

# **URBAN DEER: A MANAGEABLE RESOURCE?**

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## ECOLOGY OF URBAN AND SUBURBAN WHITE-TAILED DEER

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White-tailed deer (*Odocoileus virginianus*) presently occupy a larger geographic range than any other terrestrial mammal in North America (Pagel et al. 1991). Moreover, they have increased steadily in abundance since early in the twentieth century (McCabe and McCabe 1984), rapidly repopulating areas from which they had been extirpated during the period 1850-1900. In Indiana, for example, the present level of roughly 300,000 deer originated from 296 deer released during 1934-1942, along with additional founding stock that dispersed the state (Mumford and Whitaker 1982:481). In the central hardwoods region, recovery and expansion of deer populations have been facilitated by i) harvest regulations, ii) farm abandonment and succession on cutover areas following the 1930s, with a subsequent increase in interspersion of forest and cropland.

More recently, proliferating deer herds have spread into urban and suburban environments (e.g., Curtis and Stout 1994, Kuser 1994). Urban-suburban areas in the midwest represent a new and expanding habitat (Iverson 1988), and as suburban development encroaches into previously rural areas, habitat quality for deer may actually be enhanced in sites where fertilized lawns, gardens, and landscape plants serve as high quality sources of food.

Despite the increasing frequency with which deer occur in urban and suburban areas, little attention has focused on basic aspects of their behavior and ecology in these localities. Such information is needed because burgeoning populations of deer in suburbs can pose numerous human health and nuisance problems (Conover 1994, Swihart and Conover 1990, Wilson et al. 1985, 1990). Herein we examine several aspects of the behavior and ecology of urban and suburban white-tailed deer, and ask how these attributes differ from deer in rural areas. Our goal in comparing attributes of deer in urban-suburban areas with those in rural areas is to provide insight into the mechanisms by which deer coexist in close proximity to humans. Hopefully, these insights will be useful in developing management plans that maximize positive attributes of deer and minimize negative consequences associated with their presence in suburbs and cities.

### STUDY AREAS

A review of the literature revealed only two studies of ecology of urban or suburban white-tailed deer. Cornicelli (1992) examined behavioral and ecological attributes of deer in a southern Illinois suburban area, and Witham and Jones (1992) reported on population-level attributes of deer in the Chicago metropolitan area. In this report, we synthesize the information from these studies with unpublished results obtained from similar studies we conducted in an urban and a suburban area of Connecticut.

Data on behavior and ecology of suburban deer were available from studies in Carbondale, Illinois, during 1990-1991 (Cornicelli 1992) and in the cities of Bethel and Newtown, Connecticut from 1987-1990 (Swihart, unpub. data). At both sites, an increase in deer abundance had been noted by residents during the decade preceding the study.

Carbondale is a city of roughly 27,000 located in southwestern Illinois. Nearly 45% of the 47 km<sup>2</sup> study site had been developed, whereas 17% consisted of agricultural land, 15% woods, and 23% pasture or old fields (Cornicelli 1992).

Bethel and Newtown, adjoining communities in western Connecticut, have approximately 17,500 and 29,000 residents, respectively. Many residents commute to metropolitan areas to work, and portions of the area are characterized by large (1-2 ha) lots with affluent homes. Overall, Bethel-Newtown is less developed and more heavily wooded than Carbondale, with approximately 25% and 60% of the 25 km<sup>2</sup> study area developed and in forest, respectively. The only agricultural land is planted to orchards and nursery stock (3%).

Data on population attributes of urban deer were taken from the work conducted from 1983-1988 by Witham and Jones (1992) on populations in the Chicago, Illinois, metropolitan area, and from work (DeNicola and Swihart, unpub. data) during 1992-1993 on a herd occupying a fenced reserve in Bridgeport, Connecticut.

The greater Chicago metropolitan area contains >6.8 million residents living in a 4-county area of 5900 km<sup>2</sup> (Witham and Jones 1992). Hunting was prohibited on the roughly 7 percent of the study area owned and managed by county forest preserve districts (Witham and Jones 1992). We did not use data collected by Witham and Jones (1992) from Kane county, because it was the most rural area they examined. Rather we synthesized data collected from more densely settled areas, with particular emphasis on the 1536 ha Ned Brown Preserve in northwest Cook county.

