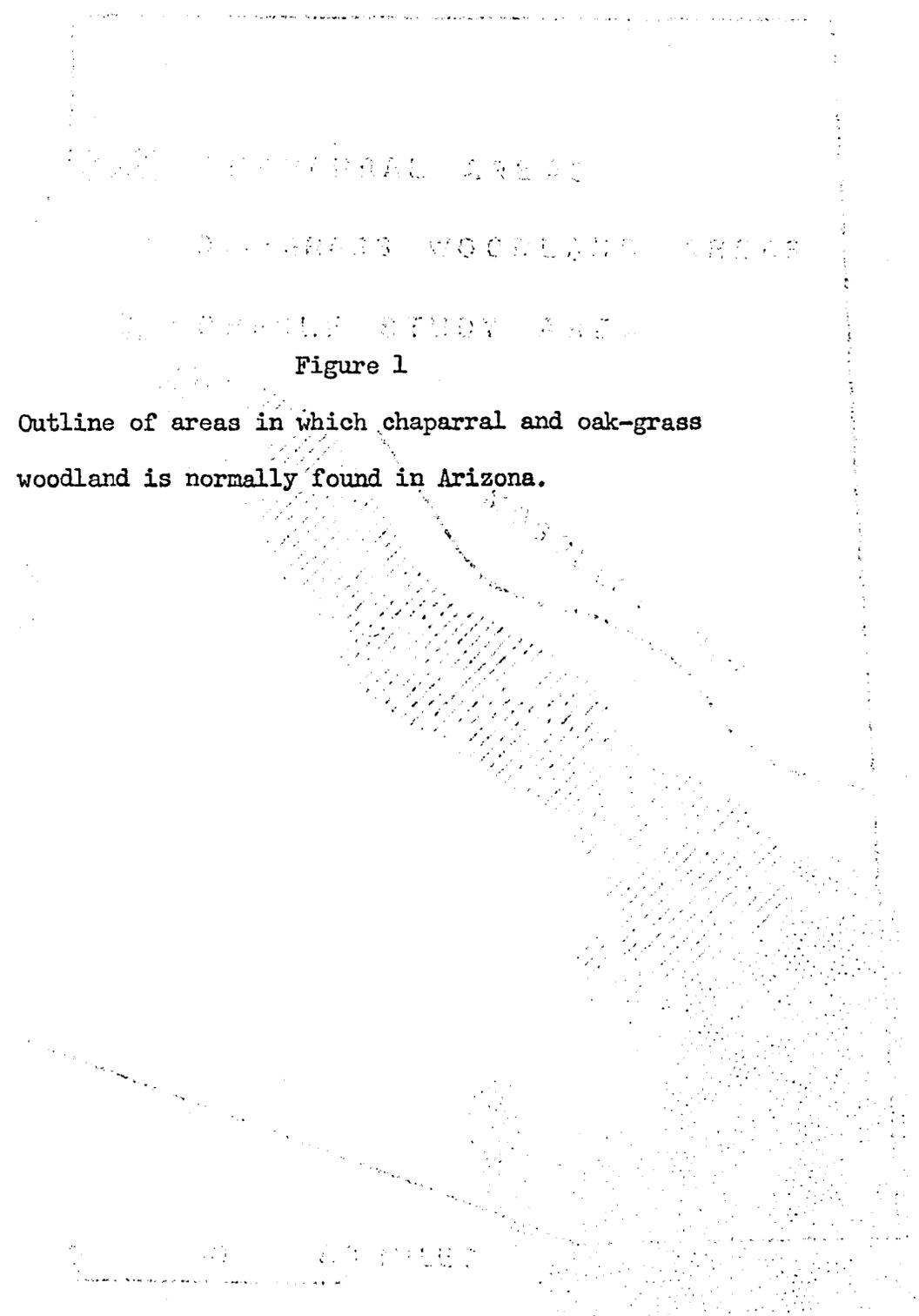
CHAPARRAL AREA

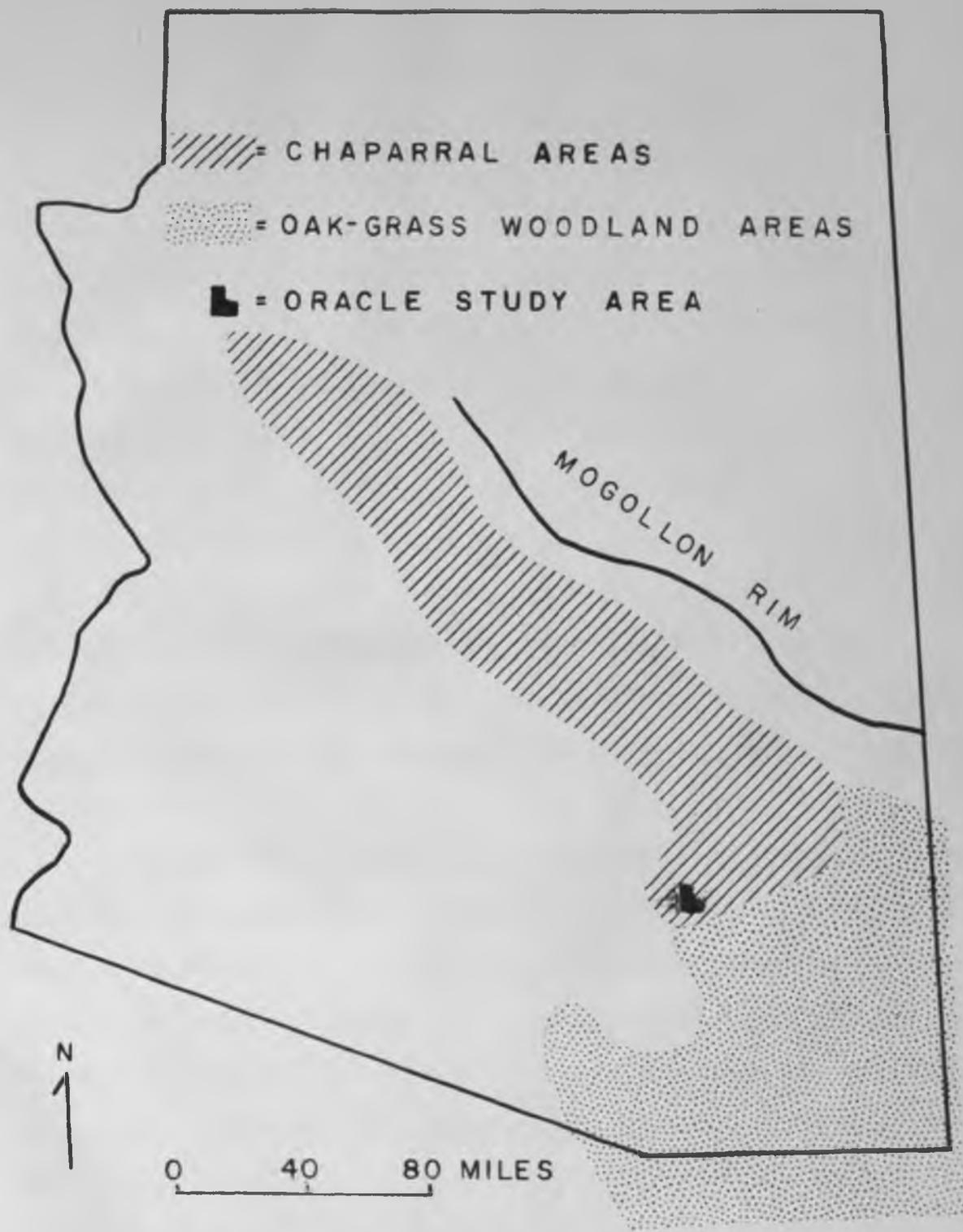
OAK-GRASS WOODLAND AREA

STUDY AREA

Figure 1

Outline of areas in which chaparral and oak-grass  
woodland is normally found in Arizona.





often is a mixture of oaks and juniper. At times pure stands of juniper are found. The open encinal is an ecotone of oak woods and grassland (Lowe, 1961). The oak-grass woodland is the prevailing habitat of the 4000 to 5000 foot area and is characterized by scattered oaks and juniper with large open spaces of grasses. Occasionally an oak-chaparral occurs in small areas as in the Greaterville area of the Santa Rita Mountains. To the north oak-chaparral is the typical oak association of the 4000 to 6000 foot altitudes and replaces both closed and open encinal. The encinal association continues south through Sonora beyond the area frequented by Scrub Jays in the winter. Above 6000 feet a transition zone of pine-oak woodland occurs, and below the encinal either grassland or yucca-agave-sotol association takes over. Running through the encinal are stream beds with associated riparian communities of trees which often extend down beyond the lower limit of the oaks and which at times draw jays to the lower elevational zones. Occasionally mesquite thickets exist in the encinal at the border of riparian areas.

The open encinal areas with associated stream bed riparian woodland were most frequented by the three species of jays, and it was within this habitat that my studies of overlap were conducted. The major grasses were the grammas of the genus Bouteloua and Hilaria; less common was Rothrox. There was a rather uncommon shrub element composed of Prosopis, Acacia greggii, Celtis, Mimosa, Rhus ovata, Arctostaphylos and Rhamnus. The larger trees were mainly oaks, including Quercus emoryi, Q. oblongifolia, Q. arizonica, and rarely Q. toumeyii. Both Pinus cembroides and Juniperus deppeana were found scattered among the

oaks. The general life-form of the area resembled a park-land with scattered trees and shrubs over open grassy hills. The oaks were 20 to 30 feet in height and usually grew separately. On steeper slopes a dense stand of trees would be found plus an increase in shrubs, which at times would approach chaparral conditions. The ground was covered with grass which was rarely tall because of grazing in both Arizona and Sonora. The ground has little topsoil either on steep slopes or on rolling hills, and small rocks were common throughout. Figure 3 is an example of this open encinal habitat.

