

# Habitat use and activity patterns of urban-dwelling javelina

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In Arizona, conflicts between homeowners and urban-dwelling javelina (*Tayassu tajacu*) continued to increase. Human-javelina conflicts often occurred when javelina responded to urban attractants and destroyed ornamental landscapes, injured pets, and frightened homeowners. This prompted initiation of a study during 1992-93 to develop recommendations to alleviate these conflicts. We captured, radio-collared, and located eight javelina from six herds to determine home ranges, habitat use, and activity patterns in Prescott, Arizona. Urban-dwelling javelina adjusted their home ranges, habitat use, and activity patterns to best use human-provided urban food, water, and cover resources. The most conspicuous of these adjustments was the increased nocturnal activity of urban-dwelling javelina to avoid human disturbances. Undeveloped land within or adjacent to Prescott provided javelina with daytime bedding areas and nighttime travel corridors. We determined that this issue was more a people problem than it was a javelina problem. Thus, strategies to resolve the conflicts must target homeowners.

*Keywords:* urban; human-javelina conflicts; home range; habitat; activity patterns

## Introduction

Reports and complaints of human-javelina conflicts have increased substantially over the past several years in Arizona. In most areas, javelina exist in wild situations and seldom encounter humans. Human-javelina conflicts develop under two scenarios. Javelina can either be attracted into residential areas to take advantage of food, water, and shelter unique to urban environments, or humans can build homes in areas used by free-ranging javelina. Both of these scenarios have resulted in negative interactions between people and javelina (Ockenfels *et al.*, 1985). Where these scenarios occurred, javelina have caused damage to gardens and landscaping as they foraged on flowers, garden vegetables, bird seed, and pet food.

As human-javelina conflicts increased, concern for the welfare of both people and javelina also increased. One concern frequently mentioned in homeowner complaints is the threat of javelina to children and pets. Although javelina typically avoid humans rather than confront them, dogs have been killed or badly injured by them (Knipe, 1956). Occasional attacks on humans by cornered or startled javelina have also been documented. Some attacks on humans occurred when dogs encountered javelina and then retreated to their owners with javelina in pursuit (Knipe, 1956).

Unfortunately, some homeowners have encouraged javelina visits into residential areas by providing food and water, regardless of property damage suffered by neighbors. Problems have also occurred when homeowners tamed javelina. This caused a loss of fear towards humans that often resulted in aggressive and dangerous behavior (Day, 1986).

To effectively minimize or eliminate conflicts, resource managers and city planners need information regarding javelina habitat use and activity patterns within urban settings. To provide this, an investigation into causes of and factors affecting human-javelina conflicts was initiated. The objectives of the study were to:

- (1) Determine home-range characteristics of urban-dwelling javelina;
- (2) Determine javelina habitat use patterns in urban developments;
- (3) Document activity patterns of urban-dwelling javelina;
- (4) Identify how residential property is used by urban-dwelling javelina; and
- (5) Identify management options to reduce or prevent human-javelina conflicts.

## Study area

The study was conducted in Prescott (112°27'W, 34°34'N), Yavapai County, central Arizona (elevation 1609 m). Prescott had an incorporated area of 80 km<sup>2</sup>. Approximately 28,000 people lived within its limits (J. Tobin, Prescott Chamber of Commerce, pers. commun.). Predominant land uses within Prescott, ranked by percent area, were: undeveloped (50%); residential (38%); public (7%); and commercial/industrial (5%). Although Prescott had a well-developed downtown area, many residential areas consisted of single-family homes interspersed in natural areas.

Topography in Prescott was moderately rugged with approximately 20% of the area containing interspersed rocky outcrops. Overstory vegetation consisted primarily of mixed ponderosa pine (*Pinus ponderosa*) and pinyon-juniper (*Pinus edulis-Juniperus spp.*) woodlands (Brown, 1982). Understory vegetation was shrub live oak (*Quercus turbinella*), mountain mahogany (*Cercocarpus montanus*), silk-tassel (*Garya flavescens*), skunk-bush sumac (*Rhus trilobata*), and manzanita (*Arctostaphylos pungens*). Minimal herbaceous cover was present.