Bridgeport is a city of approximately 100,000 residents. Deer at the Bridgeport study site occupied a 1.76-km<sup>2</sup> tract of privately owned property surrounded by commercial and high-density residential developments that were unsuitable as deer habitat. The area was enclosed by a deer-proof fence, and through vehicle traffic was prohibited, as was hunting. Upland deciduous forest dominated by oaks (*Quercus*) occupied 60% of the site, with 25% in wetlands and 15% in open fields. A thick understory of greenbriar (*Smilax*) was found throughout most of the upland areas.

## METHODS

### Behavior and Autecology

Deer at Carbondale, Bethel-Newtown, and Bridgeport were captured using dart guns, rocket nets and drop nets and fitted with radio collars for assessment of movements and habitat use. All captured deer were immobilized with a mixture of ketamine HCl and xylazine HCl, after which age and sex were determined (Cornicelli 1992).

To prevent collection of autocorrelated data, we located individual deer only 2-3 times per week and only rarely on >1 occasion each day. Observations during the course of the study were collected at a variety of times throughout the 24-hour diel cycle. Home-range size was estimated using the minimum convex polygon (White and Garrott 1990:148). Seasonal home-range estimates were calculated for 11 does and 2 bucks at the Carbondale site (Cornicelli 1992), whereas annual home ranges were estimated for 9 does at Bethel-Newtown and 12 does at the Bridgeport site.

Habitat use was assessed using telemetry data at the Carbondale site (Cornicelli 1992). Telemetry data and roadside spotlight surveys were used to assess habitat use at the Bethel site. In particular, we evaluated use of habitat in relation to proximity to houses or other foci of human activity at the Bethel site.

Briefly, roadside surveys were conducted beginning at 2300-2400 h during winter (December-March) in 1987-88 and 1989-90. A driver and a spotter searched for deer using high-powered, hand-held spotlights while traveling at 10-12 km/h. Locations of deer were recorded on a USGS topographic map, and group size, habitat type, and proximity to houses were noted. Distribution of deer in relation to housing density was assessed by determining the number of dwellings occurring within a 1-km<sup>2</sup> area centered on a deer's position and comparing the resulting frequency distribution with the distribution expected if deer distribution on the study site occurred at random. In late winter 1991 a representative 6 km portion of the route was used to assess differential visibility in open and wooded habitat. One square inch pieces of reflective tape were attached to wooden stakes, and equal numbers (20) were placed at distances of 10, 25 and 50 m at irregular intervals by a non-spotter. The number of reflective tapes seen was then recorded during a spotlighting session.

During winter at Bethel, we also conducted snow tracking surveys to determine the frequency with which deer traveled within specified distances of houses. After a fresh snow, we inspected the area within 50 m of randomly selected houses for deer tracks and bedding sites. Snow tracking was used to quantify availability and use of woody browse by deer. Upon finding a track, we recorded all browsed and unbrowsed woody plants falling within a 1x10-m strip of the trail. After examining the sample strip, the trail was followed for an additional 20 m and then a new 10-m sample strip was examined. The approximate distance of a sample strip to the nearest house was recorded. Trails were followed for 0.5-1.5 km, with length dependent upon snow cover.

Because the original snow-tracking protocol always originated near houses, undersampling of areas farther away from houses was likely. To rectify this, we conducted snow tracking by starting at a randomly selected location and searching in ever-widening circles for a track, at which point the previous sampling protocol was used.

### Population Ecology

Estimates of population density were calculated from roadside surveys at Carbondale (Cornicelli 1992), pellet group counts at Bethel-Newtown (Swihart et al. 1991), and by capture of all deer at the Bridgeport site. Witham and Jones (1990, 1992) determined minimum estimates of density in the Chicago area by counting deer from fixed-wing aircraft or helicopters during winter when snow depth was > 10 cm.

Data on fertility, survival, age structure, and sex ratio were available only for the urban study sites. The age structure of the Bridgeport herd was determined from data collected at capture for 128 deer in early spring 1992. The age structure of deer on the Ned Brown Preserve was reconstructed from age determinations for 219 deer removed from the site by sharpshooters over a 4-year period (1984-1988) (Witham and Jones 1992). Data on fertility were collected by capture of fawns soon after birth at the Bridgeport site and by examining reproductive tracts of females removed from preserves in Chicago (Witham and Jones 1992). Annual survival rates of deer at the Bridgeport site were computed using the nonparametric Kaplan-Meier method (Pollock et al. 1989), whereas survival rates of marked deer at the Ned Brown Preserve were calculated using a piecewise geometric model (Witham and Jones 1992, Heisey and Fuller 1985).

