URBAN DEER FERTILITY CONTROL: SCIENTIFIC, SOCIAL AND POLITICAL ISSUES

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In recent years the subject of alternative management options for white-tailed deer (*Odocoileus virginianus*) has received renewed interest (Warren 1991, Grandy 1993, Kellert 1993). Hunting will continue to be the most widely used management tool for most deer populations throughout the United States, but increasing urbanization, the withdrawal of private lands from the public hunting domain, and changing public attitudes about lethal control methods have reduced the domain of effectiveness of hunting as a management tool for urban deer populations. At the same time, research efforts to find effective contraceptives for free-roaming deer have increased in number and intensity (Kirkpatrick and Turner 1985, 1991); several methods are now available for testing with free-roaming deer populations (Turner and Kirkpatrick 1991, Turner et al. 1992, Becker and Katz 1994, Warren et al. 1995, Jacobsen et al. in press).

The relatively rapid arrival of potentially effective deer contraceptives and delivery systems, however, has led to an increased focus on conflicts over deer population control among hunting advocates, state conservation agencies, and various elements of the general public who seek non-lethal alternatives to increasing deer populations. This essay is an attempt to identify issues that have led to conflict and to discuss possible solutions to the increasingly hostile atmosphere that surrounds alternative deer management options.

TO "MANAGE" OR NOT TO "MANAGE"

The first and perhaps most fundamental issue that arises when deer fertility control is considered is whether a particular deer population needs any management, regardless of whether the control is lethal or non-lethal. The intellectual basis for "managing" a deer herd is to either reduce an already overpopulated herd or to prevent its overpopulation in the near future. Unfortunately, like beauty, what constitutes an overpopulation is in the eye of the beholder and our first major issue is "do we have an overpopulation of deer in an urban setting?" Those interested in biodiversity see an overpopulation when a forest understory has been destroyed and will no longer support populations of small mammals and birds. Another segment of the public will assume an overpopulation if some threshold for car-deer collisions is exceeded. Some property owners whose ornamental plants and gardens suffer damage may see an overpopulation after the loss of a single plant. Other segments of the public, will see an overpopulation problem when the health of the deer begins to deteriorate. Still others will blame deer

overpopulations for an increased number of cases of Lyme disease. All of these explanations have some validity but none are universally supported. There are those who prefer to see deer rather than small mammals or birds, who may not be concerned about defoliation of the forest understory, and others who do not drive at night may have little concern about car-deer collisions. Homeowners who have plants that deer shun express less concern about deer populations than other people with plants that deer desire.

One commonly heard rationale for the reduction of white-tailed deer herds is the need to restore hardwood forest understories. Few people with an understanding of ecology would oppose this goal, but a critical examination of the issue leads to a more crucial question. Will the control or *reduction* of a particular deer herd permit restoration of small hardwood forests in urban areas, or will this goal require *elimination* of deer? The devastated hardwood forest we see today is the result of the activity of many deer over a number of years. Once initially set back, however, the forest's recovery is extremely slow and a few deer can keep that understory from regenerating. Furthermore, the newer understory that does grow will be determined by deer food preference. Hardy exotics, like buckthorn (*Rhamnus*), which is unpalatable to deer, will take over, while sensitive native plants, like *Trillium*, will remain absent. Thus, the real-life choices may be (1) give up on the forest, (2) eliminate (not reduce) the deer herd, or (3) put a fence around the forest. Which of these choices will be publicly acceptable? Which ones will be universally acceptable? Probably none.

Still another commonly expressed uncertainty when urban deer management becomes an issue is how many deer *should* be living on a square mile of land. State agencies often use figures derived from rural or woodland habitat, such as 10 or 15 or 20 deer per square mile, though urban deer populations may have many times those numbers. Many urban settings can support numbers of deer far greater than forests because of lawns and a variety of other sources of nutrients. This concept is not difficult to understand and we all understand that a square mile of alfalfa can support more deer than a mile of pine forest. What is usually missing in these generalized discussions is a *criterion* for a target number of animals. If a population of urban deer exceeds the often quoted densities for forests and the deer are healthy, does the density matter? On the other hand, if the concern is car-deer collisions instead of the health of the deer, then perhaps density does matter but is entirely independent of biological carrying capacity. The only point here is that generalized perceptions derived from a deer population in rural upstate New York are little help for discussing a population of deer in an arboretum in New Jersey.

