Approaching the Limits of Traditional Hunter Harvest for Managing White-tailed Deer Populations at the Landscape Level

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EXECUTIVE SUMMARY

Historically, white-tailed deer (Odocoileus virginianus) populations have been managed to provide recreational opportunity, especially hunting antlered deer, and to protect deer from overharvest. This strategy of focusing harvest on bucks has worked well because the growth rate of a population is primarily dependent on the mortality rate (i.e., harvest) of female deer. With gradual increases in deer abundance in New York and much of the Northeast and declines in hunter numbers, permit systems designed to emphasize opportunity to hunt antlered deer and provide equitable distribution of antlerless deer tags may be no longer sufficient to regulate deer populations at a landscape scale. Consequently, many wildlife agencies have shifted their management focus from one that promotes recreational hunting to one of reducing conflicts between deer and humans, or a combination of both.

In an attempt to stabilize or decrease deer populations, state agencies often increase the allocation of antlerless permits. Success of a deer management strategy based on antlerless permit allocations will depend on increased voluntary participation by hunters. As managers increase the number of antlerless permits available for use in a particular area, a desired reduction in the deer population is dependent upon several factors. Hunters typically seeking deer in that area must apply for and fill additional permits, or additional hunters must be attracted to the area, apply for, and use permits there.

We address the question: to what extent can white-tailed deer populations be managed at a landscape scale (i.e., an aggregate of counties or deer management units) using traditional harvest strategies? Our objectives were to: (1) estimate white-tailed deer population densities, (2) determine levels of antlerless harvest needed to produce stable deer populations in 3 counties from each of 4 ecoregions, and (3) evaluate whether recreational hunting, under the current regulation structure in New York, is likely to remain an effective population management tool in light of current deer abundance and hunter numbers.

For this study, we stratified an area known as New York’s Southern Hunting Zone into the northern Allegheny Plateau (AP), the Catskill Mountains (CS), the Hudson Valley (BV), and the Great Lakes Plain (LP) ecoregions. Our analysis area included 12 counties (3 in each of the 4 ecoregions) that constituted 25,382 km². Deer population sizes, expressed as the number per unit area and their associated sex and age structures, were reconstructed with an updated version of Deer CAMP (Computer-Assisted Management Program). Harvest data were analyzed from 1984-1996 for the 3 representative counties in each ecoregion. The modeling procedures were used to illustrate deer harvests that would be needed to stabilize herd size at the average level for 1992-96. Harvest data were used to estimate minimum deer densities for areas open to hunting within each region. No attempt was made to estimate deer abundance in areas closed to hunting (i.e., urban parks and residential areas), so density estimates should be considered minimum values.
To assess whether traditional hunter harvest can still be used to stabilize deer populations given the reproductive potential and habitat quality in each of the 4 ecoregions, comparisons were made between: (1) needed antlerless harvest, (2) reported antlerless harvest, and (3) potential antlerless harvest. Needed antlerless harvest is a harvest of deer required to stabilize the population at the 1992-1996 calculated level. Needed harvest was estimated from the Deer CAMP model. Reported antlerless harvest was estimated from a survey of persons who bought a big game license in 1997. Survey data were used rather than actual harvest data to be consistent with the following estimates, for which survey data were the only available source. Potential antlerless harvest also was estimated using hunter survey data, and is the maximum number of antlerless deer that hunters desired to take if they are given an unlimited number of permits.

The number of hunters was estimated by multiplying the total number of deer-license buyers in 1997 times the proportion of survey respondents who actually went afield hunting in New York (89.5%). Consequently, reported and potential antlerless harvest calculations are based on data from those hunters who went afield. The total number of hunters was then multiplied by the proportion of hunters who indicated they hunted in one or more of the 3 representative counties we selected from each ecoregion. We then used the maximum number of antlerless deer that hunters desire to harvest as a reasonable indicator of the maximum number of antlerless permits for which they would be willing to apply. Multiplying that number times each hunter’s success rate provides an estimate of the potential number of antlerless deer each hunter is likely to harvest.

Calculated deer densities during 1992-96 from population reconstruction for 3 counties from each of 4 ecoregions in southern New York were: (1) AP = 15.6 deer/km²; (2) CS = 11.8 deer/km²; (3) HV = 17.2 deer/km²; and (4) LP = 9.1 deer/km². In all 4 ecoregions, the prescribed harvest needed to stabilize herd growth was equal to or exceeded the reported antlerless harvest during the 5-year period 1992-96. The additional antlerless harvest required ranged from 0.65 deer/km² in the LP to 1.18 deer/km² in the HV. This increased antlerless harvest ranged from 48% of the 1992-96 level in the AP and HV to 108% of the 1992-96 harvest level in the CS.

