URBAN DEER

A MANAGEABLE RESOURCE?

THE NORTH CENTRAL SECTION
THE WILDLIFE SOCIETY

1995

URBAN DEER: A MANAGEABLE RESOURCE?

Editor

JAY B. McANINCH
Minnesota Department of Natural Resources

Symposium Chairpersons

JAY B. McANINCH
Minnesota Department of Natural Resources

LONNIE P. HANSEN
Missouri Department of Conservation

Editorial Assistant and Symposium Coordinator

KELLY A. KELLY
Minnesota Department of Natural Resources

Proceedings of a Symposium held at the
55th Midwest Fish and Wildlife Conference, St. Louis, Missouri
December 12-14, 1993

ACKNOWLEDGEMENTS

The editor wishes to acknowledge: the critical reviews and editing of Lonnie Hansen, Mike Conover, and Al Berner (Minnesota Department of Natural Resources); the continued patience and support of North Central Section TWS Presidents Dave Case (DJ Case and Associates) and Gary Potts (Illinois Department of Conservation); the stimulating discussions lead by moderators Mike Conover, Dan Witter, Lonnie Hansen, Ken Mayer, Ernie Wiggers, Bill Porter, Lee Gladfelter, and Don Hawthorne; the professional effort provided by the authors and the support of their sponsoring institutions; and, the hard work and dedication of Marrett Grund, Wendy Krueger, Jan Lammers, Jen Nelson, Jon Parker, Dave Schad, and Michelle Stradtmann. A very special thanks to Kelly Kelly for lending her excellent production and organization skills to the symposium and this book. Kelly's persistence, determination, cheerful demeanor and unflagging support are much appreciated.

Financial support for the symposium was provided, in part, by the Archery Manufacturers Organization, Dick Lattimer, Director.

DEDICATION

This book is dedicated to the memory of H. Lee Gladfelter who died in an auto accident in October, 1994. Lee was a widely respected and well liked biologist and administrator with the Iowa Department of Natural Resources. When the idea for this symposium was introduced to the North Central Section membership, Lee stood to argue for the timeliness and importance of holding this meeting at the Midwest Conference. Lee contributed substantively to the development of the sessions and was a moderator and active participant in the symposium.

Proper citation for manuscripts from this proceedings:
(Author(s) of the paper being cited). 1995. (Title of the paper being cited). Pages 000-000 in J.B. McAninch, ed., Urban deer: A Manageable Resource? Proc. of the 1993 Symposium of the North Central Section, The Wildlife Society, pp

TABLE OF CONTENTS

URBAN DEER MANAGEMENT: LESSONS FROM THE PAST
Jay B. McAninch 1

DEER, PEOPLE AND THE URBAN LANDSCAPE

MANAGING PEOPLE IN AN URBAN DEER ENVIRONMENT:
THE HUMAN DIMENSIONS CHALLENGES FOR MANAGERS
Daniel J. Decker and Milo E. Richmond 3-10

WHAT IS THE URBAN DEER PROBLEM AND WHERE DID IT COME FROM?
Michael R. Conover 11-18

CULTURAL CARRYING CAPACITY: MODELING A NOTION
Donna L. Minnis and R. Ben Peyton 19-34

ECOLOGY OF URBAN AND SUBURBAN WHITE-TAILED DEER
Robert K. Swihart, Peter M. Picone, Anthony J. DeNicola,
Gary S. Kania, and Louis Cornicelli 35-44

URBAN DEER MANAGEMENT CASE HISTORIES

DEER AND PEOPLE IN PRINCETON, NEW JERSEY, 1971-1993
John E. Kuser 47-50

CALIFORNIA URBAN DEER MANAGEMENT: TWO CASE STUDIES
Kenneth E. Mayer, Joseph E. DiDonato,
and Dale R. McCullough 51-57

URBAN DEER "PROBLEM"-SOLVING IN NORTHEAST ILLINOIS: AN OVERVIEW
Jon M. Jones and James H. Witham 58-65

CHRONOLOGY OF THE DEER MANAGEMENT DEBATE IN RIVER HILLS, WISCONSIN
William E. Ishmael, Dale E. Katsma,
and Thomas A. Isaac 66-74

DEVELOPMENT AND IMPLEMENTATION OF A DEER MANAGEMENT PROGRAM IN IPSWICH, MASSACHUSETTS
Robert D. Deblinger and David W. Rimmer 75-79

MANAGEMENT METHODS FOR URBAN DEER

CAPTURE AND HANDLING TECHNIQUES FOR URBAN DEER CONTROL
William E. Clark 81

EFFICIENCY OF CONTROLLED, LIMITED HUNTING AT THE CRANE RESERVATION, IPSWICH, MASSACHUSETTS
Robert D. Deblinger, David W. Rimmer, Jerry J. Vaske, and Gary Vecellio 82-86

LIVE-CAPTURE AND TRANSLOCATION OF SUBURBAN WHITE-TAILED DEER IN RIVER HILLS, WISCONSIN
William E. Ishmael, Dale E. Katsma, Thomas A. Isaac, and Beverly K. Bryant 87-96

TRAP-AND-SHOOT AND SHARPSHOOTING METHODS FOR CONTROL OF URBAN DEER: THE CASE HISTORY OF NORTH OAKS, MINNESOTA
Peter A. Jordan, Ronald A. Moen, Eugene J. DeGayner, and William C. Pitt 97-104

LETHAL AND NON-LETHAL DEER MANAGEMENT AT RYERSON CONSERVATION AREA NORTHEASTERN ILLINOIS
Frank Drummond 105-109

USE OF BOWHUNTING TO CONTROL DEER IN A SUBURBAN PARK IN ILLINOIS
Jeffrey M. Ver Steeg, James H. Witham, and Thomas J. Beissel 110-116

POLICE SHARPSHOOTING AS A METHOD TO REDUCE URBAN DEER POPULATIONS
Michelle L. Stradtmann, Jay B. McAninch, Ernie P. Wiggers, and Jon M. Parker 117-122

USING A COMMUNICATION STRATEGY TO ENHANCE COMMUNITY SUPPORT FOR MANAGEMENT
Rebecca J. Stout and Barbara A. Knuth 123-131

LEADERSHIP: KEY TO SUCCESSFUL MANAGEMENT OF URBAN DEER
William F. Porter 132-135

MANAGEMENT PROGRAMS FOR URBAN DEER

NEW JERSEY'S URBAN/SUBURBAN DEER MANAGEMENT PROGRAMS AND EXPERIENCES
David Burke, Robert C. Lund, and Daniel M. Ferrigno 137

URBAN DEER MANAGEMENT IN CONNECTICUT: OUR EXPERIENCES, PHILOSOPHIES, AND STRATEGIES
Mark R. Ellingwood and Howard J. Kilpatrick 138-142

CITIZEN TASK FORCE STRATEGIES FOR SUBURBAN DEER MANAGEMENT: THE ROCHESTER EXPERIENCE
Paul D. Curtis, Rebecca J. Stout, and Lawrence A. Myers 143-149

A FACILITATED APPROACH TO MANAGING URBAN DEER: AN UPDATE FROM MINNESOTA
Jay B. McAninch and Jon M. Parker 150

MODELING THE IMPACTS OF CONTRACEPTION ON POPULATIONS OF WHITE-TAILED DEER
Robert K. Swihart and Anthony J. DeNicola 151-163

MANAGEMENT OF URBAN DEER POPULATIONS WITH CONTRACEPTIVES: PRACTICALITY AND AGENCY CONCERNS
Robert J. Warren, Lisa M. White, and William R. Lance 164-170

AGENCY CHALLENGES IN MANAGING URBAN DEER
Herbert E. Doig 171-175

URBAN DEER MANAGEMENT: LESSONS FROM THE PAST

JAY B. McANINCH, Minnesota Department of Natural Resources, Madelia, MN

Over the past 20 years, many metropolitan areas have been unable to avoid the issues created by the presence of deer in urban landscapes. Efforts to manage urban deer have often faced public criticism about the safety, cost, effectiveness and efficiency of such programs. These concerns have arisen because management proposals have featured either traditional methods such as hunting or have focused on experimental techniques such as fertility control. In addition, management programs have often involved personnel from a variety of organizations and agencies, many of whom were not wildlife managers or, worse, had no experience or training with wildlife issues. Urban deer problems have also created new challenges for managers to determine human demands for deer in their lives and landscapes as well as resolve conflicts between contradictory values and beliefs about deer. Finally, practical yet quantitative evaluations of management efforts have not been available.

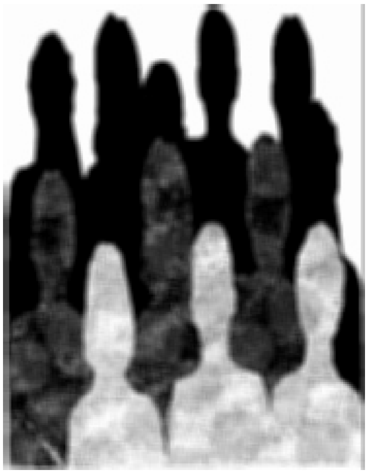
The intent of this symposium was to document the history of activities in areas in which urban deer population concerns have been addressed. To this end symposium participants were chosen based on their having had first-hand experience with urban deer issues in management and/or research. Sites and programs with a history of active discussions about deer problems were selected as case studies. Papers on evaluating urban deer management methods were given higher preference when the methods had been implemented for at least a few years and data were available for evaluation. Some space has been devoted to recent innovative management methods and ideas.

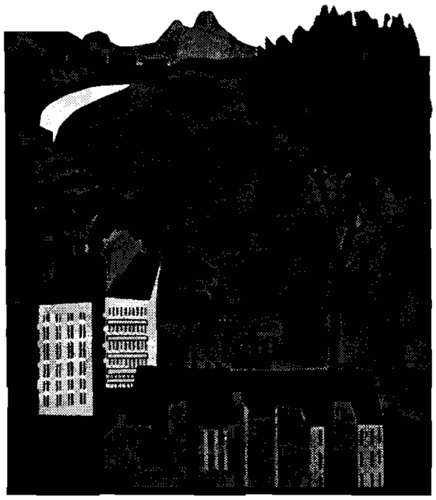
Hopefully, this symposium will serve as a beginning. The need for resource professionals to link with those who design and manage our urban landscapes is urgent. Deer are thriving in the midst of urban residents who typically have limited knowledge and, often, no experience with wildlife in any landscape. At the same time Americans have been developing new attitudes and relationships with animals that represent a shift from traditions formed in rural settings.

Several years ago homeowners were asked to invite wildlife to their backyard as a novel attempt to keep people in touch with the natural world. Today these same people are asking us what to do after some wildlife have become fulltime residents in their communities. I strongly believe that how we decide to manage deer in our communities will be a vivid testimonial to the manner in which our contemporary, urban society chooses to live with wildlife. New policies, programs and professional skills will be vital to managing these challenges successfully. The degree to which we are successful will be evident for all to see as our working environment and our efforts will be in full view of the public.

Professionally, the challenge will be to pursue this work with the vigor normally associated with traditional "wild" life work and with the notion that deer, geese, raccoons and robins will serve to maintain the link between modern man and the natural world. Unfortunately, topics like biodiversity, conservation biology, and endangered species attract the interest of young wildlifers yet, nearly all likely have their roots in an area classified as urban and home to deer. I hope the critical mass of wildlifers needed to support a professional metamorphosis will become involved in the urban wildlife arena. Perhaps in a few years we can hold another symposium, "Urban deer: Management program options for optimizing benefits among community residents", to answer the question raised in title of this symposium.

DEER, PEOPLE AND THE URBAN LANDSCAPE





MODERATORS:

Michael R. Conover
Berryman Institute and Department of Fisheries and Wildlife, Utah State University

Daniel J. Witter
Missouri Department of Conservation

MANAGING PEOPLE IN AN URBAN DEER ENVIRONMENT: THE HUMAN DIMENSIONS CHALLENGE FOR MANAGERS

DANIEL J. DECKER, Human Dimensions Research Unit, Department of Natural Resources, Cornell University, Ithaca, NY
MILO E. RICHMOND, New York Cooperative Fish and Wildlife Research Unit, Department of Natural Resources, Cornell University, Ithaca, NY

Urban deer management has fast become one of the most urgent and controversial wildlife management problems of the decade. Although deer are perhaps the wildlife species we have studied the most, have had the greatest experience managing, and arguably have achieved the highest success with management refinement, we nevertheless find ourselves facing a daunting task with deer management in an urban environment. The cause of our dilemma is two-fold: (1) hunting-based deer management approaches that we have used traditionally in rural areas cannot be applied in most urban/suburban situations and (2) the stakeholders in urban deer management are diverse in their values, beliefs, attitudes, and desires for deer, and seem to doubt whether professional deer managers understand their views.

Certainly important biological and ecological questions exist in urban deer management, but perhaps the most pressing problems arise from the human dimension. Hunters tend not to want wildlife agencies to advocate any alternatives to hunting. They resist setting a precedent for nonhunting solutions to deer population control, and perhaps eventually management of other hunted species, because they are concerned about diminishing the importance of hunting. Many wildlife managers feel the same way, a reflection of their prohunting values and conventions of the profession. Of course, some people do not believe that deer should be managed at all while others support control and management, but not by hunting or other lethal means. Still others care very little about how it is accomplished, they simply want their deer problems resolved! Thus, compared to most rural deer management situations, urban deer managers face larger, more vocal, and politically active publics that range from animal rights extremists, to animal welfare advocates, to wildlife-use proponents and, finally, to people who dislike deer altogether. A sticking point in the overall dilemma is that each stakeholder group tends to have strong opinions about what the "right" solutions are to the urban deer problem, and at present many are most interested not in reaching compromise but in having their views prevail.

A manager, particularly one who manages a highly visible resource such as the white-tailed deer, needs to have a well-thought-out philosophical and conceptual base for dealing with the complex human dimensions issues. In this paper we propose a few basic tenets that may be considered the manager's survival credo for urban deer management. We next suggest a few pragmatic answers to two important questions that managers must address in every urban deer management situation: "What do you need to know?" and "What do you need to do?" We conclude with our assessment of additional information in the human dimensions arena that we believe would help managers do an even better job of managing both deer and people in suburban habitats.

TENETS FOR MANAGING PEOPLE IN AN URBAN DEER ENVIRONMENT

Perhaps the most useful contribution we can make to the complicated and important issue of urban deer-people management is to offer a few guidelines for managers to reflect upon as they apply themselves to the challenge. We have identified eight interrelated tenets that could help managers develop a solid philosophical and conceptual base for addressing this management issue in the context of a complex human dimensions arena. These tenets relate to: (1) recognizing that traditional deer management strategies and techniques we have nearly perfected for balancing herd size, harvest rates carrying capacity and resource stakeholder wishes in rural settings must be replaced in urban settings by a new system that takes into account a much wider diversity of public intent towards the resource and its associated habitat; (2) keeping clearly in mind the distinction between scientific and ethical judgments; (3) understanding the role and limitations of biological information as input to decision making; (4) realizing that quality human dimensions data aids but does not simplify decision making in controversial management situations; (5) "objectivity" of information of any kind is considered in the context of people's values, so people with different values may not find the same information credible or even relevant; (6) extreme advocates of animal rights are unlikely to be productive participants in urban deer management and policy decision-making processes, but nevertheless should be listened to as a legitimate stakeholder in management; (7) wildlife biologists should assume the role of professional expert, communication facilitator, and perhaps final decision maker, but avoid being an advocate for particular stakeholder positions; and, (8) in urban deer management controversies wildlife managers have the unique responsibility for promoting the public interest, both short-term and long-term. As these tenets are presented in more detail, considerable overlap will be apparent. We suggest that the overlap reflects the interrelatedness of the tenets and not a redundancy.

1. The Stakeholder Tenet

Management cannot ignore the deficiencies inherent in a harvest-based approach to herd management in a heavily populated area. Regardless of one's advocacy for hunting, public safety must take precedence and no right-minded individual would lobby for the traditional hunter harvest approach if public safety is unreasonably compromised. Moreover, the wide range of urbanites' intent and attitudes, and highly developed aesthetic appreciation for wildlife, when coupled with the complexity of land ownership in a thickly settled, highly politicized land area, all argue that a new and different approach is needed.

It has been our view for some time that management decisions and actions will gain the greatest support in an arena where the public is not only informed but is allowed to contribute their own thinking and sense of values to a decision- making process (Brown and Decker 1979, Smolka and Decker 1985, Decker and Gavin 1987). Other papers bearing directly on the public's perception and involvement include: Richmond 1973, Decker and Purdy 1988, Curtis and Richmond 1992, and Stout et al. 1993. From this literature and from investigations of the interaction and concerns of the public with wildlife and its management, the concept of stakeholder has emerged. With this concept comes the need to dcfine and further identify various stakeholders. In defining stakeholder we begin with the idea that there are different stakes or different levels of investment in the issue. Stakeholders, regardless of level of investment, can be thought of as one of four general types.

The grassroots stakeholder.--is any person who wishes to be heard because of his or her beliefs, opinions, values, knowledge, training, taxpaying status or perceived threat to their health and well-being. While such stakeholders can be highly vocal, they are not organized, do not have a spokesperson to represent them and as a result may not contribute much to problem resolution. Wildlife managers must be particularly receptive and inquisitive to ensure that they do not overlook or inadequately consider grassroots stakeholders.

The citizen action stakeholder.--is an organized group that usually grows out of a grassroots concern in response to a particular issue and persists only as long as the issue persists. Resolution of the problem usually signals the end of the citizen action group. Examples include any newly formed advocacy group that is sufficiently organized to select a spokesperson to represent them.

Longstanding nongovernment organization stakeholder.--may be a member of the Farm Bureau, Sierra Club, Fund for Animals, National Rifle Association, or other group who, because of their beliefs and position on related issues, become legitimate stakeholders in the urban deer controversy.

Legally mandated public official stakeholder.--may be a spokesperson for a state agency, or represent regional or state wildlife professionals, town and county law enforcement, township, park, or regional resource supervisors or others as the professional and political organizations may dictate.

The latter two categories of stakeholders have the greatest potential of bringing well-versed professionals into a discussion and are perhaps best at recognizing all of the multifaceted aspects of the urban deer issue.

2. Distinction Between Scientific and Ethical Judgments

Wildlife managers often find that the stakeholders in urban deer management represent a broader set of beliefs and values about wildlife and management than they have traditionally encountered in rural deer management situations. Certainly the same set of values that rural residents characteristically bring to their deer management preferences exist among some urban residents, but the prevalence of familiar beliefs and values including sporthunting and larder supplementation typically is diminished. This results in urban deer management being a new challenge for managers, one where the human values are diverse, the operating rules are unclear, and the goals of management are often sketchy.

In many cases urban residents' interactions with deer are of recent origin--they did not grow up with deer as a normal element of the urban landscape. This can result in people being either extremely negative about the presence of deer, or just as likely, exceedingly enthusiastic about having deer around. Those who develop negative attitudes about deer may want extreme measures taken to eradicate local populations. This is particularly true if they have had a negative encounter with deer or fear disease. Those who enjoy deer unequivocally often have not experienced any problems caused by deer and may have their beliefs and attitudes about deer founded on incomplete or inaccurate information. Consequently, the latter group may turn a blind eye to the problems, needs, and concerns of other people who, though they may enjoy deer, are less enthusiastic and desire some level of management to limit deer numbers (i.e., limit the impacts of deer). When this breadth of beliefs and attitudes extant in the urban deer management situation is coupled with the difficulty of actually removing deer from urban habitat, it is no wonder that managers occasionally find their jobs exasperating.

Compounding this belief-attitude-values milieu is yet another variable--the manager's personal beliefs and values about deer management. This usually includes rather strong beliefs about appropriate population density goals for an urban deer population, management techniques best suited to accomplish those goals, and role the manager versus stakeholders should play in making decisions about management goals and techniques. In fact, over time wildlife managers have tended to blur the distinction between their scientific judgments based on the biological facts as they know them and their own ethical judgments based on their personal beliefs. For example, staunch support of hunting as the "only" method for population management is an ethical judgment when it precludes any fair consideration of other options. (For more elements of this tenet see Decker et al. 1991.)

3. Limits of Biological Information as a Basis for Decision Making

Management decision making is not a straightforward interpretation of biological facts that somehow reveal what should be done in managing urban deer. Decker et al. (1991) contend that no amount of biological information when considered alone ever leads to a decision to take a particular action. Management decisions are based largely on goals and objectives that reflect human desires and preferences. Biological data may indicate what is possible in terms of limits of wildlife resource productivity, likely response of the resource to management actions (alternatives), etc., but only human values come into play regarding what *ought to* be done. Even decisions about endangered species preservation are founded on our expressed societal values, through law, that species are worth saving to the best of our ability to do so. In some situations even the premise of societal value is challenged vigorously by competing interest segments of society (e.g., the timber industry/spotted owl controversy in the Northwest).

In urban deer management, the significance of the twist we put on the title of this paper becomes apparent. In a very real sense, the challenge is one of understanding and managing people in an urban deer environment. This means management of people's interactions with deer through educational communication, especially communication about protecting garden and shrubbery plantings, avoiding deer-car collisions on streets and highways, diminishing contact with deer ticks, and more. But it also means management of the process of human interactions needed to develop goals and objectives for urban deer management, as well as finding acceptable approaches for achieving management goals after they are established. These aspects of management require comprehensive, reliable and valid human dimensions insight as part of the information base for decision making (Decker and Connelly 1990, Gigliotti and Decker 1992). Managers need to have sound knowledge of who the stakeholders are, their beliefs and attitudes regarding deer and deer management, and the extent of effective educational communications required to ensure their informed participation in decision making.

A new phenomenon for many wildlife managers involved in urban deer management is how the beliefs of some of the new stakeholder groups with which they are working lead those people to interpret biological data differently. For example, in rural situations where data about large herd size and declining physical condition indicate "too many" deer and that carrying capacity has been exceeded, the beliefs and values of many urban residents may lead them to ask, "so what?," particularly if the herd is not in real danger of starvation and the urban resident enjoys seeing deer. The fact that body weight, antler development, and reproductive measures are declining may lead to one recommendation in rural environments but to another in suburbia. The point is that the old assumptions do not necessarily work in urban environments because the values of stakeholders are different (Curtis and Richmond 1992.

4. Human Dimensions Data Help But Do Not Simplify Decisions

One misperception attending the advent of scientifically obtained human dimensions data is that availability of such data makes managers' jobs easier.

In reality, it helps managers make qualitatively "better" decisions because it promotes clearer understanding of the beliefs, attitudes and preferences of stakeholders. Unfortunately, such understanding does not inherently eliminate controversy. Rather it helps managers understand the nature of the controversy and, perhaps, with experience may enable managers to avoid or reduce some wildlife controversies by anticipating more accurately the information needs that are required to improve mutual understanding among stakeholders. But just as our improved knowledge of how ecosystems function does not make those systems any less complex, our improved understanding of human systems does not simplify how they operate, or diminish the impacts they have on wildlife management. The urban deer management context is complex, and while over time research and experience will vastly improve our understanding of the human dimensions of that context, it will not become any less complex because of our knowledge of it. Our ability to conduct management within that context can be expected to improve as we learn more about processes of management decision making that result in acceptable approaches for defining objectives and selecting approaches for achieving those objectives.

Despite advances in human dimensions inquiry that allow extremely accurate predictions of public views on wildlife management issues (Loker et al. in press), wildlife managers should not succumb to the temptation of simply doing what the majority of stakeholders prefer as a way to avoid controversy. Management should not be reduced to taking a vote. The public does not always have sufficient information or experience to make decisions, and a vote is not necessarily the result of informed decision making. Interest groups can be very effective in communicating particular points of view, thereby persuading less involved people to vote one way or another with little real understanding of the consequences of their vote. If management situations become so polarized that public referenda are pursued as a course of last resort, then the manager's role is markedly diminished. The extent to which managers maintain credibility as professional, unbiased sources of expertise on deer management will determine the extent of influence they will have on reasonable outcomes (Shanks and Decker 1990).

5. Perception of "Objective" Information and Human Values

Our point here overlaps much of what we have presented already. Essentially, what a manager or biologist may present as "objective" biological facts may not be so viewed by others. New stakeholder audiences in urban deer management may question some longstanding assumptions of wildlife managers, especially as they affect interpretation of data. This can be the most unsettling challenge of all for managers, because it can be taken as an attack on our professional competence. Sometimes that is exactly what it is. And, sometimes that is exactly what we need to help us see our work differently. The solution here is for the wildlife professional to be just that--professional. We must be willing to engage in discourse that explores our assumptions, our data, and our interpretations. We must be tolerant enough to handle this kind of challenge without becoming defensive. We must be good enough to help people see why we think as we do. And, we must be open-minded enough to see where we can improve or should change if a critical analysis reveals that a change in our thinking is the right thing to do.

Wildlife managers should not feel particularly threatened or professionally demeaned because the public wants greater input into deer management policy decisions. Other professions, such as medical and health care professionals, have not been immune to this. The day when the technical specialist was also unquestionably considered the best judge of policy alternatives is long gone. For example, national health care policy will be influenced by the medical and health care professions, but decided by representatives of affected lay people who will have great influence on the decision as well. It should not be surprising that citizens who are willing to gain a basic understanding of issues as complex as national health care and demand a say in it might also feel they should participate in a local deer management issue. Wildlife managers need to embrace an expanded role in deer management policy-making given the human dimensions of the urban deer environment.

6. What About this Animal Rights Thing?

A tenet we have come to adopt in our thinking about urban deer management regarding the animal rights stance is this--extreme animal rights advocates are unlikely to be productive participants in urban deer management policy decision making, but as citizens they have a right to have their views heard. They are legitimate stakeholders, but do not have the right to disrupt accepted decision making processes. They have responsibility to participate following the established rules for policy decision making. This holds true for all participants in urban deer management, but experience has shown that animal rights advocates, perhaps recognizing their minority view status, sometimes use tactics intended to sidetrack if not derail the wildlife policy making process. The value of including this particular stakeholder view lies in the fact that the entire stakeholder process is elevated to an even loftier moral high ground and the animal rightists must now confront a wider array of public opinion than simply the hunter.

7. Wildlife Managers as Advocates

This is a tough one, and we are sure to get some disagreement about our outlook concerning wildlife managers as advocates for a particular stakeholder viewpoint. Basically, we suggest that wildlife managers in urban deer controversies should not advocate a particular viewpoint. We come to this conclusion with some difficulty because our first inclination was to recommend that the manager should express strongly held opinions about what "should" or "ought to" be done. Certainly the manager has an informed and legitimate stake in the management decision outcome. But on further consideration, we think that the process, and urban citizens, might be better served by managers taking a different role than that of advocate for their preferred decision alternative, no matter how compelling their views of its merits.

Our reason for recommending avoidance of advocacy is simple. We believe that the manager can provide much greater service to the stakeholders in an urban deer management situation by maintaining primary commitment to developing and preserving a high quality decision-making environment. To do this, the manager has to gain and hold widely recognized credibility; advocating a particular viewpoint destroys that credibility and places the manager in the category of just another vested interest. We believe that the manager will function best if seen as wildlife biologist and human dimensions expert, communication facilitator, educator, and, ultimately, as trusted decision maker. It is difficult for us to envision how these important roles can be carried out effectively or even assumed by an advocate of a particular perspective in an urban deer controversy. Someone must facilitate stakeholder discussions and a good facilitator must remain neutral.

We are not suggesting that the wildlife manager will not have a preferred outcome in mind, but we do worry that one's mind could become closed to previously hidden possibilities if one actively advocates a particular viewpoint. It seems to us that this is where the manager needs to have a great deal of faith in the policy-setting process in which he or she must operate, and in the educational efforts that they implement to achieve informed input to that process. Command of available human dimensions insight--knowledge of stakeholders' attitudes and beliefs, their information level, their ability to interpret and understand the biological and human dimensions information available--is essential for the manager to carry out this important role in urban deer management. (For further insight see work by Hahn (1987) and House (1987).)

8. Future Generations and the Public Interest

Perhaps the one exception to the nonadvocacy stance we suggested above is in the area of the interests of future generations. Wildlife professionals may have a unique responsibility to ensure--advocate--that the interests of future generations are considered. At the very least, wildlife managers need to keep one guiding principle in front of participants in urban deer management decision making--never commit the irrevocable (Decker et al. 1991). Whatever decisions are made today about urban deer management, the options for the future should not be totally foreclosed. Wildlife managers may be the only participants in urban deer management situations that are in a position to articulate this stakeholder interest effectively. Moreover, to take an advocacy position in behalf of future generations and present a posture of farsightedness does much to elevate the professional stature of the facilitator/manager.

In addition, the notion of broad public interest has to be inculcated into urban deer management. It is not unreasonable for professional wildlife managers to help stakeholders distinguish different levels of importance for different aspects of urban deer management that reflect a broader public interest. For example, clearly legitimate public health and safety concerns take precedence over nuisance concerns or recreational values in most instances. Similarly, long-term integrity of a deer population normally takes precedence over short-term nuisance abatement. The manager can be an effective spokesperson for reasoned consideration of the weight that should be given to various stakeholder views.

WHAT DO YOU NEED TO KNOW?

Given the tenets or general principles to guide "people management" in an urban deer environment, a general question wildlife managers ask is, what do we need to know to engage in management in the urban environment? Experience has shown that knowledge of the history of the situation is essential. This includes land use and human population (demographic and socioeconomic characteristics) changes relevant to the deer-people situation that exists. The public wants to know why the situation exists. In this regard, the manager can both enhance his professional stature and establish considerable credibility with stakeholders by providing thoughtful and reliable information about the past and present status of the issue. Residents will also want to know the existing policy context as background; they typically ask which wildlife management agency policies or regulations pertain, what state laws or local ordinances are in place that constrain management options, who has overall jurisdiction and more.

Besides historical background information, stakeholders also want to know as much as possible about the status of the deer herd. This of course is not human dimensions information, but from the human dimensions standpoint stakeholders will expect to be generally informed of all aspects of deer biology and management so they may develop some understanding that they can use to form opinions. It is here that wildlife biologists make or break their professional position and develop credibility among stakeholders. The credibility factor is most critical for maximum effectiveness. We believe that credibility has two main aspects in this context--credibility as a source of expert information and credibility as an unbiased facilitator of fair and reasonable dialogue for policy development. The first aspect obviously requires a sound knowledge of deer biology. Questions may run a wide gamut and the skillful manager will field and handle all of them. The second aspect, credibility as an unbiased facilitator, requires exceptional communication skills, a receptive personality, a willingness to listen and utilize comments and opinions of others as if they were his or her own and above all seek out the opinions and rationale of all those represented in the group. This role is indeed delicately balanced and requires an extremely able and perceptive individual.

Another kind of information stakeholders will normally want are estimates of the impacts the deer herd is having on people. These impacts will be either of a physical nature or perhaps a perceptual nature. For example, one will need to document actual deer-car collision rates and citizens' perceptions of the risk of deer-car collisions, the latter being measured through human dimensions inquiry. Other kinds of information have this actual vs. perceived dichotomy of characteristics: damage to plants--actual damage and cost vs. perception of magnitude and acceptability; Lyme disease--actual incidence vs. perceived incidence/risk and tolerance. This kind of information should be provided in a neutral way, as statements of fact, not qualified with the wildlife manager's judgment about whether the impact and people's reactions to it are good or bad, or should be tolerated or not. To add the qualitative element to your assessment is to reveal your biases and compromise your position as a trusted source of unbiased information and expertise for the policy development and management decision-making process.

Implicit in the foregoing discussions about how to deal with stakeholders is the assumption that one knows who the relevant stakeholders are in an issue, as well as the nature of their stake. This is not always obvious, and given the recent experience of several managers in urban deer management, one needs to be cautious about assumptions regarding stakes and stakeholders. The manager needs to keep an open mind, in fact take an inquisitive approach to identifying stakeholders so as to avoid missing someone or something of value in management consideration. After stakeholders are identified, their relevant beliefs and attitudes should be determined so that communications can be undertaken with foreknowledge of the belief and attitude bases for their opinions and preferences concerning urban deer management.

A key to dealing effectively with an urban deer management issue is to understand what stage of development the issue is in at the time managers intervene. Policy analysts have described a general issue-evolution model that is helpful in planning what needs to be done to move an issue toward successful resolution (House 1987). The kinds of action and nature of information needed differs according to how far along the issue has evolved, and whether all stakeholders are at the same place. Wildlife managers need a working knowledge of such models if they are to be effective practitioners of urban deer policy formulation and management.

WHAT DO YOU NEED TO DO?

The real test of our abilities as managers is the degree to which and with what effectiveness we can integrate the biological and human dimensions information available regarding an urban deer management situation. Our test will continue as we then attempt to apply this knowledge to develop strategies and message content for communication to influence beliefs and attitudes. By influence we do not mean manipulate to some preconceived position preferred by wildlife managers, but rather to broaden people's scope of understanding of the full set of facts, including the beliefs and values held by other stakeholders. Based upon experience in New York, it seems that an important, foundational set of communication objectives might be to increase stakeholders' tolerance of: (a) deer and (b) other stakeholders' needs and interests vis-à-vis deer. Concomitant with those objectives might be the establishment or enhancement of the wildlife manager's/agency's credibility as communicator, facilitator of stakeholder interaction, and fair policy decision maker (Decker 1985). Thus, establishing the unique and central role of the wildlife manager/agency in urban deer management is a necessary first step. Put another way, controversy, mistrust and faulty communication often exist. What is needed is trusted leadership from a credible source.

The role of communication facilitator will require networking with other organizations and individuals, especially building collaborations with relevant agencies and government officials (e.g., highway superintendents, environmental planners, health officials, law enforcement officials, green belt managers, county park officials, and more). As part of this process, the wildlife manager needs to keep emphasizing his or her role and maintain the unbiased expert status essential to facilitating satisfactory resolution of the deer management issue of concern.

A key to being the communicator and facilitator of stakeholder interaction is the possession of the best human dimensions information that can be obtained given the time and financial constraints attending the situation. The greatest threats to reasoned discussion of stakeholder values central to an urban deer management situation are misinformation, partial information, or misrepresentation (intentional or unintentional) of people's stake in an issue. The faulty information can relate either to the nature of the stake, the number of people with that stake, or the importance that people place on it. The wildlife manager may be the only party in an urban deer management situation with the responsibility for providing accurate, complete human dimensions information. That responsibility typically necessitates undertaking systematic inquiry. An interesting observation regarding this is that decision makers who are accustomed to simply applying their own "gut feelings" about the human dimensions may be among the least receptive to human dimensions data if such data do not confirm their preconceived notions. Thus, it is important that key decision makers be involved in the development of the human dimensions inquiry so that acceptance of the results will be improved.

INFORMATION NEEDS THAT CAN IMPROVE MANAGEMENT PRACTICES

Future research in the human dimensions of urban deer management could explore several important topics of benefit to decision makers.

1. Determine the set of underlying values that typically are operative in urban deer management controversies, and the way they emerge as issue interpretations among stakeholders.
2. Determine the relationship between attitudes/beliefs and degree of experience with deer in influencing people's wildlife acceptance capacity (Decker and Purdy 1988).
3. Determine the characteristics of alternative lethal and nonlethal deer-population-control technology that influences acceptability among different stakeholder groups in urban deer management situations.
4. Evaluate the effectiveness of various public input and involvement techniques, from citizen task forces to scientific human dimensions studies, in satisfactorily resolving urban deer management problems.
5. Develop approaches to monitor urban deer-people interactions (e.g., periodic surveys, deer nuisance complaints registry) such that the potential for a controversy/problem can be detected as early as possible, and perhaps dealt with more proactively.

CONCLUSION

Urban deer-people management may be one of the biggest wildlife management "problems" facing the profession today, but we believe this challenge is a harbinger for a major emphasis of wildlife management in the future; that is, <u>managing people and wildlife in developed environments</u>. Urban deer management may be the most critical example of where the integration of biological and human dimensions insight is essential for management success. Consequently, the success we have in meeting this challenge, measured in terms of effectiveness in managing processes for establishing credible management objectives and accomplishing them, will have significant influence on public confidence in the ability of wildlife professionals.

A glance back to the first indication of intelligent, focused thought about wildlife management takes us to the work of Stoddard, Leopold, Trippensee, Jackson from the 1930's. This means we have been at the business of wildlife management and conflict resolution for about 60 years. Over this 60-year period we have learned much and have applied a great deal to the management of white-tailed deer. State management agencies and biologists should be proud of their accomplishments. In the past 25 years, however, we have moved much of our expanding population out of the city and into deer habitat. With increasing numbers of both deer and people interacting with each other it is no surprise that conflict is upon us. We recognize the problem, now we must act in our best professional manner to solve it. The issue as we see it is more complex than issues faced by management in the past. It will take time and perhaps a great deal of custom fitting the situation before we are successful.

Only time will determine whether we will be effective in managing people in an urban deer environment.

LITERATURE CITED

Brown, T. L., and D. J. Decker. 1979. Incorporating farmers' attitudes into management of white-tailed deer in New York. J. Wildl. Manage. 43:236-239.

Curtis, P. D., and M. E. Richmond. 1992. Future challenges of suburban white-tailed deer management. Trans. North Am. Wildl. and Nat. Resour. Conf. 57:104-114.

Decker, D. J. 1985. Agency image: A key to successful natural resource management. Trans. Northeast Sect. The Wildl. Soc. 42:43-56.

___, and N. A. Connelly. 1990. The need for hunter education in deer management: Insights from New York. Wildl. Soc. Bull. 18:447-452.

___, and T. A. Gavin. 1987. Public attitudes toward a suburban deer herd. Wildl. Soc. Bull. 15:173-180.

___, and K. G. Purdy. 1988. Toward a concept of wildlife acceptance capacity in wildlife management. Wildl. Soc. Bull. 16:53-57.

___, R. E. Shanks, L. A. Nielsen, and G. R. Parsons. 1991. Ethical and scientific judgements in management: Beware of blurred distinctions. Wildl. Soc. Bull. 19:523-527.

Gigliotti, L. M., and D. J. Decker. 1992. Human dimensions in wildlife management education: Pre-service opportunities and in-service needs. Wildl. Soc. Bull. 20:8-14.

Hahn, A. J. 1987. Educating citizens and policymakers about public issues. Human Ecol. Forum 16:11-14.

House, V. W. 1987. Methods for policy education. In Education for Public Decisions: Module 7 of a national curriculum project entitled "Working with Our Publics."

Loker, C. A., D. J. Decker, R. B. Gill, T.D.I. Beck, and L. H. Carpenter. 1994. The Colorado black bear hunting controversy: A case study of human dimensions in contemporary wildlife management. Human Dimensions Res. Unit Publ. 94-4. Dept. of Nat. Resour., Cornell Univ., Ithaca, NY. 56pp.

Richmond, M. E. 1973. Our land animal resource. Annals of the N.Y. Acad. of Sci.:216:121-127.

Shanks, R. E., and D. J. Decker. 1990. Communication and image in the wildlife profession: A New York perspective. Trans. Northeast Sect. The Wildl. Soc. 47:27-35.

Smolka, R. A., Jr., and D. J. Decker. 1985. Identifying interest groups' issue positions and designing communication strategies for deer management in northern New York. Trans. Northeast Sect. The Wildl. Soc. 42:112-125.

Stout, R. J., R. C. Stedman, D. J. Decker, and B. A. Knuth. 1993. Perceptions of risk from deer-related vehicle accidents: Implications for public preferences for deer herd size. Wildl. Soc. Bull. 21:237-241.

WHAT IS THE URBAN DEER PROBLEM AND WHERE DID IT COME FROM?

MICHAEL R. CONOVER, Department of Fisheries and Wildlife, Utah State University, Logan, UT

In 1990, 78% of Americans resided in one of the 100 largest metropolitan areas in the U.S. (U.S. Bureau of the Census 1991). One measurement of the importance of a resource is the amount of time and money one spends to enhance or maintain it. By this measure, urban wildlife is of great importance to metropolitan residents. Conover et al. (unpubl.) reported that in 1992, the 60 million households in the 100 largest metropolitan areas in the U.S. suffered an estimated $2.4 billion in damages caused by wildlife, despite spending $1.4 billion and 240 million hours trying to solve or prevent these problems. Additionally, they spent $3 billion and probably at least an equal amount of time trying to encourage wildlife around their homes.

Not surprisingly, a major challenge for fish and wildlife agencies is responding to the needs and interests of urban residents (Kania and Conover 1991, Hesselton 1991). Studies have examined the perceptions of urban New York residents about deer (Brown et al. 1979, Decker and Gavin 1987, Connelly et al. 1987). In this study, I documented the location and history of urban deer populations in the U.S., examined the magnitude problems caused by urban deer, and surveyed the opinions of metropolitan residents about how urban deer should be managed.

METHODS

Location of urban deer populations in the U.S.

I sent a questionnaire to every state wildlife agency requesting information about the location of urban deer populations in each state. For each urban deer population, I asked when it was established and when people began to complain about deer causing problems.

Problems caused by urban deer

To assess the impact of urban deer on human society, I surveyed the literature for published and unpublished papers on problems caused by deer. Further, I used records from the U.S. Centers of Disease Control and Prevention on the prevalence of Lyme Disease in the U.S.

Opinions of Metropolitan Residents about Urban Deer

I sampled metropolitan residents in 1993 by first randomly selecting ten of the largest 100 metropolitan areas in the U.S. (U. S. Bureau of Census 1991). I randomly drew 100 names and addresses from the latest phone directory for each selected metropolitan area. Each of these 1,000 households were then sent a questionnaire and a postage-paid return envelope. A week later, everyone was sent a reminder, and 3 weeks later, non-respondents were sent a second copy of the questionnaire and postage-paid return envelope.

The questionnaire included a list of urban wildlife species, including deer, and respondents were asked whether they preferred more, less, or no change in the numbers of each species in their neighborhood. They also were asked whether their household experienced a problem with deer in 1992.

To assess any non-response bias, I called 10% of the people who had not returned their questionnaire within 2 months. I tested whether the answers of non-respondents differed from the answers I obtained from respondents using Chi-square tests. Differences in this and all other tests were considered statistically significant if $P < 0.05$ based on Bonferroni protected alpha levels.

RESULTS

Survey of Urban Deer Populations

A survey of state wildlife agencies identified 195 urban deer populations although the actual number is higher because several states did not list each urban deer population separately but lumped them together (Table 1). For instance, Virginia reported that nearly all cities in that state had an urban deer population. Urban deer populations were reported in 42 of 46 states which responded to my questionnaire; only Alaska, Arkansas, Hawaii, and New Mexico indicated a lack of urban deer. Twenty percent of the urban deer populations were reported to have been established in pre-settlement period, 18% in the 1940s and 1950s, 18% in the 1960s, 20% in the 1970s, 22% in the 1980s, and 1% in the 1990s (Table 1). When asked the approximate year that each urban deer population became large enough that people began to complain about them, state agencies reported that 6% of the problems began in the 1940s and 1950s, 9% in the 1960s, 18% in the 1980s, 51% in the 1980s, and 16% in the 1990s (Table 1).

Survey of Published and Unpublished Reports

Lyme Disease is caused by the spirochete, *Borrelia burgdorferi*, which is vectored in the eastern

Table 1. Locations of urban deer populations in the U.S. as reported by state wildlife agencies, the year when these populations were believed to become established and when local residents starting complaining about problems.

		DECADE	
STATE	CITY	Population Established	First Reports
Alabama	Birmingham	1970s	1980s
	Huntsville	1975s	1980s
	Mobile	1970s	1980s
	Montgomery	1970s	1980s
Arizona	Flagstaff	Pre-settlement	?
	Kingman	Pre-settlement	?
	Phoenix	Pre-settlement	?
	Prescott	Pre-settlement	?
	Tucson	Pre-settlement	?
	Yuma	Pre-settlement	?
California	Los Angeles Metro Area	?	?
	Marin County Cities	?	1980s
	Monterey Penninsula Cities	?	1980s
	Napa County Cities	?	?
	Orange County Cities	?	?
	San Diego County Cities	?	?
	San Francisco Bay Area	?	1980s
	Sacramento Suburban Areas	?	1980s
Colorado	Boulder	Pre-settlement	1970s
	Colorado Springs	1950s	1980s
	Estes Park	Pre-settlement	1960s
Connecticut	Danberry	1980s	1980s
	Groton	1980s	1980s
	Norwich	1980s	1980s
	Stanford	1980s	1980s
	Westport	1970s	1980s
Delaware	Wilmington	1980s	1970s
	Newark	1950s	Z1980s
Florida	Altamonte Springs	1970s	1980s
	Gainesville	1950s	1950s
	Golden Eagles Estates	1980s	1990s
	Golden Gate Estates	Pre-settlement	?
	Iverness	1950s	1970s
	Jacksonville	1950s	1950s
	Lake City	1950-65	1955-85
	Live Oak	1950-65	1955-85
	Longwood	1970s	1980s
	Oveida	1960s	1980s
	Palm Coast	1950s	1980s
	Perry	1950-65	1955-85

		DECADE	
STATE	CITY	Population Established	First Reports
Georgia	Athens	1960s	1970s
	Atlanta	1970s	1970s
	Columbus	Pre-settlement	1970s
	Macon	1960s	1960s
	Savannah	Pre-settlement	1980s
Idaho	Coeur d'Alene	Pre-settlement	1990s
	Sandpoint	Pre-settlement	1990s
Illinois	Carbondale	?	?
	Chicago Metro Area	?	?
	Edwardsville	?	1980s
	Galesburg	?	1970s
	Peoria	?	1980s
	Rockford	?	1980s
	Springfield	?	?
Indiana	Dunes Acres	1960s	1980s
	Fort Wayne	1970s	1990s
	Richmond	1970s	1990s
Iowa	Cedar Rapids	1980s	1980s
	Des Moines	1980s	1980s
	Iowa City	1980s	1980s
	Waterloo	1980s	1980s
Kansas	Hutchinson	1960s	1980s
	Kansas City Metro	1960s	1980s
	Topeka	1960s	1980s
	Witchita	1960s	1980s
Kentucky	Covington	1980s	1980s
	Louisville	1980s	1980s
	Paduch	1980s	1980s
	Florence	1980s	1980s
Louisiana	Baton Rouge	1960s	1990s
	Covington	1960s	none
	Metairie	1960s	1990s
	Monroe	1960s	none
	Shreveport	1960s	none
Maine	Bar Habor	?	1950s
	Cape Elizabeth	?	1970s
	Old Town	?	1990s
	Portland	?	1990s
	Wells	?	1980s
Michigan	Midland	1970s	1980s
	Milford	1970s	1990s
	Selfridge Air Force Base	1970s	1980s

STATE	CITY	DECADE Population Established	 First Reports
Minnesota	Bloomington	1980s	1980s
	New Ulm	1980s	1990s
	North Oaks	1970s	1980s
	Red Wing	1980s	1990s
	Twin Cities Metro Area	1990s	1990s
Mississippi	Jackson	1970s	None
Missouri	Columbia	1960-80	1980s
	Jefferson City	1960-80	1980s
	Kansas City	1960-80	1980s
	Saint Louis	1960-80	1980s
	Springfield	1960-80	1980s
Montana	Bitterroot Valley	Pre-settlement	1980s
	Flathead Valley	Pre-settlement	1980s
Nevada	Garnerville	Pre-settlement	1980s
	Lamoille	Pre-settlement	1970s
	Mindin	Pre-settlement	1980s
	Spring Creek	Pre-settlement	1970s
	Reno	Pre-settlement	1990s
New Hampshire	Concord	1990s	None
New Jersey	Berkeley Heights	?	?
	Maplewood	?	?
	Mendham	?	?
	Millburn	?	?
	Morris	?	?
	Mountainside	?	?
	New Providence	?	?
	Princeton	?	?
	Scotch Plains	?	?
	South Orange	?	?
	Springfield	?	?
	Watchung	?	?
	West Orange	?	?
New York	Albany	1940s	1970s
	Buffalo	1940s	1980s
	Ithaca	?	?
	Rochester	1940s	1970s
	Suffolk County	Pre-settlement	1960s
	Syracuse	?	?
	Westchester County	1940s	1950s
North Carolina	Charlotte	1980s	1980s
	Durham	1970s	1980s
	Greensboro	1970s	1980s

		DECADE	
STATE	CITY	Population Established	First Reports
North Carolina	Raleigh	1970s	1980s
North Dakota	Bismarck	1970s	1970s
	Fargo	1980s	1980s
	Grand Forks	1970s	1980s
	Minot	1980s	1980s
Ohio	All cities	?	?
Oklahoma	Edmond	1970s	1990s
	Norman	1970s	1990s
Oregon	Corvallis	?	1970s
	John Day	1980s	1980s
	Joseph	1980s	1980s
	La Grande	1980s	1980s
	Roseburg	?	1970s
Rhode Island	New Shoreham	1960s	1970s
	Portsmouth	?	1970s
	Scituate	?	1990s
South Dakota	Pierre	1980s	1990s
	Rapid City	1980s	1980s
	Sioux Falls	1980s	1990s
	Spearfish	1980s	1990s
	Sturgis	1980s	1990s
	Watertown	1960s	1970s
Tennessee	Chattanooga	?	1980s
	Manchester	1980s	1990s
	Memphis	?	1980s
	Nashville	?	1980s
	Oak Ridge	1960s	1970s
Texas	Austin	1930s	1940s
	San Antonio	1930s	1940s
Utah	Bountiful	1940s	1960s
	Brigham City	1940s	1960s
	Centerville	1940s	1960s
	Farmington	1940s	1960s
	Layton	1940s	1960s
	Logan	1940s	1960s
	Ogden	1940s	1960s
	Orem	1940s	1950s
	Provo	1940s	1950s
	Salt Lake City	1940s	1960s
	Sandy	1940s	1960s
Vermont	Burlington	Pre-settlement	1980s
	Essex Junction	Pre-settlement	1990s

		DECADE	
STATE	CITY	Population Established	First Reports
Vermont	Shelburne	Pre-settlement	1990s
Virginia	Nearly all cities	1960-90	1980s
Washington	Olympia	Pre-settlement	?
	Spokane	Pre-settlement	?
	Yakima	Pre-settlement	?
West Virginia	Beckley	1980s	1990s
	Clarksburg/Bridgeport	1960s	1980s
	Fairmont	1960s	1990s
	Martinbury/Shepardstown	1950s	1980s
	Morgantown	1960s	1990s
	Weirton	1960s	1980s
	Wheeling	1960s	1980s
Wisconsin	Brookfield	1960s	1980s
	Cedarburg	1960s	1980s
	Chenequa	1960s	1980s
	Eau Claire	Pre-settlement	1970s
	Fox Point/Bayside	1960s	1980s
	Green Bay	Pre-settlement	1970s
	Kohler	1960s	1970s
	LaCrosse	Pre-settlement	1990s
	Madison	Pre-settlement	1960s
	Mequon	1960s	1980s
	River Hills	1960s	1980s
	Sheboygan	1960s	1970s
	Thiensville	1960s	1980s
Wyoming	Casper	1980s	1980s
	Jackson	1970s	1980s
	Story	1970s	1980s
	Thermopolis	1980s	1980s

U.S. by the deer tick (*Ixodes dammini*) (Lane et al. 1991). In 1991, there were 9,998 human cases of this disease reported to the U.S. Centers for Disease Control and Prevention.

Another problem is auto-vehicle collisions. Romin and Bissonette (unpubl.) estimated that 300,000 vehicular collisions involving deer are reported to law enforcement agencies annually and an equal number are unreported (Conover et al. unpubl.). estimated that these collisions result in an annual loss of $1.4 billion in damage to vehicles, a loss of $1.4 billion in the value of deer, 15,000 human injuries, and 195 deaths (Conover et al. unpubl.).

Most of these accidents and incidents of Lyme Disease occur in rural areas, yet a certain, but unknown, fraction can be attributed to urban deer populations. For instance, deer damage can be extensive on farms located in metropolitan settings. Lyme disease and deer-vehicle accidents do not stop at the city limits.

Probably the most widespread problem caused by deer in metropolitan areas is the damage they cause by browsing landscaping plants located in parks and around people's homes. Deer herbivory causes more than just nuisance problems in metropolitan areas. Conover (1994) and Wywialowski (unpubl.) reported that perceived annual wildlife damage to agricultural crops was $450 and $478 million, respectively. It is unknown what fraction of this is due to deer damage, but more farmers reported problems with deer than with any other group of animals (Conover 1994); 70% of state wildlife and agricultural professionals reported that deer caused more damage in their state than any other wildlife species (Conover and Decker 1991). Most metropolitan areas contain numerous small farms that cater to local residents. Deer herbivory can be a major problem for these farmers (Conover pers. observ.). In addition, many metropolitan parks and nature preserves are managed for the goal of maintaining them as they were when first viewed by Europeans. This management goal can prove difficult, however, because herbivory by high densities of deer can cause the local loss of some plant species and regeneration problems for others.

Survey of Metropolitan Residents

Questionnaires were returned from 53% of the people receiving them. The was no difference in responses to the mail and phone surveys. Hence, data from both surveys were combined for further analysis.

When asked whether they wanted more, less, or no change in the numbers of different wildlife species in their neighborhoods, 26% of respondents wanted more deer, 66% wanted no change, and 8% wanted fewer deer. Three percent of the respondents reported that they had a problem with deer during 1992.

DISCUSSION

My results indicate urban deer populations are widespread in the U.S. and that while some of these populations date back to pre-settlement periods, most became established during the Twentieth Century. Apparently urban deer populations because established simultaneously in many different parts of the country and involve both white-tailed and mule deer. There also are a few urban populations of elk (*Cervus canadensis*). This raises the question of why this phenomenon occurred. One factor is the expansion of deer populations during the Twentieth Century. Additionally, deer may have made behavioral adjustments to changing conditions during the last century caused by the protection of deer from human predation outside the hunting season and year-round protection in urban areas. Deer apparently have learned the contradictory lesson that while a low density of humans in rural areas may pose a threat to them, at least in the fall, a high density of humans in urban areas do not. Consequently, deer now occupy urban landscapes for the first time.

Urban deer populations are causing economic losses, nuisance problems, and threats to human health and safety due to Lyme disease and deer-vehicle accidents. While there are some estimates of the size of these problems nationally, it is unclear what fraction of the total losses are caused by metropolitan deer. For instance, it is unclear how many of the estimated 600,000 deer-vehicle accidents in the U.S. annually occur inside city limits. Decker et al. (1990), however, reported that half of the residents in Tompkins County, New York had been in deer-vehicle collision. In our national survey of metropolitan residents, 3% of respondents reported that they experienced some type of deer problem in 1992. If we extrapolate this to the nation's 60 million households in the 100 largest metropolitan residents, then 1.8 million households in the U.S. face deer problems annually. Clearly, wildlife biologists must help these people alleviate or manage their deer problems.

My data indicate that economic losses, injuries and diseases caused by urban deer are serious concerns. Our data do not indicate that urban deer populations are too high or should be controlled. Any wildlife species or population has both positive and negative values for society. For instance, Langenau et al. (1984) reported that the U.S.'s white-tailed deer population provided $8.2 billion in benefits in 1975 ($1 billion for hunter expenditures, $100 million value as meat, $1.8 billion value for hunting recreation, and $5.4 billion for non-hunting recreation). To obtain the net value of deer to our society, we need to debit from these the costs or negative values of deer ($600 million in automobile repair bills, an undetermined amount of damage to agricultural crops, 40 deaths and 16,000 injuries from auto collisions, and some fraction of the 10,000 cases of Lyme Disease). I have not placed a dollar value on the loss of human life or health so that we cannot quantify the net value of deer, but clearly it is a high positive value.

The same is also true for urban deer populations. My results indicate that despite the problems caused by deer most (66%) metropolitan residents wanted local deer populations to remain at current levels. In addition, more residents preferred an increase in local deer populations (26%) than a decrease (8%). Thus deer still are viewed favorably by most metropolitan residents. The challenge for wildlife biologists will be to manage urban deer populations to minimize the negative effects these animals cause while enhancing all of the positive benefits they provide to our metropolitan residents.

ACKNOWLEDGEMENTS

I thank V. DePaepa and J. Farr for their help with the data analysis. Earlier drafts of this manuscript were edited by D. O. Conover, D. E. McIvor, K. K. Kessler, and W. C. Pitt.

LITERATURE CITED

Brown, T. L., C. P. Dawson, and R. L. Miller. 1979. Interests and attitudes of metropolitan New York Residents about wildlife. Trans. North Am. Wildl. and Nat. Resour. Conf. 44:289-297.

Conover, M.R. 1994. Perceptions of grass-roots leaders of the agricultural community about wildlife damage on their farms and ranches. Wildl. Soc. Bull. 22:94-100.

____, and D. J. Decker. 1991. Wildlife damage to crops: Perceptions of agricultural and wildlife professionals in 1957 and 1987. Wildl. Soc. Bull. 19:46-52.

Connelly, N. A., D. J. Decker, and S. Wear. 1987. Public tolerance of deer in a suburban environment: Implications for management and control. East. Wildl. Damage Control Conf. 3:207-217.

Decker, D. J., and T. S. Gavin. 1987. Public attitudes toward a suburban deer herd. Wildl. Soc. Bull. 15:173-180.

____, K. M. Loconti Lee, and N. A. Connelly. 1990. Incidence and costs of deer-related vehicular accidents in Tompkins County, New York. Human Dimensions Research Unit Series 89-7, Cornell Univ., Ithaca. 22pp.

Hesselton, W. T. 1991. How governmental wildlife agencies should respond to local governments that pass antihunting legislation. Wildl. Soc. Bull. 19:222-223.

Kania, G. S., and M. R. Conover. 1991. Another opinion on how governmental agencies should respond to local ordinances that limit the right to hunt. Wildl. Soc. Bull. 19:222-223.

Lane, R. S., J. Piesman, and W. Bergdorfer. 1991. Lyme Borreliosis: Relation of its causative agent to its vectors and hosts in North America and Europe. Annu. Rev. Entomol. 36:587-609.

Langenau, E. E., Jr., S. R. Kellert, and J. E. Applegate. 1984. Values in management. Pages 699-720 *in* L.K. Halls, ed. White-tailed deer ecology and management. Stackpole Books, Harrisburg, PA. 870pp.

U.S. Bureau of the Census. 1991. Statistical abstract of the United States: 1991 (111th ed.). U.S. Gov. Printing Office, Washington, D.C. 986pp.

CULTURAL CARRYING CAPACITY: MODELING A NOTION

DONNA L. MINNIS and R. BEN PEYTON, Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI

After decades of hard-fought management battles, the wildlife management community seems to have come to the consensus that wildlife management will be most successful in a context in which human values and subjective evaluations of desirable conditions are formally recognized (Decker et al. 1992). Not only is the social environment the context for today's wildlife management efforts, it also serves as one of the driving and controlling factors in the management process (Peyton 1987, Duda and Schaefer 1991, Schmidt et al. 1992). The premise of this paper is that the issue-laden social environment places demands and constraints on defining and achieving objectives for wildlife management. The density and social diversity of individuals living within urban landscapes set the stage for particularly challenging wildlife management issues (Decker 1991, Decker and Richmond 1994).

When the wildlife species interacting with urban residents is the relatively large, diversely valued, highly mobile and adaptable white-tailed deer (*Odocoileus virginianus*), wildlife management becomes all that much more vexing. It is inevitable that people will disagree on how many deer are enough and how best to achieve the deer management objective in the urban bio-socioenvironment. Therein lies the challenge. When resource managers work within the limits of ecological parameters, they must solve problems; but, when they work within the limits and forces of sociological parameters, they must also resolve issues.

The notion that the social environment represents a complex system with its own carrying capacity for wildlife is explored in this paper. We articulate a basic conceptual framework of cultural carrying capacity, present an expanded model of the human response to wildlife, discuss implications of CCC for wildlife management, and provide recommendations for future research. Our discussion extends beyond previous studies to include the broad range of variables that influence how people perceive wildlife populations. Our goal is to present a comprehensive theoretical framework for understanding and influencing human response to wildlife—a framework that facilitates integration of the notion of cultural limits on wildlife into our population management decisions.

THE NOTION OF CULTURAL CARRYING CAPACITY

Biological carrying capacity (BCC) is widely recognized as a cornerstone principle of wildlife management, but despite its predominance in the vocabulary of wildlife professionals, it remains a general concept rather than an operational reality (Edwards and Fowle 1954, Caughley 1979, Macnab 1985). Basically, BCC refers to an equilibrium between animals and vegetation that we index by its characteristic density of animals (Caughley 1979). The premise of BCC is that wildlife populations are constrained by the limited capacity of an ecosystem to support organisms, with the factor in shortest supply being the major control on the population (Edwards and Fowle 1954).

Over the past few decades, social conflicts over wildlife have motivated the wildlife management community to pay closer attention to the role of the human social system as a limiting force on wildlife populations (Brown and Decker 1979, O'Donnell and VanDruff 1983, Stoll and Mountz 1983). Around 1960, researchers began to formally investigate human tolerance of wildlife and wildlife damage (Craven et al. 1992). In 1986, Ellingwood and Spignesi coined the term "cultural carrying capacity" (CCC) to describe the general idea that humans have a limited capacity to cohabit with - to "support" - wildlife, a concept loosely analogous to BCC. Ellingwood and Spignesi (1986) defined CCC as "the maximum number of deer that can compatibly co-exist with a local human population" (see also Ellingwood and Caturano 1988). This capacity is a product of human cognitive/affective (e.g., perceptions, values, beliefs, attitudes, preferences) and conative responses to wildlife. Others have labeled this notion as "sociological carrying capacity" (Stoll and Mountz 1983, Decker et al. 1985, Purdy 1987) and later as "wildlife acceptance capacity" (Decker and Purdy 1988, Decker 1991).

For clarity, it is important to briefly describe two other applications of the carrying capacity concept that may be confused with CCC in the context of wildlife population management. The term cultural carrying capacity is used in some circles to refer to the limits of human population growth (Hardin 1992), which we interpret as BCC revamped to consider quality of life and then applied to the human species.

"Social carrying capacity" - or "recreational carrying capacity" - another concept derived from BCC, is used in the field of recreation resource management to describe the effects of user density on visitor satisfaction in natural areas (Stankey 1973, Becker et al. 1984, Graefe et al. 1984, Shelby and Heberlein 1984, Stankey and McCool 1984). These usages are distinctly different from the application of CCC developed here.

Because of its significance to the development of the CCC model, we will briefly review the conceptualization of wildlife acceptance capacity (WAC). Decker and Purdy (1988:53) defined WAC as the "maximum wildlife population level in an area that is acceptable to people." WAC is described as an individual stakeholder-level capacity (e.g,. deer hunters' WAC; dairy farmers' WAC; fruit growers' WAC), and, as per its definition, WAC deals with the *maximum* level of wildlife that is acceptable to a stakeholder group. The application of WAC to population management has been suggested to entail identifying the one stakeholder of greatest concern and managing for the WAC of that group (Decker and Purdy 1988). Although Decker and Purdy (1988) focused on the tolerance of individual stakeholders, they and others have recognized the utility of developing a broader conceptualization (Craven et al. 1992, Stout et al. 1993). Towards this end, we build upon earlier work to offer a conceptual framework for integrating the relevant stakeholder-level capacities.

Although significant conceptual contributions have been made (e.g., Decker and Purdy 1988, Decker 1991, Craven et al. 1992), further refinement of the notion of cultural limits on wildlife populations is needed. Definitions need to be more precise, and conceptual applications need to be more amenable for use with multiple stakeholders. Throughout this paper, we will discuss three such areas addressed by the CCC model.

First, a method that facilitates systematic consideration of preferences of multiple stakeholders needs to be developed. We *may* decide to manage for one or for several stakeholders' preferences, but we should make that decision only after analysis of all identified stakeholders. A comprehensive framework that facilitates methodical and objective consideration of preferences of multiple stakeholders will provide a solid foundation for wildlife population planning. This foundation will better enable managers to formulate management objectives that maximize wildlife resource values within both biological and sociological constraints (Brown et al. 1978, Stoll and Mountz 1986). This need highlights one of the key differences between the CCC and WAC conceptualizations: WAC is a narrower, individual stakeholder-level capacity, whereas CCC as we propose it is a broader, societal-level capacity incorporating multiple value systems.

Secondly, to answer the question, "How many deer are enough?," we need to consider not only how many deer are too many but also how many deer are too few. The WAC concept provides an initial stepping stone to get to the question of "too many," but formal treatment of the question of "too few" of a wildlife species is lacking from the literature. The framework we present accommodates the fact that people sometimes become intolerant because a wildlife population is perceived as being too low.

A final point that we address in our CCC framework is the need to clarify and expand the dynamics of human response to wildlife populations. Based on previous research on wildlife damage management and human decision-making, we propose a schematic model of attitudinal response to wildlife. The notion of tolerance of wildlife is aptly suited to situations in which the wildlife species is viewed as a pest. However, the model we propose is a wildlife population management model and is not restricted to damage control situations. We apply it to urban deer management, but it is applicable to a broad range of species in a broad range of landscapes. The CCC framework addresses only the sociological side of the wildlife population management process. The CCC framework is designed to aid managers in dealing with the social considerations involved in *identifying* a wildlife population objective, and it provides insights on how we might manage the social system regarding a population objective. When analysis of the situation using the CCC framework indicates that it is the wildlife population size that should be changed to accommodate stakeholder preferences, the subsequent step of managing for that population objective is outside the purview of the framework. That is, the CCC framework is not designed to address the onerous issues associated with trying to reach a wildlife population objective once it is set, such as deciding on the population control mechanism.

DEFINING CCC IN TERMS OF ISSUES

We define cultural carrying capacity as the wildlife population level in a defined area that produces the most manageable amount of issue activity at a particular time. Wildlife management issues are posed here as a special category of wildlife problems that involve social conflict. A premise of our CCC model is that issue management to minimize conflict is a legitimate and important practice of resource managers (Mangun 1992). In fact, the CCC notion was born of the need by resource managers for new and better tools to help resolve wildlife-related issues (Ellingwood and Kilpatrick 1994). Accordingly, we defined CCC in terms of issue management to present CCC from the perspective of the resource agency and to provide a theoretical tool that directly addresses issues regarding wildlife population levels.

The intensity and stages of issues involved are proposed here as key indicators of an agency's success in incorporating social considerations into wildlife management decisions. The cultural carrying capacity model suggests that managers can achieve adjustments in the social system and/or the wildlife population levels that may not eliminate issues but may enhance the agency's ability to manage them.

A key consideration of issue management is timing because issues tend to develop through several stages before potentially becoming unmanageable by the responsible agency (Greiwe 1979, Peyton 1984, Crable and Vibbert 1985, Crable and Faulkner 1988). These issue stages can be characterized by the associated communication patterns: who is talking to whom? The nature of the stages is illustrated by the following urban deer scenario.

When a deer is first sighted in an urban area, conditions are being established that could lead to an issue over deer populations in that area. No one is communicating about the potential issue at this time, and we might call this stage <u>latent</u>. As the deer population becomes large enough and the animals' behaviors change, deer may begin to browse on an occasional ornamental lawn shrub or dash out in front of a car. The awareness of increased incidence of deer-human interactions causes residents to begin to express concern to each other about the real or perceived threats. At this point, with communication occurring primarily <u>within</u> stakeholder groups, the issue is <u>emerging</u> (Moore 1979). When deer regularly cause vehicle accidents, loss of ornamental plants, and broken picture windows, some stakeholder groups may begin to express their concerns to the wildlife management agency, demanding some relief. When communication crosses stakeholder lines and/or the management institutions become involved, the issues are <u>active</u>. Stakeholders may write letters, make phone calls, attend public meetings or otherwise communicate their position on the related issues to other stakeholder groups, including the resource management or other involved agencies.

Often, if the management agency cannot resolve the issues among stakeholders, some constituents who believe that the management agency is not responsive to their needs may communicate their opinions indirectly to the agency via higher authority (i.e., legislative, judicial, or executive office) (Stoll and Mountz 1983, Decker et al. 1985). Ultimately, management strategies and/or goals may be prescribed by legislation rather than the purview of trained wildlife professionals (e.g., Cobb 1982, Lautenschlager and Bowyer 1985). When an agency loses control of management, the issue has become <u>disruptive</u> (Peyton 1984). Although disruptive issue activity is sometimes appropriate, it is most often undesirable because the agency loses authority and flexibility to meet wildlife management goals and objectives.

CCC, as with any capacity, must be expressed conditionally both temporally and spatially. That is, CCC is a dynamic entity that must be defined in terms of a particular time and space to be meaningful. To be feasible and effective, deer management should be prescribed on the basis of individual management units of practical size (Purdy 1987). In addition, it is important that the management unit reflects some homogeneity in sociological parameters in order to facilitate consideration of stakeholder preferences (Decker et al. 1983). For instance, systematic means of identifying "human resource units" by determining the boundaries of informal communication networks associated with unique issues have been developed (Kent et al. 1985).

CULTURAL CARRYING CAPACITY: A FRAMEWORK

Components of the CCC Framework

Conceptualization of a carrying capacity requires consideration of descriptive and evaluative dimensions (Shelby and Heberlein 1984). The descriptive component of a carrying capacity includes management parameters (any factors that can be directly manipulated by managers), impact parameters, and the relationship between the two (Shelby and Heberlein 1984). The evaluative component of a carrying capacity involves social judgments about levels of impact, and these judgments result in evaluative standards (Shelby and Heberlein 1984).

In terms of our CCC framework, the primary descriptive component is the management parameter of wildlife population size, represented on the horizontal axis (Figure 1). Because wildlife population size is a

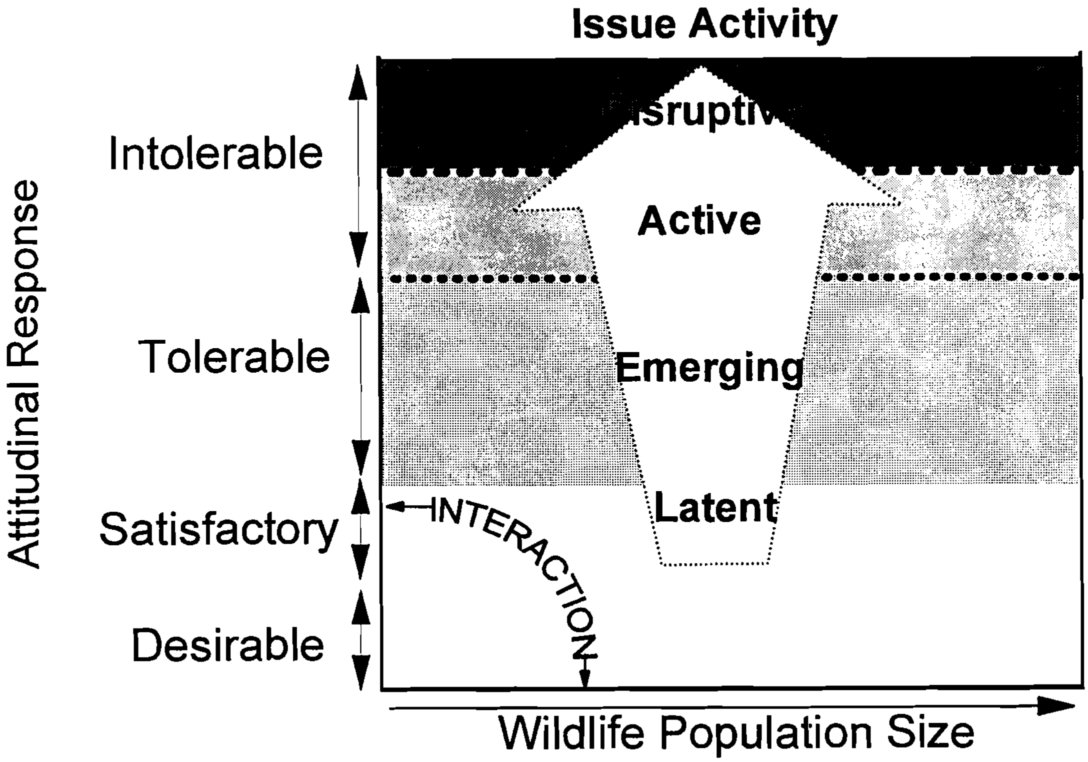


Figure 1. Cultural carrying capacity conceptual framework.

primary factor in the framework, successful application of the CCC model hinges on the availability of reliable wildlife population estimates. However, the ongoing testing and development of wildlife population estimates is a challenge we must defer to professional biologists (Curtis and Richmond 1992).