These are but a few of the criteria with which the public evaluates whether there is a need for management. However, these criteria often set the stage for the first battle that usually occurs when urban deer management issues arise. How can sound decisions be made in the light of these differing perspectives? Any decision must be a compromise. Of all the issues posed in this paper, none is more problematic than this one. In reality, there is no simple answer to this question and the decisions that are made usually reflect the desires of the largest, most vocal or most politically influential segment of the population in a particular city, county, or neighborhood. Unfortunately, any single decision is not

necessarily the wisest, and we must keep this in mind as we seek solutions.

SPORT HUNTING AND "NON-HUNTABLE" DEER POPULATIONS

The second issue that arises when deer fertility control is considered is whether a particular population should be controlled by means of hunting, other lethal means, or fertility control. Invariably, this topic engenders strong opinions, and the subsequent arguments of both sides are usually flawed. For example, there is simply no contraceptive technology available now or in the foreseeable future with which to treat large numbers of wild deer living on extensive ranges. Thus, arguments from certain quarters that deer contraception can bring an end to sport hunting are not based on reason and do little to comfort nervous state wildlife agencies. This particular argument may be based on a sincere desire to end sport hunting by those who do not approve of it, but the use of deer contraceptive technology to promote this view is specious and inflames rather than resolves the deer problem. If particular groups or individuals oppose hunting on ethical grounds, they should seek to achieve their goals with arguments about the ethics of hunting, and not with unrealistic expectations for some technological advance.

Conversely, state fish and wildlife agencies do little to comfort the general public when they refuse to acknowledge that there are non-huntable deer populations. In truth, there are areas in every state where deer hunting is illegal, unsafe, unwise, or publicly unacceptable. Whitetailed deer, largely because of their incredible adaptability to urbanization, live in densely populated urban areas, arboretums, city parks, national parks, government campuses, and military reservations. Many of these locations are not appropriate sites for public hunting, although under some circumstances, "bait and shoot" programs might be employed by qualified agency personnel. The apparent reluctance of state agencies to admit that non-huntable populations exist in their states is probably based on a combination of pressures, including concerns by hunters, declining hunting license sales, and reliance upon license fees for agency funding. This does not, however, validate the intransigence of the agencies which aggravates the very problem they are commissioned to solve. Often the perceptual differences between the animal rights groups and the state agencies reach the point where the former overstate the potential for contraception and the latter deny the existence of non-huntable deer populations. The reaction of some state agencies suggests that they fear a challenge to the presumption of synonymy between hunting and wildlife management. In any case, hostility reigns and rationality disappears. Somewhere within the range of these arguments there is a group of people who do not oppose hunting in general but who find the prospect of a hunt in the middle of a city park or in their immediate neighborhood to be unacceptable, on grounds of safety or ethics. Amazingly, this group often receives the hostility of both the animal rights groups and state agencies. Such situations have been repeated many times, in towns and cities like Morristown and Princeton NJ, Irondequoit, and North Haven NY, Pittsburgh and Philadelphia PA, Columbus OH, Chicago, IL and dozens of other locations throughout the U. S. There are usually no, or few unique dimensions to the problems that emerge in any of these locations and virtually no group, including the deer, is

served by the conflict and hostility that follow.

The solutions to these conflicts seem apparent, at least to us. Most importantly, all three groups must find the common ground. All must accept that the problem is real, and that in deer habitats of the urban "island", letting nature "have her way" is not a reasonable option. Animal rights groups must come to the realization that deer contraceptive technology is not now, nor is it ever likely to be, a substitute for hunting. They must realize that deer contraception may only be possible in small, "island" populations of urban deer and not with thousands of wary animals roaming about the mountains of Potter County, PA, and similar habitats in other states. Animal rights groups have the right to promote their viewpoint on hunting , but their arguments must be based on ethical and moral grounds. Hunters must recognize the same facts and shed irrational fears that hunting will be brought down by fertility control. We have only a few tools for deer contraception, and the few that show promise are crude. Human contraceptive technology on the other hand, has a wide array of methodologies and approaches and despite this we have not been able to stop or even slow human population growth. What then is the logic that leads us to conclude that we can control 30 million deer with contraception.?

State agencies must come to grips with the fact that there are both nonhunted and nonhuntable deer populations within their respective jurisdictions, and that they are responsible for the management of *all* wildlife in their states, huntable and nonhuntable. They must also begin to consider the larger public reactions to, and effects of, permitting or even encouraging hunting in highly visible urban areas. Do these hunts reflect or promote the often cited values and ethics of sport hunting? Does the hunting of human-habituated deer in a city park, under the eyes of an urban society, do anything to preserve the traditions of hunting? Are state agencies that promote urban hunting helping or hurting the image of hunting?