The AP ecoregion had substantially higher numbers and densities of hunters than the HV and LP ecoregions. On average, persons hunting in the AP and HV applied for more antlerless permits compared to the other 2 ecoregions. Hunters in the AP and HV had the highest success rates, and those hunting in the CS and LP had the lowest. Total antlerless harvest was 61-270% higher in the AP compared to the other 3 ecoregions.

If hunters apply for and fill antlerless permits at their maximum rate of willingness, the deer population can be stabilized only in the LP with certainty. Potential harvest equals needed harvest in the AP, however potential harvest calculations are “best-case” scenarios assuming constant success rates. Needed harvest exceeds “best-case” potential harvest in CS and HV by 51% and 30%, respectively. If hunter application and fill rates are constant, to achieve the needed antlerless harvest: (1) additional hunters will be necessary, thereby increasing hunter density substantially, and/or (2) hunters will need to spend more days afield.

The current framework of providing antlerless permits on a lottery basis may require modification in some areas of New York if managers wish to decrease deer numbers. In a best-case scenario with high hunter willingness to apply for and use additional antlerless permits, the potential harvest is about equal to the harvest needed to achieve stable deer numbers only in the AP ecoregion. In the CS and HV under the current management system, computer models indicate necessary harvests cannot be achieved regardless of how many antlerless permits are issued because hunters are unwilling to apply for and fill those permits under the current regulatory framework.

Wildlife professionals facing deer and hunter population situations like those described for parts of New York may need to promote a major shift in deer management strategies. The current management framework and antlerless permit system, which worked well for decades when deer were less abundant, may no longer be sufficient for regulating deer populations across broad landscapes. When agencies make regulations more restrictive and reduce hunting opportunity, they can reduce hunter participation to a desired level. However, the opposite is not always true. That is, when agencies make additional antlerless permits available, hunter participation and harvest does not automatically increase to a level desired by managers. Assumptions of unlimited hunter demand for opportunities to shoot more deer (especially female deer) have little substantiating evidence to support them.
ACKNOWLEDGMENTS

The authors appreciate the assistance of Ed Kautz, New York State Department of Environmental Conservation, Bureau of Wildlife, for providing deer harvest data used in the study. Kristi Sullivan, Department of Natural Resources and Cornell Cooperative Extension, provided data entry and organization. Tom Brown coordinated the review and editing process for the report. Margie Peech provided final formatting of the report.

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INTRODUCTION

Wildlife agencies manage populations of white-tailed deer (*Odocoileus virginianus*) to achieve a variety of human benefits (e.g., existence value, recreational hunting opportunity, viewing pleasure, tolerable economic conditions for farmers and homeowners). The predominant deer management strategy in the northeastern U.S. strives for maximum recreational hunting opportunity for antlered deer. This strategy, with its historical roots in a time period when deer were scarce (McCabe and McCabe 1997), works well to protect deer populations from overharvest because the growth rate of a deer population is primarily dependent on the mortality rate (e.g., harvest) of female deer (Ellingwood and Caturano 1988).

However, populations of white-tailed deer in most of the Northeast are currently at historically high levels (Warren 1997). Deer have been implicated as a causal factor in reduced songbird numbers (Tilghman 1989, Waller and Alvernon 1997, Healy 1997), prevention of forest regeneration (Tilghman 1989, Waller and Alvernon 1997, Healy 1997), reduced songbird numbers (DeCalesta 1994), decreased aesthetic attributes in parks (Underwood and Porter 1991), increased crop damage (Conover 1997), increased automobile collisions (Stout et al. 1993), and perpetuation of Lyme disease (Ostfeld et al. 1996). Consequently, many wildlife agencies have shifted their management focus from one that promotes recreational hunting to one of reducing conflicts between deer and humans, or a combination of both. Some states also have worked with stakeholders to set local deer population objectives for management units with varying capacities to support deer and public tolerance of damage or risk (Curtis et al. 1993, Curtis and Hauber 1997, Stout et al. 1997).

Establishing deer management objectives is a complex process that involves many biological and social dimensions. Harvest management is complicated by uncertainties associated with environmental variation, knowledge of the resource status (partial observability), a lack of understanding about the structure of biological relationships (structural uncertainty), and the difference between a harvest framework’s intended outcome and the actual harvest achieved (partial controllability) (Williams 1997). Information is needed concerning deer population dynamics and trends in abundance, desires of various stakeholder groups (e.g., farmers, hunters, motorists, rural landowners, etc.), factors affecting the interest and success of hunters in harvesting deer, economic costs/benefits associated with deer, the distribution of deer habitat, and political issues, to name a few of the more important parameters. Consequently, many uncertainties are associated with deer management, and computer modeling can be a helpful way to evaluate potential strategies and test hypotheses.