The impact parameters implicit in the framework are the wildlife-human interaction events that result from a certain density and distribution of wildlife. For example, one impact of urban deer populations is damage to ornamental shrubs. The evaluative component of our CCC framework, represented on the vertical axis, is the stakeholders' attitudinal response to the values gained and/or lost due to the interaction with wildlife. This attitudinal variable, which we discuss in greater detail in a later section, has four levels: desirable, satisfactory, tolerable, and intolerable.

We use the term "acceptable" to encompass responses of desire, satisfaction, and tolerance. Crick (1973) defined tolerance as the degree to which we accept things of which we disapprove. We continue with this logic and propose that the satisfactory-level response refers to the degree to which we accept things of which we approve but do not prefer. The desirable-level response then represents not only acceptance and approval but also preference. Finally, intolerance is rejecting that of which we disapprove.

A given impact may not lead to the same evaluative judgment from all urban stakeholders. For some, the values gained through the presence of deer may outweigh the economic or aesthetic values lost (e.g., shrubbery lost), and the actual impact event may not in itself determine the evaluative outcome and the corresponding attitudinal response of stakeholders. Research on the attitudinal responses of farmers to crop damage substantiates this analysis (e.g., Brown et al. 1978, Stoll and Mountz 1983). The distinction between the impact component (the wildlife-human interaction) and the evaluative component (the acceptability of the interaction) is critical to a clear understanding of the CCC model.

We propose that the attitudinal response levels correspond to certain levels of issue activity, as represented by the arrow superimposed on the Cartesian graph in Figure 1. When stakeholders find the wildlife population size to be desirable or satisfactory, we posit that they will not engage in any issue activity, and the issue will be latent. When stakeholders find the wildlife population size tolerable, they will begin to communicate about the wildlife concerns, and the issue will emerge. Once stakeholders find the wildlife population size intolerable, they will begin to actively seek change in the situation. At some point, the intolerance motivates stakeholders to engage in disruptive issue activity, which may result in the agency losing control of management decisions.

We are assuming some relationship between the wildlife population size (horizontal axis) and the attitudinal response (vertical axis) (Figure 1), but this relationship may not necessarily be direct. Certain wildlife population densities may result in varying degrees of interaction with stakeholders and elicit varying levels of response. For example, the relationship between the wildlife population size and the stakeholder response is likely to be somewhat linear for row-crop producers in northeast Michigan, with increased deer numbers resulting in increased crop losses and increasingly less tolerant responses. However, for orchard growers in western Michigan, only a few deer can produce devastating crop losses and engender immediate producer intolerance. Decker et al. (1983) used respondents' preferences for future deer population trends as an indicator of attitudinal response and found that the relationships between deer population increases and perceived damage levels or between perceived damage levels and intolerance of deer (i.e., a preference for a decrease in deer numbers) were neither constant nor linear. The utility of our model is predicated on the assumption that - whatever their nature - there are quantifiable, functional relationships among the evaluative parameter (i.e., attitudinal response), the management parameter (i.e., deer numbers), and the impact parameters (i.e., intervening variables of actual and perceived wildlife-human interactions).

Identifying a Cultural Carrying Capacity

As the "public" is actually many publics, segmenting the citizenry into stakeholders is one of the first steps towards identifying a CCC (Fazio and Gilbert 1981, Thorne et al. 1992). For our purposes, a stakeholder is any individual or group identified by the resource agency as being affected by the achievement of the agency's wildlife management objectives (Freeman 1984, Stout et al. 1992). Different stakeholders reflect different values (what they define as important) and/or different beliefs (what they perceive as "truth" or reality) (e.g., Brown and Decker 1982). Responses to wildlife populations levels will differ based on the values and beliefs that are salient to each stakeholder. It is important to note that people need not reside within the defined management area to be included as stakeholders in the CCC analysis. For instance, residents of the East Coast may express concern about what happens with wolf restoration in Wyoming, and although thousands of miles from the management site, would be stakeholders in wolf management.

The next step is to provide some theoretical structure that facilitates consideration of preferences of multiple stakeholders. Social judgment theory (SJT), which originated from the study of persuasive communication, provides some direction towards this end. SJT purports that attitudinal response is mediated by judgmental processes and effects (Sherif and Hovland 1961, Sherif et al. 1965, O'Keefe 1990). According to SJT, an individual may have a range of judgments regarding a position on a given issue, and the range that is acceptable establishes the person's "latitude of acceptance" (LOA).

Borrowing the basic idea and terminology, we can apply SJT to wildlife management, with responses now being to wildlife rather than to topical positions. Theoretically, each stakeholder in a wildlife management issue has a maximum and a minimum number of a wildlife population that is acceptable based on the evaluations of real or perceived interactions with that species (Queal 1968). The minimum wildlife population size that is acceptable to a stakeholder is labeled as the "minimum demand level" (Figure 2). For the maximum population size that is acceptable to a stakeholder, we adopt the label "wildlife acceptance capacity" proposed by Decker and Purdy (1988). These lower and upper population levels establish bounds on a range of wildlife population levels acceptable to a stakeholder (i.e., the LOA) (Figure 2). For some stakeholders, either a minimum demand or a WAC may be zero or infinity, respectively, due to the particularly strong values associated with the interactions with the wildlife species.

Each stakeholder has a "response curve" that identifies the particular attitudinal response at various wildlife population levels (Figure 3). The slope of the curve is an indicator to the volatility of that stakeholder's response. A steeply sloping response curve suggests that the corresponding deer level may soon become intolerable, resulting in disruptive issue activity. That is, as long as a wildlife population is within the LOA, a stakeholder's attitudinal response will be either at the desirable, satisfactory, or tolerable level, and we would expect them not to initiate active (or disruptive) issue activity. The critical deer population levels are outside the LOA at which disruptive issue activity is initiated (Figure 3). The points at which a stakeholder's response curve crosses the "critical response level" indicate that the stakeholder attempts to circumvent the management agency by

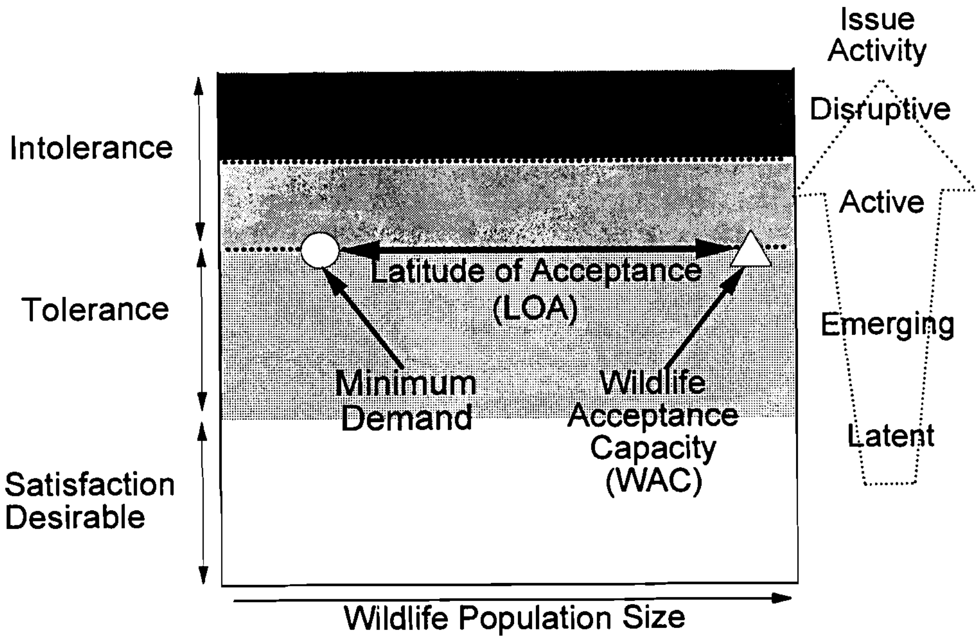


Figure 2. Parameters of the latitude of acceptance construct of the cultural carrying capacity framework.

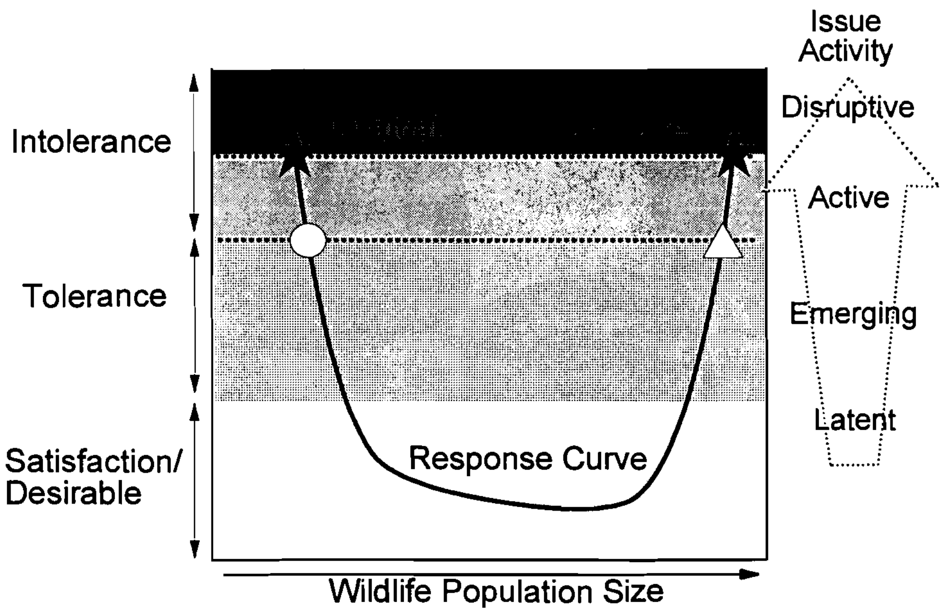


Figure 3. Example of a response curve and critical response points (depicted by the stars) of one stakeholder within the cultural carrying capacity conceptual framework.

seeking resolution from higher authority. Again, disruptive issue activity may result from wildlife populations that are either too low *or* too high (Figure 3).

The conceptual "leap" from the individual stakeholder perspective to a broader, cultural perspective is the next step. Once we have identified the LOA of each stakeholder, we can view them as a composite to determine whether current social dispositions produce a consensus on a biologically feasible range of population levels. That is, overlapping latitudes of acceptance indicate that there is some range of deer population levels that may be acceptable to all stakeholders (Figure 4), whereas mutually exclusive latitudes of acceptance indicate that there is no deer population level that will be acceptable to all without some intervention (Figure 5). Ideally, latitudes of acceptance would overlap for all stakeholders and a socially optimal deer population goal would be readily identifiable (Figure 4). Often though, at least one LOA is mutually exclusive from the others - that is, one stakeholder will have an acceptable range of deer that is incompatible with preferences of other stakeholders (Figure 5).

To help illustrate our model, we present a more operational example where the horizontal axis represents deer per square mile and specific stakeholders are identified (Figure 6). We utilize the "rural" stakeholders of farmers and hunters because they have been studied rather extensively (e.g., Brown et al. 1977, 1978; Evans 1979, Wywialowski 1994). *The hypothetical deer density preferences in Figure 6 are for illustration purposes only.* Although hypothetical, the relationships among preferences reflect results of empirical studies. That is, deer hunters have been found to be more accepting of deer than have farmers, and, of the rural stakeholders studied, orchardists have been the least accepting of deer (Decker et al. 1981, Decker and Brown 1982). In this simplified society where orchardists, bean producers, and hunters are our only stakeholders, we might define CCC as 32-36 deer per square mile in this defined area.

A final step in the process of identifying a CCC is for the management agency to evaluate the situation from its perspective and attempt to alter the situation as necessary. The model suggests that an indicator of the socially appropriate wildlife population range is the frequency and intensity of social issues resulting from the presence of the wildlife species. It is left to the management agency to define what is "manageable" issue activity. Of course, the most manageable amount of issue activity is no issue activity, but given reality, some type of issue activity is inevitable in most cases. Consequently, the agency must act to achieve some manageable level. For instance, the task of the agency in the situation in which one stakeholder's LOA is mutually exclusive from the rest (e.g., stakeholder 3 in Figure 5) is to decide whether the issue activity of this stakeholder group would be manageable if population levels were held outside this stakeholder's LOA, or whether some effort should be made to target one or more management components (discussed later) to change the LOA of this or other stakeholders. As the deer population level changes, the agency will need to monitor stakeholder values and continually reevaluate the CCC (Schenborn 1985).

It is conceivable that an agency might determine that it is in the best interest of society and/or the resource to have a wildlife population issue debated in the legislature or argued in court; however, this is usually not the case. It is more likely that defining manageable levels of issue activity is a process of the art, rather than the science, of wildlife management (Giles 1978). This process will require a clear vision of the agency's policies and mission, and the definition of "manageable" will vary depending on - among other things - the past experiences and resources of the agency in working with wildlife issues.

The Attitudinal Response Model

To this point, we have alluded that resource managers have the opportunity to influence stakeholders' preferences in order to create or shift a CCC. To suggest means to modify a stakeholder's response to a wildlife population level, we pose an expanded model of factors involved in creating that response. To provide a solid foundation for our model, we first reviewed the relevant research.

The scope of empirical investigations into human response to wildlife populations is relatively limited. Most research has revolved around the response to unacceptably high populations rather than to unacceptably low populations (Conover and Decker 1991). Research has generally been targeted toward the specific application of rural landowners' (typically agricultural producers) perceptions of wildlife and wildlife damage, usually with white-tailed deer as the species of interest (Brown et al. 1977, 1978; Brown and Decker 1979, Decker and Brown 1982, Decker et al. 1982, 1983, 1984; Tanner and Dimmick 1983, Stoll and Mountz 1983, 1986; Stoll et al. 1991). Pomerantz et al. (1986) and Siemer and Decker (1991) summarized work done on human tolerance of wildlife

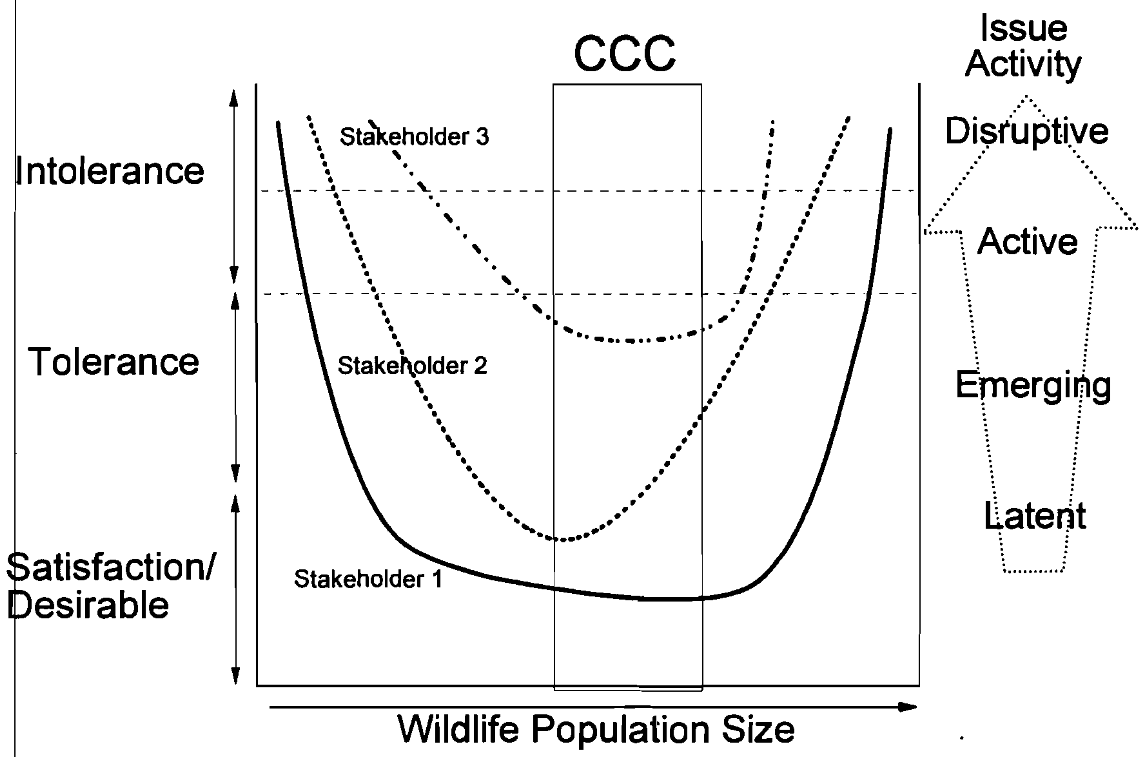


Figure 4. Example of a consensus on acceptable wildlife population size (i.e. a cultural carrying capacity is readily apparent) based on a simplified society of three stakeholders.

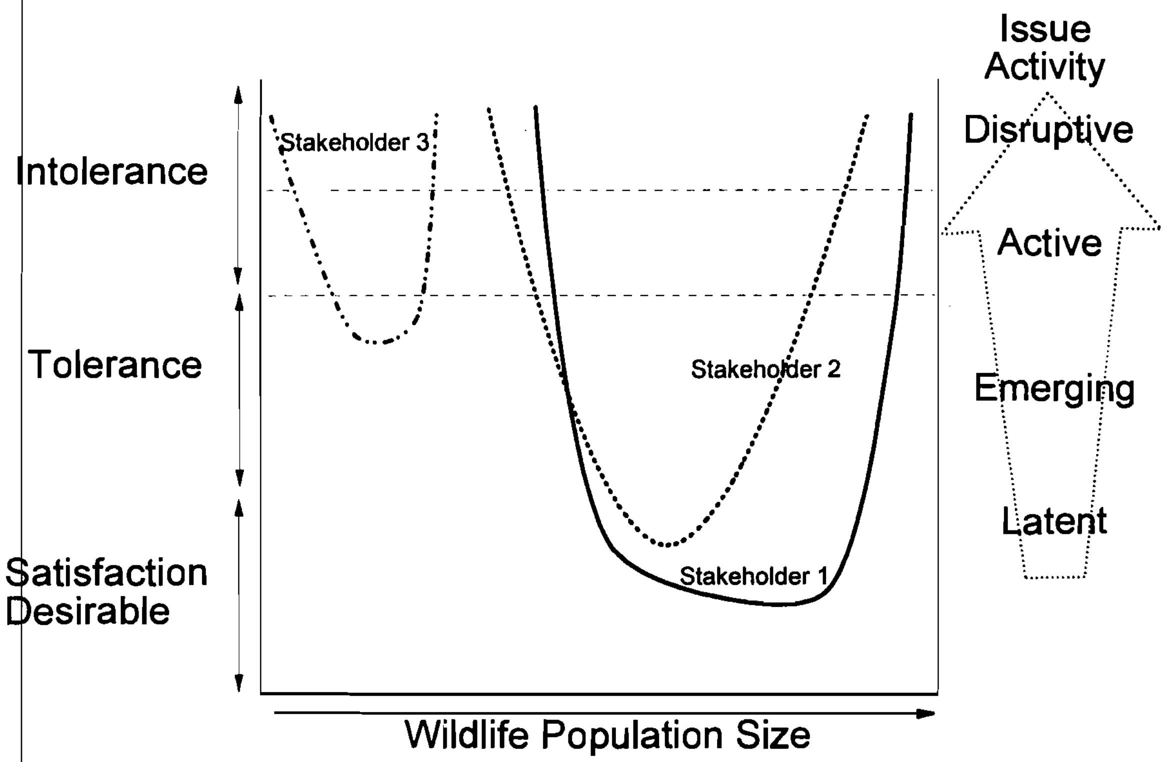


Figure 5. Example of a society in which there is no consensus on acceptable deer population size (i.e., cultural carrying capacity is not readily apparent) due to the mutually exclusive latitude of acceptance of one stakeholder (i.e., no. 3), based on a simplified society of three stakeholders.

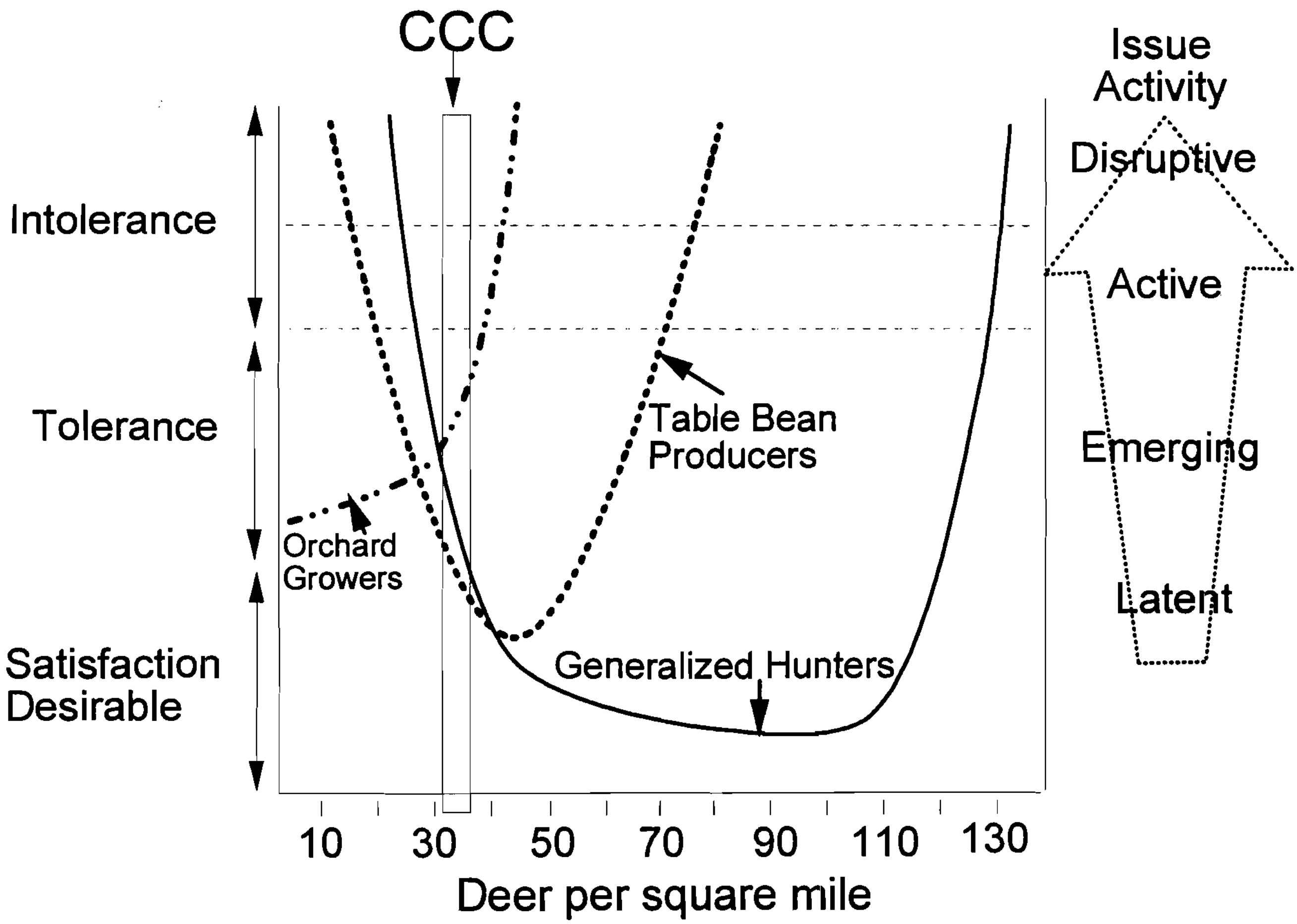


Figure 6. Hypothetical Example of a cultural carrying capacity of 32-36 deer per square mile, in a simplified society of three stakeholders, where each stakeholder is given equal consideration by the managing agency.

damage. In addition, urban/suburban populations' responses to wildlife have been studied (O'Donnell and VanDruff 1983, Brown et al. 1979, Decker and Gavin 1985, 1987) as well as have other types of wildlife-human interactions, such as deer-related vehicle accidents (Stedman et al. 1992, Stout et al. 1993) and Lyme disease transmission (Siemer et al. 1992). Indices of tolerance typically have involved measures of damage rating, preference for future deer population trends, or perceived severity of monetary loss due to damage (Craven et al. 1992).

Based on previous research regarding human response to wildlife, we have expanded the evaluative component (i.e., the vertical axis) of the CCC framework into a more detailed model we call the "attitudinal response model" (ARM). The ARM consists of four major dimensions: actuality, perceptions of actuality, attitudinal response, and behavioral response (Figure 7). The management parameter of wildlife population size from the conceptual framework is included as a component of the actuality dimension. Due to space restrictions, only the primary components of the ARM are discussed herein.

The relative complexity of the ARM reinforces that the relationship between wildlife population size and stakeholder response is far from direct. Rather, the strength and nature of the relationship between a wildlife population level and the corresponding attitudinal response may be determined by several intervening relationships. Attitudinal response to a wildlife population level is proposed as being modified by actual and perceived wildlife-human interactions. Often, it is the perception of reality rather than the actual incidence of wildlife-human interactions that determines the attitudinal response. For instance, the probability of deer-vehicle collisions may increase with increasing deer numbers, but if this is not perceived, the attitudinal response would not show a direct relationship. Alternatively, perception of risk may exceed the actual risk at increasing urban deer population levels, also producing an indirect relationship between deer numbers and attitudinal response.

The actual occurrence of a wildlife-human interaction will result in an actual gain or potential gain of values and the actual loss or potential loss of values. For simplicity, the potential to lose values is labeled as risk. This actual wildlife-human interaction results in an actual cost-benefit ratio. The actual interaction component feeds through our current experiences to create some level of awareness of the wildlife-human interaction.

Based on our current and previous experiences, we arrive at our perception of what is actually happening, and this "perceived wildlife-human interaction" factor is central to our model. We propose that there is a subjective weighing of values perceived to be gained or potentially gained against values perceived to be lost or at risk. This weighing process may range from a deliberate, rational weighing of gains and losses to a rapid, emotional assessment (Fischer 1974). Nevertheless, this perceived cost-benefit assessment may be at least as important of a consideration in management decisions as the actual cost-benefit ratio (Brown et al. 1978).

We propose that the stakeholder's response is influenced by the evaluation of the perceived costs and benefits. This is one of the decision-making process components within the ARM, which are represented by ovals. The gist of this process is stakeholders asking themselves the question of whether or not the perceived cost-benefit assessment is satisfactory/desirable or not satisfactory. A "satisfactory/desirable" response will result in the stakeholder taking no action to change the situation. Following a "not satisfactory" response, a person will either tolerate or not tolerate the perceived cost-benefit assessment. Tolerance will result in no change being sought, but intolerance will result in some type of action to change the situation to create a satisfactory perceived cost-benefit assessment.

If the individual is intolerant of his/her assessment, some behavior is anticipated. The person may either abandon the situation altogether (e.g., stop planting shrubs), try to change the situation him/herself, or try to get others to change the situation. The behaviors of interest here are those involving issue activity. The schematic representation of the behavioral response dimension illustrates the pivotal feature of our focus on issue development: active issue activity is directed to the agency, whereas disruptive issue activity bypasses the agency. The agency may respond to the issue activity by influencing any number of precursory components in this expanded model.

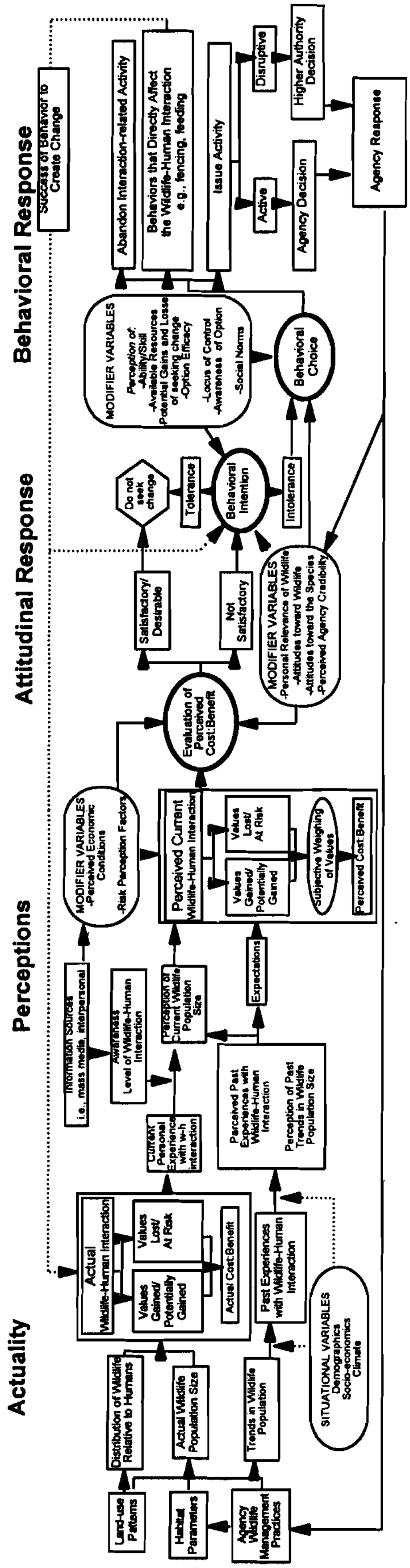


Figure 7. Schematic of the four dimensions of the attitudinal response model (ARM) of the cultural carrying capacity framework.

Several variables act to modify the decision-making processes in the ARM. Perceived agency credibility, personal relevance of the wildlife species, and attitudes toward wildlife and the particular species modify the evaluation of the perceived costs and benefits, the intention-to-behave decision, and/or the behavioral choice decision. Several other variables, such as an individual's locus of control and perceived skill, influence their behavior-related decisions.

USING CCC TO IDENTIFY MANAGEMENT STRATEGIES

As with the BCC, the primary utility of the CCC is not so much to predict suitable population ranges as it is to suggest management targets for setting and achieving management objectives. The CCC model illustrates that wildlife population levels are only one of many management targets. It suggests that the agency will most likely be faced with the binary task of, (1) creating change in the social system (e.g., attitudinal response of stakeholders) to shift or create a CCC, and (2) managing wildlife populations within defined cultural limits. In its simplest application, the overlapping latitudes of acceptance of identified stakeholders might reveal a wide range of easily attainable population levels, and a CCC would be readily apparent (Figure 4). The task of management would be to maintain the populations within those ranges as long as the social system did not change and shift the CCC range.

Most often, however, either there is no consensus on a socially acceptable population level (CCC) (Figure 5) or the wildlife population cannot be managed within the identified range because it is too narrow (Figure 6), too high (i.e., over BCC), or too low (e.g., not a viable population size). In these cases, the CCC model serves to suggest targets for management response. In particular, the intervening relationships between wildlife numbers and attitudinal response offer potential targets. Steps might be taken to change the relationship between wildlife population levels and actual interactions by targeting the biological environment. In some urban areas, the distribution and movement of deer might be shifted by habitat management to decrease risks of deer-vehicle collisions. In some crop damage areas, characteristics such as field sizes or interspersion with deer habitat may be equally as important as deer population sizes in determining crop damage impacts and thus offer another set of management targets.

Managers can target not only actual conditions but also perceptions (Knuth et al. 1992), and a series of examples serve to illustrate additional management targets suggested by the ARM. It is likely that when stakeholders must cope with losses (e.g., ornamental plant damage) or incur risks (e.g., deer-vehicle accidents) due to urban deer populations some conditions will make them less accepting than others, and these factors are represented by the "risk perception" variable in the ARM. Losses that they perceive to be involuntary on their part, situations over which they perceive little or no control, perceived threats to personal health or life, and threats that are not understood and/or are unfamiliar (e.g., Lyme disease) are all less likely to be accepted by stakeholders and may further restrict cultural carrying capacity (Merkhofer 1987, Slovic 1987).

Providing opportunities for public involvement activity (e.g., Decker et al. 1985) may increase stakeholders' actual control as well as their perceptions of control. Training or information on defensive driving tactics may place the individual in control regarding the probability of deer-vehicle collisions. That is, defensive driving training may not only diminish the actual probability of collisions, but the enhanced sense of control should also increase the individual's tolerance of the risk and, therefore, of existing urban deer numbers. Participation in selecting alternative solutions or other decisions may increase the sense of voluntary compliance or acceptance of impacts (McAninch and Parker 1991, Stout et al. 1992, Curtis et al. 1993, 1994, Stout and Knuth 1994). Feedback to respondents on mail or telephone survey results may help to make stakeholders aware of their participation and control. Information that places some risks in proper context may change unfamiliar, dreaded consequences (e.g., probability of transmission of Lyme disease) into more acceptable situations (Slovic 1987).

RECOMMENDATIONS FOR FURTHER RESEARCH

Our work on CCC has produced at least four areas to be investigated by human dimensions researchers. First is the need to identify valid measures of the components of the attitudinal response model. For instance, one critical task is to find measures of desirable, satisfactory, tolerable, and intolerable that describe stakeholders' attitudinal responses to specific wildlife population levels. Some success seems to have been achieved in crop damage studies by asking respondents whether they desire more, the same, or fewer deer in the future (e.g., Brown et al. 1977, 1978; Decker et al. 1983). However, this measure does not clearly predict intolerance and subsequent issue activity. To be useful for the ARM, this measure will likely require a complement of additional measures on respondents' intentions and behaviors regarding issue activity as well as attitudes regarding the acceptability of specific interactions with wildlife.

As useful measures of variables within the ARM become available, a second area of research will be to quantify the relationships within the model. Certainly, relationships will vary with different stakeholders, wildlife species, region and other factors; however, useful patterns of relationships are likely to be found. It will be especially useful to assess the patterns of intervening relationships between wildlife population levels and attitudinal response. For example, how is the relationship between attitudinal responses of agricultural producers and existing deer population levels modified by intervening conditions such as crop type, field size and shape, and the interspersion and juxtaposition of crops with other habitat components? A third and continuing research need will be the expansion of the CCC framework and attitudinal response model. It is anticipated that the human dimensions research community will identify other factors that are important but not yet explicit in the model.

The research above is recommended in order to operationalize the framework and attitudinal response model, but the value of the CCC framework depends on enhancing management responses to wildlife population issues. Therefore, the final recommendation is to adapt (or develop) and evaluate management responses to targets identified by the CCC framework. Once the attitudinal responses of stakeholder groups have been analyzed and understood, can we find means to bring about shifts in the CCC by targeting appropriate precursory components in the attitudinal response model? For example, are there effective ways to broaden a stakeholder's consideration of the cost-benefit comparisons so that impacts on other stakeholders are given fair consideration? How can we shift risk perception factors so that stakeholders use a more objective process in forming their attitudinal responses? These are a few of the research questions that will ultimately determine the utility of this - or any - model of cultural limits on wildlife populations.

CONCLUSIONS

The CCC framework is presented here as an organizational tool to facilitate management of issues regarding appropriate wildlife population objectives. We have attempted to move the CCC concept beyond a notion to the status of a comprehensive, structured, and evolving model. Even in the early stage of development achieved here, the model suggests a broad array of biological and sociological factors that influence human responses to interactions with wildlife. These factors provide a set of targets for management responses to these issues, some of which we can effectively manage today. The CCC framework is a step towards a standard paradigm to help integrate and coordinate long-term research to further advance our capabilities to manage wildlife issues.

LITERATURE CITED

Becker, R. H., A. Jubenville, and G. W. Burnett. 1984. Fact and judgment in the search for a social carrying capacity. Leisure Sci. 6:475-486.

Brown, T. L., C. P. Dawson, and R. L. Miller. 1979. Interests and attitudes of metropolitan New York residents about wildlife. Trans. North Am. Wildl. and Nat. Resour. Conf. 44:289-297.

____, and D. J. Decker. 1979. Incorporating farmers' attitudes into management of white-tailed deer in New York. J. Wildl. Manage. 43:236-239.

____, and ____. 1982. Identifying and relating organized publics to wildlife management issues: A planning study. Trans. North Am. Wildl. and Nat. Resour. Conf. 47:686-692.

____, ____, and C. P. Dawson. 1977. Farmer willingness to tolerate deer damage in the Erie-Ontario lake plain. Dep. Nat. Resour. Res. and Extension Series No. 8, Cornell Univ., Ithaca, N.Y. 33pp.

____, ____, and ____. 1978. Willingness of New York farmers to incur white-tailed deer damage. Wildl. Soc. Bull. 6:235-239.

Caughley, G. 1979. What is this thing called carrying capacity? Pages 2-8 *in* M. S. Boyce and L. D. Hayden-Wing, eds. North American elk: Ecology, behavior and management. Univ. Wyoming, Laramie.

Cobb, T. L. 1982 (Sept/Oct). Deer management unit-53. The Conservationist 37:12-17,41.

Conover, M. R., and D. J. Decker. 1991. Wildlife damage to crops: Perceptions of agricultural and wildlife professionals in 1957 and 1987. Wildl. Soc. Bull. 19:46-52.

Crable, R. E., and M. M. Faulkner. 1988. The issue development graph: A tool for research and analysis. Central States Speech J. 39:110-120.

___, and S. L. Vibbert. 1985. Managing issues and influencing public policy. Public Relations J. 11:3-16.

Craven, S. R., D. J. Decker, W. F. Siemer, and S. E. Hygnstrom. 1992. Survey use and landowner tolerance in wildlife damage management. Trans. North Am. Wildl. and Nat. Resour. Conf. 57:75-87.

Crick, B. 1973. Political theory and practice. Basic Books, N.Y.

Curtis, P. D., and M. E. Richmond. 1992. Future challenges of suburban white-tailed deer management. Trans. North Am. Wildl. and Nat. Resour. Conf. 57:104-114.

___, R. J. Stout, and L. A. Myers. 1995. Citizen task force strategies for suburban deer management: the Rochester experience. Pages 143-149 *in* J.B. McAninch, ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. 175pp.

___, ___, B. A. Knuth, L. A. Myers, and T. M. Rockwell. 1993. Selecting deer management options in a suburban environment: A case study from Rochester, New York. Trans. North Am. Wildl. and Nat. Resour. Conf. 58:102-116.

Decker, D. J. 1991. Implications of the wildlife acceptance capacity concept for urban wildlife management. Pages 45-53 *in* E. A. Webb and S. Q. Foster, eds., Perspectives in urban ecology. Denver Museum of Natural History, Colo.

___, and T. L. Brown. 1982. Fruit growers' vs. other farmers' attitudes toward deer in New York. Wildl. Soc. Bull. 10:150-155.

___, and T. A. Gavin. 1985. Public tolerance of a suburban deer herd: Implications for control. East. Wildl. Damage Control Conf. 2:192-204.

___, and ___. 1987. Public attitudes toward a suburban deer herd. Wildl. Soc. Bull. 15:173-180.

___, and K. G. Purdy. 1988. Toward a concept of wildlife acceptance capacity in wildlife management. Wildl. Soc. Bull. 16:53-57.

___, and M. E. Richmond. 1995. Managing people in an urban deer environment: The human dimensions challenge for managers. Pages 3-10 *in* J.B. McAninch, ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. 175pp.

___, T. L. Brown, and D. L. Hustin. 1981. Comparison of farmers' attitudes toward deer abundance in two regions of New York having different agricultural and deer population characteristics. N. Y. Fish Game J. 28:202-207.

___, ___, and G. F. Mattfeld. 1982. Farmer perception of deer damage in New York. Trans. Northeast Deer Tech. Comm. 18:12-13.

___, ___, and ___. 1985. Deer population management in New York: Using public input to meet public needs. Pages 185-196 *in* S. L. Beasom and S. F. Roberson, eds., Game Harvest Management, Caesar Kleberg Wildlife Research Institute, Kingsville, Tex.

___, G. F. Mattfeld, and T. L. Brown. 1983. Influence of deer damage on farmers' perceptions of deer population trends: Important implications for managers. East. Wildl. Damage Control Conf. 1:191-194.

___, ___, and ___. 1984. Influence of experience with deer damage on farmers' perceptions of deer population trends. N.Y. Fish Game J. 31:38-44.

___, T. L. Brown, N. A. Connelly, J. W. Enck, G. A. Pomerantz, K. G. Purdy, and W. F. Siemer. 1992. Toward a comprehensive paradigm of wildlife management: Integrating the human and biological dimensions. Pages 33-54 *in* W. R. Mangun, ed., American fish and wildlife policy: the human dimension. Southern Illinois Univ. Press, Carbondale.

___, N. Sanyal, T. L. Brown, R. A. Smolka, Jr., and N. A. Connelly. 1983. Reanalysis of farmer willingness to tolerate deer damage in western New York. East. Wildl. Damage Control Conf. 1:37-45.

Duda, M. D., and J. Schaefer. 1991. Urban wildlife program planning: The human dimension. Pages 63-66 *in* E. A. Webb and S. Q. Foster, eds., Perspectives in urban ecology. Denver Museum of Natural History, Colo.

Edwards, R. Y., and C. D. Fowle. 1954. The concept of carrying capacity. Trans. North Am. Wildl. and Nat. Resourc. Conf. 20:589-602.

Ellingwood, M. R., and S. L. Caturano. 1988. An evaluation of deer management options. Conn. Dep. Environ. Prot., Wildl. Bur., Hartford. 12pp.

___, and H. J. Kilpatrick. 1995. Urban deer management in Connecticut: our experiences, philosophies, and strategies. Pages 138-142 *in* J.B. McAninch, ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. 175pp.

___, and J. V. Spignesi. 1986. Management of an urban deer herd and the concept of cultural carrying capacity. Trans. Northeast Deer Tech. Comm. 22:42-45.

Evans, R. A. 1979. Changes in landowner attitudes toward deer and deer hunters in southern Michigan, 1960-1978. M.S. Thesis, Univ. Mich., Ann Arbor.

Fazio, J. R., and D. L. Gilbert. 1981. Public relations and communications for natural resource managers. Kendall/Hunt Publishing, Dubuque, Ia. 375pp.

Fischer, D. W. 1974. On the problems of measuring environmental benefits and costs. Soc. Sci. Inf. 13:95-105.

Freeman, R. E. 1984. Strategic management. Pitman Publishing, Marshfield, Massachusetts. 276pp.

Giles, R. H. 1978. Wildlife management. W. H. Freeman Co., San Francisco, Calif. 416pp.

Graefe, A. R., J. J. Vaske, and F. R. Kuss. 1984. Resolved issues and remaining questions about social carrying capacity. Leisure Sci. 6(4):497-507.

Greiwe, R. J. 1979. An introduction to social resource management. Foundation for Urban and Neighborhood Development, Denver, Colo. 40pp.

Hardin, G. 1992. Cultural carrying capacity. Pages 16-24 *in* M. A. Miller, ed., Focus: Carrying capacity selections. Carrying Capacity Network, Washington, D.C.

Kent, J. A., D. C. Taylor, and G. Severson. 1985. Pre-crisis management: How to manage issues before they manage you. SRM International, Denver, Colo.

Knuth, B. A., R. J. Stout, W. F. Siemer, D. J. Decker, and R. C. Stedman. 1992. Risk management concepts for improving wildlife population decisions and public communication strategies. Trans. North. Am. Wildl. and Nat. Resour. Conf. 57:63-74.

Lautenschlager, R. A., and R. T. Bowyer. 1985. Wildlife management by referendum: When professionals fail to communicate. Wildl. Soc. Bull. 13:564-570.

Macnab, J. 1985. Carrying capacity and related slippery shibboleths. Wildl. Soc. Bull. 13:403-410.

Mangun, W. R. 1992. Fish and wildlife policy issues. Pages 3-32 *in* W. R. Mangun, ed., American fish and wildlife policy: The human dimension. Southern Illinois Univ. Press, Carbondale.

McAninch, J. B., and J. M. Parker. 1991. Urban deer management programs: A facilitated approach. Trans. North Am. Wildl. and Nat. Resour. Conf. 56:428-436.

Merkhofer, M. W. 1987. Decision science and social risk management. Reidel Publishing, Dordrecht, Holland. 330pp.

Moore, R. H. 1979. Planning for emerging issues. Public Relations J. 35(11):42-46.

O'Donnell, M. A., and L. W. VanDruff. 1983. Wildlife conflicts in an urban area: Occurrence of problems and human attitudes toward wildlife. East. Wildl. Damage Control Conf. 1:315-323.

O'Keefe, D. J. 1990. Persuasion theory and research. Sage Publications, Newbury Park, Calif. 269pp.

Peyton, R. B. 1984. A typology of natural resource issues with implications for resource management and education. Michigan Academician 17(1):49-58.

___. 1987. Mechanisms affecting public acceptance of resource management policies and strategies. Can. J. Fish. Aquatic Sci. 44:306-312.

Pomerantz, G. A., C. Ng, and D. J. Decker. 1986. Summary of research on human tolerance of wildlife damage. Nat. Resour. Res. and Extension Series No. 25., Cornell Univ., Ithaca, N.Y. 42pp.

Purdy, K. G. 1987. Landowners' willingness to tolerate white-tailed deer damage in New York: an overview of research and management response. Pages 371-375 *in* D. J. Decker and G. R. Goff, eds., Valuing wildlife. Westview Press, Boulder, Colo.

____, W. F. Siemer, G. A. Pomerantz, and T. L. Brown. 1987. Deer damage control preferences and use decisions of New York orchardists. East. Wildl. Damage Control Conf. 3:118-127.

Queal, L. M. 1968. Attitudes of landowners toward deer in southern Michigan, 1960 and 1965. Mich. Acad. LIII:51-72.

Schenborn, D. A. 1985. Environmental scanning: The difference between strategic success and failure. Trans. North Am. Wildl. and Nat. Resour. Conf. 50:304-312.

Schmidt, R. H., B. R. Acord, and D. W. Hawthorn. 1992. Professionalism in wildlife damage management: Issues and directions. Trans. North Am. Wildl. and Nat. Resour. Conf. 57:115-124.

Shelby, B., and T. A. Heberlein. 1984. A conceptual framework for carrying capacity determination. Leisure Sci. 6:433-451.

Sherif, C. W., M. Sherif, and R. E. Nebergall. 1965. Attitude and attitude change: The social judgment-involvement approach. W. B. Saunders, Philadelphia. 264pp.

Sherif, M., and C. I. Hovland. 1961. Social judgment: Assimilation and contrast effects in communication and attitude change. Yale Univ. Press, New Haven, Conn. 218pp.

Siemer, W. F., and D. J. Decker. 1991. Human tolerance of wildlife damage: Synthesis of research and management implications. Human Dimensions Res. Unit Series No. 91-7, Cornell Univ, Ithaca, N.Y. 24pp.

____, G. A. Pomerantz, and D. J. Decker. 1991. A conceptual framework for analysis of agriculturalists' deer-damage-control decisions. Nat. Resour. Res. Extension Series No. 35, Cornell Univ., Ithaca, N.Y. 14pp.

____, B. A. Knuth, D. J. Decker, and V. L. Alden. 1992. Human perceptions and behaviors associated with Lyme disease: Implications for land and wildlife management. Human Dimensions Res. Unit Publ. 92-8. Cornell Univ., Ithaca, N.Y. 100pp.

Slovic, P. 1987 (Apr). Perception of risk. Science 236:280-285.

Stankey, G. H. 1973. Visitor perception of wilderness recreation carrying capacity. U.S.D.A. For. Serv. Res. Pap. INT-142. 61pp.

____, and S. F. McCool. 1984. Carrying capacity in recreational settings: Evolution, appraisal, and application. Leisure Sciences 6(4):453-473.

Stedman, R. C., R. J. Stout, B. A. Knuth, and D. J. Decker. 1992. Perceived risks of deer-related vehicle accidents: Influence on deer population preferences of the residents of Tompkins County, New York. East. Wildl. Damage Control Conf. 5:163.

Stoll, R. J., Jr., and G. L. Mountz. 1983. Rural landowner attitudes toward deer and deer populations in Ohio. Ohio Fish and Wildl. Rep. 10. 18pp.

____, and ____. 1986. Rural landowner attitudes toward deer and deer populations in Ohio-1985 update. Ohio Dep. Nat. Resour., Div. Wildl. Inservice Note 578. 23pp.

____, W. L. Culbertson, and S. E. Miller. 1991. Rural landowner attitudes toward deer and deer populations in Ohio-1989 Update. Ohio Dep. Nat. Resour., Div. Wildl. Inservice Note 642. 35pp.

Stout, R. J., and B. A. Knuth. 1995. Using a communication program to enhance community support for management. Pages 123-131 *in* J.B. McAninch, ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. pp.

____, D. J. Decker, and B. A. Knuth. 1992. Evaluating citizen participation: Creating communication partnerships that work. Trans.

North Am. Wildl. and Nat. Resour. Conf. 57:135-140.

___, R. C. Stedman, D. J. Decker, and B. A. Knuth. 1993. Perceptions of risk from deer-related vehicle accidents: Implications for public preferences for deer herd size. Wildl. Soc. Bull. 21:237-249.

Tanner, G., and R. W. Dimmick. 1983. An assessment of farmers' attitudes towards deer and deer damage in west Tennessee. East. Wildl. Da mage Control Conf. 1:195-199.

Thorne, D. H., E. K. Brown, and D. J. Witter. 1992. Market information: Matching management with constituent demands. Trans. North Am. Wildl. and Nat. Resour. Conf. 57:164-173.

Wywialowski, A. P. 1994. Agricultural producers' perceptions of wildlife-caused losses. Wildl. Soc. Bull. 22:370-382.

ECOLOGY OF URBAN AND SUBURBAN WHITE-TAILED DEER

ROBERT K. SWIHART, Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN
PETER M. PICONE, Connecticut Department of Environmental Protection, Burlington, CT
ANTHONY J. DeNICOLA, Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN
LOUIS CORNICELLI, Indiana Department of Natural Resources, Bloomington, IN

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^2 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^2 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 km2 (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^2 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^2 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^2, only 7.1% of the sightings were in these areas. In contrast, 60.9% of the area contained <60 houses/km^2, 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^2. 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.

	Seasonal					
	Summer		Winter		Annual	
Locality	M	F	M	F	F	Source
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[a]	Larson et al. (1978)

[a] >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

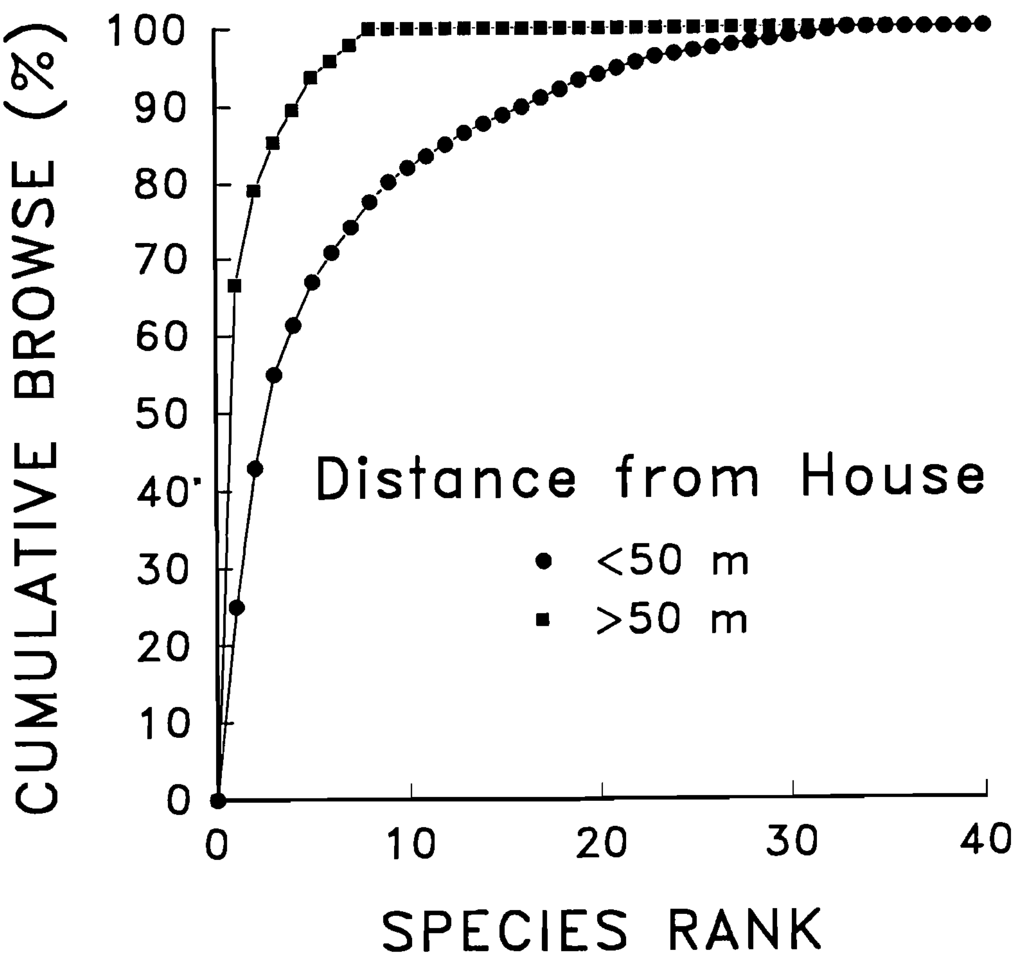


Figure 1. Cumulative percent of all woody plants browsed, plotted as function of species rank, for sites <50 m from houses and sites >50 m from houses at Bethel-Newtown, CT.

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 (*Tsuga spp.*)	Eastern redcedar
2	Yew (*Taxus spp.*)	Red maple
3	Eastern redcedar (*Juniperus virginiana*)	Witch hazel (*Hamamelis virginiana*)
4	Red maple (*Acer rubrum*)	Apple (*Malus* x *domestica*)
5	Japanese honeysuckle (*Lonicera japonica*)	
6	Privet (*Ligustrum spp.*)	
7	Rhododendron (*Rhododendron spp.*)	
8	Arborvitae (*Thuja occidentalis*)	
9	Juniper (*Juniperus chinensis*)	
10	Sugar maple (*Acer saccharum*)	

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^2 at Bethel-Newtown (Swihart et al. 1991), to a high of 72.7 deer/km^2 at Bridgeport. Absolute density of deer at Carbondale was 3.6/km^2, but ecological density was approximately 38/km^2 (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^2 (DuPage County; range 0-22/km^2, n = 14 preserves over 3 years), 9.8 deer/km^2 (Lake County; range 0-23/km^2, n = 18 preserves over 1 year), and 7.3 deer/km^2 (Cook County; range 0-45/km^2, 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^2 (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 fetues/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 interspersion 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 interspersion 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 $<60/km^2$, 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/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

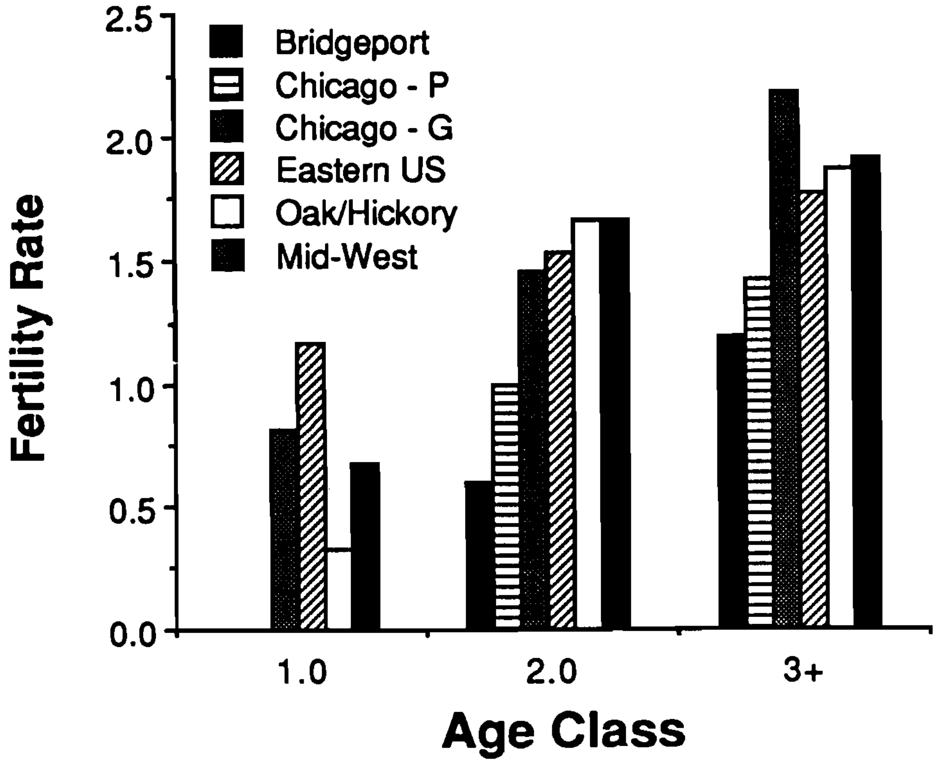


Figure 2. Age-specific fertility rates of does from urban populations (Bridgeport, Chicago) and from predominantly rural populations. Data are from Witham and Jones (1992) for Chicago, Sileo (1977) for the eastern U.S., Torgerson and Porath (1984) for the midwest oak/hickory region, and Gladfelter (1984)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

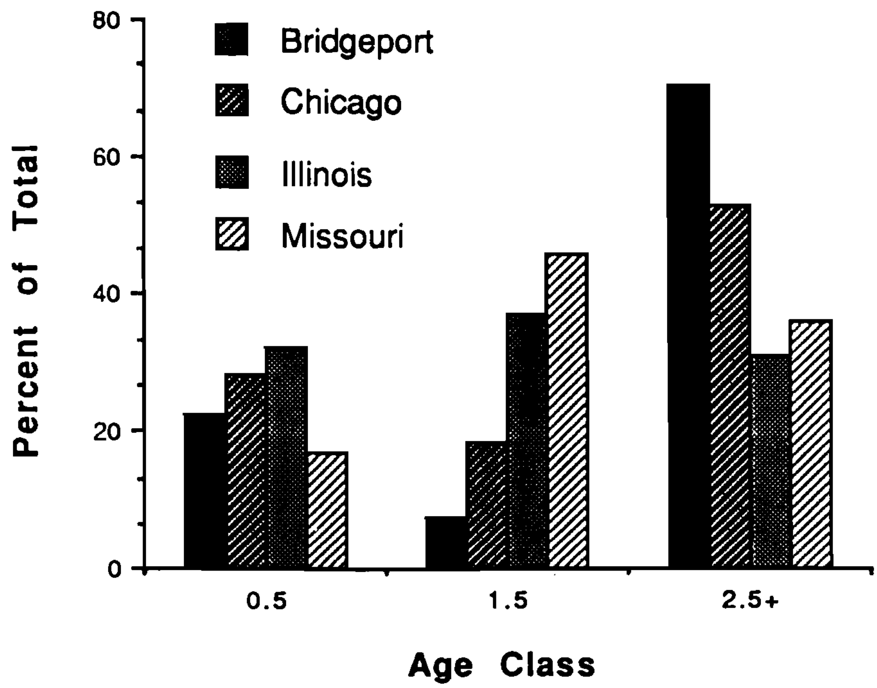


Figure 3. Age structure of deer populations in urban areas (Bridgeport, Chicago) and in predominantly rural sites. Data are from Witham and Jones (1992) for Chicago, and Torgerson and Porath (1984) for Illinois and Missouri.

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^2, although 80 deer/km^2 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^2, and densities of >30 deer/km^2 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^2, 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 unhunted rural deer. For instance, Eberhardt (1969) reported survival rates of 0.70 for adult does in unhunted populations in Michigan, and Gavin et al. (1984) determined annual survival rates of unhunted 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 unhunted 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.

ACKNOWLEDGMENTS

This is Purdue University Agricultural Research Program, Paper Number 14525. We thank M. Bertrand for aid with telemetry studies of deer at Bridgeport. This study was supported by Sporting Goods Properties.

LITERATURE CITED

Barber, H. L. 1984. Eastern mixed forest. Pages 345-354 *in* L. K. Halls, ed., White-tailed deer ecology and management. Stackpole Books, Harrisburg, PA. 870pp.

Beier, P., and D. R. McCullough. 1990. Factors influencing white-tailed deer activity patterns and habitat use. Wildl. Monogr. 109. 51pp.

Conover, M. R. 1995. What is the urban deer problem and where did it come from? Pages 11-18 *in* J.B. McAninch, ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. 175pp.

____, and G. S. Kania. 1988. Browsing preference of white-tailed deer for different ornamental species. Wildl. Soc. Bull. 16:175-179.

Cornicelli, L. 1992. White-tailed deer use of a suburban area in southern Illinois. M.S. thesis, Southern Illinois Univ., Carbondale. 111pp.

Curtis, P. D., and R. J. Stout. 1995. Citizen task force strategies for suburban deer management: The Rochester experience. Pages 143-149 *in* J.B. McAninch, ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. 175pp.

DelGiudice, G. D., L. D. Mech, and U. S. Seal. 1989. Browse diversity and physiological status of white-tailed deer during winter. Trans. North Am. Wildl. and Nat. Resour. Conf. 54:134-145.

Fuller, T. K. 1990. Dynamics of a declining white-tailed deer population in north-central Minnesota. Wildl. Monogr. 110. 37pp.

Eberhardt, L. L. 1969. Population analysis. Pages 457-495 *in* R. H. Giles, Jr., ed., Wildlife management techniques. The Wildl. Soc., Washington DC. 633pp.

Gavin, T. A., L. H. Suring, P. A. Vohs, Jr., and E. C. Meslow. 1984. Population characteristics, spatial organization, and natural mortality in the Columbian white-tailed deer. Wildl. Monogr. 91. 41pp.

Gladfelter, H. L. 1984. White-tailed deer populations and habitats of the midwest agricultural regions. Pages 427-440 *in* L. K. Halls, ed., White-tailed deer ecology and management. Stackpole Books, Harrisburg, PA. 870pp.

Hawkins, R. E. 1967. Social organization of the white-tailed deer on Crab Orchard National Wildlife Refuge. M.A. thesis, Southern Illinois Univ. Carbondale. 180pp.

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

Iverson, L. R. 1988. Land-use changes in Illinois, USA: The influence of landscape attributes on current and historic land use. Landscape Ecol. 2:45-61.

Kuser, J. E. 1995. Deer and people in Princeton, New Jersey, 1971-1993. Pages 47-50 *in* J.B. McAninch, ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. 175pp.

Larson, T. J., O. J. Rongstad, and F. W. Terbilcox. 1978. Movement and habitat use of white-tailed deer in southcentral Wisconsin. J. Wildl. Manage. 42:113-117.

Marchinton, R. L., and D. H. Hirth. 1984. Behavior. Pages 129-168 *in* L. K. Halls, ed., White-tailed deer ecology and management. Stackpole Books, Harrisburg, PA. 870pp.

McCabe, R. E., and T. R. McCabe. 1984. Of slings and arrows: An historical retrospection. Pages 19-72 *in* L. K. Halls, ed., White-tailed deer ecology and management. Stackpole Books, Harrisburg, PA. 870pp.

Mumford, R. E., and J. O. Whitaker, Jr. 1982. Mammals of Indiana. Indiana Univ. Press, Bloomington. 537pp.

Nelson, M. E., and L. D. Mech. 1981. Deer social organization and wolf predation in northeastern Minnesota. Wildl. Monogr. 77. 53pp.

Nixon, C. M., L. P. Hansen, P. A. Brewer, and J. E. Chelsvig. 1991. Ecology of white-tailed deer in an intensively farmed region of Illinois. Wildl. Monogr. 118. 77pp.

Ozoga, J. L., and L. J. Verme. 1982. Physical and reproductive characteristics of a supplementally-fed white-tailed deer herd. J. Wildl. Manage. 46:281-301.

Pagel, M. D., R. M. May, and A. R. Collie. 1991. Ecological aspects of the geographical distribution and diversity of mammalian species. Am. Nat. 137:791-815.

Pollock, K. H., S. R. Winterstein, C. M. Bunck, and P. D. Curtis. 1989. Survival analysis in telemetry studies: The staggered entry design. J. Wildl. Manage. 53:7-15.

Progulske, D. R., and T. S. Baskett. 1958. Mobility of Missouri deer and their harassment by dogs. J. Wildl. Manage. 22:184-192.

Rongstad, O. J., and J. R. Tester. 1969. Movements and habitat use of white-tailed deer in Minnesota. J. Wildl. Manage. 33:366-379.

Sileo, L., Jr. 1977. Fertility analyses of the ranges of the white-tailed deer in the eastern United States. Storrs Ag. Exp. Stn. No. 340. 43pp.

Swihart, R. K., and M. R. Conover. 1990. Reducing deer damage to yews and apple trees: Testing Big Game Repellent[R], Ro.pel[R], and soap as repellents. Wildl. Soc. Bull. 18:162-166.

___, J. J. Pignatello, and M. J. I. Mattina. 1991. Aversive responses of white-tailed deer, *Odocoileus virginianus*, to predator urines. J. Chem. Ecol. 17:767-777.

Tierson, W. C., G. F. Mattfeld, R. W. Sage, Jr., and D. F. Behrend. 1985. Seasonal movements and home ranges of white-tailed deer in the Adirondacks. J. Wildl. Manage. 49:760-769.

Torgerson, O., and W. R. Porath. 1984. White-tailed deer populations and habitats of the midwest oak/hickory forests. Pages 411-426 *in* L. K. Halls, ed., White-tailed deer ecology and management. Stackpole Books, Harrisburg, PA. 870pp.

Verme, L. J. 1969. Reproductive patterns of white-tailed deer related to nutritional plane. J. Wildl. Manage. 33:881-887.

Vogel, W. O. 1989. Response of deer to density and distribution of housing in Montana. Wildl. Soc. Bull. 17:406-413.

Wilson, M. L., G. H. Adler, and A. Spielman. 1985. Correlation between abundance of deer and that of the deer tick, *Ixodes dammini* (Acari: Ixodidae). Ann. Entomol. Soc. Am. 70:172-176.

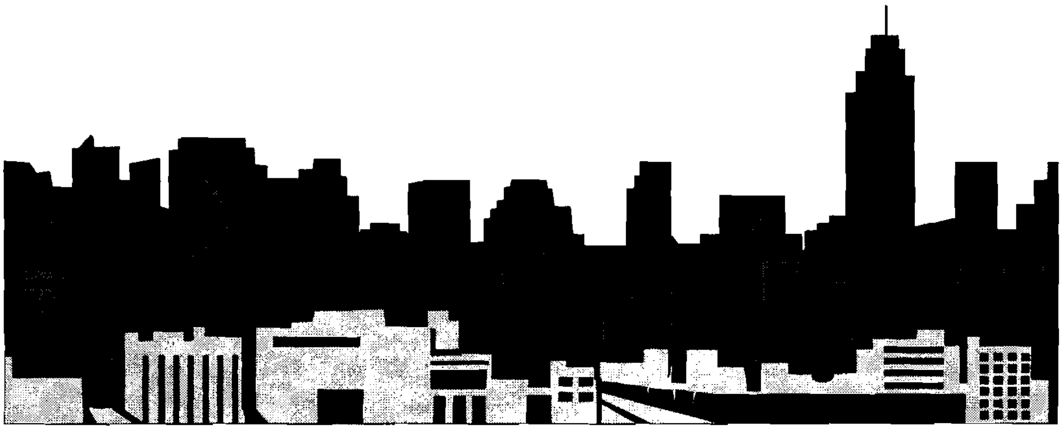
___, A. M. Ducey, T. S. Litwin, T. A. Gavin, and A. Spielman. 1990. Microgeographic distribution of immature *Ixodes dammini* ticks correlated with that of deer. Med. Vet. Entomol. 4:151-159.

Witham, J. H., and J. M. Jones. 1987. Deer-human interactions and research in the Chicago metropolitan area. Pages 155-159 *in* L. W. Adams and D. L. Leedy, eds., Integrating man and nature in the metropolitan environment. Natl. Inst. for Urban Wildl., Columbia, MD.

___, and ___. 1990. White-tailed deer abundance on metropolitan forest preserves during winter in northeastern Illinois. Wildl. Soc. Bull. 18:13-16.

___, and ___. 1992. Biology, ecology, and management of deer in the Chicago metropolitan area. Illinois Nat. Hist. Surv. Final Report, Proj. No. W-87-R. 108pp.

URBAN DEER MANAGEMENT
CASE HISTORIES



MODERATORS:

Lonnie Hansen
Missouri Department of Conservation

Kenneth E. Mayer
California Department of Fish and Game

DEER AND PEOPLE IN PRINCETON, NEW JERSEY, 1971-1993

JOHN KUSER, Department of Natural Resources, Cook College, Rutgers University, New Brunswick, NJ

Princeton's experiment in management of white-tailed deer (*Odocoileus virginianus*) began in 1972 with the passage by Township Committee of a no-firearms-discharge law. Before that, deer population had been managed by the New Jersey Division of Fish, Game, and Wildlife, and is estimated to have been 150 - 250 animals, occupying a 17-square-mile (44 km^2) range of cultivated fields, oak-hickory forest, abandoned fields, woodland edge, and developing suburbia. Given that part of the range was not good habitat (shopping center, etc.), this is near the current recommendation for balanced population levels in the Northeast Jones 1993. Legal deer harvests reported from 1961 to 1971 averaged 5 bow and 22 firearm, with a declining trend for the latter (52 shot in 1961, 16 in 1971). During this 11-year period, males represented 75% of the reported harvest.

In 1972, Princeton's Township Committee passed a no-firearms-discharge ordinance purportedly intended to protect the health and safety of citizens. We discussed the legal background of this in an earlier paper (Kuser and Wolgast 1983). After passage of the law, the Township Police Department began recording all deer-car collisions (Table 1) and continued to do so through 1991, when the function was transferred to Animal Control and the statistic changed from collisions to dead deer pickup. In our 1983 paper, we compared Princeton's 436% increase in deer-car collisions from 1972 to 1982 vs. no statistically significant change in reported roadkills in two adjoining townships which continued firearm hunting. In the 10 years since 1983, one of those adjoining townships (Lawrence) has still shown no increase in roadkills; the other (West Windsor) has had a large increase of deer population, roadkills, and vegetation damage due to creation of a refuge in Mercer County Park and the county executive's veto of a deer hunt there.

Back to 1983: in that year, Princeton Township's mayor was so beset by complaints about deer-vehicle collisions and vegetation damage (corn, soybeans, and homeowners' gardens, fruit trees, and shrubs) that he appointed a three-person ad hoc deer committee to investigate possible solutions to the problem. I was one of the three members. We looked into all the same management options discussed by Ellingwood and Caturano (1988), plus biological control by disease or parasites as well as predators. Some of our sessions were short, for example the discussion of wolves, panthers, hoof-and-mouth disease, and epizootic hemorrhagic disease - we knew beforehand that there were cogent reasons against all these. The sessions on repellents, whistles, and fencing were long, and they were productive in terms of palliative remedies. But we realized that the real problem was population, and that every doe saved from a vehicle collision would end up making the problem worse when her next fawns were born. So we wrote a report to Township Committee (Kuser et al. 1983), recommending a return to shotgun hunting (New Jersey law forbids rifle hunting of deer) and explaining why none of the other options we had studied seemed practical. To make it more convincing to safety-conscious residents, we compared the chances of human injury in a deer-vehicle accident vs. chances of injury to a non-hunter by a stray buckshot pellet, and we estimated that an average resident's chance of injury in a deer-vehicle collision was 480 times greater. Twenty years of records have borne out our estimate. Since we started keeping data on human injuries in deer-vehicle accidents in 1982, we have averaged two a year; and in Princeton and seven surrounding townships with records back to 1960, there has never been an injury to a non-hunter caused by deer hunters.

