10-4-2000

Overabundant deer: Better management through research

Dwayne R. Etter
University of Illinois

Timothy R. Van Deelen
Illinois Natural History Survey

Daniel R. Ludwig
Forest Preserve District of DuPage County, Illinois

Karmen M. Hollis
University of Illinois

James E. Chelsvig
Forest Preserve District of Cook County, Illinois

See next page for additional authors

Authors
Dwayne R. Etter, Timothy R. Van Deelen, Daniel R. Ludwig, Karmen M. Hollis, James E. Chelsvig, and Richard E. Warner

Overabundant deer: Better management through research

Dwayne R. Etter, University of Illinois, Natural Resources and Environmental Sciences, 607 East Peabody Drive, Champaign, IL 61820, USA

Timothy R. Van Deelen, Illinois Natural History Survey, 607 East Peabody Drive, Champaign, IL 61820, USA

Daniel R. Ludwig, Forest Preserve District of DuPage County, P.O. Box 2339, Glen Ellyn, IL 60137, USA

Karmen M. Hollis, University of Illinois, Department of Natural Resources and Environmental Sciences, 1102 South Goodwin, Urbana, EL 61821, USA

James E. Chelsvig, Forest Preserve District of Cook County, Route 4, Box 178, Elgin, IL 60120-9223, USA

Richard E. Warner, University of Illinois, Department of Natural Resources and Environmental Sciences, 1102 South Goodwin, Urbana, IL 61821, USA

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^2 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 22nd 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^2 to 4-6 deer/km^2 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^2 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 ($r = 0.91$, $P = 0.0009$, $n = 1$) with model population estimates at WFGFP suggesting that the model could predict trends in deer population density (Figure 2).

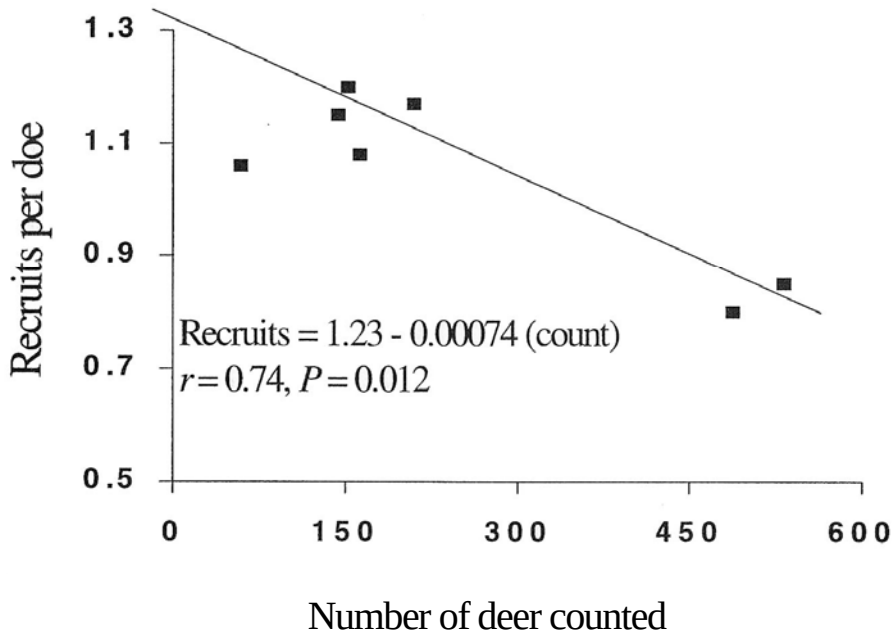

Figure 1. Regression of mean recruitment rates on winter aerial counts of the number of deer present at Waterfall Glen Forest Preserve. Aerial counts reflect the number of deer counted minus the number of deer removed after counts to provide an April 1 minimum population estimate.