#### Movement of Jays

The oak-grass woodland is not the normal breeding habitat for any jays of Arizona, although a few scattered pairs of Scrub Jays will be found nesting where chaparral-like areas are encountered. Movement of some sort, then, must take place to and from this habitat. Scrub Jay migration has been a controversial subject. Swarth (1924) and Rockwell (1907) have described a vertical movement of Jays during the late summer to lower elevations. I have observed movements to both lower and higher areas. Marshall (1957) has recorded them in pine-oak regions. But a north-south movement must take place, for I believe there were more Scrub Jays present in the open encinal than are found breeding in the surrounding scattered chaparral areas. Probably the majority of Scrub Jays move down from the extensive chaparral of Central Arizona below the Mogollon Rim. Rockwell (1907) and others have observed that breeding adults tend to remain in the nesting habitat over the winter. Eight out of fourteen banded breeding birds remained

at Oracle, Santa Catalina Mountains, over the winter of 1961-1962 plus seven out of twenty-one banded non-breeding adult birds. None of the seven nestlings banded were found during the winter. During the winter many Scrub Jays remain in the extensive chaparral breeding areas of central Arizona, but I could not tell if they were local breeding birds or migrants. Pitelka (1951a) stated that most specimens he examined from non-breeding areas of C. c. woodhouseii in the winter proved to be first year birds. There have not been, to my knowledge, any adult Scrub Jays collected in wintering grounds in Southern Arizona where the species does not breed, although this is based on few specimens.

There is rarely a pronounced flight of Scrub Jays, although Rockwell (1907) did observe a large flock movement of Scrub Jays in the fall in Colorado. My observations indicate that in Arizona these Jays move separately or in small flocks of two to five often following mountain ranges but also crossing wide stretches of desert, although during the winter of 1960-1961 flocks of ten to twelve were observed in Tucson. Numbers of birds will remain in desert environs during the winter usually along edges of towns or in riparian communities. Probably the Scrub Jays infiltrate the oak-grass woodland in small numbers and then join with others to form larger flocks. Phillips (M. S.) has recorded C. c. woodhouseii occasionally from the open encinal of Arizona. These birds could be from Southern New Mexico and so are not evidence of long distance movement of Scrub Jays. Scrub Jays moved into the open encinal in early September and remained until March.

Possibly the similar "migrations" of Steller's Jays are from the north. But the specimens collected appear to be the Arizona race,

and there are enough pine areas about to account for the numbers present. Probably many of those wintering in the open area are dispersing young-of-the year. As with the Scrub Jays, the Steller's Jays began to arrive in mid-September.