Often, when the discussion reaches this point, there are accusations of injecting "value judgments" into the issues. There is no denying this, but there is nothing about hunting that does not rest on value judgments. Whether or not one hunts is a value judgment and so is *what* species is hunted, *how* it is hunted, and *why* it is hunted. The same applies to values about restoring forests or having deer in one's backyard. The issues of deer management cannot be dealt with in the absence of values. Let us shed our fear of value judgments and recognize their importance in making decisions about natural resources.

LEGAL ISSUES

White-tailed deer engender a variety of jurisdictional and legal considerations, and the application of fertility control brings them together in new and interesting ways. Virtually all deer in our urban areas live under the management authority of the state in which they are located. Though property owners may choose to prevent a state's particular management approach, they may not impose their own policies of management, short of doing nothing without the state's assent. Thus, the application of pharmacological fertility control to deer on any nonfederal lands requires state wildlife agency permission. Although the ultimate authority remains with the state, the use of delivery equipment such as cap-

ture guns, often results in the need for additional authority. Thus, deer fertility control projects may require county, township, city, or park commission approval.

Deer residing on certain federal lands, such as military bases, federal government campuses, national seashores or recreation areas are not always under the management jurisdiction of the states, and these pertinent federal agencies have the constitutional authority to manage their deer as they see fit. However, some federal agencies have, and many more may choose to seek, agreements with state agencies. Different federal agencies may also require additional assurances. For example, the use of capture gun equipment within a National Park Service (NPS) unit, even to deliver contraceptive drugs, requires NPS certification. This includes documentation of prior experience with the equipment by the delivery team, a certificate of completion of the NPS sponsored wildlife immobilization course, current CPR certification, passage of a qualifying test, and a letter of certification from a superintendent of an NPS unit.

In addition to regulations of the local authority for management of the deer themselves, there are federal safety regulations that impinge upon use of the contraceptive agent. White-tailed deer are considered to be food animals by the Food and Drug Administration (FDA) and the U. S. Department of Agriculture (USDA). Recently, at the USDA sponsored Symposium on Contraception in Wildlife, held in Denver in 1993, the USDA abandoned responsibility for the regulation of fertility control drugs for deer. The USDA's regulatory authority extends only to disease in animals, and pregnancy is not defined as a disease. Thus, no permission is required from USDA.

The use of an experimental drug for deer fertility control, however, does fall under the authority of the FDA. A drug may be approved or licensed by FDA for use for a particular purpose in a particular species. Currently, there are no pharmacological contraceptive agents that may be commercially marketed for use in deer. Several drugs have been tested in deer that have been approved for commercial sale for use in other species. Two examples are Norgestomet® (Burns et al. 1993) and prostaglandin-F2δ (Becker and Katz 1994), which have FDA approval for use in certain domestic species, but not in deer. Others, such as the porcine zona pellucida vaccine (PZP) (Turner et al. 1992) and a GnRH vaccine (Becker and Katz 1995) have no approval for commercial use in any species. Thus, at the present time, the use of *any* pharmacological agent for deer contraception is experimental.

This brief introduction to federal regulations raises two critical questions that have proved particularly confusing for advocates, as well as opponents of deer contraception. First, may a contraceptive agent for deer be used without FDA approval, and secondly, what constitutes FDA "approval"? The FDA itself imposes no requirement for a deer contraceptive drug to be "approved", however, a state or local agency that wishes to pursue deer contraception may require that there be some level of approval by the FDA prior to use of drugs in its jurisdiction.

The use of a commercial drug for a purpose or species other than that for which it was approved, or the use of a non-commercial drug for deer contraception constitutes an *experimental* use of the drug. Investigators may apply to the FDA for an Investigational New Animal Drug exemption (INAD) to use the drug for deer con-

traception research. Attainment of an INAD for this purpose does not imply "approval" of the drug by FDA in the same sense that a commercial drug is approved for sale and use. Rather, it is an agreement that the investigators may pursue their contraceptive research, will collect certain data, follow certain procedures, and provide the FDA with these data. In turn the INAD authorizes the interstate and international shipment of the vaccine for research purposes. An INAD application requires preliminary data, and the FDA therefore assumes that testing will occur without an INAD. INADs have been issued for a number of contraceptive drugs for use in captive exotic species in zoos, but thus far the only contraceptive agent that has received an INAD for use in free-roaming deer is the porcine zona pellucida vaccine (PZP). In this particular case, the INAD is held by The Humane Society of the U. S. and it is good only for specific sites and projects. Each new experimental site requires a new application to FDA and an extension of the INAD to the new project.