In some states (e.g., New York, Pennsylvania, etc.), each hunter who purchases a deer-hunting license obtains opportunities to shoot only an antlered deer. Hunters who desire additional hunting opportunity typically must apply for antlerless deer permits. In an attempt to stabilize or decrease deer populations, state agencies have often increased allocation of antlerless permits (total number, or the number for which each hunter can apply). However, Ludwig et al. (1993) advised as a first principle of harvest management that it is necessary to understand the motivation and behavior of hunters, and the impacts of hunter participation on deer population
dynamics. Success of a deer management strategy based on antlerless permit allocations will depend on increased voluntary participation by hunters. Decker and Connelly (1989) noted that antlerless permits provide opportunities for hunters to realize different satisfactions, including a chance to shoot at least one deer, a chance to continue hunting after shooting a buck, or a chance to take an extra deer. The primary motivations for deer hunting were personal achievement, affiliation with friends and family, and appreciation of the outdoors. It appears that hunters do not have a strong desire to "manage" deer, and a combination of education and changes in harvest regulations may be needed to motivate hunters to achieve management goals.

Harvest rates can not be prescribed, whether expressed as a percentage of the population or numbers per unit area, unless an estimate of the number of female deer is available. Permits are typically issued for antlerless deer (the observable physical characteristic hunters can use for shoot/don't shoot decisions), not female deer. Thus, the population level and number or proportion of female deer plus doe and buck fawns must be estimated, and the success rate must be estimated and adjusted over time to issue an appropriate number of antlerless permits. As managers increase the number of antlerless permits available in a particular area, a desired reduction in the deer population is dependent upon several factors. Hunters typically seeking deer in that area must apply for and fill additional permits, or additional hunters must be attracted to the area, apply for, and use permits there.

A common assumption that there is adequate demand for and successful use of antlerless permits in all deer management units requires careful examination under conditions of growing deer populations across large areas. At a small geographic scale it may be possible to attract enough hunters who are willing to kill female deer such that management objectives can be attained. However those sportmen are transferring hunting opportunities and potential harvest from somewhere else, and each individual may have limited time and capability to harvest deer. If hunters are abundant and deer are scarce, the existing antlerless permit system can work well in most situations. However, nearly every published report of hunting trends indicates that the number of participants has declined during the 1980s, and with an aging hunter population and low recruitment of young hunters, further declines are anticipated in the future (Decker et al. 1993). For example, big game license sales have steadily dropped in New York since 1988 (NYSDEC, unpub. data), and the number of big game hunters is expected to decline further. This poses a management dilemma: can increased harvests of antlerless deer be achieved with current hunter numbers, and if so, how long will it be possible and what actions will be needed to achieve harvest goals at a landscape scale with a declining hunter base?

The success of setting and achieving harvest quotas for antlerless deer will be impacted by the size and boundaries of deer management units, the reproductive potential of the deer herd based on habitat quality within those areas, and the accessibility of deer on private lands. Although it may be possible to reach a deer population objective by shifting hunter participation on a few thousand square kilometers of public land (i.e., state forest or wildlife management area), achieving the same deer harvest objective may be very difficult on tens of thousands of square kilometers of private farm and forest lands. Scale factors clearly will affect the success or failure of any deer management program.

The New York State Department of Environmental Conservation, Bureau of Wildlife (DEC) has been actively involved in deer research and management for decades. During the last 20 years DEC staff have collected deer harvest data necessary for population reconstruction, and have collaboratively supported research concerning hunter behavior and other human dimensions aspects of wildlife management. The availability of comprehensive biological and human dimensions data provides a unique opportunity to examine the influence of hunter behavior on achieving deer management goals, particularly the harvest of antlerless deer.

We address the question: to what extent can white-tailed deer populations be managed at a landscape scale (i.e., an aggregate of counties or deer management units) using traditional harvest strategies? Our objectives were to: (1) estimate white-tailed deer population densities, (2) determine levels of antlerless harvest needed to produce stable deer populations in 3 countries from each of 4 ecoregions, and (3) evaluate whether recreational hunting, under the current regulation structure in New York, will remain an effective population management tool in light of current deer abundance and hunter numbers.

**STUDY AREA**

New York's 62 counties comprise nearly 122,000 km² and have a human population exceeding 18 million people. However, over 50% of New York's human population live in only 9 counties that include New York City, its northern suburbs, and Long Island. The southern portion of the remaining "Upstate" area is about as densely populated as the median state in the United States.