The Mexican Jay reaches its northern limit at the base of the Mogollon Rim. These birds do not appear to move far from their breeding areas, as do members of the other two jay species. Flocks will wander only within a few miles of their flock home range (Hardy, 1961). In late September flocks of Mexican Jays moved into the oak-grass woodland from the closed encinal and pine-oak woods above in the mountains. The flocks are definitely composed of both adults and first year birds, the majority being adults. These may be large family flocks that existed during the breeding season (Hardy, 1961). I am sure that the flocks of the other two species of Jays present are only winter groupings that break up when the birds return to their breeding areas.

Once the jays have entered this area they remain throughout the winter and into early spring. Some Arizona Jay flocks may wander back into higher habitats, but usually they return. In mid-March all species begin to retreat towards their respective breeding grounds. Figure 1 outlines the area in which oak-grass woodland was found.

### Flocking Behavior

Most species of jays are gregarious and often form large flocks, but little is known about interspecific flocking. The Mexican Jays were by far the most gregarious, and also were the most common. Next in abundance were Scrub Jays, and least abundant were Steller's Jays.

Roughly a square mile of oak-grass woodland along the Box Canyon Road in the Santa Rita Mountains would contain twenty-five Mexican Jays, ten Scrub Jays, and five Steller's Jays, although this varied greatly.

Mexican Jays almost always travelled and fed in flocks. The flocks usually numbered from twenty to thirty birds. When feeding, the flock members were dispersed and would bunch together only when excited. Even when moving over the habitat the flock would often remain in a spread state. Mexican Jays are known for a loud voice and often moved about making a huge clamor, but often the flock would be very quiet and unobtrusive. They spent extensive periods feeding quietly and often roamed without making any noise. It is amazing that a large dispersed flock could move off together without any vocal stimulation. They must keep some sort of visual contact with the other flock members. Sentinel birds perched on top of trees do warn flocks of imminent danger (Hardy, 1961). Normally, flocks of Mexican Jays were difficult to approach, but they were very curious and would come to investigate most odd noises.

The flocking behavior of the Scrub Jay was in many respects similar to that of the Mexican Jays, but there were a few differences. They were not quite as gregarious, and were usually found in flocks of five to fifteen birds. They were more vociferous than Mexican Jays. Scrub Jays were often calling querulously; and when moving about, the flocks were often very noisy. But there were times when they remained as silent as the Mexican Jays, and were equally difficult to observe. These Jays also exhibited the ability to move off all at once when dispersed over a large area without any noticeable vocal stimulus. Scrub

Jays were extremely shy and difficult to approach; and unlike the Mexican Jays, they did not respond to odd noises. They too had sentinel individuals perched above the flock, and these sentinels noticed the approach of intruders at a great distance.

The Steller's Jay in its normal habitat of pine forest was often found in large flocks, but in the oak-grass woodland they usually travelled about in pairs or flocks of five to eight. Rarely a larger flock was seen. In oak areas during the fall and winter the Steller's Jays would usually associate with a larger Mexican Jay flock and travel about in their company. But such a flock was not really mixed. When Steller's Jays were traveling with Mexican Jays, they usually remained as a smaller separate group to one side or followed behind. Occasionally they were mixed together but this was exceptional. While feeding the two species remained close but usually separate. No conflicts have been observed when the two were together, except that the Steller's Jay would give way to the Mexican Jay when one approached the other.

Marshall (1957) observed that Scrub and Mexican Jays remain separate when in the same area, and my observations substantiated this. These two never travelled in company; but at times their path crossed, and for a while they would be seen feeding intermixed. But when they began to move the Scrub Jays went one way and the Mexican Jays another. I never observed any conflict between the Mexican and Scrub Jays. Neither bird appeared to be dominant over the other, even when perched within a few feet of each other.

Steller's and Scrub Jays rarely came together. When they did,

occasionally conflicts arose. Twice along Box Canyon Road I observed Scrub Jays chasing away Steller's Jays. This occurred when they accidentally came together while searching for food. But one did not seek out the other to fight. The normal situation, then, concerning the spatial relationship among the three species of jays in the oak-grass woodland is many one-species flocks moving over the same area, coming together and parting as separate entities. The fact that they tend to isolate themselves is evident when one shoots into a seemingly mixed flock. All the Scrub Jays fly off in one direction, the Mexican Jays in another, and the Steller's Jays in a third unless they follow near the Mexican Jays. Normally these jays can tolerate the other's presence, although at times the Scrub Jays were antagonized by the proximity of a Steller's Jay. But these jays usually show a preference for their own species instead of mixed flocking.

I observed one main exception to this rule of no mixed flocking. That occurred when flocks of Piñon Jays (Gymnorhinus cyanocephala) moved through the open encinal. These birds are very gregarious, often in flocks of fifty to one-hundred individuals and remain in a very tight group. They are also very noisy, sounding like a flock of miniature crows. One flock was present in November of 1960 along Box Canyon Road. During the period September 20 to December 20, 1961, there was a large-scale invasion of Piñon Jays throughout the encinal areas of southeastern Arizona and northern Sonora. Throughout this period hundreds of Piñon Jays were roaming through the hills and mountains. Often Mexican and Steller's Jays, and to a lesser extent Scrub Jays, would be seen following along at the rear of these flocks as the

Piñon Jays trooped through the oaks. Probably the jays were attracted by the constant "cawing" of the Piñon Jays. Usually the other jays would follow along for a mile or so and then drop back. I observed no conflicts among the jays while associated with these Piñon Jay flocks.

### Feeding Behavior

Since bill and foot structures of these three Jays are extremely similar (Ridgway, 1904), and since they are all present in the same habitat, it was not surprising that they were seen to feed upon the same food and to obtain the food using the same methods.

The Mexican Jay usually fed beneath the oaks meticulously searching the ground. In open encinal they often ranged far into grassland in search of food. Their searching technique was to pry with their bills under most small twigs, leaves and small rocks that were in their path. Seeds and insects were picked from under these objects and from the surface of the ground. If insects were flushed and flew off, the jays would usually not chase after them, though at times some did fly after some large insects. Arizona Jays have been observed hawking for insects from trees (Hardy, 1961). Occasionally the other two species were observed hawking, but only infrequently. Often the Mexican Jays would concentrate their searching to the area under a tree if seeds were plentiful; generally they searched over a larger area.