THE SCIENCE

Contraceptive Agents

In recent years there have been several attempts to explain, discuss, and evaluate the scientific aspects of deer contraception (Nettles 1993) but most have been overly simplistic or have failed to explain adequately the complexity of the subject to an interested and concerned, but largely uninformed, public. A variety of potential contraceptive agents are available, each with advantages and disadvantages. Additionally, there are at least three delivery modes for these agents, each of which also presents advantages and disadvantages. Most recent discussions of deer contraception have attempted to evaluate a particular method in isolation and without reference to other methods. Because no single approach is without its shortcomings, the evaluation of only one approach is often misleading and fails to provide the reader with a frame of reference. Thus, deer contraceptive approaches are only meaningful in a comparative sense.

A second problem associated with recent discussions of deer contraceptive methods is that no "gold standard" has been provided with which to compare these methods. Without such a standard, these discussions could be compared to the evaluation of a law in the absence of a constitution. A "standard" for the evaluation of wildlife contraceptives in general has been previously discussed in terms of the theoretical "ideal" wildlife contraceptive (Turner and Kirkpatrick 1986, Kirkpatrick and Turner 1991, Seal 1991). Basically, these ideal characteristics include:

1. Contraceptive effectiveness of at least 90%.
2. The ability for remote delivery, with no handling of animals.
3. Reversibility of contraceptive effects (although this may not be important for deer).
4. Safety for use in pregnant animals.
5. Absence of signnificant health side effects
6. No passage of the contraceptive agent through the food chain.
7. Minimal effects upon individual and social behaviors.
8. Low cost.

Any future evaluations of deer contraceptive methods should attend to these characteristics, at least until better or more appropriate ones emerge.

The various chemical and vaccine approaches to deer contraception have been reviewed extensively (Kirkpatrick and Turner 1985, 1991), but a generic description of some approaches and the biological and regulatory issues they raise may be helpful. There are also three delivery systems currently used, providing six combinations of agents and delivery.

The largest group of compounds that have been tested in deer is the steroid hormones, composed of various estrogens and progestins, natural and synthetic. Many steroids are effective contraceptive agents but they are accompanied by a variety of problems. The major problem is their passage through the food chain, where predators, scavengers, or humans may consume residues of the drugs. This potential danger can be attenuated by the use of natural hormones, such as estradiol and progesterone, which are identical throughout all mammals. Thus the accidental ingestion of these two hormones would not expose consumers to anything they do not already produce. Because estradiol and progesterone are metabolized very quickly, however, they must be administered either daily or by means of surgically placed implants-neither method is practical in the field.

Another approach with the steroid hormones is to administer synthetic steroids, which have been used successfully to inhibit reproduction in deer (Plotka and Seal 1989). These molecules have been modified with various side chains that cause the liver not to "recognize" them and thus metabolism is very slow. Consequently, smaller doses can be used less often, and they will exert their contraceptive influence longer. Their long life increases the danger of passage through the food chain and the accumulation of non-natural steroids in consumers. For this reason it is unlikely that many of the synthetic steroids will ever be permitted by the FDA to be used in deer. A few, like Norgestomet®, already have FDA approval for use in domestic livestock, but a lengthy withdrawal period will probably be imposed if they are used on deer. Therefore, they would have to be used several months prior to the breeding season which would require very large doses. Because the breeding season of white-tailed deer and legal hunting seasons usually coincide and the hormone residue must be present to be effective as a contraceptive, the FDA will not likely approve a steroid for use in free-roaming deer. A possible advantage of synthetic steroids is that passage through food chains represents an opportunity to administer the drugs orally, which would lead to new regulatory problems associated with oral delivery. These problems will be discussed in the next section.

Non steroid approaches to contraception include a variety of molecules and can be divided into two groups: non vaccines and vaccines. The latter are also called immunocontraceptives. The non vaccines are complex in their physiological actions but basically they exert a direct inhibitory effect upon some group of cells that are requisite to successful reproduction. Examples include molecules that block the actions of reproductive hormones, such as gonadotropin-releasing hormone (GnRH) antagonists, prostaglandins, and cytotoxins. The GnRH antagonists block the proper functioning of the pituitary gland and consequently prevent stimulation of the gonads and sperm or egg production. Prostaglandins are molecules that cause pregnancy failure and either fetal absorption or abortion in cattle and a number of other domestic species, but in two separate tests they did not work well in deer (Becker and

Katz 1994; J. Stahl, Columbus Metroparks, Pers. Commun.). More recently, in a third test, as yet unpublished, larger doses of injectable prostaglandins were capable of terminating pregnancies in deer. Cytotoxins may actually destroy certain pituitary cells and thereby prevent production of sperm and eggs. This approach has been suggested for use in deer but has not yet been tested.