Annual precipitation averaged 71 cm; the majority fell as rainfall in afternoon summer (June–Sept.) monsoon storms. Summer temperatures averaged 18–21°C during the day and 10°C at night, whereas winter temperatures rose above 10°C during the day and usually fell below freezing at night (Sellers and Hill, 1974).

## Methods

### *Capture and telemetry*

During 1992, we trapped at specific residences frequented by javelina. We baited box traps with commercial wild-bird seed. Captured javelina were routed into a squeeze-chute attached to the box trap, where we then immobilized them with 7:1 mixtures of Ketamine HCL (100 mg/mL) and Xylazine (20 mg/mL) hand-injected intramuscularly at 0.22 mL/kg estimated body weight. We marked javelina with color-coded, numbered ear tags and attached transmitter neck collars. We released javelina on-site once they recovered.

We attempted to trap only one javelina per herd. We believed that because of javelina's social structure and territoriality (Knipe, 1956; Sows, 1984; Day, 1986), aside from the temporary splitting of herds and occasional movements between herds, each marked individual represented the movements of an entire herd. To avoid trapping more than one animal from the same herd, we located each collared animal up to 30 days, thus determining territorial boundaries, before we continued trapping in the general area.

We monitored marked javelina between 1st April 1992 and 31st March 1993 in four residential areas of Prescott. Movements were monitored during two time periods: (1) 0601–1800 or daytime; and (2) 1801–0600 hours Mountain Standard Time or nighttime. Each animal was located  $\geq 1$  a week during the daytime and  $\geq 2$  a week during nighttime. We chose to monitor javelina more often at night because homeowners claimed that most javelina-caused damage occurred then. When necessary, we used hand held spotlights to observe javelina at night. Locations were taken  $\geq 3$  hours apart to reduce the likelihood of autocorrelation. The order in which javelina were located was random.

We plotted locations on U.S. Geological Survey (USGS) 7.5' topographic maps and derived Universal Transverse Mercator (UTM) coordinates to the nearest 0.1 km. We measured slope (degrees) with a

clinometer, air temperature ( $^{\circ}\text{C}$ ) with a thermometer, and estimated the distance (m) javelina were from escape cover (any cover capable of concealing at least a subadult javelina). Weather conditions were classified as the presence or absence of precipitation (i.e., raining or snowing or snow on the ground). Topography classes, vegetation habitat types, urban habitat types, and escape cover types were visually appraised.

We visually observed collared animals from 5–20 m to record herd size. We also determined herd activity (moving, bedded).

### *Home ranges*

We determined home ranges (minimum-convex polygon) and core-use areas (50% minimum-convex polygons) after removing outliers (Samuel *et al.*, 1985; Ackerman *et al.*, 1990). We examined home-range use areas (size, area of overlap) by daytime and nighttime and tested for temporal differences in size using a paired *t*-test. Relationships between herd size and home-range and core-use size were examined with linear correlation. Home-range overlaps were expressed as the distance (m) that one home range extended into another.

### *Habitat selection*

We generated 52 random points to help estimate habitat availability (Marcum and Loftsgaarden, 1980) and plotted them with a Geographical Information System (GIS). At each of these points, we established a 40-m<sup>2</sup> plot where we measured or visually estimated identical data as at javelina locations. We estimated urban habitat type availability by digitizing city-mapped boundaries between developed and undeveloped land use areas and then calculating the area in km<sup>2</sup>.

We used log-likelihood *G*-test contingency tables (Zar, 1984) to test for temporal differences in vegetative habitat use patterns and for differences between use and availability. We also used a *G*-test to test for differences in urban habitat type use and availability.

If *G*-tests indicated that differences occurred, we calculated Bonferroni simultaneous confidence intervals to determine which habitat types were selected or avoided (Neu *et al.*, 1974). If avoidance or selection was detected for a particular habitat type, Jacobs' *D* was then calculated to indicate direction and magnitude of avoidance or selection (Jacobs, 1974).

We used GIS to measure distance (m) between javelina locations and the nearest mapped streambed and paved road; we suspected streambeds were used as travel corridors and that paved roads may affect javelina movements within urban areas. Because these data were not normally distributed, we used Mann-Whitney *U*-tests to test for temporal influences on distances from roads and streambeds. Additionally, we tested for any differences in distance to escape cover by time of day and relative to presence or absence of precipitation.