A small food item was swallowed on the spot; a larger one was carried in flight to a tree or rock, there to be pecked apart. Only a few strong pecks were needed to open most nuts or to break up large

beetles. The food item was held in one or both feet and then pecked until broken. Mexican Jays will also search through oak trees for seeds, but they feed mainly on the ground. Hardy (1961) has also mentioned this.

Scrub Jays utilized the same feeding techniques, but did tend to remain closer to the trees and shrubs. Scrub Jays would be found searching through shrubs, while the other two usually would not. Scrub Jays did not wander out into the open grass areas as often as the other two Jays. The Scrub Jay utilized perches for feeding as did the Mexican Jays, but they used rocks on the ground more than perches in trees. Scrub Jays, too, would store food but this habit was observed only infrequently.

The Steller's Jays fed in the same way as the Mexican Jays and wandered over the same area. They were observed to do more searching through the oaks than did the Mexican or Scrub Jays.

In order to determine any differences in food preference, fourteen Scrub Jays, fifteen Mexican Jays and six Steller's Jays were collected between November 5 and January 20 in the oak-grass woodlands. When the stomachs were studied an attempt was made to remain unbiased by labeling the stomach with numbers so that I did not know what species I was working on until all were analyzed. Table 2 is a visual analysis of the per cent composition by volume of plant, animal, and mineral material. This data is an estimation for it would be difficult to measure volume when the contents were broken up. From Table 2 it is obvious that all jays were consuming about the same percentage of plant and animal material. No species consumed a greater proportion of one

Table 2

Percent composition of animal, vegetable, and mineral material in stomachs of three species of jays collected in the oak-grass woodland.

Specimen		Per cent Animal	Per cent Vegetable	Per cent Mineral
Scrub Jay	1	40	55	5
	2	25	65	10
	3	30	65	5
	4	30	60	10
	5	45	40	5
	6	5	85	10
	7	50	40	10
	8	65	20	15
	9	40	50	10
	10	40	45	15
	11	35	55	10
	12	40	50	10
	13	45	45	10
	14	40	55	5
Average		38	52	9
Mexican Jay	15	35	60	5
	16	25	70	5
	17	45	45	10
	18	25	65	10
	19	30	60	10
	20	25	60	15
	21	20	70	10
	22	40	50	10
	23	60	35	5
	24	70	25	5
	25	50	40	10
	26	20	75	5
	27	20	70	10
	28	45	45	10
29	35	55	10	
Average		36	50	10
Steller's Jay	30	50	40	10
	31	25	65	10
	32	45	45	10
	33	25	65	10
	34	20	75	5
	35	70	20	10
Average		39	52	9

type than any other species. All three utilized vegetable materials as a staple but much animal material was consumed. The animal material was entirely insects. The plants were mainly acorns but occasionally other seeds were eaten. The winters are mild enough in this area to allow insects, especially beetles, to be active. Even if they were not out, I feel sure the Jays would locate them under small rocks. Of interest is the fact that no spiders or scorpions were taken by any of these Jays. Scorpions probably remain under rocks too large to be probed under by jays. But spiders definitely would be found by jays, for spiders are extremely common in this area. Possibly spiders are too quick for Jays, but I would doubt it.

Table 3 is a qualitative analysis of the stomach contents. It is clear that these jays utilized the same food items. No species utilized one type of food any more than any other species of jay (see percentages in Table 3). Also it is clear that jays in oak areas use acorns as a staple item. Most jays had at least one acorn in the stomach. Next in importance were beetles (Coleoptera) of several families, but ground dwellers, for the most part, and of a size range of seven to twenty millimeters. The lepidopterans eaten were mostly larval forms except for a few adult moths. The seeds were a problem to identify, and at times the best that could be done was to put them in a size class. Primarily selecting acorns, the jays would also eat almost any large seeds found; but they would usually pass over the numerous small seeds of grasses and herbs. Normally the three jays selected food in a range from seven to twenty-five millimeters, as is illustrated in the beetle size selection. All jays had pebbles or sand in small

Table 3

Qualitative analysis of stomach contents of three species of jays collected in oak-grass woodland.

In parentheses are percentages of total contents of stomachs of that species made up by a particular food item.

Food Item	Number of Stomachs Containing a Food Item		
	Scrub Jay	Mexican Jay	Steller's Jay
Insect Coleoptera (Gen)	4 (11%)	5 (12%)	2 (15%)
Tenebrionidae	2 (5%)	5 (8%)	2 (7%)
Scarabacidae	2 (4%)	2 (4%)	0
Cerambycidae	0	0	1 (3%)
Carabidae	1 (3%)	2 (2%)	1 (2%)
Curculionidae	1 (3%)	2 (2%)	0
Elateridae	1 (3%)	0	0
Lepidoptera (Gen)	2 (3%)	1 (1%)	1 (2%)
Saturniidae	0	1 (2%)	0
Arctiidae	0	1 (1%)	0
Pyrilidae	0	0	1 (1%)
Hymenoptera (Gen)	1 (1%)	2 (2%)	1 (2%)
Formicidae	2 (2%)	2 (1%)	1 (2%)
Orthoptera (Gen)	1 (1%)	2 (1%)	1 (2%)
Acrididae	2 (2%)	1 (1%)	0
Hemiptera			
Pentatomidae	0	0	1 (2%)
Neuroptera			
Myrmeleontidae	0	0	1 (1%)
Vegetable			
Oak Acorns	11 (34%)	12 (36%)	4 (40%)
Juniper Seeds	2 (4%)	5 (6%)	0
Manzonita sized seeds	7 (8%)	5 (4%)	1 (4%)
Small Herbaceous seeds	4 (2%)	3 (1%)	1 (3%)
Grass Seeds	6 (4%)	7 (3%)	2 (4%)
Mineral			
Pebbles	14 (7%)	15 (7%)	6 (8%)
Sand	7 (2%)	5 (3%)	1 (1%)
Total Number Stomachs	14 (100%)	15 (100%)	6 (100%)

quantities in their stomach which probably helped grind the food.