Each of the nonvaccine, nonsteroid agents has advantages and disadvantages. They can all be delivered in relatively small doses, which facilitates remote delivery, and most cannot pass through the food chain because of their protein nature. However, GnRH antagonists cause significant behavior changes and must be administered often, prostaglandins, because of the specter of aborted fetuses, may invoke strong negative feelings in some segments of society, and cytotoxins will face stringent FDA scrutiny and regulation.

Immunocontraceptives, or vaccines, exert their actions by causing the target animal to produce antibodies against some molecule requisite to successful reproduction. Their actions are similar to the vaccines used for disease prevention. Some specific examples include anti-GnRH vaccines, anti-sperm vaccines, and anti-zona pellucida vaccines. Anti-GnRH vaccines cause the production of antibodies against GnRH and the effects are the same as those described above for GnRH antagonists. Anti-sperm vaccines cause antibodies against sperm cells and can be used in both the male and the female. Several versions of anti-sperm vaccines have been tested in laboratory animals and nonhuman primates (Primikoff et al. 1988, Herr et al. 1990), but none have yet been tested in deer. Anti-zona pellucida vaccine, better known as PZP, raises antibodies in the treated female deer which presumably block fertilization (Liu et al. 1989). This vaccine has been successfully tested in captive (Turner et al. 1992, 1995) and free-roaming deer (McShea et al. 1993).

The advantages of the vaccines are that they can be delivered remotely in very small doses. Also, because they are primarily protein, they are readily digested and cannot pass through the food chain. From a regulatory standpoint, there should be less difficulty obtaining permission to use these agents experimentally in deer. The vaccines, however, must be used with another agent, an adjuvant, which is a general immunostimulant. One of the best adjuvants, Freund's Complete adjuvant occasionally causes abscesses and tissue granulomas in some species, which raises regulatory concerns. Alternative adjuvants that do not cause abscesses or granulomas have recently shown strong promise, and it appears that protein based contraceptive vaccines will have fewer regulatory problems than steroid hormones.

Delivery Systems

The three most likely methods of administration for deer contraceptives are injection by dart or biobullet, surgical implants, or oral delivery. Coupling three delivery systems with two major groups of contraceptive agents, steroid and non-steroid, there are six possible configurations for inducing contraception in deer, and each configuration carries with it advantages and disadvantages. Surgical implants are costly and cause stress to the animals because the procedure involves capture and surgery. However, large quantities of a contraceptive agent can be im-

planted and the deer can be marked with tags or collars (Plotka and Seal 1989).

Oral delivery is a desirable approach because of the low cost involved. Steroids are currently the only contraceptive agents that can be delivered orally, but ingestion must occur almost daily, and there remain the regulatory problems associated with steroids. Some research is underway that seeks to deliver vaccine-based contraceptives orally.

Current research (Bradley 1994, Tyndale-Biscoe 1994) may permit virus-vectored oral delivery of protein contraceptive molecules, which would normally be digested rather than absorbed into the blood stream, but again there will be regulatory constraints. The first and most probable regulatory constraint for virus vectored oral contraceptives will be that of species specificity, which will be extremely difficult and costly to attain. Also, the prospect of viral mutation and the possibility that a mutation may lead to the contraception of non-target species will result in significant regulatory hurdles.

Another approach for oral delivery is to microencapsulate a vaccine or drug in a biodegradable, nontoxic coating that will protect the active ingredient from digestion and can be absorbed via the lymphatic system. This approach has already been applied to medical vaccines in humans (Eldridge et al. 1989) and is being tested for use with contraceptives in deer. This approach may not evoke serious regulatory hurdles for the microcapsules themselves, but there will be restrictions placed on any orally delivered active contraceptive ingredient that is not species specific.