## RESULTS

### Behavior and Autecology

#### *Home-range size*

Summer and winter home ranges of suburban deer in Carbondale averaged 8 and 42 ha for does and 27 and 129 ha for bucks, respectively (Table 1, Cornicelli 1992). For both sexes, home ranges were

largest in winter and early spring and smallest in summer (Cornicelli 1992). Annual home ranges averaged 158 ha for suburban does in Bethel-Newtown and 67 ha for urban does in Bridgeport (Table 1).

#### *Distribution and behavior in relation to humans*

Although one might predict that deer in areas of human activity would alter their activity patterns to become more nocturnal, deer at Carbondale were primarily crepuscular, not differing noticeably from patterns exhibited by rural deer (Cornicelli 1992).

Telemetry and spotlighting data revealed that suburban deer avoided highly developed areas. At Bethel-Newtown, deer were spotted more often in areas of low housing density, whereas areas of high density were rarely used ( $X^2 = 78.8$ , 1 df,  $P < 0.0001$ ). Although 26.1% of the study area contained  $>80$  houses/km<sup>2</sup>, only 7.1% of the sightings were in these areas. In contrast, 60.9% of the area contained  $<60$  houses/km<sup>2</sup>, and 81.2% of sightings occurred in these areas of low to moderate housing density, with most sightings occurring in areas with 40-59 houses/km<sup>2</sup>. At Carbondale, deer used wooded habitats heavily and tended to avoid developed areas (Cornicelli 1992).

Although suburban deer avoided highly developed areas, they routinely were sighted close to

Table 1. Seasonal and annual home ranges for urban-suburban deer and for deer in other localities.

Locality	Seasonal					Source
	Summer		Winter		Annual	
	M	F	M	F		
Carbondale, IL	27	8	129	42	-	Cornicelli (1992)
Illinois	73	28	111	130	130	Hawkins (1967)
Michigan	90	35	125	58	-	Beier & McCullough (1990)
New York	233	221	150	132	-	Tierson et al. (1985)
Minnesota	319	83	-	-	-	Nelson & Mech (1981)
Wisconsin	-	-	300	345	-	Rongstad & Tester (1969)
Bethel, CT	-	-	-	-	158	
Bridgeport, CT	-	-	-	-	67	
Missouri	-	-	-	-	162	Progulske & Baskett (1958)
Florida	-	-	-	-	245	Marchington & Hirth (1984)
Washington	-	-	-	-	158	Gavin et al. (1984)
Wisconsin	-	-	-	-	178 <sup>a</sup>	Larson et al. (1978)

<sup>a</sup>>86% of deer were does.

houses in areas of moderate or low housing density (Cornicelli 1992). One-hundred seven of the 309 sightings (34.6%) at Bethel-Newtown occurred on lawns, with a mean distance of 21 m from the nearest house. Deer were 53% more visible in open versus wooded sites; thus, the actual percent of deer occurring on lawns undoubtedly was lower, falling within the range of 25.7-34.6%. Several deer were spotted <3m from houses, and deer occasionally were seen walking <15 m from houses during the day.

Snow tracking also indicated that deer adapted readily to human presence. Sixty-seven percent of houses we examined ( $n = 27$ ) had been visited by deer. Tracking for 23.6 km revealed that, on average, 2.5 houses were visited by deer during foraging trips. In fact, 18 of 24 (75%) bedding sites were found <50 m from a house. On one occasion, deer tracks led to a picture window with potted plants inside.

#### Winter foraging patterns

Browsing intensity was highest close to houses at Bethel-Newtown, indicating that feeding activity was greatest near houses. Deer were presented with a veritable smorgasbord near houses. Species richness ( $n = 72$ ) was twice as great <50 m from a house compared with greater distances ( $n = 35$ ). Deer took advantage of this plant diversity by broadening their dietary intake. Fully 35 species were browsed <50 m from houses, whereas only 8 were browsed at greater distances, more than a 4-fold difference. The diet breadth of deer was greater close to the house (Kolmogorov-Smirnov test,  $P < 0.05$ ), as nine species accounted for 80% of plants browsed, whereas, only 2 species accounted for a similar percentage >50 m from houses (Figure 1).