The following table shows the results of the experiment. The first column shows the number of insects which were fed, the second column shows the number of insects which were not fed, and the third column shows the number of insects which were fed and then starved. The fourth column shows the number of insects which were fed and then starved and then fed again. The fifth column shows the number of insects which were fed and then starved and then fed again and then starved again. The sixth column shows the number of insects which were fed and then starved and then fed again and then starved again and then fed again. The seventh column shows the number of insects which were fed and then starved and then fed again and then starved again and then fed again and then starved again. The eighth column shows the number of insects which were fed and then starved and then fed again and then starved again and then fed again and then starved again and then fed again. The ninth column shows the number of insects which were fed and then starved and then fed again and then starved again and then fed again and then starved again and then fed again and then starved again. The tenth column shows the number of insects which were fed and then starved and then fed again and then starved again and then fed again and then starved again and then fed again and then starved again.

## Flocks of Scrub Jays in the Breeding Season

Little behavioral work has been conducted with jays of the New World, especially concerning the breeding cycle. Wilson (1923) described rather completely the nesting of the California race C. c. californica. Amadon's (1944) preliminary work on C. c. coerulescens and Hardy's (1961) and Gross' (1949) are the only other detailed works on behavior in jays. The present work is not meant to be a complete life history, but an analysis of the intraspecific interactions of C. c. nevadae during the breeding season.

In central Arizona the Scrub Jay is one of the most common breeding birds in the chaparral. Figure 1 outlines the normal breeding distribution of the Scrub Jay in Central and Southern Arizona. The habitat preference of the Scrub Jay in Northern Arizona is the subject of future work. Chaparral is restricted in Arizona to the hillsides from 4200 to 6000 feet south and west of the Mogollon Rim. In the north, piñon-juniper habitat is present. Chaparral covers this altitudinal range as far south as the north end of the Santa Catalina Mountains, Galiuro Mountains, and the Pinaleno Mountains; east of this limit encinal associations are present. This community is characterized by Quercus turbinella, Arctostaphylos, Rhus, Cercocarpus, Cowania, Celtis, and Berberis (Nichol, 1943) which form an extremely dense low habitat. Toward the south the habitat becomes thinner and taller with Nolina microcarpa as the grass element. There are a few cut encinal areas,

that resemble chaparral in Northern Sonora, which also harbor Scrub Jays (Marshall, 1957).

#### Description of Study Area

Figure 4 was taken in the study area at Oracle on the north side of the Santa Catalina Mountains, Pinal County. This area is slightly atypical as far as Scrub Jay breeding environment is concerned, for it is at the southern edge of chaparral (see Figure 1). But a dense population of jays was present and the openness of the vegetation facilitated seeing the birds. Figure 2 is an outline of the study area. It was composed of approximately one-hundred acres of rolling low hills. Trees there are Quercus emoryi, Q. toumeyi and rarely Juniperus deppeana, averaging ten feet high, although the Emory Oak reached twenty-five feet along stream beds. The oaks formed rather dense stands which were favored by the jays for nesting. On the upper parts of the hills the oaks were very scattered and there were many open rocky spaces. Shrubs were Arctostaphylos, Cowania, Mimosa, Ceanothus, and Gercocarpus, which formed a dense low growth. This together with the oak thickets gave the area its chaparral aspect. Many open areas had Nolina as the only plant element. The general life-form of the area, then, was dense chaparral-like stands from five to twelve feet tall with many open areas of scattered oaks and Nolina.

#### Pair Formation

The process of pair formation is difficult to observe, especially in Scrub Jays. They do not appear to have any ritualistic pairing behavior as do Blue Jays (Cyanocitta cristata) (Hardy, 1961). At two

localities I observed what may have been a part of the Scrub Jay pairing behavior. These were at Oracle from March 10 to 15, 1961, and a chaparral area twelve miles north of Kirkland Junction, Yavapai County, on March 4, 1962. Because of the vagueness of the pattern and the difficulty in determining whether or not a pair-bond had been established, the pattern here described must remain hypothetical. The following description is a combination of observations on pair-formation.

With the onset of warm weather an increase in Scrub Jay activity and agitation was noted. Often the flock would be found feeding in open areas. At irregular intervals feeding would stop and one bird would chase another across an open space. After one pair started, three or four other pairs would begin to chase and to call. This chase was manifested in a series of rapid hops and short glides close to the ground. The calls associated with this chase had a musical quality usually not heard at other times of the year. This rather musical "querp" call continued through the breeding season. It could not be determined whether males were chasing females or other males. Because fighting was never observed, it was assumed that females were associated with the chase. The chase would go around the low shrubs of the area and end with the two birds perched on the ground or a low perch next to each other. At first all interaction appeared to end at this point, but later the birds would start bobbing up and down and continue calling after they had landed. Each series of chases lasted about four or five minutes followed by a thirty minute period of feeding before chasing was started again. Often six or seven pairs would be running back and forth. Such a melee was difficult to interpret. The chasing took

place over a three or four hour period during the hotter portions of the day. It is supposed that chasing was repeated over a three or four day period, but this was noted in only one out of the two cases observed.

Before the onset of these chasing periods little pairing was observed and after this period pair-bonds had definitely been established. Whether or not this behavioral pattern is oriented toward pair-formation can not be proved at this time, but it was never observed at other times of the year. I can only conclude that it is possibly a mechanism of pair-formation. Hardy (1961) has described courtship feeding of nesting birds; perhaps it is tied in with the above pattern of pairing. He concludes, from limited information, that pair-formation is probably not associated with flocking, but my evidence appears to show that it may be associated with flocking. Also the pair-formation process may stimulate the breeding birds to leave the flock. By mid or late March pairs of Scrub Jays began to select nesting sites.

### Flocking

In late February the Scrub Jays at Oracle were evidently aggregated into loose flocks of fifteen to twenty-five birds. These flocks were very tenuous, for often birds would separate and appeared to move into areas occupied by another flock. Though wide-ranging in winter, they began to restrict their feeding range to a fifty to sixty acre area as spring approached. Because of the difficulty in banding enough birds, this flock structure and the lack of pairing is merely presumed.

In early March some birds within the flocks began to move about in pairs; and soon after this, pairs began to drop out and select nesting areas. But a loose flock structure persisted in these places. Each flock did have some birds that appeared to be paired but non-nesting. These flocks, then, consisted of non-breeding birds which remained in a very loose group throughout the nesting season. Non-breeding flocks present in resident areas have not been reported in Scrub Jays before.