Remote delivery works best with the non steroid agents because smaller volumes can be used, but this method necessitates identification of individual deer, a difficult and costly, but not impossible, task in order to prevent multiple treatments or the uncertainty of how many deer have been treated. Methods for simultaneous delivery of vaccine and dye mark are available but need refinement. Remote delivery of steroids is almost prohibitive because of the large volume of drug necessary to bring about contraception, even with sophisticated, sustained release formulations (Kirkpatrick et al. 1982; Turner and Kirkpatrick 1982, 1991). A variety of small self injecting, commercially available darts exists that can deliver any number of compounds to free roaming animals. Advantages of darting include the high level of accuracy and the range, which can exceed 50 m. A disadvantage is that the darts have to be recovered. The biobullet involves a hollow 0.25 cal. cartridge made of biodegradable, non toxic material, which is fired from a CO_2 powered gun (Willis et al. 1994). The bullet imbeds itself in muscle tissue and dissolves, releasing the drug from its hollow cavity. An obvious advantage of the biobullet is the elimination of the need to recover the projectile. Disadvantages include the limited range, which rarely exceeds 30 m, and occasional injury to the deer.

Genetics

One of the recent concerns about the use of deer contraception agents has been that the genetic composition of the herd may be altered (Nettles 1993). This is a legitimate scientific question that deserves discussion. A second consideration of genetics is whether there will be some individual, genetically based differences in the response of deer to a contraceptive agent. This possibility is unlikely in the case of steroid hormones, because of the absence

of individual or genetic variability in responsiveness, the question has been directed more at vaccines than at other agents. Vaccines clearly show greater variability in contraceptive responsiveness than do steroid hormones. However, this issue has two interesting aspects. The first is the possibility of an inherent, genetic difference in the response of the deer to a vaccine, i.e., some deer will make lots of antibodies and thereby become infertile, while others will make few antibodies and will thereby produce offspring, perhaps with that same resistance to the vaccine. There are currently no data to address this issue and it deserves appropriate research. The second aspect relates to the health of the deer and the differences in responses to vaccines, i.e., unhealthy deer won't make antibodies and will therefore produce more unhealthy deer, while healthy deer will make antibodies and will not reproduce. In the extreme, this scenario leads to the specter of a growing herd of unhealthy deer. There are no data to support this perspective. In contrast, there are data showing good contraception in wild horses in extremely poor condition and in zoo animals that have been treated specifically because they are unhealthy.

Considering the limited potential applications for deer contraception and the small numbers that will be treated, the genetic questions may be of little importance. The use of terms like "mass immunizations" in connection with deer genetics issues is misleading. A more relevant consideration for genetic issues is whether the potential genetic effects of contraception are less or greater than those of hunting. The issues over deer contraception thus far have mostly been posed in the context of whether it is an acceptable alternative to hunting. Based on numbers of deer taken by hunters, contraception will never remotely approach the impact of hunting on the deer gene pool.

Behavior

Other frequently asked questions revolve around potential changes in the behavior of deer treated with contraceptives. This concern deserves serious investigation for at least two reasons. Whatever management tool is used, contraception or hunting, managers should recognize that deer are highly social animals and that our goal should be to minimize social disruption. This issue, of course, is ethical rather than scientific. The complexity of the behavior issue is compounded by the different behavioral effects of different deer contraceptives. Most of the steroid hormones discussed thus far cause a doe to "imitate" pregnancy endocrinologically, thus we must be willing to accept behaviorally "pregnant" deer (no breeding behavior) with this approach. The use of GnRH vaccines and antagonists represent a nonsurgical sterilization, and we must be willing to accept a loss of reproductive behaviors with this approach, along with whatever changes there are in social behaviors. The use of PZP vaccine carries with it the risks of prolonged estrous cycles, which raise concerns over energy costs during the winter, increased movement by the deer and therefore the risk of more car-deer collisions, and energetic costs to males, who will continue to seek out estrous females.

Only one study has been completed that examined the potential changes in behavior as a result of deer contraception. The study confirmed that PZP contraception can extend estrous cycles into the month of February in Virginia (McShea et

al. 1993). The study also confirmed, however, that the energetic costs of extended estrous cycles in PZP treated female deer were significantly less than those of pregnancy and lactation in untreated deer. Also, male deer in this study did not significantly increase energy expenditures in the presence of females with extended breeding seasons.

More studies are needed in order to answer all germane questions regarding potential behavior changes. The same questions should also be asked about hunting. Does hunting cause increased expenditures of energy by deer? Can the behavioral changes caused by hunting be compared to those caused by contraception? These questions have already been answered for hunting and data are accumulating for contraception. The point here is that there are consequences that result from *any* form of management.

How Many Deer Must Be Treated?