We used a log-likelihood *G*-test contingency table to determine if javelina use of slope differed by time of day. We then used Chi-square contingency tables, Bonferroni simultaneous confidence intervals, and Jacobs' *D* to determine if there was any daytime or nighttime selection or avoidance of slope. Finally, we used another *G*-test to determine if there was a difference in how javelina used topographic features between day and night.

### *Activity patterns*

We calculated frequency distributions of activity patterns during four time periods (0001–0600, 0601–1200, 1201–1800, and 1801–2400) for four seasons (Spring = March–May, Summer = June–Aug., Fall = Sept.–Nov., and Winter = Dec.–Feb.). Seasonal limits were determined subjectively according to changes in local weather. Because activity data were categorical, we used log-likelihood *G*-test contingency tables to evaluate any activity differences among seasons, among periods within seasons, and among air temperature classes. Differences were judged significant when  $P \leq .05$ .

Table 1. Herd and home-range characteristics of urban-dwelling javelina in Prescott, Arizona, 1992–93

Herd no.	Animal no.	Herd size	Home-range size (km <sup>2</sup> ) <sup>a</sup>			Core area (km <sup>2</sup> ) <sup>b</sup>	No. of locations
			Daytime	Nighttime	Overall		
1	1, 6	7	0.2	0.9	1.0	0.1	150
2	2, 4	17	2.2	4.4	4.9	0.5	264
3	3	19	4.3	5.3	8.2	1.8	173
5	5	14	3.7	6.3	7.5	1.7	190
7	7	10	1.0	2.7	3.7	0.6	128
8	8	7	2.1	2.9	4.3	0.8	102
$\bar{x}$		12.0	2.25	3.75	4.93	0.92	167.8
SD		5.6	1.56	1.96	2.63	0.69	56.6

<sup>a</sup>Minimum-convex polygon as calculated by HOME RANGE (Ackerman *et al.*, 1990).

<sup>b</sup>50% minimum-convex polygon as calculated by HOME RANGE (Ackerman *et al.*, 1990).

## Results

### Capture and telemetry

We captured and radiomarked eight javelina from six herds. Two collars were inadvertently placed in herd No. 2 (Table 1). It was necessary to trap individuals from one herd three times; the initial capture, once because of mortality, and once due to collar slippage. For analysis from herds containing more than one collared animal, we only used data from the first javelina caught in that herd. When it died, we then included data from the next collared animal in that herd.

### Home ranges

Home-range characteristics varied among herds (Table 1). Home-range sizes differed ( $t_d = 4.70$ , 5 df,  $P = .005$ ) between day and night. Core areas were considerably smaller than home ranges. Home-range size was positively correlated ( $r = 0.64$ ,  $P = .057$ ,  $n = 6$ ) with average herd size, but core-use size was not ( $r = 0.46$ ,  $P = .139$ ,  $n = 6$ ).

Javelina No. 3 (herd No. 3) was the only radiomarked animal that wandered outside its established home range. This individual travelled  $\geq 14.5$  km from his established herd area during September 1992, stayed away for approximately 2 weeks, then returned. In April 1993, he again travelled toward the same area, but was killed by a car. A visual observation (11th September 1992) obtained during the first excursion suggested he probably travelled alone.

Four herds had overlapping home ranges, and overlap distances ranged up to 1000 m. Overlap of javelina home ranges occurred predominately during night. We found that overlap areas encompassed homes that routinely fed javelina. No core-use area overlap occurred.

### Habitat selection

Javelina use of vegetative habitat types did not differ ( $G = 2.86$ , 2 df,  $P = .239$ ) by time of day, however, use of types did differ from availability (Table 2). Javelina selected for areas of open woodland overstory with a shrubland understory and avoided all other (i.e., savannah, open or closed forest) vegetation types.

Javelina use of developed and undeveloped areas differed ( $G = 114.65$ , 1 df,  $P < .001$ ) by time of day. Javelina did not use undeveloped and developed areas in proportion to their availability either in daytime or nighttime (Table 2). Javelina primarily selected undeveloped natural areas during daytime and developed areas during nighttime.