Twenty-one out of twenty-five birds in one flock were banded at my study area, all at the house marked as a banding station (Figure 2). A feeding station had been in operation there for one year, and most of the members of the loose non-breeding flock fed or drank there, since it was the only constant water supply available in the study area. Using weight as a sex indication (Pitelka, 1951), there was approximately an equal sex ratio in the non-breeding flock. Age could not be determined, but there were too many for them all to have been first year birds. This group of about twenty-five birds ranged over the southern two-thirds of my study area. Another flock roamed about the extreme northern end of the plot, but I did not work with them. Often during the day the flock appeared to break up and individuals wandered in all areas. Some mixing with other flocks occurred, but normally the same flock members reassembled. Table 4 is a list of selected observations of banded birds at the study area. The non-breeding birds roamed over all areas whether occupied by nesting pairs or not. The flock members usually were dispersed over many home ranges and rarely traveled as a large group, small groups of four or five

being the normal case. Separate birds also wandered over the study area. The flock usually fed in the vicinity of the feeding station, thus most observations are from the home ranges close to it. None of the birds banded as flock members in May broke from the flock to nest. As shown in the table the nesting birds were almost always present on the home ranges. Only in late June after the young had left the nest did they begin to wander (See June 22 of Table 4).

### Territory and Home Ranges

Usually territory is defined as that part of the habitat, including the nest, which the male or pair defends from intrusion by individuals of the same species. Such defenses would be manifested by singing, fighting, and chasing (Hind, 1959). Home range is that area in which the breeding pair spends most of its time.

By early April the breeding pairs had established an area in which the nest was to be placed. These areas were easily located by observing birds perched on tops of trees. This may well be proclamation of territory as stated by Hardy (1961). Nest building began in late April. By mid-May all breeding birds had begun nesting, and at this time I began to measure their areas of activity (Figure 2). During this period the non-breeding birds were present throughout the area occupied by the breeding birds. The breeding pairs did not oppose these intruders. The intruding flock was usually spread over the four or five breeding areas. But the breeding pairs had definite areas which other pairs recognized and would not enter (Table 4). Hardy (1961) observed territorial defense in Scrub Jays, but stated that

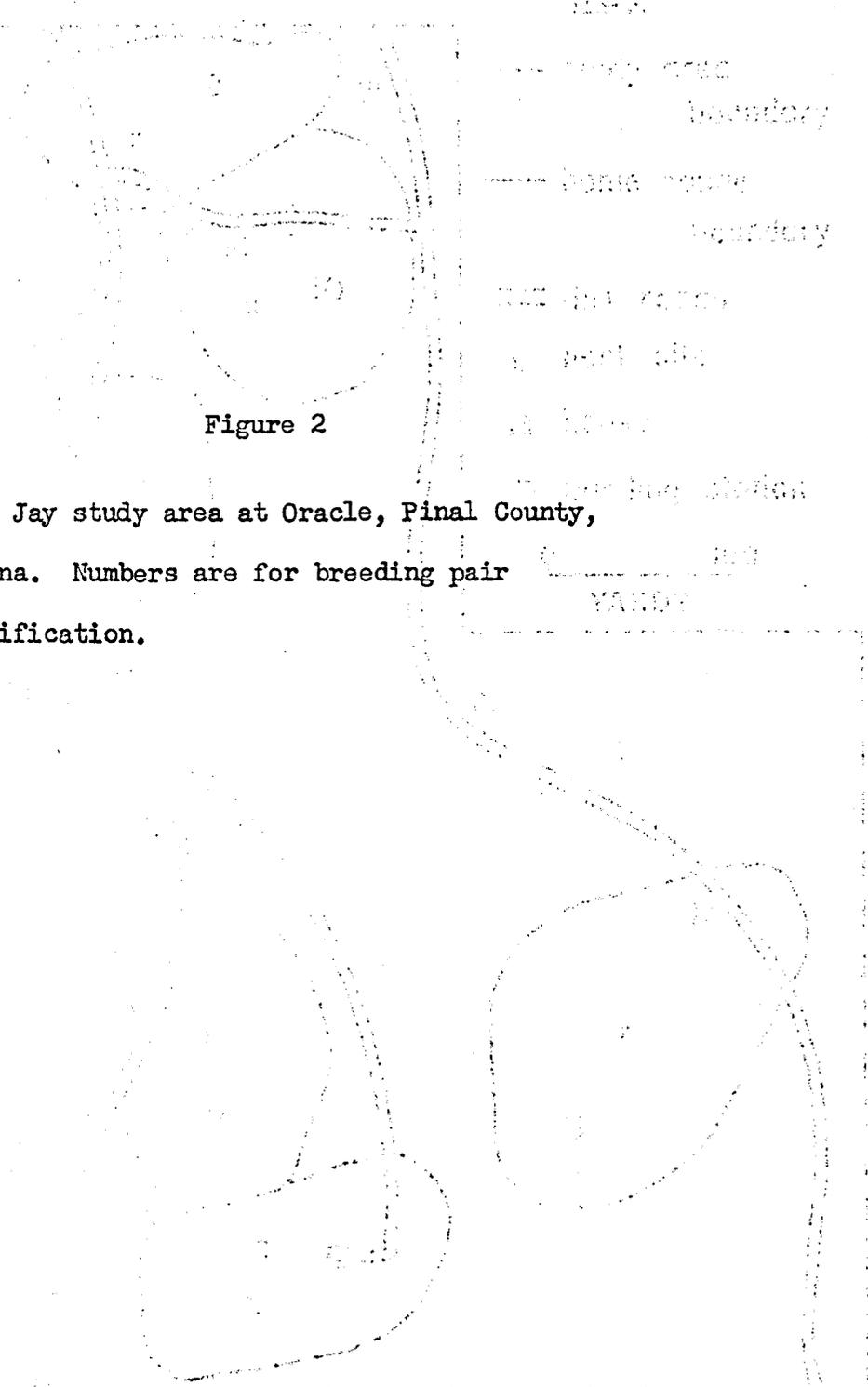


Figure 2

Scrub Jay study area at Oracle, Pinal County,  
 Arizona. Numbers are for breeding pair  
 identification.