After we presented this report to Township Committee, they said "No", because they thought too many residents were against returning to shotgun hunting. So we decided we needed to find out what people thought, and how public opinion was divided. We asked my colleague, Jim Applegate, to write survey questions which we asked a random sample of 206 residents (Kuser and Applegate 1985) . The answers indicated that although a majority of residents believed there were problems caused by deer in excess of our cultural carrying capacity, a strong majority did not want to repeal no-discharge. This was a paradox. We wrote a second report to Township Committee (Kuser et al. 1984), detailing the results of the survey and recommending two courses of action: education of residents, and encouragement of more bowhunting in lieu of firearms. Both programs were successful. We held public meetings and invited outstanding experts to explain programs such as Jay McAninch's deer control program at Cary Arboretum. We wrote a brochure, "What You Can Do About Deer", and people made good use of the recommended fences, repellents, and plants that are prickly or poisonous. Reported bowkill rose from 0 in 1972 to 153 in 1987, substantially

Table 1. Data on deer from Princetown Township, 1972-1992.

Year	Roadkill[a]	Human injury[b]	Reported Harvest		Total Mortality	Lyme Cases[d]
			Bow[c]	Firearm		
1972	33	-	0	0	33	0
1973	50	-	3	0	53	0
1974	73	-	10	0	83	0
1975	68	-	9	0	77	0
1976	81	-	9	0	90	0
1977	83	-	6	0	89	0
1978	82	-	11	0	93	0
1979	106	-	21	0	127	0
1980	104	-	26	0	130	0
1981	113	-	34	0	147	0
1982	144	3	36	0	180	0
1983	177	0	53	0	230	0
1984	196	0	65	0	261	0
1985	167	0	85	0	252	0
1986	200	4	102	0	302	0
1987	179	4	153	0	332	0
1988	169	0	115	0	284	6
1989	196	2	126	0	322	9
1990	176	2	117	0	293	11
1991	167	2	103	32	293	22
1992	227	4	105	42	374	18

[a]Deer-car collisions 1972-1990 (Princeton Twp. Police Dept.) deer removals 1991-1992 (Princeton Health Comm.).
[b]Not reported until 1982; thereafter by Princeton Twp. Police Dept.
[c]Data source: New Jersey Division of Fish, Game, and Wildlife.
[d]Data source: Princeton Health Commission.

helped by New Jersey's liberalization of bow seasons and bag limits (Wolgast and Kuser 1993). Some things we tried appeared to have little effect: these included putting whistles on police cars (which still hit deer), and installing Swareflex reflectors and warning signs for motorists along deer-accident-prone roads (they're still deer-accident-prone). I took up bowhunting at some time in the early 1980's, fenced everything around our house that we didn't want deer to eat, and grew daffodils and foxgloves.

By the mid-1980's, the deer committee had become a subcommittee of the Environmental Commission and expanded to 6 members. We continued to encourage bowhunting, we revised "What You Can Do About Deer", and we pointed out to residents that although New Jersey law establishes a 450-foot safety zone around buildings, it need not apply if the bow hunter has written hunting permission from owners of all buildings within 450 feet of his/her stand.

In the late 1980's, Lyme disease entered the scene with profound results. According to Princeton's Health Commission, 3 cases were reported in 1987, 6 in 1988, 9 in 1989, 11 in 1990, 22 in 1991, and 18 in 1992. This became an important factor influencing public opinion, which in turn influenced local government actions. In May 1990, the Environmental Commission and Health Commission jointly sponsored a seminar on Lyme disease which brought forth an overflow crowd at Township Hall. Speakers were Dr. Segal, of Robert Wood Johnson Hospital, New Brunswick on medical aspects of the disease, and Dr. Telford, of the Harvard Institute of Public Health, on epidemiology of Lyme disease and the relationship between deer, ticks, mice, and spirochaete in causing the disease in humans. Telford was a member of the team which produced a landmark reference on this subject (Wilson et al. 1990) which all of us should read if we haven't already.

In 1991, Len Wolgast and I, sensing that there was a swing in Princeton Township residents' attitudes towards deer management, repeated the 1984 survey verbatim. We found a significant increase in the number of voters who were aware of damage to vegetation (55.8% vs. 27.0%), and we found that more than twice as many had taken measures to control problems with deer. A bare majority of voters still favored retaining the 1972 no-discharge law, but a majority now favored allowing exceptions for farmers and landowners whose vegetation was being destroyed (Kuser et al. 1993). We thought that the emergence of Lyme disease was the most important reason for peoples' change of mind, although not the only one - many residents were just tired of deer after seven more years of their exceeding CCC. In our 1991 survey, 28 out of 100 respondents identified ticks as a concern, 6 said they had been bitten by deer ticks, and 3 said they had had Lyme disease. In 1984, there had been none of this.

Subsequently, Princeton's Township Committee voted 5-0 to suspend the no-discharge ordinance on special-permit firearm hunting days from 1991 on. The suspension was upheld against a challenge by the Princeton Committee for Residential Safety when New Jersey Superior Court refused to issue a temporary restraining order blocking it. This change produced harvests of 32 additional deer in 1991 and 42 in 1992.

So, where are we today? Our public education and bowhunting programs have apparently succeeded in halting the increase in deer population, but not in reducing it (Wolgast and Kuser 1993); it is estimated to remain in the 800-1,200 level, which is too high in the opinion of most township residents: in May 1991, Township Committee mailed a newsletter containing survey questions on deer, library, and open space to 4,163 resident voters. By July 1, 597 signed responses (14.3%) had been received and tabulated. Ninety-two percent of those answering the deer question thought it was important to control deer population. Eighty percent favored doing so by hunting, preferring shotgun over bow hunting by a nearly 3:1 margin. Two hundred respondents also made written suggestions, with 81 suggesting a managed hunt, 61 fertility control, 24 giving the meat to the needy, 17 expressing fear of Lyme disease, and 12 calling bowhunting inhumane.

So we have stabilized deer population, but at a level above 92% of our people's idea of cultural carrying capacity, and four times as high as Jones et al (1993). What are we doing about this, what are we going to do, and what else can we do? As of now, we are monitoring harvests by bow hunting, permit shotgun hunting, and continuing roadkill. We think that roadkill trends over a 3- or 4-year period are reasonably accurate indicators of deer population trends (Bellis and Graves 1971; McCaffery 1973), although ours vary on a year-to-year basis (Table 1) probably because of variation in weather or food supply. The unusually high roadkill in 1992 has been followed by many months in 1993 with roadkill less than half last year's. I think last year's high roadkill was caused by light summer rains, just enough to keep roadside vegetation green when forage in the woods was dried up, and a total failure of the acorn crop in the fall. If roadkill begins a significant three- or four-year downtrend, we will know that our current program is succeeding; if not, we will have to seek new options. The greatest difficulty with our present program is hunter access to three types of areas: 1) public land with deed restrictions forbidding hunting, 2) large estates whose owners do not allow hunting, and 3) areas with quarter-acre or half-acre lots near creek beds with dense brush and one or two neighbors who don't want bow hunting. If fertility control becomes operational, it will be popular and will most likely be tried (cost permitting); in lieu of fertility control, many of us believe that we will be advocating some form of sharpshooting (State, municipal, or professional). I don't know where we will go with either of these approaches, and I come to this conference to share ideas with you, and hopefully to return to Princeton with more good ideas than I bring (my colleagues there await!).

ACKNOWLEDGEMENTS

I want to thank Len Wolgast and Jim Applegate at Rutgers, and Bob Lund, Bob McDowell, Dan Ferrigno, Sue Predl, and Cindy Kuenstner of New

Jersey Fish & Game. They have taught me most of what I know about deer and helped our deer committee and environmental commission in many ways over the years. And all of us owe a debt to Aldo Leopold, whose observations about deer released from predation are as true today as ever. New Jersey Agricultural Experiment Station Publication P-17304-01-93, partially paid for by McIntire-Stennis funds.

LITERATURE CITED

Bellis, E.D., and H.B. Graves. 1971. Deer mortality on a Pennsylvania interstate highway. J. Wildl. Manage. 35:232-237.

Ellingwood, M.R., and S.L. Caturano. 1988. An evaluation of deer management options, Publ. No. DR-11, Connecticut D.E.P. Wildlife Bureau, Hartford, CT. 12p.

Jones, S.B., D. DeCalesta, and S.E. Chunko. 1993. Whitetails are changing our woodlands. Amer. Forests 99:20-25; 53-54.

Kuser, J.E. 1984. Recommendations #2 to the Princeton Township Committee from the Ad Hoc Deer Committee. Township Administrator's Office, Princeton, NJ 08540. 54p.

___, and J.E. Applegate. 1985. Princeton township: the history of a no-discharge ordinance's effect on deer and people. Proc. N.E. Fish & Wildlife Conf., 42:150-155.

___, and L.J. Wolgast. 1983. Deer roadkill increases with no-firearms-discharge law. Bull. NJ Acad. Sci. 28:71-72.

___, J.E. Applegate, and L.J. Wolgast. 1993. Princeton voters' opinions shift on deer management. Bull. NJ. Acad. Sci. 38:5-6.

___, T.C. Southerland, and T.M. Poole. 1983. Recommendations to the Princeton Township Committee from the Ad Hoc Deer Committee. Township Administrator's Office, Princeton, NJ. 51p.

McCaffery, K.R. 1973. Road-kills show trends in Wisconsin deer populations. J. Wildl. Manage. 37:212-216.

Wilson, M.L., A.M. Ducey, T.S. Litwin, T.A. Gavin, and A. Spielman. 1990. Microgeographic distribution of immature *Ixodes dammini* ticks correlated with that of deer. Med. and Vet. Entomol. 4:151-159.

Wolgast, L.J., and J.E. Kuser. 1993. Bowhunting stabilizes a New Jersey white-tailed deer population. Bull. NJ Acad. Sci. 38:7-8.

CALIFORNIA URBAN DEER MANAGEMENT: TWO CASE STUDIES

KENNETH E. MAYER, California Department of Fish and Game, Wildlife Management Division, Sacramento, CA
JOSEPH E. DiDONATO, East Bay Regional Park District, Oakland, CA
DALE R. McCULLOUGH, Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA

California is often considered to be the bell-weather State for many social, economic, and resource management trends in the nation. This distinction in large part holds true for many emerging trends. However, with regard to urban deer management, California has just recently begun to grapple with this management issue.

Even though California has the largest human population of any state in the Union, with more than 32 million people (1990 Census) and with a large deer population (700,000 to 800,000 deer), few serious urban deer problems exist. Deer depredation problems have historically occurred in many agricultural areas of the State, some dating back to 1875 in southern California (Longhurst et al. 1952). Because deer have generally been extirpated from the central valley of California (except in remanent riparian habitats), most agricultural deer depredation problems occur in the central and south coast areas and in northeastern California. More recently, with the growth of the wine industry in the Napa Valley and surrounding areas, deer depredation problems have steadily increased.

Historically, the California Department of Fish and Game's (CDFG) management approach to these agricultural depredation problems has been to issue depredation permits (shooting permits). These permits are issued exclusively to the landowner, authorizing the take of offending animal(s) (California Fish and Game Code section 4181.5). This lethal measure, together with fencing and landowner understanding and/or tolerance of the problem, has served to maintain or resolve most agricultural-depredation situations in the State.

There are six native subspecies of mule deer (*Odocoileus hemionus*) in California. The coastal areas, from the Oregon border to Mexico, are inhabited by black-tailed deer (*O. h. columbianus*), and southern mule deer (*O. h. fuliginatus*), respectively. Deer populations in these areas are considered resident. Deer of the Cascade and Sierra Nevada ranges are primarily California mule deer (*O. h. californicus*) and Rocky Mountain mule deer (*O. h. hemionus*). While localized resident populations of these deer exist, most are migratory (e.g., deer that travel considerable distance between summer and winter range habitats). Thus, more than half of the deer in California fall in this category. Because the majority of deer are migratory, urban, and suburban developments are seldom interspersed with quality deer habitat, and the fact that white-tailed deer (*O. virginianus*) have a high net recruitment rate (Haugen 1975; McCullough 1979) compared to mule deer (McCullough 1987a) may be the reason why urban deer problems occur less in California than in the eastern and midwestern states, where the white-tail deer is the native species.

Due to the increased development in the coast range and Sierra Nevada foothill communities of California, urban deer are becoming a growing local concern. As the human population increases in these suburban and rural areas, along with its concomitant development, deer-human conflicts will most certainly intensify. Increasingly, the influence of animal welfare and animal rights groups on local political decisions is becoming more prevalent. As a result, management options for these deer populations have often been restricted to nonlethal means. This constraint has forced local governments and the CDFG to take expensive nonlethal approaches to manage urban deer populations. To illustrate these nonlethal approaches and their overall effectiveness we have selected two case studies to review: Angel Island and Ardenwood Regional Park (Figure 1). From this review, we hope to describe the successes and failures and provide insight to more efficient management options for the future.

CASE STUDY - ANGEL ISLAND

Angel Island is located in San Francisco Bay, San Franciso and Marin Counties, California. This popular, 738 acre (299 ha) recreation areas is administered by the California Department of Parks and Recreation (CDPR). Much of the Island has typical habitat for black-tailed deer.

Deer were abundant on Angel Island at the time of European settlement, but were eliminated sometime before 1900. In 1915, the United States Army relocated an unspecified number of black-tailed deer to the Island from a ranch in Sonoma County. It has been suggested that the introduction was to provide sport hunting opportunities for army personnel and that hunting regulated the Island's deer population

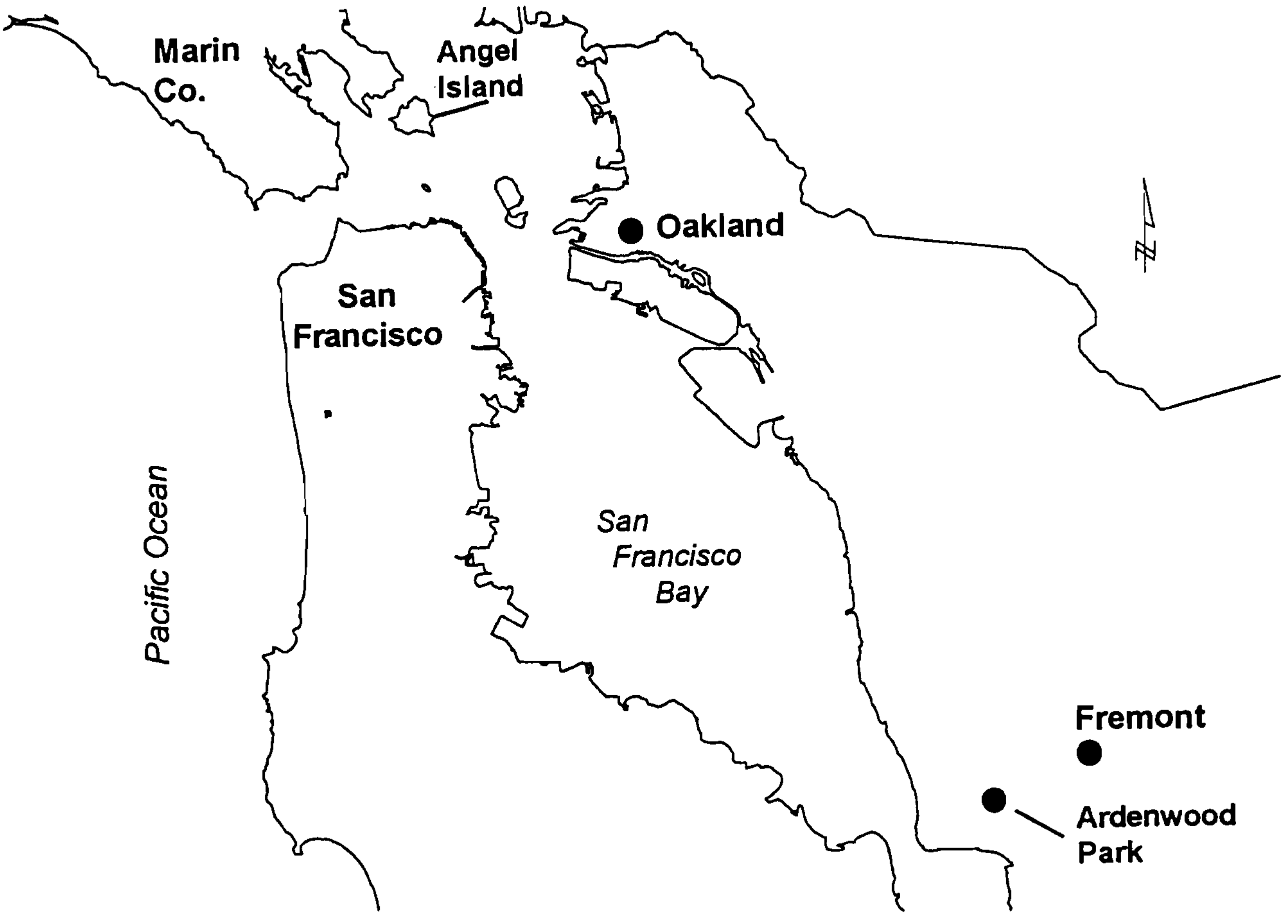


Figure 1. San Francisco Bay Area, California Angel Island and Andenwood Park.

(California Department of Fish and Game 1977, Goldsmith 1982).

In 1955 Angel Island became a State park and hunting was eliminated. Subsequent to that ban, the deer population exhibited wild fluctuations in growth similar to those described for other island situations where ungulate populations existed in the absence of predators (Klein 1968, Caughley 1981, Leader-Williams et al. 1981).

Pronounced peaks in the deer population had a detrimental impact on both the habitat of the Island and the animals themselves. Physiological condition of deer deteriorated rapidly, native plants were replaced by less palatable exotic species, other vegetation was severely hedged and erosion was promoted (White 1981). Because of the high public use of the Island and the extensive damage that occurred to the Island habitat, CDFG was requested to find a solution.

In 1966, approximately 300 deer lived on Angel Island. As a solution to the over-population problem, the CDFG issued depredation permits to CDPR to kill 50 deer. Carcasses deemed suitable for human consumption were donated to charity. Public opposition to the shooting of deer was immediate and intense, and it prevented further reduction of the deer herd by lethal means. While State agencies and preservation groups argued, spurred on by the news media, many of the deer died of starvation (White 1981). As a result, the deer population declined, habitat conditions improved and human interest in the problem waned.

Deer numbers peaked again on the Island in 1976 (California Department of Fish and Game 1977). In an effort to prevent large scale starvation, the San Francisco Society for the Prevention of Cruelty to Animals (SPCA) proposed to feed the deer. The feeding proposal was opposed by CDFG on the basis that it would maintain an artificially high population. Instead, the Department recommended culling the herd by shooting 50 animals. As in the past, this approach was blocked by negative public reaction. During the public controversy it was requested that an

Environmental Impact Report (EIR) be prepared before culling could proceed. Since it was evident that no immediate action would be taken, CDFG permitted SPCA to initiate supplemental feeding of the deer. Subsequent to the feeding, a Draft EIR was prepared (Calif. Dep. Fish and Game 1977). Because no objective follow-up study was made, the success of the feeding program is a matter of dispute. The SPCA claimed success and CDFG statements implied that many deer died after the program was initiated (Goldsmith 1982). Nevertheless, the problem diminished and once again public attention waned.

In 1980, deer on the Island were reaching a third population peak. Sever browsing occurred with many deer concentrated around the picnic grounds (White 1981). The problem was brought to a head by a proposal to introduce coyotes to effect population control (McCullough 1987b). Public hearings were held to develop possible solutions to the problem. Recommendations derived from the hearings included introduction of predators, shooting and relocation (White 1981). While the public response to shooting was favorable, the option was quickly eliminated through court action. The SPCA filed a Writ of Mandate against the CDPR and CDFG claiming that the agencies must comply with the 1977 EIR. In an effort to reach a compromise, an out-of-court settlement was made. The Angel Island deer were to be relocated pursuant to the relocation alternative in the EIR.

Relocation provided a publicly acceptable management solution to the overpopulation of black-tailed deer on the Island. Because the demand for humane treatment was the impetus behind the lawsuit, the fate of the transplanted animals was an important part of the move and the final project evaluation.

Between August 26 and September 20, 1981, 215 deer were captured and processed, 203 of which were released into the Mayacamas Mountains on the 54,362 acre (22,000 ha) Cow Mountain Recreation Area near Ukiah, Mendocino County (Clark et al. 1982). Deer were captured using Clover traps, panel traps, drop nets, and drive nets. All animals were medically processed which included taking blood samples, fecal and hair samples, preventative medical treatment, and marking with ear tags and tattoos. Fifteen deer were fitted with radio- telemetry collars for a follow-up study (O'Bryan and McCullough 1985).

Twelve deer died during the capture operation, five of which died as a direct result of the capture. The remaining seven died as a result of a pre-existing health condition. Of the 203 deer successfully relocated there were 159 (78%) were adults and 44 (22%) were fawns. The adults were comprised of 91 (57%) males and 68 (43%) females. All males had their antlers removed prior to relocation so they were not legal game during the 1981 deer hunting season (Clark et al. 1982). Following the capture and relocation, a drive census on the Island found 44 deer alive and 16 dead deer (D.R. McCullough, unpubl. data).

The deer habitats of the Mayacamas Mountains included mixed chaparral, chamise-redshank chaparral, blue oak woodland and montane hardwood (Mayer and Laudenslayer 1988). While the habitats were typical for black-tailed deer other environmental conditions were considerably different than the Island environment. Predators, that were entirely absent from Angel Island, were prevalent in the release area. These predators were mountain lion (*Felis Concolor*), coyote (*Canis latrans*), black bear (*Ursus americana*), bobcat (*Lynx rufus*), and feral dogs (*Canis familiaris*). These together with the high level of human activity (extensive road network, adjacent urban developments and diverse recreational use) created a significantly different environment for the relocated Angel Island deer.

In an effort to evaluate the success of the relocation and relative effectiveness of a capture-relocation approach to solving the urban deer over-population problem, a study was initiated to monitor survival of deer during the year after relocation (O'Bryan and McCullough 1985). All relocated deer were ear-tagged and tattooed and 15 adult deer (two males, 13 females) were fitted with radio collars with mortality sensors. Radio-collared deer were located from both the ground and air every five to six days during the first three months, every week during the following six months, and every two weeks for the remaining three months of the study. Throughout the monitoring effort, the fate of each animal was determined. If the animal expired, the carcass was examined to determine the cause of death as well as its age and condition.

O'Bryan and McCullough (1985) estimated that only 15% of the radio-collared Angel Island deer survived the entire year following relocation. The initially poor physical condition of the Angel Island deer is believed to have contributed to their high mortality rate after relocation. First mortalities consisted of the most emaciated animals. Thereafter, malnutrition was not a direct cause of death, although it may have predisposed deer to other mortality factors. Further, O'Bryan and McCullough (1985) reported that many relocated deer died because they failed to recognize hazards not encountered on Angel Island and thus reacted inappropriately. Predators and humans were not avoided, and a high proportion of mortalities were related to vehicle traffic. Although most relocated deer were unable to adapt to hazards that were absent on the Island, they soon behaved in other ways similar to resident deer.

The direct cost of the capture, relocation, and follow-up (monitoring study) was $87,568 or $434 per animal moved (Clark et al. 1982). Considering survival rate, $2,876 was spend for each deer surviving for one year, assuming the survivorship of the radio-collared sample is representative of the relocated population (O'Bryan and McCullough 1985).

Following the removal of deer from Angel Island in 1981, the population once again expanded. It was obvious that the boom-bust process was headed for the next cycle. The SPCA proposed that the population be controlled by chemosterilization, and that they would pay for and carry out the program. Modelling of the population by D. R. McCullough (unpub) showed that about 80-90% of the adult females would have to be treated for the control to be successful. This would require the capture and treatment of approximately 60 adult females. After considerable negotiation, CDFG approved the project.

The capture effort began in July 1984 with the use of modified Clover traps (McCullough 1975). Captured females were sedated with 10-30mg of xylazine given intravenously, and then implanted in the shoulder musculature with a 1 x 4 cm sylastic cylinder containing lg of melangestrol acetate (MGA) prepared by U.S. Seal. All deer captured were fitted with color-coded, reflective ear tags before release (Botti 1985, McCullough 1987b).

By November, after great effort had yielded only 30 females captured and treated (15 adults, 15 fawns; one adult female died in a subsequent recapture for a net of 14 adult females treated), it was obvious that nowhere near the required number of females could be captured. The project encountered the dilemma that deer that were readily captured at high population for relocation when near starvation could not be captured easily at lower density before crisis conditions had been reached. Yet, because contraceptive approaches cannot work on populations already at the crisis level, it was necessary that a high proportion of animals be treated at a subcrisis level to arrest further population growth for the contraception to be successful (McCullough in press). The SPCA quietly abandoned the project with a minimum of media attention.

Subsequent observations by D. R. McCullough and P. I. Garcia showed that none of the treated females (i.e., those with ear tags) were followed by fawns over the next five years. Therefore, the MGA implants were successful in functionally stopping reproduction for at least five years, and perhaps longer on Angel Island.

The contraception program had minimal impact on the rate of population growth. In 1985, the population was estimated by mark-recapture methods to be between 210 and 240 animals (D. R. McCullough and G. S. Fowler unpub), and growth towards a fourth peak was underway. Due to failure of alternative methods of population control, shooting by rangers was reluctantly accepted at a public hearing. Thus, through a depredation permit issued by CDFG, the CDPR personnel take (shoot) 10 to 20 deer per year to maintain the population at a level where the Island vegetation is not effected by browsing.

CAGE STUDY: ARDENWOOD REGIONAL PARK

Ardenwood Regional Park, is located in the City of Fremont, Alameda County and is operated by the East Bay Regional Park District (EBRPD) as an historic farm. The park is owned by the city of Fremont and leased to EBRPD. The park, approximately 200 acres (81 ha) consists of several historic buildings, maintenance and office buildings, and a miniature railroad. Additionally, 60 acres of the property is leased to a commercial farmer. The park is open to the public and annual visitation exceeds 60,000 people per year. Habitat in the park consists of approximately 50% open or cultivated fields, 25% buildings and 25% forest and orchard.

A six-foot-high, chain-link fence was erected in 1985 around the entire park to provide security. Subsequent to establishing the park, residential housing developments and roads have been built on all sides of the park effectively rendering it an urban island. While the Park District and CDFG raised concerns about the effect of this urban development on the area's deer population, local governments did little to address these concerns in their planning efforts. At the time the fence was erected, it was estimated that eight to twelve black-tailed deer were trapped inside the enclosure.

As the deer population within the park grew, it began to have a serious negative effect on park management objectives and productivity of the commercial and interpretive farmlands. Annually, deer browsing caused an estimated $12,000 to $15,000 of damage to landscape plants and row crops.

In 1991, the Ardenwood park Advisory Committee and the EBRPD Board of Directors voted to remove the entire herd from the park to relieve the depredation problem. Following the vote, EBRPD began negotiating with CDFG to remove the deer. Based on the Angel Island experience, including survival rates and capture expense found in other similar capture-relocation efforts (Clark et al. 1982, Jessup 1982, O'Bryan and McCullough 1985) the CDFG recommended lethal removal of the deer instead. park officials, advisory committee members, and local humane groups opposed this removal method. As the debate intensified regarding the best approach to remove the deer, the Ohlone Humane Society hired a private biological consultant to conduct an independent evaluation of the Ardenwood Regional Park deer situation (Povilitis 1991). Based on this evaluation the Ohlone Humane Society requested the CDFG to reject the relocation of the Ardenwood deer and in its place conduct a sterilization program. As the humane groups argued over which was the best non-lethal approach to use the CDFG reluctantly agreed with EBPRD to relocate the deer. Thus, an agreement was signed in 1991 between CDFG and EBRPD authorizing the capture and relocation of the Ardenwood deer. However, this was done with the understanding that a study funded by EBRPD would be conducted that would focus on the effects of the deer relocation on both the relocated deer and resident deer in the release site area.

The relocation proceeded even though an attempt was made by the Ohlone Humane Society to legally block the project through a restraining order. Thus, a corral trap was quickly constructed within Ardenwood Park to capture the deer. The trap consisted of an interior corral and two funnel-type wings extending out from the main trap. The deer were driven into the corral trap by a team of people walking in a horizontal line towards the narrow neck of the funnel. Originally, a helicopter was scheduled to be used to herd the deer into the corral trap. However, it was determined that the stress on the deer from being chased by the helicopter would result in unacceptably high capture mortality. Hence, a "soft" drive approach was employed.

The entire herd of 29 deer was captured in three days. Twenty-seven deer were medically processed, ear tagged, and fitted with radio collars or ear tag transmitters. Two deer died during the capture. Antlers were removed from the bucks to reduce injury during transport. Of the 27 deer relocated, nine (33%) were bucks, and 18 (66%) were does. Five (19%) of the deer were fawns, two (7%) were yearlings, and the remaining 20 (74%) were adults.

Once captured, the animals were loaded into transport trailers in groups of three to five animals per section and trucked two hours to the Ohlone Wilderness for release. All animals were released at the same site over a three day period (December 10-12, 1992).

Habitats in the Ohlone Wilderness, administered by EBRPD were typical black-tailed deer habitat. Habitats consisted of blue oak woodland, blue oak-digger pine, coastal oak woodland, and annual grassland (Mayer and Laudenslayer 1988). Land uses included livestock grazing, wilderness camping, and hiking by permit only. Hunting was prohibited in the wilderness. However, hunting for deer and pigs occurs on adjacent private properties and in-holdings.

Similar to the Angel Island deer, Ardenwood park deer were subjected for the first time to predators after relocation. Primary predators were mountain lion, coyote, and bobcat.

Status and behavior of the radio-collared deer was monitored daily from the ground for the first 30 days after the release and four to five days per week for the following three months. Additional monitoring was conducted on an infrequent basis from a helicopter for the remainder of the 12 month period due to the difficulty in finding the low numbers of deer surviving past the first three months.

The follow-up study lasted for one year from the relocation date. At the conclusion of the follow-up study, 23 of the 27 deer were dead, one was alive and the fate of three was unknown (animals either died, left the area, or radios failed). On November 11, 1993, the last Ardenwood deer was found dead apparently the victim of a vehicle collision.

Of the 24 known mortalities, six were confirmed kills by mountain lions, two by coyotes, and four by undetermined predators. Cause of death for eight animals was undetermined because of scavengers. Two animals were hit by vehicles and one died after being entangled in a barbed-wire fence. One doe traveled a straight line distance of almost 18 miles (30 km) only to be killed by a commuter train less than three miles (5 km) from the entrance to Ardenwood Regional Park.

Direct expenditures for the project were estimated at $85,000. This included cost for equipment, and the follow-up study. However, the total project cost of $134,000 is significantly higher if CDFG and EBRPD personnel time is included.

The effects of the relocation on the Ardenwood park deer was obvious. Because previous attempts to capture and radio tag resident deer in the release site and a control area failed, it was impossible to assess the effects of the relocation on the resident deer population.

CONCLUSION

In both case studies the management options available to the responsible agencies to address the urban deer problem were limited by local political actions and demands from special interest groups. In both cases, the least effective (considering the humane treatment of the animals) and most costly approach was selected because of political pressure. The public out-cry over the death of the deer after both relocations was as intense as the political pressure prior to selecting the relocation option. In fact, newspaper editorials at the conclusion of the Angel Island relocation suggested that donations be withheld from the SPCA until they modified their intractable position on the non-lethal approach to solving urban deer problems.

While similar to the Angel Island situation, the Ardenwood Regional park deer problem evolved into a heated debate between humane groups and park officials over the proper non-lethal approach to use. While these groups debated, the CDFG tried unsuccessfully to dissuade the EBRPD from selecting relocation as the means to solve their deer problem. In retrospect, the capture and relocation of the deer immediately reduced damage within the park, but failed as a humane management approach to solve the over- population problem.

As a result of these two experiences, the CDFG has begun to redefine its approach to over-populations of urban deer. First, it is imperative that the Department's urban deer management policy be clearly described in the State's Strategic Deer Management Plan. This emerging policy consists of four key actions. They are: 1) Develop a public awareness program at the local level that includes identification of potential problems and appropriate solutions; 2) Take immediate corrective action on localized over-population problems prior to the development of a crisis. However, if these intermediate measures are not implemented by local agencies, require that all costs associated with resolving the resulting urban deer "crisis" be paid for by the local agency; 3) Eliminate the capture-relocation of deer as a management option and; 4) Consider recommendations to reduce reproduction (contraception) where appropriate if all cost associated with the initial and follow-up contraception work are paid for by the local agency. It is hoped that with the establishment and implementation of this broad-based urban deer management policy problems of the past will not plague the future.

ACKNOWLEDGEMENTS

We greatly acknowledge the thoughtful review of this manuscript by Terry M. Mansfield, Sonke Mastrup, and Bill Clark of the California Department of Fish and Game. Their editorial comments were vital to the completion of the final draft.

LITERATURE CITED

Botti, F.L. 1985. Chemosterilants as a management option for deer on Angel Island: Lessons learned. Cal. Neva Wildl. Trans. 1985:61-65.

Calif. Dep. Fish and Game. 1977. Angel Island State park deer reduction program. EIR, Calif. Dep. parks and Recreation, Sacramento. 27pp.

Caughley, G. 1981. Overpopulation. Pages 7-20 *in* P.A. Jewell, and S. Holt, eds., Problems in the management of locally abundant wild mammals. Academic Press, N.Y., N.Y. 361pp.

Clark, B., P. Gullett, B. Browning, J. Parrish, and F. Botti. 1982. 1981 Angel Island deer translocation. Admin. Rep. 82-3, Calif. Dep. Fish and Game, Sacramento. 15pp.

Goldsmith, A.E. 1982. The Angel Island deer herd: A case history of wildlife management controversy. Cal. Neva. Wildl. Trans. 1982: 78-82.

Haugen, A.O. 1975. Reproductive performance of white-tailed deer in Iowa. J. Mammal. 56:151-159.

Jessup, D.A., R. Mohr, and B. Feldman. 1982. A comparison of four methods of capturing bighorn. Trans. Desert Bighorn Counc. 1982:21-25.

Klein, D.R. 1968. The introduction, increase and crash of reindeer on St. Matthew Island. J. Wildl. Manage. 32:350-367.

Leader-Williams, N., T.A. Scott, and R.M. Pratt. 1981. Forage selection by introduced reindeer on South Georgia, and its consequences for the flora. J. Appl. Ecol. 18:83-106.

Longhurst, W.M., A.S. Leopuld, and R.F. Dasmann. 1952. A survey of California deer herds their ranges and management problems. Game Bull. No. 6, Calif. Dep. Fish and Game, Sacramento. 136pp.

Mayer, K.E., and W.F. Laudenslayer, Jr. 1988. A guide to wildlife habitats of California. Calif. Dep. Forestry, Sacramento. 166 pp.

McCullough, D.R. 1975. Modification of the Clover deer trap. Calif. Fish and Game 61:242-244.

___. 1979. The George Reserve deer herd: Population ecology of a K-selected species. Univ. of Michigan Press, Ann Arbor. 271pp.

___. 1987a. The theory and management of *Odocoileus* populations. Pages 535-549 *in* C.M. Wemmer, ed., Biology and management of cervidae. Smithsonian Institution Press, Washington, D.C.

___. 1987b. North American deer ecology: fifty years later. Pages 115-122 *in* T. Tanner, ed., Aldo Leopold: the man and his legacy. Soil Cons. Soc. Am., Ankeny, Iowa.

___. In press. Demography and management of wild populations by reproductive intervention. *In* U.S. Soil and E.D. Plotka, eds., Symposium on contraception in wildlife, Philadelphia, PA.

O'Bryan, M.K., and D.R. McCullough. 1985. Survival of black-tailed deer following relocation in California. J. Wildl. Manage. 49:115-119.

Povilitis, T. 1991. An evaluation of the Ardenwood deer issue. Ohlone Humane Society, Fremont, Calif. 5,21 pp.

Temple, L.J., and W. Evans. 1981. Survival rates of mule deer (*Odocoileus hemionus*) associated with transplants in Northern New Mexico. N.M. Dep. Fish and Game Rep., Santa Fe, N.M. 14pp.

White, J. 1981. Trouble on Angel Island. Outdoor Calif. 42:9-12.

URBAN DEER "PROBLEM"-SOLVING IN NORTHEAST ILLINOIS: AN OVERVIEW

JON M. JONES, Illinois Department of Conservation, Elgin, IL
JAMES H. WITHAM, Arizona Department of Fish and Game, Kingman, AZ

Similar to the trend in deer numbers statewide, white-tailed deer (*Odocoileus virginianus*) have become abundant in metropolitan northeast Illinois (Witham and Jones 1990). The prolific and adaptable nature of whitetails allows them to exploit most, if not all, suitable habitat near urban centers, including residential areas. Fear of humans seemingly diminishes with repetitive close contact, the absence of harassment, and in some cases supplemental feeding. The absence of deer population regulatory mechanisms has allowed deer numbers to increase rapidly in many suburban/urban areas in Illinois, but to date most notably in the Chicago metropolitan area (i.e., Cook and the surrounding counties).

Preservation of open spaces by state, county, and municipal agencies in the form of parks, nature preserves, natural areas, nature centers, forest preserve districts, and conservation districts has foresightedly provided a barrier against complete development of the metropolitan landscape. These areas provide aesthetic and recreational values to the urban environs, refuges for native plants and animals, and protect remnant examples of presettlement assemblages of plants and animals. As an example, county-owned forest preserve districts (FPD) in Cook, Lake, and DuPage counties in extreme northeastern Illinois presently include 109,350 acres (44,253 ha), or 9 percent of the total area of the 3 counties. Unfortunately, these preserves are often disjunct and scattered throughout the counties (Figure 1 shows Cook County forest preserves as an example). Land acquisition by the county forest preserve districts, often to establish green belts to interlink preserves, is a priority but is increasingly precluded by competition for remaining undeveloped properties with private or commercial interests.

FPD properties are further augmented by numerous municipal parks, nature centers, open lands associations, golf courses, arboreta, and minimally-developed private and commercial holdings. Most of which can be deemed potential, if not current, deer habitat. Individual FPD properties in Cook, DuPage and Lake counties range in size from a few acres (<1 ha) to >10,000 acres (>4,046 ha). Based on annual aerial counts during winter, deer occur on most preserves, and several have minimum winter deer densities exceeding 100 deer per square mile (57.9 deer/km2). All of these remnant open spaces are presently closed to firearm deer hunting. Additionally, municipal or county ordinances or policies often preclude archery hunting on public lands or private properties within incorporated municipal boundaries. Therefore, hunters are limited to the decreasing private, unincorporated properties; the reported archery harvest total for Cook, DuPage, Lake, and Kane counties was 740 during 1992.

The nationwide population shift from rural to urban areas has lead to increased residential and commercial development radiating outward from urban centers. Within the Chicagoland area, human population estimates outside the city limits of Chicago increased from 3,605,398 residents in April 1970 to 4,477,450 in April 1990; conversely the population of the City of Chicago dropped from 3,369,357 to 2,783,726 during this period according to the (Northeastern Illinois Planning Commission (NIPC 1993). Based on analyses of land uses, determined via Landsat satellite data, Witham et al. (1992) concluded that >70 percent of Cook, DuPage, Kane and Lake counties combined was "residential" and "urban". Although conversion of open spaces to suburban developments displaces many animals utilizing these areas, this loss of habitat may be temporary for more adaptable "generalist" species such as white-tailed deer.

Insularization of preserves and open spaces, which restricts deer travel lanes and dispersal routes, and immigration of deer into residential areas due to high population densities or displacement are primary causes for deer-human conflicts in northeast Illinois. Current concerns expressed by residents include deer-vehicle accidents, damage to ornamental plants and vegetable gardens, damage to agricultural crops and nursery stock, the potential transmission of diseases and parasites from deer to humans, and damage to remnant natural areas.

Deer-vehicle accidents (DVA), reported annually to the Illinois Department of Transportation (IDOT), on state-maintained roads alone in Cook, DuPage and Lake counties increased from 266 in 1981 to 1300 during 1992. DVA summaries for <u>all</u> routes, compiled by the IDOT since 1989, show an increase in from 1,446 DVA in 1989 to 2,063 in 1992 in the 3 metro counties; the latter year involved 2 human fatalities and 145 human injuries. This threat to human

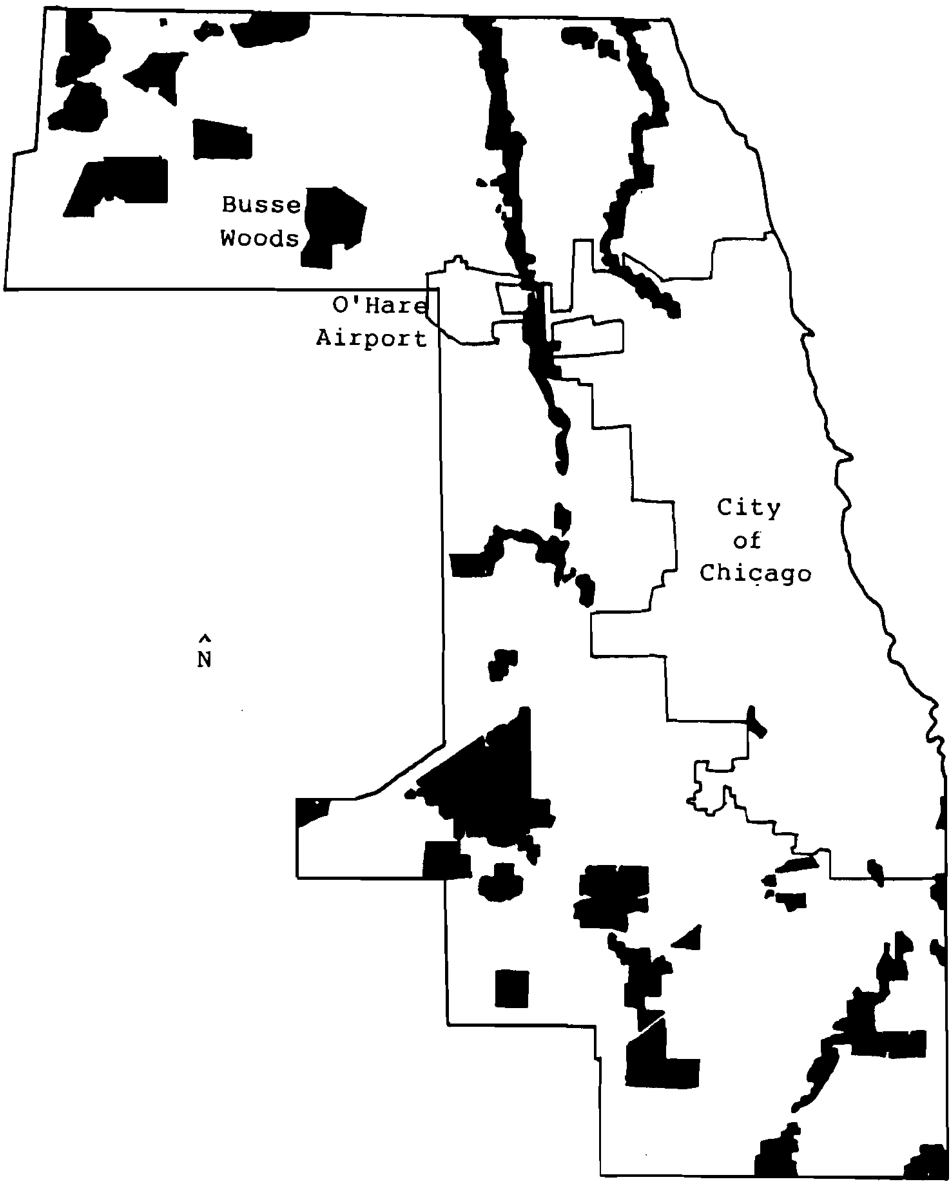


Figure 1. Forest Preserve District of Cook County. Preserves are shown in black.

safety is magnified on airports with resident deer. From March 1982 to July 1993, 4 deer-aircraft strikes were reported at O'Hare International Airport, and 4 strikes were reported at Peoria Regional Airport during September-November 1992 (Sliwinski 1993, Sliwinski, USDA-APHIS-ADC, pers. comm.). At least one deer was reported struck by a taxiing plane at Pal-waukee Airport in Wheeling during the last 2 years.

The potential for transmission of diseases from deer to humans (e.g., Lyme disease, encephalitis, and parasites in deer feces) seems to be a genuine fear of some homeowners (especially those with children) whose yards are frequented by deer. Reports of damage to ornamental, nursery, orchard, and garden plants received by IDOC offices have increased over the last decade as have requests to handle calls on "displaced" (i.e., deer observed in new and/or unusual places), injured and dead deer.

From an ecological perspective, high deer densities on remnant natural areas may virtually extirpate rare or endangered plants (Miller et al, 1992), reduce the abundance (as well as cover, density, vigor, diversity) of native plants species (Strole and Anderson 1992, Witham and Jones 1992), and possibly provide a competitive edge to exotic plant species. The loss of native plants negatively impacts other fauna reliant upon this plant life (McShea and Rappole 1992). Overbrowsing also compromises long-term efforts of ecosystem preservation and restoration efforts on the preserves.

URBAN DEER RESEARCH

Until the early 1980's, control of deer numbers near urban areas was limited to recreational archery hunting, occasional nuisance Deer Removal Permits issued for specific properties by IDOC personnel, poaching, and inaction or avoidance. A deer-plane strike at O'Hare International Airport in March 1982 prompted herd reduction on site, conducted cooperatively by the Illinois Department of Conservation and U.S. Fish and Wildlife Service personnel.

Due to public concerns about increasing deer numbers in the Chicago metropolitan area and concerns of natural area managers, the IDOC funded the Urban Deer Research Study (Pittman-Robertson Project #W-87-R). This study was conducted by the Illinois Natural History Survey (INHS) during 1983-90; the study area included Cook, DuPage, Kane, and Lake counties. Project activities were reviewed annually by members of a Community Liaison Committee (Table 1). This 6.5 year applied research project was integral in establishing procedures and guidelines for the future management of deer in urban settings, or currently unhuntable areas in Illinois (Jones and Witham 1990, Witham and Jones 1986, Witman and Jones 1989, Witman and Jones 1990, and Witman and Jones 1992). The Urban Deer Study provided many baseline datasets and initiated methodologies that are still being used, although continually updated, by agencies conducting deer control programs. The "hands-on" evaluation of deer population control techniques, as well as the review of techniques used elsewhere, provided precedence on what could be accomplished by what techniques and established working procedures for effectively accomplishing herd reduction goals. Experimental herd reductions were implemented in the Ned Brown Preserve (also called Busse Woods), Forest Preserve of Cook County, in central Cook County during the winter of 1985-86 and on O'Hare International Airport during the winter 1987-88.

DEER HERD REDUCTION ON BUSSE WOODS FOREST PRESERVE

The Ned Brown Preserve, more commonly known as Busse Woods, encompasses approximately 5 square miles (1,536 ha) including a 596 acre (241 ha) manmade reservoir (Figure 2). A 440 acre (177 ha) dedicated State nature preserve and federally-registered Natural Landmark is located in the north-central portion of the forest preserve. Busse Woods is divided into north and south halves by a 4-lane highway (i.e., State Route 72, Higgins Road) of high traffic volume. Neighboring land uses include several large indoor shopping malls, 2 tollways, 2 State highways and

Table 1. Agencies comprising the Community Liaison Committee for the INHS Urban Deer Study.

American Humane Association
Brookfield Zoo, Chicago Zoological Society
Forest Preserve District of Cook County
Forest Preserve District of DuPage County
Fund For Animals
Great Lakes Outdoor Writers
Illinois Audubon Society
Illinois Department of Conservation
Illinois Natural History Survey
Illinois Nature Preserves Commission
Illinois Wildlife Federation
Kane County Forest Preserve District
Lake County Forest Preserve District
Max McGraw Wildlife Foundation
Morton Arboretum
Chicago-O'Hare International Airport
Sierra Club
U.S. Department of Agriculture - Animal Damage Control

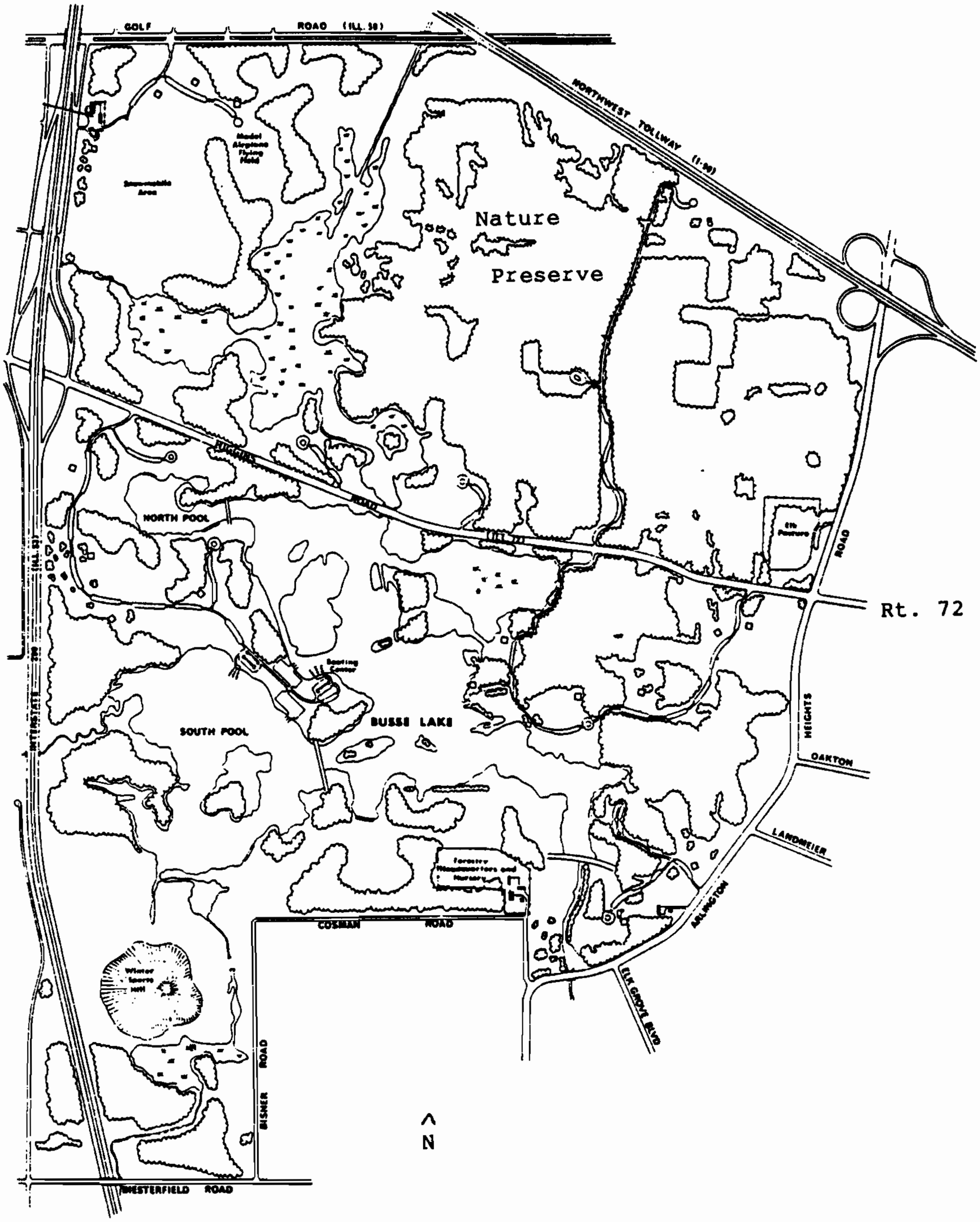


Figure 2. Ned Brown Preserve, or Busse Woods, in the Forest Preserve District of Cook County.

residential and commercial developments. Analysis of black and white aerial photographs of Busse Woods in 1949, 1964, 1970 and 1985, and of adjacent lands up to 3.1 miles (5 km) from the preserve boundaries, showed gradual insularization of the preserve. Agricultural land uses, which dominated (80%) adjacent properties in 1949 declined to 5% by 1985; intensive development dominated 70% of the landscape by 1985.

Approximately 66% of the preserve is mature second growth woodlots dominated by oaks (*Quercus spp.*), sugar maple (*Acer saccharum*) and basswood (*Tilia americana*), 10% is in old field successional stages, wetlands and mowed grassy areas, 15% is in open water, and 9% is roads and other developments (e.g., parking lots, picnic shelters, and restrooms). Dwyer et al. (1985) estimated 1.5 million people visited the preserve during 1985.

Busse Woods was the focus of many studies of the INHS Urban Deer Study. Aerial counts of deer numbers on the preserve began during the winter of 1983-84 using fixed-wing aircraft and were continued annually via helicopter starting in 1985. Minimum estimates of deer density during 1983-84 were 95.6 deer per square mile (37/km2) on the northern portion of the preserve and 11.2 per square mile (4.4/km2) on the southern half. The native woodlots on the northern section exhibited a classic browseline in the early 1980's and became the focus of intensive vegetation monitoring programs. A 72.2 feet x 170.6 feet x 8 feet high (22m x 52m x 2.4m) exclosure was constructed in the fall of 1983. Measurements of percent cover, stem density and species richness of understory plants $\leq$ 3.3 feet (1m) along 12 65.6 feet (20m) permanent transects within the exclosure and adjacent control plot began in August 1984 and were conducted annually thereafter in April-May. Other vegetation monitoring projects initiated on site in 1985 and 1986 included: permanent transects and quadrats to characterize the understory plants $\leq$ 3.3 feet (1m) in the four large native woodlots and to provide a comparison of the heavily browsed woodlots north of Route 72 to the minimally browsed woodlots south of the roadway; analysis of understory shrubs and saplings $\geq$ 3.3 feet; analysis of canopy tree composition, dominance and frequency; analysis of percent canopy closure; and mapping of woodlot soil types.

Rocket-netting and marking of Busse Woods deer to determine survival and dispersal began during winter 1983-84. Additionally, 35 deer were collected for condition evaluations, population age and sex reconstruction, analysis of reproductive rates and as part of a post-translocation survival substudy (Jones and Witham 1990) during the winters of 1983-84 and 1984-85. Based on condition evaluations and morphometry analyses, Busse Woods fawns were significantly smaller and had lower fat reserves in spring than elsewhere in the four county study area; winter mortality (N=16, >50% fawns) was first documented at Busse Woods in March 1985 during a driveline count.

Experimental reduction of the Busse Woods herd began during the winter of 1985-86. Objectives were to reduce deer density to 20 per square mile (8/Km2) and thereby allow regeneration of understory vegetation, reduce deer-vehicle accidents on adjacent roadways, and improve overall condition of the herd. During the winters of 1985-86 through 1987-88, 328 deer (189 females and 139 males) were collected; the desired herd density for the entire preserve was reached after winter 1986-87 collections and for the north half of the preserve after winter 1987-88 removals. Removals were conducted primarily by INHS sharpshooters; however, rocket-netting and drive-netting of deer were attempted on site. Mean removal rates via sharpshooting were 62.5 minutes per deer during the first winter and 108.1 minutes during the third winter presumably due to fewer and more wary deer present. Mean removal rate for rocket-netting, for the purpose of translocation, of 24 deer over two days in December 1984 (i.e., prior to herd reduction) was 170 minutes per deer. Associated costs were not determined for the various removal methods.

Recovery of native understory vegetation continues to date; reduction of deer numbers in a heavily-browsed, essentially closed canopy woodlot did not produce a rapid proliferation of understory plants. Although potentially more difficult to "sell", herd management activities must be implemented on a more proactive basis. Deer-vehicle accidents on roads adjacent to Busse Woods declined from 37 in 1982 to $\leq$ 13 annually since 1987. Based on condition evaluations and body weights, condition of the remaining animals increased significantly even in the absence of an immediate vegetative response to lower deer numbers.

DEER HERD REDUCTION ON CHICAGO-O'HARE INTERNATIONAL AIRPORT

The second experimental herd reduction implemented by the INHS was at Chicago-O'Hare International Airport (O'Hare) during late winter 1987-88. O'Hare is 7,700 acres (3,116 ha) and completely fenced with 6-7 feet (1.8- 2.1 m) fencing. At the time of INHS involvement, approximately 1,606 acres (650 ha) of O'Hare property was undeveloped and was comprised of early second growth (i.e., shrub and sapling) woodlots, a mixture of early successional fields, marshy areas, 3 tree nurseries, and maintained grassy areas adjacent to the runways and taxiways.

The assistance of INHS was solicited by City of Chicago personnel in response to a deer-plane strike in March 1987 which caused >$100,000 in damage to the aircraft. INHS Urban Deer Study personnel observed 66 deer during an aerial count, via helicopter, in January 1988. Herd reduction was initiated in January 1988. Objectives were to reduce deer numbers to 10, based on the decision of airport personnel, to insure human safety and to train airport personnel to coordinate future herd reductions as necessary. During January to April 1988, 54 deer (31 females and 23 males) were removed from O'Hare; 8 were rocket-netted and translocated as part of another substudy, 4 were rocket-netted and euthanized, and the remainder were taken primarily by sharpshooters in elevated blinds over bait sites. The overall mean removal rate for sharpshooting was 162 minutes per deer removed; deer became very wary at bait sites toward the end of removal activities. Five deer were counted during a subsequent aerial count via helicopter in April 1988; however, due to poor snow cover actual numbers of deer remaining were presumed to be at least two times higher.

DONATION OF VENISON

Prior to the INHS Urban Deer Study, no guidelines existed for the handling and donation of deer carcasses removed under authority of special IDOC permit. Most of the animals collected during the Busse Woods and O'Hare herd reductions were processed in a State-licensed facility and donated to the Greater Chicago Food Depository under authority of the Illinois Good Samaritan Food Donor Act (Good Sam. Act) which allows the donation of food to charitable organizations and limits donor liability. The INHS establish procedures and set precedence in the actual handling and donation of carcasses. INHS activities culminated in a letter of agreement between the Illinois Departments of Agriculture, Conservation, and Public Health in April 1989 which specifically outlined methods of handling (e.g., field-dressing, cooling, inspection, processing and donation) of deer carcasses collected by these nonhunting means.

The Good Sam. Act was amended in January 1993 to specifically include definitions of "wild game" and "wild game donor" in the lists of foods for donation and of donors. Wild game carcasses were defined, in part, as carcasses with entrails removed; thus, field-dressed carcasses, not only processed (e.g., ground) meat, could be donated to charities. To date, a new and more extensive memorandum of understanding to cover wild game carcasses was being negotiate by the three aforementioned State departments.

URBAN DEER MANAGEMENT

Deer herd reduction at Ryerson Conservation Area, Lake County

The winter of 1988-89 was a transitional period relative to urban deer control in NE Illinois. During fall 1988, the Lake County Forest Preserve District (LCFPD), assisted by the INHS and IDOC, proposed a proactive herd reduction program at the 550 acre (222.6 ha) Ryerson Conservation Area (RCA) and State nature preserve in south-central Lake County. Coupled with the Forest Preserve District of Cook County (FPDCC) assuming responsibility for controlling deer numbers on preserves initially managed by the INHS researchers, this was the first example of a public land-managing agency openly implementing a herd reduction program, and donating the resultant venison, using procedures established by INHS.

A discussion of RCA, and comparison of deer removal methods used since 1988, are provided by Mr. Frank Drummond (Wildlife Biologist, LCFPD) elsewhere in this proceedings. However, certain aspects of this program merit discussion here, namely the "controversy" surrounding the proposed sharpshooter culling of RCA deer. Local opposition to the proposed culling became organized as "the Concerned Veterinarians and Citizens to Save the Ryerson deer" (CVCSRD). Opposition focused on the killing of deer and deemed sharpshooting "inhumane". The issue drew considerable media coverage which often focused on citizens versus governmental agency and on an overly-simplified choice between native plants or deer. A Temporary Restraining Order filed by CVCSRD and the Humane Society of the United States in Lake County Circuit Court to stop the proposed sharpshooting was dismissed, with prejudice, in February 1989. However, LCFPD opted to "keep the peace" by box-trapping and translocating deer as long as this technique was effective in achieving the proposed removal of 60 deer and as long as release sites were available. IDOC limited release sites to "bonafide zoological institutions" which did not include commercial or personal game breeding facilities; only one zoo/wildlife park in central Illinois agreed to accept deer. The inability to capture adequate numbers of deer to achieve the desired herd reduction necessitated removal of >50% of the animals via sharpshooting.

Initiation of site- and species-specific project

Overlapping the INHS's study, the Urban Deer Management Project (UDMP) was initiated by IDOC in November 1988. The UDMP serves in an extension capacity by providing information, assistance, and recommendations to public land management agencies and individual landowners experiencing deer related damage in areas where the modern forms of deer population regulation (i.e., hunting) are not currently possible. The single person UDMP staff is responsible for: performing site-evaluations for, and providing information and recommendations to, individual landowners experiencing deer-related damage; handling calls from the public concerning dead, injured and displaced deer, and responding to requests for information on urban deer; supervising nonhunting deer management programs in urban/suburban areas Statewide. The latter entails reviewing applications for special IDOC Deer Population Control Permits, issuance of these permits as merited, viewing and approving bait and sharpshooting sites to insure human safety, and administering proficiency tests of proposed sharpshooters.

Additionally, the UDMP has been responsible for implementing, refining and formalizing guidelines on urban deer control methods and donation of venison developed by the INHS Urban Deer Study. The UDMP has assisted in the development of IDOC guidelines on the issuance of Deer Population Control Permits (DPCP) which are issued exclusively to land management agencies in urban, suburban or unhuntable areas. DPCP are requested via an application in the form of a site specific deer management proposal which documents the need to remove deer from a specific property, estimates current numbers or density of deer, proposes desired herd density goals, identifies techniques to be used, and describes the means by which the effectiveness of the program will be evaluated. Current guidelines for DPCP restrict herd reduction/control techniques to those "field-proven effective", place restrictions on live-capture and intrastate translocation, and mandate that venison resulting from lethal programs be donated to not-for-profit charitable organizations.

Current management programs in NE Illinois

An increasing number of land management agencies have expressed interest in deer management, requested IDOC assistance in appraising their current deer situation and alternatives, and have applied to IDOC for DPCP. The number of agencies implementing herd control programs has increased from four (working on four separate sites) during the winter of 1988-89 to six agencies (conducting 14 separate site-specific programs) in Cook, DuPage and Lake counties during the winter 1992-93; only lethal methods of removal were used during the last two winters. The latter programs resulted in 19,800 pounds (8,981 kg) of inspected and processed (i.e., ground) venison being distributed to > 40 local charities. Estimated cost per deer removed varied widely among agencies collecting deer during winter 1992-93. These costs ranged from $91.32/deer for a long-term program on an 1,800 acre (728.5 ha) fenced site where a pre-removal aerial count was not conducted and sharpshooting was performed by staff personnel to ≥ $300/deer for a new program in a 10 square mile (25.9 km2) village where an aerial count was conducted and sharpshooters were hired contractually from outside the agency. Additionally, several municipalities in NE Cook County and SE Lake County have solicited public input on the need for controlling deer numbers and are currently weighing deer population control and damage abatement alternatives.

Relatively few (i.e., two programs in five years) of the deer control programs in NE Illinois have stimulated organized public opposition. Those that have, seem to face the most vocal opposition from local residents or groups. Although the latter have sought advice from outside (generally out-of-state) "experts" and from national animal rights organizations, this localized opposition seemingly borders on the "Not In My Backyard" syndrome and brings with it localized and individual definitions of "humane". The first sharpshooting program proposed in Lake County was deemed inhumane by local opposition which viewed live-capture and translocation as the acceptable alternative. More recently, the first herd reduction program proposed and implemented by the Forest Preserve District of DuPage County (FPDDC) at the Waterfall Glen Forest Preserve during winter 1992-93 has met with opposition and renewed media interest. The use of rocket-netting and immediate euthanization via penetrating captive bolt as a technique to augment sharpshooting has been a focus of opposition at Waterfall Glen. In this case, live-capture, if used as a lethal technique, was deemed inhumane and sharpshooting was acceptable as a last resort. Despite protests at the gates to Waterfall Glen, covered by several members of the media, and attempts to physically disrupt deer removal activities, the herd reduction program has continued.

CONCLUSION

The subject of lethal deer control in urban areas in Illinois remains an emotional issue; the "controvery" associated with the aforementioned programs exemplifies the dire need for proactive/preemptive education of the urban public(s) and elected officials, but with the absolute knowledge that some individuals will never accept the killing of an overly abundant species to preserve an ecosystem or to maximize human safety. However, the inescapable and immediate need to control deer numbers in order to insure human safety, to protect existing natural areas or ecosystem (e.g., prairie and savanna) restorations projects, and/or reduce deer-related damage to private property has forced local land management agencies and municipalities to pursue relatively expensive and labor-intensive herd reduction programs despite the potential for a somewhat "tarnished" public image. The number of herd control programs in northeast Illinois will undoubtedly continue to increase, but it remains to be seen whether the subject of urban deer management becomes "old news". Continued public education by state, county, and municipal agencies will hopefully facilitate greater public awareness and minimize the need to "prove" the need for herd management time and time again.

LITERATURE CITED

Dwyer, J.F., H.W. Schroeder, and R.L. Buck. 1985. Patterns of use in an urban forest recreation area. Proc. 1985 Outdoor Recreational Trends Symp. Volume II.

Jones, J.M., and J.H. Witham. 1990. Post-translocation survival and movement of metropolitan white-tailed deer. Wildl. Soc. Bull. 18:434-441.

McShea, W.J., and J.H. Rappole. 1992. White-tailed deer as keystone species within the forest habitats of Virginia. Va. Jour. Sci. 43:177-186.

Miller, S.G., S.P. Bratton, and J. Hadidian. 1992. Impacts of white-tailed deer on endangered and threatened vascular plants. Natural Areas Jour. 12:67-74.

Northeastern Illinois Planning Commission. 1993. The components of population change in northeastern Illinois, 1980-1990. Data Bull. 93-1. NIPC, Chicago, IL. 62pp.

Sliwinski, R.P. 1993. White-tailed deer at O'Hare International Airport: A report of the history, present conditions and future implications of deer and deer management at the world's busiest airport. USDA-APHIS-ADC management proposal. 57pp.

Strole, T.A., and R.C. Anderson. 1992. White-tailed deer browsing: Species preferences and implications for central Illinois forests. Nat. Areas Jour. 12:139-144.

Witham, J.H., and J.M. Jones. 1986. Deer-human interactions and research in the Chicago metropolitan area. Pages 155-159 *in* L.W. Adams and D.L. Leedy, eds., Integrating man and nature in the metropolitan environment. Proc. Natl. Symp. on Urban Wildl. Natl. Institute for Urban Wildl., Columbia, MD.

___, and ___. 1989. Managing urban deer in Illinois: the role of state government. Pages 81-84 *in* A.J. Bjugstad, D.W. Uresk, and R.H. Hamre, eds. Ninth Great Plains Wildl. Damage Control Workshop Proc., Gen. Tech. Rep. RM-171. USDA Forest Service And Range Experimental Station, Fort Collins, CO. 181pp.

___, and ___. 1990. White-tailed deer abundance on metropolitan forest preserves during winter in northeastern Illinois. Wildl. Soc. Bull. 18:13-16.

___, and _____. 1992. Biology, ecology, and management of deer in the Chicago metropolitan area. Final Job Completion Report, Pittman-Robertson project W-87-R. 108pp.+appendices.

___, E.A. Cook, and J.M. Jones. 1992. White-tailed deer habitat change in metropolitan northeastern Illinois. Appendix F *in* J.H. Witham and J.M. Jones, Biology, ecology, and management of deer in the Chicago metropolitan area. Final Job Completion Report, Pittman-Robertson project W-87-R. 108pp.+ apendices.

CHRONOLOGY OF THE DEER MANAGEMENT DEBATE IN RIVER HILLS, WISCONSIN

WILLIAM E. ISHMAEL, Department of Natural Resources, Spring Green, WI
DALE E. KATSMA, Department of Natural Resources, Plymouth, WI
THOMAS A. ISAAC, Department of Natural Resources,Hartford, WI

The presence of deer (*Odocoileus spp.*) herds in a suburban environment creates challenging management situations for communities and wildlife professionals. Divergent opinions about deer population levels, deer damage, Lyme disease, the need for deer control, and the best control option leads to politically volatile situations. Public debate over whether deer are indeed causing problems and need to be controlled delays management decisions and allows further herd growth prior to initiating herd control measures. The decision to initiate control measures incites further debate over selection of a preferred management option.

Professional resource management agencies usually recommend lethal control methods such as regulated hunting or sharpshooting as the most efficient and effective herd control option. In addition, groups appointed to evaluate management options often recommend hunting or sharpshooting as the best method (Cobb 1982, Univ. of Wisc. 1987, McAninch and Parker 1991). However, efforts to implement lethal control options have been actively challenged by animal activist groups through litigation or disruptive activities (Cook 1974, Lampton 1982, Girard et al. 1993) further focusing media attention on an already volatile situation. Municipal governments also express concern about public safety and liability and efforts may be hampered by existing firearm discharge ordinances (Ishmael and Rongstad 1984, McAninch and Parker 1991).

Although many of these conflicts are unavoidable, resolution of debates may be facilitated through an analysis of past conflicts regarding urban deer management. In this paper, we chronicle the series of events that developed between 1985 and 1993 as the Village of River Hills, Wisconsin took steps to address problems associated with a growing white-tailed deer (*Odocoileus virginianus*) population. Information in this paper is from various sources, including internal agency documents, personal communications, minutes of the River Hills Citizens Deer Advisory Committee (CAC), minutes of the River Hills Village Board of Trustees, and local newspaper articles. We have attempted to verify all information obtained from unpublished reports or personal communications.

COMMUNITY PROFILE

The Village of River Hills is an affluent 5.32 square mile (13.8 sq. km) suburb of Milwaukee located in north-eastern Milwaukee County. Incorporated in 1930, the village contains some of the oldest and largest estate properties in southeast Wisconsin. Eighty percent of River Hills is zoned for a 5-acre (2 ha) minimum lot size and larger lots are common. Currently, 1,638 people reside in the village. The area includes 575 residences, two schools, two churches, two country clubs, village government offices and municipal buildings. The entire village is zoned as single-family residential.

Village government consists of a 7-member Board of Trustees (Board) elected to 3-year terms. The Board is responsible for enactment of village ordinances, policies, and budgets and conducts regularly-scheduled monthly meetings. A village manager, appointed by the Board, oversees public services and operations such as the village police and fire departments and department of public works.

Village residents have an average annual per capita income of approximately $100,000 and the average 1992 valuation of a residence in River Hills was $407,000. Average annual village budgets total approximately $2 million.