The principal browse species of deer varied as a function of distance from houses (Table 2), reflecting

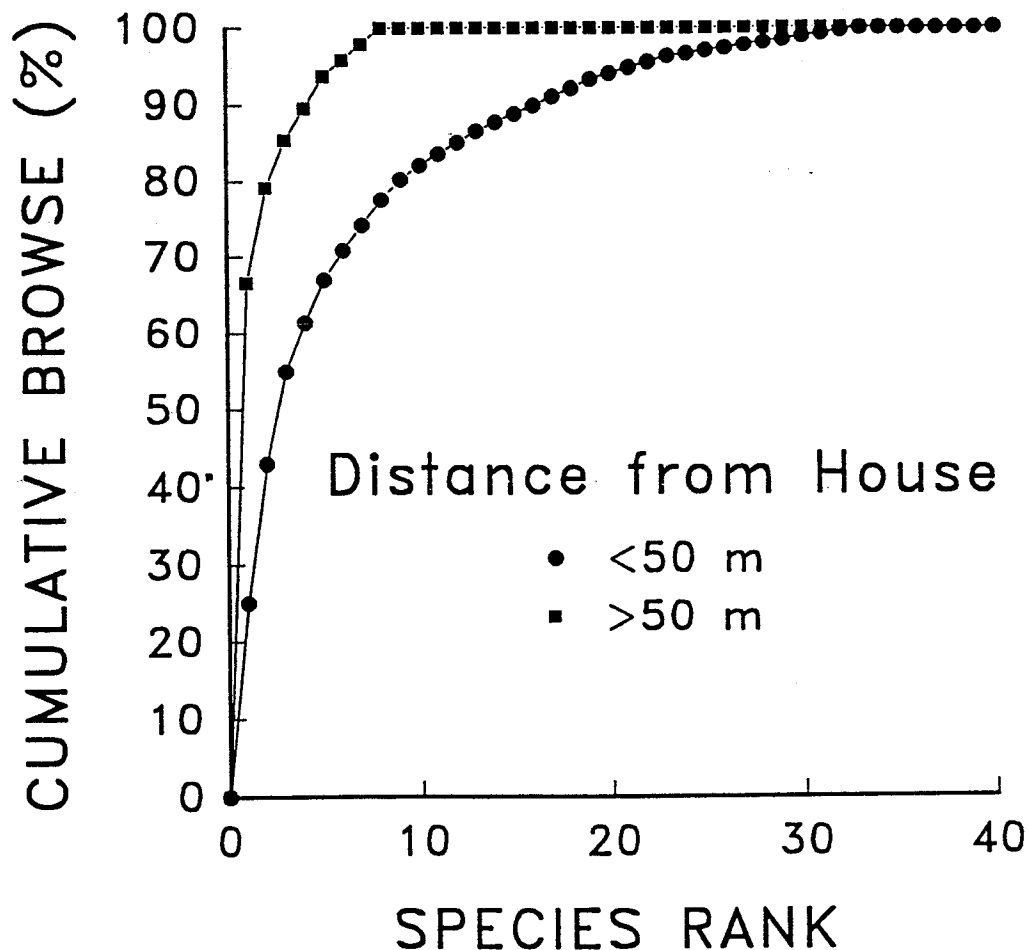


Figure 1. Cumulative percent of all woody plants browsed, plotted as function of species rank, for sites <50 m from houses and sites >50 m from houses at Bethel-Newtown, CT.

Table 2. Principal browse species during winter in Bethel-Newtown, CT, ranked in descending order of use.