For this analysis we stratified an area known as New York' Southern Hunting Zone based on the classification of McNab and Avers (1994), into the northern Allegheny Plateau (AP), the Catskill Mountains (CS), the Hudson Valley (HV), and the Great Lakes Plain (LP) ecoregions (Figure 1). The Southern Hunting Zone is an administrative portion of New York located north of New York City's northern suburbs in Westchester and Rockland Counties, where deer management authority has been legislatively delegated to the DEC, and the agency administers regulated shooting of antlerless deer. Our intensive analysis area included 12 counties (3 in each of the 4 ecoregions: AP, CS, HV, and LP) that constituted 25,382 km². We selected contiguous counties with mostly rural land which were contained primarily within each ecoregion. Counties with large metropolitan areas were avoided. Land area for selected counties was obtained from the New York State GAP Analysis database (New York GAP Project, unpubl. data).

The AP is a dissected plateau (34,384 km²) characterized by irregular topography and moderate relief. Elevations range from 200-600m. Active and abandoned farmland cover nearly
50% of the landscape, mostly on the lower slopes. Approximately 60-70% of the area is in second or third generation Allegheny and northern hardwood forests (Alerich and Drake 1995).

The CS area is a plateau (9,229 km²) inclusion into the edge of the AP with a steep (600-900 m) scarp on its eastern edge along the HV border. The Catskill Mountains form the primary land feature with ridges interfaced with deep ravines. Glaciation is expressed only in rounded hilltops and cirques. Elevations range from 275-1260 m and less than 20 percent of the area is classified as having gentle slopes. About 70-80% of the area is comprised of hardwood forests with remnant farms scattered in lowland valleys.

The HV consists of a ridge-and-valley complex (12,531 km²) bounded on east and west by steep escarpments. Gentle slopes cover over 50% of the area, and about 50-60% of the land classified as hardwood forest. Farms are common in lowlands, as this area is important for fruit and vegetable production. Elevations range from 10 m along the Hudson River to 300 m in the northern foothills of the Catskills.

The LP (19,761 km²) is characterized by its flatness and shallow entrenched drainage that results from a combination of gentle glacial moraines and flat lake beds. The vast majority of the LP is in lowland farming or residential classes, with 40-45% of the area in hardwood forest cover. Elevations range from 75-300 m with gentle slopes comprising more than 50% of the area.

METHODS

Deer population sizes, expressed as the number per unit area and their associated sex and age structures, were modeled in the AP, CS, HV, and LP ecoregions. Harvest data were analyzed from 1984-1996 for 3 representative counties in each ecoregion and used for intensive reconstruction. The modeling procedures described below were used to illustrate harvest levels that would be needed to stabilize herd size at the average for 1992-96. Harvest data were used to estimate minimum deer densities for areas open to hunting within each region. No attempt was made to estimate deer abundance in areas closed to hunting (e.g., suburban parks, preserves, etc.), hence density estimates should be considered minimum values.

Deer Population Modeling

Populations were reconstructed with an updated version of Deer CAMP (Computer-Assisted Management Program) (Moen et al. 1986). This version determines the population needed to support the observed harvest and estimated crippling loss, illegal kill, road kill, predator kill, and summer and winter fawn mortality over a specified period of years, while also reaching a specified ratio of population change between 2 given years. Because few reliable data are available to estimate deer mortality factors in New York other than direct hunter harvest, values we used for the population reconstruction included: (1) crippling loss = 10% of the
harvest, (2) illegal kill = 2.5% of the pre-hunt population, (3) road and predator kills not accounted for in fawn mortality = 0.5-1% of the population, and (4) summer and winter fawn mortality rates of 15%. These mortality rates are considered representative for deer populations in rural New York State based on previous reconstructions conducted by Aaron Moen. Road kill and fawn mortality rates are conservative; if actual rates are higher, the deer population estimate would be larger. The same mortality rates were used for population reconstruction in all counties, and we changed only the reproductive output for each of the 4 ecoregions based on a sample of mean yearling antler-beam diameter. Lower mortality rates were used for yearling and adult deer, proportional to an age-related vulnerability curve that reached a maximum at age 12. This non-random portion of summer and winter mortality accounted for physiological stress, and included age-related predation.

The reconstruction program calculates deer numbers at 4 points: after parturition, in the pre-hunt population, the post-hunt population, and at the end of the winter. Because the mortality rates are applied as the calculations proceed through the year, each mortality calculation is not a simple multiplication of a single number times a rate. The rates were applied to the reconstructed populations as dynamic calculations throughout the deer-year rather than to a specific number of deer each year.

