

### Overabundant deer: Better management through research

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**Abstract:** Overabundance of white-tailed deer (*Odocoileus virginianus*) continues to challenge wildlife professionals nationwide, especially in urban settings. Moreover, wildlife managers often lack general site-specific information on deer movements, survival, and reproduction that are critical for management planning. We conducted radio-telemetry research concurrent with deer culling in forest preserves in northeastern Illinois and used empirical data to construct predictive population models. We culled 2,826 deer from 16 forest preserves in DuPage County (1992-1999) including 1,736 from the 10 km<sup>2</sup> Waterfall Glen Forest Preserve. We also radio-marked 129 deer from 8 preserves in DuPage and adjacent Cook County (1994-1998). Recruitment was inversely associated with deer density suggesting a classic density-dependent response. Female deer were philopatric and 20% of adult males dispersed. Survival was high for all sex and age classes, and deer-vehicle collisions accounted for >55% of known mortalities. Based upon data from other areas, early attempts to apply population models to deer at Waterfall Glen Forest Preserve were not useful. The subsequent quantification of the density-dependent recruitment response and use of other empirical data strengthened the predictive capability of models. Our experience illustrates the importance of understanding demographics of overabundant deer in order to set realistic objectives and make sound management decisions.

**Key words:** Chicago, deer, Illinois, management, model, *Odocoileus virginianus*, overabundance, population, suburban

Overabundance of white-tailed deer is one of the greatest challenges facing wildlife professionals in the 22<sup>nd</sup> century (Warren

1997). However, the natural or human-induced mechanisms that normally control overabundant deer are poorly understood and

management practices applied to regulated hunted populations may not pertain to protected, overabundant populations (Etter 2001). Regulated hunting has been advocated as the most effective means for controlling deer populations, but hunting is not an option for population control in many semi-isolated suburban areas (DeNicola et al. 1997, Etter et al. 2000).

Forest preserve districts in the Chicago region have attempted site-specific control of deer populations using lethal removal since 1984. Management objectives typically specified reducing deer populations from >50 deer/km<sup>2</sup> to 4-6 deer/km<sup>2</sup> over several years (Etter et al. 2000). Initially, aerial counts proved sufficient for setting removal quotas because substantially more deer were counted than could realistically be culled in a single season. However, as populations were reduced managers needed a more accurate method for estimating deer abundance. Site-specific information on deer movements, survival and reproduction were needed for use in population models that could accurately predict the impacts of removal on local herds. We conducted an 8-year deer culling program in the suburbs of Chicago, generated empirical data from a radio-telemetry study, and constructed predictive population models. We emphasize here the significant improvements in predictive models resulting from field research.

## **Methods**

### **Study area**

The study area consists of Cook and DuPage Counties, Illinois located west of downtown Chicago. Total area is approximately 335,000-ha. Land cover is

dominated by urban/built-up land (57.5%) and associated urban grassland (14%). The remainder is forested/woodland (14.2%), crop land (4.9%), rural grassland (4.1%), wetland (3.3%), open water (1.8%) and barren/exposed land (0.2%) (Illinois Department of Natural Resources 1996). Forest preserves occupy approximately 11% of the total land area in Cook and DuPage Counties combined and account for about one third of open lands within the Chicago suburbs. Firearm deer hunting is not allowed in the 4-county region surrounding Chicago. Hunting is prohibited in forest preserves, but archery hunting is allowed on some adjacent private lands.

### **Deer culling**

We culled deer from forest preserves during November-March, 1992-1999. Culling techniques included sharpshooting (1992-1999) and capture with rocket-nets followed by euthanasia via a penetrating captive bolt (1992-1994). The University of Illinois Laboratory Animal Care Committee reviewed and approved all capture and euthanasia techniques.