Rank	<50 m from house species	>50 m from house species
1	Hemlock ( <i>Tsuga spp.</i> )	Eastern redcedar
2	Yew ( <i>Taxus spp.</i> )	Red maple
3	Eastern redcedar ( <i>Juniperus virginiana</i> )	Witch hazel ( <i>Hamamelis virginiana</i> )
4	Red maple ( <i>Acer rubrum</i> )	Apple ( <i>Malus x domestica</i> )
5	Japanese honeysuckle ( <i>Lonicera japonica</i> )	
6	Privet ( <i>Ligustrum spp.</i> )	
7	Rhododendron ( <i>Rhododendron spp.</i> )	
8	Arborvitae ( <i>Thuja occidentalis</i> )	
9	Juniper ( <i>Juniperus chinensis</i> )	
10	Sugar maple ( <i>Acer saccharum</i> )	

distant-dependent changes in availability of native and ornamental plants. When close to houses, deer relied extensively on evergreens and ornamentals. Preference values for ornamentals were in general agreement with the results of browse surveys in commercial nurseries by Conover and Kania (1988). Predictably, reliance upon ornamental plants declined at >50 m from houses, although an evergreen, eastern red cedar (*Juniperus virginiana*) continued to dominate the diet.

### Population Ecology

#### Population density

Estimates of ecological density (based on suitable habitat) at the Connecticut study sites ranged from a low of 8.3 deer/km<sup>2</sup> at Bethel-Newtown (Swihart et al. 1991), to a high of 72.7 deer/km<sup>2</sup> at Bridgeport. Absolute density of deer at Carbondale was 3.6/km<sup>2</sup>, but ecological density was approximately 38/km<sup>2</sup> (cf. Cornicelli 1992). Surveys of Witham and Jones (1992) yielded mean minimum estimates in reserves of the Chicago metropolitan area of 5.4 deer/km<sup>2</sup> (DuPage County; range 0-22/km<sup>2</sup>, n = 14 preserves over 3 years), 9.8 deer/km<sup>2</sup> (Lake County; range 0-23/km<sup>2</sup>, n = 18 preserves over 1 year), and 7.3 deer/km<sup>2</sup> (Cook County; range 0-45/km<sup>2</sup>, n = 54 preserves over 7 years). In 1983 before a removal program was instituted at the Ned Brown Preserve, minimum density was 19.7 deer/km<sup>2</sup> (Witham and Jones 1992).

#### Fertility and survival

Fertility rates of does at Bridgeport averaged 0.60 fawns/yearling doe and 1.20 fawns/adult doe for 1992 and 1993 (Figure 2). Doe fawns failed to produce offspring in either year (Figure 2). Fertility rates of

does from the high-density Ned Brown and Des Plaines preserves of Chicago averaged 1.00 fetuses/yearling doe and 1.42 fetuses/adult doe. Doe fawns failed to produce offspring (Witham and Jones 1992). In Chicago preserves characterized by lower densities, fertility rates averaged 0.82 fetuses/doe fetuses, 1.46 fetuses/yearling doe, and 2.19 fawns/adult doe (Witham and Jones 1992) (Figure 2).

Annual survival of buck fawns (n = 21) at Bridgeport (0.77) was twice as high as doe fawns (n = 22, 0.38), but fawn survival was lower than survival of older age classes. Annual survival was 0.86, 0.82, and 0.83 for yearling does (n = 7), adult does (n = 37), and adult bucks (n = 47), respectively. Data were insufficient to calculate survival rates of yearling bucks. At Ned Brown Preserve in Chicago during periods when no removals occurred, 6-month survival rates of buck fawns and doe fawns were 0.87 and 0.81, respectively, annual survival rates for yearling bucks, yearling does, adult bucks and adult does were 0.83, 0.56, 0.62, and 0.67, respectively (Witham and Jones 1992).

Collisions with vehicles were the predominant source of deer mortality at Ned Brown Preserve, accounting for 78% of deaths due to causes other than removal (Witham and Jones 1992). Collisions with vehicles represented a particularly important mortality agent for yearling bucks (100% of all non-removal deaths, n = 4) and adult bucks (80% of all non-removal deaths, n = 15).

Vehicular traffic at the Bridgeport site was minimal. Collisions with vehicles accounted for 10%

of mortalities at the site, with poaching (21%), malnourishment (3%), and unknown causes accounting for the remainder. Deer-vehicle collisions also appeared to be a significant mortality factor at the suburban sites. At Bethel-Newtown, cause of death was known for 7 marked deer; 2 died from collisions with vehicles and 5 from hunting. At Carbondale, reported roadkills tripled from 1981-89, resulting in deaths of approximately 13-16% of the population annually by 1989 (Cornicelli 1992).