The computer model determined the numbers, sex composition, and age structures of the deer population for 3 counties in each of the 4 ecoregions for 1984-1996 that would meet a change ratio of 1.0 (i.e., a stable population) between 1991 and 1996. The average numbers of male and female deer in the fawn, yearling, and adult age classes during the 5-year period between 1992-1996 were calculated, and numbers of antlered (yearling and adult bucks) and antlerless (male and female fawns, yearling and adult does) deer were estimated. The number of antlerless deer in the legal harvest reported by the DEC for the 12 selected counties was divided by the estimate of abundance determined by reconstruction modeling to provide calculated antlerless harvest rates for each area.

The antlerless harvest rate needed to stabilize deer populations at 4 different levels of reproduction (using average yearling antler-beam diameters as a measure of habitat quality and reproductive potential for deer in each ecoregion) was expressed as a fraction of the number of antlerless deer in the pre-hunt population. This harvest rate was determined with the 1986 version of the Deer CAMP program (Moen et al. 1986). Reproductive rates, which were correlated with average yearling antler beam diameters (Severinghaus and Moen 1983), were used to determine the reproductive rates for 4 female age groups: does bred as fawns, as yearlings, young adults, and older adults. A series of 10-year runs for deer with yearling antler beam diameters of 17, 18, 19, and 20 mm determined antlerless harvest rates that stabilized populations while also supporting other mortality factors. The antlerless harvest rates were divided into a yearling and adult rate, and a fawn rate, with the latter being 0.75% of the former because hunters were less likely to fill a doe permit with a fawn than with a yearling or adult doe (A. Moen, pers. observ.). Ten-year runs were completed to overcome any effects of the initializing procedure in the program. The 17 mm (HV), 18 mm (CS), 19 mm (AP) and 20 mm (LP) beam-diameter values were representative of the range productivity conditions in the counties from the 4 ecoregions being evaluated based on measurements from samples of harvested bucks.

Modeling Hunter Participation and Success

To assess whether traditional hunter harvest still can be used to stabilize deer populations, given the reproductive potential and habitat quality in each of the 4 ecoregions of interest, comparisons were made between: (1) needed antlerless harvest, (2) reported antlerless harvest, and (3) potential antlerless harvest. Needed antlerless harvest is a harvest of deer required to stabilize the population at the 1992-1996 calculated level. Needed harvest was estimated from the Deer CAMP model. Survey data were used rather than agency estimates of reported harvest so we could compare reported and potential harvest directly. For our purposes, reported harvest equaled the number of hunters who hunted in each ecoregion times the mean number of antlerless permits for which hunters in that ecoregion applied, times the mean per hunter success rate for that ecoregion. Potential harvest equaled the number of hunters who hunted in the ecoregion times the mean number of permits for which hunters in that ecoregion said they were willing to apply if they could legally harvest an unlimited number of deer, times the mean per hunter success rate for that ecoregion.

An estimate of the number of hunters who went afield (as opposed to license buyers) in each of the 4 ecoregions (n=997) was initially required because reported and potential antlerless harvest calculations are based on data from those hunters who went afield. This estimate of active hunters was obtained by multiplying the total number of New York deer-license buyers in 1997 times the proportion of survey respondents (adjusted for nonresponse bias) who indicated they went afield hunting in New York (89.5%), and in turn by multiplying this product by the proportion of hunters who indicated they hunted in one or more of the 3 counties from each of the 4 ecoregions. Hunters could indicate up to 3 counties in which they hunted anywhere in the state (not just in the 4 ecoregions described above).

We did not have a direct measure of how many antlerless permits for which hunters were willing to apply to use in the calculation for potential harvest. As an indirect measure, we had information about the maximum number of deer hunters were willing to harvest (total) and of these, the minimum number that hunters wanted to be bucks (minbucks). Subtracting minbucks from total provided a maximum estimate of the number of does hunters were willing to harvest.

Our deer hunter model includes 2 main assumptions: (1) the hunter bias (0.75) against filling an antlerless permit with a fawn compared to a yearling or adult female represents hunter behavior accurately, and (2) a hunter's rate of success in filling antlerless permits remains constant even if the hunter obtains more than one permit. (The latter is a conservative assumption because in the event success rates diminish for subsequent permits, the results reported below are optimistic vis-a-vis harvest capability).
Hunter participation data:

A random sample of 5,323 big game license buyers was selected from among the 513,310 resident licenses of this type sold during the 1997-98 hunting license year. A self-administered questionnaire was mailed to license buyers on 5 January 1999 following a conventional 4-wave mailing procedure (Dillman 1978). An assessment of nonresponse bias was made via telephone interviews with 50 nonrespondents to the mail survey. Survey results are adjusted for nonresponse bias only for statewide variables as indicated below.