Table 2. Habitat use patterns of urban-dwelling javelina in Prescott, Arizona, 1992–93

Variable	No. of locations observed	% locations observed	Bonferroni 90% CI <sup>a</sup>	No. of locations expected	% locations expected	Jacobs' <i>D</i> <sup>b</sup>
Habitat type: Vegetative (overstory/understory) ( $G = 82.80$ , 2 df, $P < .001$ )						
Open Woodland/grass-shrub	95	10.2	8.1–12.3	311	33.3	–0.63
Open Woodland/shrub	743	79.5	76.7–82.3	156	16.7	0.90
Other	97	10.3	8.2–12.4	468	50.0	–0.79
Habitat type: Urban: Day ( $x^2 = 24.72$ , 1 df, $P < .001$ ); Night ( $x^2 = 34.88$ , 1 df, $P < .001$ )						
Day						
Developed	90	22.2	18.2–26.2	155	38.3	–0.37
Undeveloped	315	77.8	73.8–81.8	250	61.7	0.37
Night						
Developed	299	56.4	52.2–60.6	203	38.3	0.35
Undeveloped	231	43.6	39.4–47.8	327	61.7	–0.35

<sup>a</sup>Bonferroni simultaneous confidence intervals calculated according to Neu *et al.* (1974).

<sup>b</sup>Jacobs' *D* calculated according to Jacobs (1974).

The distance javelina locations were to the nearest highway ( $Z = -3.56$ , 934 df,  $P < .001$ ), to the nearest maintained road ( $Z = -12.36$ , 934 df,  $P < .001$ ), and to the nearest streambed ( $Z = -3.38$ , 934 df,  $P = .001$ ) differed by time of day. Generally, urban-dwelling javelina were closer to these features at night.

The average distance javelina were to escape cover differed ( $Z = -5.03$ , 934 df,  $P < .001$ ) with presence or absence of precipitation. Javelina were closer to escape cover when precipitation was present ( $\bar{x} = 1.05$  m,  $SD = 1.68$ ,  $n = 116$ ) than when it was not ( $\bar{x} = 1.24$  m,  $SD = 0.96$ ,  $n = 818$ ). Overall, we found that javelina did not venture far from escape cover.

Shrubs (78.4%) constituted primary escape cover for urban-dwelling javelina. The next most common cover was rocks in combination with shrubs (11.3%). Grasses (3.2%) and trees (1.2%) were seldom used for escape cover. When houses (2.1%) and other artificial structures (0.9%) were used, it was predominately during night, during a rain or snow storm, or when snow was on the ground.

Javelina use of slope differed ( $G = 226.54$ , 3 df,  $P < .001$ ) with time of day. Average slope used during the night ( $\bar{x} = 9.4^\circ$ ,  $SD = 8.2$ ,  $n = 530$ ) was less than during the day ( $\bar{x} = 19.1^\circ$ ,  $SD = 9.9$ ,  $n = 405$ ; Table 3). Consequently, javelina use of topography classes differed ( $G = 193.85$ , 3 df,  $P < .001$ ) with time of day. More javelina locations were on flats (34.5%) and in drainages (16.0%) at night than during the day (5.9%, 3.7%, respectively). Conversely, more javelina locations were on hillsides during the day (88.9%) than at night (48.1%).

### Activity patterns

Urban-dwelling javelina activity patterns varied ( $G = 174.00$ , 1 df,  $P < .001$ ) by time of day as javelina typically moved more during the night and bedded more during the day. Seasonally (Fig. 1), javelina moved more during night than day in spring ( $G = 45.58$ , 3 df,  $P < .001$ ), summer ( $G = 174.00$ , 3 df,  $P < .001$ ), and fall ( $G = 91.55$ , 3 df,  $P < .001$ ). During winter, javelina moved most ( $G = 72.76$ , 3 df,  $P < .001$ ) during the early night. Javelina bedded more during the day in all seasons. During winter, javelina also bedded more during the late night.