#### *Age structure and sex ratio*

The most notable aspect of age structure of the urban populations was the strong skew toward older age classes (Figure 3). About 70% of the deer at Bridgeport were >2.5 years of age in January 1992. Likewise, reconstructed age structures for the Ned Brown Preserve in Chicago indicated that >50% of the deer were >2.5 years old (Figure 3), although this trend was more pronounced for females (Witham and Jones 1992).

At Bridgeport, males comprised 76%, 20%, and 58% of the fawn, yearling, and adult age classes, respectively. The low proportion of yearling males presumably was a consequence of small ( $n = 10$ ) sample size of yearlings. At Ned Brown Preserve, males comprised 50%, 46%, and 13% of fawn, yearling, and adult age classes in a shot sample backdated to 1984 (Witham and Jones 1992).

## DISCUSSION

### **Behavior and Autecology**

Home ranges of suburban and urban deer tend to be smaller than home ranges of conspecifics in less developed landscapes, at least in the east and midwest. For instance, seasonal home ranges of deer in Carbondale were smaller than seasonal ranges for deer in rural areas, whether enclosed (Beier and McCullough 1990) or free-ranging (Hawkins 1967, Nelson and Mech 1981, Rongstad and Tester 1969, Tierson et al. 1985) (Table 1). Moreover, annual range sizes reported for deer at Bridgeport and Bethel-Newtown were as small or smaller than annual home ranges of does in rural areas (Gavin et al. 1984, Larson et al. 1978, Marchinton and Hirth 1984, Progulske and Baskett 1958) (Table 1).

Small home ranges may result from several factors, 3 of which appear applicable in the present examination of urban and suburban deer. First, population density often is inversely associated with home-range sizes in mammals, including deer (Marchinton and Hirth 1984). Density at the Bridgeport and Carbondale sites was high; deer also

were abundant at the Bethel-Newtown site. Second, local movements may be restricted if suitable habitat is patchily distributed, resulting in insular areas where activity is concentrated. Such a situation appears to occur in Carbondale, where deer are associated with widely scattered wooded sites (Cornicelli 1992). Third, increased interspersions of concealment sites (wooded areas) with feeding sites (fields, lawns) in suburban settings may reduce the movements needed to meet daily energetic requirements. Indeed, the frequent use of lawns at both suburban sites undoubtedly was facilitated by the interspersions of lawn and woodland habitat; yards in Bethel-Newtown often abutted wooded terrain, and in Carbondale small patches of woods and fields were abutted or encircled by residential developments.

Our data suggest that white-tailed deer habituate to human presence in urban-suburban areas. Additional evidence of habituation comes from anecdotal observations of increased approachability (Witham and Jones 1987) as well as experimental documentation that human scent fails to elicit aversive responses in suburban deer (Swihart et al. 1991).

In contrast to our findings, Vogel (1989) concluded that abundance of white-tailed deer and mule deer (*Odocoileus hemionus*) in Gallatin County, Montana, declined as housing density in rural areas increased. The maximum housing density considered by Vogel (1989) was  $<60/\text{km}^2$ , corresponding to a moderate density at the Bethel-Newtown site. Moreover, 95% of his study plots were in what we have described as low housing density ( $<40$  houses/ $\text{km}^2$ ). Taken alone, the findings of Vogel (1989) suggest a strong aversion by deer to areas of human habitation. However, our findings clearly indicate that when areas devoid of humans are lacking, white-tailed deer readily use areas of low to moderate development.

Suburban deer routinely forage close to houses. Data from Bethel-Newtown indicate that for suburban deer in northern latitudes, ornamental plants near houses are important components of the diet. Deer are generalist herbivores, and winter dietary diversity apparently is important for maintenance of body mass and nutritional health (DelGiudice et al. 1989). When humans in suburbs increase plant diversity by planting exotic species or creating additional edge, deer can respond to these changes by increasing diet breadth, as at Bethel-Newtown. Fertilization of lawns and landscape plants also may improve the quality and quantity of food. Thus, suburban areas may actually