### **Capture and marking**

We captured deer using rocket-nets (Hawkins et al. 1968), drop-nets (Ramsey 1968) or remote dart gun (Kilpatrick et al. 1997) from November through April 1994-1998. Deer were sexed and aged by tooth replacement and wear (Severinghaus 1949). We marked deer with 2 numbered plastic ear tags and 2 metal ear tags inscribed with contact information for the research agency. We fitted most females and selected males with radio-collars equipped with motion sensitive mortality switches (Telonics, Mesa,

Z and Advanced Telemetry Systems, Isanti, MN).

### Monitoring

Deer were monitored a minimum of twice per week for movements and dead or alive status. A Hughes Jet Helicopter was used to search for missing deer. Deer wearing collars transmitting in mortality mode were located and cause of death was determined by site inspection and field necropsy. Local law enforcement and transportation departments reported deer-auto collisions (DACs) involving marked deer. MICROMORT software was used to estimate cause-specific and annual mortality rates (Heisey and Fuller 1985).

### Counts and population estimates

We conducted annual helicopter counts of deer at Waterfall Glen Forest Preserve (WFGFP) at least once per winter (range 1-5) from 1992-1999 (Witham and Jones 1990). We subtracted the number of deer culled after counts to provide an April 1 minimum population estimate. We tallied DACs, which were reported to the Illinois Department of Transportation, on roads adjacent to WFGFP from 1992-1998.

We constructed an individual based deer population model for WFGFP using computer software Stella 5.0 (High Performance Systems, Inc., Hanover, NH; Etter 2001). We used the April 1 minimum population estimate for  $N$  at time  $t$ . We regressed the fawn-to-doe ratio of the harvest on winter helicopter counts to estimate density effects on recruitment (McCullough 1979). We incorporated the density-dependent recruitment function, sex ratio, sex-specific

survival and annual harvest into models. We verified model predictions by correlating annual model estimates with DACs (an independent data set; Etter 2001) using simple linear regression (Sokal and Rohlf 1995).

### Results

We captured 200 deer from 8 forest preserves in winter 1994-1998. We radio-marked 15 males and 114 females (Etter 2001). Annual deer survival from our radio marked sample exceeded 80% for males and females and DACs accounted for >55% of mortalities (Etter 2001). All age-classes of females were highly philopatric. Yearling and adult female dispersal was <8% and doe fawns dispersed at rates <10% annually (Etter 2001). Twenty percent (3 of 15) radio-marked males dispersed as yearlings (2) or adult (1) (Etter 2001).

From 16 forest preserves in DuPage County, we culled 2,826 deer, including 1,786 from the 10 km<sup>2</sup> WFGFP, from 1992-1999 (Etter et al. 2000). Recruitment rates were negatively correlated ( $r = 0.74$ ,  $P = 0.012$ ,  $n = 7$ ) with winter aerial counts at WFGFP after elimination of influential observation (1997) (Cook's  $D = 0.506$ , 1, 7). We used the derived regression equation, recruits =  $1.23 - 0.00074$  (count), to model density-dependent recruitment for WFGFP (Figure 1).

DACs were positively correlated ( $r = 0.91$ ,  $P = 0.0009$ ,  $n = 7$ ) with model population estimates at WFGFP suggesting that the model could predict trends in deer population density (Figure 2).