Javelina activity was dependent ( $G = 79.90$ , 5 df,  $P < .001$ ) on air temperature (Fig. 2). Javelina bedded more when air temperatures were  $<5$  or  $>25^\circ\text{C}$ . Conversely, javelina moved more when air temperatures were more moderate.

Table 3. Use of slope by urban-dwelling javelina in Prescott, Arizona, 1992–93

Slope (degrees)	No. of locations observed	% locations observed	Bonferroni 90% CI <sup>a</sup>	No. of locations expected	% locations expected	Jacobs' D <sup>b</sup>
Day ( $x^2 = 108.85$ , 3 df, $P < .001$ )						
<5	53	13.1	9.3–16.9	160	39.6	–0.63
5–14	117	28.9	23.9–33.9	143	35.4	–0.15
15–24	116	28.6	23.6–33.6	51	12.5	0.47
>24	119	29.4	24.3–34.5	51	12.5	0.49
Night ( $x^2 = 21.35$ , 3 df, $P < .001$ )						
<5	283	53.4	48.5–58.3	210	39.6	0.27
5–14	155	29.2	24.8–33.6	188	35.4	–0.14
15–24	49	9.2	6.4–12.0	66	12.5	–0.17
>24	43	8.1	5.4–10.8	66	12.5	–0.24

<sup>a</sup>Bonferroni simultaneous confidence intervals calculated according to Neu *et al.* (1974).

<sup>b</sup>Jacobs' D calculated according to Jacobs (1974).

## Discussion

### *Home ranges and habitat use*

In general, home-range characteristics of urban-dwelling javelina were similar to nonurban javelina. Urban-dwelling javelina established overlapping home ranges, with core-use areas used exclusively by the herd occupying the home range (Jewell, 1966; Schweinsburg, 1969, 1971). Urban-dwelling javelina did have larger average home-range sizes and areas of overlap than Day (1986) reported for nonurban herds. In Tucson, deVos *et al.* (1983) also found home ranges of urban-dwelling javelina to be larger than those of nonurban herds. However, this may not always be the case, as Bellantoni and Krausman (1991) reported otherwise for the Tucson area. We also observed that home-range size of urban-dwelling javelina, like nonurban javelina, increased with herd size (Day, 1986).

Movements of urban-dwelling javelina were more widespread at night than during the day. We suspect this was due to their travelling between developed and undeveloped areas in search of human-provided food sources during a time period with minimal human disturbance. We observed home-range overlap only at night when javelina travelled to permanent food sources provided by some homeowners. Interactions between herds were limited because herds typically used these common sites at different times during the night (J. Summers, pers. commun.). Larger home ranges possibly resulted because some javelina travelled to urban areas at night to use homeowner-provided food, but then had to return to natural areas to meet daytime bedding requirements. Although urban-dwelling javelina fed on alternate foods provided by homeowners during nighttime, like nonurban javelina, they also foraged for food during daytime (Sowls, 1984; Day, 1986). Interestingly, we observed that herds that existed solely within the city foraged within residential areas more often during daytime than did those herds living on the city periphery. These herds exhibited tameness when being fed by homeowners, however, they easily became aggressive when homeowners did not quickly provide food. In fact, arcadia doors of homeowners who regularly fed javelina were often smudged with javelina nose prints, and some javelina followed their "feeders" down roads while waiting for food.

The movement of javelina No. 3 outside its home range was not unusual. Nonurban adult male javelina are more mobile than females (Supplee, 1983), and they have been documented travelling far outside their home ranges (Day, 1977; Supplee, 1983; Oldenburg *et al.*, 1985; Bellantoni and Krausman, 1991).