Number of hunters in each ecoregion:

An estimate of the number of hunters who went afield (as opposed to license buyers) in each of the 4 ecoregions (numhunt) was initially required because reported and potential antlerless harvest calculations are based on data from those hunters who went afield. This estimate of active hunters was obtained by multiplying the total number of New York deer-license buyers in 1997 times the proportion of survey respondents (adjusted for nonresponse bias) who indicated they went afield hunting in New York (89.9%), and in turn by multiplying this product by the proportion of hunters who indicated they hunted in one or more of the 3 counties from each of the 4 ecoregions. Hunters could indicate up to 3 counties in which they hunted anywhere in the state (not just in the 4 ecoregions described above).

Reported and potential antlerless harvest:

Hunters indicated the number of antlerless deer permits they sought, received, and filled in 1997. Application and fill rates for antlerless deer permits reported in this paper are on a per hunter basis because hunters can apply for, receive, and fill multiple antlerless permits in different counties or ecoregions. We know the number of permits they applied for or filled, but not the specific area where the permits were used. Thus, we apportioned each hunter's application and fill rates equally among the counties in which the person stated that they hunted.

Hunters also were asked how many deer they would want to harvest if they could harvest an unlimited number of deer of either sex (totdeer), and as a minimum, how many of those would be bucks (minbucks). From these data, we calculated the mean maximum number of antlerless permits (maxapps) for which hunters likely would apply using the formula:

maxapps = totdeer - minbucks

We used the maximum number of antlerless deer that hunters desire to harvest as a reasonable indicator of the maximum number of antlerless permits for which they would be willing to apply. Multiplying that number times each hunter's success rate provides an estimate of the potential number of antlerless deer each hunter is likely to harvest. This approach may overestimate the potential harvest, as success rates for 2nd or 3rd permits would likely be lower than for 1st permits. We have no data to estimate success rates for multiple permits, so the potential harvests presented should be considered a "best case" scenario; the actual harvest achieved could be substantially lower.

Reported antlerless harvest could be calculated in at least 2 ways given that we have the following information for each county:

numhunter = number of persons hunting in selected counties

app rate = mean number of antlerless permits for which these hunters applied

fill rate = mean number of antlerless permits these hunters filled

success rate = mean rate of permits filled for which hunters applied (i.e., mean of fill/app for all individual hunters in a county).

Importantly, the mean success rate was not calculated simply by dividing the mean fill rate for hunters in a county by the mean application rate for hunters in that county, which produces a biased estimate of success. Rather, the success rate is the mean of individual hunters' success rates. To ensure greatest comparability among estimates of reported and potential antlerless harvest, we calculated both using the mean success rate term:

reported harvest = numhunt x app rate x success rate.

potential harvest = numhunt x maxapps x success rate.

RESULTS

In this analysis, calculated deer densities during 1992-96 from population reconstruction for 3 counties from each of 4 ecoregions in southern New York were: (1) AP = 15.6 deer/km²; (2) CS = 11.8 deer/km²; (3) HV = 17.2 deer/km²; and (4) LP = 9.1 deer/km². The proportion of female deer in the reconstructed population was similar for all 4 ecoregions: the prehunt population consisted of approximately 55% female deer and 45% male deer.

In all 4 ecoregions, the prescribed harvest needed to stabilize herd growth was equal to or exceeded the reported antlerless harvest during the 5-year period 1992-96 (Tables 1 and 2). The additional antlerless harvest required ranged from 0.65 deer/km² in the LP to 1.18 deer/km² in the HV. This increased antlerless harvest ranged from 48% of the 1992-96 level in the AP and HV to 108% of the 1992-96 harvest level in the CS.
Table 1. Mean number of antlerless permit applications and permits filled by hunters, success rate per hunter, and reported antlerless deer harvest in 3 counties from each of 4 ecoregions of New York State, 1996.

<table>
<thead>
<tr>
<th>Ecoregion</th>
<th>Mean number of permit applications per hunter</th>
<th>Mean number of permits filled per hunter</th>
<th>Success rate (^a)</th>
<th>Reported harvest</th>
<th>Reported harvest/km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allegheny Plateau</td>
<td>0.942</td>
<td>0.261</td>
<td>0.215</td>
<td>12,654</td>
<td>1.69</td>
</tr>
<tr>
<td>Catskill Mountains</td>
<td>0.687</td>
<td>0.164</td>
<td>0.180</td>
<td>6,647</td>
<td>0.92</td>
</tr>
<tr>
<td>Hudson Valley</td>
<td>0.816</td>
<td>0.258</td>
<td>0.217</td>
<td>5,776</td>
<td>1.18</td>
</tr>
<tr>
<td>Lake Plains</td>
<td>0.624</td>
<td>0.210</td>
<td>0.192</td>
<td>4,513</td>
<td>0.78</td>
</tr>
</tbody>
</table>

\(^a\)Success rate is the average of the number of antlerless permits each hunter filled divided by the number of permits for which that hunter applied.