River Hills is bounded on the west by the Milwaukee River and on the east by a six-lane interstate highway. The village contains more than 27 miles (43 km.) of paved roads, including two, six-lane east-west thoroughfares bisect the village. Relatively high-density residential development surrounds the village, except for along the north border. Natural vegetation, including mature woodlots, covers a portion of most properties and is interspersed with remnant farm fields, pasture, conifer plantations, apple orchards, and landscaped lawns. Many residents have planted ornamental trees and shrubs for screening and aesthetics. Earthen berms (<50 ft.) have been constructed along major traffic arteries as sound and visual barriers. Approximately 75 percent of the gross land area (4 sq.mi., 10 sq.km.) is considered to be suitable deer range as classified by Wisconsin Department of Natural Resources (DNR) methodology

(McCaffery 1987) although deer inhabit all areas of the village. A village ordinance restricts the discharge of firearms and bows and arrows effectively prohibits hunting. Although a village ordinance has prohibited deer feeding since 1990, many residents still provide feed to deer and other wildlife throughout the winter months.

DEER POPULATION

Deer damage to native and planted vegetation and car-deer collisions have been increasing since the late 1970's in the communities of Fox Point, Bayside, Mequon, and River Hills, Wisconsin (Table 1). These communities share common borders and are located immediately north of the city of Milwaukee. By 1981, the deer population in and around the Schlitz Audubon Center (SAC), a corporate-owned 185-acre (75 ha) nature preserve in Bayside, had grown to intolerable levels and SAC managers requested DNR approval to live-capture and translocate deer to a state-owned wildlife management area 25 miles (40 km) north of the Milwaukee metropolitan area. Between 1981 and 1985, SAC managers used chemical immobilization techniques to capture deer (Ashley 1982). Some were radio-tagged and released back to the preserve as part of an ongoing public education program conducted by SAC staff. Estimated costs of these initial removal efforts totalled approximately $400 per deer removed (SAC unpubl. rpt.). In 1986, SAC began using box traps instead of chemical immobilization and, in addition to employing volunteer labor, trapping costs were reduced to an estimated $72 per deer (See CAC minutes June 11, 1987). Between 1981 and 1993, 168 deer were removed from SAC.

Anecdotal reports by River Hills residents indicate deer were transient or present in low numbers in the village prior to 1970. By 1970, deer sightings were more common and 9 deer-vehicle collisions were reported on village streets. Although no censuses were conducted prior to February, 1986, the number of deer-vehicle collisions, adjusted for increased traffic volume, indicate a stable or slowly growing deer population prior to 1983 (Bryant 1992).

Rapid suburban and commercial development on agricultural lands to the north and west of River Hills proceeded through the 1970's and early 1980's and, combined with adoption of local firearms ordinances in these areas, resulted in a larger refuge for deer. Intensive development of lands bordering River Hills caused the village deer population to become more insular and may have displaced some deer into the less densely developed village. Deer-vehicle collision data (Village of River Hills unpubl. rpt.), reports by village residents and officials, and more prominent browse lines and damage to ornamental vegetation suggests an increase in the rate of herd growth beginning in 1983. An initial helicopter census during winter 1985-86 resulted in a count of 159 deer (30/sq.mi., 12/sq.km.). Continued annual helicopter censuses, combined with deer-vehicle collision data, indicate the village deer population reached a peak of 339 (64/sq.mi., 25/sq.km.) by August, 1988 despite deer removal efforts that were initiated in 1987 (Figure 1). Annual removal of deer since 1987 succeeded in reducing the population to approximately 90 deer during the winter of 1992-93 (Ishmael et al. 1995).

THE DEER DEBATE

Prompted by concern over increasing car-deer collisions and citizen complaints of deer damage to native and planted vegetation, the Board appointed a four-member Citizens Deer Advisory Committee in May, 1985. The CAC was established to study the extent of the deer problem and provide recommendations to the Board on action necessary to resolve deer-related problems in the village.

The CAC requested the assistance of wildlife professionals from the DNR and University of Wisconsin (UW) to provide background information on deer damage abatement, deer population survey techniques, and options for population control. CAC members were also referred to, and gathered information from, resource management agencies, municipal governments, and advisory groups in other states that were experiencing similar problems with urban deer populations. The CAC requested that DNR conduct an aerial census of the village deer population and in November, 1985 the Board authorized funding for helicopter charter. The DNR agreed to obtain necessary flight approvals, prepare maps and aerial photos for the flight, provide observers, and provide a report to the village on the number and location of deer counted.

The first aerial census was conducted in February, 1986 and 159 deer were counted in the village (30/sq.mi., 11/sq.km.) (Figure 2). Deer population goals for Wisconsin deer management units are established through a public hearing process and winter population goals for units in southeast Wisconsin have been set at 10 to 15 deer per square mile of range (Ishmael 1990). The CAC felt that these were reasonable goals to adopt for the village.

Following the 1986 aerial census, DNR recommended that the village implement a sharpshooting program during winter 1986-87 to

Table 1. Chronology of events that took place between 1970 and 1993 related to deer management in the Village of River Hills, Wisconsin.

Year	Event
1970-80	Growth of deer populations in Fox Point, Bayside, Mequon, and River Hills becoming evident. Car-deer collisions increased and damage to native and planted vegetation becoming noticeable.
	Suburban and commercial development in areas surrounding River Hills. Deer being displaced by development and existing herds becoming more insular. Firearms ordinances and lack of hunting access creates more refuge for deer.
1981	Schlitz Audubon Center (SAC) of neighboring Bayside begins translocating deer to rural sites.
1984	Increasing car-deer collisions and vegetation damage in River Hills. Problem is brought to the attention of Village Board of Trustees (Board).
1985	
May	Board appoints 4-member Citizens Deer Advisory committee (CAC) to study deer problem and make recommendations.
November	Board approves funding to conduct aerial census of village deer population.
1986	
February	First aerial census conducted. 159 deer (30/sq.mi., 11/sq.km.) counted.
April	Department of Natural Resources (DNR) and University of Wisconsin (UW) personnel recommend sharpshooting as herd control method.
June	CAC recommends prohibition of deer feeding, follow-up aerial census, abatement methods, and further study of control options.
1987	No aerial census due to lack of snow.
April	DNR herd projections estimate village herd could exceed 300 by August.
July	CAC recommends trial live-capture/translocation program. Board requests trapping permit from DNR.
September	Board authorizes expenditures for up to $16,000 for trapping program.
December	Trapping commences and continues through March, 1988.
1988	
January	Second aerial census (227 deer) indicates peak pre-trapping population of 289 deer.
	Lyme disease information mailed to vilage residents.
March	Trapping operations cease - 44 deer captured during winter 1987-88.
September	CAC recommends sharpshooting program. Board adopts recommendation.
October-November	Bait and shooting sites selected and established.
	Animal rights groups and concerned residents lobby Board to consider alternative control options. Village unable to secure cost-effective liability insurance coverage for sharpshooting operations.
December	Sharpshooting program delayed. Live-capture efforts intensified and continue through March, 1989.
1989	
January	Presentation on wildlife contraception technology to the Board.

Year	Year
1989	
February	Third aerial census (248 deer) indicates peak pre-trapping population of 339 (64/square mile, 25/km^2.).
March	Trapping operations cease - 122 deer captured during winter 1988-89. Radio-tagging study begins.
April-November	Board investigation of liability insurance coverage, necessary for sharpshooting program, continues.
December	Live-capture efforts commence and continue through March, 1990.
1990	
January	Fourth aerial census (171) indicates peak pre-trapping population of 290 (55/square mile, 21/km^2). Village firearm ordinance repealed and re-created to allow firearm discharge under special conditions.
February	Letter sent to all village residents on traffic speed enforcement and safety.
October	Survey questionnaire regarding deer management program mailed by Board to all village residents. DNR closes southeast Wisconsin release sites to any further release. CAC recommends short-term sharpshooting program, live-capture/euthanasia, and donation of meat from shot and trapped deer to local food pantries.
November	Board adopts CAC recommendation and applies to DNR for shooting and trapping permits. Board enacts ordinance prohibiting deer feeding.
December	Fifth aerial census (161) indicates a peak pre-trapping population of 193 (36/square mile, 41/km^2). 10 deer trapped and euthanized at meat processing facility. Candlelight vigil conducted in protest of deer killing. Board rescinds decision to implement sharpshooting program.
1991	
January	Board policy adopted for continuation of live-capture/translocation program. Trapping commences. Deer translocated to release sites in Dane County.
June	Results of radio-tagging study presented to CAC.
September	DNR discontinues authorizations of release to rural sites.
October	Bid requests sent to Wisconsin licensed deer farms.
December	Trapping commences and continues through ?March?, 1992. All captured deer are translocated to deer farm.
1992	
January	Sixth aerial census (96) indicates a peak pre-trapping population of 178 deer (34/square mile, 13/km^2).
March	Trapping ceases - 64 deer translocated to deer farm.
August	Bid requests sent to Wisconsin licensed deer farms.
November	Trapping commences and continues to December 11. 18 deer captured and translocated to deer farm.
December	Sixth aerial census (86) indicates a peak pre-trapping population of 118 deer (33/square mile, 9/km^2). Trapping ceases on December 11.

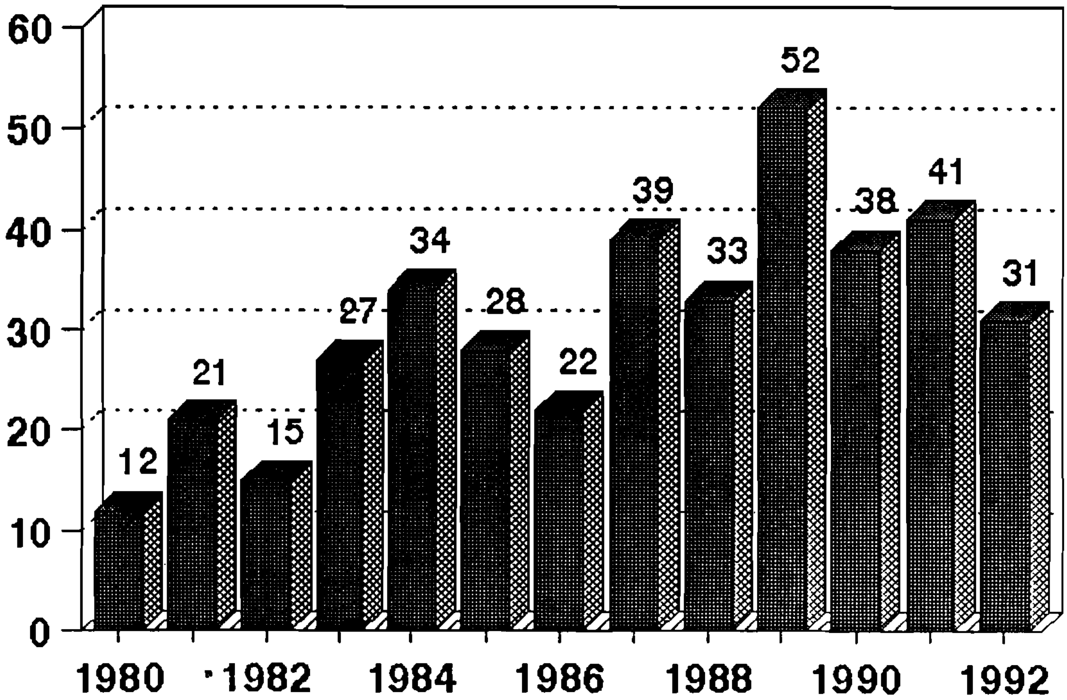


Figure 1. Car-deer collisions in River Hills, Wisconsin 1970-1992.

sharply reduce the herd. Although the CAC seriously considered this option, they felt that lethal control would be viewed negatively by the majority of village residents and that discharge of firearms in the village would raise additional concerns regarding public safety and liability. The following CAC recommendations were given to the Board in June, 1986 (Board minutes 6/18/86): 1) Prohibit deer feeding in the village; 2) Conduct a follow-up aerial census during winter 1986-87; 3) Provide information to village residents on deer damage abatement methods; and, 4) Continue to study the need for adopting an annual herd reduction program.

At this time, no action was taken on the CAC recommendation to prohibit deer feeding. However, literature on deer damage abatement techniques was made available to village residents and funding for a winter 1986-87 aerial census was approved.

During 1986, the CAC continued to make contacts with other states and also requested input from managers of the SAC regarding deer removal operations at SAC. In addition, DNR and UW personnel met with Board members in November, 1986 to discuss potential options for deer herd reductions including sharpshooting, live-capture and translocation, and live-capture/euthanasia. Lack of snow cover during winter 1986-87 prevented an aerial census (Figure 2) although DNR projections of herd growth estimated the village deer population could exceed 300 (56/sq.mi., 21/sq.km.) by August, 1987.

Continued increases in car-deer collisions and vegetation damage, coupled with herd growth projections, compelled the CAC to recommend that a "trial" live-capture and translocation program be initiated during winter 1987-88. This recommendation was opposed by a small number of residents who did not want the deer population reduced, although no organized protests took place. The Board approved this recommendation in September, 1987 and authorized funding up to $16,000 for the trapping program. Trapping began in December, 1987 under permit by DNR. All trapping and translocation was conducted by village Department of Public Works employees. Forty-

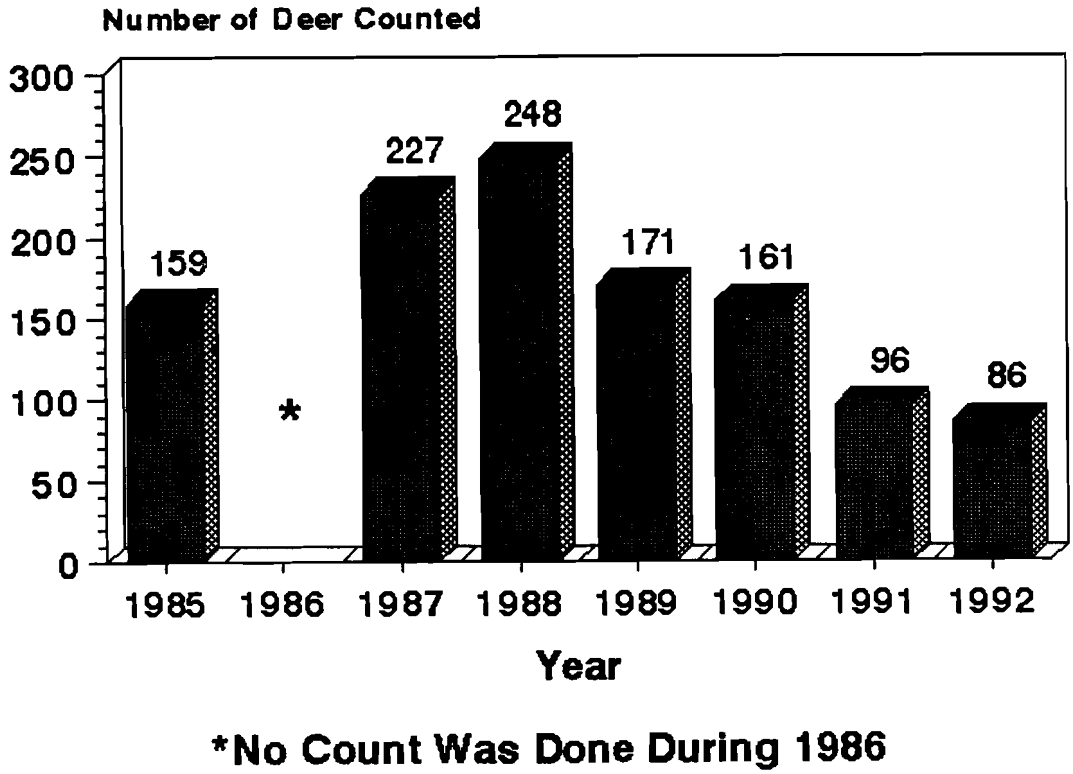


Figure 2. Results of annual aerial deer counts in River Hills, Wisconsin 1985-1992. Winters are labeled by initial year (e.g. 1985 is 1985-86).

four deer were captured and removed during winter 1987-88 (Ishmael et al 1995). An aerial census in January, 1988 indicated a pre-trapping population of 289 (54/sq.mi., 21/sq.km.) (Figure 2).

During late 1987 and early 1988, concerns about the spread of Lyme disease entered discussions about deer management in the village. Although few, if any, deer ticks (*Ixodes dammini*) had been found in southeastern counties prior to this time (Godsey et al. 1987), village health officials were concerned that, should ticks and the disease become common, a dense deer population in close contact with humans may facilitate the spread of Lyme disease among residents and their pets. As a result, informational materials on Lyme disease were mailed to all village residents.

Limited trapping success and projections of continued herd growth, followed by further consultation with DNR, UW, and other states agencies, lead the CAC to recommend implementing a one-year sharpshooting program to reduce the herd to a point where live-capture and translocation could effectively control herd growth. This recommendation was adopted by the Board in September, 1988 and preparations began to establish bait stations and shooting sites. Until this time, public reaction to deer removal efforts had come largely from village residents. However, as local media coverage of the plan to shoot deer became intense, the plan to conduct sharpshooting drew an immediate negative response from many individuals and groups outside the community. A local animal rights group was granted a request to meet with the Board chairman and CAC to express their opposition to the plan and to recommend non-lethal alternatives. In addition, a group of village residents organized and prepared an alternative proposal to addressing the deer problem. The proposal included reducing traffic speeds on village streets, construction of fence barriers at frequent deer crossings, emphasis on vegetation damage abatement techniques, translocation to Wisconsin licensed deer farms, and recommended the Board investigate the potential for using contraception technology to control herd growth. This group, later organized into "The Friends of River Hills", continues to emphasize non-lethal methods for controlling deer-related property damage in the village and published a deer damage control handbook for landowners (Friends of River Hills 1991). Interestingly, publicity regarding the proposal to shoot deer also caused the village office to be flooded with calls from individuals volunteering to take part in the shooting program or requesting venison from shot deer.

Plans to conduct sharpshooting were further stymied due to difficulties in securing cost-effective village liability insurance coverage for sharpshooting activities. This problem, in addition to negative public reaction, compelled the Board to delay implementation of the sharpshooting program and to increase trapping efforts during winter 1988-89.

In January, 1989 Dr. Ed Plotka of the Marshfield Medical Research Foundation was invited by the Board to make a presentation on contraceptive technologies that could potentially be used for deer population control. This option was not approved due to questions about costs, efficiency, and federal and state approvals.

During early 1989, the Board and CAC continued to seek cost-effective liability insurance coverage and a private contractor to conduct a sharpshooting program. Trapping and translocation continued although a February, 1989 aerial census indicated the herd was still increasing. At this time, a research project was initiated jointly by the DNR, UW, and River Hills which involved radio-tagging a sample of resident and translocated deer. The objectives and results of this study are reported by Bryant and Ishmael (1991), Bryant (1992), and Ishmael et al (1995). No further Board action regarding deer control was noted until late 1989 when the village again applied for a DNR permit to trap and translocate deer. Trapping again continued through winter of 1989-90 and 120 deer were removed.

Preliminary results of the tagging study indicated in early 1990 that translocated deer were suffering high post-release mortality and were also causing property damage near release sites (Bryant and Ishmael 1991). In addition, deer populations on southeast Wisconsin release sites had reached or exceeded population goals and DNR discontinued authorizations of releases to these sites after the 1989-90 trapping effort.

In October, 1990 the CAC unanimously approved the following recommendations to the Board regarding deer removal during winter 1990-91 (CAC minutes 10/15/90): 1) Conduct a short-term sharpshooting program; 2) Continue live-capture efforts and transport deer to a licensed meat processing facility; and, 3) All meat from captured or shot deer will be donated to food pantries in the Milwaukee metropolitan area. The Board adopted these recommendations and applied to DNR for permits to shoot deer at baited sites and to trap and euthanise. At this time, the Board also enacted a village ordinance prohibiting the feeding of deer. Ten deer were captured in December, 1990 and transported to a licensed meat processing facility where they were killed with blunt trauma to the head. Although this is a common livestock killing technique used by meat processing facilities, local media portrayed these deer as being "bludgeoned to death" and negative public reaction was intense. Shortly after media reports, a candlelight vigil was organized and held at the village hall to demonstrate opposition. As a result of strong negative public reaction, the Board rescinded it's decision to implement a sharpshooting program and suspended live-capture/euthanasia efforts.

In January, 1991 the Board adopted a policy of continuing an aggressive translocation program. DNR required that captured deer be translocated to release sites in Dane County as these were the only sites in southern Wisconsin that were below population goals. Problems associated with deer damage near these release sites lead the DNR to discontinue authorizations of all live release of captured deer following the winter of 1990-91.

In September, 1991, the number of CAC members was increased to nine in an effort to obtain a broader range of viewpoints and backgrounds. A CAC recommendation to establish an over-winter goal of 75 deer for the village was approved by the Board. Also, the DNR agreed to authorize the sale of captured deer to Wisconsin licensed deer farms as an alternative to release to rural sites, with proceeds of the sale being returned to the state as required by Wisconsin statute. State statutes (ss. 29.578) authorize private landowners, under license by DNR, to raise deer in captivity for the purposes of "breeding, propagating, killing, and selling". The state currently licenses approximately 360 such operations. As a condition of sale to deer farms, the village was required to submit requests for bids to all licensed operations. Bids were reviewed by DNR and a successful bidder was selected in consultation with the village. Beginning in December, 1991 all captured deer (from River Hills and SAC) were sold to a deer farm. Fifty-six deer were trapped prior to January 15, 1992 when the Board recommended discontinuing trapping until an aerial count could be done. The January 24 aerial count indicated 96 deer were present. Trapping was resumed and 22 more deer were trapped by mid-February at which time trapping was halted.

In January 1992, the CAC approved a recommendation to set up a controlled study of the impact of browsing on natural vegetation in the village. In May, the CAC recommended that a panel made up of representatives from the UW, Milwaukee Public Museum, and DNR be set up to answer residents' questions including, but not limited to, deer population criteria, practical remedies for plant damage, solutions in other areas of the country, and deer movement patterns. Also, in June, 1992, the CAC recommended that the Board contact representatives of adjacent communities to discuss deer management.

Following the June CAC meeting, the Board voted to restructure the CAC along with the former Citizens Committee on the Environment (CE) (a committee responsible for establishing a recycling program and privatizing the village's garbage removal service), into a new CE charged with handling all environmental issues including the deer management. The membership of the new CE was increased from 10 to 12 and included 6 members from the former CAC. One of the new CE's first actions was to ask the village manager to contact state and county traffic engineers for suggestions to reduce car/deer accidents.

During July-August, 1992, a new trapping permit and bid contract were drawn up in cooperation with the DNR, and bids were sent out. Only one bid was submitted, by the same successful bidder as 1991, at a rate of $25 per deer. In November 1992, the CE recommended an initial trapping of 15 deer followed by a cessation of trapping until an aerial count is completed, at which time the CE would make a further recommendation as to the number of deer trapped. Fifteen deer were trapped and a December 1992 aerial count indicated 86 deer were present. Trapping was halted following this count due to concerns by the CE that the count's inherent inaccuracy combined with further trapping and additional car/deer collisions may result in the deer population dropping below the prescribed goal of 75.

THE FUTURE

At the time of this writing, River Hills is preparing for a seventh season of deer trapping and removal. The DNR estimated a population of 100 deer for fall 1993 based on the previous aerial count, subsequent car\deer collisions, and annual herd growth. It is anticipated that 15 to 25 deer will need to be removed to reduce the population to 75 deer. The CE determined during it's February 1993 meeting that 75 should not be a permanent deer goal, but the number should be set each fall based on CE recommendations.

It is likely that River Hills and SAC will continue trapping and relocating deer to deer farms as long as this option is available. It is not known what will occur if no deer farm decides to bid on the deer. This issue will need to be resolved in the near future.

In 1991, DNR established a "Metro" Deer Management Unit, covering the Milwaukee metropolitan area, to provide a more regional approach to deer management in southeast Wisconsin. Archery and gun deer season lengths and harvest limits were liberalized in this unit to allow hunters to take up to four deer (1 buck plus three antlerless). Early results indicate that this program is working where hunting is allowed. The long-term success of the program will depend on the willingness of landowners and municipalities to allow hunting on their land.

The DNR is currently developing an urban deer "task force" made up of representatives of several metropolitan communities (including River Hills), other state and county government agencies, and interest groups and stakeholders to study urban deer issues and recommend deer management options that could be used on a more regional basis. A series of facilitated meetings will be held, similar to the approach used in Minnesota (McAninch and Parker 1991). The first meeting of this task force is scheduled for January 10, 1994.

ACKNOWLEDGEMENTS

The preparation of this paper would not have been possible without the assistance of many groups and individuals. We gratefully acknowledge the assistance and cooperation of the River Hills Board of Trustees, Village Manager, Joe Szyper, Kurt Fredrickson of the River Hills Department of Public Works, and other village staff for providing much of the information included in this report. Additional information was provided by the Schlitz Audubon Center and the municipalities of Mequon, Fox Point, and Bayside. We also thank the members of Whitetails Unlimited and Safari Club International who provided funding and radio-telemetry equipment for the study of urban and translocated deer.

LITERATURE CITED

Ashley, R.F. 1982. Milwaukee's dear deer. Wis. Nat. Resour. 6:6-11.

Bryant, B. 1992. Movements and mortality of suburban and translocated suburban white-tailed deer in southeastern Wisconsin. M.S. thesis. Dept. of Biological Sciences. Univ. of Wis.-Milwaukee. 78 pp.

___, and W. Ishmael. 1991. Movement and mortality patterns of resident and translocated suburban white-tailed deer. Pages 53-58 *in* L.W. Adams and D.L. Leedy eds., Wildlife conservation in metropolitan environments. N.T.U.W. Sym. Sec. 2. 264pp.

Cobb, T.L. 1982. Deer management unit 53. New York State Conserv. 37:12-17, 41.

Cook, J. 1974. Court denies bid to halt 6-day Jersey deer hunt. *New York Times*, Dec. 7, pB33.

"Friends of River Hills". 1991. Best methods handbook for controlling wildlife damage to plants and garden. 8 pp.

Godsey, M.S., T.E. Amundson, E.C. Burgess, W.L. Schell, G.P. Davis, R.A. Kaslow, and R. Edelman. 1987. Lyme disease ecology in Wisconsin: Distribution and host preferences of (*Ixodes dammini*) and prevelance of antibodies to (*Borrelia burgdorferi*) in small mammals. Am. J. Trop. Med. Hyg. 37:180-187.

Girard, G.T., B.D. Anderson, and T.A. DeLaney. 1993. Managing conflicts with animal activists: white-tailed deer and Illinois nature preserves. Nat. Areas Journ. 13:1-10.

Ishmael, W.E. 1990. Counting heads in the herd. Wis. Nat. Resour. 14(5):21-28.

___, and O.J. Rongstad. 1984. Economics of an urban deer-removal program. Wildl. Soc. Bull. 12:394-398.

Lampton, B. 1982. Controversy in the 'Glades. Florida Wildl. 36:12-18.

McAninch, J.B. and J.M. Parker. 1991. Urban deer management programs: A facilitated approach. Trans. North Am. Wildl. and Nat. Res. Conf. 56:428-436.

McCaffery, K.R. 1987. Reinventory of deer range. Wis. Dept. Nat. Resour. Bur. of Res. publ. # W-141-R-23. 25 pp.

University of Wisconsin. 1987. Report on deer management. Univ. of Wis. Arb. Manage. Subcomm. 21 pp.

DEVELOPMENT AND IMPLEMENTATION OF A DEER MANAGEMENT PROGRAM IN IPSWICH, MASSACHUSETTS

ROBERT D. DEBLINGER, Division of Fisheries and Wildlife, Field Headquarters, Westborough, MA
DAVID W. RIMMER, The Trustees of Reservations, Crane Memorial Reservation, Ipswich, MA

Records dating back to the colonial era indicate that a moderate abundance of white-tailed deer (*Odocoileus virginianus*) inhabited extensive mature forests in the northeastern United States. However, white man's agricultural activities throughout the 17th - 19th centuries led to a drastic decline in deer habitat. Coupled with market hunting, deer abundance declined so precipitously that by 1900 deer sightings were reported as rare events in newspapers (Allen 1929). With the advent of regulated hunting in the mid-1900s and the decline of agriculture in New England, deer populations grew to the point where current abundance is at record levels. In Massachusetts, where agriculture has declined drastically (i.e. 42% less acreage from 1951 to 1971 and 4% annual decline since), the annual adult male deer harvest has increased steadily from 1000 in 1967 to 5000 today. The statewide deer herd is currently estimated at approximately 70,000 (G. Vecellio, MA Div. Fish and Wildl., pers. comm.).

Increased deer abundance in areas where predators are virtually absent and hunting is prohibited has created local over-population problems in various locations in the northeast United States. In Massachusetts, such problems have occurred on the islands of Martha's Vineyard and Nantucket, at the Parker River National Wildlife Refuge, Newburyport, the Quabbin Reservation in central Massachusetts (despite a thriving coyote (*Canis latrans*) population) and at the Richard T. Crane, Jr. Memorial Reservation (CMR) and the Cornelius and Mine' Crane Wildlife Refuge (CWR), Ipswich and Essex, Massachusetts.

The purpose of this paper is to provide a chronology of the deer over-population problem at CMR/CWR and to describe events that culminated in the implementation of a controversial program to reduce a previously unhunted population of deer.

STUDY AREA

The CMR and the CWR are located in Ipswich and Essex, Massachusetts and are owned and operated by The Trustees of Reservations (TTOR), a statewide, land conservation organization. The CMR is a 567 ha, 9.0 km barrier beach visited by some 400,000 people per year. The CWR is a series of five drumlin islands, totaling 284 ha, surrounded by salt marsh estuary . Both properties lie between the mouths of the Ipswich and Essex rivers bordered to the east by the Atlantic ocean (Figure 1).

The properties were donated to TTOR over a period of years from 1949 to 1974. Property regulations prohibited the use of firearms (hunting) until 1985.

CHRONOLOGY OF THE DEER OVER-POPULATION PROBLEM

In the late 1970s and early 1980s, deer were a common site by residents of Ipswich and property managers at the CMR and CWR (Wayne Mitton, TTOR, Pers. Comm.). By 1980, the deer tick (*Ixodes dammini*) which transmits Lyme disease had been discovered at CMR/CWR, and soon thereafter nearby residents began suffering from Lyme disease (Lastavica et al. 1989). As the deer population increased, vegetation destruction and deer starvation became evident. By 1982, TTOR began discussing the issue internally and consulted with Massachusetts Division of Fisheries and Wildlife (MDFW) biologists to consider a deer management program.

In 1983 the Massachusetts deer hunting regulations allowed three weeks of archery hunting in November, nine days of shotgun hunting in December followed by three days of hunting with muzzleloaders. MDFW initially suggested that any hunting at CMR/CWR be limited to shotguns during the nine day shotgun season to maximize hunter success and efficiency. Furthermore, TTOR was advised that hunters use slugs and not buckshot. Hunting was to be open to the public with 75 hunters participating each day.

A change in the TTOR regulation that prohibited hunting required a vote by the TTOR Executive Committee as well as the Ipswich Selectmen. The latter was included in the deed when the property was donated to TTOR by the Crane family. So although TTOR properties are private in that they are owned by a private, non-profit organization, the process to allow hunting was very much public.

After much debate and media attention, the Ipswich Board of Selectmen voted unanimously to allow hunting for one year in 1983. The vote energized anti-

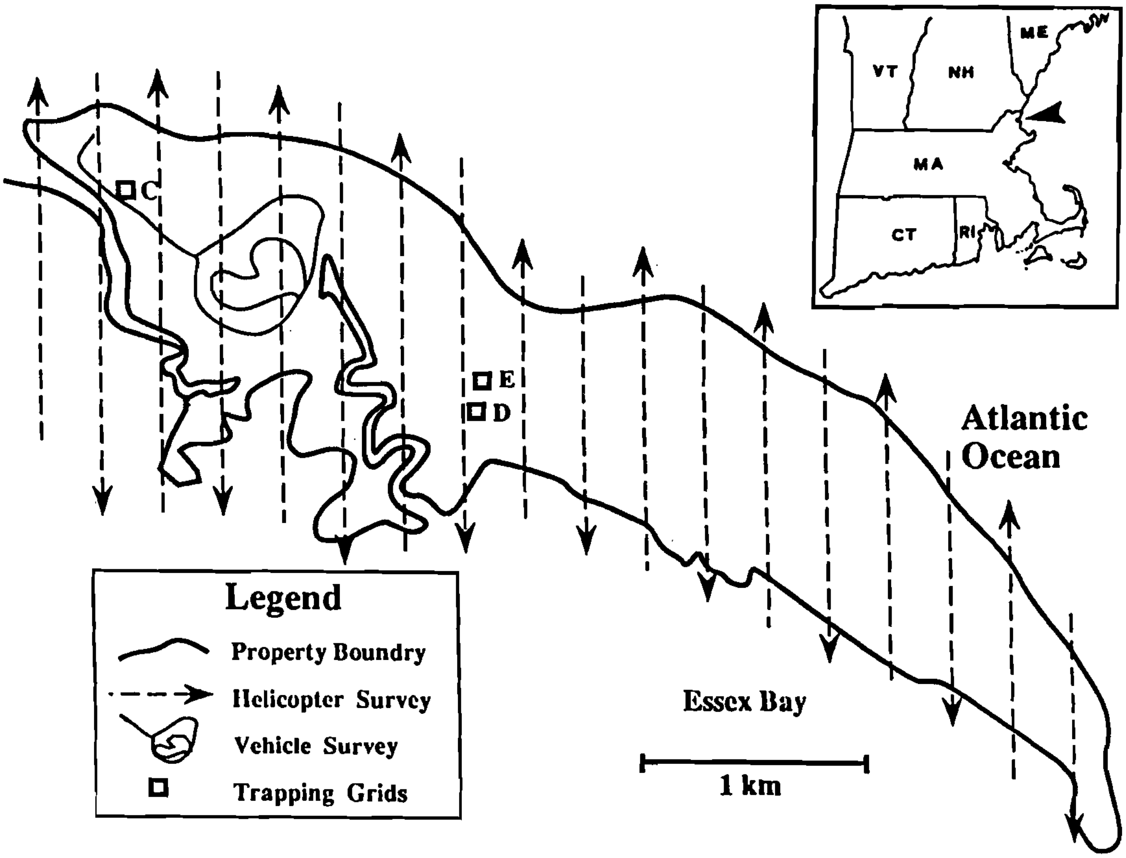


Figure 1. Richard T. Crane Memorial Reservation, Ipswich, Massachusetts in relation to New England.

hunting and animal rights groups who organized publicprotests on the Ipswich Common. Protesters threatened to create a public safety problem by entering the CMR and CWR on opening day of the hunting season and positioning themselves between the deer and hunters. The day before the hunt was to begin, TTOR canceled the controlled hunt.

TTOR established a committee composed of employees, wildlife biologists, veterinarians, nearby residents, anti-hunters and Board Members to seek alternatives to public hunting. At the same time, TTOR launched a carrying capacity study, conducted by Cornell University professor Aaron Moen, to determine the number of deer the properties could support on an annual basis without destruction of vegetation. In addition, TTOR and MDFW cooperated in a program to survey deer during fall, winter and spring as well as conduct an annual helicopter census of deer on the CMR in January. Other research included a Lyme disease study conducted by Harvard University, a deer body condition study conducted by MDFW and a joint TTOR/MDFW study during spring to locate deer that died of starvation the previous winter.

As results from research began to appear, TTOR worked with the committee between 1983 and 1985 to discuss alternatives to public hunting. The following suggestions were forwarded:

1. Use artificial feeding to alleviate winter starvation to sustain an unnaturally high population density,
2. Use professional sharpshooters to reduce deer density,
3. Repel deer from the CMR/CWR using commercially available chemical repellents,
4. Fence the CMR and CWR and drive the deer off of the properties,
5. Trap and relocate deer,
6. Reintroduce predators such as wolves to reduce deer density,
7. Use physical sterilization or birth control to keep the population from increasing,
8. Do nothing; "Let nature take its course."
9. Use controlled, limited hunting as a compromise between public hunting and professional marksmen.

Of the alternatives listed above, sharpshooting was preferred by most committee members, including a Massachusetts humane society. The reasoning was: If reducing the number of deer is the only practical solution, it should be done by professional marksmen to ensure that it is done humanely and that the deer do not suffer. Anti-hunting groups disagreed and would not support options that resulted in killing deer. They favored a "do nothing" approach arguing that starvation is natural and nature's way of solving the problem. After several meetings, the committee was disbanded because it became obvious that a unanimous decision was unattainable.

TTOR and MDFW staff met with researchers to discuss results and develop a plan that would begin to solve the problem by autumn 1985. Research results indicated that vegetation communities could support 45 deer at CMR and 16 deer at CWR (Moen 1984). Deer surveys indicated that 300 to 350 deer inhabited the properties annually. In addition, 17 deer (16 were fawns) were found dead from starvation during a spring mortality survey of 15% of the CMR in 1984. The following spring 21 carcasses (16 fawns) were located in the same study area.

To gather direct information regarding deer body condition as well as to begin to reduce the number of deer, a TTOR employee who was proficient with firearms, under direct supervision of a veterinarian, shot 35 deer at night over bait in March and April 1985. All deer shot were visibly malnourished and necropsies indicated that they were, indeed, in poor physical condition.

Taken together the research results and expert advise helped TTOR to develop a Deer Management Program to reduce the population to ecological carrying capacity (approx. 60 deer) within five years. The program included sharpshooting at night over bait during March and April, 1985 and 1986, and controlled, limited hunting each fall. The objectives of the program were to:

1. Reduce vegetation destruction due to over-browsing, thereby eliminating starvation,
2. Increase the health of the deer population.
3. Reduce the deer tick population and the threat of Lyme disease.

The hypothesis used to design, test and justify the controlled, limited hunt was to make requirements and training programs so rigorous that participants would approach the efficiency of sharpshooters. Therefore, TTOR developed strict rules and regulations for hunters wishing to participate in the controlled, limited hunt. Hunters were required to live locally, attend seminars, pass shooting proficiency tests and participate in surveys.

The controlled, limited hunt required that special hunting regulations be approved by the MDFW Regulatory Board. TTOR requested a 90 day shotgun hunting season between 1 November and 31 January so that the hunt could be conducted virtually unannounced to the public. In addition, it was desirable that two female deer be harvested per hunter rather than only one allowed by MDFW regulation. After public hearing in 1985, the MDFW Board unanimously approved the special deer hunting regulations for CMR/CWR.

Just prior to the November hunting season, an anti-hunting group filed suit in Suffolk County Superior Court alleging that the proposed hunt was illegal because 1) CMR and CWR are located within an "Area of Critical Environmental Concern" and that MDFW failed to file an "Environmental Notification Form" prior to setting regulations that established a hunt. Such a failure, it was argued, would be in violation of the Massachusetts Environmental Policy Act (MEPA) and 2) because the makeup of the MDFW Board was unconstitutional in that the enabling legislation that created the Board states that five of the seven Board members must have purchased a hunting license during the previous five years. The anti-hunting group argued that hunters making hunting regulations is biased and that the enabling legislation is unconstitutional.

The Suffolk County Superior Court Judge denied the injunction against the hunt. The court ruled that changes in wildlife management regulations regarding method of harvest of wildlife, necessitated by changing population or habitat trends, is within the sole authority of MDFW and its Board and does not trigger MEPA review. On the constitutionality of the Board, the court ruled that the anti-hunting hunting group did not have the legal standing to argue such a case. The case was appealed and in January, 1986 and the Superior Court's decision was upheld by the Massachusetts Appeals Court.

The last step in gaining approval for the hunt was a vote by the Ipswich Board of Selectmen. TTOR requested that the Board modify the CMR/CWR regulation prohibiting the discharge of firearms to allow the special controlled, limited hunt. Although debate was lengthy and heated and the issue received wide media attention, the Selectmen voted 4-1 to allow the hunt for five years.

The hunt began without fanfare as opening dates were not announced. Once local residents noticed that CMR was closed to recreational use other than the ongoing hunt, the local media produced several newspaper articles. However, the program's success in meeting objectives quickly resulted in public support and reduced media attention.

Ecological objectives were met after four years (Deblinger et al. 1993 and Deblinger et al. 1993) and the deer population is currently maintained at or near carrying capacity using the same hunters and methodology first employed in 1985. The sharpshooter program proved costly and inefficient compared to the hunt and was discontinued after spring, 1986.

After the approved five year hunting program was completed and it was determined that a small maintenance hunt was necessary to keep the deer population from increasing, the Ipswich Selectmen voted unanimously to extend the hunt for an additional ten years or until 1999.

WHAT CAN BE LEARNED?

Controlled, limited hunting can be used effectively where firearms can be discharged safely. At the CMR/CWR, shotguns and slugs were used to maximize safety and efficiency. In addition, it has been our experience that logical and objective programs based on scientific research results will receive local, state and judicial approval. In fact, membership in TTOR increased over the time period of the Deer Management Program as people perceived that TTOR went to great lengths to study the deer over-population problem and implement a cautious, scientifically based deer reduction plan.

The CMR/CWR controlled, limited hunt was modified for use at the Parker River National Wildlife Refuge (PRNWR) located two kilometers north of the CMR across the Ipswich Bay. Suffering from a similar, coastal deer over-population problem, the U.S. Fish and Wildlife Service consulted with TTOR to develop a controlled, limited hunting program in 1987. The program succeeded without incident; no protests, no litigation. The PRNWR is similar in size and proximity to residences as the CMR. Lessons learned from the CMR/CWR controlled, limited hunt were also applied at a much larger and more remote area in central Massachusetts.

The Quabbin Reservation and Reservoir (Greater Boston's water supply), 86,000 acres, phased in a similar controlled, limited hunt on a much larger scale (10,000 acres per year over five years) to increase forest regeneration and slow erosion rates and sedimentation into the reservoir. Although extremely rural and populated by coyotes, the prohibition of hunting resulted in deer completely browsing the forest understory. The Massachusetts legislature opened the property to hunting in 1991 and the MDFW Board approved special regulations including an extended season to reduce the Quabbin's burgeoning deer population. An anti-hunting group used the federal Endangered Species Act to seek an injunction against the hunt on the grounds that: 1) hunters might harass bald eagles (that nest at the Quabbin Reservation), 2) hunting would reduce the natural supply of deer carcasses available to Bald Eagle's to scavenge during winter; and, 3) that Bald Eagle's might ingest lead and die of lead poisoning by feeding on the carcass of a deer that had been shot during the hunt but not retrieved by the hunter. Federal District Court and Appellate Court ruled that the hunt was not a risk to the Bald Eagle. Approaching the third year of the Quabbin hunt, it remains marginally controversial attracting a few protestor's and media each hunting season. Hunters, however, reduced deer density from 60 to 30 per square mile after one year of hunting over a 10,000 acre study area.

MANAGEMENT IMPLICATIONS

By law deer management programs must conform to state fish and wildlife regulations. As was the case at the CMR and CWR, state regulations may not allow the flexibility needed to conduct a controlled, limited hunt. Game and fish agencies often have the ability to create special regulations for unique situations, but this is not necessarily advisable. In Massachusetts, the process by which regulations are created requires a public hearing that may draw media attention. Furthermore, creating special regulations for specific areas becomes cumbersome for state agencies. It is our experience that the more the hunt is designed to comply with existing regulations, the easier it is to implement. It is important, however, that controlled, limited hunts be designed with assistance from the state fish and wildlife agency.

Within the northeastern United States, such controlled, limited hunts are likely to be controversial. It is, therefore, advisable to develop a public relations plan including press kits that contain background information and answers to predictable questions and to deliver basic data and objectives to key media contacts in a pro-active fashion (Vecellio et al. 1993).

No matter how well designed, hunting in areas historically closed to hunting will draw public attention, especially by anti-hunting groups and may lead to litigation. Quantitative ecological information regarding population estimates, carrying capacity, deer mortality, deer body condition, deer damage (e.g. vehicle collisions), and effects of browsing is invaluable for the deer population manager and will garner public support for what might, on the surface, appear to be a distasteful management program.

ACKNOWLEDGMENTS

Financial support for the CMR and CWR deer management program was provided by The Trustees of Reservations. We are grateful for the support of TTOR employees Wayne Mitton, Peter Pinciaro, Wally Prisby, Ed Pacquin, Amanda Moors, Steven Sloan and Russ Hopping. Jay McAninch was instrumental in designing the controlled, limited hunt and subsequent research. Massachusetts Division of Fisheries and Wildlife staff Wayne MacCallum, Carl Prescott and Dr. Steve Williams provided support, necessary state approval, permits and assistance in the field. Dr. Aaron Moen, Cornell University, conducted the carrying capacity study and provided valuable advise prior to the hunting program. Dr. John Litvaitis, University of New Hampshire, conducted food habits studies and Dr. Andy Spielman, Harvard University, and many of his students, especially Dr. Mark Wilson and Dr. Sam Telford III provided valuable assistance in our understanding of Lyme disease. We thank Gary Vecellio for reviewing the manuscript.

LITERATURE CITED

Allen, G. M. 1929. History of Virginia deer in New England. Trans. New Engl. Game Conf.:19-41.

Deblinger, R. D., M. L. Wilson, D. W. Rimmer, and A. Spielman. 1993. Reduced abundance of immature deer ticks, *Ixodes dammini* (Acari:Ixodidae), following incremental removal of deer. J. Med. Entomol. 30:144-150.

___, D. W. Rimmer, J. J. Vaske, G. Vecellio and M. P. Donnelly. 1993. Ecological and hunter support of a controlled deer hunt in coastal Massachusetts. Northeast Wildl. 50:11-21

Lastavica, C. C., M. L. Wilson, V. P. Berardi, A. Spielman and R. D. Deblinger. 1989. Rapid emergence of a focal epidemic of Lyme disease in coastal Massachusetts. New Eng. J. Med. 320:133-137.

Moen, A. N. 1984. Deer management at the Crane Memorial Reservation and Wildlife Refuge. Cornerbrook Press, Lansing, N.Y. 90pp.

Vecellio, G, M. Ellingwood and R. D. Deblinger. 1993. Controlled deer hunts - Affecting public perception and media relations. Proc. 16th Ann. SE Deer Study Group, Jackson, Mississippi. Abstr.

MANAGEMENT METHODS FOR URBAN DEER

MODERATORS:

Ernie Wiggers
Department of Fish and Wildlife,
University of Missouri

William F. Porter
College of Environmental Science and Forestry,
State University of New York, Syracuse

CAPTURE AND HANDLING TECHNIQUES FOR URBAN DEER CONTROL

WILLIAM E. CLARK, California Department of Fish and Game, Wildlife Management Division
Rancho Cordova, CA

In California, the Department of Fish and Game has used a variety of capture techniques to capture urban deer. In 1981, during the highly publicized Angel Island deer relocation, capture techniques included clover traps, panel traps, drop nets, standing tangle nets and chemical immobilization. In two recent deer overpopulation controversies in East Bay Regional Parks District's (EBRPD) urban parks, deer were captured in the Ardenwood Regional Preserve by having people on foot drive the deer into a double-winged funnel trap where standing tangle nets were strategically placed. In the Coyote Hills park where herding the deer with a helicopter into the tangle nets was tried and was largely unsuccessful, a second capture attempt using helicopter net-gunning proved to be both very successful and cost efficient. In choosing a suitable capture method, many factors must be considered. These include reason for capture (i.e., relocation, marking, euthanasia or sterilization), the terrain, number of animals to be captured, and amount of money and human resources available.

In the Angel Island capture and relocation, costs per animal were approximately $450 (215 animals) - compared to approximately $3,200 per animal in the Ardenwood Preserve (27 animals), and approximately $300 per animal in the adjacent Coyote Hills park (28 animals).

Because of intense public awareness and scrutiny, deer capture techniques need to be evaluated not only for effectiveness and cost efficiency but for animal welfare considerations as well. In the three major urban deer capture projects discussed, animal welfare groups were invited to participate in the planning, preparation, construction and baiting of traps and in the actual capture and handling of the animals. Wildlife agency personnel and veterinarians trained in wildlife medical care and in safe capture and handling techniques are essential to a successful urban deer capture project.

EFFICIENCY OF CONTROLLED, LIMITED HUNTING AT THE CRANE RESERVATION IN IPSWICH, MASSACHUSETTS

ROBERT D. DEBLINGER, Division of Fisheries and Wildlife, Field Headquarters, Westborough, MA
DAVID W. RIMMER, The Trustees of Reservations, Crane Memorial Reservation, Ipswich, MA
JERRY J. VASKE, Dept. of Natural Resource Recreation and Tourism, Colorado State University, Fort Collins, CO
GARY M. VECELLIO, Division of Fisheries and Wildlife, Field Headquarters, Westborough, MA

The increasing presence of white-tailed deer in many areas of the northeast poses significant challenges to wildlife managers. Both ecological and social considerations compound the problem (Decker and Connelly 1990). Such problems are particularly acute in coastal and suburban areas where Lyme disease has reached epidemic proportions (Lastavica et al. 1989). Although alternatives to public hunting have been offered, few have worked (Ellingwood and Caturano 1988). Wildlife managers find themselves in the middle of a debate between hunters eager to solve the problem, suburban residents concerned about safety, animal welfare advocates concerned about humane methodology and animal rights advocates against human interference.

The Richard T. Crane, Jr. Memorial Reservation (CMR) in Ipswich and the Cornelius and Mine' Crane Wildlife Refuge (CWR) in Essex, Massachusetts illustrate the types of problems associated with suburban, coastal deer over-population. By the early 1980s vegetation destruction and deer starvation became apparent. Moen (1984) estimated the deer population at CMR/CWR to be between 350 and 400 while ecological carrying capacity for deer was 36 at CMR and 15 at CWR.

The deer tick that carries the bacteria responsible for Lyme disease was first observed at CMR in 1980. By 1987 35% of the suburban residents living in the vicinity of and 66% of those living adjacent to CMR had contracted Lyme disease (Lastavica et al. 1989).

In 1983, the owners and managers of CMR and CWR, The Trustees of Reservations (TTOR), a private, non-profit land trust, and the Massachusetts Division of Fisheries and Wildlife (MDFW) proposed and received the necessary state and local approval to open the properties to public hunting during the fall deer (shotgun) season. Anti-hunter protests and threats to infiltrate CMR just prior to opening day, however, forced cancellation of the hunt for safety reasons.

TTOR assembled a committee of employees, board members, wildlife biologists, veterinarians, animal welfare and anti-hunting advocates, and nearby residents to explore alternative strategies to solve the problems of vegetation destruction, deer starvation and Lyme disease. Although consensus could not be reached, controlled, limited hunting was identified as a potentially effective strategy to bridge the gap between what most committee members preferred (i.e. professional marksmen) and public deer hunting. The goals of the controlled deer hunting program were to reduce the population to biological carrying capacity, minimize vegetation destruction, eliminating starvation, increase deer body condition, and reduce the threat of Lyme disease (Deblinger et al. in press).

Although the controlled, limited hunt began in the fall of 1985, anti-hunting groups tried unsuccessfully to halt the hunt by seeking a court injunction. Their attempts attracted media attention but did not disrupt the hunt. The Superior Court and later the Massachusetts Appeals Court ruled against plaintiff groups and the hunt occurred each autumn receiving less media attention over time.

This manuscript describes the effectiveness of controlled, limited hunting as a method for efficiently reducing over-populated deer. We 1) detail the steps in developing and implementing a controlled, limited hunt, 2) report daily and annual hunter success rates, and 3) compare this technique to the use of sharpshooters.

STUDY AREA

CMR is a 567-ha, 9-km barrier island visited by approximately 400,000 people per year. CWR totals 284-ha with 5 drumlin islands and a large salt marsh estuary. Both properties lie between the mouths of the Ipswich and Essex Rivers bordered to the east by the Atlantic ocean. Habitat types at the CMR consist of sand dunes dominated by American beachgrass (*Ammophila breviligulata*), maritime forests of mixed red maple (*Acer rubrum*) and pitch pine (*Pinus rigida*), and eastern deciduous forest uplands. A planted mature spruce/fir (*Picea spp. / Abies spp.*) forest provides winter thermal cover over 100-ha of the largest drumlin island while the other dominant habitats consist of grass fields and overgrown fields. CMR and CWR are accessible by staff using a four-wheel drive vehicle over designated trails and by the public on foot.

METHODS

Prior to the controlled, limited hunt, "sharpshooters" shot deer at night using bait and spotlights. Once the deer were accustomed to consuming the bait, a deer was selected and shot with a .22 magnum rifle from a nearby truck (within 10 m). Different TTOR employees functioned as sharpshooters but only one worked a particular bait station at any time.

With the creation of the controlled, limited hunt (as opposed to sharpshooters) MDFW created special regulations to ease logistics of the hunt and to ensure that hunters would have ample time to meet harvest quotas. The 9 day Massachusetts shotgun deer season was increased to 90 days during November, December and January for CMR and CWR. All CMR/CWR hunters received special permits to harvest 2 deer of either sex. Other Massachusetts hunters receive a tag to harvest an antlered deer and can enter a lottery to receive an antlerless deer permit.

In August, 1985 TTOR contacted approximately 250 local deer hunters by mail informing them of the controlled, limited hunt and inviting them to apply. Prospective hunters were required to: be residents of one of ten towns bordering Ipswich and Essex; prove 5 years of deer hunting experience or have a valid, hunter safety certificate; possess a valid hunting license; attend a pre-hunt seminar; and pass a shooting proficiency test.

The shooting proficiency test allowed a prospective hunter 5 shots at a 30 cm x 30 cm target. Each hunter was required to hit the target a total of 3 times, once from 30, 40 and 50 m using a 10 to 20 gauge shotgun with slugs. Distance from each slug hole to the center of the target was measured and totaled for each participant and their scores ranked. Individuals with the highest scores participated in the hunt. Hunters were privately notified when they would hunt. Those with the best scores hunted the first day of the hunting season.

The cutoff for participation in any given year was based on the pre-determined quota of deer to be harvested. Approximately 40% of the pre-season deer population estimate was used as a harvest quota from 1985 through 1990. By 1991, all ecological objectives had been achieved and the deer population was reduced to ecological carrying capacity (Deblinger et al. 1993). A target harvest rate of 25% was used to maintain the population level in subsequent years.

Hunting days were not publicly announced to avoid protesters and media attention. CMR and CWR were closed to the public when hunting occurred. Hunters arrived each morning at a designated parking area and were briefed by TTOR staff about daily organizational procedures. Hunting hours were from 1/2 hour before sunrise to 1500 hrs. Each hunter was assigned a specific hunting area that day and was transported by TTOR personnel to that area. During the first year of the hunt, hunters were instructed to shoot only antlerless deer.

During the second year, hunters were allowed to shoot an antlered deer but only after first harvesting an antlerless deer. Thereafter, hunters were instructed to take the first good shot at any deer and not trophy hunt. Only one deer could be harvested per day. Successful hunters were required to leave the deer intact and walk to a pre-arranged destination where TTOR personnel would transport the deer and hunter to a necropsy laboratory on site. Each harvested deer was eviscerated and necropsied (which took approximately one hour) whereafter the carcass was released to the hunter.

RESULTS

Hunter Participation and Density

The total number of hunters necessary to achieve harvest goals declined each year as both the deer population and harvest goals declined. In 1985, for example, 122 hunters applied, 119 qualified (3 failed the shooting test), and 76 participated (Table 1). By 1991, 54 hunters qualified (no one failed the shooting test) and 49 participated.

During the 7 year study 109 different hunters participated with between 49 and 76 people hunting in any given year (Table 1). Twenty-four percent of these individuals hunted in only one year; 16% hunted all seven years. Between 9 and 26 hunters participated on any given day depending on the number of deer to be harvested, the weather and our experience with individual hunters. During 1985, 10 to 16 participants hunted the entire property (131 to 210 acres per hunter) on any given day. During 1985, 107 deer were harvested over 11 days (Table 1). As the abilities of the hunters became apparent, our confidence regarding safe hunter density increased to a maximum of 26 per day. In 1991, 49 hunters harvested 28 deer in 2 days using 25 hunters per day (84 acres per hunter).

Table 1. Hunter participation and results at the CMR/CWR, Ipswich and Essex, Massachusetts, 1985-1991.

Year	Days hunted (N)	Hunters qualified (N)	Hunters participants (N) [a]	Hunter days (N)	Deer harvested (N)	Hunter success[b]	Hunter success (%)[c]
1985	11	19	76	148	107	72	141
1986	12	81	72	177	84	47	117
1987	6	64	50	99	62	63	124
1988	8	62	62	162	59	36	95
1989	6	56	56	128	55	43	98
1990	4	55	53	84	48	57	91
1991	2	54	49	50	28	56	57
TOTAL	49	491	418	848	443	52	106

[a] A total of 109 different persons hunted from 1985-1991. Hunters were allowed to hunt 2 or more days until 1991 when each hunter hunted 1 day. Hunters were allowed to harvest 2 deer (1 per day) per year.
[b] Hunter success is defined as the number of deer harvested per hunter-day.
[c] Hunter success is defined as the number of deer harvested divided by the number of participants.

Hunters were told that unless they cooperated completely with all rules of the program and demonstrated complete effort toward harvesting a deer (i.e. utilized all of their allocated time hunting), they would not be invited back the next year. In 1985, the pool of prospective hunters was 122 while in 1991 it was 54. Each year a few new hunters were recruited as we learned of their desire to participate and the need to replace hunters who had moved away or decided not to participate. Hunter attrition increased over the years due to qualified hunters changing residence, the hunt becoming more challenging, and the number of hunting days declining as harvest quotas declined. Only 3 of 122 hunters disobeyed a program rule and were declined invitation the following year. Fairly dividing hunting opportunities proved challenging. In 1985, for example, each hunter was given 2 consecutive days to harvest a total of 2 deer. The quota was reached after 11 days using 76 of 119 hunters. Those passing the shooting test with low scores did not hunt. As the pool of hunters declined and shooting proficiency increased, the proportion of qualified hunters participating increased. For example, in 1989 all 56 qualified hunters participated and the majority hunted 2 days. By 1991, 49 of 54 hunters participated but they each hunted only one day. Balancing hunting opportunities, hunting success and hunter density to facilitate hunter satisfaction requires a sufficient pool of prospective hunters.

Hunter Success

Hunter success can be calculated in different ways. Overall, hunter success for the 7 year study (49 days of hunting) was 52% (443 deer were harvested in 860 hunter-days) (Table 1). A total of 109 individual hunters harvested 443 deer (4.06 deer per hunter) over seven years (0.58 deer per year per hunter). Approximately 70,000 hunters participate in the Massachusetts shotgun deer season with about 7,000 harvesting at least one deer for a season success rate of 10%. This figure represents a seasonal success rate since it is not known how many days each individual hunts. Calculating hunter success similarly for CMR and CWR, seasonal success equaled 141% in 1985, 116% in 1986, 124% in 1987, 95% in 1988, 98% in 1989, 91% in 1990 and 57% in 1991. Such comparisons are unfair, however, since CMR/CWR hunters could harvest 2 deer of either sex; only about 25% of Massachusetts hunters receive both an antlerless permit and an antlered deer tag. Nonetheless, hunter success at CMR/CWR was high.

The above annual success rate can raise above 100% if a hunter harvests two deer per year (100% equals 1 deer harvested per hunter; 200% equals 2 deer harvested per hunter). If, however, we define the maximum success rate as 100% which simply means as long as a hunter harvests at least one deer, he/she is successful, annual hunter success for CMR/CWR was follows: 94% of the hunters were successful in harvesting at least one deer in 1985, 75% in 1986, 82% in 1987, 68% in 1988, 64% in 1989, 72% in 1990, and 57% in 1991.

Annual hunter success calculated as the total number of deer harvested per season (i.e. year) divided by the total number of hunter-days declined from 72% in 1985 to 36% in 1988 but rose to 56% in 1991 (Table 1). Hunter success can be influenced by manipulating harvest restrictions on sex and age, hunter effort and/or hunter density. In 1988, for example, 62 hunters harvested 59 deer in 8 days (36% hunter success) using between 16 and 26 (mean = 20) hunters per day. By maximizing hunter density in 1991 to 25 hunters per day, 50 hunters harvested 28 deer in 2 days (56% hunter success).

Other variables that effected hunter success included: deer density (which declined each year until 1989), deer habituation to man, proportion of highly skilled hunters, and weather.

Sharpshooter Efficiency

Sharpshooters were used to obtain deer for body condition analyses in March and April, 1985 and March, 1986. This method was less efficient compared to controlled, limited hunting. In 1985 the sharpshooting program was scrutinized and approved by an animal welfare group (humane society). Each deer was shot in the head at close range. Compared to shooting deer in the neck or chest with rifles at long range, our methods may have been less efficient.

Up to three bait stations were used in 1985 over 13 days (mean=2.6 deer/night). Once a sharpshooter killed a deer at a bait station, other deer usually did not return to that station that night. Therefore, only 2 - 3 deer were taken per night. Because the bait stations needed to be accessible by vehicle and spaced far enough apart so as not to alarm deer from one station to another efficiency was further restricted. Sharpshooters learned to give deer 2 to 3 days to re-habituate to people prior to each shooting session.

Two sharpshooters killed 28 deer at two stations over 5 days in March 1986 (mean=5.6 deer/night), working at non-overlapping portions of CMR. Doubling the number of sharpshooters increased efficiency per night but not per person given the constraints on the total number of bait stations.

Efficiency of deer killed per day was higher for hunters than sharpshooters. If, however, as many sharpshooters and bait stations could be used as hunters, efficiency may be similar.

Cost Efficiency

The costs associated with the controlled, limited hunt were higher than those for the sharpshooter program. Expenses for the hunt increased due to the ecological and social research requirements, the security needed to prevent protesters from infiltrating the area, and the staff needed to transport hunters and deer. Five to eight TTOR employees worked during any given hunting day depending on the number of hunters, where they hunted and the need for security. Four to five pick-up trucks and 1 all-terrain vehicle were used. Other expenses included necropsy laboratory supplies and utilities for the lab.

During the first 7 years of the hunt, personnel costs averaged $1,164 per day while laboratory supplies, utilities, data analysis and deer survey costs averaged $4,300 per year. In 1985 when 107 deer were harvested over 11 days, the total hunting program cost $17,104 or $160 per deer. During 1991, however, when 28 deer were harvested in 2 days, the program cost $6,628 or $237 per deer.

These costs obviously depend upon the amount of security needed as well as the amount of research required. We were less constrained by financial resources given the willingness of TTOR to fund the program the severity of the problem. This latter point partially explains the rationale for the in depth research.

In contrast, sharpshooter costs simply involve an hourly wage paid to staff on special detail. We estimated that in 1985, $4,000 was spent to remove 35 deer by one sharpshooter over 13 days ($144/deer). In 1986, $3,000 was spent to remove 28 deer by 2 sharpshooters over 5 days ($107/deer). These figures would be higher if security personnel were necessary to keep the public away.

Hunter Beliefs About Controlled, Limited Hunting

Individuals surveyed during the 1991 hunt supported the deer management program. Nearly all (98%) of the respondents believed that reducing the size of the herd would improve the health of individual deer and reduce damage to vegetation. Almost as many felt deer herd reductions would decrease the number of deer ticks (94%), and effectively control Lyme disease (90%). Only about a quarter (27%) worried about contracting Lyme disease while hunting at CMR/CWR, and most (94%) felt the disease could be prevented by taking precautions such as using repellents, tucking pant cuffs into socks, and examining themselves for ticks.

Almost all (98%) respondents believed the experience was worth the money they spent to participate (approx. $80). Compared to other public hunting areas, hunting at CMR/CWR was viewed as more enjoyable (98%), a good substitute (86%), safer (96%), and equally as challenging (77%) as compared to hunting at other public areas. Despite the number of rules and regulations, only 15% thought the hunt was too restrictive. Only about a tenth thought there were too many hunters to enjoy being in the field, and even a smaller number (6%) felt there was too much competition from other hunters. When asked to rate the overall quality of the day's hunt 58% considered the experience excellent or perfect, 27% as good/very good, and only 15% as fair/poor. These positive ratings provided by hunters may be partially explained by their relatively high success rates.

DISCUSSION

The CMR/CWR deer management program was protested by animal rights/anti-hunting groups and litigated in state superior and appellate court. Once implemented, however, the desired ecological outcomes were achieved, public relations improved. Membership in TTOR continued to grow as people observed the careful, scientific way the program was established, organized and operated.

Although TTOR did not search for the least expensive, most efficient solution to deer population reduction, controlled, limited hunting turned out to be highly effective and efficient. It utilized the public to help solve a problem involving public natural resources. Hunters appreciated the ability to hunt in an area of the state where such opportunities were limited. They became educated about and supported TTOR and its land conservation stewardship mission.

CMR/CWR hunters demonstrated unusually high success rates. Reasons for this efficiency may be related to pre-hunt seminars, shooting proficiency tests, familiarity with property, and general TTOR staff involvement with hunters. By annually re-educating and testing the proficiency of a group of deer hunters, their skills improved to levels consistent with sharpshooters (although it must be recognized that shooting over bait is inherently different than hunting).

Most importantly, the program is currently in its tenth year; all ecological and sociological objectives have been met, TTOR enjoys positive public feedback, and the deer population is annually managed with the help of the public as a valuable natural resource.

ACKNOWLEDGMENTS

Financial support for the CMR and CWR deer management program was provided by The TTOR. We are grateful for the support of TTOR employees Wayne Mitton, Peter Pinciaro, Wally Prisby, Ed Pacquin, Amanda Moors, Steven Sloan and Russ Hopping. Jay McAninch was instrumental in designing the controlled, limited hunt and subsequent research. Massachusetts Division of Fisheries and Wildlife staff Wayne MacCallum, Carl Prescott and Dr. Steve Williams provided support, necessary state approval, permits and assistance in the field.

LITERATURE CITED

Deblinger, R. D., M. L. Wilson, D. W. Rimmer, and A. Spielman. 1993. Reduced abundance of immature deer ticks, *Ixodes dammini* (Acari:Ixodidae), following incremental removal of deer. J. Med. Entomol. 30:144-150.

___, D. W. Rimmer, J. J. Vaske, G. Vecellio, and M. P. Donnelly. 1993. Ecological and hunter support of a controlled deer hunt in coastal Massachusetts. Northeast Wildl. 50:11-21.

Decker, D. J., and N. A. Connelly. 1990. The need for hunter education in deer management: Insights from New York. Wildl. Soc. Bull. 18:447-452.

Ellingwood, M. R., and S. L. Caturano. 1988. An evaluation of deer management options. Conn. Dept. Envir. Protect., Public. No. DR-11, 12pp.

Lastavica, C. C., M. L. Wilson, V. P. Berardi, A. Spielman, and R. D. Deblinger. 1989. Rapid emergence of a focal epidemic of Lyme disease in coastal Massachusetts. New Eng. J. Med. 320:133-137.

Moen, A. N. 1984. Deer management at the Crane Memorial Reservation and Wildlife Refuge. Cornerbrook Press, Lansing, N.Y. 90pp.

LIVE-CAPTURE AND TRANSLOCATION OF SUBURBAN WHITE-TAILED DEER IN RIVER HILLS, WISCONSIN

WILLIAM E. ISHMAEL, Department of Natural Resources, Spring Green, WI
DALE E. KATSMA, Department of Natural Resources, Plymouth, WI
THOMAS A. ISAAC, Department of Natural Resources, Hartford, WI
BEVERLY K. BRYANT, Wehr Nature Center, Franklin, WI

During the past 20 years increasing numbers of deer (*Odocoileus spp.*) in urban environments have posed unique and challenging management situations for communities and wildlife professionals. The presence of deer in urban areas is viewed positively by residents because of the animal's high aesthetic value (Decker and Gavin 1987). However, as herds increase, deer depredations and safety concerns typically lead to public demand for damage abatement and the need for deer population control.

Many urban residents hold humanistic and moralistic attitudes toward animals (Kellert 1976) and these attitudes often conflict with traditional ecological approaches to wildlife management. Proposals to hunt deer in urban areas have sparked heated debates in communities across North America and, in some situations, have lead to litigation or disruptive activities by anti-hunting or "animal rights" groups (Cook 1974, Lampton 1982, Girard et al. 1993). In addition, municipal managers also express concerns about public safety and liability regarding the discharge of firearms in close proximity to human development. These conflicts and concerns have compelled wildlife managers and communities to consider additional options for property damage abatement and deer population control.

Those opposed to lethal control options frequently cite live-capture and translocation as a viable, more humane alternative to hunting or sharpshooting. A variety of live-capture and translocation techniques have been used in attempts to control wildlife populations or to restock depleted ranges and these efforts are thoroughly documented in both the scientific and popular literature. Recent studies (Ishmael and Rongstad 1984, O'Bryan and McCullough 1985, Witham and Jones 1990) demonstrate that live-capture and translocation of deer, as a population reduction or control method, tends to be relatively expensive and inefficient and may not appreciably extend the lifespan of an individual animal. Still, volatile public opposition to lethal control has lead to the continued consideration of live-capture and translocation as a preferred alternative to lethal methods.

In this paper, we describe a situation where live-capture and translocation is being used to control an urban population of white-tailed deer (*Odocoileus virginianus*). Much of the data presented in this paper has been reported elsewhere (Bryant and Ishmael 1991, Bryant 1992) but has been updated to the present.

BACKGROUND

Deer damage to native and planted vegetation and car-deer collisions have been increasing since the late 1970's in the villages of Fox Point, Bayside, Mequon, and River Hills, Wisconsin. These communities share common borders and are located immediately north of the city of Milwaukee. By 1981, the deer population in and around the Schlitz Audubon Center (SAC), a corporate-owned 185-acre (75 ha) nature preserve in Bayside, had grown to intolerable levels and SAC managers requested approval from the Wisconsin Department of Natural Resources (DNR) to begin live-capturing and translocating deer to a state-owned wildlife management area 25 miles (40 km) north of the Milwaukee metropolitan area. SAC managers used chemical immobilization techniques to capture deer (Ashley 1982). Some were radio-tagged and released back to the preserve as part of an ongoing public education program conducted by SAC. Estimated costs of these initial removal efforts totalled approximately $400 per deer removed (SAC unpubl. rpt.). Beginning in 1986, SAC began using box traps instead of chemical immobilization and, in addition to employing volunteer labor, removal costs were reduced to an estimated $72 per deer. Between 1981 and 1993, 168 deer were removed from SAC.

In 1985, residents of River Hills, adjacent to and west of Bayside, began expressing concerns about vegetation damage and car-deer collisions resulting from increasing numbers of deer. At this time, a four-member Citizens Advisory Committee (CAC) was appointed by the River Hills Board of Trustees (Board) to study the growing problem and recommend management options. Based on recommendations of the CAC, the Board approved a live-capture and translocation program. The DNR granted authority to conduct live-capture efforts and the program was implemented in winter 1987-88 (Ishmael et al. 1995).

As part of the permit authority granted by DNR, all deer captured in River Hills and SAC were required to be number-tagged to monitor post-release dispersal and survival. Beginning in 1989, a sample of captured deer were also radio-tagged as part of a more intensive research effort conducted jointly by DNR, the University of Wisconsin (UW)-Milwaukee, and the Village of River Hills (Bryant 1992).

STUDY AREA

River Hills

The Village of River Hills is a 5.32 square mile (13.8 sq. km) community of estate properties located in northeastern Milwaukee County (Figure 1). Eighty percent of River Hills is zoned for a 5-acre (2 ha) minimum lot size and larger lots are common. Currently, 1,638 people reside in the village. The area includes 575 residences, two schools, two churches, two country clubs, and village government offices and municipal buildings. The entire village has been zoned as single-family residential.

River Hills is bounded on the west by the Milwaukee River and on the east by a six-lane interstate highway. Two, six-lane east-west thoroughfares bisect the village. Relatively high density residential development surrounds the village except along the north border. A firearm ordinance prevents hunting within the village.