One last issue that often emerges during the debate surrounding deer contraception is how many animals need to be treated to achieve a desired population effect. This question cannot be answered in the absence of a goal and it cannot be answered on the basis of population modeling which uses generalized data from other sites.

The problem surrounding the question of how many deer need to be treated now becomes even more complex. Those who advocate nonlethal control methods generally insist that information about absolute numbers be provided before any management options are exercised. According to this view, only when the population size is known can an intelligent decision be made about what kind of management action must occur. Experience has shown that neither the proponents or opponents of deer contraception, or hunting, have reliable data about the urban deer populations in question. There is always a lot of speculation and guessing, but few hard numbers derived in scientifically sound ways. Should the population be held at current numbers or should it be reduced by 10% or should it be allowed to increase at 5%? To answer these questions one must first know how many deer are involved.

Wildlife agencies' views are somewhat different. Their view might be summarized as "too many deer are always too many, regardless of the absolute number," and the real issue is the consequence of too many deer, i.e., car-deer collisions, impact on vegetation, etc. In other words, relative numbers are more important than absolute numbers. Knowledge of absolute numbers may be very important for implementation of fertility control, though absolute numbers are less important for reduction programs based on hunting.

The second problem is that of computer modeling based on data from other sites. Generalized data are applied to specific sites and populations, and the results seldom have any meaning. Twenty-five years of experience with contraception in wild horses has told us a great deal and perhaps the most important lesson is that modeling is useful only if it is based on *site specific data*. At an absolute minimum, site-specific fawning rates (in terms of fawns per doe and percent of does fawning), mortality rates, and age of recruitment are necessary to determine what percent of adult does need to be treated to achieve some specified goal over some specified period of time. Non specific data have little value and only serve to confuse the participants in the discussions.

SUMMARY

The issues of deer contraception and the perceived conflicts of contraception with hunting have reached epic proportions. Many of these conflicts may be about management in general versus no management. In any case, at the local level, much of the conflict has lacked a factual grounding and has been fueled by misinformation, and emotions generally have outrun reason. The extent of the polarity between hunting advocates and animal welfare or animal rights groups has obscured the science of fertility control and prevented the objective evaluation of that science. Both hunting and contraception have been evaluated individually and without meaningful comparisons between the two approaches.

Much of what the public perceives about the issues of deer fertility control comes through popular media, particularly newspapers that cover local conflicts, and more recently, national sportsman's magazines and animal welfare organization periodicals. Many of the newspaper articles were prepared by sportswriters, who have sensationalized the problems and have produced almost nothing with balance. The same can be said for a smaller number of articles written by those journalists sympathetic to the animal rights movement. In general, magazines have done a better job, but even the best have confounded readers with partial perspectives on complex issues. This media problem certainly transcends deer issues, and there is no simple solution on the horizon. Responsible and careful journalism from a neutral perspective can probably do more to defuse the current conflicts over deer management than can any other effort. In the final analysis, however, the human perception of urban deer and the issues that surround them reflect a large diversity of public values and opinions. The problems will not easily be reduced to simple solutions, or even to simple questions.

Finally, the public and agencies, on both sides of the issues, have largely failed to recognize that deer fertility control is still experimental. Several years of testing and evaluation will be necessary if a validated management tool is to be achieved, although many trials can be carefully planned to provide some management relief during testing. The opposition that accompanies the issue of deer fertility control experiments is often anti-intellectual. If there are flaws in this management approach, as opponents suggest, they will become apparent through scientific testing. No new idea should be prevented from being given a chance to succeed, or fail.

The most critical dimension of the urban deer issue is, surprisingly, one of the most noticeably absent in most local conflicts. That dimension is tolerance of urban wildlife. The issue of urban deer is only one part of the growing phenomenon of successful urban wildlife. No signs indicate that there will be fewer urban wildlife species or animals in the future, and there are continuing increases in human populations with encroachment on remaining wildlife habitat. Reason then points toward continued escalation of conflict between urban wildlife and humans. Fertility control is certainly not the answer to all the problems, but until proved otherwise in well designed tests, it should be given its day in the court of scientific and social judgment.

LITERATURE CITED

Becker, S. E., and L. S. Katz. 1994. Effects of exogenous prostaglandin $F_{2\partial}$ ($PGF_{2\partial}$) on

pregnancy status in white-tailed deer. Zoo Biol. 13:315-323.

_____, and _____. In Press. Gonadotropin-releasing hormone (GnRH) analogs and active immunization against GnRH to control fertility in wildlife. *in* T. Kreeger, ed. Proc. Symp. Contraception in Wildl. Manage. U. S. Dept. Agric./ Denver Wildl. Res. Cent., Denver, CO.