KEY

--- study area boundary

— home range boundary

== dirt roads

x nest site

■ house

○ banding station

0 100  
YARDS

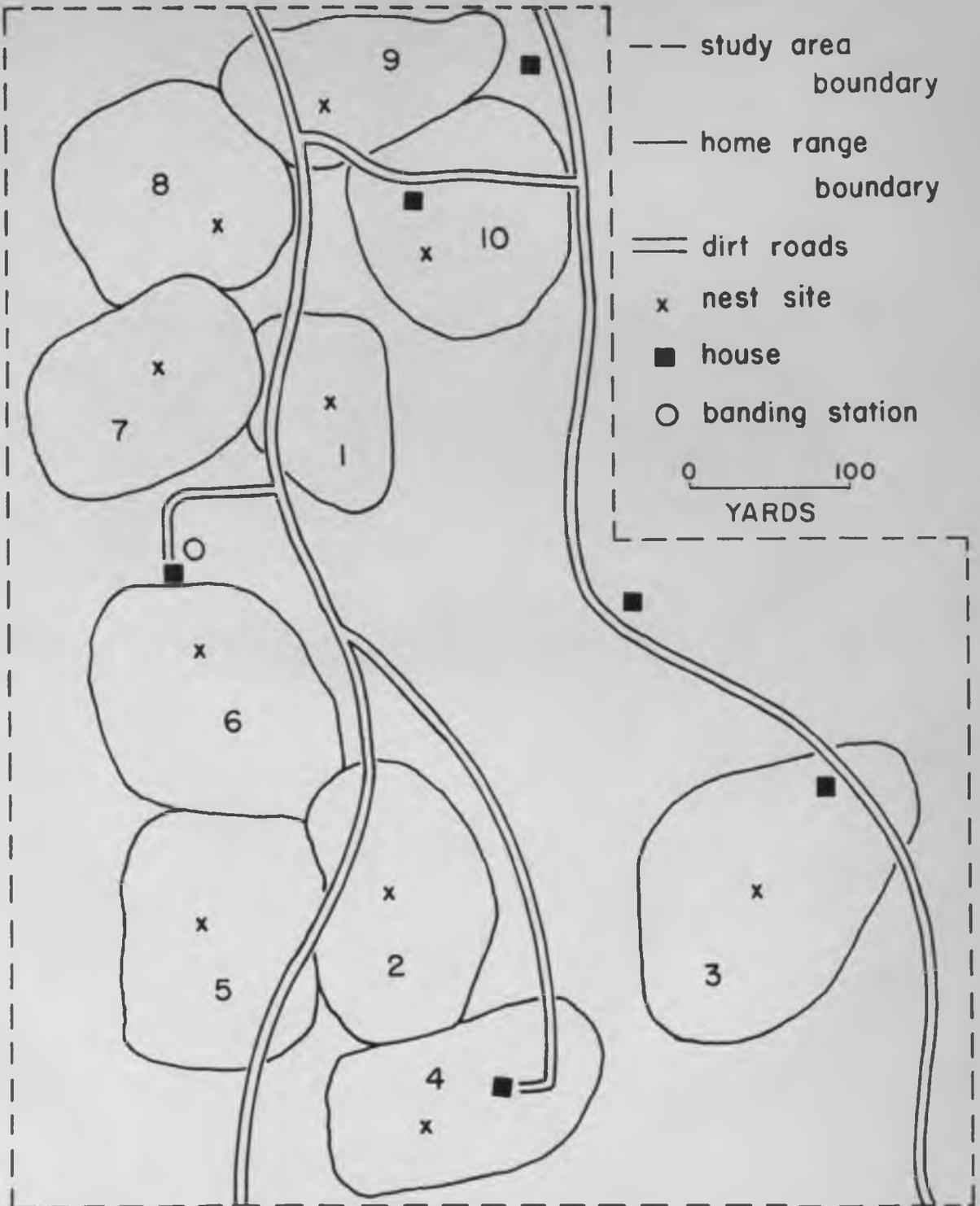


Table 4

Selected observations of color marked Scrub Jays at the Oracle Study area. The areas 1-10 correspond to the home ranges as outlined in Figure 2. Numbers in the squares represent individual marked jays, Birds 1-14 were nesting. Birds 15-36 were non-breeding individuals. Numbers underlined nested in that particular area.

DAY	AREA									
	1	2	3	4	5	6	7	8	9	10
18	<u>1,2,</u> 23,31,34	<u>5,</u> 24	<u>7,8</u>	<u>3,4,</u> 24	<u>6</u>	<u>9,10,</u> 15,18,23, 25,32	<u>11,</u> 15,18,32	<u>13</u>	<u>14</u>	<u>12,</u> 34
20	<u>1,2,</u>	<u>5,</u> 18,19,23, 27,30,33	<u>7,8,</u> 27,30	<u>3,</u> 23,33	<u>6</u>	<u>9,10,</u> 15,18,20, 24,25	<u>11,</u> 15,24,32	---	---	---
23	<u>1,2,</u> 30	<u>5,</u> 15,23,30, 34,36	<u>7,8,</u> 15,26,35,	<u>3,</u> 18,19,23, 27,30	<u>5,6</u> 18,24,25, 31	<u>9,10,</u> 20,24,28, 31	<u>11,</u> 24,31	<u>13</u> 16	---	---
26	<u>1,2,</u> 15,18,30	---	---	---	---	<u>10,</u> 15,18,24, 25	<u>11,</u> 15,18,21	<u>13,</u> 15,30	<u>14</u>	<u>12</u>
31	<u>1,2,</u> 18,21,23, 30	<u>5,</u> 18,21,24, 28	---	<u>3,4,</u> 18,28,34	<u>6,</u> 17,23,28, 34	<u>9,10,</u> 15,17,24, 26,29	<u>11,</u> 22,25	<u>13</u>	<u>14</u>	<u>12</u>
2	<u>1,2,</u> 15,19,23,	<u>5,</u> 20,24,28	<u>7,8,</u> 30	<u>3,4,</u> 18,20,25, 28	<u>6,</u> 18,20,28,	<u>9,</u> 18,19,20, 24,35	<u>11,</u> 19,24,27	<u>13</u> 19	<u>14</u> 34	<u>12</u> 34
5	<u>1,2,</u> 18,20	<u>5,</u> 17,23,28	<u>7,8,</u> 22	<u>3,4,</u> 17,28,30 28	<u>6,</u> 17,18,21 30,33	<u>9,10,</u> 17,18,28,	<u>11,</u> 18,21,22	<u>13,</u> 22	<u>14</u>	<u>12</u>
8	<u>1,2,</u> 15,17	<u>5,</u> 23	<u>7,8,</u> 22	<u>3,4,</u> 18,23,28	<u>6,</u> 23,27,28	<u>9,10,</u> 18,28	<u>11,</u> 18,24,30	<u>13</u>	---	---
15	<u>1,2,</u> 18,21,25	<u>5,</u> 25,29,34	<u>7</u>	<u>3,4,</u> 8,19,23, 28	<u>6,</u> 5,23,28 34	<u>9,10,</u> 19,20,23	<u>11,</u> 19	<u>13,</u> 19	<u>14</u>	<u>19</u>
22	<u>1,2,</u> 19,20	<u>5,</u> 6,18,19	<u>7,</u> 30	<u>3,</u> 5,19,21	<u>6,</u> 5,18,19	<u>9,10,</u> 11,18	<u>11,</u> 2,18	---	---	---