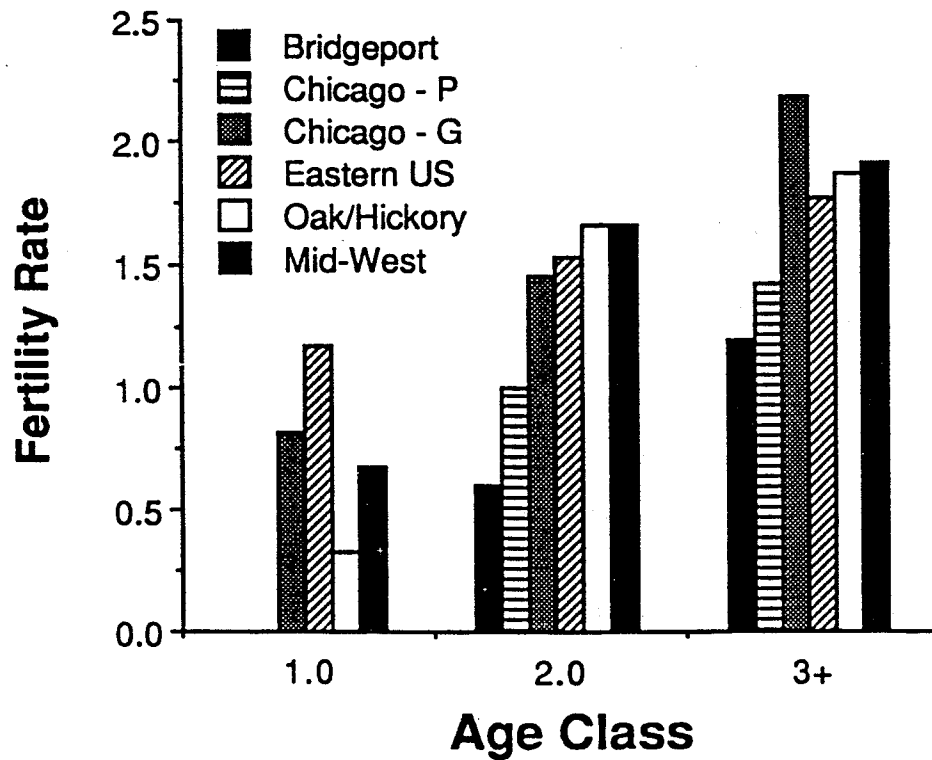


Figure 2. Age-specific fertility rates of does from urban populations (Bridgeport, Chicago) and from predominantly rural populations. Data are from Witham and Jones (1992) for Chicago, Sileo (1977) for the eastern U.S., Torgerson and Porath (1984) for the midwest oak/hickory region, and Gladfelter (1984) for the midwest agricultural region. Chicago data are separated into areas with deer at high densities (Chicago-P) and low densities (Chicago-G).

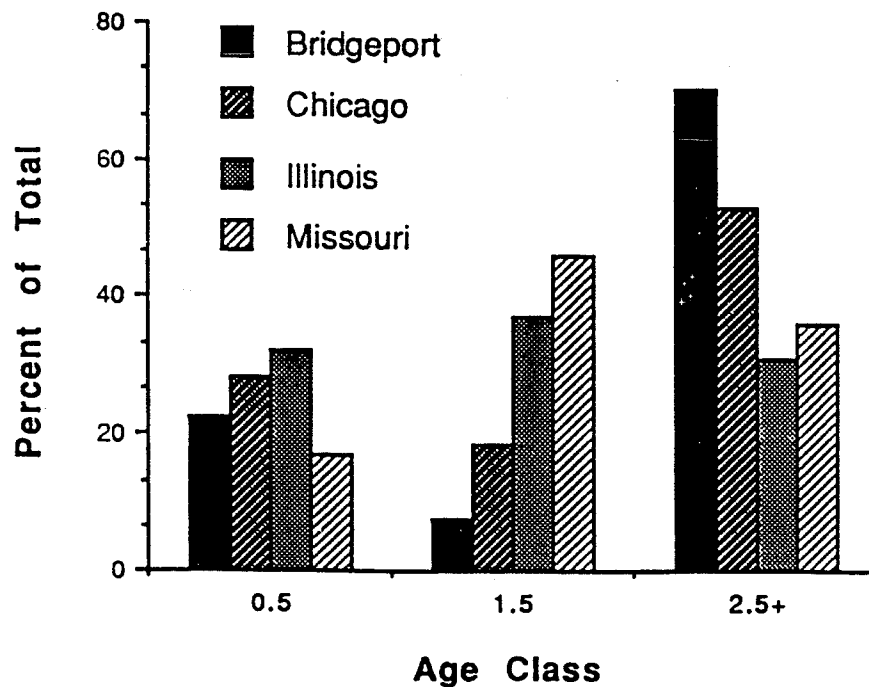


Figure 3. Age structure of deer populations in urban areas (Bridgeport, Chicago) and in predominantly rural sites. Data are from Witham and Jones (1992) for Chicago, and Torgerson and Porath (1984) for Illinois and Missouri.



provide improved deer habitat, at least in terms of dietary requirements.