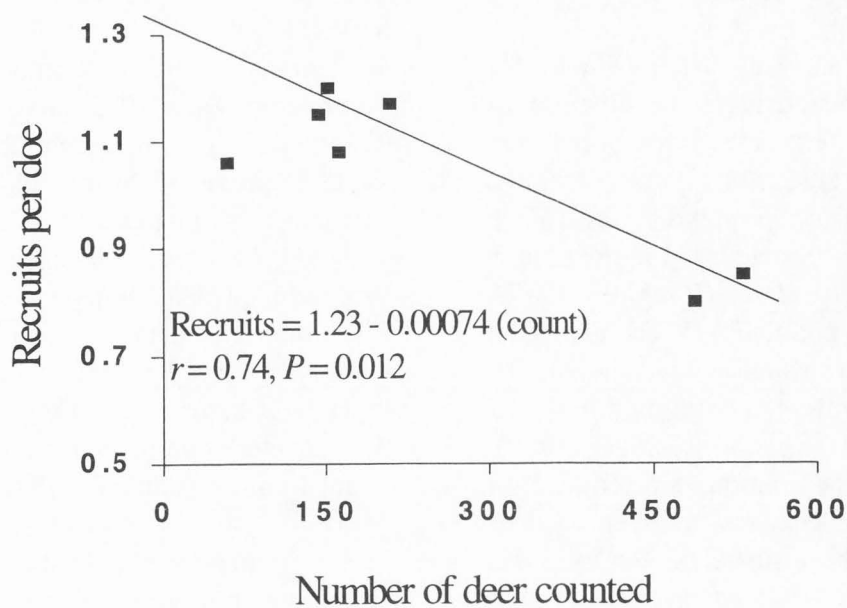


Figure 1. Regression of mean recruitment rates on winter aerial counts of the number of deer present at Waterfall Glen Forest Preserve. Aerial counts reflect the number of deer counted minus the number of deer removed after counts to provide an April 1 minimum population estimate.

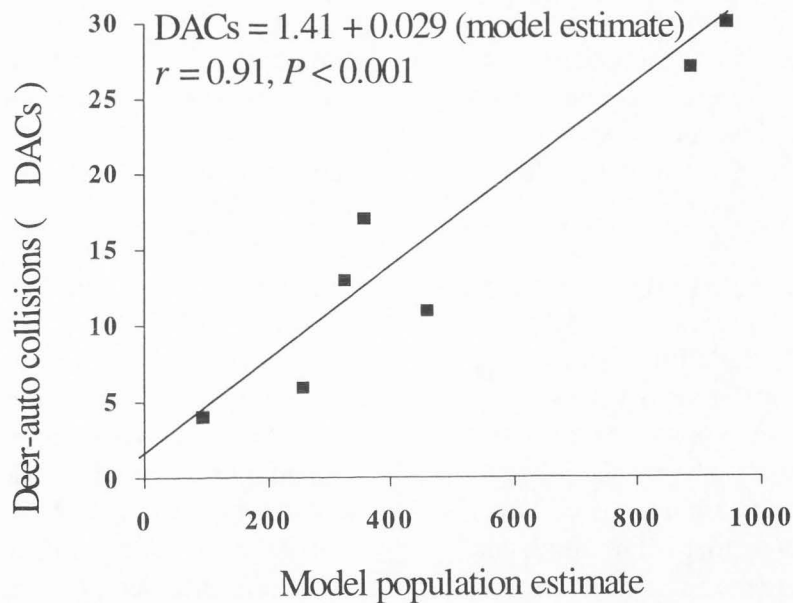


Figure 2. Regression of deer-auto collisions (DACs) on model population estimates at Waterfall Glen Forest Preserve.

## Discussion

Many techniques are available for analysis of harvest data and estimation of population levels (e.g., life-tables, population reconstruction, sustained yield models; Caughley 1977, Roseberry and Wolfe 1991). However, these techniques require many continuous years of data (Caughley 1977). For example, population reconstruction techniques for deer should include at least 10 years of data because the maximum life span of deer is  $\leq 10$  years (Ozoga 1969). Furthermore, as populations are reduced on small sites, sample sizes (number of deer harvested) may be insufficient for use with these techniques. When age-distribution methods are employed for life table analysis, a table based on age estimates of  $<150$  individuals may lack the needed precision for management (Caughley 1977). In urban areas, intense public and political scrutiny requires biologists to accurately determine site-specific population levels. This is a new approach for many biologists who commonly estimate relative deer densities over a broad area or region. Predictive models generated from empirical data provide an alternative to standard techniques for estimating population levels.