Natural vegetation, including mature woodlots (*Quercus spp., Carya spp., Acer spp., Tilia americana*), covers a portion of most properties and is interspersed with remnant farm fields, pasture, conifer (*Pinus spp.*) plantations, orchards, and landscaped lawns. Many residents have planted ornamental trees and shrubs for screening or aesthetics. Large (<50') earthen berms have been constructed along major traffic arteries as sound and visual barriers. Approximately 75 percent of the gross land area (4 sq. mi., 10 sq.km.) is considered to be suitable deer range as classified by DNR methodology (McCaffery 1987). Prior to 1990, deer feeding was allowed in the village and many residents provided feed for deer and other wildlife throughout the winter months.

Release Sites

Captured deer were translocated to one of seven release sites in southern Wisconsin. These sites included five state-owned wildlife management areas (Theresa, Allenton, Deansville, Brooklyn, Goose Lake), the Northern Unit of the Kettle Moraine State Forest, and a privately-owned DNR licensed deer farm.

The Theresa, Allenton, and Kettle Moraine State Forest release sites are described by Bryant (1992). The Deansville, Brooklyn, and Goose Lake Wildlife Management Areas are located in Dane County in southcentral Wisconsin and are 2,000 acres, 3,000 acres, and 2,100 acres in size, respectively. Vegetation on these properties consists primarily of lowland brush, cattail wetlands, lowland hardwoods, scattered upland woodlots, mesic prairie, and active agricultural fields. All state-owned release sites were below their prescribed deer population goals of 20 deer per square mile (8/sq. km.) of range during the year of release. These six properties are open to public hunting during the state's fall archery and gun deer seasons and, due to their proximity to major metropolitan areas, receive moderate to heavy hunting pressure.

The privately-owned deer farm release site is located in Fond du lac County in east-central Wisconsin and includes 390 acres enclosed by a 10-ft. high permanent fence. Beginning in 1991, all deer captured by River Hills and SAC were sold by DNR to this licensed facility. By state law, all proceeds from the sale of wild deer must be returned to state accounts and therefore were not available to cover costs associated with the translocation program. Deer numbers on the farm are controlled by the owner. Wisconsin statutes (ss 29.578) pertaining to licensed deer farms authorize the breeding, propagating, killing, and selling of deer owned by the licensee.

METHODS

Live Capture and Translocation

Permits for removal of deer were issued by the DNR to River Hills under state statute 29.59(2) which regulates the control of nuisance wildlife. Trapping operations were conducted by River Hills Department of Public Works' employees. Technical advice on trap construction and trapping methods was initially provided by SAC and DNR personnel.

Deer were captured using modified Stephenson box traps of plywood and angle iron construction (Diehl 1988). Two styles of traps were constructed. Initially, ten traps were constructed and consisted of two sections, each 4x4x6 feet (1.2x1.2x1.8 m) with one drop door on each end. As trapping efforts increased, ten additional traps were constructed with dimensions of 4x4x8 feet (1.2x1.2x2.4 m) with a drop door on one end and nylon netting on the opposite end. A drop tarp was attached above the net end to darken the interior after capture. The heavy wooden drop doors were counter-weighted to reduce the risk of injury to deer and people.

Six transport crates were built to facilitate deer handling. Crates were constructed of plywood and angle iron and were 4x1.5x6ft.(1.2x0.5x1.8 m) with a

Figure 1. Map of River Hills, Wisconsin.

sliding door on the entry end. A smaller sliding door was constructed on the opposite end to facilitate ear tagging. The crates were not wide enough to accommodate the antler spread of four mature bucks that had to be released back into the village. Also, the small sliding door was not large enough to allow ear-tagging of some larger bucks.

Village employees obtained written permission and a liability waiver from property owners prior to placing traps. Traps were placed in areas of high deer activity, usually in feeding areas adjacent to woody cover, and were pre-baited for up to a month with a combination of apples and shelled corn.

Each trap was checked twice daily at approximately 0800 and 1500 hours (K. Fredrickson, pers. comm.). Captured deer were transferred to transport crates, ear tagged, loaded onto a pickup or flatbed truck with the use of a boom truck or crane lift, and driven to release sites. Colored ear-tags (Duflex Mfg.) were serial numbered and were labeled with the words "Urgent Call Local DNR Office". During 1989 and 1990 this handling and tagging system was used to radio-tag 38 of the translocated deer for more intensive study (Bryant and Ishmael 1991).

Aerial Censuses

Aerial censuses of the deer population in River Hills were conducted annually during winter. Censuses in 1986, and 1988-90 were flown with an Engstrom (Model 211) helicopter. Flights in 1991-92 were conducted with a Bell (Model 47) helicopter. All flights included two DNR observers in addition to the pilot. All land area in the village was censused by flying individual square mile blocks in a concentric flight pattern at an altitude of 200 to 300 feet. Counting conditions were best immediately following snowfall and under bright light conditions. Censuses were normally conducted between 0900 and 1300 hours. Results were reported as minimum estimates of the deer population in the village at the time of the census although counts were probably within 5 to 10 percent of actual numbers. Helicopter counts in similar cover types but with less extensive cover, were found to be very close to ground counts (Stoll et al. 1991). Ground counts conducted at SAC agreed with helicopter counts of SAC. Following each aerial census, peak annual deer population estimates were calculated by combining aerial counts with the number of deer trapped prior to the census date, plus the number of car-killed deer between August 1 (post-fawning) and the census date (Figure 2).

Results

A total of 438 deer were removed from River Hills between 1987 and 1992 (Table 1). Of these, 324 were translocated to state-owned wildlife management areas, 93 were sold to a deer farm, and 21 were killed in traps (Figure 3). Of the 21 deer killed in traps, 11 were killed because of trap-related injuries. Initially, the DNR allowed deer to be translocated to state-owned lands within deer management units where deer populations were estimated to be below population goals. Deer management units within 40 miles (64 km.) of River Hills were below goals from 1986 through the 1989-90 trapping season. During winter 1990-91 deer were translocated to state-owned lands in Dane County (80 mi., 129 km). Results of tagging studies (Bryant and Ishmael 1991) and complaints from landowners about damage caused by translocated deer lead DNR to discontinue authorization of translocation to rural sites after the 1990-91 trapping season.

In December, 1990, the River Hills requested permission to conduct sharpshooting at baited sites and to kill deer in traps. A total of ten deer were killed in traps, delivered to a licensed meat processor, and the meat was donated to charitable food pantries in the Milwaukee metropolitan area.

During the 1991-92 and 1992-93 trapping seasons, deer were sold to deer farms. Bids for the purchase of captured deer were solicited from all licensed deer farms in Wisconsin (>360). The DNR approved contracts between River Hills and the high bidder ($150/deer in 1991 and $25/deer in 1992) for transport of captured deer to the deer farm. The contracts specified pick-up of captured deer up to two times per day if necessary.

EFFICACY OF LIVE-CAPTURE AND TRANSLOCATION

Annual population estimates indicate the number of deer in River Hills peaked at 339 (64/sq.mi., 25/sq.km.) during fall, 1988 followed by a decline to 86 deer by December, 1992 (Figure 2). We feel that the primary reasons for the decline is a combination of the number of deer removed, the removal of a disproportional number of adult females (Table 1), and the relatively insular nature of the deer population in River Hills. Removing a high proportion of adult females would reduce the reproductive rate of the population. Ingress appears to be limited by manmade barriers around the village and removal of family groups of females may reduce the population for several years (Porter et al. 1991).

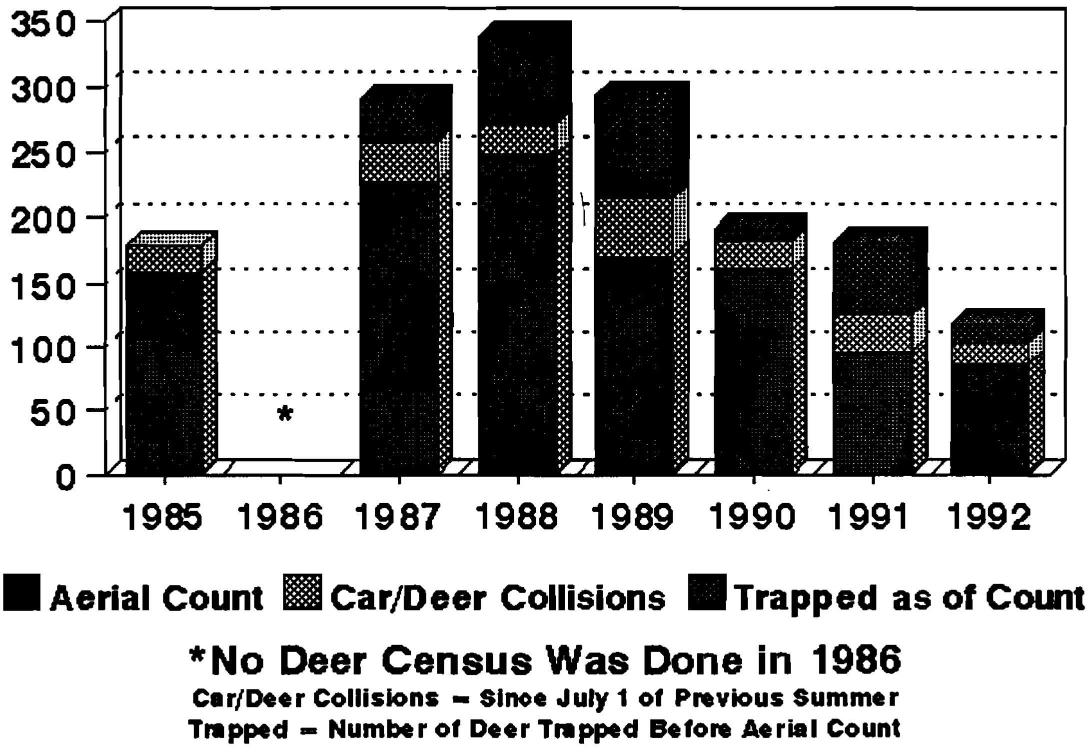


Figure 2. Estimated peak deer populations, River Hills, Wisconsin.

Table 1. Summary of census and deer removal data for River Hills, Wisconsin from 1986 through 1992.

Year	Census	Census Date	Males Adult	Males Juvenile	Females Adult	Females Juvenile	Total
1987/88	227	01/27/88	6	9	18	11	45*
1988/89	248	02/12/89	9	32	49	32	122
1989/90	171	01/27/90	18	38	42	22	120
1990/91	161	12/07/90	10	17	19	14	61*
1991/92	96	01/28/92	12	18	29	16	75
1992/93	86	12/11/92	2	4	8	1	15
TOTALS			57	118	165	96	438*

*Totals for columns and rows are different because of 2 unknown (1 each in 1987/88 and 1990/91) trapping season.

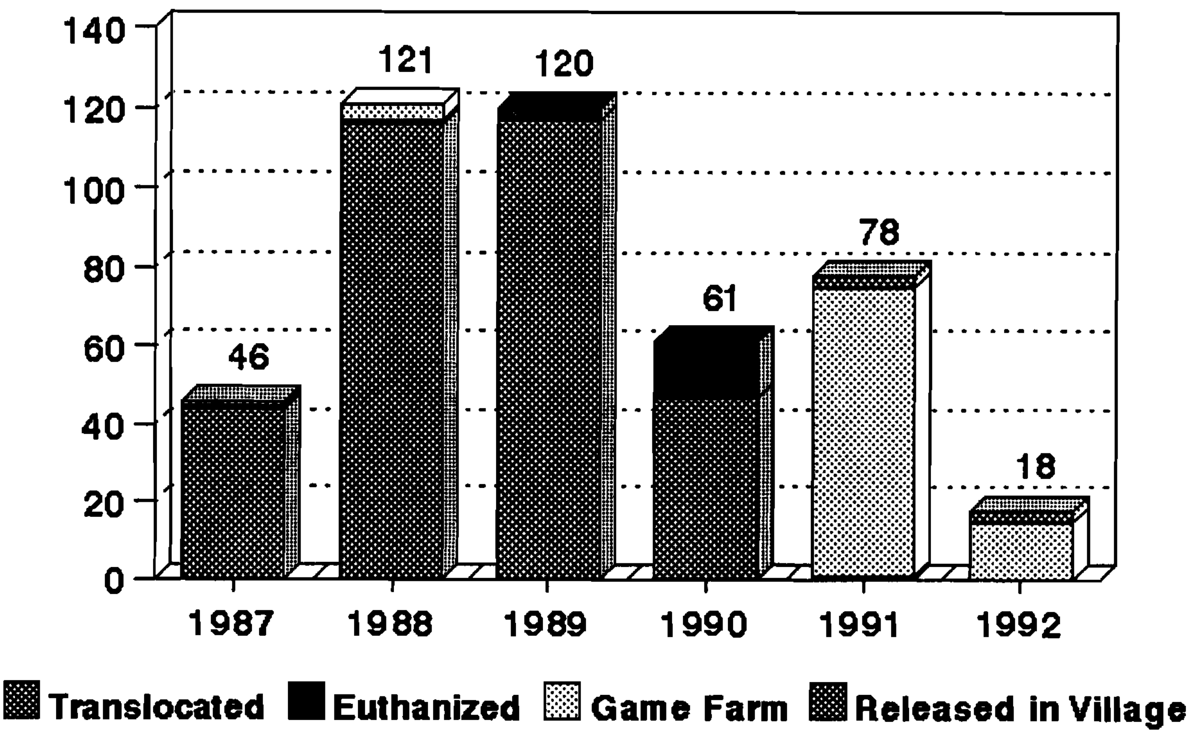


Figure 3. Disposition of trapped deer from River Hills, Wisconsin.

The capture of a higher proportion of adult females than expected has been previously reported for winter trapping projects (Mattfeld et al. 1974). The adult sex ratio in an unhunted deer population should approach 50:50 (Hayne 1984). Car-killed deer records, recorded in River Hills since 1971, indicate a sex ratio of approximately 0.90 males to females (averages were: m=3.73,f=3.98; d=3.4, sd=0.62, n=22; t=5.65, P<0.0001). We used an assumed sex ratio of 1.0 to approximate expected proportions of adult males to adult females in the population. The proportion of females trapped was significantly different than expected under this assumption (χ^2=50.4, P,<0.005) (Table 1). The ratio of adult males to females for car-killed deer since live-capture began is 0.97 (n=144). Capture rates of male and female fawns were not significantly different from expected (χ^2= 2.25). Bryant (1992) reported that the number of deer-vehicle collisions are more closely related to traffic volume than to changes in deer populations. However, the number of collisions have declined since 1989 despite increases in traffic volume since this time (Figure 4).

Fate of Translocated Deer

Of the 310 ear-tagged deer translocated to state-owned lands between 1987 and 1991, 168 (54%) have been reported dead (43% were reported dead within 1 year post-release). Mortality rates for ear-tagged deer underestimate total mortality because of unreported deaths. Bryant (1992) found that mortality rates of radio-tagged translocated deer were more than twice that reported for ear-tagged deer during the same period (96% vs. 45%). Length of post-release survival for ear-tagged deer reported dead averaged 285 days. Sources of mortality for translocated deer were vehicle collisions (36%), gun and bow hunting (56%), capture myopathy (4%), and trap injuries (5%).

Translocated ear-tagged deer moved an average of 8.2 airline miles (5.1km) from the release sites and had a tendency to maintain their "tameness", establish new home ranges near or in residential areas, and cause nuisance problems in their new range (Bryant 1992). Similar observations have been made in other studies of

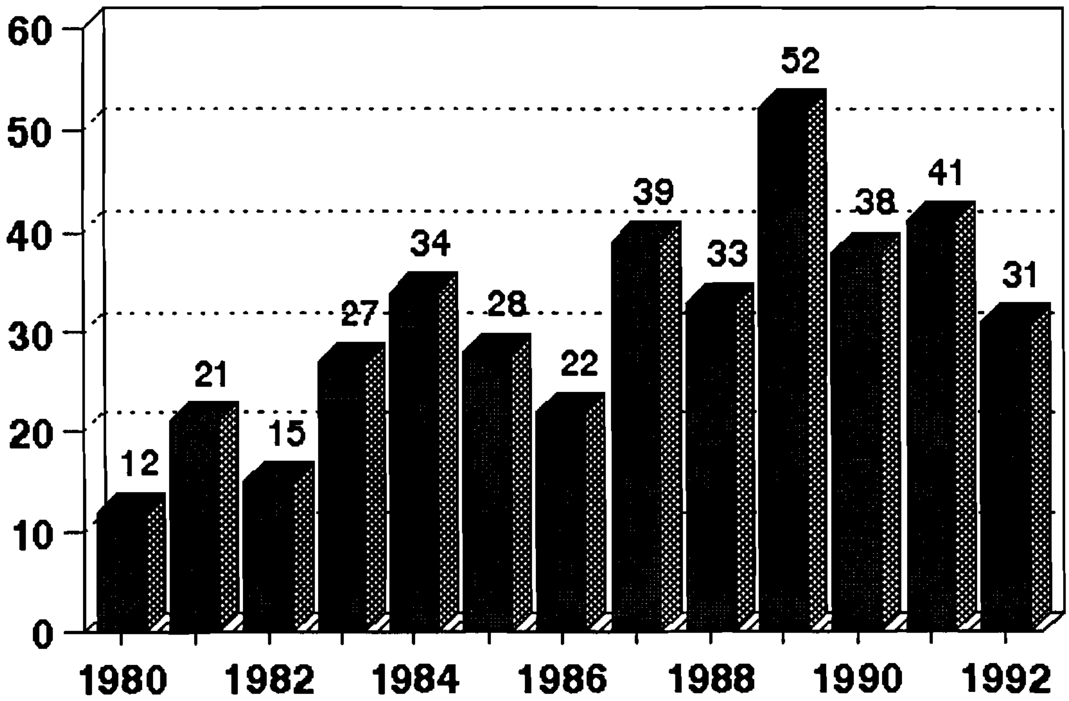


Figure 4. Car-deer collisions, 1980-992 in River Hills, Wisconsin.

deer translocated from similar settings (O'Bryan and McCullough 1985, Witham and Jones 1990).

The fate of the 93 deer sold to the deer farm is unknown. Wisconsin statutes authorize the "breeding, propagating, killing, and selling" of deer on licensed deer farms. Although DNR requires licensees to submit annual reports on numbers of deer killed or sold, the fate of individual animals cannot be determined from these documents.

PUBLIC RESPONSE TO DEER REMOVAL METHODS

A summary of public response to deer management in River Hills is reported by Ishmael et al. (1995).

COST ANALYSIS OF LIVE-CAPTURE AND TRANSLOCATION

The costs of trapping and translocating deer were subject to debate in the media and at village meetings on several occasions. Debate usually centered on which costs were directly related to trapping and how to amortize the initial costs of traps and other equipment. For this paper, information on trapping program costs were obtained from village budget reports and personal communications with Village Manager, J. Szyper and Director of Public Works, K. Fredrickson.

Trap construction costs included $330 for materials and $300 for labor for each trap or $12,600 for 20 traps. Transfer crates cost $150 in materials and $90 for labor or $1,440 for 6 transfer crates.

Operational costs for trapping and translocating deer are more difficult to estimate. The number of days of trapping varied considerably between years (Table 2). Each day of operation required checking traps two times by one employee (approx. 4 hours) and required two employees for crate transfer and loading. One or two employees would then transport deer to a release point. Other operational costs involved maintenance of traps, purchase of bait, prebaiting traps, and relocating traps. Operational costs by calendar year, excluding vehicle mileage costs, were

Table 2. Summary of trapping results, December 1987 - December 1992 at River Hills, Wisconsin.

Trapping year	Trapping dates[a]	Trap days[b]	Number of deer caught[c]	Number of trap days/capture
1987/88	12/01/87 - 02/26/88	592	45	13.2
1988/89	12/27/88 - 04/12/89	2100	122	17.2
1989/90	01/27/89 - 04/09/90	2640	120	22.0
1990/91	12/20&21/90 - 04/12/91	1900	64	29.7
1991/92	12/02/91 - 02/18/92	1440	78	18.5
1992/93	11/25/92 - 12/16/92	360	18	20.0
TOTAL		9032	447	20.2

[a]Dates are inclusive of weekends and holidays, except for Christmas, New Years, and the last two weekends of the 1992/93 trapping season.
[b]There were 20 traps set per year except for the 1987/88 season where 6 traps were used for the first two weeks followed by 10 traps.
[c]Includes deer that were released at trap site.

approximately $44,700, $31,625, $16,000, and $8,500 for 1989 through 1992, respectively. Costs associated with vehicle mileage and maintenance are not included in operational cost figures above. Transportation to release sites averaged 40 miles one-way for winters 1987-88 through 1989-90 and 80 miles for 1990-91. Village-owned vehicles were used including: pickup trucks, a 1-ton flatbed truck, and a 1-ton flatbed truck equipped with a cranelift for loading traps and transfer crates. These vehicles were also used for other village activities and were not purchased specifically for trapping deer.

Operational costs per deer removed was estimated to average $303 for these four years and ranged between $261 to $567. Reports by others of costs associated with live-capture and translocation programs indicate costs of approximately $400 per deer (Ishmael and Rongstad 1984, O'Bryan and McCullough 1985, SAC unpubl. rpt.). If costs for traps, transport crates, and vehicle mileage were included with operational costs, the cost per deer removed from River Hills would be comparable to those reported elsewhere.

In addition to trapping costs, the village also contracted for helicopter service for conducting all aerial censuses. Costs varied each year, but averaged $600 per census (3 hrs. @ $200/hr.), totalling $3,600 for six censuses.

PROS AND CONS OF LIVE-CAPTURE AND TRANSLOCATION

Pros

Controversy over proposed lethal control methods made live-capture and translocation the most socially-acceptable option for herd management in River Hills. Documentation of high mortality rates and nuisance problems associated with translocated deer did not change overall public attitudes about translocation. Sale of live-captured deer to private deer farms has not caused public concern in the village.

Live-capture has been successful in reducing the deer population in the village to near CAC-recommended levels. River Hills was able to provide the funding, personnel, and equipment necessary to reduce the deer population through live-capture and translocation.

Live-capture and translocation has provided opportunities for research of translocated deer and comparisons with resident deer (Bryant 1992). Lethal control methods could also provide opportunities to study the population dynamics and health of the resident deer through necropsy and analysis of dead deer.

Cons

A major concern of most communities considering options for controlling deer populations is cost. Live-capture and translocation is relatively expensive compared to lethal control methods (Ishmael and Rongstad 1984). In addition, translocation to rural areas results in high mortality rates of translocated deer and additional nuisance problems (O'Bryan and McCullough 1985, Witham and Jones 1990, Bryant 1992).

The initial controversy surrounding proposals for lethal control methods generates intensive media coverage. This level of media coverage in large metropolitan areas could help inform and educate urbanites of the need for using lethal control methods for urban deer populations. When deer are released in rural areas or on a private deer farm, most people are left with the impression that these deer will live for a long time. In this study, the fate of the translocated deer or the fact that translocated deer were causing problems for others was seldom reported. By allowing translocation we are losing the opportunity to educate the vast majority of people in urban areas about the population ecology of free-ranging deer.

Translocation and sale to private deer farms required less village expense for transportation. However, there appears to be limited interest from deer farm owners in Wisconsin. If more communities opt for this method of control, there may not be enough demand from deer farms to dispose of the necessary number of deer. The transfer of ownership of deer from the public to the private sector also has some negative connotations. There is no control over the fate of these deer beyond that provided by state laws on humane and adequate care. Further, animal-activists may object to sale of deer to private deer farms that conduct fee hunts, although these objections have not developed in this situation.

Although this effort appears to be successful in meeting the objective of reducing the deer population and associated damage in River Hills, this method has limited applicability to other communities because of the expense and the insular nature of the River Hills herd. At current population levels, it appears that River Hills will only have to remove a relatively small number of deer each year to maintain the population at goals specified by the CAC. This may not be the case for other locations. As an example, deer have been translocated from the SAC every year since 1981. The SAC is connected to other areas of deer habitat by corridors of cover associated with Lake Michigan shoreline. An average of 10 deer per year were removed from SAC between 1981 and 1991 followed by the removal of 33 and 31 during the winters of 1991-92 and 1992-93, respectively. An aerial survey during winter 1992-93 found 19 deer on the property, similar to counts in previous years.

ACKNOWLEDGEMENTS

The preparation of this paper would not have been possible without the assistance of many groups and individuals. We gratefully acknowledge the assistance and cooperation of the River Hills Board of Trustees, Village Manager, Joe Szyper, Kurt Fredrickson of the River Hills Department of Public Works, and other village staff for providing much of the information included in this report. Additional information was provided by the Schlitz Audubon Center and the municipalities of Mequon, Fox Point, and Bayside. We also thank the members of Whitetails Unlimited and Safari Club International who provided funding and radio-telemetry equipment for the study of urban and translocated deer.

LITERATURE CITED

Ashley, R.F. 1982. Milwaukee's dear deer. Wis. Nat. Resour. 6:6-11.

Bryant, B. 1992. Movements and mortality of suburb an and translocated suburban white-tailed deer in southeastern Wisconsin. M.S. thesis. Dept. of Biological Sciences. Univ. of Wis.-Milwaukee. 78pp.

___, and W. Ishmael. 1991. Movement and mortality patterns of resident and translocated suburban white-tailed deer. Pages 53-58 *in* L.W. Adams and D.L. Leedy eds., Wildlife conservation in metropolitan environments. N.T.U.W. Sym. Sec. 2. 264pp.

Cook, J. 1974. Court denies bid to halt 6-day Jersey deer hunt. New York Times, Dec. 7, pB33.

Decker, D. J., and T.A. Gavin. 1987. Public attitudes toward a suburban deer herd. Wildl. Soc. Bull. 15:173-180.

Diehl, S.R. 1988. Selective removal as an alternative in deer management. Pages 1-10 *in* L. Nielson and R.D. Brown, eds., Translocation of wild animals. Wis. Humane Soc., Milwaukee.

Girard, G.T., B.D. Anderson, and T.A. DeLaney. 1993. Managing conflicts with animal activists: White-tailed deer and Illinois nature preserves. Nat. Areas Journ. 13:1-10.

Hayne, D.W. 1984. Population dynamics and analysis. Pages 203-210 *in* L.K. Halls ed., White-tailed deer ecology and management. Stockpole Books, Harrisburg, P.A. 870pp.

Ishmael, W.E., and O.J. Rongstad. 1984. Economics of an urban deer-removal program. Wildl. Soc. Bull. 12:394-398.

Kellert, S.R. 1976. Perceptions of animals in American society. Trans. North Am. Wildl. and Nat. Resour. Conf. 41:533-545.

Lampton, B. 1982. Controversy in the 'Glades. Florida Wildl. 36:12-18.

Mattfeld, G.F., Sage, R.W., Wiley III, J.E., and D.F. Behrend. 1974. Seasonal difference in sex ratio of box trapped deer. J. Wildl. Manage. 38:563-565.

McCaffery, K. 1987. Reinventory of deer range. Wisc. Dept. Nat. Resour. Bur. Res. Publ. W-141-R-23. 25 pp.

O'Bryan, M.K., and D.R. McCullough. 1985. Survival of black-tailed deer following relocation in California. J. Wildl. Manage. 49:115-119.

Porter, W.F., N.E. Matthews, H.E. Underwood, R.W. Sage Jr., and D.F. Behrend. 1991. Social organization in deer: Implications for localized management. Environ. Manage. 15:809-814.

Stoll Jr., R.J., M.W. McClain, J.C. Clem, and P. Plageman. 1991. Accuracy of helicopter counts of white-tailed deer in western Ohio farmland. Wildl. Soc. Bull. 19:309-314.

Witham, J.H., and J.M. Jones. 1990. Post-translocation survival and movements of metropolitan white-tailed deer. Wildl. Soc. Bull. 18:434-441.

TRAP-AND-SHOOT AND SHARPSHOOTING METHODS FOR CONTROL OF URBAN DEER: THE CASE HISTORY OF NORTH OAKS, MINNESOTA

PETER A. JORDAN, RONALD A. MOEN, EUGENE J. DeGAYNER[1], and WILLIAM C. PITT[2] Department of Fisheries and Wildlife, University of Minnesota, St. Paul MN 55108

Public demand for some degree of herd control has arisen where deer have successfully adapted to suburban settings and have increased to high densities (Geist 1980). For traditional wildlife managers, urban deer management has created new challenges, including intense concern for public and property safety as well as for sensitivities and sharply differing opinions in local residents. Herd reduction in a suburban setting has different challenges than in unhunted, urban lands as reported by Ishmael and Rongstad (1984) and McAninch and Parker (1991). Nevertheless, new solutions are evolving through cooperative efforts between suburban communities and wildlife agencies and wildlife biologists.

This paper describes the history and nature of problems arising from a rapidly expanding population of white-tailed deer (*Odocoileus virginianus*) within a suburban community, North Oaks, Minnesota, and the effectiveness of techniques developed to manage that population.

BACKGROUND

The Village of North Oaks is an affluent, low-density suburb 8 mi (13 km) north of St. Paul, Ramsey Co., Minnesota. The Village itself was designated a game reserve in the 1940s. From the 1950s North Oaks was and continues to be developed from a landscape of farms and woodlands. In northern Ramsey County around North Oaks, control of deer by local hunting virtually ceased by the 1970s. The average annual legal kill for firearms plus archery, from 1972-90, was 9.

Estimates of deer numbers within the North Oaks region prior to the 1950s are lacking. More recent accounts suggest that, deer increased steadily through the 1960s (Arthur Hawkins pers. comm.) until, the mid-1970s when a significant number of home owners began complaining about garden damage. In response, University of Minnesota and Minnesota Department of Natural Resources (MN-DNR) biologists began aerial counts of deer within North Oaks in 1976. Results through 1994 clearly show an increasing trend ranging from an estimated 265 in 1976 to 864 in 1993 (Table 1) .

Besides garden damage, there was widespread concern that deer were impeding forest vegetation, particularly the shrub layer that forms screenings around homes, as well as affecting the future forests by suppressing seedlings of oaks (Sillings 1987). The public was also concerned that high deer numbers would increase human exposure to Lyme disease which regionally has been found to be as prevalent as anywhere in the U.S. (Callister et al. 1988). Deer-vehicle accidents were also a concern but more a problem on adjacent highways than within the Village itself.

Despite these resources North Oaks residents have never wanted to be free of deer. However, a significant number vociferously complained that deer around their homes were unacceptably numerous. But, to typical in similar urban-deer deliberations throughout the U.S. in recent years (Ishmael and Rongstad 1984, McAninch and Parker 1991). Decisions on deer control by the Village council have met strenuous opposition.

THE DEER HERD

Numbers and distribution of deer within North Oaks were counted in January or February from a helicopter over snow every year except two, 1976-1994 (Table 1). These figures are adjusted for estimated counting inaccuracies and for animals previously removed that winter. The counts were taken during the season when it seemed to us that an annual high of numbers were present within the Village, but must be viewed only as approximations since animals were continually moving across the boundaries. The relatively low figure for 1994 was believed due to movement of animals northward from the northeast corner (zone 3, Figure 1) due to construction work. The estimates indicate that Village-wide density, based on 7.8 mi^2 that excludes lakes but not wetlands, for the

---

[1]Present address, U.S. Forest Service, Petersburg, AK

[2]Present address, Utah State Univ., Logan, UT

Table 1. Annual numbers of deer from aerial surveys plus numbers of deer removed by two methods for the City of North Oaks, Minnesota. Winter designation is by January to March of the calendar year.

Winter	Population Estimate	Numbers Removed: Method: Sharpshoot	Numbers Removed: Method: Trap/shoot	Total	Percent Removed
1976	265				
1977	240				
1978	310				
1979	370				
1980	355	36		36	10
1981	365	50		50	14
1982	500	44	79	123	25
1983	546	32	22	54	10
1984	375				
1985	310				
1986	550				
1987	no count				
1988	400				
1989	650				
1990	no count		61	61	-
1991	720		109[a]	109	15
1992	660	-	183	183	28
1993	800	19	171	190	24
Total		181	625	806	

17 counts over 19 winters ranged between 31 and 111/mi² (12-43/km²).

In winter, spatial distribution of deer was consistently uneven, as shown by a 3-winter average, 1991-93, (Table 2) from count data by aerial-count zones. These values were not adjusted for deer missed during counting nor for those removed prior to the count. On average the counts were 12% lower than the Village-wide figures in Table 1. The zone densities show that the eastern one-third (Figure 1: zones 1a-6, Table 2)-- some 2.9 mi² (7.6 km²) consisting primarily of the Hill Farm, plus about 0.5 mi² (1.3 km²) of residential housing, had a winter-count density of 99/mi² (38/km²). The highest deer densities found in an entirely residential zone - zones 5 and 6, about 1.3 mi² (3.4 km²) between the Hill Farm and Pleasant Lake, showed 91/mi² (35 deer/km². In contrast, in the south and southwest sectors zones 7 and 8, that were about 50:50 residential and open space but mostly lacking in woody cover, density was only 11/mi² (/km²).

There was good evidence that some deer wintering in North Oaks spent other seasons elsewhere. During the 1970s and early 1980s, from snow-track evidence and reports by A. Hawkins (pers. comm.), it appeared that many of the deer were entering the Village in early winter, particularly across the northeastern boundaries (Figure 1). Within the Village, general reports and observations on seasonal presence

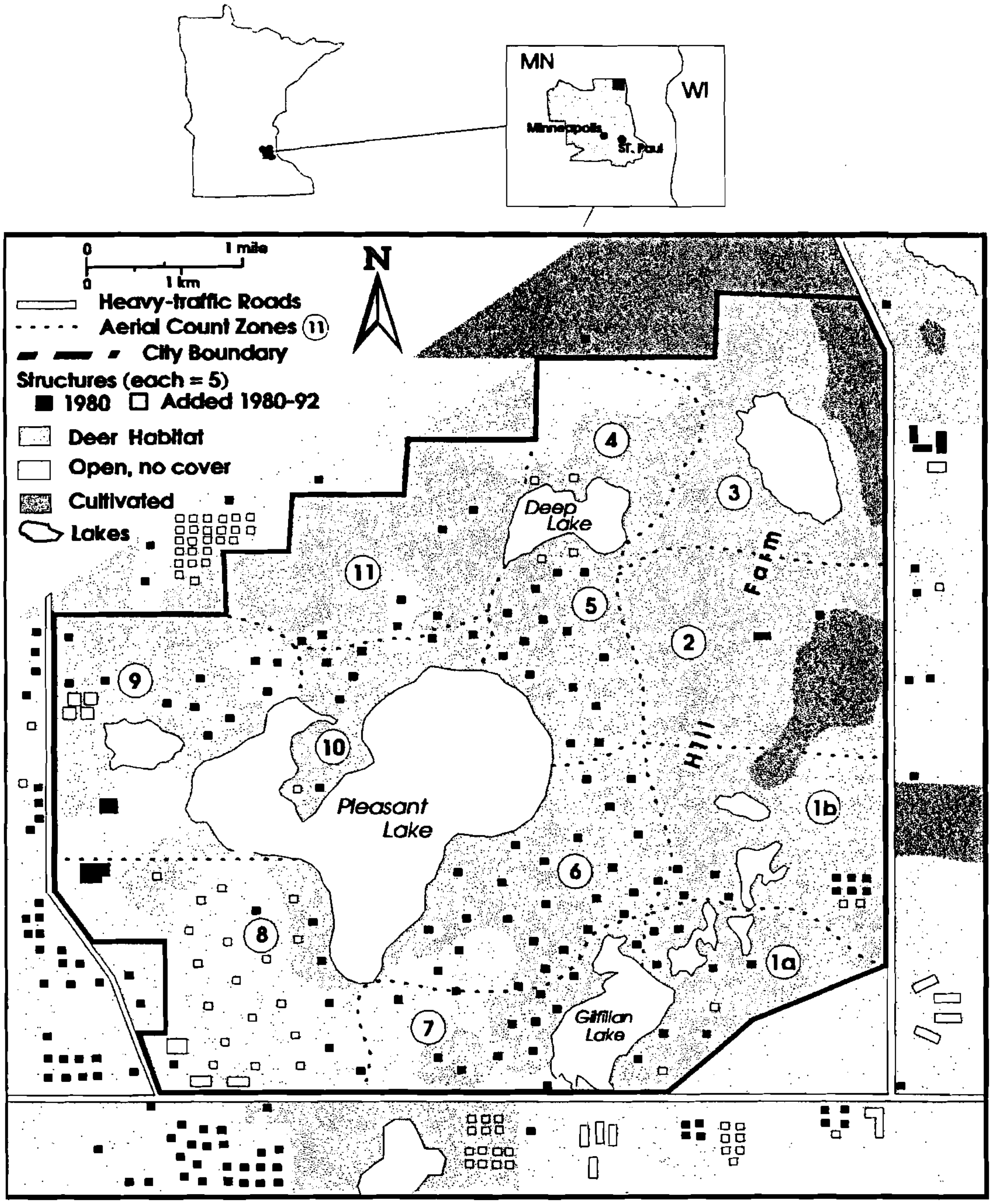


Figure 1. The Village of North Oaks and surrounding land use types, 1992, showing pre- and post-1980 structures, cover types, and zones demarcated for tallying aerial-counted deer.

suggested that numbers of animals were moving from undeveloped sectors into residential areas for the winter. In all years, there were concentrations of tracks between the Hill Farm and residential areas east of Pleasant Lake (Figure 1), suggesting many deer were regularly entering and leaving the residential sector. In general, based on the relatively large numbers of deer removed from individual home sites (see below), mid-winter movements were apparently common.

Reports of deer around residential homes during summer months have been reasonably frequent since, but not before, the mid or late 1980s. Good numbers had undoubtedly long used undeveloped sectors of the Village during summer, particularly the east and northeastern sectors where habitat was particularly suitable for fawning. At the same time, summer densities in this sector were unlikely as high as the near-100/mi^2 in winter there.

Table 2. Three winters of trapping success for trap-and-shoot removals of deer at North Oaks, 1991-93.

Winter	Trap Nights	Deer Caught	Captures/100 Trap-nights
1991	520	97	18.7
1992	903	183	20.3
1993	1846	171	9.3
3-Year Sum	3269	451	13.8

INCEPTION OF DEER CONTROL

In the late 1970s, the Village mayor and council requested that the MN-DNR take action to control the Village's deer numbers. The agency ruled that any removals, other than a public hunt, must be initiated and funded by the local jurisdiction. The hunt option was rejected, and, after considerable discussion and controversy, the Village undertook its own control program, under advisement and permit from the MN-DNR. Winter, is the only season when trap capture was feasible and thus a trap and shoot program was considered the only practical means for killing deer. Annual permits to kill a specified number of deer, agreed upon by the MN-DNR and the Village, were issued by the MN-DNR, with procedures and dates subject to that agency's approval. If the permit quota was achieved before the ending date, the Village could, and occasionally did, request an additional quota, subject again to MN-DNR approval. Our group at the University assisted in developing a removal program, which for us provided field experience for students and data for research projects.

There were two periods of deer removals winters 1980-1983 and 1990-1994 (Table 1). A "winter" here is designated by the calendar year of its later months, e.g. "1990" = Nov/Dec 1989 through March 1990. In the first winter, 1980, deer in both residential and undeveloped sectors were taken by sharpshooting. However, because of safety restrictions, deer in large portions of the residential sector could not be removed. In 1982, a winter of severe weather, trapping was initiated on residential properties, wherein captured deer were shot in the trap. During 1980-1983, sharp-shooting was the sole means of removing deer from the undeveloped sector, mainly the Hill Farm. During 1990-94, all residential-area removals were by trap-and-shoot, with sharpshooting, (starting in 1992), confined to undeveloped sectors. In 1991, a few deer on the Hill Farm were live-captured in rocket nets and then shot.

The interruption of removals during 1985-89, resulted from an apparent slowing or reversal of herd growth, coupled with a continuing minority opposition to killing of deer and a concern for Village expenditures. A condition set by the Village council for deer removal in 1984 was that the aerial count must exceed 400 (Table 1). By 1989 increased complaints from home-owners plus a sharp rise in the annual count led to the Council's resumption of a control program.

METHODS OF CONTROL

Sharpshooting

Where fields of fire offer a totally safe and locally acceptable circumstance for shooting and shooters are competent in all aspects of marksmanship and safety, sharpshooting is the most humane and often the most economical method for reducing deer. Compared to trapping, success in sharpshooting is less dependent on severity of winter except when confined to bait stations. On the other hand, wariness increases more rapidly to shooting than to trapping. We used a .243-caliber rifle, equipped with a 3- or 4-X telescopic sight, and, later augmented this with a laser sight to increase accuracy. Through 1992 we used 100-grain, hollow-point bullets, but then switched to Nozzler™-partition bullets. Shots were never taken at animals in motion. A single shot to the neck at < 50 yd (46 m) consistently killed the deer immediately. A wounded animal running near or through a residential neighborhood was totally unacceptable. Our permits allowed shooting from the bed of a pickup: compared to being on foot, this increased effectiveness by providing a shooting rest on the cab, by affording greater safety because shots were directed more downward, and by allowing closer approach to deer because of their lower wariness of a vehicle. A recent refinement was use of a barrel bipod to increase stability in sighting. In 1994, six stations baited with shelled corn were established, and shooting towards the station was from a pre-designated position. This technique provided further assurance to concerned citizens that our sharpshooting was safe.

When, during 1980-83, sharpshooting was within residential neighborhoods, it was restricted to home sites where owners had made a written request, and shots were taken only where the fields of fire was confined totally to that property. Shooting hours were scheduled with the owners wishes as well as to early weekday mornings, so that it was confined to dawn, before children were out for school buses. No problems arose, but concern by a vocal minority over safety and a sufficient public distaste for shooting in their neighborhoods led to persistent questioning of this method. Also, due to the limited hours and locations available for shooting, sharpshooting did not prove effective in overall reduction of deer in the residential sector. An exception to this is discussed below.

For undeveloped areas of North Oaks, sharpshooting has been consistently effective. In the 1990s, all shooting was confined to the Hill Farm (Figure 1), where there was no constraint on hours, because the land was not open to the public. During 1980-83, however, Village residents could ski there, so shooting hours were restricted to a limited number of week-day mornings.

Trap-and-Shoot

Killing deer in a trap was the primary means for reducing residential- area animals. Deer were live-captured in single-gate Clover traps (Clover 1956) baited with shelled corn and occasionally apples. We tried a collapsible version (Thompson et al. 1989) to make shooting of captured deer easier, but this did not improve effectiveness and required more time.

Trapped deer were approached on foot and shot with a .22 caliber rifle. Carcasses were immediately removed from the site; at the end of the trap line they were field dressed, during which weights, linear measures, and fat deposits were recorded. Dressed carcasses were consigned to the MN-DNR for public distribution according to state regulations.

Traps on residential properties were located out of sight from public roads and neighboring houses, and usually from the owner's house also. Trap sites were generally within 50 ft (15 m) of vehicle access. Home sites were selected for traps based on a) owners' written request, b) availability of a well screened site, c) not adjacent to homes where persons were not opponents of deer killing, and d) presence of relatively high deer numbers.

Traps on residential properties were generally set after dark and checked before light, then left closed during the day. Trapping was stopped during weekends except in 1994 when they were run Saturday mornings to increase removal opportunities.

Traps were installed in October or early November for anchoring them before the ground froze, and also to be ready in case winter weather was early. To survey for local deer presence, candidate sites were pre-baited. As trapping weather approached, traps were first left open with bait inside to condition deer to enter. Traps were run during the season of snow cover with mid-day temperatures consistently below freezing. In most years, this was from mid December to early March, but in some years the operation was delayed until after the year-end holidays. Occasionally traps were moved during mid-winter if a site was unproductive.

Trap success varied with several factors, a critical one being care in setting the trap itself. Strong winds sprung traps if the trip line was in contact with the side netting. Heavy snow or freezing rain caused trip mechanisms to fail, and trapping was stopped in such weather. A strong relationship existed between severity of weather and trap success, with highest rates occurring during winters of above-normal snow and below-normal temperatures. Best success occurred just before major storms and again several days after a storm when temperatures were falling. If mild weather with loss of snow cover persisted for week or more, trapping was usually stopped because of a marked decline in capture rate.

Only 6 traps were used during the first two winters of trapping, 1982 and 1983, but when trapping was resumed 1990-94 the maximum was from 17 to 25. Because all traps in residential areas had to be cleared before daylight, a trap line of 10-15 miles being tended by two persons in a truck could not include more than 15-20 traps, unless some were in undeveloped sectors and could be checked after day-light.

We had minor problems with a few persons, apparently opposed to killing of deer, tampering with traps. In one case, after five incidents of two traps being sprung or covered with deer repellent, the person responsible was identified and confronted by a law-enforcement officer, after which there were no further incidents.

Rocket Netting

Rocket-netting of deer, reported effective in some circumstances (Palmer et al. 1980), was used to a small extent on the Hill Farm. The capture site in front of a 4-rocket, 5 x 10-m net was baited with corn, and the rockets were detonated from within a vehicle some 60 ft (20 m) away. Deer came to the baited site most frequently at dawn and dusk. Best success in capture followed waiting until 2-4 deer were feeding within 2-4 ft of the folded net.

PERSONNEL AND CONTRACTUAL ARRANGEMENT

The majority of workers were undergraduate and graduate students in wildlife. Starting in 1993, a seasonal, non-university person assumed full responsibility for field operations. As deer removal becomes more routine and less of a research and development challenge, the university will withdraw, leaving future deer removals, as needed, to a private consultant or the Village itself. Assuming the former, costs will no doubt be higher reflecting the contractor's taxes, insurance, employee benefits, and profit or entrepreneurial risk.

RESULTS

A total of 1067 deer were removed during 9 winters: 72% by trap-and-shoot, <1% (10 deer) by rocket-netting, and 28% by sharpshooting (Table 1). Removals comprised 10-45% of the estimated deer present each winter, based on best estimates from the aerial counts, for an annual average of 20%. In general, the great majority of trap-and-shoot removals were from residential properties; while most removals by sharpshooting were in undeveloped areas. Thus, the 72% by trap-and-shoot indicates that not only were more deer removed from the residential sector than outside, but the rate of cropping was substantially higher there.

Removal Success

Success rate in sharpshooting was not determined because a time log for this activity alone was not maintained. On the other hand, trap-night records were kept during three winters, 1991-93, and showed success ranging between 9.8 and 20.8 ($\bar{x}$=13.8) captures/100 trap-nights (Table 2). A trap sprung from any cause except obvious vandalism was treated as a "trap-night." Full trapping data were not recorded during the severe winter of 1982; however, with only 6 traps in use, 79 deer were taken indicating a success of 37-40 captures/100 trap-nights. In 1992, with up to 26 traps in use, the highest one-night catch was 8. The range in success rate was clearly related to weather severity, as described above.

Removal Costs

Our records on allocation of costs are not complete; however, gross figures show cost of removal, regardless of method, ranged between $72 and $197/deer (Table 3). Largest expenditure was for hourly labor, and next highest was for vehicle operations. These figures do not include liability coverage taken out by the Village ($2500-5000/yr), administrative activities by the Village including processing home-owner requests for removals; helicopter charter for counts ($500-$1100/yr) but does include time of the counter; activities of the MN-DNR including pickup and disposal of carcasses; and administrative and facilities costs at the University. These figures include construction of 9 Clover traps at $250-300 each and rental of 16 from the MN-DNR at $25/yr plus maintenance. They also reflect research-related necropsy measurements and data compilation, not essential to deer removal; these accounted for no more than an additional 10%.

Cost per deer was not adjusted for inflation over the 15 years, and this in part accounts for per unit costs being generally lower in the early 1980s than early 1990s. The wide variation between 1982-- $72 and 1983-- $140 undoubtedly reflects that the former was a severe winter and latter a mild one. The highest rate, $197 in 1990, apparently reflected both a mild winter and some problems in operational efficiency that winter.

Removal Effectiveness

While consensus within North Oaks has clearly favored reducing but not eliminating deer, the Village Council has not defined a deer-population goal. The criterion of deer level most commonly used in decision making was the total count for the Village; while citizens' demands for herd reduction were based almost entirely on densities within residential neighborhoods. The two are only partially related.

The steady increase in the Village count, 1976-93, was generally accompanied by an increase in complaints from home owners. And the Village council, while not specifying a maximum allowable density or an index of complaints upon which to base removal action, did respond with a parallel growing insistence on herd reduction. Our results indicate that through 1993, whether or not we slowed growth, the removals were not achieving the non- quantified population objectives. The steadily increasing number taken in the 1990s seemed matched by a steady increase in herd size, so that percent removed did not change until 1994 (Table 1). Since the 1994 count figure is believed misleadingly below the number present at the beginning of that winter, the 45% removed figure would be similarly misleading. On the other hand, percent removed in 1994 was unquestionably higher than the estimated 22 and 23% of the preceding 2 years. Our conclusion is that, while

Table 3. Expenditures for deer removals in the North Oaks deer management program. Not reflected are costs of insurance, city activities, activities by the DNR, or the helicopter flights for counting deer.

Winter	Removal Cost	Cost/Deer Removed
1991	$15,000	140
1992	$17,245	94
1993	$22,684	110

past efforts were not sufficiently effective, the removal rate achieved in 1994 would most likely reverse the upward trend in numbers and provide the means for bringing the population closer to a level acceptable by the community. On the other hand, the increased removal from 1993 to 1994 involved more animals outside than inside residential sectors, so the apparent improvement is not as great as the gross figures suggest.

The question of how much effect removals outside residential areas have on deer density in the neighborhoods cannot be answered directly. Indirect evidence cited above suggests that some deer at least are moving between the two sectors, so removals outside will to some extent reduce residential levels, but that extent is not known. No doubt the closer removed deer is to a residential boundary, the more likely that animal had been frequenting the residential sector.

Besides the issue of reducing the herd as a whole and holding it at some level well below its capacity to expand, an interesting question is whether deer in one locale can be reduced for longer periods than predicted by population dynamics and fluid, continuous dispersal into suitable habitats.

While the reversal of the upward trend in numbers for a few years starting in 1984 did not appear directly related to our removals, there could have been some degree of control effect. On the other hand, during 1980-83, it appeared that intensive removals in the southeastern residential sector, zone 1a (Figure 1), was responsible for a sharp drop in animals counted there the following 4-5 winters along with the impression by residents that local numbers were effectively reduced for some time. We reasoned that the removals had included the majority of matriarchal does or group leaders, and hence may have broken a learned habit of using that neighborhood, as suggested with the "Rose-Petal" hypothesis (Porter et al 1991, Mathews and Porter 1993).

CONCLUSIONS AND RECOMMENDATIONS

Our experience at North Oaks indicates that a combination of removal techniques, adjusted to local setting and circumstances, is the best means for deer control in a suburban setting. Nine winters of removals over a 19-year study at North Oaks provide a full-scale example of a community initiative in deer-control. Given that public hunts were not acceptable to this community, and that herd reduction could be achieved only by killing of deer, it is concluded that the combination of trap-and-shoot and sharpshooting, each used where most feasible and permissible, afforded a relatively cost-effective and humane program. Sharpshooting was most effective and efficient in open or undeveloped sectors, while trap-and-shoot was most applicable for residential neighborhoods. The latter might, however, be impractical where weather conditions do not lead deer to risk entering traps as during a northern winter when deer are strongly attracted to high energy food such as corn.

In planning urban deer control, a tendency is to design the program around a fixed number, then calculate an annual removal rate to maintain that level. A consistent annual program is advantageous for personnel planning - quite important for assuring continuance of a reliable and safe operation. Yearly continuity may also be preferable for those communities where minority opposition is relatively strong, and a break in operations would require debating the issues all over again in order to resume a control program. On the other hand, from an ecological and economic standpoint, periodic or pulse removals may have some advantages. When operational circumstances permit starting up on short notice, then a removal program could be confined to the occasional winters of above-average severity when per-deer costs are minimal. And, even if operations are not so responsive on short notice, economies might be realized by putting in a larger effort but only every third or so winter. A periodic approach may be also foster better reproduction for native trees by providing browsed saplings the 2-3 years relief needed to out-reach deer.

There is need to study and develop possible strategies for providing residential neighborhoods relatively long-term relief through an intense effort that removes matriarchal individuals, hence breaks a tradition of groups returning annually to a given tract. Such efforts ought to be accompanied by actions that discourage new colonizers such as prohibiting providing food for deer or even trying scare tactics. Urbanization is a learned habit for deer, so there must be potential for aversive conditioning to discourage uninitiated new comers to a neighborhood.

Finally, rather than setting a fixed number as an accepted population maximum, perhaps communities should use more relevant criterion such as the level of negative deer impacts that are acceptable. Thus when garden or natural-vegetation damages or vehicle accidents or threat of Lyme disease exceed a designated level, control would be applied. Furthermore, it might be applied only locally just in response to local problems.

ACKNOWLEDGMENTS

In addition to many students and North Oaks residents vital to the success of the deer program, the following made special contributions: In the field and with data analysis, W. Adair, T. Anderson, J. (Brown) Albrecht, L. Dorwiler, B. Giese, K. Jessen, D. Krueger, J. Pertz, R. Rainbolt, J. Sillings, J. Stewart, T. Sutter, and J. Tillma; for historical records, A. Hawkins and J. Brainard; and for administrative coordination, R. Johnson, B. Joselyn, and Tim Wallace of the MN-DNR. For the Village, Mayor W. Johnson led community decisions on deer control, and N. Rozycki and T. Watson provided vital coordination. The map was prepared by J. Albrecht; L. Knutson (MN-DNR) assisted in aerial counting for many years; and D. Krueger devised valuable improvements in techniques.

LITERATURE CITED

Callister, S.M., W.A. Agger, R.F. Schell, and J.L. Ellingson. 1988. *Borrelia burgdorferi* infection surrounding LaCrosse Wisconsin. J. Clin. Microbiol. 26:2632-2636.

Clover, M.R. 1956. Single-gate deer trap. Calif. Fish and Game 40:367-373.

Geist, V. 1980. Downtown deer. Natural History 89(March)56-56.

Ishmael, W.E., and O.J. Rongstad. 1984. Economics of an urban deer removal program. Wildl. Soc. Bull. 12:394-398.

Mathews, N.E., and W.F. Porter. 1993. Effect of social organization on genetic organization on free-ranging white-tailed deer in the Adirondak Mountains. J. Mammal. 74:33-47.

McAninch, J.B., and J.M. Parker. 1991. Urban deer management programs: A facilitated approach. Trans. North Am. Wildl. and Nat. Resour. Conf. 56:428-436.

Palmer, D.T., D.A. Andrews, R.O. Winters, and J. W. Francis. 1980. Removal techniques to control an enclosed deer herd. Wildl. Soc. Bull. 8: 29-33.

Porter, W.F., N.E. Mathews, H.B. Underwood, R. W. Sage Jr., and D.F. Behrend. 1991. Social organization in deer: Implications for localized management. Environ. Manage. 15:809-815.

Sillings, J.L. 1987. White-tailed deer studies in a suburban community: Ground counts, impacts on natural vegetation, and electric fencing to control browsing. M.S. thesis, Univ. Minn., St. Paul. 88pp.

LETHAL AND NON-LETHAL DEER MANAGEMENT AT RYERSON CONSERVATION AREA, NORTHEASTERN ILLINOIS

FRANK DRUMMOND, Lake County Forest Preserve District, Libertyville, IL

Managing deer in natural areas in metropolitan environments presents unique problems to managers faced with responsibilities to the resource and pressure from a diverse and frequently polarized public. Deer populations in the Chicago metropolitan area have increased substantially in the last 20-30 years (Witham and Jones 1987), and will likely remain abundant due to extensive systems of unhunted county forest preserve districts that function as sanctuaries for deer and other wildlife.

The Lake County Forest Preserve District (LCFPD) owns and manages 18,693 acres (7,565 ha) of land. The LCFPD is a tax supported public agency overseen by elected commissioners. Their management philosophy is to preserve and restore natural communities, provide recreational opportunity, and educate the public. The most ecologically significant properties are dedicated as Illinois nature preserves, where management and public use are restricted by state statute. One of these sites is the 550 acre (223 ha) Edward L. Ryerson Conservation Area (RCA).

Perceived changes in understory vegetation, first observed in 1984, were believed to be caused by deer. By 1988, deer browsing had caused a decline in spring wildflowers preferred by deer, particularly the large flowered trillium (*Trillium grandiflorum*). Deer at RCA appeared in excellent condition with no evidence of winter starvation (LCFPD 1988). There was no reason to believe the deer population would decline in the near future. Based upon decreases in certain spring ephemerals and concern for the future health and diversity of the forest community, the LCFPD decided to thin the deer population in 1988.

STUDY AREA

The Edward L. Ryerson Conservation Area is a 550 acre (223 ha) preserve located along the Des Plaines River, in Lake County, Illinois, containing a 279 acre (113 ha) dedicated state nature preserve. It contains 9 natural communities: dry mesic upland forest, dominated by white and red oak (*Quercus alba* and *Q. rubra*); mesic upland forest, dominated by sugar maple (*Acer saccharum*) and red oak; mesic floodplain forest, dominated by sugar maple, hackberry (*Celtis occidentalis*), and American elm (*Ulmus americana*); wet mesic floodplain forest, dominated by silver maple (*A. saccharinum*), hackberry, and American elm; wet floodplain forest, dominated by silver maple and cottonwood (*Populus deltoides*); northern flatwoods, dominated by swamp white oak (*Q. bicolor*) and American elm; sedge meadow; fen; and low gradient river.

The preserve provides habitat for 3 Illinois endangered species; the red-shouldered hawk (*Buteo lineatus*), purple fringed orchid (*Habenaria fimbriata*), and hairy white violet (*Viola incognita*); and, 2 state threatened species: the veery (*Catharus fuscescens*) and dog violet (*V. conspersa*). In addition, a number of rare species occur, such as the blue spotted salamander (*Ambystoma laterale*), spotted salamander (*A. maculatum*), and eastern massasauga (*Sistrurus catenatus catenatus*).

RCA is located near Deerfield, IL and surrounded by residential development on all sides, except west of the Des Plaines River where an agricultural field remains intact. Narrow margins of forest along the river connect RCA to forest preserve property to the north and south.

BACKGROUND OF DEER MANAGEMENT CONFLICT

In 1988 the LCFPD proposed a deer control program for RCA that relied on lethal removal by marksmen. Concurrently, the Concerned Citizens and Veterinarians to Save the Ryerson Deer (CCVSRD) filed for a temporary restraining order to prevent deer from being killed. A court approved settlement stipulated that lethal removal would not take place before 6 March 1989, until which time a reasonable effort would be made to trap and relocate deer to achieve herd reduction objectives. Under terms of the settlement, CCVSRD hired a consultant to assist with deer trapping, provided a veterinarian to assist with the program, paid the costs of blood testing and translocation, and agreed to pay for 2 additional box traps and bait.

Trapping did not remove enough deer and marksmen were hired after the 6 March deadline to complete the job. Cooperation during the trapping program did not eliminate friction between the 2 groups when the LCFPD decided to cull deer. CCVSRD members and sympathizers actively picketed and protested, collected a 3,105 signature petition opposing lethal removal, wrote letters to county commissioners and LCFPD's president and director, made threatening phone calls, and demanded that alternative methods be used.

MATERIALS AND METHODS

Trapping and Relocation

From 1989 to 1991 trapping was done with 5 modified Stephenson box traps baited with corn and set in the late afternoon shortly before the preserve closed. Traps were checked in the early morning before the preserve opened to the public. If a deer was caught, it was ear-tagged, and a blood sample taken for bluetongue and Lyme disease testing. While awaiting test results deer were kept in wooden crates in a darkened barn. If results were negative, the deer were relocated; if positive, deer would be euthanized.

In 1989, a consultant was hired by the CCVSRD who entered the box traps to subdue and remove the trapped deer by hand. No drugs were used. This method was discontinued after 1989 due to the risk of injury to personnel and deer.

In 1990, a corral trap was constructed on site to supplement box trapping. The corral was built of 2.2 m chain link fence backed with opaque, nylon fabric, and enclosing an area of approximately 0.3 acres (0.12 ha). The corral was baited with corn and had 2 gates allowing deer to enter. The gates could be closed remotely, and deer were sedated using a dart rifle from a "window" in the fence. The corral was discontinued after the 1990 season because of the likelihood of injury when deer attempted to escape. Blood test, holding, and transport procedures were the same as in 1989.

Beginning in 1991, trapped deer were transferred from the box trap to a smaller transport crate without handling, then weighed, and sedated with a 5:1 ketamine:xylazine mix (4.1 mg/kg) while still in the crate, to facilitate ear-tagging, blood sampling, and general inspection.

Trapped deer were taken to a state approved wildlife park in central Illinois, 200 miles from RCA. Deer were transported in wooden crates in the back of a truck.

Lethal Removal

Lethal removal is done with public safety of utmost importance. Marksmen must pass a shooting proficiency test and be approved by the Illinois Department of Conservation. They use .22 magnum rifles with telescopic sights and shoot from elevated blinds over baited sites. The elevated blinds assure that bullet path/trajectory is into the ground. Shooting takes place when the preserve is closed to the public.

Shooting blinds are erected in forest openings at least a month before any shooting begins. The sites are baited with corn every morning and afternoon at least 2 weeks prior to the commencement of shooting, and daily during the culling program.

Deer carcasses are field dressed on site and taken to a local packing plant for processing. The venison is donated to charitable institutions in Lake County under the provisions of the Good Samaritan Food Donor Act.

RESULTS

Trapping and Relocation

In 1989, 76 deer were counted from the air and a removal permit was obtained for 60 deer. Trapping began as a joint effort between the LCFPD and CCVSRD and took place from 14 February to 1 May 1989, comprising 70 days. Eighteen deer were relocated, 1 died during handling, 1 was euthanized after a positive test for Lyme disease, and 2 of 7 radio-collared deer released into RCA died post-release. Cost per deer trapped was $637.00, not including costs incurred by the CCVSRD (figures unavailable). LCFPD staff put in an average of 38.75 hours per deer trapped (Figure 1).

In 1990 a removal permit was obtained for 13 deer, later amended to 14. Eleven deer were corral and box-trapped and relocated between 12 March and 9 April 1990, 1 died during handling, and 2 died during transport. Construction of the corral trap added significantly to the cost of trapping, which averaged $1,251 per deer (Table 1). Man hours were 33.0 per deer (Figure 1).

In 1991 a removal permit was obtained for 28 deer. The wildlife park agreed to accept 6 deer which were successfully trapped and relocated between 19 and 26 February 1991. Two more deer died during handling. Cost per deer was $603, and required 23.6 man hours of staff time (Table 1, Figure 1).

In 1992, the wildlife park declined to accept any more trapped deer. As there were no other state approved release sites willing to accept deer, the trapping program was discontinued.

Lethal Removal

In 1989 shooting took place between 23 March and 16 April. Thirty-nine deer were shot, yielding 2,513 pounds (1,142 kg) of venison donated to local

Table 1. Itemized cost of trapping and relocating deer from Ryerson Conservation Area, 1990 - 1991[a]

Item	1990	1991
Aerial Count	1006	225[b]
Consultant	1456	710
Additional Equipment	0	418
Blood Tests	634	432
Bait	67	145
Labor	5796	2132
Corral Trap	5094	0
Transport	707	759
Printing and PR[c]	2747	0
Total	17507	4821
Cost Per Deer	1251	603

[a]itemized figures are not available for 1989
[b]cost of aerial count shared with 1991 shooting program
[c]an outside media consultant was hired in 1990

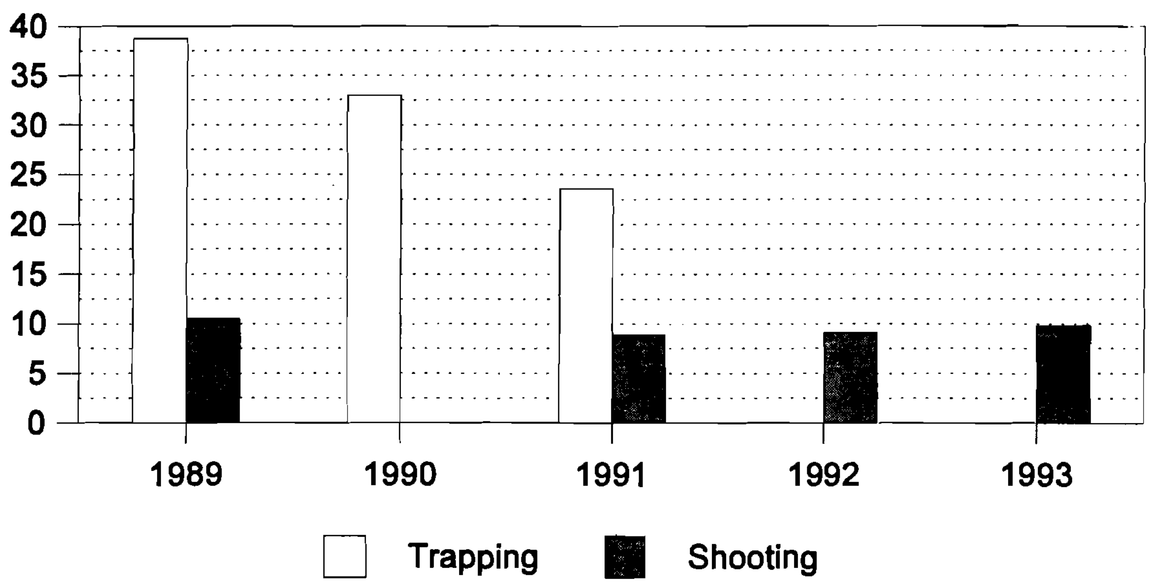


Figure 1. Average man hours required per deer removed from Ryerson Conservation Area, by both trapping and shooting, 1989 - 1993.

Table 2. Itemized cost of shooting deer in Ryerson Conservation Area, 1991 - 1993[a].

Item	1991	1992[b]	1993[b]
Aerial Count	225	567	570
Marksmen	1440	2840	2790
Meat Processing	811	1897	1134
Bait	145	225	257
Ranger Police	525	0	0
Additional Equipment	0	721	1612
Staff Time	2053	4307	4115
Public Meeting	0	93	228
Total	5199	10650	10706
Cost Per Deer	260	242	255

[a]itemized figures are not available for 1989
[b]costs include additional deer culled from 2 other preserves

charities. Costs averaged $286/deer (Table 2) and man hours per deer averaged 10.5 (Figure 1).

In 1990 no deer were shot, as trapping was sufficient to remove the maximum number permitted.

In 1991 20 deer were shot between 7 March and 22 March, yielding 1,268 lbs. (576 kg) of venison donated locally. Culling cost an average of $260/deer (Table 2). Staff hours per deer shot averaged 8.9 (Figure 1).

In 1992 the LCFPD counted 32 deer in RCA and received a permit to remove 19 deer, which were culled between 4 February and 5 March 1992. Removal costs averaged $242/deer, and staff time averaged 9.1 hours/deer (Table 2, Figure 1).

In 1993 25 deer were counted and marksmen removed 12 deer from RCA between 8 February and 26 February. Removal costs and man hours averaged $255/deer and 9.8 hours/deer (Table 2, Figure 1).

DISCUSSION

In three years experience trapping deer, it proved to be more expensive and more time consuming than shooting deer. Additional shortcomings were the shortage of state approved release sites and the occasional stress related mortalities of trapped deer. However there were some advantages to trapping and relocating: it is a non lethal method and was therefore more palatable to elected officials and various constituency groups. And it is very selective; one can relocate only does and release all males caught.

Excepting the year the corral trap was constructed, our costs were similar to those reported by Ishmael and Rongstad (1984) of $570/deer for boxtrapping.

Contracting with marksmen proved to be more cost effective, require fewer man hours, was quick and humane, and provided meat that was donated to local food pantries and soup kitchens. Disadvantages to shooting deer included safety concerns of preserve neighbors, the need for highly skilled marksmen because of the small caliber involved, and the strong objections of local animal welfare advocates.

Our annual mean figures for man hours per deer shot were higher than the 3 man hours/deer reported by Palmer et al. (1980), but similar to the 13.5 documented by Ishmael and Rongstad (1984) whose costs were only $73.95/deer. Our costs were much higher because we contracted with outside marksmen, bore the cost of processing the venison, and include flight time for aerial counts as part of the overall deer program costs.

CONCLUSIONS

Protecting natural areas from deer browsing deemed excessive in metropolitan environments continues to be a controversial subject. Announcement of plans to cull deer at RCA in order to preserve the diversity of a state recognized natural area set off a series of protests and an anti-LCFPD media campaign that was totally unexpected in its magnitude and intensity. The LCFPD naively assumed most of the public would agree with a holistic management approach with priority given to protecting forest communities rather than one species or individuals of one species.

It is unlikely opposition to shooting deer represented a majority opinion of county residents. However, opponents were very vocal and made effective use of local media. Results of the court approved settlement forced the LCFPD to adopt more costly and less effective methods to reduce deer densities and delayed lethal removal. The spectre of 1989's opposition caused LCFPD commissioners to continue to favor trapping and relocation over culling herds until the wildlife park could no longer accept more deer.

LITERATURE CITED

Ishmael, W.E., and O.J. Rongstad. 1984. Economics of an urban deer removal program. Wildl. Soc. Bull. 12:394-398.

Lake County Forest Preserve District. 1988. Control of white-tailed deer in Ryerson Conservation Area. 63 pp.

Palmer, D.T., D.A. Andrews, R.O. Winters, and J.W. Francis. 1980. Removal techniques to control an enclosed deer herd. Wildl. Soc. Bull. 8:29-33.

Witham, J.H., and J.M. Jones. 1987. Deer-human interactions and research in the Chicago metropolitan area. Pages 155-159 *in* L.W. Adams and D.L Leedy, eds. Integrating man and nature in the metropolitan environment. National Institute for Urban Wildlife, Columbia, MD.

USE OF BOWHUNTING TO CONTROL DEER IN A SUBURBAN PARK IN ILLINOIS

JEFFREY M. VER STEEG, Division of Wildlife Resources, Department of Conservation, Springfield, IL
JAMES H. WITHAM, Game and Fish Department, Kingman, AZ
THOMAS J. BEISSEL, Division of Wildlife Resources, Department of Conservation, Sterling, IL

The white-tailed deer (*Odocoileus virginianus*) is the largest native mammal in Illinois and is abundant statewide. Deer herds that persist at high density in state parks and other areas can alter composition and structure of flora through intensive foraging on preferred plants (Witham and Jones 1992). Such deer-induced changes in plant communities can have negative secondary effects on the welfare of sympatric wildlife species that depend on vulnerable vegetative strata for reproduction, food and cover. The Rock River valley in northern Illinois has a history of dense deer populations. Aldo Leopold (1936) estimated deer density in an area located 10 miles (16 km) from what is now Rock Cut State Park (RCSP) at 64 deer per square mile (24 deer/km^2).

Similar to deer population trends statewide, deer abundance at RCSP has increased during the last decade. This change in herd size is evident from increases in deer sightings, deer-vehicle accidents on adjacent roads, and bark stripping damage to elm trees (*Ulmus rubra*) during late winter.

The first aerial count of deer at RCSP, conducted in December 1987, documented densities of > 73 deer per square mile (28 deer/km^2). Based on the desire to reduce deer abundance and to expand opportunity for recreational bowhunting on public lands in northern Illinois, the Illinois Department of Conservation (IDOC) implemented 53-day either-sex bowhunts in 1988 and in 1989. These were the first hunts held at RCSP.

In 1990, the IDOC proposed a three-year program to reduce deer density at RCSP to 25 deer per square mile (10 deer/km^2). The 1990-1991 herd reduction program at RCSP was designed to increase the harvest of female deer during a 39-day modified hunt that required archers to take two antlerless deer before harvesting an antlered buck. A midwinter (January to March) sharpshooting phase followed the bowhunt to ensure that annual population reduction goals were achieved. The reproductive performance of the RCSP herd was assessed from deer collected by bowhunters and sharpshooters (Witham 1991). Because actual rates of reproduction were less than those initially assumed, bowhunting regulations were further modified in 1991 and the desired herd reduction was achieved in two years rather than three. Although RCSP deer hunts were not designed from a research perspective, they provide valuable data on the use of bowhunts as a management tool. This paper reports the results of these bowhunts.

