When Should Wildlife Fertility Control Be Applied?

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Hunting has been the traditional method for managing populations of white-tailed deer (*Odocoileus virginianus*) and other wildlife for many decades. For rural landscapes, this is the only practical way to regulate numbers of free-ranging deer. However, much recent research has focused on finding alternative, non-lethal techniques to regulate deer populations in suburban areas closed to hunting because of safety concerns or social attitudes. Wildlife managers and communities across the United States are attempting to determine if immunocontraception, or some other form of fertility control, can be a practical alternative to regulated hunting.

The purpose of this presentation is to provide a decision-making framework for communities and agencies that are considering the application of fertility control drugs or vaccines to suburban deer herds. Before applying fertility control agents, communities need to carefully evaluate the following questions:

(1) Is the proposed application biologically feasible?

(2) If feasible, are the fiscal and human resources available to support the work over the long term?

(3) If resources are available, does the community fmd the management or research plan to be socially acceptable?

(4) If the plan is acceptable, can all regulatory and permit requirements be met?

We plan to briefly explore each of these issues to set the stage for the workshop. Other presenters will cover all of these topics in greater detail throughout the day.

Biological Feasibility

Some of the first questions asked by many communities considering the "se of contraception include, how many deer are in the population in question, and how many will require treatment? This baseline information is critical to the decision-making process. It is also data that can be very difficult and expensive to obtain. The actual number of deer in a population is nearly impossible to determine.

To answer these questions, the minimum size of the deer population must be estimated, and the appropriate age and sex structure devised in order to evaluate deer population dynamics in response to different treatments, whether simulated or real. The boundaries for the population must be delineated, and a sample of deer could be culled or harvested for several years to determine their physiological condition and reproductive rates at different densities.

A citizen task force in the Town of Irondequoit "ear Rochester, NY, has recommended "sing immunocontraception to manage the local deer population. As a case study, we used 4 years (1993-96) of culling data from this herd to simulate the biological feasibility of contraceptive applications. The age and sex structure of the population was simulated using a newly developed, automated program for reconstructing a deer population (Moen 1994). This program establishes a" initial breeding population of the size necessary to support human-related mortalities (i.e., culling, deer-car collisions), and natural deer mortalities with a biologically reasonable sex and age structure in the initial population. Simulated annual reproduction and losses contribute to changes in the sex and age structure in successive years, and population dynamics reflect both the causes and effects of treatments.

The annual culling program and vehicle mortality comprised most losses in this unhunted suburban deer herd. A" additional 12% mortality accounted for unknown losses. This simulation produced a" initial pre-culling population size of 905 deer in 1993. The number of deer culled was accounted for in the model by age and sex class, and we included the number of deer that were killed by cars and other losses in the mortality data each year. Consequently, the fall deer population in subsequent years was 852,702, and 457 deer for 1994-96, respectively.

Next we asked the question, "how many female deer should be treated with contraceptive vaccines in order to reduce the number of births to match the number of does culled each year?" The number of females culled each year was divided by the weighted mea" reproductive rate for the population to determine the number of females that would have to be treated with contraceptive or abortive agents to remove their potential fawns from the population, matching female fawn numbers with the number culled (Table 1). Note the number of females to be treated is twice the number culled because of the 1:1, male:female fawn sex ratio; and the total is divided by 0.89 to account for the 89% efficacy (6 of 55 immunocontracepted deer at Seneca Army Depot produced fawns in 1998) we have observed for contraceptive vaccines delivered via dart gun.

Table 1. Simulated population sizes and numbers of female deer to be treated with reproductive inhibitors to match the effects of culling for the Irondequoit, NY, deer herd, 1993-96.

Year	Population Size	Wtd. Mean Repro. Rate	Females Culled	Females to be Treated[a]	% Female Population
1993	90.5	0.75	53	160	29%
1994	852	0.75	107	321	61%
1995	702	0.80	151	425	105%
1996	457	1.13	47	94	40%

[a] Females to be treated = ([No. females culled/Wtd. mean repr. rate] * 2)/0.89

The proportion of female deer treated in any given year to match the actual culling that took place varied from 29 - 105%. This wide variation is directly related to the number of female deer culled in relation to changing deer numbers and shifts in the population age and sex structure over this 4-year period. If this culling had not taken place, during 1995 when 151 female deer were removed, more females in the herd would need to be treated with contraceptives than were actually available in the population. This is definitely beyond the upper limit of biological feasibility and is not practical.