We first constructed a working model for WFGFP after 2-3 years of culling. This model (old model) included mean fecundity rates determined from harvested does in an adaptive management approach (e.g., we adjusted fecundity rates each year according to the previous winters rate), estimated fawn mortality based upon available literature, and provided for adjusting the sex ratio. Original estimates seemed practical as the population declined under intensive culling in 1992 and

1993 (Figure 3). However, after a reduced harvest in 1994 the old model did not detect an increase in the population in 1995. Subsequently, our 1995 harvest significantly exceeded the estimated number of deer at WFGFP predicted by the old model. We attributed this increase in deer density from 1994-1995 to density-dependent recruitment. We included density-dependent recruitment and empirical data on deer survival and movements into a new model in 1996. Independent trend data (DACs) verified that the new model predicts annual trends in deer population levels at WFGFP (Figure 2).

Managers should be aware of the predictive power of site-specific models generated from empirical data. Caughley (1977) stated that the two most important demographic parameters required for estimating population growth rate are age-specific reproduction and survival. At a minimum, managers should collect data for these two parameters for inclusion in site-specific models. However, collection of additional data will prove invaluable in making management decisions (Table 1).

## Management implications

Biologists attempting to manage overabundant deer require techniques of estimating site-specific population levels. Some empirical data for use in predictive population models can be collected relatively quickly ( $\geq 2$ -years) compared to data required by standard harvest techniques. Nonetheless, estimates of density-dependence, because of its value in modeling, will require a longer-term commitment to data collection. Population models derived from empirical data will provide credibility to site-specific population estimates.



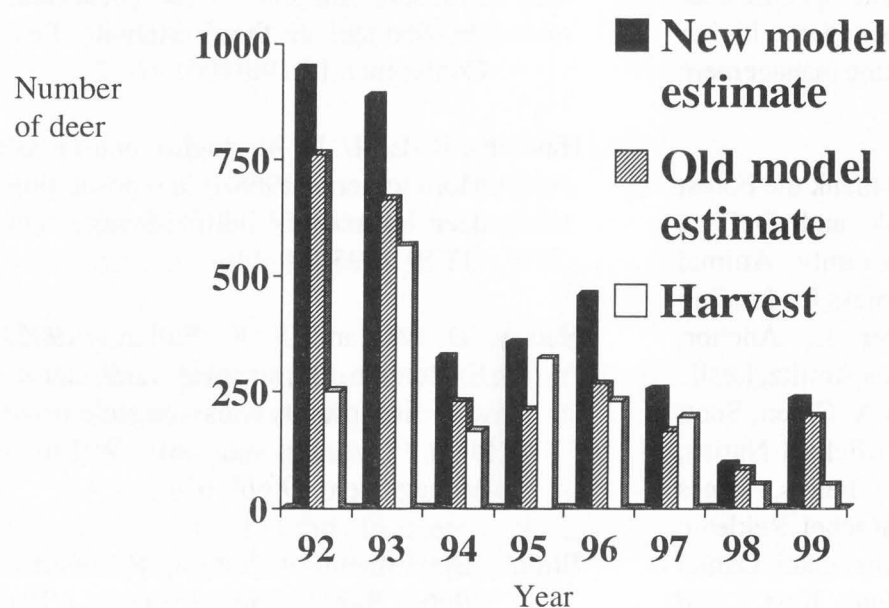


Figure 3. New (empirical) and old model population estimates, and the number of deer harvested from Waterfall Glen Forest Preserve 1992-1999.

Table 1. Recommended data for constructing site-specific predictive models.

Parameter	Data source
Age-specific recruitment	Culled deer, observations from marking studies
Age-specific survival	Culled deer, radio-telemetry studies
Sex ratio	Culled deer, observations from marking studies
Immigration/emigration	radio-telemetry studies
Age distribution	Culled deer
Population trend	Culled deer, counts, deer-auto collisions

Furthermore, understanding site-specific deer demographics will provide managers a higher level of confidence when making management decisions.

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