SITE DESCRIPTION

RCSP is located in the city of Loves Park, 6.2 miles (10 km) northeast of Rockford, Winnebago County, Illinois. Rockford, the second largest city in Illinois, has a human population of 140,000. The park was dedicated in 1962 and currently encompasses 3093 acres (1252 ha). It is bisected by Interstate 90 (I-90) with 89 percent of the total park area located west of I-90. RCSP east of I-90 consists of 299 acres (121 ha) of old fields and small woodlots and a 49-acre (20-ha) lake. Park area west of I-90 includes the 163-acre (66-ha) man-made Pierce Lake, 1202 acres (486 ha) of native and reforested woodland and 1381 acres (559 ha) of early- to mid-successional old fields. Agricultural land use predominates to the north and east of RCSP. Private property west and south of RCSP includes residential, commercial and agricultural land uses. Two portions of the park, totaling 110 acres (44 ha), are dedicated as state nature preserves.

RCSP is an intensively used multi-purpose recreational park with annual attendance estimated at > 1 million visits. Attendance is skewed, with the highest use (69-78 percent of annual visits) during summer (IDOC, unpublished data, 1986-1989). Park use during summer (1 May - 31 October) centers around Pierce Lake and nearby recreational developments including picnic areas, a boat rental stand and camping sites. A diverse trail system winds throughout the park and is extensively used by bikers, equestrians, hikers and joggers. RCSP is open to the public during winter (1 November - 30 April) for cross-country skiing, dog-sledding, ice fishing, ice skating, jogging/hiking and snowmobiling.

METHODS

Deer abundance

Periodic aerial counts of deer were made from helicopters beginning in December 1987, the winter prior to the first bowhunt. At least one count was made each winter following the bowhunt, preferably after fresh snowfall. Method of counting deer followed

Witham and Jones (1990). The percentage of deer that remained undetected during helicopter counts was not estimated.

1988 and 1989 Bowhunts

The bowhunts extended for 53 days (1 November to 31 December excluding Thanksgiving, Christmas and the six days of the statewide firearm deer season) in 1988 and in 1989. No firearm hunting was allowed at RCSP. All bowhunters were required to purchase a statewide, either-sex archery deer permit and to pre-register for the hunt. Pre-registration allowed the IDOC to provide prospective bowhunters with site specific information and regulations, and a windshield permit. Hunters were also required to sign in at an unmanned check station 90 minutes before sunrise daily. The maximum daily quota of 75 hunters was filled on a first-come, first-served basis. Hunting hours were one-half hour before sunrise until 10:00 a.m. Hunters were required to case their bows or render them inoperable by 10:00 a.m., and to sign out and record harvest no later than 10:30 a.m. No specific harvest goals were established for the bowhunts.

1990 Bowhunt

The 39-day bowhunt in 1990 was 14 days (26 percent) shorter than those held during 1988 and 1989. Unlike the first two hunts, the 1990 bowhunt, which ran from 5 November to 14 December, remained open during the six-day statewide firearm deer season. No firearm hunting was allowed at RCSP. The park was closed on Thanksgiving.

A person was eligible to hunt if he/she possessed a statewide 1990 Illinois archery deer permit. Hunters who filled their statewide permit(s) previously could participate in the hunt, but were limited to taking antlerless deer only. An antlerless deer was defined as any deer without antlers or deer with antlers < three inches (7.6 cm) in length.

Beginning in 1990, annual deer reduction goals were established from computer population model simulations based on data collected from the east-central Illinois farmland deer study (Nixon 1989) and modified for RCSP. To increase doe harvest, hunters were required to take two antlerless deer before being eligible to use an unfilled statewide permit to harvest an antlered buck. Antlerless deer were registered and tagged by the IDOC without charge to the hunter.

A maximum of 75 hunters was allowed to hunt daily. The daily quota of hunters was filled on a first-come, first-served basis with reservation sign-up starting at 10:00 a.m. on the day prior to the day of hunting. On the day of the hunt, bowhunters were allowed to register at the park headquarters 90 minutes before sunrise. Hunters surrendered their hunting licenses and were issued backpatch permits for themselves and windshield permits for their vehicles. IDOC staff reviewed site regulations and safety information daily for each group of hunters. Instructional pamphlets (George 1990) that detailed shot placement and animal recovery were made available to hunters to minimize wounding loss. Hunting hours were the same as in 1988 and 1989. At the check-out station, licenses were returned in exchange for the hunter's backpatch and windshield permit. For each hunter, the check-out station operator recorded the check- out time, number of deer observed, area hunted and previous hunter safety education. Hunters tracking wounded deer at 10:00 a.m. were required to check out within designated times, but were allowed to return without archery equipment to continue tracking. Unsuccessful bowhunters frequently assisted other hunters in tracking. Local residents, referred by bowhunting associations, were "on-call" to help find wounded deer.

Successful hunters brought the entire deer to a field dressing station for processing. A wildlife biologist performed a postmortem assessment on carcasses during field dressing. Data collected included sex, age class, whole body and eviscerated body weights, linear measurements (i.e., total length, right hind foot, chest girth), ovaries, kidney fat indices and Kistner score (Kistner et al. 1980). Reproductive status and physical anomalies were noted. Viscera were collected and delivered to a rendering facility. Bowhunting alone did not achieve the reduction goal. From January to March following the bowhunt, sharpshooters shot deer at night over sites baited with corn and occasionally hay.

1991 Bowhunt

The procedures for the 39-day bowhunt in 1991 were similar in most respects to the 1990 hunt. However, bowhunters were required to take only one antlerless deer before harvesting an antlered buck. Permits valid for an entire week were allocated in advance during six separate drawings before and throughout the season. This system guaranteed hunters a larger block of time to hunt than did the daily registration approach used in 1990. Additional drawings were held at 11:00 a.m. on the day prior to a hunt and at 5:00 a.m. on the morning of a hunt which provided an opportunity for standby hunters to fill vacancies or openings created by "no-show" bowhunters.

Table 1. Age and sex of bow-killed deer at Rock Cut State Park, Illinois, 1988-1991.

	YEAR			
	1988	1989	1990	1991
Total Deer Harvest	52	48	73	28
Proportion of Females in Harvest	0.442	0.500	0.644	0.607
Proportion of Antlerless Deer in Harvest	0.576	0.645	0.945	0.750
Number of Adult Females	18 (0.346)[a]	17 (0.354)	18 (0.247)	11 (0.393)
Number of Yearling Females	-[b]	-	8 (0.110)	5 (0.179)
Number of Female Fawns	5 (0.096)	7 (0.146)	21 (0.288)	1 (0.036)
Number of Adult Males	22 (0.423)	17 (0.354)	1 (0.014)	5 (0.179)
Number of Yearling Males	-	-	3 (0.041)	2 (0.071)
Number of Male Fawns	7 (0.135)	7 (0.146)	22 (0.301)	4 (0.143)

[a]proportion of total annual harvest
[b]yearling included in adult age class in 1988 and 1989

Hunters were required to check out with their entire deer, but IDOC staff recorded only the sex and age class of each animal. Hunters eviscerated their own deer at the check-out station. This requirement was aimed at eliminating the nonhunting public's negative reaction to viscera left in the park during the 1988 and 1989 hunts. Entrails were buried in an on-site landfill. Sharpshooting followed the bowhunt to kill the remainder of the removal quota.

RESULTS

Bowhunters harvested more deer in 1990 than in 1988, 1989 or 1991 (Table 1). Seventy-three deer were harvested by bowhunters in 1990. An additional seven animals registered by bowhunters were classified as "pickups" (i.e., a carcass found and claimed by a hunter). The requirement to harvest two antlerless deer prior to harvesting an antlered buck encouraged hunters to register pickups. Arrow wounds were found on three of the seven pickups; cause of death was not determined for the remaining four deer. These seven deer have been excluded from the analysis. Expressed as a ratio of does taken per hunt day, the 1990 antlerless quota increased the daily rate of removal of females by 2.7 times over previous bowhunts at RCSP. The number of trips per hunter ranged from 1-35. Most (81 percent) individuals hunted five or fewer days. The deer removal rate by hunt days (Witham 1991) was highest during the first 10 days of the hunt, but declined progressively during the next two quarterly intervals. Removal rates increased during the last nine days of the hunt, coinciding with heavy snowfall on 3 December 1990.

In 1991, total harvest decreased, but the proportion of females in the harvest remained high (Table 1). The total number of hunter trips was 52.2 percent of the potential maximum, compared with 76.5, 68.1 and 90.2 percent in 1988-1990, respectively (Table 2).

Wounding rates

IDOC staff made a concerted effort to document the cause of death of all deer found dead in the park during and immediately following the hunt in 1989. Thirteen deer were found and examined. Five deer were determined to have died as a result of the archery hunt. The remaining eight deer died of non-hunting related causes, primarily vehicle collisions.

In 1990, 50 hunters returned to RCSP to track wounded deer after 10:30 a.m. Of those, 15 hunters recovered their deer. Therefore, a minimum of 35 deer were wounded and not recovered. Excluding the seven deer that were classified as pickups, the total number of deer struck by bowhunters at RCSP in 1990 was 108. The minimum wounding rate was 32.4 deer per 100 struck.

Table 2. Deer bowhunter trips at Rock Cut State Park, Illinois, 1988-1991.

	YEAR			
	1988	1989	1990	1991
Number of Hunter Trips	3040 (76.5)[a]	2707 (68.1)	2637 (90.2)	1527 (52.2)
Mean Trips/Day	57.4	51.1	67.6	39.2
Season Length (Day)	53	53	39	39

[a]percent of maximum trips possible

A deer that is hit by an arrow but not recovered by the hunter (i.e., wounded) has one of three fates. Mortality is one possible outcome that can occur within a short (i.e., mortal wound but the hunter cannot locate the carcass) or longer (e.g., debilitating wound that culminates in death) timeframe. A second category of wounded deer would be those animals that survive with a permanent injury (e.g., cripple) which may or may not impair individual long-term survival. Deer that survive a wound with no permanent physical impairment are a third potential outcome of wounding. We know that all deer wounded by archers at RCSP did not die (e.g., several deer subsequently killed by sharpshooters had arrow wounds that had healed) and that some deer wounded by archers did not survive (e.g., three of seven "pickups" registered by bowhunters had lethal arrow wounds). This study did not enable a quantitative determination of the fates of wounded deer.

More than 100 volunteers solicited from a wide range of interested publics participated in a deer carcass search of approximately 17 percent of the 2382 acre (964 ha) huntable portion of RCSP after the 1990 bowhunt and prior to sharpshooting. Five carcass remnants were found by searchers during the 3.5 hour search. Of these, three were sun-bleached partial skeletons with algae growing on the bone. The remaining two deer consisted of skeletons and hides only. None of the carcasses provided sufficient information to determine cause of death. For the size of the area searched, the number of deer carcass remnants was low and not considered atypical for natural mortality over a period of several months.

Deer abundance

Winter helicopter counts of deer were made between December 1987 and January 1991. A minimum population density of 73 deer per square mile (28 deer/km^2) was counted for the west portion of RCSP based on the first aerial count (16 December 1987) prior to bowhunting. Following the 1991 bowhunt a flight was made over RCSP on 16 January 1992. Observers recorded 147 deer. This equates to a density of 36.5 deer per square mile (14.1 deer/km^2) prior to sharpshooting. The management goal of 25 deer per square mile (10 deer/km^2) was considered reached when the number of deer observed during the post-harvest count was approximately 100-125.

DISCUSSION

Bowhunting

The proportions of female deer in the archery harvests at RCSP in 1988 and 1989 (Table 1) were slightly larger than the proportion of females in the statewide archery harvests (< 0.40), in 1991 and in 1992. We believe that many bowhunters at RCSP in 1988 and 1989 accepted the herd reduction goal of the IDOC and cooperated by harvesting does even though prior to hunting, the park had developed a reputation for many large-antlered bucks. It is also possible that many hunters increased their chances of success during the short three to four-hour daily hunts by being less selective than usual in attempting to harvest deer.

The controversy about bowhunting RCSP reached its peak in 1990. In response to a local group's intensive campaign to eliminate the archery deer hunt, bowhunters overwhelmingly supported the IDOC's efforts to increase the harvest of antlerless deer. Hunter participation was similar to 1989 (Table 2) despite the 26 percent reduction in season length. The proportion of antlerless deer in the 1990 harvest increased by 46.5 percent, and the female proportion of the total kill increased by 28.8 percent compared to 1989 (Table 1). Total deer harvest increased by 52.1 percent from 1989 to 1990. We believe that hunter cooperation had as much to do with the improved harvest statistics as did the newly imposed antlerless quota. Support for this assumption can be found in the 1991 harvest data.

Season length and hunting hours were the same in 1990 and 1991, but hunter trips declined by 42 percent in 1991 (Table 2). We believe two factors are primarily responsible for this change. First, controversy surrounding the 1991 bowhunt was minimal. Objections to the 1990 bowhunt motivated hunters to participate as a show of support for the program. Second, hunters knew that a total of 216 deer had been removed the previous winter through a combination of bowhunting (n=80) and sharpshooting (n=136). The IDOC expected to reach the deer population objective at the conclusion of the 1991 bowhunt/sharpshooting program, one year ahead of schedule. For this reason, and because a decrease in bowhunter participation was anticipated, the IDOC reduced the antlerless quota per hunter from two to one deer. Although this strategy failed to maintain high participation rates, it did not result in a significant decline in the proportion of females harvested (Table 1). The proportion of antlerless deer in the total harvest did decline, however. An examination of the data reveals that bowhunters in 1991 removed proportionately far fewer fawns of both sexes than in 1990 and increased the proportional harvest of all male deer, especially adults. The proportion of adult females in the harvest also increased. We suspect that bowhunters, cognizant of the reduced deer population and without the motivation created by intense controversy, selected for larger deer in general and passed up fewer opportunities to take males.

Maintaining the RCSP deer herd at a pre-harvest level of < 150 animals by bowhunting poses special problems when considering management options. Consistently attracting large numbers of bowhunters is difficult because the IDOC recently opened 2234 acres (904 ha) of public land to bowhunting within 35 miles (58 km) of RCSP. Far fewer restrictions apply to deer hunting on the new property. In addition, the smaller deer population at RCSP will reduce the effectiveness of bowhunters pursuing the antlerless portion of the deer herd. Furthermore, as observed in 1988-1991, hunters using RCSP for even a few hours each day tend to concentrate deer in inviolate portions of the park. From a deer reduction standpoint, a four hour per day, 39-day bowhunt is unlikely to reach the annual removal goal.

However, under certain conditions, bowhunting alone can reduce a deer population. Bowhunters in east-central Illinois apparently reduced an estimated pre-hunt population of 550 deer by 68 percent after two seasons of hunting (R. Willmore, personal communication: 1993). Hunters were allowed to hunt all day and deer were concentrated on approximately 800 acres (324 ha) of woodland on the perimeter of a 1300-acre (526-ha) peninsula when interior crop fields were harvested.

The bowhunts at RCSP demonstrated that a bowhunting program can be structured to significantly increase the proportion of antlerless deer in the harvest. The hunts also proved to be safe and cost-effective. The effects of such a bowhunt on a specific deer herd are determined by many factors, not the least of which is hunter support and participation.

Sharpshooting

Volunteer and contractual sharpshooters were used following the bowhunts in 1990 and 1991 to ensure that annual deer herd reduction goals were reached. From late January to early March, sharpshooters removed 136 deer in 1991 and 60 deer in 1992. Volunteer sharpshooters did not achieve the 134 deer reduction goal by the intended date. The sharpshooting project leader removed the remainder of the deer quota (plus two additional deer).

Sharpshooters in January - March 1991 removed proportions of antlerless (0.927) and female (0.654) deer very similar to that of bowhunters in 1990 (Table 1). From November 1991 to March 1992, sharpshooters and bowhunters removed similar proportions of female deer (0.600 and 0.607 respectively). In 1991 however, bowhunters removed proportionately fewer antlerless deer (0.750) than did either bowhunters in 1990 (0.945) or sharpshooters in 1991 and 1992 (0.927 and 0.900 respectively). Sharpshooters maintained a large component of fawns in the cull following the 1991 bowhunt, supporting the conclusion that the decrease in fawn proportion of the 1991 bowhunt harvest was due to hunter selectivity rather than a change in herd structure.

Sharpshooting was more efficient than bowhunting. Using data from the November-December 1990 bowhunt and the January-March 1991 sharpshooting program, the overall removal rate for sharpshooting was 3.76 deer per day, nearly twice that for bowhunting (1.95 deer per day). Allowing sharpshooters to roam from bait site to bait site in 1992, rather than remain at a single location (as required in 1991) increased their efficiency.

Public opinion

In 1989, a group of residents living near RCSP organized to oppose the archery deer hunt. Less than 24 hours before the scheduled hunt, the group filed a Motion for Restraining Order with the Cook County Circuit Court in an attempt to stop the hunt. The motion was dismissed, but the group continued to

Table 3. Estimated cost of deer bowhunting program at Rock Cut State Park, Illinois, 1990.

	Hours	Hourly Wage($)	Total ($)	Cost per deer ($)[a]
Park Staff	337	10.00	3370.00	46.16
Contractual Security	240	4.50	1080.00	14.80
Contractual Clerical	99	4.50	446.00	6.11
Postage			150.00	2.06
Telecommunications			258.00	3.53
Mileage			749.00	10.26
Total			6053.00	82.93

[a]n=73

intensively lobby the Governor, General Assembly and local media. Objections to the bowhunt ranged from philosophical concerns about hunting in general to criticism of the efficacy, efficiency, safety and humaneness of bowhunting. Opponents also objected to restricting general public access to RCSP from 8:00 a.m. to 10:30 a.m. daily during the bowhunt.

In 1990, the IDOC provided a forum for public input on two occasions. An administrative rule hearing took place in May in Springfield, the state capitol. A second hearing was held in Rockford two and one-half months prior to the scheduled bowhunt. The Rockford hearing was attended by more than 400 people. Testimony was heard from 30 people in favor of the archery hunt and 30 opposed during the five hour hearing. Two-thirds of the nearly 200 people signing a registration sheet indicated their support for the IDOC's proposal. In his report (Draper 1990), the hearing officer stated ". . . public opinion alone would be a poor method for determining state policy on an issue such as wildlife management, the number of persons supporting or opposing the Department's position has relatively minor importance in the ultimate decision." The report recommended that the IDOC ". . . consider adopting the proposed rule and going forward with the intended plan." Input from these hearings and discussions with representatives of opponents and proponents of the archery hunt resulted in modifications for the 1990 hunt.

The opening day of the 1990 hunt was covered by radio and newspaper reporters and three Rockford television stations. Opposition to the 1991 bowhunt was practically non-existent.

Costs

The principle expenditure for the 1990 bowhunt was in IDOC staff personal services (Table 3). Two additional short-term contractual personnel were hired for security and office support. Estimated cost of the 1990 bowhunt was $83.00 per deer. Each bowhunter was required to purchase at least one statewide either-sex archery deer permit for $15.00. A minimum estimate of the revenue generated by the sale of statewide archery permits to bowhunters registered at RCSP in 1990 was $149.00 per deer. Costs were not analyzed for the 1988, 1989, or 1991 bowhunts.

The average cost to remove deer (n=105) by 16 volunteer sharpshooters following the 1990 bowhunt including IDOC expenditures and the value of volunteer donations (eg., sharpshooting, carcass processing, bait) was $233.00 per deer (Witham 1991). Volunteer and professional sharpshooters killed 132 deer suitable for donation to charities in 1991. The carcasses produced 6,635 pounds (3,010 kg) of ground venison valued at $11,877. Bowhunters in the same year donated over 500 pounds (227 kg) of ground venison to charities.

CONCLUSIONS

It was not possible to reduce the deer herd at RCSP by bowhunting alone within the three year period called for in the IDOC plan. Constraints on season length and hunting hours severely limited the bowhunters' opportunity to maximize harvest. However, results of the 1990 bowhunt demonstrate that an archery deer hunt can be designed to contribute substantially to population reduction or maintenance goals by selectively removing female deer. Hunter education and cooperation are important requirements for realizing the potential of such a program.

ACKNOWLEDGEMENTS

We thank B. Anderson and B. Ver Steeg for reviewing the manuscript.

LITERATURE CITED

Draper, C.R. 1990. Report to the Department of Conservation, state of Illinois, concerning opposed rule changes, white-tail deer bow hunting at Rock Cut State Park. 18 pp.

George, J.L. 1990. Big game shot placement guide. Natl. Bowhunter Educ. Foundation. Murray, KY. 23 pp.

Kistner, T.P., C.E. Trainer, and N.A. Hartmann. 1980. A field technique for evaluating physical condition of deer. Wildl. Soc. Bull. 8:11-17.

Leopold, A. 1936. Report to Mr. Howard D. Colman on Rockford deer area. 6 pp.

Nixon, C. 1989. Illinois deer investigations. Illinois Perf. Rept. Pittman-Robertson Project W-87-R-8, 9, 10. 592 pp.

Witham, J.H. 1991. Reduction of local deer herd at Rock Cut State Park, Winnebago County. Contract Completion Rept., Illinois Dept. Conserv., Div. Wildl. Resour. 41 pp.

___, and J. M. Jones. 1990. White-tailed deer abundance on urban sanctuaries during winter in northeastern Illinois. Wildl. Soc. Bull. 18:13-16.

___, and _____ . 1992. Biology, ecology, and management of deer in the Chicago metropolitan area. Illinois Final Perf. Rept. Pittman-Robertson Project W-87-R. 108 pp.

POLICE SHARPSHOOTING AS A METHOD TO REDUCE URBAN DEER POPULATIONS

MICHELLE L. STRADTMANN[1], School of Natural Resources, University of Missouri, Columbia, MO
JAY B. McANINCH, Department of Natural Resources, Madelia, MN
ERNIE P. WIGGERS, School of Natural Resources, University of Missouri, Columbia, MO
JON M. PARKER, Department of Natural Resources, St. Paul, MN

High deer populations in urban communities create traffic hazards, concerns about human health, and cause extensive damage to native and planted vegetation. While many residents expect these issues to be resolved, they are often unwilling to accept the use of traditional management methods. Variations of controlled hunting have been the primary methods used to manage deer numbers (Palmer et al. 1980, Ellingwood and Caturano 1988, Deblinger 1990), although trap and transfer has also been reported (Bryant and Ishmael 1990, Jones and Witham 1990, O'Bryan and McCullough 1985). In response to concerns about cost, safety, efficiency and public acceptance, sharpshooting has been proposed as an alternative (Witham and Jones 1992, Ishmael and Rongstad 1984). However, only limited information exists on the actual cost, efficiency and safety of the technique.

In 1991, the Minnesota Valley Deer Management Task Force (DMTF) developed a deer management plan for the cities of Bloomington, Burnsville, Eagan and Mendota Heights, Minnesota (McAninch and Parker 1991). The DMTF recommended a variety of methods to control and manage deer populations including sharpshooting. On the basis of the DMTF recommendations, a 3-year sharpshooting program, using police officers from the Bloomington Police Department (BPD) was adopted in the city of Bloomington. We discuss the development, administration and implementation of the BPD sharpshooting program in Bloomington and present data on cost and efficiency. We also discuss safety concerns and public reaction to the program.

METHODS

Program development

Sharpshooting was approved as one of several reduction options by the Bloomington Natural and Historic Resources Commission (NHRC) and the Bloomington City Council for a 3-year experimental period. A number of agencies participated in the development and implementation of the sharpshooting program (Table 1). The program was coordinated by the Bloomington Planning Division under special permit granted by the Minnesota Department of Natural Resources (DNR) to the BPD. Staff from the DNR Section of Wildlife acted as advisors for the program, the BPD provided sharpshooters and the Parks Maintenance Department (PMD) and DNR, Division of Law Enforcement handled logistics.

Deer population reduction goals for selected areas within the city were developed by the DNR and were based on helicopter counts, population modeling and density goals of 15-25 deer per square mile.

Program implementation

The sharpshooting task was assigned to the Special Operations Unit of the BPD. The Special Operations Commander was in charge of supervision, data collection and budgeting and made administrative adjustments to the program as needed. Officers were recruited and provided with an explanation of the program and expectations for time commitment and performance. Officers were required to supply their own firearms (.222 to .243 caliber rifles with scopes), pass a shooting test and receive BPD authorization for a non-standard weapon. To pass the shooting test, officers had to hit a 7" (18cm) diameter target at 25 (23m) and 50 (46m) yards, 10 seconds after a "fire" command was given. Officers were also required to attend an orientation session that covered a wide range of topics, from public interaction to safety standards and shot placement.

Throughout the program, emphasis was placed on public safety. Officers were instructed to shoot only toward adequate backstops, use only one shot to kill each deer, and to remember safety was more important than killing deer. Deer were shot within predetermined shooting lanes and from stationary positions such as a stand or vehicle. Deer were only to be shot while they were standing or walking slowly. To eliminate deer running after the shot, officers were instructed to use only neck shots. Officers were advised to allow deer to

---

[1]Present address, Department of Natural Resources, Madelia, MN

Table 1. Agency participation in the sharpshooting program in Bloomington, Minnesota, 1991-1993.

Agency/Organization	Participation
Bloomington Natural and Historic Resources Commission and City Council	Deer feeding ban Approval of program and final recommendations Waiver of firearms discharge ordinance
Bloomington Planning Division	Deer Management Plan update DNR permit application Public notification of program Coordination of program review
Bloomington Police Department	Budgeting Bait site selection Sharpshooter supervision Data collection
Bloomington Parks Maintenance	Bait site selection Sign posting Maintain site access and baiting Carcass collection
Department of Natural Resources - Section of Wildlife	Permit allocation Bait site selection Advise police department Assist in program review
Department of Natural Resources - Division of Law Enforcement	Bait site selection Distribution of carcasses

begin feeding before shooting to give time for other deer to arrive at bait sites. If shooters had the option, adult females or other antlerless deer were to be shot first.

Bait sites were selected based on proximity to deer concentrations, access for vehicles and opportunities for safe shooting. Residents were notified of the locations and dates of the program through local newspapers. Letters were also sent to residents bordering each shooting area. In 1991-92 (PY1) sites were baited with five gallon pails of shelled or eared corn 1-2 weeks before shooting began and checked or replenished as needed. In 1992-93 (PY2) and 1993-94 (PY3), 500 bushels of corn were placed at bait sites 2 weeks before shooting began and replenished as needed. Signs were posted at all park access points and along public trails one week prior to the start of shooting.

When officers were assigned to shoot, they reported to the BPD dispatcher at the start of their shift and checked out ammunition, spotlights and radios. Officers usually arrived at bait sites at dusk and remained at the site for 3-5 hours. Dead deer were removed from bait sites so that approaching deer would not become wary. Officers returned to the station to file activity reports and return equipment. Activity reports included information on hours on duty, bait site number, sex and age of deer observed, deer killed and shots fired. Carcasses were collected immediately following sharpshooting, were field dressed, and females examined for presence of fetuses. Carcasses were delivered to the DNR, Division of Law Enforcement for final disposition to charitable organizations.

In PY1, in addition to shooting over bait, 3 drives were conducted. While the drives were not as controlled as shooting over bait, every attempt was made for drives to be conducted safely. Sharpshooters were set in positions with adequate backstops and each carried hand-held radios. Some drivers also carried hand-held radios and guards were posted at park entrances to prevent people from entering the park during sharpshooting.

In 1992 and 1993, the Bloomington Planning Department coordinated the program review in conjunction with PMD, BPD and DNR-Section of Wildlife. NHRC reviewed the program and made adjustments based on recommendations from the group. NHRC forwarded their recommendations to the City Council who provided approval for the following year.

Analysis

Success rates (deer killed/hr) were calculated by dividing the number of hours sharpshooters were on duty (not just in the field) by the number of deer they killed. Cost per deer was calculated by dividing the number of deer killed into the total costs for the program. Program costs included daily BPD administration, sharpshooter wages, wages for staff to dispose of deer and maintain bait sites, equipment and bait. Costs for staff to conduct drives in PY1 were included in the total costs for that year. Differences in success between years, officers, bait sites and weather conditions were tested using the Kruskal-Wallis statistic. Daily maximum temperature, daily snow cover and snowfall information was obtained from Minneapolis/St. Paul International Airport.

RESULTS AND DISCUSSION

The BPD sharpshooting program ran from 18 November to 13 March in PY1, from 16 November to 12 February in PY2 and from 15 November to 27 February in PY3. In PY1, 21 officers participated in the program and each worked an average of 2.9 shifts (range=1-8) (Table 2). In PY2, 16 officers each worked an average of 4.3 shifts (range=1-10). In PY3, only the 9 most efficient officers from PY2 participated in the program and each worked an average of 10.7 shifts (range=6-22). An average of 1.7, 1.5 and 2.3 sharpshooters worked per night in PY1, PY2 and PY3, respectively.

Sharpshooters killed 135 deer in PY1, 167 deer in PY2 and 152 deer in PY3 (Table 3). In PY1, 40 of the deer were killed during 3 drives conducted along a creek bottom. The portion of the total kill that were adult females (≥ 1.5 years) ranged from 30% in PY1 to 42% in PY2. Conversely, the portion of kill that were adult males ranged from 27% in PY1 to 19% in PY2.

Four bait sites were used in PY1, 6 in PY2 and 10 in PY3 (Table 4). Sharpshooters worked an average of 52 hours (range=29-76) and killed an average of 24 deer (range=5-40) at each bait site in PY1. In PY2, sharpshooters worked an average of 45 hours (range=5-98) and killed an average of 28 deer (range=4-66) at each bait site. At each bait site in PY3, sharpshooters worked an average of 37 hours (range=6-127) and killed an average of 15 deer (range=0-68). There were no significant differences in success (rate) between bait sites in any year ($P>0.26$, $P>0.83$ and $P>0.06$ in PY1, PY2 and PY3, respectively). These results were expected since all bait sites were carefully selected based on accessibility, safety and proximity to deer concentrations. In addition, large amounts of bait were used to attract the deer to the site before and during shooting operations.

No accidents occurred during the 3 years of the BPD sharpshooting program. Two complaints about shooting hours were received by BPD in PY2. The Planning Department received calls during each of the 3 years, but no specific complaints about the sharpshooting program were taken. Instead, callers inquired about the general deer management program, policy, alternative solutions, damage, deer feeding and disposition of carcasses.

Table 2. Number of sharpshooting days, total sharpshooting hours and mean hours worked and deer killed per sharpshooter during the Bloomington Police Sharpshooting Program, Bloomington, Minnesota, 1991-1994.

	1991-92	1992-93	1993-94
Sharpshooting days	27	44	41
Sharpshooting hours	237	270	383
Mean hours per sharpshooter	11.3 (4-28)	16.8 (3-41)	41.5 (24-87)
Mean deer killed per sharpshooter	4.5 (0-13)	10.4 (0-24)	16.8 (3-32)

Table 3. Number of deer killed at bait sites by sex and age in the Bloomington Police Sharpshooting Program, Bloomington, Minnesota, 1991-1994.

	Number of deer killed				
Year	Adult female	Adult male	Fawn female	Fawn male	Total
1991-92	30 (31%)	28 (29%)	16 (17%)	21 (22%)	95
1992-93	70 (42%)	31 (19%)	26 (16%)	40 (24%)	167
1993-94	55 (36%)	35 (23%)	30 (20%)	31 (21%)	151

Sharpshooters reported that they did not recover six deer in PY2 and 2 deer in PY3. All deer were recovered in PY1. One of the unrecovered deer was known to have been hit in the jaw from a bullet that passed through another deer, but was never found. In most of the other cases, sharpshooters did not record any evidence that a deer was actually hit. In addition, while 3 calls were received regarding unrecovered deer in PY2, all showed no evidence of bullet wounds and were determined to have died from collisions with vehicles. Success rates for all sharpshooters combined did not differ between years ($P<0.01$, $x=0.40$, 0.62 and 0.39 for PY1, PY2 and PY3, respectively). However, success rates differed among individual sharpshooters in PY1 and PY2 but not in PY3 ($P<0.001$ in PY1 and PY2 and $P>0.06$ in PY3). Individual success ranged from 0 to 1.11 deer/hr in PY1 ($x=0.41$), and 0 to 0.84 deer/hr in PY2 ($x=0.50$) and from 0.11 to 0.65 deer/hr in PY3 ($x=0.37$).

Weather conditions varied between program years. There were no significant differences in snowfall between years ($P<0.59$, $x=0.53$", 0.23" and 0.32" in PY1, PY2 and PY3, respectively) or daily maximum temperature ($P>0.39$, $x=30.2$ and 28.5 and 25.6 C in PY1, PY2 and PY3, respectively) between years. However, there were significant differences in the amount of snow on the ground ($P<0.001$). An average of 8.8" (22.3cm), 3.9" (9.9cm) and 4.4" (11.1cm) of snow were on the ground on shooting nights in PY1, PY2 and PY3, respectively. Only 2 nights (7.4%) had no snow cover in PY1, while in PY2 and PY3 there were 14 nights (31.8%) and 13 (31.7%) without snow cover, respectively. Success did not differ on days with or without snow cover ($P>0.94$) or between days with <6" or $\geq$ 6" of snow cover ($P>0.52$). These results were somewhat unexpected because snow, particularly when accumulated on the ground, was thought to effect the success of sharpshooting.

The sharpshooting program cost $26,142 and $30,610 and $31,277 in PY1, PY2 and PY3, respectively (Figure 1). Cost per deer killed was $194 in PY1, $183 in PY2 and $206 in PY3. The single largest cost for the program was sharpshooter wages, which was expected because of the overtime wages paid.

Success and costs of the BPD sharpshooting program compared favorably with other deer control programs reported in the literature. BPD sharpshooters killed an average of 0.51 deer/hr, spent 1.96 hours per deer killed at an average cost of $184.85 per deer. Witham and Jones (1992) reported sharpshooters killed 0.37 and 0.39 deer/hr at Ryerson Conservation Area and Chicago-O'Hare International Airport, respectively. Costs per deer at Ryerson Conservation Area were $287.98. Ishmael and Rongstad (1984) reported that shooting deer over bait took 13.5 hours (0.07 deer/hr) and cost $73.95 per deer. However, shooters were paid $3.65/hr plus travel expenses whereas sharpshooters from BPD were paid an overtime rate.

In this study, we believe there were many indirect as well as direct benefits to using police officers as sharpshooters. The primary advantages stemmed from the BPD ties to the community and the comprehensive training received by each officer. The public has open communication with the police department to register concerns, receive answers to questions or respond to emergencies. Because they were on duty while sharpshooting, officers followed public safety procedures as they would have on any assignment. In addition, officers were continuously briefed and updated in firearms and public safety standards. For these reasons, we believe residents felt very safe knowing police officers were the sharpshooters. In addition, the City Attorney in Bloomington felt the use of police officers was

Table 4. Number of shooting hours and deer killed and mean deer killed per hour at each bait site in the Bloomington Police Sharpshooting Program, Bloomington, Minnesota, 1991-1994.

	1991-92				1992-93				1993-94			
Bait Site	N	Total hours	Total kill	Mean deer killed per hour	N	Total hours	Total kill	Mean deer killed per hour	N	Total hours	Total kill	Mean deer killed per hour
1	20	71	38	0.61	16	45	31	0.94	10	23	7	0.30
2					4	9	7	1.00				
3	9	32	12	0.39	13	36	18	0.58	10	31	3	0.10
4	8	29	5	0.23	3	5	4	0.90				
5					22	77	41	0.60	24	66	23	0.35
6	21	76	40	0.56	27	97	66	0.68	39	123	68	0.55
7									9	21	17	0.82
8									2	6	0	0.00
9									12	34	8	0.24
10									4	7	0	0.00
11									11	27	14	0.53
12									11	36	11	0.31

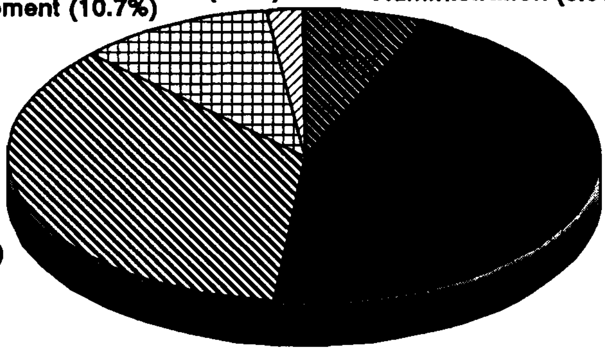


Figure 1. Average annual costs for the Bloomington Police Department Sharpshooting Program, 1991-1994.

preferred because their activities are covered by the city should an accident occur or a liability issue arise. Police commanders also felt more comfortable having officers, who must report to them, conduct sharpshooting activities rather than a private contractor or shooter who would not have ties to the community.

Finally, we believe negative public reaction to the program was minimized because residents were continually informed of the purpose and progress of the program. Open and honest communication with the public is important in maintaining appreciation for and confidence in any public agency involved in decisions about highly emotional issues.

LITERATURE CITED

Bryant, B. K., and W. Ishmael. 1990. Movement and mortality patterns of radio-tagged suburban and translocated suburban white-tailed deer. Pages 53-58 *in* L. W. Adams and D. L. Leedy, eds., Wildlife Conservation in metropolitan environments. NIUW Symp. Sec. 2. 264pp

Deblinger, R. D. 1990. Crane Memorial Reservation and Crane Wildlife Refuge white-tailed deer management program: Annual Report, 1989. The Trustees of Reservations, Beverly, MA. 12pp.

Ellingwood, M. R., and S. L. Caturano. 1988. An evaluation of deer management options. Comm. Dept. Envir. Protect. Public. No. DR-11, 12pp.

Ishmael, W. E., and O. J. Rongstad. 1984. Economics of an urban deer-removal program. Wildl. Soc. Bull. 12:394-398.

Jones, J. M., and J. H. Witham. 1990. Post-translocation survival and movements of metropolitan white-tailed deer. Wildl. Soc. Bull. 18:434-441.

McAninch, J. B., and J. M. Parker. 1991. Urban deer management programs: A facilitated approach. Trans. North Am. Wildl. and Nat. Resour. Conf. 56:428-436.

O'Bryan, M. K., and D. R. McCullough. 1985. Survival of black-tailed deer following relocation in California. J. Wildl. Manage. 49:115-119.

Palmer, D. T., D. A. Andrews, R. O. Winters, and J.W. Francis. 1980. Removal techniques to control an enclosed deer herd. Wildl. Soc. Bull. 8:29-33.

Witham, J. H., and J. M. Jones. 1992. Biology, ecology, and management of deer in the Chicago metropolitan area. Illinois Nat. Hist. Surv. Final Report, Proj. No. W-87-R. 108pp.

USING A COMMUNICATION STRATEGY TO ENHANCE COMMUNITY SUPPORT FOR MANAGEMENT

REBECCA J. STOUT[1] and BARBARA A. KNUTH, Human Dimensions Research Unit, Department of Natural Resources, Cornell University Ithaca, NY

THE NEED FOR COMMUNICATION STRATEGIES

Many of the papers in this volume address the potential efficacy of various white-tailed deer (*Odocoileus virginanus*) management methods in urban communities. Biological and technical information pertaining to the application of deer management methods are important components for identifying alternatives to address deer management problems in urban communities. Decisions about whether to implement a particular management method are facilitated if the effectiveness, feasibility, and practicality of the method is known. However, this in itself will not ensure that a method will be implemented successfully.

Understanding the sociopolitical climate in urban communities, which includes the attitudes, values, beliefs, and perceptions of the public and decision makers, is important in determining the particular deer management method to be implemented. Major challenges facing deer managers in urban settings include: (1) gaining access to relatively small tracts of deer habitat controlled by public and private landowners; (2) negative perceptions held by the public about hunting and guns; (3) concerns over public health and safety issues regarding the deer herd and various deer management methods; (4) compliance of the management method with state law and local ordinances; and, (5) cooperation of local government officials with the deer management agency (Curtis and Richmond 1992, Gigliotti et al. 1992).

Part of the problem associated with urban deer management stems from the fact that deer managers are accustomed to dealing with traditional, rural, hunters and farmers, not with urban constituents. It appears that a dichotomy exists in the attitudes of some residents from urban versus rural communities. Kellert detected a link between childhood residence and a dominionistic attitude towards animals (Kellert 1976), and, in urban areas a decline of utilitarian perspectives toward animals (Kellert 1993). Kellert (1993) also noted an increase in moralistic attitudes about animals, particularly among those who are "urban, more highly educated, female and younger" (Kellert 1993:9).

Other evidence of what we call a growing "urban wildlife attitude" is found in residents' personal experiences and interactions with deer. Some attribute human personality traits to deer living in their backyards, and treat deer like pets. For them, the death of a deer is visually and emotionally a traumatic event. In a letter to the editor of an urban newspaper, a resident exhorted the quick removal of car-killed deer because the sight of a dead deer upset children in the neighborhood (Evans 1993). Another deplored the use of a lethal method to manage deer in an urban park, referring to its implementation as a lost opportunity to teach nonviolence to children (Andersen 1993). As society continues to become more urbanized, it is predictable that society's attitudes toward wildlife and management methods will continue to change.

People living in urban communities interact with deer differently than those in rural communities. Deer managers need to adapt communication strategies about deer biology and alternative management methods to the interests and needs of people living in urban communities. In this chapter, we begin with a framework for understanding people's perceptions about deer and deer management methods. We then discuss the development of a communication strategy to address these perceptions, and how to improve communicating information about deer management methods. We use a case study from Rochester, New York, to discuss the benefits and problems of implementing a communication strategy. Last, we offer some suggestions for those who may consider using a communication strategy to develop community support for deer management methods in urban communities.

MANAGEMENT PERCEPTIONS VS. REALITY

Why should knowledge of the perceptions of urban residents be important to deer managers? Managing deer in urban communities often becomes

[1]Present address, Department of Wildlife and Fisheries Sciences, Texas A & M University, *College Station, TX.*

controversial when wildlife managers decide to implement conventional hunting methods without taking the perceptions of local residents into account (Decker 1987). Often, people's perceptions about deer management methods influence the decision to implement a particular method. As Timm (1992:3) stated, "attitudes and perceptions nowadays, whether correct or based on misinformation, are often translated into policy and law."

In the past, legal restrictions have blocked implementation of traditional hunting methods in many urban communities. For example, some community and park officials have enacted laws prohibiting discharge of firearms or traditional hunting methods in the community (Diamond 1992, Deblinger et al. 1993, Hauber 1993). Deer managers wishing to implement hunting, sharpshooting, culling deer over bait, and methods using dart-delivery systems (e.g., contraception or tranquilizers) often must work with local politicians to change laws permitting discharge of firearms.

Even when laws are changed to support implementation of a method, litigation may occur, especially when management methods are opposed by a segment of stakeholders in the community. When discussing "reality" versus "perception," Timm (1992:3) described the effect on wildlife damage management by stating, "...we often feel frustrated by having to work in a society where everyone's opinion seems to have as much weight as what WE know to be the real facts; and effective, decisive action is delayed, postponed, or made impossible by debate, litigation, and public opinion generated by inaccurate publicity, or worse." The reality is that deer managers need to consider the opinions of a variety of people in the community, regardless of whether the appropriate management method appears to be obvious. Investing in a communication strategy that achieves community support reduces the potential for litigation.

Another reality is the assurance of financial support for implementing deer management methods. If a hunting method is implemented, typically the cost is covered through hunter license fees. Implementing nontraditional methods (i.e., those other than hunting) may require alternative funding sources, since many deer management programs are supported primarily through hunting license sales. If the state agency approves the use of a nontraditional method, often the financial burden falls on the taxpayers. Communication strategies are needed to ensure urban residents understand the tradeoffs in costs for implementing nontraditional methods.

To most effectively address the "multiple realities" present in urban communities, deer managers also need to effectively inform and communicate with urban residents about alternative management methods prior to implementation of a particular method. Kellert (1993:11) stated that "modern wildlife and deer management must recognize that the public is not something to work around, but to work with in pursuit of more effective, efficient, and equitable programs." Public input as a part of the communication strategy is necessary to enhance community support for a management method. Wildlife management agencies can use communication strategies to diffuse present or potential controversies, and to resolve misunderstandings about deer biology, management methods, and the policy-making process before decisions about implementing a deer management method are made.

URBAN RESIDENTS' TOLERANCE TOWARD DEER

Identifying underlying values and perceptions that urban residents associated with deer is an important step in analyzing the acceptability of various deer management methods. A communication strategy may determine whether urban residents perceive a need for implementing a deer management method in their community. Many people enjoy seeing deer in and around their neighborhoods, until some event triggers a change in their attitudes or perceptions about deer. Indicators of these changes in tolerance are preferences for the size of the deer herd and deer management methods. For example, in Rochester, New York, newspapers reported the story of one resident who enjoyed seeing deer around her home. She opposed using lethal methods to manage the deer population, until she was involved in a deer-car accident. The accident caused her to be hospitalized, after which she changed her opinion and began to support a lethal management method (Alatzas 1993).

Researchers in the Human Dimensions Research Unit at Cornell University hypothesize that people tolerate damage by wildlife until they reach their wildlife acceptance capacity. Wildlife acceptance capacity is the maximum size wildlife population that is acceptable to people (Decker and Purdy 1988, Decker 1991). In urban communities, factors determining people's wildlife acceptance capacity include the risk of deer-car accidents, risk of contracting Lyme disease, degree of damage to ornamental shrubs and gardens, and effect of deer on the plant diversity and ecology of parks (Connelly et al. 1987, Decker and Gavin 1987, Stout and Knuth 1993a).

The degree to which these concerns are important accordingly affect people's preferences for the size of the deer population. In a study focusing on deer-car accidents (Stout et al. 1993a), the degree of importance of accidents was expressed as a level of perception of personal risk, perception of societal risk, personal involvement with deer-car accidents, and attitudes about deer. Perceptions of personal risk include "how severe the concern affects me personally" and "the probability that it will happen to me." Perceptions of societal risk encompass a broader range of how severe the consequences are for people in general (e.g., increased economic costs or loss of human life), the probability of occurrence (e.g., frequency, magnitude), and acceptance of the problem (e.g., something we should live with vs. control). The degree of personal involvement (e.g., a household member vs. a stranger in a deer-car accident) and one's attitudes and values about deer were also significant in predicting a preference for a reduction in the size of the deer population.

Understanding preferences for the size of the deer herd leads to identification of management methods to achieve the desired deer population objectives. Some deer management methods may be more appropriate for maintaining or allowing the size of the deer herd to increase slightly, while others may be more effective at decreasing the size of a deer herd.

When forming opinions about deer management methods, we hypothesize that people balance the benefits and costs of deer against their perceptions about management methods. In a study of residents from Rochester, New York, we asked respondents to indicate their most important consideration when assessing various deer management methods (Stout and Knuth 1993a). Most important was the degree to which the method posed a threat to human health and safety, maintained a healthy deer population, and minimized the suffering of deer. Identifying these key concerns is the basis for the development of communication strategies that address the needs of the urban community.

COMMUNICATING WITH THE PUBLIC

The appeal for agencies taking an active role in communicating with the public is the potential to improve the credibility and image of the agency and to increase support for agency programs (Fazio and Gilbert 1986, Shanks and Decker 1990). Wildlife professionals in New York believe the most important role of communication is to educate the public about wildlife management needs and programs. Wildlife professionals also seek to ensure two-way communication between the public and the wildlife manager to develop agency management goals, and to evaluate and modify existing programs (Shanks and Decker 1990).

Two-way communication between agencies and stakeholders can be more effective if the communicators share a common base of understanding. Key concerns of respondents from the case study in Rochester imply that deer managers need to communicate three general types of information: (1) biological, management, and technical information that addresses the degree to which alternative management methods improve the health of the deer herd; (2) risk assessments of the management method's effect on the health and safety of people; and, (3) the degree to which the method minimizes suffering of individual deer.

Many deer managers who interact with the public currently employ communications to inform the public about deer biology and management. It is important, however, that these communications are tailored to the particular concerns and issues of urban residents. Deer managers need to be prepared to discuss the most current information and technological advances in urban deer management techniques.

Urban residents want to understand the extent of the risk of the deer management method to the health and safety of people in the community. For the deer manager, some of this information may be unavailable, or at best, an estimate. Particularly for this reason, the risk message should outline clearly how the risk assessment was conducted. The risk message should indicate several levels of risk to allow individuals to assess the acceptability of risk personally (Knuth 1990). Presenting boundaries of risk as a single number, or communicating a particular level of risk as being "safe" or "unsafe," hides underlying value judgments made by the person who conducted the risk assessment. One level of risk may be acceptable to one person, but quite unacceptable to another.

Once a risk assessment is conducted, the community at large can decide at what level the risk of implementing a deer management method is acceptable or unacceptable. The management agency, local government, or other entity makes this judgment based on public input, and determines what is the community's acceptable or unacceptable risk level for deer-car accidents, Lyme disease, and so forth.

Before incorporating risk concepts into an overall communication strategy, agencies should evaluate their credibility as risk messengers and analysts. Risk communication from a wildlife management agency may be inappropriate when the credibility of the risk messenger is questionable (Knuth 1990). For example, if an agency has a history of promoting deer hunting as the only available method in urban environments, then risk communication about other methods may be perceived as biased. Agencies may consider engaging other public or private entities in presenting risk information (e.g., local insurance agents about deer-car accidents, cooperative extension agents about deer damage to plantings, grassroots organizations) to present a risk message.

The third type of information that should be communicated in urban settings is the effect of the management method on individual animals. Because of its association with an animal rights agency, this is perhaps the most controversial of the three general types of information. Traditionally, deer managers often focus on the effect of deer management methods on controlling a deer population rather than the effect on an individual animal. Providing information about the effectiveness of a method for reducing the size of the deer herd would probably satisfy the information needs of those in the community who are concerned about overpopulation of deer in relation to the incidence of deer-car accidents, Lyme disease, and other problems.

Communication difficulties arise, however, when deer populations are discussed with those concerned about the welfare of individual deer. Communicating with animal rightists about the effect of a management method on individual deer would probably be fruitless, since animal rightists would be resistant to considering any management method, whether lethal or nonlethal, that affects deer. However, some animal welfare advocates are more open to considering other management alternatives, given the human risks and concerns associated with deer. The need to focus on communications that address minimizing the suffering of deer is substantiated by Kellert (1993), who believes many people would prefer humane, nonlethal techniques that manage the specific individual animal(s) causing the damage problem. Ignoring the effect of a management method on individual deer may give the public the impression that deer managers are anti-welfare and are unconcerned about the humane treatment of deer. Our interactions with wildlife professionals indicate this is often not the case.

When evaluating management methods about individual deer or the deer population, it is important that deer managers do not place a value judgment on their assessment (Decker et al. 1991). An example is communicating the consequences of no management action taken in an urban environment with a high deer population. A deer manager investigating deer carcasses in a park may communicate an estimate of the number of deer that starved in the area. The effect of starvation is assessed on individual deer, without judging the morality of starvation.

APPLYING A COMMUNICATION STRATEGY IN ROCHESTER, NEW YORK

Following is a brief description of a case study on which we base our discussion about communication strategies that address urban deer problems. The communication strategy was developed and implemented in 1991-92 by the New York State Department of Environmental Conservation in the Greater Rochester metropolitan area (Stout and Knuth 1993a). The strategy focused on communicating information about deer biology and management to stakeholders who would assess risk perceptions and make recommendations pertaining to deer population size and management methods.

The urban area under investigation was located in deer management unit (DMU) 96, of the Greater Rochester area in central-northern New York State. Historically, socio-political factors impeded several attempts by the New York State Department of Environmental Conservation (DEC) Bureau of Wildlife, grassroots organizations, and local governments to implement various deer management solutions. Most of the controversy surrounding deer management centered on Durand Eastman Park in the town of Irondequoit. In the early 1990s, Irondequoit government officials and grassroots organizations proposed alternative solutions for managing its deer population. Town government officials developed an economically feasible deer management plan to trap and transfer deer to venison farms. DEC rejected the plan because it set a legal precedent that allowed deer, a public resource, to be used for commercial profit. Grassroots organizations proposed other nonhunting solutions, but to no avail. DEC's rejection of these community efforts did little to enhance the agency's credibility.

During this same time period, in rural DMUs throughout the region, DEC implemented successfully several Citizen Task Forces (CTF) (Nelson 1992, Stout et al. 1993b). CTFs involved a variety of people in recommending to DEC a deer population objective for their respective DMUs. DEC used these recommendations to manage the deer herd by issuing hunting license permits in rural areas. Expanding on the ability of CTFs to reach agreements and improve agency credibility, DEC formed a partnership with Cornell Cooperative Extension and developed a public communications plan for an urban environment. The modified CTF approach implemented in the Rochester area (Curtis et al. 1993, Stout and Knuth 1993b) involved stakeholders from the community in developing solutions to address concerns about the deer population. In this case, key stakeholders recommended not only a deer population objective as in the rural CTFs, but also a deer management technique to achieve the objective (Curtis et al. 1993, Stout and Knuth 1993b). In addition to the CTF, a variety of other mechanisms, such as workshops and news releases, were part of DEC's overall communication strategy.

DEC's goal for the communication strategy was to educate the public about deer biology and management, and the consequences of implementing various deer management techniques. CTFs provided a forum for a variety of stakeholders in the DMU to engage in face-to-face discussions about deer management alternatives, and potentially to reach a consensus concerning recommended actions to address deer management issues.

The specific elements of the communication strategy evolved more formally once the direction of the CTF and the various outcomes were discernible. The specifics of the communication strategy remained flexible, depending on the willingness of CTF members to participate in communication activities. Initially DEC and CCE distributed a news release about the CTF approach to Rochester newspapers. Eight months after convening the first meeting, CTF members developed deer management recommendations for DMU 96. At that time, DEC presented the CTF with a draft of an action plan to communicate the CTF's recommendations to the public. The purpose and objectives of the "Public Involvement Plan" were to develop: ...a strategy of action for DEC and the Task Force in a combined effort to meet the DMU 96 communication goals and objectives.

The communication goal was to build support of the Task Force constituency and the community for the Task Force recommendations and future agreements for action developed by local government decision-makers.

The communication objectives were to continue communication with and facilitate the cooperation of local governments, in order to provide a safe and cost-effective suburban deer management program for DMU 96; to provide education and information opportunities on deer and other wildlife management issues for affected and interested people and policy-makers; and to keep the media fact-informed and encourage high visibility of the Task Force.

DEC implemented several components specifically mentioned in the plan. It developed and distributed two press releases about deer and deer management to educate the community before the recommendations of the CTF were finalized. Once the CTF completed its report, DEC announced and held a press conference attended by television, magazine, and newspaper reporters. Through the media, DEC and CTF members presented the recommendations to the public, and encouraged local government officials to act on recommendations addressing deer management methods for Irondequoit. DEC provided reporters with packets of information that included a press release about the recommendations of the CTF, a copy of the CTF report, and additional information about deer management.

After the press conference, DEC continued meeting with government officials responsible for decisions that affected implementation of the CTF's recommendations in Irondequoit. The implementation of these recommendations received much publicity. The media focused on the controversy surrounding those for and against culling deer at bait stations in a county park. After the deer were culled, DEC held several informational workshops to assess the status of the deer population for the public and the media.

EVALUATION OF THE COMMUNICATION STRATEGY

To assess the effect of the communication strategy, we evaluated the CTF as it was underway (Stout and Knuth 1993a). We also assessed the effect of the communication strategy on public opinion by mailing questionnaires to residents (n=795) in the early and late stages of the communication strategy, i.e., as the CTF got underway, and just before the CTF-recommended deer management methods were implemented. In addition, we conducted a content analysis of newspaper articles about deer and deer management.

Results from the evaluation indicated the communication strategy stimulated community leaders and decision makers toward a course of action for managing deer in the urban community. Those who participated on the CTF were more positive about the image of DEC's communication, management, and personnel after the CTF was underway. Listening to the concerns of stakeholders on the CTF improved

DEC's credibility. The CTF provided stakeholders in the community a forum to discuss concerns and alternatives, with all but one individual reaching agreement about the chosen deer management methods. Deer managers discussed with CTF members the practicality of alternative deer management methods in relation to state regulations. Outcomes from the CTF component of the communication strategy received media attention from newspapers and radio and television stations in the greater Rochester metropolitan area.

Despite the involvement of stakeholders on the CTF, the implementation of one recommended management method, to cull deer in Irondequoit, was opposed by some members in the community. Opponents of the deer management method used litigation to temporarily threaten its implementation. A grassroots organization that was represented on the CTF was one of the principal litigants. Much of the media coverage focused on the controversy surrounding the CTF's recommendation, rather than on substantive issues, or on educating people about deer biology and management. One exception was a weekly newspaper whose readership was the town of Irondequoit, which printed verbatim the news releases that DEC issued. The media tended to overlook the positive outcomes associated with the CTF reaching consensus about deer management methods in a major portion of the DMU.

In addition, results from surveying residents indicated that public attitudes about deer management methods changed little from the time that the CTF was implemented until its recommendations were publicized. It appears that, although the overall communication strategy informed community leaders and decision makers about the alternatives and consequences of deer management methods (primarily via the CTF), more effort was needed to inform the community at large. Deer managers were unable to rely on the media in the urban community to inform the public adequately about the basics of deer biology and management, or the entirety of the outcomes from the CTF.

DEVELOPING A COMMUNICATION STRATEGY

Based on the preceding discussion about communication strategies and experiences in Rochester, New York, we recommend that agencies consider the following steps when planning and developing effective communication strategies:

1. Analyze the historical context and situational factors to anticipate and understand people's perceptions about the size of the deer herd and alternative deer management techniques.
   - What is the history of deer management in the area?
   - How credible is the wildlife management agency?
   - Who are the key stakeholders, grassroots organizations, and government officials that have been involved in deer management issues in the past? What are their positions about deer-related issues?
   - What is the nature and degree of conflict that has occurred about deer and deer management in the community?
2. Collect data about deer biology and management, public opinion about deer in the urban community, and deer-people interactions from which risk assessments may be calculated.
   - What types and how much deer damage has occurred?
   - What deer population trends are available? Have the police kept track of deer-car accidents?
   - Have there been surveys of residents' attitudes and concerns about deer or deer management methods?
3. Inform the public about the status of deer biology and management and risks and benefits associated with the deer herd that pertain to the urban community.
   - What communication outlets are most effective in informing the community (e.g., paid newspaper advertisements, radio interviews, television news broadcasts, organizational newsletters)?
   - How much money and staff time will be devoted to the communication strategy? How can these resources be used most effectively and efficiently?
   - What are potential deer management methods and their likely consequences (e.g., on health of deer herd, on overall risk estimates)?
4. Plan and implement a mechanism (e.g., survey, public meeting, Citizen Task Force) to obtain input about public perceptions of the preferred size of the deer population and management methods. (See Young 1991 for information about alternative mechanisms.)
   - What are the goals and objectives for obtaining public input?
   - Does the level of concern about the size of the deer herd warrant management actions, or is the deer population at an acceptable level at this time? If management actions are warranted,
     - To what degree and in what manner should the public be involved in recommending deer management methods?
     - Who are the decision makers and how should they be involved?
     - What are the information needs of those who are recommending management actions? How can this information be collected?

5. Communicate the outcomes from #4 (regardless of whether a management method is warranted) regarding public preferences and the subsequent management decision.
- Who are the stakeholders targeted for the communication?
- What outlets are best to inform stakeholders about the outcomes (e.g., press conference, paid advertisements, public meeting, workshop, personal communication, organizational newsletters)?
6. If management actions are warranted, continue follow-up communication activities to ensure implementation of the management methods.
- Who needs to be involved in implementing the methods?
- What partnerships need to be created, laws changed, or financial support acquired?
- What outlets can be used to keep the public informed about progress toward implementing management methods?
7. Assess outcomes from implementing the management methods, and the need to continue the communication strategy. Report the agency's evaluation to the community at large.
- What outlets are best to inform stakeholders about results? (e.g., press conference, public meeting, workshop, personal communication, organizational newsletters)?

RECOMMENDATIONS

To rephrase the question posed for this book, are urban deer a manageable resource? Biological and technical information about alternative management methods alone won't ensure implementation of a method. Deer managers also need to consider the socio-political context in which decisions to implement deer management methods are made. Communications should address the information needs of urban residents by engaging in two-way communications and obtaining public input about management methods.

We suggest that deer managers who implement a communication strategy consider these rules of thumb. First, be open to discussing with urban residents the alternatives and consequences of a variety of deer management methods, even if the methods are contrary to findings from scientific data. Be prepared to relay agency policy about alternative deer management techniques to the public.

Second, work with media or communications specialists when developing a communication strategy, and find ways to use available communication outlets to the fullest. For example, provide local libraries and public broadcast stations with a suburban deer management video (Cornell Cooperative Extension 1993).

Third, the greater extent to which the communication messages reach the intended audiences, the greater chance that public input will result in implementation of management methods. Part of this was achieved in Rochester, New York, where a communication strategy involved local government and community leaders in recommending and implementing deer management methods; however, evidence from mail questionnaires implied the communication strategy should be continued to convey messages about deer management methods to the community at large. Currently, the public needs to be informed and involved in reassessing the outcomes from the method implemented the previous spring. Without public input and support, it is questionable whether any management method will be implemented again the following year.

LITERATURE CITED

Alatzas, T. 1993. A too-close encounter with doe turns bait-shoot-foe into a fan. Rochester Democrat and Chronicle, April 13.

Andersen, J. 1993. A missed opportunity. Rochester Democrat and Chronicle, April 25.

Connelly, N. A., D. J. Decker, and S. Wear. 1987. White-tailed deer in Westchester County, New York: public perceptions and preferences. Human Dimensions Res. Unit Publ. 87-5. Dept. of Nat. Resour., Cornell Univ., Ithaca, NY. 42pp.

Cornell Cooperative Extension. 1993. Suburban deer management: voices, views and visions (video). Education Television Center, Media Services Resource Center, Cornell University, Ithaca. 28:30 minutes.

Curtis, P.D., and M.E. Richmond. 1992. Future challenges of suburban white-tailed deer management. Trans. North Am. Wildl. and Nat. Resour. Conf. 57:104-114.

____, R. J. Stout, B. A. Knuth, L. A. Myers, and T. M. Rockwell. 1993. Selecting deer management options in a suburban environment: A case study from Rochester, New York. Trans. North Am. Wildl. and Nat. Resourc. Conf. 58:102-116.

Deblinger, R. D., J. J. Vaske, D. W. Rimmer, and M. P. Donnelly. 1993. Ecological and social support for a controlled deer hunt. Pages 125-128 *in* G. A.

Vander Stoep (ed.), Proceedings of the 1992 Northeast Recreation Research Symposium. Gen. Tech. Rep. NE-176. U.S. Dep. of Ag. Forest Service, Northeastern Forest Experiment Station, Radnor, PA. 171pp.

Decker, D. J. 1987. Management of suburban deer: an emerging controversy. East. Wildl. Damage Control Conf. 3:344-345.

____. 1991. Implications of the wildlife acceptance capacity concept for urban wildlife management. Pgs. 45-53 *in* E.A. Webb and S.Q. Foster eds., Perspectives in Urban Ecology. Proc. Symp. on Perspectives in Urban Ecology, Denver Museum of Natural History, Denver, CO.

____, and T. A. Gavin. 1987. Public attitudes toward a suburban deer herd. Wildl. Soc. Bull. 15:173-180.

____, and K. G. Purdy. 1988. Toward a concept of wildlife acceptance capacity in wildlife management. Wildl. Soc. Bull. 16:53-57.

____, R. E. Shanks, L. A. Nielsen, and G. R. Parsons. 1991. Ethical and scientific judgements in management: Beware of blurred distinctions. Wildl. Soc. Bull. 19:523-527.

Diamond. J. 1992. Must we shoot deer to save nature? Natural History (August):2-8.

Evans, G. 1993. Prompt removal of deer. Irondequoit Press, September 30.

Fazio, J. R., and D. L. Gilbert. 1986. Public relations and communications for natural resource managers. Kendall Hunt Publishing Company, Dubuque, Iowa. 399pp.

Gigliotti, L. M., R. E. Shanks, D. J. Decker, and B. A. Knuth. 1992. Opportunities for meeting wildlife management objectives through local government: an assessment of communication program potential. Human Dimensions Res. Unit Publ. 92-5, Dept. of Nat. Resour., Cornell Univ., Ithaca, NY. 86pp.

Hauber, J. 1993. White-tailed deer management in the town of Irondequoit and Durand Eastman Park. New York State Department of Environmental Conservation, Avon, N.Y. 11p. + app.

Kellert, S. R. 1976. Perceptions of animals in American society. Trans. North Am. Wildl. and Nat. Resour. Conf. 41:533-546.

____. 1993. Public view of deer management. Pages 8-11 *in* R. L. Donald ed., Deer management in an urbanizing region: Problems and alternatives to traditional management. The Humane Society of the United States, Washington, DC. 52pp.

Knuth, B. A. 1990. Risk communication: a new dimension in sport-fisheries management. North Am. Journal of Fisheries Management 10:374-381.

Nelson, D. 1992. Citizen task forces on deer management: A case study. Northeast Wildlife 49:92-96.

Shanks, R. E., and D. J. Decker. 1990. Communication and image in the wildlife profession: a New York perspective. Trans. Northeast Sect. Wildl. Soc. 47:27-35.

Stout, R. J., D. J. Decker, B. A. Knuth, J. C. Proud, and D. H. Nelson. 1994. Public involvement in deer management decision-making: Comparison of three approaches for setting deer population objectives. Human Dimensions Res. Unit Publ. 94-2, Dept. of Nat. Resour., Cornell Univ., Ithaca, NY. 211pp.

____, R. C. Stedman, D. J. Decker, and B. A. Knuth. 1993. Perceptions of risk from deer-related vehicle accidents: implications for public preferences for deer herd size. Wildl. Soc. Bull. 21:237-249.

____, and B. A. Knuth. 1994. Evaluation of a citizen task force approach to resolve suburban deer management issues. Human Dimensions Res. Unit Publ. 94-3, Dept. of Nat. Resour., Cornell Univ., Ithaca, NY. 134pp.

____, and ____. 1995. Effect of a suburban deer communication program, with emphasis on the attitudes and opinions of suburban residents Human Dimensions Res. Unit Publ. 95-1, Dept. of Nat. Resour., Cornell Univ., Ithaca, NY. 135pp.

Timm, R. M. 1992. Perceptions and realities: when does 2 + 2 = 5? East. Wildl. Damage Control Conf. 5:3-7.

Young, C. 1991. Fostering residential participation in urban wildlife management: Communication strategies and research needs. Pages 203-209 *in* L. W. Adams and D. L. Leedy. eds., Wildlife Conservation in Metropolitan Environments, Natl. Inst. for Urban Wildl., Columbia, MD. 264pp.

LEADERSHIP: KEY TO SUCCESSFUL MANAGEMENT OF URBAN DEER

WILLIAM F. PORTER, State University of New York, College of Environmental Science and Forestry, Syracuse, NY

The common thread to the papers presented in this volume is the need for change in the way we, as wildlife professionals, view deer management. In the past 30 years, we have achieved remarkable success in managing deer populations. However, the days are gone when the deer manager could focus exclusively on the rural environment, when the primary constituency was the hunter and the farmer, and when the only means to population control was antlerless-deer harvest. Today, we face the complexity of managing deer in environments where traditional approaches to population control are politically controversial or logistically inappropriate. The question is, are we as wildlife professionals going to include what are now considered non-traditional approaches to management in our arsenal of alternatives. Are we going to take the lead in resolving new issues of deer management, or are we going to follow others or be pushed out of the way altogether?

As the papers presented here aptly demonstrate, deer management can be as successful in urban settings as in the rural environment. While we confront complex issues in urban deer management, the programs in California, Minnesota, Illinois, Wisconsin, New York, Massachusetts and elsewhere give us hope for the future of deer management. These cases show creative thinking and chronolog experiences that are important to broadening our approach to deer management. At the same time, these cases demonstrate that successful management programs are hard won.

What are the fundamental elements necessary to success of non-traditional deer management programs? Effective leadership is the common core to all of the successful programs. Leadership can be defined as having four principal components: vision, communication, positioning and self-management. *Vision* provides a direction, a goal in the vernacular of management planning. *Communication* is the effort to persuade others to help us achieve that goal. *Positioning* is laying the foundation to sustain a management program and to take advantage of opportunities that may arise in the future. *Self-management* is paying attention to our actions, ensuring that they engender trust and respect. Specifically, our actions must demonstrate integrity, state-of-the-art knowledge, skill and an open mind to all aspects of management. If we examine the cases of urban deer management, we can see that these components of leadership were applied successfully.

Vision is probably the easiest element to identify. On all of the cases described in this symposium the vision is the same: to achieve an acceptable density of deer while maximizing safety, humaneness and cost-effectiveness. There appears to be little debate about the importance of the safety of people involved in the management actions or the humane treatment of the deer. The issues to be resolved are the appropriate density and the management techniques that can be implemented. As observed in nearly every case, getting all the stakeholders to agree to the vision may not be possible at the outset. And, given the fiscal constraints faced by those agencies or organizations responsible for conducting the management, some agreed-upon solutions may be unworkable. What is crucial is that all stakeholders engage the process and remain engaged. Experiences with successful management programs show that stakeholders adopt or acquiesce to a common vision through an evolutionary process. As steps in that process, the management program begins with agreement to undertake small reductions in deer populations, employing relatively expensive techniques, and moves toward greater reductions using less costly procedures.

Communication is the key to implementing and sustaining any management program. All significant stakeholders need to be persuaded to support (or not openly oppose) the management action. We tend to emphasize sending our message out, but the first step in the process is listening. Wildlife agencies are accustomed to using public surveys as their means of listening. More recent is the development of citizen task forces, as illustrated by the Minnesota and New York programs (Stradtmann et al. 1995, Stout et al. 1995). This approach holds at least 4 important advantages. 1) All stakeholder groups need to perceive that their position is understood by opposing groups and the task force provides a forum to accommodate that need. 2) The task force provides an opportunity to educate the participants, teaching them to separate the science from the myth about deer biology and management, discriminate the substantive from the superfluous issues. 3) The approach forces diverse interest groups to confront the challenge of making a decision in the midst of disparate perspectives and limited budgets. 4) Upon reaching a consensus, the task force gives all participants ownership in the decision. With ownership comes not only a proprietary interest in the management program, but a responsibility to work for its success.

The controversial nature of urban deer management leads to questions about the best strategy for dealing with the media. Interestingly, while most management programs have taken a relatively passive role, the California case suggests we should consider an active role (Mayer et al. 1995). The passive approach seeks to avoid headlines by maintaining a low profile. The active approach seeks to educate journalists to discern the substantive issues from the emotional debate and pre-empt media reporting of erroneous and inflammatory material. The California experience suggests developing programs to *feed the media:* provide abundant factual information and unusual media access to biologists and to management efforts. Clearly, there are substantial costs and significant risks associated with developing informational briefings and inviting journalists and television cameras to be present when animals are being handled. However, the potential return is enormous if the effort serves to dispel misunderstandings of deer, keep the focus on the substantive issues, and ensure continuity of political support.