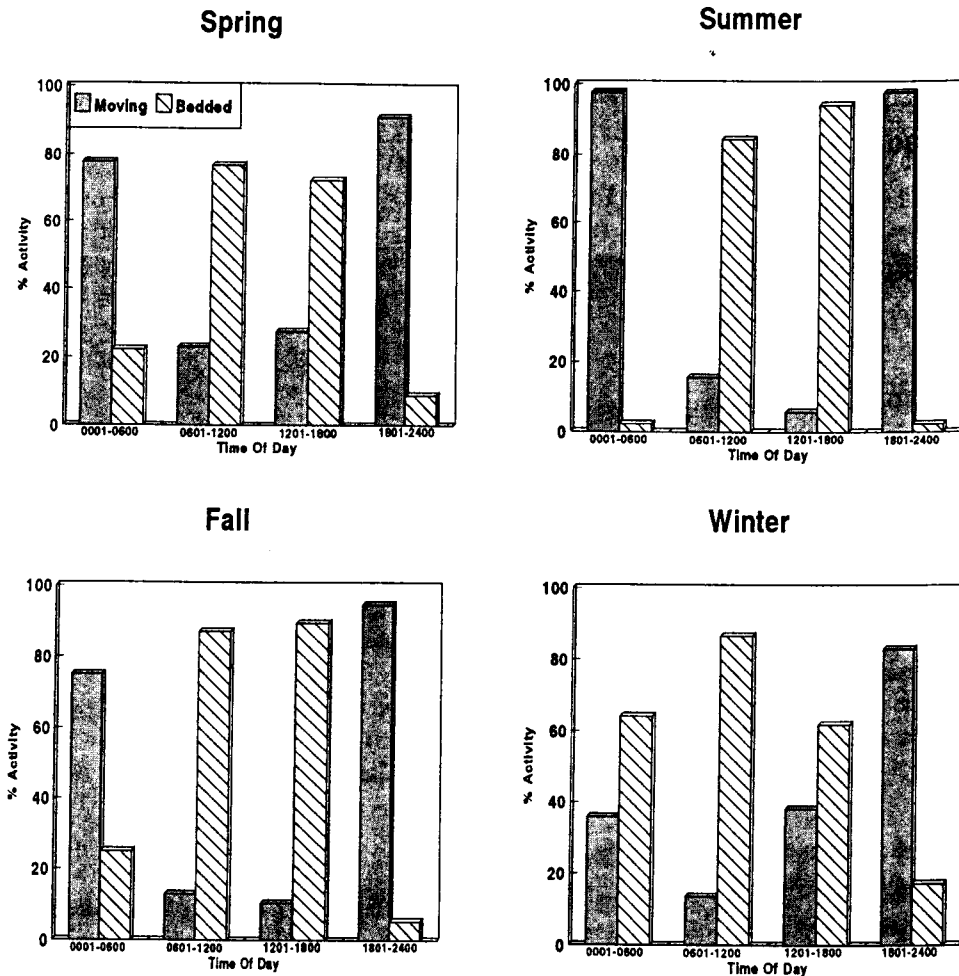


Figure 1. Seasonal activity patterns by time of day for urban-dwelling javelina in Prescott, Arizona, 1992-93.

Although the motivation for these movements is unknown, Supplee (1983) speculated that this may be related to low hierarchy status. Bissonette (1976) hypothesized that such javelina would disperse in response to herd crowding and mating competition.

Roads posed a danger to urban-dwelling javelina. Generally, javelina waited in or adjacent to available cover until traffic cleared, then crossed roads in single file. However, on numerous occasions, we observed traffic swerving or stopping to avoid hitting javelina. Such observations, coupled with a 38% car-related mortality of collared javelina, suggested that javelina-car collisions are numerous and may affect population growth in an urban setting.

Our study supports deVos *et al.* (1983) and Bellantoni and Krausman (1991) in that we found urban-dwelling javelina closer to developed areas at night. We grossly defined all residential areas of Prescott as "developed"; In reality, large portions of many areas were actually a matrix of homes in natural or undeveloped settings. In most cases, no structural boundaries physically separated developed sites from undeveloped areas. Many developed areas in Prescott were not tract-home sites. The occurrence of structural