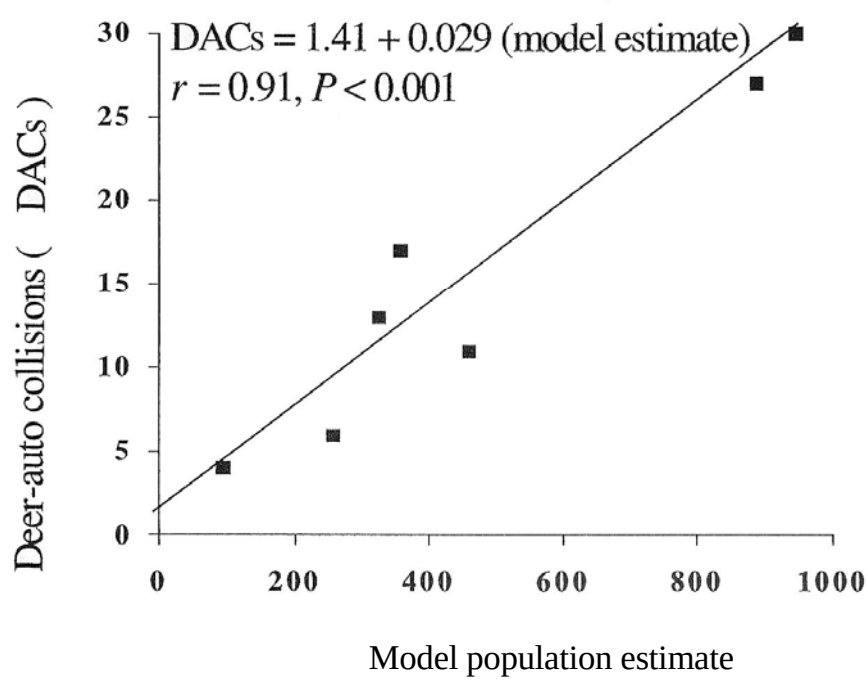

Figure 2. Regression of deer-auto collisions (DACs) on model population estimates at Waterfall Glen Forest Preserve.

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 <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 (> 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.

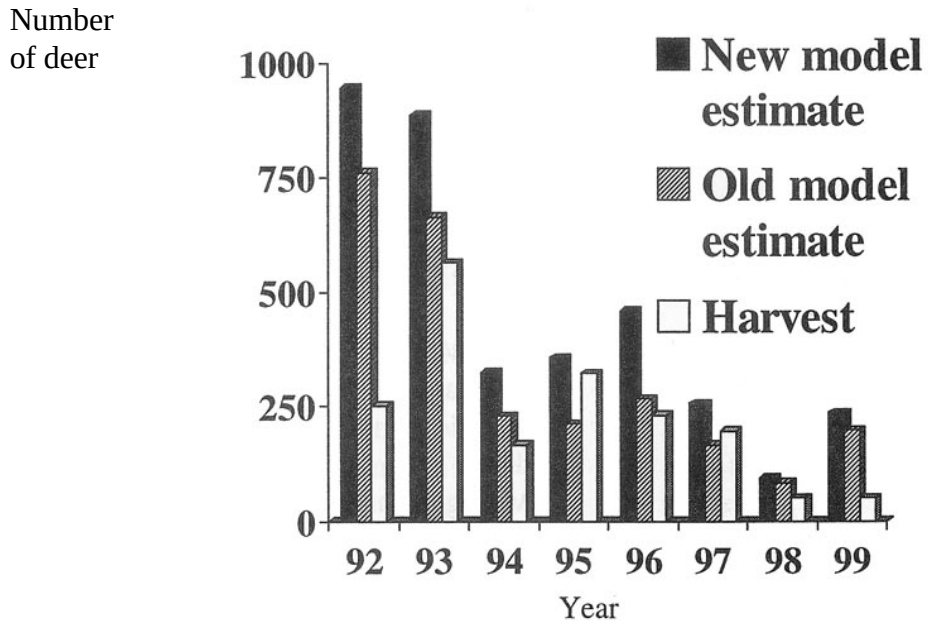

Figure 3. New (empirical) and old model population estimates, and the number of deer harvested from Waterfall Glen Forest Preserve 1992-1999.