The third component to leadership, positioning, recognizes that accomplishing a vision is a long-term endeavor. Two of the elements most helpful to preparing for future challenges are documentation and science. Integral to documentation is a clear statement of the standard by which we will judge success of the program. The Massachusetts (Deblinger et al. 1995), Illinois (Ver Steeg et al. 1995) and Minnesota (Jordan et al. 1995) cases, emphasize population abundance as the principal criterion of program success. Appropriately, their programs document population size as it changes with management. An equally important variable to document is cost. The evolution of management programs provides excellent detail on costs: translocation, $300 - 400 per deer (Ishmael et al. 1995); sharpshooting, about $175 per deer (Stradtmann et al. 1995); controlled hunting, about $100 per deer (Deblinger et al. 1995, Ver Steeg et al. 1995). While cost-effectiveness is perhaps the most obvious set of program facets that must be documented, many other facets should be considered. Cases presented here document everything from relative efficiency of trapping techniques to the health of animals to be translocated.

Positioning in deer management is also dependent on a strong linkage between management and scientific research. Our success in rural environments can be traced to the extensive research conducted during the 1960's and 1970's. While our knowledge of physiology, behavior and population dynamics of deer in rural environments aids us when designing management programs in urban areas, there is still substantial uncertainty. The management programs described here represent experiments. As we apply our trial-and-error approach, we learn how to improve our management. The application of rigorous scientific thinking into the design of these management experiments maximizes the potential return of information for the investments we make. Indeed, this linkage of management trials with science is the essence of an approach known as adaptive management (Walters 1986).

The cases described here show the extraordinary potential of linking management with science. For instance, we know little about deer populations at densities exceeding those of 20-40/mi^2 that common to rural landscapes. The programs described by Deblinger et al. (1995) and by Jordon et al. (1995) include collection of a broad spectrum of basic biological data from relatively dense deer populations. Ishmael et al. (1995) document high mortality suffered by translocated deer. These data cause us to re-evaluate the humaneness of this approach, or rethink the manner in which we apply it, thus helping us to improve our methods. The feedback loop from science back to management is illustrated by Deblinger et al. (1995) and Ver Steeg et al. (1995) with the use the biological data to adjust removal quotas each year.

The final aspect of leadership is self management. We must continually seek to establish and maintain trust by all stakeholders in professional wildlife biologists. In today's society, we can not expect this trust, nor will it arise unattended. Rather, we have to earn the trust by deliberate action. The first step in earning the trust is maintaining an open mind. The task-force approach, as described by the New York and Minnesota cases (Stout et al. 1995, Stradtmann et al. 1995) can open deer management programs to different values and new approaches to solving problems. The approach will inevitably result in challenges to traditional thinking. If we rise to these challenges with an open mind to new these ideas, the task force meetings provide a forum to build not just trust, but new constituencies.

A second crucial step in self management is staying current on research findings and management experience. As wildlife biologists, we have a responsibility to bring technical information to the decision-making process and the strength of our leadership is enhanced when that information is state-of-the-art. However, maintaining currency is difficult because new developments, research findings and creative management programs are outpacing reporting in traditional literature outlets. For instance, in research, our knowledge of fertility control is changing rapidly (Warren 1995), and there is important research underway on several other non-traditional techniques for deer management. Indeed, this symposium exemplifies the challenge to keeping abreast of management programs because many of the experiences reported here are novel to the wildlife literature and not widely known. Special symposia have always facilitated this communication and these are now being augmented by computer networking which makes information available long before it appears in published journals.

A third step is the professionalism demonstrated by the attention to detail in the design and implementation of management protocols. One of the best illustrations is the attention to safety and detailed reporting required of shooters as described by Stradtmann et al. (1995) in Minnesota. Another excellent example is the testing for disease incorporated by Drummond (1995) in Illinois. The procedures outlined by Clark, which include active participation by veterinarians, and the protocols now being devised by universities for supervising animal handling and care, are excellent models for others to follow. If we are to engender public support for management, we must meet stringent criteria for safe and humane action.

Our success with deer management on rural landscapes has not come easy. It was achieved by people with the leadership abilities to see clearly where management had to go, and who could incorporate new ideas and communicate a shared vision. The achievement rests on a foundation of detailed documentation and broad-based research, and on people with open minds and a dedication to professionalism. Success in urban environments will not be easy either, but the prescription for leadership is the same.

We return to the question with which we began. Are we, as wildlife professionals, ready to take on the responsibilities of leadership for managing deer in urban environments? The issues appear complex, the techniques are uncertain, and the political context seems to be a quagmire. The financial and personnel resources of most natural resource agencies are seriously constrained by a decade of declining budgets. Yet, the urban environment is the home of the vast majority of the future constituents of wildlife professionals. Even today, it is largely here that the supporters and benefactors of all wildlife conservation reside. As (Doig 1995) observes, there is only one conclusion: we must find a way to engage and resolve the issues of managing urban deer. The cases presented here suggest we are beginning to exercise that leadership.

LITERATURE CITED

Deblinger, R. D., D. W. Rimmer, J. J. Vaske and G. Vecellio. 1995. Efficiency of controlled, limited hunting in the Crane Reservation in Ipswisch Massachusetts. Pages 82-86 *in* J.B. McAninch, ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. 175pp.

Doig, H. E. 1995. Agency challenges in managing urban deer. Pages 171-175 *in* J.B. McAninch, ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. 175pp.

Drummond, F. 1995. Lethal and non-lethal deer management at Ryerson Conservation Area, northeastern Illinois. Pages 105-109 *in* J.B. McAninch, ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. 175pp.

Ishmael, W. D., D. E. Katsma, T. A. Isaac, and B. K. Bryant. 1995. Live-capture and translocation of suburban white-tailed deer in River Hills, Wisconsin. Pages 87-96 *in* J.B. McAninch, ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. 175pp.

Jordan, P. A., R. A. Moen, E. J. De Gaynor and W. C. Pitt. 1995. Trap-and-shoot and sharpshooting methods for control of urban deer: Case history - North Oaks, Minnesota. Pages 97-104 *in* J.B. McAninch, ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. 175pp.

Mayer, K. E., J. E. DiDonato, and D. R. McCullough. 1995. California urban deer management: Two case studies. Pages 51-57 *in* J.B. McAninch, ed., Urban deer - A manageable resource? Proc. 1993

Symp. North Central Section, The Wildlife Society. 175pp.

Stout, R. J., and B. A. Knuth. 1995. Using a communication strategy to enhance community support for management. Pages 123-131 *in* J.B. McAninch, ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. 175pp.

Stradtmann, M. L., J. B. McAninch, E. P. Wiggers, and J. M. Parker. 1995. Police sharpshooting as a method to reduce urban deer populations. Pages 117-122 *in* J.B. McAninch, ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. 175pp.

Ver Steeg, J. M., J. H. Witham, and T. J. Beissel. 1995. Use of bowhunting to control deer in a suburban park in Illinois. Pages 110-116 *in* J.B. McAninch, ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. 175pp.

Warren, R. J. 1995. Management of urban deer populations with immunocontraceptives: Practicality and agency concerns. Pages 164-170 *in* J.B. McAninch, ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. 175pp.

Walters, C. 1986. Adaptive management of renewable resources. MacMillan Publishing Company. New York. 374 pp.

MANAGEMENT PROGRAMS FOR URBAN DEER

MODERATORS:

H. Lee Gladfelter
Iowa Department of Natural Resources

Donald W. Hawthorne
Animal Damage Control Program,
Animal and Plant Health Inspection Service,
US Department of Agriculture

NEW JERSEY'S URBAN/SUBURBAN DEER MANAGEMENT PROGRAMS AND EXPERIENCES

DAVID BURKE, New Jersey Division of Fish, Game and Wildlife, Nacote Creek Research Station, Port Republic, NJ
ROBERT C. LUND, New Jersey Division of Fish, Game and Wildlife, Northern District Office, Hampton, NJ
DANIEL M. FERRIGNO, New Jersey Division of Fish, Game and Wildlife, Nacote Creek Research Station, Port Republic, NJ

New Jersey ranks 46th in size (19,660 square kilometers) and ninth in human population (7,600,000+). Despite its small size and reputation of being an urban state, an estimated 150,000 white-tailed deer (*Odocoileus virginianus*) exist on 12,175 square kilometers of diverse deer range. Deer-human conflicts have existed for many years at the interface of suburban/urban areas and deer range, and within isolated pockets of undeveloped lands, such as county parks, industrial complexes, private estates and quasi-public watersheds, particularly in northeastern New Jersey.

Past efforts to deal with control of deer in areas of high deer-human conflict, and in open space areas slated for development have involved: liberalization of deer hunting seasons, bag limits and regulations; implementation of cooperative, controlled hunting programs; lethal and nonlethal removal by special permit; transfer of ownership and management responsibility of confined deer populations to land owners; education of other government officials, land owners and the general public regarding the issue, responsibility for the problem and management approaches; and, adoption of an urban/suburban deer management policy. Current and future efforts to mitigate deer-human conflicts within and near developed areas are expected to involve: expansion of controlled hunting programs, where they may be conducted safely and efficiently; increased use of lethal and nonlethal deer removal techniques in unhuntable areas; research and monitoring of alternative deer population control measures, including the use of fertility control materials; and, a community based approach affording the public greater input into the development of and responsibility for site-specific, deer management programs.

URBAN DEER MANAGEMENT IN CONNECTICUT: OUR EXPERIENCES, PHILOSOPHIES, AND STRATEGIES

MARK R. ELLINGWOOD[1] and HOWARD J. KILPATRICK, Department of Environmental Protection, Wildlife Division, North Franklin, CT

CHARACTERISTICS OF CONNECTICUT

Connecticut is 5,009 square miles (12,973 km^2) of diverse landscapes ranging from the rolling mountains of the Berkshires to the coastal plain of Long Island Sound. Connecticut is 59% forested and 14% farm land. Approximately 72% (3,600 square miles; 9,324 km^2) of Connecticut is considered potential deer habitat, of which 86% is privately owned. We have a human population of 3.3 million, or an average of 658 people per square mile (254 per km^2). Seventy-nine percent of our population is urban and 21% is rural. By national standards, our populace is affluent and well educated. In 1992, 32,000 of Connecticut's 90,000 licensed hunters purchased deer permits.

STATUS OF DEER IN CONNECTICUT

Habitat loss and market hunting nearly eliminated white-tailed deer (*Odocoileus virginianus*) from Connecticut by the late 1800's. Deer experienced a steady increase during the 1900's, as a result of legal protection and forest recovery. This increase was accompanied by the steady liberalization of crop protection options and limited hunting options. In 1974, Connecticut's Deer Management Act reclassified deer to a managed game species, and allowed for Connecticut's first regulated deer hunting season in 1975.

In 1992, 32,000 Connecticut hunters took 12,000 deer; crop protection permittees took 900 deer, and; 2,800 deer roadkills were reported. In 1993 we had approximately 51,000 wintering deer in Connecticut, or 14 deer per square miles (5.4 km^2) of deer range. Herd health was good (yearling beam diameters average 18 mm) and population turnover moderate (male yearling fraction equaled 42%).

URBAN DEER MANAGEMENT IN CONNECTICUT

The increase in our deer herd has been accompanied by expanding urbanization. The effect of urbanization on deer and deer habitat depends on the degree of development. Light settlement, the predominant form of urbanization in Connecticut, appears to enhance habitat quality, discourage deer hunting, and signals a change away from traditional agrarian values. Not surprisingly, this type of development is accompanied by increases in damage complaints and deer/vehicle collisions.

Connecticut deer management has generally been predicated on the belief that in an urban state where 86% of deer habitat is in private ownership and hunter access is efficiently regulated by landowners, it is unlikely that we will shoot too many deer. Consequently, our approach has been to risk overharvest, rather than flirt with overpopulation. Our deer management program can thus be aptly described as an urban deer management program. Our commitment to herd stabilization is reflected in our liberal season schedule, which includes (1) multiple, lengthy seasons; (2) the availability of multiple permits; (3) liberal bag limits; and, (4) a mandated harvest of antlerless deer during all seasons. In 1993, these seasons allowed for the legal harvest of 13 deer per hunter on private land in "deer sensitive" urban areas of our state. By law, eight of 13 deer had to be antlerless, the remainder could be deer of either sex.

Our program has several notable features which highlight our interest in encouraging hunting, with particular emphasis on urban deer. Mandatory written consent of landowners (on forms provided by the state) encourages responsible hunting, and gives landowners the confidence to open their property to individuals of their choosing. Our 108 day archery season gives ample opportunity for deer hunting in urban areas where shooting restrictions frequently preclude the use of firearms, and where landowners appear to appreciate the discrete nature of bow hunting. Archers are issued a four tag deer permit that allows for the taking of two mandatory antlerless deer and two deer of either sex. Our two month free season for landowners who own 10 or more acres and their lineal descendents, encourages landowners to deer hunt and to allow others on their land.

---

[1]Present address, New Hampshire Fish and Game Department, Keene, NH

OBSERVATIONS REGARDING URBAN DEER PROBLEMS

Our experience is that Connecticut's suburban residents love deer at low densities; tolerate them at moderate densities, and; look for someone to blame at high densities. Our message to the public is that we are committed to maintaining deer numbers at moderate levels, but we can only do so with their cooperation. We contend that suburban deer herds should be stabilized before the onset of deer conflicts since such problems are difficult to redress.

Connecticut suburban deer problems are typified by the presence of refuges, which serve as the focal point of local problems. Consequently, we maintain that most urban deer problems can be addressed through controlled hunting programs. These refuges include water company holdings, corporate lands, unhunted state parks, nature preserves, and municipal open space. Such properties are typically closed to hunting due to: safety concerns; perceived conflicts between "preserving" nature and killing deer, and; sensitivity, driven by political or financial considerations. It is noteworthy that Connecticut appears to lack the severe urban deer problems that have been reported by other states. This may reflect: our moderate deer densities; differing cultural carrying capacity (CCC); or, the failure of communities to effectively call attention to their problems.

Deer hunter access to private land is controlled via written, dated consent of landowners on state issued consent forms. This requirement minimizes landowner/hunter conflicts, encourages good landowner/hunter relationships, and encourages ethical and responsible hunting. We believe that in the absence of written consent, many landowners would close their land to hunting. Hunters reportedly enjoy the more controlled atmosphere afforded by regulated access. The flip side of this issue is that in an urban state such as Connecticut, hunter access is often highly restricted, and thus facilitates deer herd growth.

In 1986, we used consent forms to quantify firearm deer hunter access to private land by county. Firearms deer hunters accessed only eight to 32% of estimated deer habitat. As expected, access was most limited in urban counties resulting in poor prospects for herd control. Despite overall shortfalls in land access, it is noteworthy that the numbers of landowners allowing access, and the total acreage opened to deer hunting, appears to have increased steadily during the past 19 years.

ANIMAL RIGHTS ACTIVITY

Animal rights activity is common in Connecticut and is accepted as a routine component of deer management. We argue that the maintenance of moderate deer densities in Connecticut is in the best long-term interest of the deer, native plant and animal communities, and the entire citizenry of the state. We promote regulated hunting as an ecologically sound, socially beneficial, and fiscally responsible means to this end. Animal rights interests counter that: (1) deer managers only serve the interests of the hunting community; (2) deer management is driven by economic rather than ecological or social interests; (3) deer hunting is counterproductive, i.e., it promotes herd growth and diminishes herd fitness, and; (4) deer management is best left to natural regulatory processes. Our critics divert program resources, consume staff time, and delay the implementation of management plans. In some cases, they have delayed deer control on properties owned by image sensitive entities, such as corporate interests, environmental land trusts, and municipalities. Our experience is that when deer numbers exceed local tolerance thresholds, local residents with accurate information regarding the options are supportive of herd reduction efforts.

Most of our deer controversies have involved one or two local activists supported by various animal rights organizations. These interests form coalitions which effectively use the media to make their case. They earn credibility via extensive media coverage.

Ironically, constant pressure from animal rights interests may discourage agency experimentation with nontraditional deer control options due to a concern for setting an undesirable precedent. In short, animal rightists may create intransigence, and in so doing, galvanize support for regulated hunting.

PUBLIC EDUCATION

We believe the majority of Connecticut deer problems could be resolved through regulated hunting. However, prevailing social, political and economic views frequently serve as obstacles to the application of hunting programs in Connecticut. A lack of familiarity with hunting which includes a negative stereotype of hunters, and questions regarding why deer are hunted, prompt resistance to hunting, and represent obstacles that we have attempted to overcome through education. Educational efforts have principally focused on: the "redefinition" of deer hunting as a tool for addressing ecological and sociological concerns, and; the potential for land managers to precisely and productively regulate deer hunters.

In 1986 we defined CCC as "the maximum number of deer that can compatibly coexist with a local human population" (Ellingwood and Spignesi 1986). Our intent was to popularize the notion that diverse human interests serve as the foundation for deer management decision making, and that in urban areas priority consideration is given to managing against potential deer/human conflicts. Our use of deer/vehicle collision frequencies, deer kill data from our crop damage control program, and more recently, home owner complaints, as components in management decision making demonstrates our interest in conflict abatement. Our inclusion of human density data, crop damage data, and deer/vehicle collision data in the formulation of state deer management zones further conveyed our interest in CCC. An additional benefit to the popularization of the concept of CCC has been our ability to effectively refute deer hunting critics who lack the same value system as urban residents concerned with deer damage, deer/vehicle collisions, and Lyme disease. CCC has improved our ability to express our concerns and interests to diverse publics and in so doing, to define them as stakeholders in our deer management efforts.

The booklet, An Evaluation of Deer Management Options, (Ellingwood and Caturano 1988) was published by the Connecticut Wildlife Division, in cooperation with the New England Chapter of The Wildlife Society and The Northeast Deer Technical Committee. The booklet was written to: (1) document (and clarify) for the public why deer are managed; (2) provide a concise, definitive evaluation of deer conflict abatement options; (3) preempt the inevitable rehashing of "old ideas" that typically occurred each time a deer conflict arose, and thus; (4) save staff time. The intended audience for the booklet was land management decision makers such as town committees, land trusts and corporate land managers.

The booklet emphasizes the ecological and sociological consequences of not managing deer, and thus refutes the popular notion that deer management is driven solely by hunter interests. This approach has helped nonhunters and land managers to realize that they have a vested interest in deer management issues and that deer programs are responsive to their interests. The booklet addresses the following eight management options: (1) regulated hunting; (2) allowing nature to take its course; (3) trapping and transferring; (4) fencing and repellents; (5) fertility control; (6) supplemental feeding; (7) sharpshooting, and; (8) reintroduction of predators. It attempts to objectively compare the practicality and effectiveness of these methods as herd control options, and concludes that regulated hunting is the fundamental basis for successful deer management. Connecticut's experience with the booklet has been very positive. A high quality 30 minute film based on the booklet currently is being produced under the auspices of the Northeast Deer Technical Committee with a grant from the U.S. Fish and Wildlife Service.

A second booklet entitled A Guide to Implementing a Controlled Deer Hunt (Ellingwood 1991) was published by the Connecticut Wildlife Division as a companion publication to the deer management options booklet. The content of this booklet is illustrated by the following excerpt.

"The effectiveness of regulated hunting in meeting local management needs is closely tied to the applicability of hunting to the target area. Regulated hunting is frequently ruled out as a deer management option due to a perceived incompatibility between hunting and various land-use activities and/or safety considerations. In many circumstances, however, regulated deer hunts can be 'customized' to avert such conflicts and still meet local management objectives. Such customized hunts are commonly referred to as controlled deer hunts. As the name infers, controlled hunts feature guidelines which control and/or restrict hunting activity, making it compatible with the special needs of a particular site. A controlled hunt represents a relatively safe, orderly and efficient herd reduction opportunity."

The primary message of this booklet is that landowners need not relinquish control of their property to hunters to achieve a reduction in their local deer herd. This message is offered in an effort to combat fear of hunting that is rooted in ignorance. Experience indicates that most Connecticut citizens are unfamiliar with hunting rules, regulations, and seasons, and are somewhat supsect of hunters and hunting.

The booklet provides a detailed explanation of how to plan a controlled deer hunt. Topics covered range from hunter screening and selection to program safety and efficiency. It concludes with a reiteration of our interest in cooperatively working with large landowners to create controlled hunt programs. The target audience is land managers responsible for $\geq$640 acres (259 ha). Response to the booklet has been excellent, and the booklet has contributed to the opening of several large properties in Connecticut.

CONTROLLED HUNTING IN CONNECTICUT

The Connecticut Deer Program routinely administers controlled hunts on large private parcels at the request of landowners. For us, this entails: the listing of planned hunts in our annual hunting field guide; the selection of hunters through an existing computer lottery process, and; the processing of site-specific controlled hunt deer permits by our licensing office. We also offer to facilitate prehunt meetings and to serve as spokesmen and media representatives for controlled hunt interests. Finally, we facilitate deer data collection through our existing check station system and provide summary reports as requested. This program has tremendous appeal to potential participants, and offers minimal additional work for our staff. These services encourage responsible herd management and offer a positive example for other landowners to emulate.

Experiences at Bluff Point Coastal Reserve illustrate the challenges we've encountered, the tools we've employed, the strategies we've implemented and the mistakes we've made in addressing a controversial urban deer problem. Bluff Point Coastal Reserve is a state owned 800 acre (323 ha) coastal peninsula located in the urban town of Groton, CT. In 1975, this remnant coastal hardwood forest was designated a coastal reserve for the expressed purpose of protecting its native ecological associations, unique faunal and floral characteristics, geological features and scenic qualities in a condition of undisturbed integrity. Bluff Point is an exceedingly popular recreational site for hikers, off-road bicyclists, joggers, and others.

Severe vegetative impacts of deer were first documented at Bluff Point in 1984. Reports of starvation at Bluff Point were common throughout the 1980's. The presence of browse lines, intensive winter browsing, and widespread bark stripping in 1990, coupled with night spotlight and aerial count data, prompted us to propose a controlled hunt at Bluff Point in 1990. The proposed hunt was challenged on biological grounds, based on the results of a summer vegetative survey conducted by an animal rights consultant. Legal efforts to prevent the 18 day hunt failed and the hunt was implemented in November of 1990. Sixty-seven deer were taken in six days. Critics claimed we were extirpating the herd and the media reported that we had exceeded our harvest goal. This conclusion was based on confusion regarding partial aerial counts and actual population estimates.

Since then, we have actively quantified deer numbers and vegetative impacts at Bluff Point. Our efforts have included annual aerial deer surveys, fall spotlight counts, winter dead deer surveys, and forest regeneration studies. Random surveys of Bluff Point visitors demonstrated that the majority of Bluff Point users would support a reduction if: (1) deer were having deleterious impacts on native plant communities, and/or; (2) deer were starving at Bluff Point. In fact, both events were thoroughly documented at Bluff Point but not widely reported by the media. Perhaps most notably, we invited six independent state, federal and private experts to assess the impacts of deer on Bluff Point vegetation. Their written documentation provided compelling evidence of the severe overpopulation.

The results from these efforts were compiled in a legislatively mandated management plan for Bluff Point, and have convinced all interests that a serious deer overpopulation exists. Critics have recently acknowledged the existence of a problem, but have argued that the problem resulted from the 1990 hunt which destabilized a naturally regulated deer population. A proposal for a second controlled hunt has been offered and is currently under consideration for implementation in 1994. Local legislators have expressed support for the proposal while some critics have endorsed sharpshooting as an alternative and characterized our proposal as a recreational hunt.

NONTRADITIONAL DEER MANAGEMENT OPTIONS

Nontraditional deer management options (NDMO's) are being employed in an increasing number of states. We conducted a survey of 42 Northeast deer biologists and researchers in order to assess their views on NDMO's (Ellingwood and Kilpatrick 1991). Ninety-three percent of respondents supported the use of NDMO's when regulated hunting is not an option and 60% agreed that their use would enhance the credibility of management programs. Only 22% felt that the use of NDMO's would set undesirable precedent. Seventy-nine percent of respondents felt that deer managers would eventually be forced to use NDMO's if they failed to employ them voluntarily. Respondents (N=39) ranked various deer management options in the following order from most preferred to least preferred: (1) regulated hunting; (2) shoot over bait; (3) shoot with marksmen; (4) shoot at night; (5) trap and euthanize; (6) fertility control; (7) trap and transfer, and; (8) no action.

THE FUTURE IN CONNECTICUT

We anticipate that Connecticut urban deer problems will eventually warrant implementation of nontraditional deer management options. Given the prevailing atmosphere in Connecticut, the fact that requests for NDMO options could conceivably come from any corner of our state, and our own resource limitations, we are concerned about: overextending our staff; controlling the application of NDMO's; the disposition of deer carcassess; being able to objectively define the application criteria for new control technologies, and; mitigating differences between adjoining land interests with differing management priorities. We anticipate that the line between huntable and unhuntable lands will continue to be further blurred in Connecticut since the distinction is as much a product of social sentiment and personal opinion as it is quantifiable features of the landscape.

Future urban deer management efforts in Connecticut may include: crossbows; shooting over bait; sharpshooting; shooting out of season, or; trapping and euthanizing. The application of such techniques only would be considered: in urban areas with a quantified problem; on parcels of some minimum size; if the effort and technique are sanctioned at the local level; if costs are borne by local interests, and; if the program is locally managed. Our intent would be to empower qualifying urban communities to address local problems with minimal staff involvement.

Controlled deer hunts will likely increase in popularity as urban herds expand and/or as people grow frustrated with the cost of NDMO's. Our ability to administer unlimited hunts is a function of the complexity of the hunts. Some hunts will likely warrant special attention; the need for micromanaged hunts will serve as an impediment to our involvement, and will likely result in a need for trained private hunt managers (possibly trained by the state). This will allow for more precisely managed hunts and for more thorough screening of hunt participants.

CONCLUSIONS

Based on our experiences, both positive and negative, we offer the following suggestions / observation: 1) act to prevent rather than correct urban problems; 2) create stakeholders by discussing ecolgical and cultural themes; 3) create coalitions between preservationists and conservationists; 4) teach landowners how to control hunting activity on their land; 5) draw distinctions between the interests of local residents and outside critics; 6) anticipate opposition in all circumstances, and familiarize yourself with common animal rights positions; 7) don't place too much confidence in population survey data; 8) don't rule out bow/crossbow hunters as urban deer control agents; 9) anticipate questions from the media and keep your message simple and consistent; 10) don't waste time trying to educate your critics; 11) identify one or two spokesmen to handle media relations; 12) use qualified outside experts to diffuse biological debates; 13) funding sources and program flexibility is linked; alternative funding sources will be an essential part of effective urban deer management in Connecticut; 14) the media is a poor forum for public debate of technical issues.

LITERATURE CITED

Ellingwood, M. R. 1991. A guide to implementing a controlled deer hunt. Connecticut Wildlife Division Pub. No. DR-16. 12pp.

___, and S. L. Caturano. 1988. An evaluation of deer management options. Connecticut Wildlife Division Publication No. DR-11. 12pp.

___, and H. J. Kilpatrick. 1991. A survey of nontraditional deer management options. Trans. Northeast Deer Tech. Committee. 27:62-66.

___, and J. V. Spignesi. 1986. Management of an urban deer herd and the concept of cultural carrying capacity. Trans. Northeast Deer Tech. Committee. 22:42-45.

CITIZEN TASK FORCE STRATEGIES FOR SUBURBAN DEER MANAGEMENT: THE ROCHESTER EXPERIENCE

PAUL D. CURTIS and REBECCA J. STOUT[1], Department of Natural Resources, Cornell University, Ithaca, NY
LAWRENCE A. MYERS, New York State Department of Environmental Conservation, Bureau of Wildlife, Avon, NY

There is little doubt that suburban deer (*Odocoileus virginianus*) management is demanding increased attention and resources from many state wildlife agencies. Deer conflicts in residential locations have increased greatly during the past 10-15 years (Flyger et al. 1983, Diamond 1992). Population increases of deer in parks and suburbia has been aided by hunting restrictions imposed by towns and private landowners (Decker et al. 1982, Curtis and Richmond 1992). These local ordinances have limited or eliminated legal hunting in some suburban areas, although hunting is the traditional control method used to manage deer populations in rural landscapes.

The challenge facing many state and local governments is how to manage growing deer herds in residential landscapes (Brush and Ehrenfeld 1991, Curtis and Richmond 1992, Diamond 1992). Deer can present safety hazards to motorists, consume ornamental shrubs, and are perceived as agents in Lyme disease transmission (Connelly et al. 1987, Decker 1987, Siemer et al. 1992). These negative deer-people interactions have increased public concern and awareness about deer management, and expanded the number and types of potential stakeholders in the decision-making process. A diversity of people want to participate in recommending management objectives and methods for controlling deer numbers. Consequently, wildlife agencies are exploring different ways to resolve difficult deer-related issues through public consensus in suburban communities.

This paper describes a Citizen Task Force (CTF) approach (Decker 1991, Hall 1992, Stout et al. 1992, Curtis et al. 1993) used to set goals and select management approaches for deer in the greater Rochester metropolitan area. Cornell Cooperative Extension (CCE) and the New York State Department of Environmental Conservation (DEC) cooperatively developed and coordinated the public involvement process. The model and activities that occurred through March 1993 were described in detail at the North American Wildlife and Natural Resource Conference (Curtis et al. 1993), and will be briefly reviewed here. The purpose of this discussion is to reevaluate the approach and outcomes based on implementation of the CTF recommendations during April through December 1993.

STUDY AREA

Rochester is located within Monroe County in northwestern New York, along the southern shore of Lake Ontario (Curtis et al. 1993). Much of the area contains industrial or residential development, and western portions of the Town of Greece contain agricultural and forest lands. Monroe County operates several suburban parks near Rochester, and the site with the most intense deer management controversy is the 965-acre (390 ha) Durand Eastman Park located within the Town of Irondequoit (Figure 1). Many deer-people conflicts also occur near the suburban fringes of other parks and undeveloped open lands.

BACKGROUND

This was one of the last parts of New York to be opened for deer hunting because deer only recently repopulated this area (Hauber 1993). However, high densities of people and intense residential development complicate hunting for deer. Currently only longbows may be used to take deer (either sex) during regular or archery seasons within portions of this unit (Figure 1). The Town of Irondequoit passed a local law banning the use of bow and arrows in 1978 (Hauber 1993). Monroe County regulations also prohibited hunting in county parks throughout the region. Consequently, deer populations in Durand Eastman Park and the Town of Irondequoit have grown with little restriction since the late 1970s. Today, a minimum of at least 87 deer/mi^2 (33 deer/km^2) occupy portions of Durand Eastman Park (J. Hauber, NYSDEC, pers. commun.; 1992 helicopter survey data).

---

[1]Present address, Department of Wildlife and Fisheries Sciences, Texas A & M University, College Station, TX

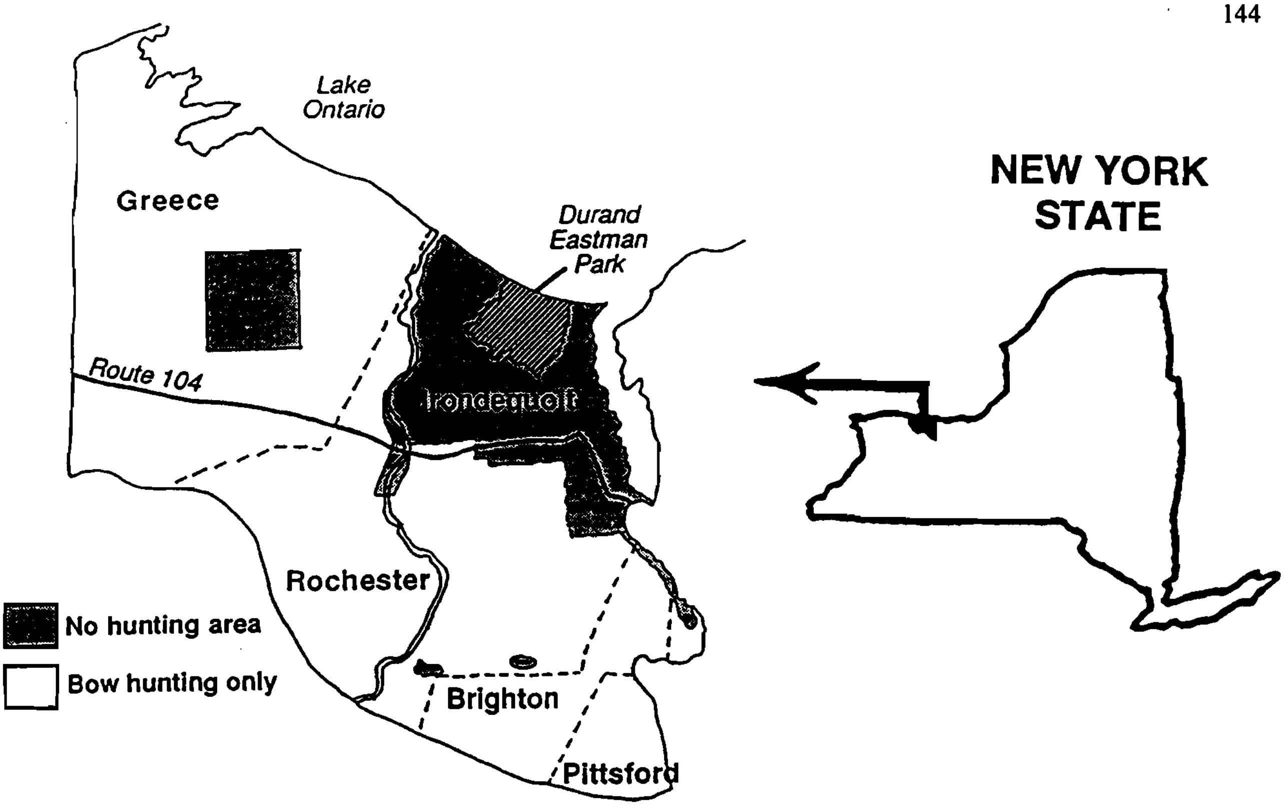


Figure 1. Closed and bowhunting - only areas in the deer management unit under consideration by Citizen Task Force members from the greater Rochester metropolitan area, 1992.

Much of the controversy concerning deer management is the result of human-deer conflicts in the Town of Irondequoit. Three very vocal deer-related citizen organizations are active in the town: (1) the Irondequoit Deer Action Committee (IDAC), (2) the Monroe County Alliance for Wildlife Protection (MCAWP), and (3) Save Our Deer (SOD). The primary concerns of IDAC members are reducing the risk of human injury from deer-vehicle accidents, deer damage to personal and public property, and the health of the local deer population (Town of Irondequoit 1990). MCAWP has proposed to increase awareness of public safety and reduce deer-vehicle accidents by publicizing defensive driving techniques and deer movement patterns, and wants to prevent the killing of deer (MCAWP 1992). Both MCAWP and SOD (Enos 1992) support experimental reproductive inhibition techniques (Turner et al. 1992) to regulate deer numbers in Irondequoit. These citizen organizations have lobbied town, county, and state governments to make their desires known.

Town, county, and state governments have been constrained by each other's laws and regulations (Hauber 1993). DEC has the authority to issue permits for the removal of nuisance deer and set quotas for hunter harvest. Monroe County legislators oversee county parks, where regulations prohibit hunting. The Town of Irondequoit has enacted laws restricting the discharge of bow and arrows. For more than 15 years, DEC has recommended bow hunting to regulate deer numbers on town and county lands. This tangled web of authorities and regulations resulted in a lack of coordinated action to address deer management issues, and contributed to a stalemate that damaged the credibility of government agencies and elected officials.

THE PUBLIC INVOLVEMENT PROCESS

During fall 1991, DEC staff decided to attempt another resolution of the deer management controversy in the greater Rochester area with a modification of the CTF process used elsewhere in New York. In 1990, DEC and CCE had initiated a cooperative effort to involve citizens in wildlife management decisions (Decker 1991, Hall 1992, Stout et al. 1992, Curtis et al. 1993). CTFs were organized in selected rural areas across the state to provide stakeholders with the opportunity for choosing a desired deer population level for their particular area. CCE agents facilitated meetings, and with DEC input, selected 8-14 individuals to serve on each CTF. The CCE facilitator served as an objective third party with no direct stake in the outcome of the task force process. DEC professionals provided technical information, and described the legal and practical framework within which deer management decisions are made.

During December 1991, DEC and CCE staff organized an 11-member CTF representing various stakeholder groups in the Rochester area (Curtis et al. 1993). This was the first time the task force approach was used in a suburban situation with intense deer management conflicts in New York. The CTF process used in the urban community was adapted from the approach used in rural areas (Nelson 1993, Stout and Knuth 1993, Stout et al. 1993). Unlike their rural counterparts, CTF members were charged with two tasks: set a deer population objective for their unit, and recommend management strategies to achieve this goal. CTF members were selected based on input from the meeting organizers (CCE and DEC). SOD representatives did not serve on the CTF because this group was formed after the public involvement process was initiated, and plans for the meetings were finalized. Background information was provided to CTF members during the initial meeting in January 1992. The role of the CCE facilitator and DEC technical staff was outlined clearly. DEC wildlife managers reviewed deer population trends, described New York State's deer management system, and served as advisors throughout the process.

In March, the CTF reached consensus that an appropriate population objective was 20-25 deer/mi^2 (8-10 deer/km^2) in areas with quality deer habitat. A helicopter count of deer in the Town of Irondequoit indicated densities were about 4 times the recommended level (Hauber 1993), and CTF members agreed that reductions were necessary in northern portions of the unit. The number of deer recommended for removal during the first year was equal to the confirmed number of deer killed on roadways during 1991 (80 for Irondequoit, 120 for Greece). If deer-vehicle accidents and damage reports were not reduced during 1993, the number of deer removed would be doubled in 1994.

During the April meeting, discussion focused on selecting methods for accomplishing the deer population objective. DEC staff indicated deer population objectives could be achieved where archery hunting was permitted (i.e., the southern half of the unit, and the Town of Greece in the northern portion). Because of restrictions on discharging bow and arrows or firearms in the Town of Irondequoit, CTF members decided to address that area separately. It became apparent that the deer population objective could not be reached in the Town of Irondequoit without cooperation between town, county, and state governments, and local legislative changes authorizing proposed management actions. During a meeting in May, CTF members met with elected officials and representatives from government agencies. The president of the Monroe County Legislature emphasized that citizens needed to be more unified in accepting a single alternative, and CTF members should assist with building a public consensus in the community.

In June, the CTF discussed the efficacy of remotely-delivered reproductive inhibitors for deer (Turner et al. 1992), and the feasibility of initiating a study in Durand Eastman Park. After much discussion and debate, selective culling with professional sharpshooters was selected as the preferred short-term removal method in the Town of Irondequoit. Research to develop practical reproductive inhibitors for deer was selected as the long-term option of choice.

CTF members met in July to review and discuss the draft recommendations and a communication strategy. DEC presented an approach which included: a series of 3 press releases concerning deer biology, management, and the CTF process, a press conference, continued meetings with local government officials, and an informational workshop. DEC considered the CTF process to be part of a larger communication strategy (Stout and Knuth 1994). News releases were issued during August, and the press conference was scheduled for September. One member of the CTF decided not to support a portion of the final recommendations after receiving pressure from her organization. Her group drafted a minority opinion (MCAWP 1992) which was also distributed at the press conference. SOD members were present at the press conference to voice their opinions as well. The media focused on the controversy surrounding the culling or "bait-and-shoot" recommendation of the CTF, rather than agreements reached on bow hunting in portions of the unit, and the long-term solution of contraception research.

OUTCOMES OF THE CTF PROCESS

Following the press conference, a working group comprised of government and agency decision-makers was established to implement the CTF recommendations. Representatives from town, county, and state government worked together to revise existing laws in order to permit selective culling of deer in the Town of Irondequoit and Durand Eastman Park. Monroe County legislators approved the CTF recommendations and amended their firearms law to allow the shooting of deer in the park during the proposed culling effort. Irondequoit Town Council members also approved the CTF recommendations, and amended the town firearms law to allow deer to be taken for selective culling and research purposes. DEC wildlife managers authorized state permits for deer culling, provided law enforcement assistance, and collected biological data from the 80 deer that were eventually removed from Durand Eastman Park.

Animal welfare and rights groups stepped up their public campaigns to thwart implementation of the CTF recommendations. When it became obvious that the deer culling would be implemented, MCAWP, SOD, the Humane Society of Rochester and Monroe County, the Fund for Animals, Animal Advocates of Upstate New York, and the Humane Society of the United States filed a court injunction delaying the removal of deer from Durand Eastman Park (Hauber 1993). The injunction was unanimously overturned by N.Y. State's Appellate Court, and the bait-and-shoot plan commenced. Deer culling ceased about three weeks later, when the last of the 80 deer recommended to be removed by the CTF were taken.

Although selective culling was intended to be the most cost-effective option for reducing deer numbers (other than hunting), the entire program cost $37,547, or $469 per deer removed (Hauber 1993). Much of this money ($13,490; 36%) was used to pay overtime for law enforcement personnel to ensure public safety and maintain order. However, more than $9,258 (25%) was required for inspection of deer carcasses by the N.Y.S. Department of Agriculture and Markets (DAM). The damage permit issued by DEC for the deer culling operation included conditions for processing the venison for human consumption (in N.Y. State's Penal Institutions) according to DAM standards (Hauber 1993). Unfortunately, less than 20% of the deer culled were declared fit for human consumption under DAM standards due to the general poor health of the herd or poor shot placement. Once the meat was processed, DAM inspectors declared the venison unfit for human consumption because of small amounts of deer hair found in the packaged meat.

In addition to the 80 deer which were culled, DEC biologists examined 23 deer found dead by Durand Eastman Park staff. Starvation was an important source of mortality for these deer (Hauber 1993). High deer densities and poor quality range, combined with more than 40 inches (102 cm) of snowfall during mid-March 1993, resulted in poor survival of deer in Durand Eastman Park.

Was the bait-and-shoot program a success? The legal precedent for removing deer from the park was established, and the objective of 80 animals was reached. However, DEC staff concede that this level of removal will have little impact on the deer population in the Town of Irondequoit or Durand Eastman Park. At this point in time, it appears reported deer-vehicle accidents will not be significantly lower in 1993 compared to 1992. Currently, the government working group is making plans to cull an additional 160 deer from Durand Eastman Park in early 1994. Also, DEC continues to promote bow hunting as a more cost-effective method for lowering deer numbers.

What about the CTF recommendation to evaluate deer contraception as a long-term solution to the problem? State and local governments are interested in pursuing wildlife contraception research, however, funding for a project is not available. DEC has offered to provide technical assistance if town and county governments will pay for a university research. DEC staff continue to attend conferences (i.e., Contraception in Wildlife Management Symposium, Denver Tech Center, Denver, CO) to keep abreast of emerging technologies, but there are still many hurdles to be overcome concerning delivery systems and efficacy of contraceptives for deer. DEC is currently not willing to make a long-term investment in research on contraceptive techniques, but biologists would consider using contraceptive materials if they were registered and available for deer management activities.

DEC staff believe that the lack of research on contraception and population modeling will have little effect on the decision to proceed with a bait-and-shoot program for removing 160 deer in 1994. Although many people have an interest in knowing how many deer are in Irondequoit, and would like to know the proportion of the herd taken by culling, there is no strong push to commit town or county dollars for assessing deer numbers. There is some discussion of using infrared technology to improve deer detection during aerial counts, but funding has not been allocated for that project. DEC biologists conducted spotlight surveys (n = 2) in and around Durand Eastman Park during September and October 1993, and counted an average of 223 deer. DEC staff indicate there is ample justification for proceeding with deer removals in Irondequoit based on damage to vegetation, continued high reports of deer-vehicle collisions, and poor physical condition of deer examined during spring 1993.

EVALUATION OF THE CTF APPROACH

An evaluation of activities which occurred to date provides insights for improving the CTF approach for resolving controversial wildlife management situations. The following discussion addresses issues that influenced the both the outcomes of this process, and the agencies charged with implementing the CTF recommendations.

In suburban locations with long-standing wildlife management controversies, building consensus was more challenging than in more rural areas. The facilitator indicated that sharing ideas and working together to resolve existing problems was the goal of the CTF, not to achieve a majority vote. At the suggestion of the facilitator, the group agreed that at least 10 of 11 members must approve of a particular action for it to be included in the final recommendations, so that no single individual could stall the process. Although this modified definition of consensus seemed reasonable and worked well initially, it created problems during the final stages of the process. We believe that in future CTFs, consensus should be considered as unanimous agreement. If complete agreement cannot be reached, the facilitator should emphasize areas where there is common ground and the greatest progress can be made.

It's unreasonable to expect all individuals participating in a CTF to reach consensus on every aspect of complex and controversial deer management situations. Including participants who have a wide range of attitudes and values about deer is essential for any public involvement process to be credible and arrive at a fair recommendation (Susskind and Cruikshank 1987). We recommend that CTFs strongly emphasize a problem-solving approach. Allowances for individual beliefs and differences of opinion should be discussed at an early stage, to determine if consensus can be achieved. To keep individuals with minority opinions involved in and supportive of the process, they should be given an outlet to voice their opinions in the final recommendations.

A mechanism for any interested individual in the community to voice his or her opinions should be part of the CTF process. In rural areas, CTF members and CCE agents agreed to have their names published in the local paper so people in the community could contact them with additional input. Recently, a public meeting has been scheduled after the first CTF meeting in some areas so that members could learn about opinions of people in the community (D. Faulknham, DEC, pers. commun.). If time and funding permits, CTFs may also consider implementing an opinion survey using scientifically-rigorous techniques.

In the Rochester area, not all interests participated in the CTF approach. A citizens' group (SOD) with strong animal welfare interests was formed and became active in the community after the CTF process was initiated. Although SOD members reluctantly agreed to voice their concerns through the MCAWP representative, they felt left out of the decision-making process, and eventually fought implementation of the CTF recommendations. Involving all interests in the process may not necessarily prevent groups from blocking an action plan, however, the fairness of involving all community interests in arriving at a solution cannot be disputed.

During January through August 1992, local deer-related citizen groups (MCAWP, IDAC, SOD) continued to promote their organizational goals. CTF contacts with the media were limited until prior to releasing recommendations at a press conference in September. Although the press conference was used successfully to publicize a portion of the recommendations, the media focused on the controversy surrounding the bait-and-shoot program, rather than highlighting the justification for action and other more positive agreements made by CTF members. A series of news releases describing the CTF's progress, issued monthly and approved by task force participants, may have reduced misinformation in the media and the level of controversy. Paid advertisements in newspapers could have provided a more structured message and highlighted positive gains. With additional financial resources and staff time, the media could have been used as a proactive educational tool.

Wildlife managers had the professional expertise to discuss expected outcomes of various methods for managing deer populations. However, we urge all CTF participants to make decisions concerning deer management alternatives based on science rather than personal values (Decker et al. 1991). People should be encouraged to explore their personal attitudes and beliefs associated with deer in order to find common ground. These underlying values can then be used to form the basis for management recommendations. Scientifically-collected information concerning public opinions about deer, or the status of the deer population, should be treated objectively. It's especially important for the facilitator to maintain an unbiased approach and help CTF participants separate science from value judgments.

We emphasize that agency biologists are not giving up control of deer management, as long as wildlife managers clearly establish legal and practical bounds at the beginning of the process. However, the flexibility of the consensus process may occasionally put the wildlife agency in a difficult situation. If CTF members decide to discuss nontraditional approaches for resolving deer conflicts, wildlife managers may have little research-based information available to respond to questions or predict future outcomes of proposed actions. Also, decisions to use techniques other than hunting may require changes in agency policy. The wildlife agency must be able to respond quickly to information requests and be willing to consider policy changes if the CTF process is to succeed.

Increasingly, wildlife management decisions are being made in the political arena. It's impossible to remove politics from the ultimate decision. No matter what the final outcome may be, some members of the community will not be supportive of the final plan. The CTF approach forced state and local governments to work together to develop and implement an action plan. A coordinated effort among stakeholders, agencies, and local government officials was necessary to gain approval for culling deer in Durand Eastman Park. DEC staff believed the CTF process and recommendations were an important factor which contributed to winning the court challenge and setting the legal precedent to bait-and-shoot deer in the park. However, the CTF recommendations may again be challenged in the courts again if 160 deer are culled in spring 1994.

Undoubtedly, the most important attribute of the CTF process was that a diversity of interests were brought together to discuss the benefits and concerns about deer in a suburban community. Although there is still much controversy being generated by groups with strongly-held minority beliefs, many people are focused on resolving deer management conflicts, and support efforts to immediately reduce deer numbers. It will be interesting to see if additional financial resources are allocated for contraceptive research once deer populations are reduced to desired levels, and deer-human conflicts are minimized. Or will the community be more supportive of hunting for regulating deer numbers after bearing the costs of deer culling for several years? One thing is certain. The attitudes and values of citizens towards deer are dynamic, and it is critical for wildlife agencies to monitor and be responsive to public opinion over time. Flexibility is an important component of any successful deer management program.

ACKNOWLEDGMENTS

We thank P. Bush, J. Fodge, J. Hauber, N. Holmes, G. Parsons, J. Proud, and M. Hall from the DEC, and T. Pollock from the Monroe County Parks Department, for their valuable assistance with and assessment of the CTF meetings. We also appreciate the assistance of agencies and elected officials who served as technical advisors at CTF meetings. Finally, we would like to thank Citizen Task Force members S. Baker, R. Blevins, J. Carpenter, D. Habes, J. Krebs, R. Lehman, C. Michaloski, S. Mooberry, D. Ophardt, J. Smitley, and A. Van Dam for their interest and time spent addressing deer management concerns.

LITERATURE CITED

Brush, C. C., and D. W. Ehrenfeld. 1991. Control of white-tailed deer in non-hunted reserves and urban fringe areas. Pages 59-66 *in* L. W. Adams and D. L. Leedy, eds., Wildlife Conservation in Metropolitan Environments. NIUW Symp. Ser. 2, Natl. Inst. for Urban Wildl. 264pp.

Connelly, N. A., D. J. Decker, and S. Wear. 1987. Public tolerance of deer in a suburban environment. East. Wildl. Damage Control Conf. 3:207-218.

Curtis, P. D., and M. E. Richmond. 1992. Future challenges of suburban white-tailed deer management. Trans. North Am. Wildl. Nat. Resour. Conf. 57:104-114.

_____, R. J. Stout, B. A. Knuth, L. A. Myers, and T. M. Rockwell. 1993. Selecting deer management options in a suburban environment: A case study from Rochester, NY. Trans. North Am. Wildl. and Nat. Resour. Conf. 58:102-116.

Decker, D. J. 1987. Management of suburban deer: an emerging controversy. East. Wildl. Damage Control Conf. 3:344-345.

_____. 1991. Human dimensions evaluation research to assist public participation processes. Colo. Div. Wildl. Occ. Pap. Ser. No. 2 (Nov.). 4pp.

_____, T. L. Brown, S. J. Tuttle, and J. W. Kelley. 1982. Posting of private lands in New York: A continuing problem. Conserv. Circ. 20(7). Dep. Nat. Resour., N.Y. State Coll. Agric. and Life Sci., Cornell Univ., Ithaca, N.Y. 6pp.

_____, R. E. Shanks, L. A. Nielsen, and G. R. Parsons. 1991. Ethical and scientific judgments in management: Beware of blurred distinctions. Wildl. Soc. Bull. 19:523-527.

Diamond, J. 1992. Must we shoot deer to save nature? Nat. History 8(Aug.):2-8.

Enos, B. 1992. Save our deer group forms, holds meeting. Irondequoit Press (Jan. 13), Rochester, N.Y. pp3-4.

Flyger, V., D. L. Leedy, and T. M. Franklin. 1983. Wildlife damage control in eastern cities and suburbs. East. Wildl. Damage Control Conf. 1:27-32.

Hall, M. 1992. Citizen task force on deer management. East. Wildl. Damage Control Conf. 5:195.

Hauber, J. 1993. White-tailed deer management in the Town of Irondequoit and Durand Eastman Park. N.Y. State Dep. Environ. Conservation, Avon, N.Y. 11pp.+app.

Monroe County Alliance for Wildlife Protection. 1992. Minority report: Deer management unit 96 citizens task force. Rochester, N.Y. 13pp.

Nelson, D. 1993. Citizen task forces on deer management: A case study. Northeast Wildl. 49:92-96.

Siemer, W. F., B. A. Knuth, D. J. Decker, and V. L. Alden. 1992. Human perceptions and behaviors associated with Lyme disease: Implications for land and wildlife management. HDRU Series 92-8, Human Dimensions Res. Unit, Dep. Nat. Resour., N.Y. State Coll. Agric. and Life Sci., Cornell Univ., Ithaca, N.Y. 100pp.

Stout, R. J., and B. A. Knuth. 1994. Evaluation of a citizen task force approach to resolve suburban deer management issues. Human Dimensions Res. Unit, Publ. 94-3 Dept. Nat. Resour., Cornell Univ., Ithaca, N.Y. 134pp.

_____, and _____. 1994. Using a communication program to enhance community support for management. Pages xx-yy *in* J.B. McAninch ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. pp.

_____, D. J. Decker, and B. A. Knuth. 1992. Agency and stakeholder evaluations of citizen participation in deer management decisions: Implications for damage control. East. Wildl. Damage Control Conf. 5:142.

_____, _____, _____, J. C. Proud, and D. H. Nelson. 1994. Public involvement in deer management decision-making: Comparison of three approaches for setting deer population objectives. Human Dimensions Res. Unit, Publ. 94-3 Dept. Nat. Resour., Cornell Univ., Ithaca, N.Y. 211pp.

Susskind, L., and J. Cruikshank. 1987. Breaking the impasse: consensual approaches to resolving public disputes. Basic Books, Inc. N.Y. 276pp.

Town of Irondequoit. 1990. Irondequoit town hall report (winter). Rochester, N.Y. pp. 14-15.

_____. 1991. Irondequoit town hall report (spring). Rochester, N.Y. page 16.

Turner, J. W., Jr., L. K. M. Liu, and J. F. Kirkpatrick. 1992. Remotely delivered immunoc ontraception in captive white-tailed deer. J. Wildl. Manage. 56:154-157.

A FACILITATED APPROACH TO MANAGING URBAN DEER: AN UPDATE FROM MINNESOTA

JAY B. McANINCH, Minnesota Department of Natural Resources, Madelia, MN
JON M. PARKER, Minnesota Department of Natural Resources, St. Paul, MN

Implementation of urban deer management programs has been hindered by disagreements over the significance of the problems caused by deer, the methods form removing deer, the lack of emphasis on nonlethal programs, and the degree of confidence of stakeholders in wildlife professionals to objectively conduct management programs. In 1990, we reported on the adoption of a facilitated urban deer management program by 4 cities in the lower Minnesota River Valley. The program was developed and issued by a Deer Management Task Force (DMTF) composed of city, county, state, and federal agency staff and animal protection, conservation and hunting supporters. Consensus was reached by the DMTF on recommendations for setting deer density goals, the use of deer population management methods techniques to reduce deer/vehicle collisions, control of vegetation damage, and artificial feeding of deer. The DMTF approved use of annual program review and discussion conducted by the DMTF.

In 1991, Bloomington adopted a deer density goal of 15-25 deer per mi^2 and implemented several of the DMTF recommendations to manage deer. The program included use of an Alternative Deer Control Program (ADCP) (a deer removal method using qualified firearms participants with a hunting license), sharpshooting by police and conservation officers and public information sessions on reducing deer/vehicle collisions, damage to vegetation, and deer feeding. In 1991-92 and 1992-93, 335 and 342 deer, respectively, were removed from the city and public lands. Review meetings of the DMTF in 1992 and 1993 focused on deer density determination methods, concerns over violations committed by ADCP participants, public information describing the DMTF work, and deer/vehicle collision information form the 4 cities. Considerable discussion centered on the potential use of contraception for controlling deer and on the willingness of the DMTF to consider use of these methods.

To date, all members of the DMTF have adhered to the recommendations and process adopted in 1990. Completion of the first 3-year management program in 1994 will provide the first opportunity to test the strength of the groups' resolve. In addition, gradual changes in the membership of the DMTF has reduced the commitment of individuals to the original agreements. Prospects for the long-term viability of this approach to deer management are unknown.

MODELING THE IMPACTS OF CONTRACEPTION ON POPULATIONS OF WHITE-TAILED DEER

ROBERT K. SWIHART and ANTHONY J. DeNICOLA, Department of Forestry and Natural Resources, Purdue University, West Lafayette, Indiana

Deer in urban and suburban areas often present unique management challenges because of their close proximity to humans and because residents of these areas exhibit diverse and conflicting opinions regarding deer (Decker and Richmond 1995, Conover and McClure 1995, Kellert 1988). Increasingly, nontraditional management techniques are being explored for regulating population size in a socially acceptable manner (e.g., Curtis and Stout 1995, Stradtmann et al. 1995).

Contraception is one technique that is mentioned regularly as a potentially useful management tool, particularly by members of the public who oppose lethal control. Considerable experimental work is underway to test the effectiveness of various drugs for reducing fertility rates of deer (Plotka and Seal 1989, Turner et al. 1992) and other mammals (e.g., Bickle et al. 1991, Eagle et al. 1992, Henderson et al. 1987, Turner and Kirkpatrick 1991). Technological advances are occurring rapidly, and contraceptives may soon become available for wildlife management purposes. Unfortunately, practical guidelines for implementation of a contraceptive program (i.e., number of animals to treat, treatment interval, etc.) have received scant attention. Likewise, implications of a contraceptive control program for population attributes are largely unknown (cf. Bomford 1990).

Our objective was to examine the effect of various contraceptive management strategies on population attributes of white-tailed deer (*Odocoileus virginianus*) using a deterministic simulation model. We focused solely on contraceptives which target does. Specifically, we modeled the effect of contraceptive quality (efficacy and longevity), treatment intensity (proportion treated, years between treatments, age classes treated), and initial condition (population size, sex ratio, age structure) on population growth, sex ratio, and age structure. Results from simulations with herds in "poor" and "excellent" health were used to develop predictive equations that could be used in developing general guidelines for contraceptive management of deer.

METHODS

The structure of our model elaborated upon models developed by Garrott (1991) and Garrott et al. (1992) for examination of contraceptives as a tool in management of feral horses (*Equus caballus*). An age-structured model was formulated using a Leslie projection matrix with 15 age classes (see Caswell 1989). Schedules of age-specific birth and death rates were taken from published values to reflect a herd with poor potential for growth and a herd with excellent growth potential (Table 1). Growth potential was quantified by calculating the dominant eigenvalue of the

Table 1. Age-specific schedules of annual fertility (m_x) and survival[a] (l_x) rates used to depict deer herds with poor growth potential (λs = 1.0005) and excellent growth potential (λs = 1.4913).

Age Class	Poor Growth Potential			Excellent Growth Potential		
	Female		Male	Female		Male
	m_x	l_x	l_x	m_x	l_x	l_x
1	0.25	0.40	0.35	0.90	0.65	0.60
2	1.20	0.75	0.65	1.85	0.95	0.85
3-10	1.80	0.75	0.65	2.10	0.95	0.85
11-14	1.80	0.65	0.55	2.10	0.85	0.75
15	0	0	0	0	0	0

[a]Monthly survival rates were calculated from l_x values by assuming constancy of survival rates throughout the year.

Leslie matrix (λs), i.e., the annual rate of population change after attainment of a stable age distribution (Caswell 1989). If $\lambda s < 1$, then the population will decline, if $\lambda s > 1$, then the population will increase, and if $\lambda s = 1$, then the population will remain unchanged. We chose fertility and survival schedules for our "poor" herd such that $\lambda s = 1.0005$ and for our "excellent" herd such that $\lambda s = 1.4913$ (Table 1).

Populations were projected for a 20-year period. We began a simulation trial by assigning the number of individuals alive immediately after the birth pulse (N_0) into initial vectors of abundance for males and females. For simplicity, deer were placed only in the first 10 age classes. The proportion of males in the initial population was varied among trials and ranged from 0.3-0.6. Several initial age distributions also were used in the trials (Table 2); in any given trial, the same initial age distribution was used for both sexes to allocate deer among age classes. Sex ratio at birth varies as a function of fertility in deer; hence, the proportion of male newborns was estimated for each female age class using the fertility rates in Table 1 and the regression relation of Verme (1983).

We chose late summer-early fall as the period of contraceptive treatment, because many current contraceptives are most effective when delivered shortly before the rut. The prerut population was computed by calculating monthly survival rates and projecting each initial abundance vector forward 3 months.

Once a prerut population was obtained, a determination was made as to whether a treatment with contraceptives would occur. We conducted trials in which contraceptives were administered to does in the herd annually, every other year, every fourth year, or every tenth year. If no treatment was scheduled, the prerut population was projected forward 9 months to parturition.

If a treatment was scheduled, a predetermined proportion of the does was targeted. The proportion of does was constant for a given simulation trial and varied from 0.33-0.99 among trials. Treatments within a trial were administered in one of two ways. In the non-selective treatment, females were treated randomly with respect to age; this treatment regime is roughly comparable to treating does as they are encountered, assuming that equal encounter probabilities exist among age classes. In the selective treatment, age classes of does were ranked according to their reproductive values (Caswell 1989, Roughgarden 1979). Does with the highest reproductive value were treated first, followed by does with the next highest value, and so on until the desired number of does had been treated. Obviously, the selective treatment can only be used in situations in which deer are marked and ages are known, whereas the non-selective treatment can be used with marked or unmarked populations.

Contraceptives may not be 100 percent effective in preventing births, particularly when used in

Table 2. Initial age distributions used in simulations. Initial age distributions were chosen so that initial fawn: doe ratios were equivalent for herds with poor and excellent growth potential.

	Poor Growth Potential			Excellent Growth Potential		
Age Class	Type 1	Type 2	Type 3	Type 1	Type 2	Type 3
1	0.400	0.330	0.477	0.400	0.330	0.477
2	0.147	0.335	0.003	0.338	0.547	0.169
3	0.097	0.042	0.031	0.123	0.015	0.021
4	0.073	0.042	0.043	0.020	0.015	0.030
5	0.065	0.042	0.056	0.020	0.015	0.038
6	0.058	0.042	0.068	0.020	0.015	0.046
7	0.051	0.042	0.080	0.020	0.015	0.055
8	0.044	0.042	0.080	0.020	0.015	0.055
9	0.036	0.042	0.080	0.020	0.015	0.055
10	0.029	0.041	0.082	0.019	0.018	0.054

field situations. Efficacy varies among contraceptives, and remote delivery of contraceptives with projectiles may lead to errors in classification (i.e., listing a doe as treated when the contraceptive was not delivered because of a poor shot or equipment failure). Hence, we varied efficacy among our simulation trials, using values of 0.50, 0.75, and 0.99. A value of 0.99, for example, indicates that 99% of treated does failed to reproduce. We also varied contraceptive longevity. Currently, some synthetic steroid contraceptives are capable of preventing pregnancy for at least 2 years, but immunocontraceptives last a single year. Thus, we conducted simulations using longevity values of 1 and 2 years. Because technological advances could lengthen the effective life span of future contraceptives, we also ran simulations with longevity values of 4 and 10 years.

After treatment with contraceptives, the prerut population was projected forward to spring. Untreated does (and those treated does in which contraceptives were ineffective) reproduced according to the fertility rates appropriate for the herd under consideration (Table 1). The preceding algorithm was used until the population had been projected for 20 years, at which time a new trial was begun with different values for initial conditions and/or contraceptive treatment.

In all simulations, the "desired" population size, N_d, was arbitrarily set equal to 200. Values of 100, 200, and 400 were used for N_0. Upon completing the simulations, a subset of the trials was used in constructing regression equations. We used the following logic in determining which trials to use: If a herd began the simulation at 400, no increase in abundance was deemed tolerable, because the population already greatly exceeded the desired level. Hence, trials resulting in population growth were deleted. However, we reasoned that a treatment scheme for herds beginning at 100 or 200 would be satisfactory if populations at time t, N_t, did not exceed $1.1N_d$. In other words, a population 10% above the desired level was tolerated. Finally, no population $<0.5N_d$ was used in constructing regression equations, because the goal of our study was to determine characteristics of programs that could stabilize populations rather than drive them to extinction.

Multiple regression was used to develop predictive equations for population size, female age structure, and sex ratio at t = 2 and 5 years. Variables were selected using an algorithm implemented by Hintze (1992:367). We did not construct equations for longer time intervals because we intended these equations to serve only as general guidelines, and we presumed that managers would reevaluate management plans at intervals of ≤ 5 years.

RESULTS

Population Size

We ran 15,552 trials for each type of herd. Significant relationships existed between most independent variables and abundance after t years (Table 3). As expected, the relative importance of N_0 declined from 2 to 5 years. Nonetheless, N_0 was the most important predictor of population size in all regressions. At both time intervals, population size was negatively correlated with the proportion of does treated, selective treatment of does with high reproductive values, efficacy and longevity of the contraceptive, and the proportion of bucks in the initial population (Table 3). Positive correlations with population size were evident for N_0 and the time interval between contraceptive treatments (Table 3). Specific examples follow to illustrate some of these relationships and their implications for contraceptive management.

Using a contraceptive with an efficacy of 99% applied at annual intervals in a nonselective manner, a poor herd can be reduced even when <33% of the does are treated (Figure 1A). In contrast, a herd in good condition can only be reduced under this treatment regime if nearly 90% of does are treated (Figure 1B).

Increasing the longevity of a contraceptive can markedly enhance the effectiveness of a contraceptive program, and this effect becomes more pronounced as herd condition improves (Figure 2A). For instance, increasing longevity from 1 to 2 years resulted in a population in excellent health that was roughly 50% smaller after 5 years (Figure 2B).

For herds in poor condition, population levels can be stabilized with treatments at intervals as great as 10 years (Figure 3A). For herds with excellent growth potential, though, annual treatments are necessary (Figure 3B).

Targeting does with high reproductive values reduces the time interval necessary to achieve a given level of population control (Figure 4). However, the benefit of selective treatments must be balanced against the increased costs associated with time spent marking does and finding and treating a particular subset of them.

Sex Ratio

The proportion of males in a population at 2 years was related positively to the initial sex ratio and

Table 3. Regression coefficients for equations to estimate deer abundance after 2 or 5 years for herds with poor or excellent growth potential[a]. Only variables with P< 0001 are listed. Explanatory variables are discussed in the text.

	Poor[b]		Excellent	
Variable	2 years	5 years	2 years	5 years
Selective treatment[c]	-0.0235	-0.0393	-0.0220	-0.0357
Proportion treated	-0.1964	0.2740	-0.4021	-0.9684
Contraceptive efficacy	-0.2120	-0.3058	-0.4535	-1.3722
Contraceptive longevity	-0.0828	-0.1432	-0.0067	-0.0122
Application interval	0.0447	0.2092	0.0046	0.0324
Initial proportion bucks	-0.3847	-0.6330	-0.4021	-0.5474
N_0	0.9371	0.9219	0.7155	0.5345
Intercept	0.3625	0.4413	1.2140	2.7186
Dependent variable:	$\log_{10}(N)$	$\log_{10}(N)$	N	N
Number of trials	9628	7256	5309	1699
R^2	0.890	0.857	0.874	0.789

[a]An interactive FORTRAN program is available from the authors for calculating predicted levels of abundance as a function of proportion of does treated, after specifying the other independent variables.
[b]Values of N_0 application interval, and contraceptive longevity were subjected to $\log_{10}$ transformation before regressions were done.
[c]Nonselective (uniform) treatment = 1, selective = 2.

negatively to the proportion of does treated, contraceptive efficacy, and contraceptive longevity (Table 4). At 5 years the preceding variables were significant predictors, as well as application interval and selectivity of treatments (Table 4). For a herd with excellent growth potential, N_0 had a slight effect on sex ratio and entered the regression as a nuisance variable resulting from correlations introduced by our process of trimming data prior to regressions. For any given treatment combination, sex ratios ceased to be affected by the initial sex ratio after 10 years (Figure 5).

Age Structure of Females

As expected, treatment with contraceptives was related negatively to the proportion of doe fawns and positively to the proportion of adult does in the population (Table 5). For example, treatment of 99% of the does on an annual basis with a contraceptive that was 99% effective would more than double the proportion of does in the population after 20 years relative to an untreated population with the same growth potential (Figure 6).

DISCUSSION

Importance of Initial Conditions

Considerable attention has been focused recently on improving the technology associated with contraception. Although the importance of technological advances should not be undervalued, our results indicate that initial conditions also are quite important, at least over the short time frames that we have examined (Table 3). We chose 2- and 5-year periods because we felt they would be more useful to individuals using an adaptive management strategy whereby plans are reevaluated on a regular basis. Also, various sectors of the public expect resolution of wildlife problems within a short period of time.

In particular, N_0 explained the majority of the variation in N_t for all regressions (Table 3). Thus, the success or feasibility of a contraceptive program is determined largely by N_0. For example, imagine a herd with excellent potential for future growth that consists of 30% males. Given current technology, we

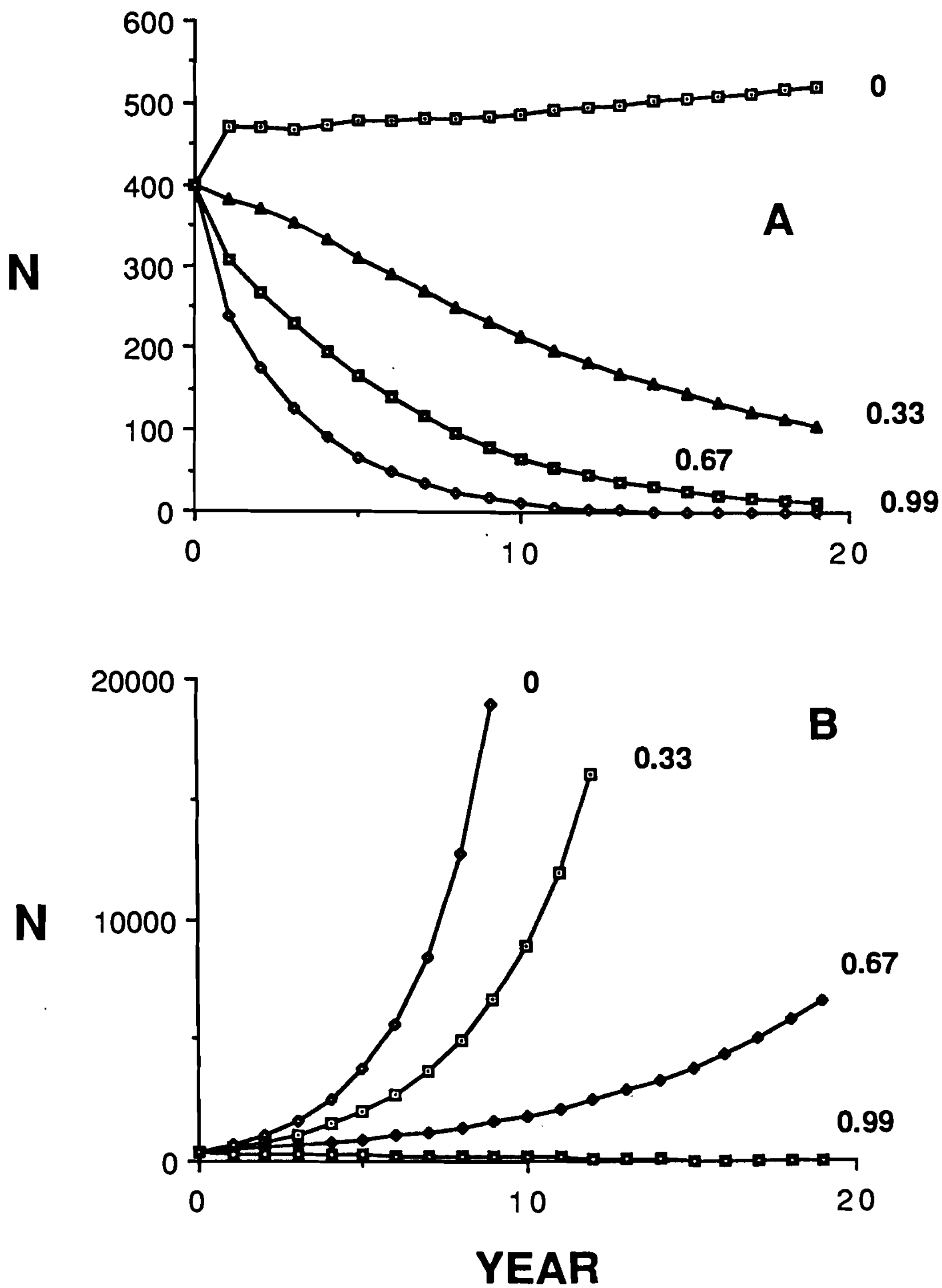


Figure 1. Effect of varying the percentage of does treated on population trajectories for herds with poor (A, λs = 1.0005) and excellent (B, λs = 1.4913) growth potentials subjected to annual, nonselective treatment with a contraceptive that is 99% effective and lasts for 1 breeding season.