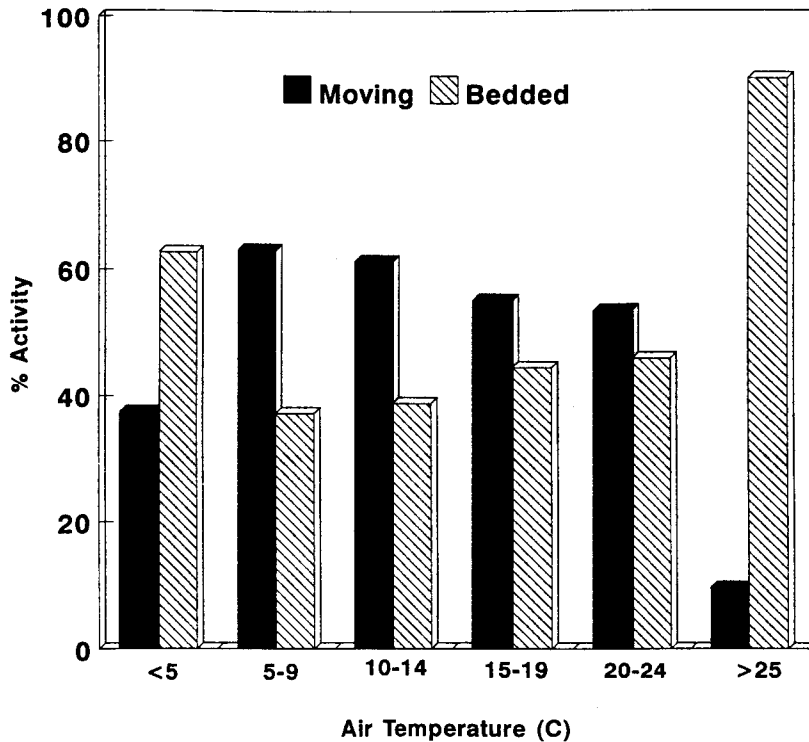


Figure 2. Urban-dwelling javelina activity relative to air temperature in Prescott, Arizona, 1992-93.

boundaries, such as fences, increased with increased housing density closer to the city center and javelina locations greatly decreased in these fenced residential areas.

Urban-dwelling javelina predominately used flats and streambeds when moving through developed areas at night; streambeds provided continuous ribbon-like expanses of undeveloped cover for travel corridors, cover similar to that preferred by nonurban javelina (Sowls, 1984; Day, 1986). They then returned to the security of undisturbed hillsides for daytime bedding. Vogel (1989) had observed similar behavior in urban-dwelling deer (*Odocoileus spp.*) in Montana. Steep, undeveloped areas within or adjacent to urban areas are likely to have low use by people, thereby providing urban wildlife with an undisturbed day-use area.

Similar to nonurban javelina, urban-dwelling javelina used dense vegetation and rugged topographic features for hiding and escape cover (Day, 1986). However, urban-dwelling javelina also used homes and other human-made structures for escape and thermal cover during day or night. Javelina have long been known to thrive in cut-over and agricultural areas (Leopold, 1959, 1966) as long as suitable cover was available for daytime hiding (Sowls, 1984). The same situation seemed to occur in urban areas.

#### *Activity patterns*

Urban-dwelling javelina activity patterns were similar to nonurban javelina. We believe their activity patterns were related to hiding and thermal needs. Urban-dwelling javelina exhibited similar seasonal variation in activity patterns to those of nonurban javelina (Eddy, 1961; Ellisor and Harwell, 1969; Schweinsburg, 1969; Bigler, 1974). The main difference was that urban-dwelling javelina were more nocturnal year round. Vogel (1989) observed a similar shift toward increased nocturnal activity for urban-dwelling deer. Increased nocturnal activity by urban wildlife may have been the result of increased food and lower human



disturbance levels at nighttime. Maximizing nighttime feeding activity when human disturbance is low and when urban predators, such as dogs, are less likely to be out has obvious survival benefits.

Urban-dwelling javelina activities were not influenced by precipitation, and similar results were observed for nonurban herds by Jennings and Harris (1953), Schweinsburg (1969), and Bissonette (1978). Like nonurban javelina, urban-dwelling javelina activity patterns seemed to be largely controlled by ambient temperature. For example, Schweinsburg (1969) observed that nonurban javelina typically ceased feeding and bedded more when air temperatures  $\geq 26.5^{\circ}\text{C}$ . Eddy (1961) also observed this in nonurban javelina, but at slightly higher air temperatures ( $31\text{--}33^{\circ}\text{C}$ ). Our data were comparable.