Table 2. Mean maximum number of antlerless permits for which hunters would be willing to apply and potential antlerless harvest in 3 counties from each of 4 ecoregions of New York State, 1996.

<table>
<thead>
<tr>
<th>Ecoregion</th>
<th>Maximum permits for which hunters would apply</th>
<th>Potential antlerless harvest</th>
<th>Potential antlerless harvest/km²</th>
<th>Needed antlerless harvest</th>
<th>Needed antlerless harvest/km²</th>
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</thead>
<tbody>
<tr>
<td>Allegheny Plateau</td>
<td>1.412</td>
<td>18,968</td>
<td>2.53</td>
<td>18,725</td>
<td>2.51</td>
</tr>
<tr>
<td>Catskill Mountains</td>
<td>0.936</td>
<td>9,056</td>
<td>1.26</td>
<td>13,672</td>
<td>1.85</td>
</tr>
<tr>
<td>Hudson Valley</td>
<td>1.273</td>
<td>9,010</td>
<td>1.84</td>
<td>11,753</td>
<td>2.36</td>
</tr>
<tr>
<td>Lake Plains</td>
<td>1.298</td>
<td>9,388</td>
<td>1.62</td>
<td>8,119</td>
<td>1.43</td>
</tr>
</tbody>
</table>
Hunter Participation Model

The AP ecoregion had substantially higher numbers and densities of hunters than the HV and LP ecoregions (Table 3). The CS ecoregion had an intermediate number and density of hunters. Numbers and densities of hunters calculated represent maximums because some hunters hunted in more than one ecoregion. On average, persons hunting in the AP and HV applied for more antlerless permits compared to the other 2 ecoregions (Table 1). Hunters in the HV and AP had the highest success rates, and those hunting in the CS and LP had the lowest. Total reported antlerless harvest was 61-270% higher in the AP compared to the other 3 ecoregions (Table 1). On a land-area basis, reported antlerless harvest was approximately twice as high in the AP compared to the CS and LP.

If hunters apply for and fill antlerless permits at their maximum rate of willingness, the deer population can be stabilized only in the LP with certainty (Table 2). Potential harvest equals needed harvest in the AP, however potential harvest calculations are “best-case” scenarios assuming constant harvest rates. Needed harvest exceeds “best-case” potential harvest in CS and HV by 51% and 30%, respectively.

If hunter application and fill rates are held constant, to achieve the needed antlerless harvest: (1) additional hunters will be necessary, (2) hunter density would have to increase substantially (Table 3), and/or (3) hunters will need to spend more days afield. Hunters appear willing to apply for more antlerless permits than they currently do (Table 2). Hunters in the LP stated they were willing to apply for twice as many permits as they currently do if they could shoot as many deer as they wanted. Hunters in the other 3 ecoregions stated they are willing to apply for 42-50% more than current levels. Note these scenarios do not represent a large “latent demand” under the current permit system.

Table 3. Number and density of current hunters and hunters needed to stabilize the deer population in 3 counties from each of 4 ecoregions of New York State, 1996.

<table>
<thead>
<tr>
<th>Ecoregion</th>
<th>Number of current hunters</th>
<th>Density of current hunters/km²</th>
<th>Additional hunters needed</th>
<th>Total hunters needed</th>
<th>Density of needed hunters/km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allegheny Plateau</td>
<td>62,480</td>
<td>8.34</td>
<td>30,218</td>
<td>92,698</td>
<td>12.38</td>
</tr>
<tr>
<td>Catskill Mountains</td>
<td>53,751</td>
<td>7.47</td>
<td>56,957</td>
<td>110,708</td>
<td>15.38</td>
</tr>
<tr>
<td>Hudson Valley</td>
<td>32,618</td>
<td>6.66</td>
<td>15,449</td>
<td>48,067</td>
<td>9.82</td>
</tr>
<tr>
<td>Lake Plains</td>
<td>37,672</td>
<td>6.50</td>
<td>28,884</td>
<td>66,556</td>
<td>11.45</td>
</tr>
</tbody>
</table>

DISCUSSION

Deer numbers and hunter numbers are headed in opposite directions. Deer numbers across the Northeast are at record levels while hunter numbers continue to slowly decline (USFWS 1997). In New York, deer abundance appears to be increasing in 60% of current management units, concomitant with declines in antlerless harvests. This discrepancy is creating a challenge for wildlife professionals who wish to manage deer populations to meet a variety of objectives. There is a strong and increasing desire to lower deer densities in many areas to achieve other ecosystem benefits (Alverson and Waller 1997, DeCalesta 1994). Our case study indicates that the current framework of providing antlerless permits on a lottery basis may require modification in some areas of New York if managers wish to decrease deer numbers.