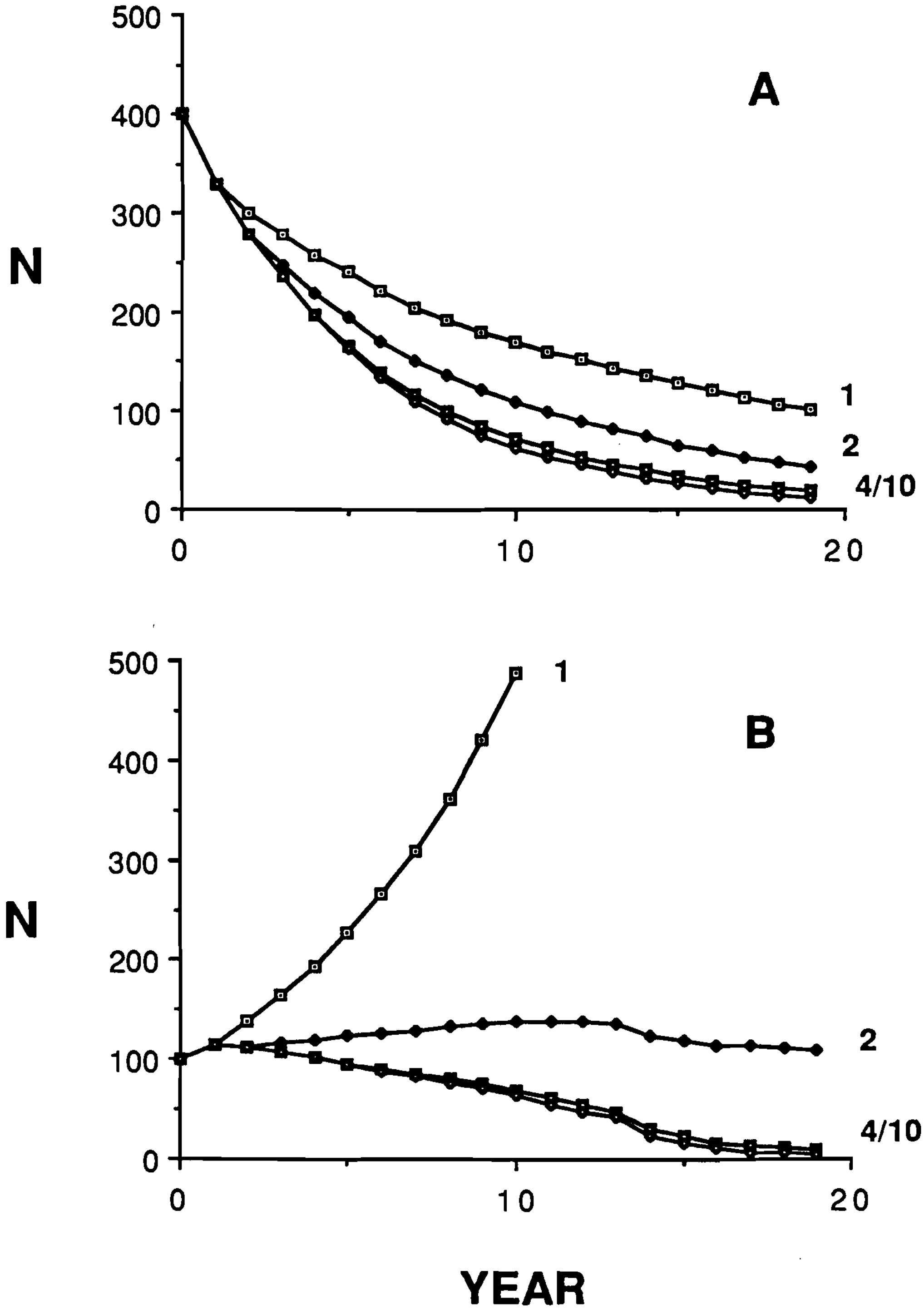


Figure 2. Effect of contraceptive longevity on population trajectories for herds with poor (A) and excellent (B) growth potentials subjected to annual, nonselective treatment with a contraceptive that is 75% (A) or 99% (B) effective. For the excellent herd, 67% of does were treated, for the poor herd.

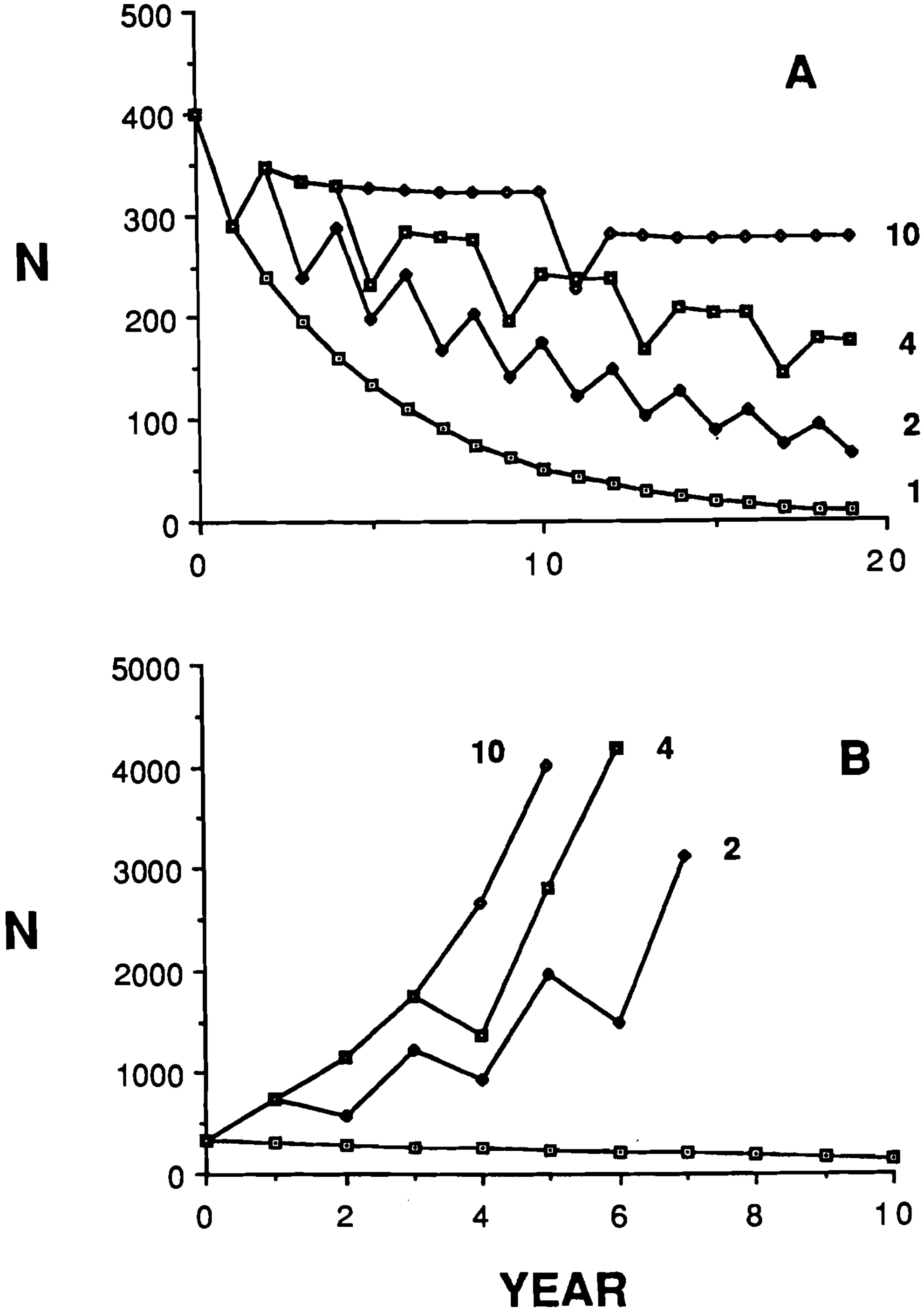


Figure 3. Effect of application interval on population trajectories for herds with poor (A) and excellent (B) growth potentials subjected to nonselective treatment with a contraceptive that is 99% effective and lasts for 1 breeding season. For the excellent herd, 99% of does were treated, whereas 67% were treated for the poor herd.

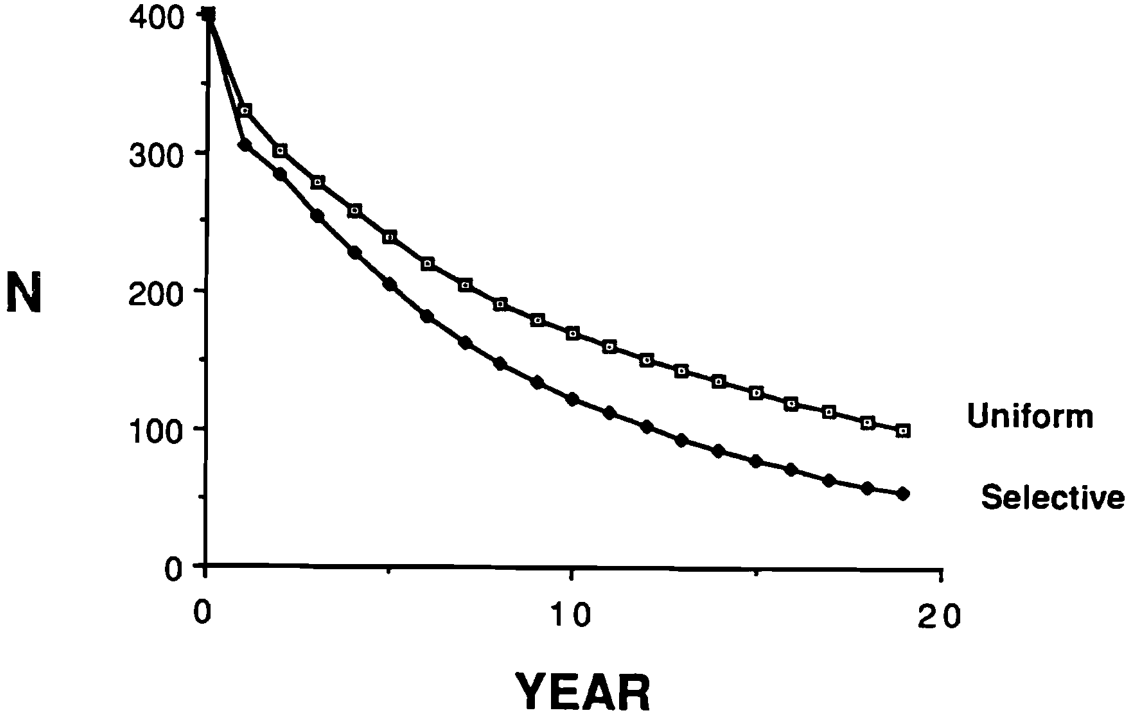


Figure 4. Effect of selectively treating does according to age-specific reproductive values on population trajectories for a herd with poor growth potential in which 33% of the does are treated annually with a contraceptive that is 75% effective for one breeding season.

Table 4. Regression coefficients for equations to estimate proportion of bucks after 2 or 5 years for herds with poor or excellent growth potential. Only coefficients for variables with P < 0001 are listed. Explanatory variables are discussed in the text.

	Poor[a]		Excellent	
Variable	2 years	5 years	2 years	5 years
Selective treatment[b]	-	-	-	0.0057
Proportion treated	-0.0342	-0.0392	-0.0178	-0.0807
Contraceptive efficacy	-0.0362	-0.0429	-0.0204	-0.1191
Contraceptive longevity	-0.0122	-0.0169	-	-0.0008
Application interval	-	0.0346	-	0.0033
Initial proportion bucks	0.5211	0.1693	0.5862	0.5528
N_0	-	-	-0.0090	-0.0142
Intercept	0.2582	0.3869	0.2063	0.3041
Number of trials	9628	7256	5309	1699
R^2	0.911	0.810	0.884	0.860

[a]Values for contraceptive longevity and application interval were subjected to $\log_{10}$ transformation before regressions were done.
[b]Nonselective (uniform) treatment = 1, selective = 2.

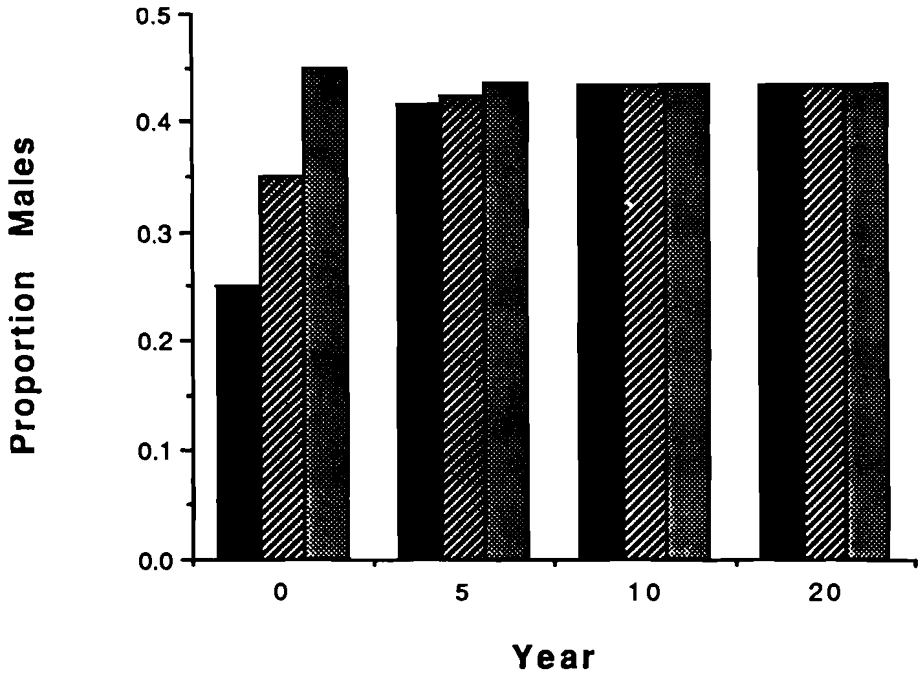


Figure 5. Changes in sex ratio over time for populations subjected to an identical management program but differing in initial sex ratio. For each of the three trials, 33% of does were nonselectively treated each year with a contraceptive that was 95% effective for one breeding season.

Table 5. Regression coefficients for equatins to estimate proportion of doe fawns and adult (3-15 year old) does after 5 years for herds with poor or excellent growth potential. Only coefficients for variables with P $\leq$ 0001 are listed. Explanatory variables are discussed in the text.

	Poor		Excellent	
Variable	Fawns	Adults	Fawns	Adults
Selective treatments[a]	-0.0226	0.2415	-0.0098	0.0299
Proportion treated	-0.1771	0.2254	-0.2688	0.4198
Contraceptive efficacy	-0.2645	0.3421	-0.3592	0.5343
Contraceptive longevity	-0.0059	0.0114	-0.0071	0.0062
Application interval	0.0188	-0.0215	0.0060	-0.0048
Initial proportion bucks	-	-	0.0343	-0.0451
N_0	-	-	-0.0474	0.0479
Intercept	0.5388	0.2250	0.7981	-0.1814
Number of trials	9628	7256	5309	1699
R^2	0.733	0.745	0.643	0.754

[a]Nonselective (uniform) treatment = 1, selective = 2.

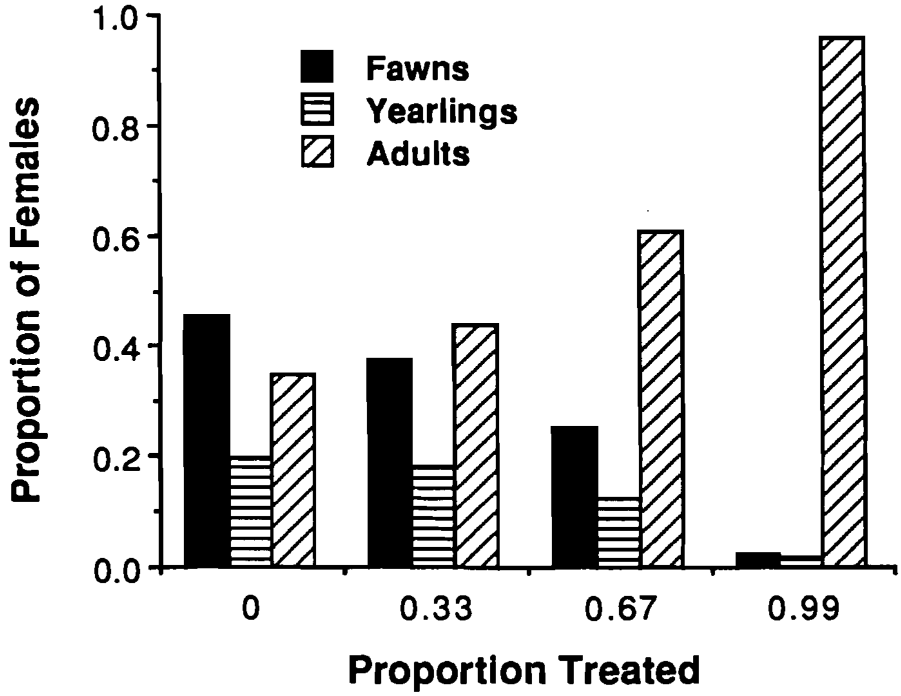


Figure 6. Effect, after 20 years, of changing the percentage of does treated on age structure for a population with a excellent growth potential (λs = 1.49) in which does were treated nonselectively each year with a contraceptive that was 99% effective for one breeding season.

could treat the herd with a contraceptive that would last 1 breeding season and prevent 90% of treated does from reproducing the following spring. Further, suppose we chose to treat a certain percentage of the does annually in a nonselective manner. If N_0 is 75% of our desired (or tolerable) population size (N_d), then "only" about 73% of the does in the herd would have to be treated each year to prevent the population from exceeding N_d after 5 years. If $N_0 = N_d$, the percentage in need of treatment on an annual basis rises to 86%. And if $N_0 = 1.5N_d$, about 90% of the does would have to be treated each year for 15 years to reach N_d. Although the likelihood of encountering a herd in excellent condition at levels as high as $1.5N_d$ is remote in the absence of an extensive supplemental feeding program, the example nonetheless points out the importance of implementing contraceptive programs in a proactive fashion, before populations have reached or exceeded levels deemed tolerable. Alternatively, removal of a portion of the herd could be conducted before the contraceptive program is initiated. In many situations, an initial culling of the herd will be the only feasible option.

Influence of Growth Potential

The potential for population growth, λs, noticeably influenced population trajectories under comparable management regimes. Suppose the values given in the example above for contraceptive longevity, efficacy, application interval, and initial sex ratio were used with both poor and excellent populations, with $N_0 = N_d$. For the poor herd, <5% of the does would require annual treatment to maintain a population at its initial size after 5 years. As we saw earlier, the analogous value for a herd in excellent condition is 86%. Given such large discrepancies, a refinement of the model to incorporate intermediate values of λs is needed. In a future version, it should be possible to incorporate λs as a predictor variable in regression models. Because few biologists are blessed with the wealth of information required to calculate λs, it may be more practical to qualitatively assign populations into "growth groups" (e.g., poor, fair, average, good, excellent) for planning purposes.

Tradeoffs in Contraceptive Management

Current technology will define the values for variables such as contraceptive longevity and efficacy, and historical or external conditions will dictate values of N_0 and initial sex ratio. Within these constraints, selectivity of treatments, proportion of does treated, and application interval can be manipulated. For example, suppose a poor herd of $N_0 = N_d$ deer with 50% bucks was treated nonselectively using the values for contraceptive longevity and efficacy of 1 year and 90%, respectively. Annual treatment of 31% of the does in the herd would result in attainment of N_d after 5 years, according to our regression equations (Table 3).

Attaining Nd after 5 years by treating every other year would require administering contraceptives to about 55% of the does during the treatment years. And attainment of N_d using treatment every fifth year would necessitate treating 85% of the does.

Information on age-specific and/or size-specific reproductive value can be useful in formulating management plans that make more efficient use of each treatment (Robel 1994). To illustrate, we compared the proportion of does treated annually in a poor herd with the following characteristics: $N_0 = 2N_d$, contraceptive efficacy = 80%, longevity = 1 year, application interval = 1 year, initial sex ratio = 1:1. With a nonselective treatment, the predicted percentage of does in need of treatment on an annual basis is 43% to attain N_d after 5 years. Using a selective treatment regime in which does with highest reproductive values are targeted first, only 29% must be treated to achieve the same result. Selective treatments are less effective for populations exhibiting excellent growth potential (Table 5). Managers seldom have information on reproductive values for each age class. As an approximation, though, reproductive values are highest for prime-age does (3-10 years), followed by yearlings, old does, and fawns (cf. Table 1).

In the preceding discussion we have not considered differences in cost associated with various contraceptive management strategies. Costs will vary primarily in relation to differences in person-hours expended, which in turn should relate fairly closely to the number of does treated. We currently are conducting research on contraceptives with two herds occupying areas of 0.7 and 4 mi^2. We have expended roughly 2-6 person-hours per deer in capture and an additional 1-3 hours in treatment of each deer. Our experience indicates that costs increase as the proportion of captured or treated deer increases (see also Witham and Jones 1992). Because cost is an important consideration, and because the influence of treatment intensity, application interval, and treatment selectivity on cost has not been determined, future work should focus on costs associated with various contraceptive management plans.

Variation in Sex Ratio

Results of our simulations generally made intuitive sense. However, some findings were not entirely obvious. For instance, sex ratios became increasingly skewed toward females as the proportion of does treated increased (Figure 7). This relationship derives from the effect of increasingly intensive

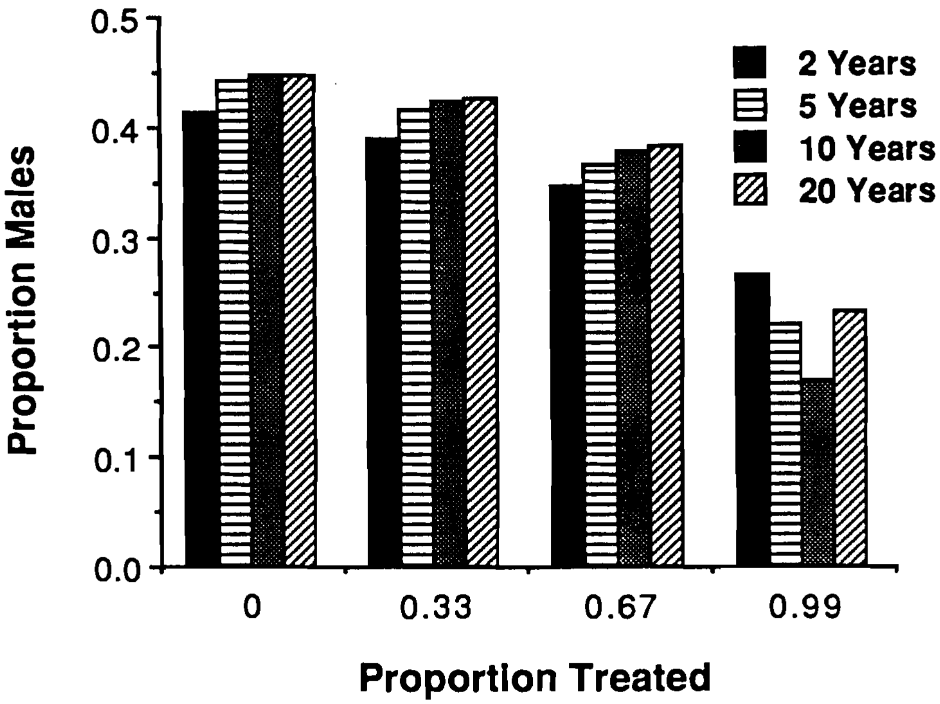


Figure 7. Effect of changing the percentage of does treated on sex ratio for a population with a excellent growth potential (λs = 1.49) in which does were treated nonselectively each year with a contraceptive that was 99% effective for one breeding season.

treatment on female age structure. As an increasing proportion of does are treated and reproduction declines, the distribution of does becomes skewed toward older age classes (Figure 6). Thus, the vast majority of untreated does exhibited high fertility rates and produced relatively more female offspring (Verme 1983). This phenomenon in essence creates a situation in which managers using contraception are "swimming upstream", inasmuch as increasingly intensive treatmentregimes create conditions favoring disproportionate production of females.

CONCLUSIONS AND IMPLICATIONS

Contraception has the potential to become a useful tool for deer biologists in urban and suburban settings. However, limitations associated with contraception should be understood. Contraception is not an efficient means of reducing population size in long-lived vertebrates such as deer, and this is especially true for herds in good health. Moreover, the ability of contraceptives to stabilize numbers varies enormously with the condition of the herd. Although contraceptives could be used effectively to stabilize or reduce population levels of a herd in poor condition, our results indicate that current technology applied to a herd in excellent condition would require treatment of >80% of does on an annual basis simply to stabilize population size. Treatment of such a large proportion of the female population would be logistically difficult and expensive for large populations. Thus, proactive implementation of contraceptive management, which by definition would typically involve a healthy herd, may be feasible only for relatively small (N < 500) and accessible populations.

As population size changes, schedules of birth and death may change also. Our Leslie-type model does not incorporate density-dependent effects. However, we have provided a broad characterization of variation in fertility and survival schedules by modeling populations with quite different growth potentials. Populations must be viewed as dynamic assemblages; an overpopulated herd that exhibits poor growth potential in year t could exhibit improved growth potential 2 to 5 years later due to implementation of a contraceptive (or other) control program that reduces N and hence intraspecific competition. Until more refined predictions are available, we suggest reconstructing management plans periodically to account for changes in herd condition and population size. The predictive equations we have constructed bracket the potential options available for use with deer. For herds of intermediate growth potential, a rough guideline may be obtained by interpolation of values taken from the equations for herds in poor and excellent condition.

ACKNOWLEDGMENTS

We thank Mark Ellingwood and Bob Warren for helpful reviews of the manuscript. Support for this project was provided by Northern Indiana Public Service Company and Sporting Goods Properties. This is Purdue University Agricultural Experiment Station Technical Contribution Number 14533.

LITERATURE CITED

Bickle, C. A., J. F. Kirkpatrick, and J. W. Turner, Jr. 1991. Contraception in striped skunks with Norplant® implants. Wildl. Soc. Bull. 19:334-338.

Bomford, M. 1990. A role for fertility control in wildlife management? Bur. Rural Resour. Bull. No. 7, Dep. of Primary Industries and Energy, Canberra, Australia.

Caswell, H. 1989. Matrix population models. Sinauer Assoc., Sunderland, MA.

Conover, M. R. 1995. What is the urban deer problem and where did it come from? Pages xx-yy *in* J.B. McAninch ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. pp.

Curtis, P. D., and R. J. Stout. 1995. Citizen task force strategies for suburban deer management: The Rochester experience. Pages xx-yy *in* J.B. McAninch ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. pp.

Decker, D. J., and M. E. Richmond. 1995. Managing people in an urban deer environment: The human dimensions challenges for managers. Pages xx-yy *in* J. McAninch ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. pp.

Eagle, T. C., E. D. Plotka, R. A. Garrott, D. B. Siniff, and J. R. Tester. 1992. Efficacy of chemical contraception in feral mares. Wildl. Soc. Bull. 20:211-215.

Garrott, R. A. 1991. Feral horse fertility control: Potential and limitations. Wildl. Soc. Bull. 19:52-58.

___, D. B. Sniff, J. R. Tester, T. C. Eagle, and E. D. Plotka. 1992. A comparison of contraceptive technologies for feral horse management. Wildl. Soc. Bull. 20:318-326.

Henderson, C. J., P. Braude, and R. J. Aitken. 1987. Polyclonal antibodies to a 32-KDA deglycosylated polypeptide from porcine zonae pellucidae will prevent human gamete interaction *in vitro*. Gamete Res. 18:251-265.

Hintze, J. L. 1992. Number cruncher statistical system. Product 5.3 - Advanced statistics. Kaysville, Utah.

Kellert, S. R. 1988. Public views of deer management. *In* J. Grandy and S. Lieberman, eds. Deer management in an urbanizing region: Problems and alternatives to traditional management. Humane Soc. of the U.S.

Plotka, E. D., and U. S. Seal. 1989. Fertility control in female white-tailed deer. J. Wildl. Dis. 25:643-646.

Robel, R. J. 1994. Selective harvest management of red deer in Scotland. Fifty-fifth Midwest Fish and Wildl. Conf. Abstract 109.

Roughgarden, J. 1979. Theory of population genetics and evolutionary ecology: An introduction. MacMillan Publ. Co., Inc., New York.

Stradtmann, M. L., J. McAninch, J. M. Parker, and E. Wiggers. 1994. Use of police sharpshooters to remove urban deer. Pages xx-yy *in* J.B. McAninch ed., Urban deer - A manageable resource? Proc. 1993 Symp. North Central Section, The Wildlife Society. pp.

Turner, J. W., Jr., and J. F. Kirkpatrick. 1991. New developments in feral horse contraception and their potential application to wildlife. Wildl. Soc. Bull. 19:350-359.

___, I. K. M. Lui, and J. F. Kirkpatrick. 1992. Remotely delivered immunocontraception in captive white-tailed deer. J. Wildl. Manage. 56:154-157.

Verme, L. J. 1983. Sex ratio variation in *Odocoileus*: A critical review. J. Wildl. Manage. 47:573-582.

Witham, J. H., and J. M. Jones. 1992. Biology, ecology, and management of deer in the Chicago Metropolitan area. Illinois Nat. Hist. Surv. Final Rep., Proj. No. W-87-R. 108pp.

MANAGEMENT OF URBAN DEER POPULATIONS WITH CONTRACEPTIVES: PRACTICALITY AND AGENCY CONCERNS

ROBERT J. WARREN and LISA M. WHITE, Daniel B. Warnell School of Forest Resources, University of Georgia, Athens, GA
WILLIAM R. LANCE, Wildlife Laboratories, Inc., 1401 Duff Drive, Suite 600, Fort Collins, CO

The need to control populations of white-tailed deer (*Odocoileus virginianus*) in urban environments is increasingly common in wildlife management today. Public opposition, municipal ordinances, or concerns for human safety often prohibit the use of lethal methods of deer population control (e.g., hunting or controlled shooting) in many urban and suburban areas. Therefore, interest in the potential use of contraception as a non-lethal method of controlling deer in these areas has increased dramatically in the past 10 years (Warren 1995).

Our paper will briefly review the biotechnology of contraception, methods of delivery of this technology, the published literature on contraceptive research in white-tailed deer, and the potential for practical application of contraceptives to deer populations in urban or other restricted environments. We also will discuss practical, legal, regulatory, and public interest issues associated with the proposed use of contraceptives in controlling urban deer populations.

METHODS OF CONTRACEPTION

There are three basic methods of contraception that have possible application to urban deer management - surgical sterilization, synthetic steroid hormone supplementation, and immunocontraceptive vaccines. Our paper will primarily consider application of contraceptives to females. The polygamous breeding behavior of deer makes any male-targeted contraceptives ineffective at the population level. In other words, only a few untreated, fertile bucks in an urban deer population would be capable of breeding most of the does in that population.

Surgical sterilization is obviously a permanent method of contraception. It requires capture of individual deer and application of field surgery. Both of these requirements increase the cost of this technique of contraception and create concerns for animal safety. Therefore, we will focus our discussion on synthetic steroids and immunocontraception as possible methods for use in urban deer population management.

Exogenous synthetic steroid hormones result in contraception by altering the animal's reproductive hormone balance. The hormones (e.g., synthetic progesterone and/or estrogen) are either ingested or implanted subcutaneously and produce sufficient circulating levels of these hormones to block or inhibit the hormonal stimulation from the brain necessary for normal ovarian activity, ovulation, and pregnancy.

The basic principle of immunocontraception is to inject an animal with a vaccine to stimulate its immune system to produce antibodies against a protein involved in reproduction. The antibodies produced interfere with function of the protein in the reproductive process, thereby resulting in contraception. Vaccines used in this manner are proteinaceous reproductive hormones, or the proteins surrounding the sperm or ovum, or proteins involved in implantation.

METHODS OF APPLICATION

Several technologies currently are available for applying contraceptives to deer. Oral delivery methods, whereby a contraceptive steroid is contained within a bait, generally have been ineffective (see section on synthetic steroids below). Oral delivery methods are being evaluated that may be capable of delivering contraceptive vaccines via a modified live virus or bacterium (see section on immunocontraception below).

Subcutaneous implants potentially can be an effective contraceptive delivery technique in deer. These implants usually are made of a physiologically inert material, which releases the contraceptive steroid for several years. The major disadvantage of subcutaneous implants is that they require time-consuming and costly capture of individual deer for implantation.

Obviously, delivery technologies that could be administered remotely would be more practical for routine application in urban deer management. Most immunocontraceptive vaccines can be delivered remotely by using commercially available, syringe darts. Remotely delivered darts have several disadvantages, however. The accuracy depends on the quality of the equipment and the experience and skill of the user. Missed darts may not be recovered and could remain in the environment as a potential human exposure hazard (especially for curious children).

Additionally, improperly used darts can produce tissue trauma in deer.

Recent research has evaluated the use of remotely deliverable, intramuscular implants (i.e., "biobullets") containing contraceptives. BallistiVet Inc. (Minneapolis, Minn.) produces an implant "gun" that is capable of remotely injecting a 0.25-caliber, biodegradable "biobullet" at ranges of up to 20 or 30 m. The biobullet is made from compressed food-grade material (hydroxypropyl cellulose) and contains a hollow chamber into which a freeze-dried compound can be placed. The biobullet degrades within a few hours after implantation and releases the freeze-dried compound. The biobullet technique has been used successfully to vaccinate free-ranging bison (*Bison bison*) against brucellosis in Montana (Davis et al. 1991) and to remotely deliver an immunocontraceptive vaccine to free-ranging feral horses (*Equus caballus*) on Cumberland Island, Georgia (Goodloe 1991). The biobullet also has been used successfully to remotely deliver contraceptive vaccines to deer in large enclosures at the University of Georgia (L. M. White, unpubl. data) and at Purdue University (R. K. Swihart, pers. commun.). It also has been used to remotely treat deer with an intramuscular implant containing a contraceptive steroid (see section on synthetic steroids below).

SYNTHETIC STEROIDS IN DEER

Daily, oral administration of synthetic steroid hormones can inhibit ovulation in female deer. Roughton (1979) demonstrated that daily administration of oral melengestrol acetate (MGA; a synthetic progesterone) effectively inhibited ovulation in captive white-tailed deer. However, orally administered synthetic steroids are not practical for urban deer management because it is impossible to guarantee daily treatment necessary to maintain infertility. Harder and Peterle (1974) also showed oral treatment with diethylstilbestrol (DES; a synthetic estrogen) was not a practical method of contraception in deer. Microencapsulation of DES can allow treatment intervals to be extended up to 30 days, but the high doses of microencapsulated DES required to be effective are not readily accepted by deer (Matschke 1977a).

Subcutaneous hormone implants have had only limited success in preventing pregnancy in female deer. These contraceptives require trapping and handling of individual deer, which are very costly. Bell and Peterle (1975) reduced reproductive rates of deer by using silastic-silicone rubber tubing implants containing MGA and DES. Matschke (1977b, 1980) examined fertility control in deer with silastic implants of DES and a synthetic progesterone (DRC-6246). These implants have limited application in the field because of the short time span of effective hormone release. Calculated release times for DES were 1-2 years versus 3 years for DRC-6246 (Matschke 1977b); however, in a field trial, suppressed reproduction only lasted for 2 years (Matschke 1980).

Plotka and Seal (1989) showed that MGA implants induced infertility for 2 years in nonpregnant, captive deer. However, when applied to five pregnant does during winter, pregnancy was not interrupted. They removed the implants in late pregnancy, but nonetheless one of the treated does died. Plotka and Seal (1989) recommended that pregnant deer not be treated with MGA implants unless pregnancy is first terminated. It is unfortunate that contraceptive steroid implants cannot be used in winter, because at this season of the year deer generally are easiest to bait and capture for treatment, which would improve the practicality of applying this technique.

The main limitation of using steroid implants for contraception in deer is the relatively short time of efficacy. Efficient and practical management of deer populations in the absence of regulated hunting or trap-and-removal programs requires a contraceptive capable of lasting the reproductive life of the doe (Matschke 1980). Levonorgestrel (LNG) is a synthetic progesterone that provides effective, long-term (>5 years) contraception when implanted in humans (Diaz et al. 1982). Contraception of deer for >5 years from one contraceptive treatment might justify the time and cost associated with capturing and treating individual deer, and hence has potential for providing a practical technique for contraceptive management of urban deer populations.

Despite the potential for LNG, two studies with LNG implants in captive white-tailed deer have proven them to be ineffective. In the first study, Plotka and Seal (1989) implanted five does with a single, solid silastic-silicone rod containing 200 mg LNG; three of the five does became pregnant. Plotka and Seal (1989) did not measure LNG concentrations, so the lack of contraception may have been related to the shape and matrix of the silastic implant, all of which can affect steroid hormone release (Robertson et al. 1983).

In the second study with LNG implants in deer, White et al. (1994) used the technique as it is applied in humans, which consists of 216 mg of LNG sealed inside six small silastic-silicone tubes. White et al. (1994) compared six versus nine LNG implants (containing a total of 216 versus 324 mg of LNG) in adult versus fawn does. Fawns were included to determine the effects of LNG implantation on puberty attainment. Despite significant release of LNG from both doses of implants, White et al. (1994) observed that three of five implanted adults and one of two fawns that survived 2 years post-implantation became pregnant. These researchers did not recommend the use of LNG in deer.

Researchers at Purdue University and the University of California have successfully applied remotely delivered norgestomet (NGM) as a contraceptive in white-tailed deer (R. K. Swihart, pers. commun.) and black-tailed deer (*Odocoileus hemionus*) (Jessup et al. 1993). This synthetic progesterone was developed and is marketed for synchronizing estrus in domestic livestock. Antech Laboratories, Inc. (Champaign, Illinois) has complexed 42 mg of NGM into silastic-silicone rods and loaded it into biobullets for remote delivery purposes (D. J. Kesler, pers. commun.). In both species of deer, NGM was nearly 100% successful in preventing pregnancies; however, it only was effective for 1 year (Jessup et al. 1993, D. J. Kesler, pers. commun.). Therefore, annual treatments would be required to maintain control over deer reproduction. More importantly, these annual treatments would need to be administered before the autumn breeding season (i.e., NGM would need to be administered before ovulation could occur). This requirement would limit the applicability of this contraceptive technique primarily to smaller sites within urban areas where substantial control over the deer herd exists. In these situations it might be possible to annually treat deer with NGM delivered via biobullets. Deer in urban areas usually are accustomed to vehicles. Therefore, it might be practical to remotely administer NGM biobullets to deer along roadways prior to the breeding season. However, applying a synthetic steroid in an urban environment where residues might enter the human food chain creates a significant concern for federal and state regulatory agencies (see section below on agency concerns).

IMMUNOCONTRACEPTION IN DEER

Immunocontraception is a new contraceptive technology that may be more applicable to urban deer populations. The results of research on this new technology for birth control have proven so successful and safe that contraceptive vaccine trials have been conducted on human females with favorable success (Jones et al. 1988).

Immunocontraceptives have advantages over synthetic steroids that may make them effective and efficient for use in urban deer management. Immunocontraceptives can be delivered remotely, which makes them more feasible for field application than methods that require capture of individual deer. Also, protein-based contraceptive vaccines likely would be deactivated if ingested orally by nontarget species, thus eliminating the problem of residues from synthetic steroids. Digestion of the contraceptive vaccine after oral ingestion would render the vaccine immunologically ineffective, and would minimize the risk to nontarget species or humans. The major disadvantage of immunocontraceptive vaccine technology today is repeated injections (i.e., booster vaccinations) are necessary to maintain effective antibody levels.

Generally, contraceptive vaccines are prepared by adding a protein (i.e., the antigen) to an adjuvant. The adjuvant increases the immunological reaction to the antigen. The most commonly used antigens in contraceptive vaccines are proteins involved in fertilization. One immunocontraceptive tested in captive deer is based on stimulating antibody response to the zona pellucida (ZP). The ZP consists of a series of proteins surrounding the ovum that is essential to sperm-egg binding during fertilization. The ZP immunocontraceptive stimulates the female to produce antibodies to ZP. Normal fertilization of the egg is prevented by blocking the sites of attachment for the sperm cells to the ovum. The ZP used in these contraceptive vaccines is commonly obtained from pig ovaries, thus it is termed porcine zona pellucida or PZP.

Turner et al. (1992) used syringe darts to vaccinate female white-tailed deer with PZP and Freund's complete adjuvant (a mixture of oil, water, and killed bacterial proteins). These researchers then administered a second and third injection (i.e., boosters) at 3 and 6 weeks, respectively, after the initial injection. Six months after the first injection, the does were bred by a fertile buck. None of the PZP-treated does (0 of 7 treated does) produced fawns in this study, compared to 86% (6 of 7 control does) of control does.

The results of the study by Turner et al. (1992) are encouraging, but the need for multiple booster injections limits the practicality of using PZP in urban deer populations. It will be difficult to consistently administer a second and third vaccination to individual does in a free-ranging urban deer population. Does that do not receive booster vaccinations would have ineffective antibody levels against ZP, and therefore would remain fertile. This problem of individual females not receiving booster vaccinations and remaining fertile was noted by Kirkpatrick et al. (1990) in their study of PZP vaccine and free-ranging feral horses on Assateague Island, Maryland. In this study, they observed foaling rates of 0% in 18 mares that received two boosters of PZP vaccine, compared to 12.4% in eight mares that received only one booster.

The need for booster vaccinations may not be a limitation in the future. Recent research with PZP has included microencapsulation of the booster vaccinations so that only one vaccination per year is required. The vaccines are microencapsulated for release over a period of weeks or months after injection (J. F. Kirkpatrick, pers. commun.). If perfected, this research will enable the booster vaccinations to be administered in the same injection (i.e., in the same syringe dart) with the initial vaccination.

In addition to ZP proteins, one other possible source of antigens for use in contraceptive vaccines are proteins of the sperm cell membranes. Several different sperm proteins have been considered for use in anti-sperm contraceptive vaccines (Naz and Menge 1990). The potential use of anti-sperm vaccines in deer populations would involve treatment of the female, not the male. In other words, females would become immune to sperm cells. Infertility in treated females then could result because anti-sperm antibodies can bind sperm cells (reviewed in Shulman 1986), or reduce the movement of sperm through the reproductive tract (Clarke 1988), or alter sperm binding to the ZP (Naz et al. 1992).

Very little research exists on the use of anti-sperm vaccines in deer. White et al. (1993) presented preliminary data on an anti-sperm vaccine for deer. They developed anti-sperm vaccines using sperm from deer, bull, and boar testes. These vaccines were injected into adult does, from which blood samples were collected for antibody analysis. High anti-sperm antibody levels occurred in does injected with anti-sperm vaccines made from all species tested. However, antibody recognition of deer sperm was greatest in those does injected with either deer or boar sperm. The high antibody levels persisted for a period of at least 7 months post-immunization. The does treated in this preliminary trial became pregnant (L. M. White, unpubl. data).

A new area of research in immunocontraception is to develop a biologically vectored, oral delivery method. This technology is in early stages of development. The goal is to genetically modify a bacterium or virus so that it contains either the ZP or sperm proteins described previously. The microorganism then serves as a live vector to orally deliver an immunocontraceptive vaccine to a deer population. Similar technologies have been used recently to deliver orally effective rabies vaccines to wildlife populations (Wandeler et al. 1988).

A microorganism-vectored technology for the delivery of contraceptive vaccines would greatly reduce the cost and time required to apply immunocontraceptives to free-ranging deer populations. This technology would enable delivery of immunocontraceptives to a much greater number of individuals in a population than by other remote delivery technologies. However, serious concerns may exist regarding the potential risk of applying this technology. For example, nontarget species, including humans, might be at risk of being exposed to microorganism-vectored contraceptive vaccines. Controlling the spread of the bacterium or virus to other deer populations would be difficult if not impossible. Much more research is needed before this technology can even be considered for field testing.

PRACTICAL APPLICABILITY CONCERNS

Will eliminating reproduction in treated individuals control a deer population? Current research results indicate several contraceptive techniques are effective in individually treated deer. Limited research has been conducted to determine the effectiveness of contraceptive management at a population level. Applications of contraceptives to captive deer are not equatable to applications in free-ranging deer populations. Reduced reproduction rates by does treated with contraceptives may result in greater survival rates for fawns produced by untreated does that escape treatment with the contraceptive. Additionally, immigration of deer from areas surrounding a treated deer herd may negate density reductions in the treated herd. This problem could be rectified by erecting a deer-proof fence. Controlled research to evaluate the effectiveness of deer contraceptives at the population level is needed. Wildlife population numbers are dynamic and are the result of multiple factors, only one of which is reproduction.

The potential effect of contraception on deer behavior and population dynamics is another practical concern. The rutting period might be extended by treating does with contraceptives. Does that fail to conceive can continue estrous activity for up to 7 months (Knox et al. 1988). In response to an extended breeding season, bucks might continue territorial and reproductive behavior for a much longer period of time than normal. Rutting bucks significantly reduce their food intake, which leads to significant body weight losses (Warren et al. 1981). Thus, if an extension of the rutting period occurs, then bucks might experience significant over-winter mortality rates. An extended rut also might indirectly increase the potential for deer-vehicle collisions, because deer generally are more active and move greater distances during the breeding season (Kammermeyer and Marchinton 1977).

The inability to identify individual females in a free-ranging population for remote vaccination is another practical limitation to the field application of immunocontraceptives in urban deer management. The feral horses that Kirkpatrick et al. (1990) treated with PZP vaccine had unique color markings which enabled the researchers to identify individual mares for repeated vaccination. It is not possible to identify individual white-tailed deer does from a distance for remote delivery of a contraceptive vaccine. Thus, some does in a treated population might receive unnecessary boosters (i.e., more boosters than necessary to maintain effective antibody titers). If this were to occur, there would be not likely be a concern regarding vaccine overdose or toxicity. Rather, urban deer managers would be unnecessarily wasting time, effort, and vaccine. It might be possible to mark deer at the time of vaccination using remotely delivered paint balls to minimize double boosting individual does. This technique has been used successfully to remotely mark elk (*Cervus elaphus*) after vaccination via biobullet against brucellosis on the National Elk Refuge near Jackson Hole, Wyoming (E. T. Thorne, pers. commun.).

LEGAL, REGULATORY AND PUBLIC INTEREST ISSUES

Although the technology to enable effective contraceptive management of certain urban deer populations likely will be available someday, several questions regarding legal, regulatory, and public interest issues must be answered before this technology can be applied in routine urban deer management programs. Each issue can potentially block the future use of contraception.

There are basic legal questions that must be answered. The foundation of wildlife laws established in the original 13 American colonies was that wild animals were owned in common by the people of the states (Matthews 1986). The wildlife resource was managed in trust for the people of the state by the state wildlife agency. The state wildlife agency then, by virtue of license, granted limited rights to an individual to legally take game under certain conditions. The concept of state ownership of wildlife within the states boundaries, whether on private or public lands, was the foundation of North American wildlife law. Over the past 200 years, as international migratory bird treaties, endangered species laws, and other federal statutes have been enacted, the overriding regulatory authority regarding some species has been transferred from state to federal agencies. The questions of state control, public ownership, and the state's duty to protect the wildlife resource within a its borders constitutes a body of law that is in transition and open to political debate (Matthews 1986).

This question becomes pivotal when determining who has authority to capture urban deer for application of contraceptive techniques and under what conditions. State officials have management authority over white-tailed deer, even in urban environments. However, county and municipal ordinances may restrict the control options that state officials can consider. A related legal issue is whether a federal agency (e.g., USDA Animal Damage Control) has authority to apply this technique to deer in urban settings? Do state wildlife agencies need to establish separate policies or regulations for the application of wildlife contraceptives? To date, at least three state wildlife agencies (Indiana, Minnesota, and New Jersey) have developed or drafted policies regarding applications of wildlife contraceptives. Federal and state licensing procedures also may require that only certified wildlife biologists, veterinarians, or registered pesticide applicators may apply these vaccines for urban deer population control. If any agency intervenes to control a wildlife population through contraception, then a flurry of legal challenges by coalitions representing the wildlife resource utilization interests of that state are likely to follow.

A critical legal question deals with liability. Which agency or individuals would be legally liable if there were alleged secondary effects from the contraceptives to nontarget species, such as domestic animals or humans? Eventually, some entity must manufacture and distribute the contraceptive technology. If a public agency manufactures and distributes the final product for the field, then it may or may not have legal protection against product liability lawsuits. Private, nonprofit or profit entities will be forced to address the liability and risk associated with misapplication of wildlife contraceptive technology. The potential liability associated with a product that has potential to adversely affect reproductive performance in any species may be too great for a company to ever consider producing the product.

If all legal issues could be addressed and a manufacturer found that was willing and capable to produce the technology, then the next hurdles would be the federal regulatory barriers. All methodologies discussed in this paper except surgical sterilization fall under the regulatory authority of 21 CFR and the Food and Drug Administration Center for Veterinary Medicine (FDA/CVM). The sponsoring agency or company would have to provide FDA/CVM with well-controlled studies to demonstrate an optimum effective dose, the safety of that dose for the target species, and the effectiveness of that dose under actual conditions of field use. The manufacturing procedure for that product must be in full compliance with FDA's current Good Manufacturing Practices (cGMPs) along with validated analytical procedures to warrant the safety, purity, and strength of the final product. If the contraceptive technology requires oral delivery in broadcast baits applied to an area, then the regulatory concerns of the Environmental Protection Agency (EPA) also will have to be addressed. The use of oral delivery technology would greatly exacerbate the inherent liability issues that could arise from ingestion by nontarget species.

An important question regarding wildlife contraceptive technology is, "Who will pay the bill?" The actual contraceptives may be economical, but the personnel and operating expenses associated with delivering contraceptives to significant numbers of individuals in an urban deer herd likely will be costly. Certainly the hunting public would object to the use of state wildlife agency funds, which are derived largely from license sales and Pittman-Robertson revenues, for wildlife contraceptive programs. The general tax-paying public of a state may object to paying for a contraceptive program to be mainly applied to one county or a specific urban area within that state. The cost of the program on a county or municipal level may be too great for a municipality to bear. The question of "Who is going to pay the bill" has never been adequately addressed. In the economic environment of the 1990s and the future, federal funding is not guaranteed.

A diversity of public interest groups likely will support or oppose wildlife contraceptive programs. Humane and anti-hunting groups likely would support contraceptive applications, but may find themselves opposed by other groups that are against the application of any new biotechnology. Likewise, groups representing interests of the hunting public generally would oppose the use of such technology and may be joined in their position by organizations that consider such applications of the biotechnology to be "ecological barbarianism."

In conclusion, contraceptive techniques represent one possible management tool that may be useful in the control of urban deer populations in the future. However, many research, management, ecological, and biopolitical questions must be answered before contraceptive management programs can be implemented as a possible solution to the problem of too many deer in urban environments. The questions and concerns regarding the application of wildlife contraceptives we identified in this paper are only the major ones recognized <u>at this time</u>. In our opinion, if the technology were perfected and available today, another 10-20 years will be required before all legal, regulatory and public interest issues discussed in this paper will be settled to permit routine managerial application of contraceptives to free-ranging wildlife populations.

LITERATURE CITED

Bell, R. L., and T. J. Peterle. 1975. Hormone implants control reproduction in white-tailed deer. Wildl. Soc. Bull. 3:152-156.

Clarke, G. N. 1988. Lack of correlation between the immunobead test and the enzyme-linked immunosorbent assay for sperm antibody detection. Amer. J. Reprod. Immunol. 18:44-46.

Davis, D. S., J. W. Templeton, T. A. Ficht, J. D. Huber, R. D. Angus, and L. G. Adams. 1991. *Brucella abortus* in bison. II. Evaluation of Strain 19 vaccination of pregnant cows. J. Wildl. Dis. 27:258-264.

Diaz, S., M. Pavez, P. Miranda, D. N. Robertson, I. Sivin, and H. B. Croxatto. 1982. A five-year clinical trial of levonorgestrel silastic implants (NORPLANT™). Contraception 25:447-456.

Goodloe, R. B. 1991. Immunocontraception, genetic management, and demography of feral horses on four eastern U.S. barrier islands. Ph.D. Dissert., Univ. of Georgia, Athens. 150 pp.

Harder, J. D., and T. J. Peterle. 1974. Effect of diethylstilbestrol on reproductive performance of white-tailed deer. J. Wildl. Manage. 38:183-196.

Jessup, D. A., N. K. Jacobsen, and D. J. Kesler. 1993. Remotely delivered and reversible contraception of black-tailed deer by norgestomet ballistic implants. Proc. Annu. Conf. Wildl. Dis. Assoc. 42:39 (Abstract).

Jones, W. R., S. R. Judd, R. M. Y. Ing, J. Powell, J. Bradley, E. H., Denholm, U. W. Mueller, P. D. Griffin, and V. C. Stevens. 1988. Phase I clinical trial of a World Health Organization birth control vaccine. Lancet 8598:1295-1298.

Kammermeyer, K. E., and R. L. Marchinton. 1977. Seasonal change in circadian activity of radio-monitored deer. J. Wildl. Manage. 41:315-317.

Kirkpatrick, J. F., I. K. M. Liu, and J. W. Turner, Jr. 1990. Remotely-delivered immunocontraception in feral horses. Wildl. Soc. Bull. 18:326-330.

Knox, W. M., K. V. Miller, and R. L. Marchinton. 1988. Recurrent estrous cycles in white-tailed deer. J. Mammal. 69:384-386.

Matschke, G. H. 1977a. Microencapsulated diethylstilbestrol as an oral contraceptive in white-tailed deer. J. Wildl. Manage. 41:87-91.

___. 1977b. Fertility control in white-tailed deer by steroid implants. J. Wildl. Manage. 41:731-735.

___. 1980. Efficacy of steroid implants in preventing pregnancy in white-tailed deer. J. Wildl. Manage. 44:756-758.

Matthews, O. P. 1986. Who owns wildlife? Wildl. Soc. Bull. 14:459-465.

Naz, R. K., C. Brazil, and J. W. Overstreet. 1992. Effects of antibodies to sperm surface fertilization antigen-1 on human sperm-zona pellucida interaction. Fertil. Steril. 57:1304-1310.

___, and A. Menge. 1990. Development of antisperm contraceptive vaccine for humans: Why and how? Human Reprod. 5:511-518.

Plotka, E.D., and U.S. Seal. 1989. Fertility control in female white-tailed deer. J. Wildl. Dis. 25:643-646.

Robertson, D. N., I. Sivin, H. A. Nash, J. Braun, and J. Dinh. 1983. Release rates of levonorgestrel from silastic[R] capsules, homogenous rods and covered rods in humans. Contraception. 27:483-495.

Roughton, R. D. 1979. Effects of oral melengestrol acetate on reproduction in captive white-tailed deer. J. Wildl. Manage. 43:428-436.

Shulman, S. 1986. Sperm antigens and autoantigens: effects on fertility. Am. J. Reprod. Immunol. 10:82-89.

Turner, J. W., I. K. M. Liu, and J. F. Kirkpatrick. 1992. Remotely delivered immunocontraception in captive white-tailed deer. J. Wildl. Manage. 56:154-157.

Wandeler, A. I., S. Capt, A. Kappeler, and R. Hauser. 1988. Oral immunization of wildlife against rabies: concept and first field experiments. Rev. Infect. Dis. 10:S649-S653.

Warren, R. J. 1995. Should wildlife biologists be involved in wildlife contraception research and management? Wildl. Soc. Bull. 23:441-444.

___, R. L. Kirkpatrick, A. Oelschlaeger, P. F. Scanlon, and F. C. Gwazdauskas. 1981. Dietary and seasonal influences on nutritional indices of adult male white-tailed deer. J. Wildl. Manage. 45:926-936.

White, L. M., P. M. Smith, C. C. Miller, R. A. Fayrer-Hosken, and R. J. Warren. 1993. Development of an anti-sperm immunocontraceptive for white-tailed deer (*Odocoileus virginianus*). Theriogenology 39:339 (Abstract).

___, R. J. Warren, and R. A. Fayrer-Hosken. 1994. Levonorgestrel implants as a contraceptive in captive white-tailed deer. J. Wildl. Dis. 30:241-246.

AGENCY CHALLENGES IN MANAGING URBAN DEER

HERBERT E. DOIG, New York State Department of Environmental Conservation, Albany, NY

There is a common saying that "you can remove a man from the country but you cannot remove the country from the man". In a likely analogy, "you can remove a deer from the country but you cannot remove the country from the deer". If we can accept that comparison, we then must refer to "urban deer" as deer in an urban environment. Though this seems to be a play on words, the subtle difference in meaning can make a big difference in how agencies view their responsibilities for management of the deer resource.

Similarly, people with differing interests and values see deer in totally different ways. There are those among us that would describe deer as playful brown animals with big brown eyes and graceful form. Others view deer as steaks and chops on four legs that elude the most skillful of hunters and are nearly always scarce. Still others picture deer as stealthy marauders with boundless appetites and many friends and relatives that invade neighborhoods by night to steal the most prized of cultivated plants. And there are those who believe that deer are huge animals, made of granite, that launch their bodies into the paths of vehicles as they traverse our thoroughfares. Yet, most in this room would describe deer as one of the largest land mammals in most ecosystems that reproduce at relatively high rates and, if left unchecked, will overpopulate and degrade available food supplies.

Herein lies a problem for agencies charged with management of the deer resource, a problem based on social values rather than biological science, a problem that presents serious challenges to the creativity, integrity and social skills of the professional staff employed by those agencies. I say social skills because wildlife science has done a commendable job of researching the biology of deer, interpreting the knowledge gained and applying that knowledge to develop management systems that will work in the traditional sense of wildlife management. We have not been as successful, however, in addressing the people side of the equation.

Many of us have fought the battles with the sporting public, first to give protection to vulnerable stocks, then to convince the same constituents that we weren't that serious when we advocated no killing of does because "dead does don't breed". Many of us now find ourselves seeking new ways to increase annual harvests from populations that seem to have outgrown the ability of traditional hunting to control their numbers.

Recreational hunting has been the technique used to maintain deer numbers at levels compatible with food supplies and human uses of the land. And, recreational hunting has been the focus of deer management objectives by fish and game agencies. It is now becoming evident that if deer are to be managed to satisfy a more diverse public, the responsible agencies must rethink their program objectives and management strategies.

CHANGE

With the movement of the human population toward a more urban society, demands for improved quality of life have led municipal planners toward what was described in the 1960's as "design with nature". Residential developments have been required to preserve open space and local parks and wild places have been preserved and created among the more densely populated neighborhoods. Little consideration was given to the ecological implications of such development and the benefits to wildlife were displayed as one of the building blocks of the open space movement.

Wildlife biologists joined the movement visualizing enhanced wildlife habitats in close proximity to people as a laudable objective. Few of us had the foresight to anticipate that the adaptability of deer would foster their occupation of these natural and manmade niches. Nor did we predict the spread of Lyme disease and more recently rabies which have become associated with local deer populations. The realization of these occurrences has caused great concern among urban residents and a demand for action from governmental agencies.

CHALLENGES

The Constitution of the United States and declaration of the State Ownership Doctrine have placed ownership of wildlife with the people. Management of these resources is shared between the State and Federal Governments with the States asserting jurisdiction over resident wildlife. The State fish and wildlife agencies are, therefore, charged with management of the deer resource to the extent authorized by law. Traditional fish and wildlife laws are designed to provide for management of deer as game species and while provisions have been made to address wildlife nuisance, many agencies are limited in their ability to address complex urban deer problems by virtue of insufficient legal authority. The states must examine their legal mandates and authorities and where current language is limiting, seek legislative change. There will be resistance from some legislative bodies to grant the degree of flexibility needed by the agencies. Until this is done however, the agencies will find themselves with responsibility for deer management without the ability to carry it out.

Management flexibility is complicated in many states where authorities to restrict discharge of firearms are placed with local government. The rationale for such restricting ordinances must be based on safety considerations but many pressure groups use safety as a means to prevent hunting. Agencies often find themselves faced with deer problems in towns and villages that ban the discharge of firearms. These municipalities may have extensive areas of woodland and overgrown fields that are ideal deer habitat. Appropriate or not from a safety standpoint, the ability to solve deer problems are greatly limited by no-discharge ordinances and often the greatest task confronting agencies is convincing local politicians that safe use of firearms may be the only realistic method to control deer numbers.

The long range outlook for deer-human conflicts in urban settings is not encouraging. Urban sprawl and suburban development on the fixed land base will continue to exacerbate the human-deer interaction. The desire for improved quality of life will cause municipal planners to favor open space requirements in residential communities and deer will adapt to this "new" habitat. Fish and wildlife agencies must become involved with land use planning, conduct research and advocate plant communities and open space characteristics that are inhospitable to deer so that their occurrence will be discouraged and future problems may be avoided. This will be a new role for most biologists who are dedicated to improving habitats for wildlife rather than avoiding their presence.

As urban residents seek a rural connection, lands peripheral to suburban develops are being acquired and often lift idle. These new owners bring to the rural setting an urban philosophy that is reflected in their ownership goals. They desire privacy or are used to protecting their property by keeping people away, and one of the first acts of new owners is to post their land against public use. Many are absentee owners and are not available for people to contact to gain access for hunting purposes and most are not sympathetic to recreational hunting anyway. This results in an expanding base of private land that constitutes good habitat for deer but reduced opportunity for public hunting to control deer numbers. Deer numbers increase, thereby causing greater risk of deer-auto collision and a reservoir for animal expansion into surrounding residential areas. Agency managers are faced with becoming more creative as they develop strategies for gaining a measure of deer control on these lands.

Deer have proven to be very adaptable to human presence. They adjust their feeding habitats and find many varieties of ornamental shrubs much to their liking. There has been a resistance on the part of deer managers to place a high research priority on finding repellents or other methods for discouraging deer from destroying preferred ornamentals. With the emergence of urban deer problems, however, agencies must redirect their priorities and consider new research that will find satisfactory alternatives for homeowners. Developing new partnerships with private companies may facilitate this research direction.

Deer trap and transfer techniques have been refined with experience to the point that their application is commonplace. Use as a solution for removing nuisance deer in urban habitats however, doesn't hold much promise. Even through animals can be trapped, suitable habitats for deer are generally already inhabited, often at or above carrying capacity. Transferring deer nuisance from one location to another doesn't make good sense, and people living in areas where deer may be transferred are not always receptive to the new introductions. Agencies must consider trap and transfer as a tool, but only for application under limited circumstances.

In a significant departure from the norm, there is a growing interest in the use of reproductive inhibitors as an approach to controlling deer populations in urban areas. There is research currently underway as presentations at this symposium indicate. Many people are advocating use of reproductive inhibitors as the solution to increasing deer numbers, and in some states, legislators are advancing bills that would mandate their use. Such premature advocacy presents problems for agencies that must evaluate the full impact of these techniques before they are applied and be assured that problems such as loss of genetic diversity, reduced population vitality and residues of chemicals in the flesh of treated deer do not cause problems in the future.

In addition to considerations of issues that involve deer, fish and wildlife agencies must face the challenges that human behavior creates. Deer management is of interest to people who hold a broad spectrum of values relating to deer. In working with these people to find acceptable strategies for responding to an urban problem, agencies must seek a common ground upon which to build consensus. There are people who hold views that are uncompromising on both ends of the value spectrum - hunters that see recreational hunting as the only solution, and animal rights advocates that reject any option that will be lethal to deer. It takes skillful application of negotiation techniques to arrive at public consensus.

Bringing people together is also complicated by some politicians who grasp the urban deer conflict as an opportunity to gain visibility and promote, the often popular, government "bad guy" theme. These people have little interest in finding solutions to difficult problems but rather use the issue to gain personal recognition and often fan the fires of conflict. Agencies must work with local political subdivisions if solutions to deer problems are to be found, and the political motives of a few must be factored into the strategies that are selected.

Communicating with urban residents is often made more difficult by the lack of understanding of the land ethic among the people that are involved. Working with these people necessitates an educational process to bring everyone to a common level of understanding. Agencies must, therefore, consider public education among its strategies for finding solutions to deer problems.

The lack of understanding of basic ecological principles and the heightened concern of involved citizens often puts pressure on agencies to "do something" to satisfy immediate political and media attention. Such pressure is inevitable, especially when the conflict is fueled by an exposure of people to Lyme disease or, more recently, rabies. Agencies must temper their responses so that the final solution is based upon "doing something right" so that deer control objectives have reasonable assurance of being met.

The communication skills required of agency staffs must, by necessity, be flexible. A clear message that deer management in urban environments will take new directions rather than follow tried and true recreational hunting must be conveyed to traditional constituencies. Support from hunters is important to the success of these efforts. Biologists have generally good rapport with hunters as much of their interaction has been with these constituents through the years. A more difficult challenge is to develop effective communication with the new constituencies that are evolving. These people are not as well organized, often have diverse interests and understanding, and are less knowledgeable of the role that government plays in managing wildlife. Nonetheless, biologists are put in the position of working with these interests as they collaboratively seek acceptable strategies for problem solving.

The most difficult of challenges facing fish and wildlife agencies are internal to their organization. Administrator's in their efforts to balance the political, social and ecological facets of urban deer management must call upon staff for objective, science based recommendations tempered with social realities. The scientific training received by biologists has not always included strategies for working with people, and professional staffs may not be prepared technically to integrate the changing values placed upon the resource by people. Very competent biologists are finding that scientific training is not enough when developing management schemes for deer in urban environments. Some may not show a willingness to change and may take refuge behind the honorable shield of "science" to protect their communications vulnerabilities rather than change with the times. But, science for science sake is a luxury that most agencies cannot afford.

Most fish and wildlife agencies are finding that they are no longer held with the high esteem that has historically been associated with their work. As the image of government employees becomes tarnished by those who have failed the public trust, the credibility of agencies and their employees suffers. The regulatory role of many agencies has also turned public attitudes against them. Among new constituencies, the past fish and game focus of agencies has left them with a plaid shirt image seemingly responsive only to license buyers, and the exclusive sustained yield management thrust of programs suggests that the broader interest in wildlife, though shared by the agencies, exists in words only. Agencies must work diligently to build their credibility with people who share new and different interests while assuring the traditional constituencies that they are not being abandoned.

New challenges require creative thinking to develop strategies that are responsive to emerging needs. In addition to the common resistance people have to change, it is important that agency staffs be uninhibited in their exploration of new ideas. In some states, looking to private interests to solve public problems may be discouraged by long standing agency roles of exercising custody over public resources yet a mix of public and private initiatives offers some promise in future control of urban deer populations. Convincing biologists that the long range public interest may be served better by such strategies is a major challenge for agency administrators.

Among the skills that will be most useful to fish and wildlife personnel as they address the social issues impacting deer management in urban areas is conflict resolution. The ability to bring opposing views together in agreement on common goals will be essential to future management directions. Past practice of employing consultants to mediate conflicts becomes a luxury when the need becomes common place. That, coupled with the rapidly increasing demand for these skills requires that agencies provide training for staff in this area of expertise.

Closely linked to such training is the ability of agencies to develop and implement rational alternatives in an hysterical climate. Especially when the public health is involved, people demand immediate relief in situations where immediate satisfaction is not possible. Agencies are faced with pressures to be responsive to the short term concerns of people while developing solutions to the longer term deer management problem.

Fish and wildlife agencies have been steeped in the conservation ethic and consistently strive for maximum utilization of the wildlife resource. Disposing of animals taken as part of an urban deer control program offers new challenges to agency effectiveness however. Consistent with the national movement to donate venison to needy people, agencies make every effort to make the meat of animals taken available to public institutions and agencies that feed the hungry. In so doing, they are confronted by Health and Agriculture Department bureaucracies that often stifle this initiative. In fulfilling their mission to protect the public from disease, these agencies are not sympathetic to systems that they cannot control. Their "no risk" goals are often reinforced by law and regulations that may prevent reasonable use of the public resource. Fish and wildlife agencies must work their way through the maze of governmental roadblocks if they are to carry out their wise use mandates.

The problems of overabundance of deer and effective management strategies may call into question the priorities of associated organizational units within fish and wildlife agencies. This is especially true in areas of law enforcement where historically, protection of the deer resource has been among the highest priorities established for wildlife enforcement officers. Catching poachers and deer-jackers has consumed a high proportion of enforcement effort especially during the late summer and autumn months. This is appropriate when illegal taking is a controlling factor in deer abundance and when recreational hunting programs, designed to allocate available harvests, is an effective means for controlling deer numbers. However, agencies must reevaluate this enforcement priority, in areas where active programs to manage deer are not effective in preventing property damage and excessive numbers of deer-auto collisions. Redirecting enforcement efforts towards more stressed resources and acceptable user behavior, must be considered by agency administrators. Gaining acceptance for altering this enforcement activity that is popular with officers as well as the license buying and landowner publics, will challenge the resolve and personnel skills of agency decision-makers.

Finally, the bottom line for program implementation for all agencies is their ability to allocate available resources to seek and apply proposed strategies. Research to find new techniques for controlling deer is expensive, and implementation of proven methods will be costly. When factored with the biological characteristics of the animal, management programs may cost hundreds of thousands of dollars. Since most fish and wildlife agencies are facing austere times and revenue sources are trending downward, new sources of funding must be found or difficult fiscal reallocation decisions must be made. Since most fish and wildlife programs are funded primarily by sale of hunting and fishing licenses and federal excise taxes on related equipment, challenges to the use of these funds for programs that do not benefit the license buyer will be and in some states are being made. The appropriateness of such expenditures must be addressed by agencies and acceptable solutions to the funding dilemma must be found. Turning to municipalities to shoulder the burden of cost is not the answer as most local governments do not have the resources that will be necessary on a continuing basis for maintaining deer control programs. Deer control and research will have to be sustained indefinitely in most situations.

CONCLUSION

Control of deer abundance in urban habitats is a complex issue with social, political and biological components. Fish and wildlife agencies have responsibility for stewardship of this resource and must develop and implement programs that will achieve the goal of managing wildlife so that their occurrence and abundance are compatible with the capacity of habitats to support them and consistent with peoples interests. Many difficult challenges face these agencies as they carry out their legal mandates and, they must organize to meet the challenges with well thought out strategies and policy directions. Biologists and managers are learning that the future for deer management may not be in the proven methods of recreational hunting, but in new partnerships with state legislators, land use planners and local governments who find themselves desperately seeking legal and political solutions to biological and social problems.

THE WILDLIFE SOCIETY
NORTH CENTRAL SECTION

Illinois
Indiana
Iowa
Michigan
Minnesota
Missouri
Ohio
Wisconsin