usually one pair recognized another's area and would remain out of it. I never observed fighting among the contiguous breeding pairs, but it may have occurred without my knowledge. Because non-breeding birds were allowed in the area, I have called the area defined as territory by Hardy, a home range with the understanding that it functions as a territory as far as other breeding birds are concerned. The only area defended against all Scrub Jays was the immediate vicinity of the nest, and it is this area that I shall call the defended territory. The defended nest site area was on the average a radius of forty feet from the nest. This size was estimated by observing how close flock members could pass to the nest, and with the aid of a portable tape recorder. Normally jay calls were played back at various distances from the nest site. The recorder was left playing hidden from sight. The nesting pair responded to these calls only when they were approximately forty feet from the nest or closer. This method was used to augment the infrequent instances of approaches by non-breeding birds. Thus, there is a territory within a larger home range, both of which may be defended against intrusion by breeding jays and only the former against non-breeders.

Figure 2 outlines the nest sites and home ranges of ten breeding pairs at the Oracle study plot. The sizes of the ten home ranges were: pair 1 = 2.8 acres; pair 2 = 5.2 acres; pair 3 = 6.0 acres; pair 4 = 5.5 acres; pair 5 = 4.8 acres; pair 6 = 3.3 acres; pair 7 = 5.1 acres; pair 8 = 4.6 acres; pair 9 = 4.2 acres; pair 10 = 3.8 acres. The average size was 4.5 acres. This is similar to the 5.3 acres average from three pairs measured by Hardy (1961). Hardy did observe territorial defenses,

but he did not have any non-breeding birds present in his rather atypical Scrub Jay breeding area in the Sandia Mountains of New Mexico.

The only water available was at the house banding station. Most of the breeding pairs in my area drank at this spot. To reach it they had to fly over one or two home ranges of other pairs. These flights were usually at a height of fifty feet or more and did not initiate any response by pairs below. The drinking spot was a neutral area, not belonging to the home range of any pair. Hardy (1961) also found that a drinking spot was neutral ground.

#### Flock Reaction to Predators

When the flock or small segment of it was feeding, a single sentinel bird was usually present perched above the other flock members. When a predator was spotted, this bird started bobbing and calling, and warned the other members of the flock of possible danger. Not only would the flock be warned; but any nesting pair close by, though not part of the flock, would also be alerted.

On three occasions I observed the flock warn the local breeding pairs, and twice I observed the flock come to the aid of agitated parents. The flock discovered, on separate occasions, two gray foxes (Urocyon cinereoargenteus), one Sonoran Whipsnake (Masticophis bilineatus) and a domestic cat (Felix domesticus) in the study area. The cat was stalking a nestling that had just left nest site number two. A small group from the non-breeding flock spotted the cat, and their calls brought the parents. Together they drove the cat away. In the other two occasions the predators were driven away before they spotted

any nests or young. The two cases in which the flock was attracted by agitated calls of the parents involved another gray fox and a Sonoran Whipsnake. I placed the snake in the nest tree of pair number 1. The parent's calls attracted nine other Jays, two of which were breeding birds from adjacent areas. The snake was driven from the tree. The fox had grabbed a nestling before the parents arrived. A total of fifteen Scrub Jays and two Piñon Jays were attracted, but the fox had already killed the young. During periods of danger home range boundaries were crossed by other breeding pairs, and they joined in with the other Jays to distract the predator.

The mobbing technique of Scrub Jays consists of each bird calling raucously and hopping or diving at the predator as close as possible. Often the birds will nip at it, especially if it is a snake. Occasionally a jay would grab the snake's tail and pull. Larger predators were not approached so daringly. Such constant harassment of the predator often caused it to leave without causing any harm.

Figure 3

View of typical oak-grass woodland at  
Greaterville, Pima County, Arizona.

Figure 4

View of chaparral in Scrub Jay study area,  
Oracle, Pinal County, Arizona.



#### CONCLUSIONS

The observations of three species of jays in the oak-grassland woodland of southwestern Arizona demonstrate that their feeding habits and food preferences are similar. The maintenance of single species flocks insure some spatial isolation. When the three species come into close contact, little conflict results, so little in fact, that one would expect to find flocks more often mixed instead of pure. If the birds were accustomed to formation of single flocks when isolated from each other in the breeding habitats, then they would probably continue to remain in separate flocks during the winter.

Possibly several flocks of separate species in an area functions, as far as protection is concerned, in the same manner as one large mixed flock. If one species spots a possible predator, undoubtedly that flock's outcry would warn any other flock in the vicinity. Nevertheless, spatial separation was present and the species did not often come into direct contact. Therefore, there is little evidence of competition, which does not infer that competition may not have been present in the past.

The presence of non-breeding flocks within breeding Scrub Jay populations has not before been recognized. The small size of the completely defended territory is probably correlated with the presence of these non-breeding flocks. It would be inefficient to have most of the habitat maintained as completely defended territories if flocks of jays

were also present. The intruding flock members would disturb the breeding pair so much that the care of the nestlings might be affected. Thus the decreased size of the territory may be an accommodation for flocks during the breeding season. An advantage of these flocks is understandably an increased awareness of predators for all Scrub Jays present, for a flock has a much greater chance of spotting a predator than a single pair, especially with perched sentinel birds. The breeding pair may benefit either by being warned by agitated calls from the flock, or by having the flock respond to the pairs' distress calls and help reduce the effectiveness of a predator, or both.

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