### Population Ecology

Densities of deer in rural areas vary in response to numerous factors; thus, generalizations regarding densities reported in this paper are difficult. Areas comprised of deciduous forest and/or farmland generally exhibit densities of  $< 12$  deer/km<sup>2</sup>, although 80 deer/km<sup>2</sup> of forested habitat is possible (Gladfelter 1984, Torgerson and Porath 1984, Barber 1984). Densities in several of the urban-suburban areas exceeded 12 deer/km<sup>2</sup>, and densities of  $> 30$  deer/km<sup>2</sup> were not uncommon. Attainment of high density in urban and suburban settings is facilitated by 3 factors.

First, insularity of suitable habitat may restrict movements or dispersal (but see Nixon et al., 1991). This certainly is true in an enclosed population, such as the Bridgeport herd, but such conditions may also exist in the absence of fences if areas are highly developed (Witham and Jones 1992). Second, an absence of hunting-induced mortality and a dearth of "natural" mortality enhances survivorship, particularly of adults. Third, survival may be further enhanced if residents supplementally feed deer.

Fertility rates of deer in urban areas are influenced by population density and physical condition. Fawn, yearling and adult does at Bridgeport and the Ned Brown-Des Plaines preserves in Chicago had substantially lower fertility rates than rural deer from comparable geographic areas (Sileo 1977, Gladfelter 1984, Torgerson and Porath 1984) (Figure 2). Fertility of does from other Chicago metropolitan preserves were comparable to values from rural populations (Figure 2). Fertility rates are related to nutritional status of does, and postnatal survival of fawns is inversely related to population density, presumably because suitable fawning sites become limiting (Ozoga and Verme 1982, Verme 1969). The Bridgeport, Ned Brown, and Des Plaines areas exhibited mean densities ranging from 15-73 deer/km<sup>2</sup>, and physical condition of deer at these sites was relatively poor (Witham and Jones 1992). By contrast, sparser deer populations in other Chicago area preserves were in good condition (Witham and Jones 1992).

Survival rates of urban deer are comparable to rates reported in studies of un hunted rural deer. For instance, Eberhardt (1969) reported survival rates of 0.70 for adult does in un hunted populations in Michigan, and Gavin et al. (1984) determined annual survival rates of un hunted Columbian white-tailed deer as 0.60 for adult bucks and 0.80 for adult does.

Annual survival of fawns is highly variable, ranging from  $< 0.25$  (Gavin et al. 1984, Fuller 1990) to 0.58 (Eberhardt 1969).

Lack of hunting-induced mortality can result in highly skewed age structures, and urban deer reflect this pattern (Figure 3). Relative frequency of adults in the Bridgeport and Ned Brown populations are roughly 1.7 times greater than adult proportions in hunted populations of Illinois and Missouri (Torgerson and Porath 1984; Figure 3). In general, then, population attributes of urban-suburban deer are similar to those of deer occupying other un hunted areas.

### CONCLUSIONS

Urban and suburban environments share several factors that, in sum, qualify them as unique habitats for deer. First, suitable habitat, particularly wooded refugia, typically is patchily distributed and surrounded by unsuitable areas. This insularity can reduce local movements, and perhaps frequency or success of dispersers. Second, urban-suburban areas lack natural predators, and hunting mortality often is reduced or eliminated. Finally, humans occur in relatively high densities in cities and suburbs. Our results indicate that deer adapt remarkably well to living in close proximity to people. In fact, developed areas appear to be important foraging sites for suburban deer, at least in areas with little agriculture.

Adaptability of deer, combined with improved interspersion and foraging opportunities and reduced risk of mortality to hunting or predation, create ideal conditions for rapid growth of deer populations in urban and suburban areas. The challenge facing wildlife managers is to develop innovative solutions to problems presented by deer in these human-dominated landscapes, and whenever possible to deal proactively with management of deer in cities and suburbs.

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