Cost-Effectiveness and Practicality

Currently the U.S. Food and Drug administration requires that each free-ranging deer treated with experimental contraceptive vaccines be identified with warning tags which state, "DO NOT CONSUME" (*see regulations* section below). During 3 years of capturing and collaring 183 deer for an immunocontraception study at Seneca Army Depot in New York, we calculated an average cost of $136/deer for fuel and equipment, requiring 11.2 hrs/deer for labor. The cost for the tint dose of contraceptive vaccine ranged from $18-25. Using these data, we developed a conservative cost estimate for conducting a deer contraception program each year in Irondequoit (Table 2).

Table 2. Estimated numbers of female deer to be treated with reproductive inhibitors and minimum costs for the program in Irondequoit, NY, during 1993-96.

Year	Projected Females Treated	Actual Females Captured[a]	Capture Costs ($)[b]	Person/hrs Required[c]	Labor costs ($)[d]	Vaccine costs ($)[e]	Annual cost ($)
1993	160	200	27,200	2,240	22,400	9,663	$59,263
1994	321	201	27,336	4,494	44,940	14,543	$86,819
1995	425	130	17,680	5,950	59,500	14,211	$91,391
1996	94	0	0	1,322	13,220	2,851	$16,071
Total			$72,216		$140,060	$41,268	$253,544

[a] The actual number of females to be captured to match the effects of culling were adjusted upward to account for the *average* annual mortality *(20%* loss from road kill and other causes) observed during the 4-year period. For 1993, *160/0.8* = 200 deer captured and treated. For 1994 and 1995, Actual new females captured = (projected treated at time t+1 - projected treated at time t)/0.8. For 1994, (321-160)/0.8 = 201 new females captured; and for 1995, *(425-321)/0.8* = 130 new females captured. No additional females required capture during 1996 in this example.

[b] Capture costs are based on an average of $136 per deer (plus labor; see column 5) for 183 tagged deer at Seneca

Table 2 (con't)

Army Depot.

'Person hours required were based on an average of I I .2 hours/deer for 183 deer treated at Seneca Army Depot.The projected number of females treated was increased 20% to account for average annual mortality; therefore Person hours = (projected no. females treated/0.8) * 11.2.

[d] Labor costs were based on a minimal salary of $10/hour and the number of person hours needed.

[e] An average cost of $2 1.50 ($ 18 for GnRH; $25 for PZP) was used for the prime dose of contraceptive vaccine, and currently two doses are required in the first year ($43/deer). One booster dose is required in subsequent years. Costs were adjusted upward given the 89% weighted average for solid hits with vaccine darts from a blind (96% efficacy) and vehicle with a spotlight (72% efficacy).

As long as contraceptive vaccines or abortion agents need to be delivered by dart-gun or biobullets, it will be extremely expensive to treat enough individual deer to regulate herd population growth. If a community decides to use contraceptive vaccines to control deer numbers, people need to realize this requires a long-term commitment of funding and personnel. As for culling, abortion agents, or other non-lethal management approaches, vaccine treatment is not something that can be done for one or two years, then simply dropped. Careful planning is needed to get the equipment and people in place that are necessary to treat deer each year at specific times.

Deer capture and marking with collars or tags accounted for about 28% of the total program costs. If US-FDA decides that deer treated with contraceptive vaccines are "safe" for human consumption, then possibly this cost could be eliminated for a "management" level program. However, even with capture costs removed, funding needed for labor and vaccine expenses still totaled more than $180,000 during 4 years. More than 400 female deer would require multiple vaccine treatments to match the effects of culling in this case.

During the 4 years included in this case study, a total of *358* female deer were culled. Cost estimates for the culling operation were available for 1993 and 1994. During 1993, 80 deer (53 females; 27 males) were taken, and culling and processing cost $37,500, or $470 per deer. With greater experience and efficiency in 1994, *$49,582* was spent to remove 160 deer, at a cost of $3 10/ deer. At the 1994 rate, culling 358 female deer from the population would cost less than half as much ($110,980 versus $253,554) as the immunocontraception program outlined in this example. A similar sharpshooting program conducted by the Bloomington, Minnesota, police department cost $185/deer (Stradtmann 1995). Using the cost figures from Minnesota, the culling operation in Irondequoit would have cost about one-fourth of the total estimated charge for contraception. In addition, more than 7 tons (14,473 tbs.) of stew meat and ground venison were distributed to needy families by Foodlink during 1993-96 as a result of the culling operation.