The ability to maintain stable deer populations in New York by simply increasing the number of antlerless permits may be limited. In a best-case model with high hunter willingness to apply for and use additional antlerless permits, the potential harvest is about equal to the harvest needed to achieve stable deer numbers only in one of 4 ecoregions examined (the AP ecoregion). In the CS and HV under the current management system, computer models indicate harvests necessary for halting population growth cannot be achieved regardless of how many antlerless permits are issued because hunters are unwilling to apply for and fill those permits under the current regulatory framework.

The potential harvest estimates presented indicate a best-case scenario and a maximum level of hunters’ willingness to apply for and use antlerless permits. These calculations assumed harvest rates for 2nd, 3rd, or more permits would be similar to that for 1st permits (18-26%). We anticipate that actual harvest rates for additional permits may be substantially lower, which will reduce the estimated potential harvest. The potential antlerless harvest needed to stabilize herd size may be attainable only in the LP under the current regulatory framework.

Because the number of big game license buyers in New York has been declining since 1988 (DEC unpubl. data), and reasons for the decline have been attributed to factors outside of the agency’s control (Decker et al. 1993), it is unlikely that substantially more people can be recruited into the overall hunter population and sustained. A goal of stabilizing or decreasing deer numbers by increasing the number of available antlerless permits may be possible only if the available hunters are willing to apply for and fill additional antlerless permits. It is uncertain whether this could be accomplished by additional hunter incentives (e.g., Quality Deer Management, Miller and Marchington 1995), or through regulatory changes (e.g., over-the-counter antlerless tags issued with a big game license). Education would be required to change hunter attitudes so that satisfaction achieved by harvesting additional antlerless deer is sufficiently high to motivate such behavior. The degree to which hunters’ attitudes might be changed is not known.

Wildlife professionals may need to promote a major shift in deer management strategies. The current management framework and antlerless permit system, which worked well for
decades when deer were less abundant, may no longer be sufficient for regulating deer populations across broad landscapes with abundant deer populations and a limited population of hunters. When agencies make regulations more restrictive and reduce hunting opportunity, they can reduce hunter participation to a desired level. However, it is not clear that the opposite is true or to what limit it may be true. That is, when agencies make additional antlerless permits available, hunter participation and harvest does not automatically increase to a desired level. Assumptions of unlimited hunter demand for opportunities to shoot more deer (especially female deer) have little substantiating evidence to support them.

We want to emphasize that the estimates of deer density presented are conservative. Our modeling effort was based on harvest data, and therefore deer in suburban areas that were inaccessible to hunters were not considered. There are many communities, parks, and corporate complexes across New York that are closed to hunting by state and local laws, or by having ordinances prohibiting firearms discharge. These areas closed to hunting often contain high-density herds if the habitat is suitable. The result is that thousands of additional deer exist on the landscape that were not accounted for in our analysis. Changes in the current deer management system are needed to address these suburban concerns within a more comprehensive context.

Hunter access also limits the ability to proportion deer harvest and achieve deer management goals. Deer are not equally distributed across the landscape, and with a more liberal antlerless harvest system, there is potential for overharvest on public lands with good access. Conversely, posted private lands may serve as refugia for deer during hunting season and make adequate harvests of antlerless deer difficult to achieve in some locations. These problems are not new, and no single deer harvest system has satisfied all management objectives at all scales.

Establishing boundaries for deer management units continues to pose a significant challenge. Herd reproductive potential varies by habitat quality, and ecoregions are logical ways to evaluate deer populations at a landscape scale. Harvest quotas could be determined for each ecoregion based on the proportion of public and private land available for hunting and the relative access to deer. However, setting deer harvest quotas at a landscape scale may not be meaningful to important stakeholder groups (e.g., farm landowners, hunting clubs, nature preserves, etc.). More specialized management at a much finer scale will often be required to satisfy specific landowner objectives. A very flexible system would be needed to meet deer management objectives at multiple scales.

Additional regulations and permit requirements, even if appropriate from the manager's standpoint, make deer hunting more complicated, and this also may discourage hunters whose primary interest in deer hunting is recreational. Additional research is needed to document the potential effectiveness of deer management systems at the landscape scale. We need better information describing deer population dynamics, hunter behavioral responses to changes in deer management prescriptions, and landowner satisfaction. This will require management "experiments" on a landscape scale.

LITERATURE CITED