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.

Acknowledgments. We thank the Forest Preserve Districts of Cook and DuPage Counties, Illinois, Cook County Animal Control, and Chicago Wilderness for funding this research. Christopher L. Anchor, Theodore W. Anchor, Deborah Antlitz, Leslie Berns, Mark J. Ermer, Brian A. Green, Scott N. Kobal, Gregory Lavryk, Michael Narish, John Oldenburg, Melina F. Peters, James Phillips, Brian P. Piccolo, Rachel Rekleau, JoEllen Siddens, Raymond Soszinski, Daniel Thompson, Mark A. Van Kast, and MathewZaura assisted with deer-capture, radio-monitoring, data processing, and administration.

Literature cited

Caughley, G. 1977. Analysis of vertebrate populations. John Wiley & Sons, New York, USA.

DeNicola, A. J., S. J. Weber, C. A. Bridges, and J. L. Stokes. 1997. Nontraditional techniques for management of overabundant deer populations. Wildlife Society Bulletin 25:496-499.

Etter, D. R. 2001. Ecology and management of overabundant white-tailed deer from suburban Chicago, Illinois. Ph.D. Thesis. University of Illinois, Urbana-Champaign.

Etter, D. R., D. R. Ludwig, S. N. Kobal, T. R. Van Deelen, and R. E. Warner. 2000. Management of white-tailed deer in Chicago, Illinois forest preserves. Proceedings of the Vertebrate Pest Conference 19:190-196.

Hawkins, R. E., L. D. Martoglio, and G. G. Montgomery. 1968. Cannon-netting deer. Journal of Wildlife Management 32:191-195.

Heisey, D. M., and T. K. Fuller. 1985. Evaluation of survival and cause-specific mortality rates using telemetry data. Journal of Wildlife Management 49:668-674.

Illinois Department of Natural Resources. 1996. Illinois land cover, an atlas. Illinois Department of Natural Resources, Springfield, Illinois, USA.

Jones, J. M. and J.H.Witham. 1992. Urban deer "problem"-solving in northeast Illinois: an overview. Pages 58-65 *in* J. B. McAninch, editor. Urban deer: a manageable resource? Proceedings of the 1993 Symposium of the North Central Section, The Wildlife Society.

Kilpatrick, H. J., S. M. Spohr, and A. J. DeNicola. 1997. Darting urban deer: techniques and technology. Wildlife Society Bulletin. 25:542-546.

McCullough, D. R. 1979. The George Reserve deer herd: Population ecology of a K-selected species. University of Michigan Press, Ann Arbor, Michigan, USA.

Ozoga, J. J. 1969. Some longevity records for female white-tailed deer in northern Michigan. Journal of Wildlife Management 33:1027-1028.

Ramsey, C. W. 1968. A drop-net deer trap. Journal of Wildlife Management 32:187-190.

Roseberry, J. L., and A. Woolf. 1991 A comparative evaluation of techniques for analyzing white-tailed deer harvest data. Wildlife Monograph 117: 1-59.

Severinghaus, C. A. 1949. Tooth development and wear as criteria of age in white-tailed deer. Journal of Wildlife Management 13:195-216.

Sokal, R. R. and F. J. Rohlf. Biometry. 1995. W. H. Freeman and Company, New York, New York, USA.

Warren, R. J. 1997. The challenge of deer overabundance in the 21st century. Wildlife Society Bulletin 25:213-214.

White, G. C. and R. M. Bartmann. 1997. Density dependence in deer populations. Pages 120-135 *in* W.J. McShea, *editor*. The science of over abundance: deer ecology and population management. Smithsonian Institution Press, Washington, D.C. USA.

Witham, J. H., and J. M. Jones. 1990. White-tailed deer abundance on metropolitan forest preserves during winter in northeastern Illinois. Wildlife Society Bulletin 18:13-16.