Community Acceptability

Some communities would prefer to use non-lethal alternatives for deer herd management in suburban areas if they can be shown to be efficient, humane, and practical (Curtis et al. 1997). A Citizen's Task Force in Irondequoit recommended immunocontraception as the preferred, long-tam approach for controlling the deer herd in and around Durand Eastman Park when contraceptive vaccines became available (Curtis et al. 1995). Currently, this field study is underway to determine the feasibility of using contraceptive vaccines to regulate numbers of free-ranging deer (Nielsen et al. 1997). However, community support for any deer management action, lethal or non-lethal, will require significant public education (Stout et al. 1997). It may be necessary to build consent for management among several stakeholder groups with divergent viewpoints (Curtis and Hauber 1997). It is our experience that addressing the social conflicts associated with suburban deer herds is much more difficult than managing the biological aspects of regulating deer numbers. When communities become aware of the cost and long-term commitment required, support may be gained for methods that are more efficient and less costly than immunocontraception.

Regulatory and Permit Requirements

There are no commercially-available immunocontraceptive vaccines for wildlife. Vaccines prepared with the two primary antigens, gonadotropin-releasing hormone (GnRH) and porcine zona pellucida (PZP), are classified as experimental drugs and are only produced in a few labs in the U.S. Vaccines can only be administered to deer under guidelines of a US-Food and Drug Administration (FDA) Investigational New Animal Drug (INAD) permit. In addition, state wildlife agency permits are necessary to capture or treat any deer with drugs. Consequently, treatment of deer with contraceptive vaccines is being conducted primarily in research settings by universities and state wildlife agencies.

FDA has concerns about the safety of adjuvants used with contraceptive vaccines, and currently requires treated, free-ranging deer to be marked with warning tags stating, "DO NOT CONSUME." It is not clear if or when FDA restrictions on consumption of deer meat treated with vaccines will be relaxed. Also, animal care committees at universities have raised concerns about treating deer with Freund's Complete Adjuvant. Consequently, there are many parts of the regulatory and commercialization process for contraceptive vaccines that still need to be developed before this can be a viable management alternative for communities with overabundant deer herds.

Summary

This case study highlights both the biological and practical concerns associated with darting deer with immunocontraceptive vaccines. Except for small areas (2 square miles or less) with excellent access, it will be nearly impossible to treat most females in a free-ranging deer herd and boost them when needed. Consequently, applications will primarily be limited to public lands (i.e., small urban parks). In addition, applications will probably occur in herds with 300 female deer or less, because few communities will be able to afford $80,000/ year or more to collar and treat that number of deer with immunocontraceptive vaccines.

It is important to mention several additional impacts of contraceptive vaccines. For example, female deer treated with the PZP vaccine will exhibit multiple estrous cycles, and excessive chasing behavior by male deer may exhaust critical fat reserves. Much more research needs to be completed to clearly document this physiological cost. Increased winter mortality for PZP-treated females could occur in years with heavy snowfall or very cold temperatures.

With an estimated annual mortality rate of 20% for roadkill and other losses, a deer herd treated only with contraceptive vaccines will remain at a high level for several years after initiation of a contraception program. From a practical standpoint, it would be better to cull a herd to a goal population size, then dart a portion of the remaining females with contraceptive vaccines to stabilize herd growth (Nielsen et al. 1997). The proportion of deer darted would depend on average reproductive rates and the female age structure of the herd. This can only be calculated with a dynamic population reconstruction model because of the large number of interacting variables.

With several years of reduced fawn production, the herd will shift to an older age structure. It is not known how this might affect deer behavioral interactions over the long term. Also, long-term treatment of females with PZP may impact ovarian function and follicle development (this has been documented for small mammals). More basic physiological research is needed to document these effects on deer populations. A biologically-based, computer model that tracks detailed sex and age information over time is necessary for evaluating the many selective effects of both lethal and non-lethal methods on deer population dynamics.

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