Bradley, M. P. 1994. Experimental strategies for the development of an immunocontraceptive vaccine for the European red fox, *Vulpes vulpes*. Reprod. Fertil. Dev. 6:307-317.

Burns, P. D., J. C. Spitzer, G. L. Burns, and B. B. Plyler. 1993. Inhibition of estrus and corpora lutea function with Norgestomet®. Theriogenology 39: 863-873.

Eldridge, J. H., R. M. Gilly, J. K. Stass, Z. Moldozeanu, J. K. Muelbroek, and T. R. Tice. 1989. Biodegradable microcapsules: vaccine delivery systems for oral immunization. Curr. Top. Microbiol. Immunol. 146:59-66.

Grandy, J. W. 1993. Deer management in an urbanizing region. Pages 5-7 *in* R. L. Donald, ed. Deer management in an urbanizing region: problems and alternatives to traditional management. The Humane Society of the U.S., Gaithersburg, MD.

Herr, J., R. M. Wright, E. John, J. Foster, T. Kays, and C. J. Flickenger. 1990. Identification of human acrosomal antigen SP-10 in primates and pigs. Biol. Reprod. 42:377-382.

Jacobsen, N., D. Jessup, and D. Kessler. In press. Reversible contraception of black-tailed deer with Norgestomet® biobullet. J. Wildl. Manage.

Kellert, S. 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 U.S., Gaithersburg, MD.

Kirkpatrick, J. F., and J. W. Turner, Jr. 1985. Chemical fertility control and wildlife management. BioSci. 35:485-491.

_____, and _____. 1991. Reversible fertility control in nondomestic animals. J. Zoo Wildl. Med. 22:392-408.

_____, _____, and A. Perkins. 1982. Reversible fertility control in feral horses. J. Equine Vet. Sci. 2:114-118.

Nettles, V. F. 1993. Report to the subcommittee of wildlife contraception, Int. Assoc. Fish Wildl. Agencies.

Plotka, E. D., and U. S. Seal. 1989. Fertility control in white-tailed deer. J. Wildl. Dis. 25:643-646.

Primikoff, P., W. Lathrop, L. Woolman, A. Cowan, and D. Myles. 1988. Fully effective contraception in the male and female guinea pigs immunized with the sperm protein PH-20. Nature 335:543-546.

Seal, U. S. 1991. Fertility control as a tool for regulating captive and free-ranging wildlife populations. J. Zoo Wildl. Med. 22:1-5.

Turner, J. W., Jr., and J. F. Kirkpatrick. 1982. Androgens, behaviour, and fertility control in feral stallions. J. Reprod. Fert. (Suppl. 32): 79-87.

_____, and _____. 1986. Fertility control as a management tool for feral horse populations. Equine Vet. Sci. 6:278-284.

_____, and _____. 1991. New developments in feral horse contraception and their potential application to wildlife. Wildl. Soc. Bull. 19:350-359.

_____, _____, and I. K. M. Liu. In Press. Immunocontraception in white-tailed deer. *in* T. Kreeger, ed. Proc. Symp. Contraception in Wildl. Manage. U. S. Dept. Agric./ Denver Wildl. Res. Cent., Denver, CO.

_____, I. K. M. Liu, and J. F. Kirkpatrick. 1992. Remotely-delivered immunocontraception in captive white-tailed deer. J. Wildl. Manage. 56:154-157.

Tyndale-Biscoe, C. H. 1994. Virus-vectored immunocontraception of feral mammals. Reprod. Fertil. Dev. 6:281-287.

Warren, R. J. 1991. Ecological justification for controlling deer populations in Eastern national parks. Trans. North Am. Wildl. & Nat. Resour. Conf., 56: 56-66.

_____, R. Fayrer-Hoskens, L. White, L. Paige Willis, and R. Goodloe. In Press. Research and field applications of contraceptives in white-tailed deer, feral horses, and mountain goats. *in* T. Kreeger, ed. Proc. Symp. Contraception in Wildl. Manage. U. S. Dept. Agric./ Denver Wildl. Res. Cent., Denver, CO.

Willis, P., G. H. Heusner, R. J. Warren, D. Kessler, R. A. Fayrer-Hosken. 1994. Equine immunocontraception using porcine zona pellucida: A new method for remote delivery and characterization of the immune response. Equine Vet. Sci 14:364-370.