Similar to nonurban javelina, urban-dwelling javelina became more active during daytime hours in the winter (Day, 1986). Zervanos (1972) suggested that any increase in daytime javelina activity in winter is in response to increased thermoregulatory demands. When we found urban-dwelling javelina bedded during lower temperatures, they were often piled one on top of another. Sowls (1984) postulated that bedding in huddled groups prevents heat loss when temperatures drop to a point where it would be energy inefficient to continue feeding.

Naturally-occurring bedding cover for javelina in Prescott may not provide adequate thermal protection during extreme cold periods. During such times, we often found the more "urban" herds bedded underneath homes or structures. This particularly happened when there was snow on the ground. Man-made structures, such as underneath homes, likely provided more thermal cover than naturally-occurring cover and javelina herds more accustomed to urban settings were more likely to take advantage of the warmer facilities.

Although studies conducted on nonurban javelina found increased daytime activity only during winter, we also noted an increase during spring. We attribute this to the low seasonal temperatures of Prescott. Prescott's high elevation causes seasonally lower temperatures compared to the lower deserts where most javelina studies have been conducted. Therefore, increased daytime activity in spring is congruent with expected behavioral patterns, being more a temperature-driven behavior than seasonally driven.

## Conclusions

Javelina have adapted to habitat conditions in Prescott by using food, water, and cover provided by homeowners. It is apparent that homeowners improved the local habitat quality, thereby allowing javelina to survive in urban settings.

To the frustration of many Prescott homeowners, urban-dwelling javelina did not discriminate between foods in yards where they were welcome and those where they were not. Although most homeowners did not want javelina in their yards (Ticer *et al.*, 1994), those feeding javelina appeared unwilling to forego encouraging javelina into their neighborhood. Therefore, homeowners wanting to exclude javelina from their yards would have to consider strategies such as constructing fences or putting in hot-wires to prevent intrusion. Effective javelina management in urban areas will require a concerted effort by all homeowners and agencies. To prevent or reduce javelina use, homeowners will need to coordinate with neighbors to remove attractants. Fencing may be required in some areas to eliminate problems. Agencies may need to enact regulations that preclude feeding of any wildlife in unfenced yards.

If future development occurred from within the central core of the city and progressed outward, then we suspect javelina would be pushed in the same direction. However, javelina existing around the city's perimeter would still continue to frequent into the city for available resources.

Therefore, as long as undeveloped pockets of land or densely-vegetated travel corridors remain within the city, and homeowners provide wildlife with supplemental food, water, and cover sources, javelina will continue to thrive near residential areas and human-javelina conflicts will continue.

Most importantly, this issue is more a people problem than it is a javelina problem. Although the majority of the people of Prescott are interested in and enjoy wildlife in their area (Ticer *et al.*, 1994), conflicts

sometimes develop between homeowners and javelina. Conflicts place emphasis on the need for resource agencies and planning and zoning commissions to develop strategies for managing javelina inhabiting urban areas and the people encouraging them.

Strategies involve educating homeowners and agencies on methods to reduce the presence of unwanted wildlife. Fences are one method to isolate residential attractants. Woven-wire and brick or wood walls, if >1 m in height, should curtail javelina entry into an area. Hot-wire strands are also highly effective in preventing intrusions. Information about plants most likely to be eaten by javelina and those that are not eaten can be provided.

Resource agencies could test various taste aversion substances, repellents, and ultrasonic chaser devices on captive and free-ranging javelina and disseminate the information to planning and zoning agencies. Lastly, cities should consider implementation and enforcement of local laws and ordinances that preclude feeding wildlife in unfenced settings.

### Acknowledgments

This project was completed with the assistance and cooperation of many individuals, including local wildlife managers Bill Foldesh, Don Buckley, and Bill Ough, and retired research biologist Jerry Day. Wildlife Assistant Barbara Garrison, and volunteers Ginny Goldsmith and Robert Ticer provided field assistance. Biologist Bill Carrel contributed aerial telemetry support. Local homeowners provided us with helpful information and assisted with trapping javelina. Jen Wennerlund and Scott Woods contributed GIS technical support. Carl Gustavson provided statistical support. Vicki Webb and Beth Worsnup contributed clerical support while Rich Glinski helped administer the project. This project was supported by the Urban Wildlife Program of the Arizona Game and Fish Department Heritage Fund.

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