Experimental Contraceptive Vaccines for Wildlife

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Background

Deer and other wildlife enhance our communities and are enjoyed by many residents. However, with low mortality rates and an absence of natural predators, White-tailed Deer (*Odocoileus virginianus*) populations have the potential to double in size every 2-3 years (Moen, 1986, Seagle and Close, 1996). During the past two decades deer densities have reached unprecedented levels in many suburban communities (Curtis and Richmond, 1992), increasing the number of conflicts between deer and suburbanites. For example, it's estimated that deer-related vehicle accidents cost New York State motorists between $50 and $70 million annually (Decker and Loconti, 1989, Decker, et al., 1990).

Hunting, the traditional management tool for regulating wildlife populations, is impractical in some urban landscapes such as parks and airports. Moreover, suburbanites with strong preservation values may question the acceptability of hunting as a management tool. Consequently, wildlife agencies and university scientists are exploring contraceptive methods for managing unhuntable deer herds. This report provides a preliminary assessment of two immunocontraceptive vaccines which may be used to address suburban deer-management concerns in the future.

One of the methods for inhibiting reproduction in wild, free-ranging animals being investigated in New York and other states is immunocontraception. Basically this approach provides for interference within an organism's own reproductive system by artificially inducing an antigenic response that blocks some phase of the reproductive cycle. In essence, reproductive hormones or other potential reproductive antigens are made "non-self" (physiologically unrecognizable) by coupling them with foreign proteins (Talwar and Gaur, 1987, Miller et al., in press). The animal's immune system then creates antibodies that bind the hormone or protein and render it inactive. For White-tailed Deer, the immunizing vaccine will actively inhibit reproduction for 1-3 years without a booster dose once a sufficient antibody response has been

achieved (Turner and Kirkpatrick, 1996).

The mammalian reproductive system is physiologically complex; thus it can be blocked by immunocontraceptive vaccines at several different levels. Two such vaccines are currently being tested at the Seneca Army Depot near Romulus, New York. A Gonadotropin-Releasing Hormone (GnRH) vaccine developed by the USDA-National Wildlife Research Center in Colorado (Miller et al., in press), functions at the pituitary level. GnRH is a small peptide hormone produced by the hypothalamus that stimulates the anterior pituitary gland to produce Lutenizing Hormone (LH) and Follicle Stimulating Hormone (FSH) in females and males. Antibodies to GnRH interfere with its biological action, reducing production of LH and FSH (these hormones are necessary for ovulation and sperm production). Consequently, the GnRH vaccine is effective for both males and females. Male piglets injected with GnRH vaccine in laboratory trials had regressed testes that lacked viable sperm (Meloen et al., 1994). Also, testes from treated rats showed little testosterone production, essentially indicating physiological castration of these males (Miller et al., in press).

Porcine Zona Pellucida (PZP), another vaccine developed from pig ovaries, works at the level of the egg and prevents sperm penetration. It is effective for only female mammals. The Zona Pellucida, a noncellular glycoprotein layer between the egg and granulosa cells surrounding it, functions in sperm-egg recognition, providing species specificity and ensuring that only a single sperm penetrates the egg at fertilization. Antibodies to ZP proteins produced by the female will bind to the ZP of her own eggs, thereby blocking conception by preventing sperm penetration. PZP vaccines have been shown to limit fertility in both free-ranging and captive White-tailed Deer (Turner et al., 1992).

While the antigen-antibody response is well understood and predictable, the ability to deliver PZP vaccines via dart gun to free-ranging deer under field conditions in a cost-effective manner requires further evaluation. It is unclear whether or not sufficient numbers of female deer can be treated with the necessary two doses of PZP vaccine at the appropriate times to have population-level effects. Seagle and Close (1996) estimated that more than 50% of the female deer in a closed population must be treated with contraceptive vaccines to significantly reduce population size during a 5 to 10 year time frame.

Our large-scale field trial at Seneca Army Depot was designed to evaluate the efficacy of remote delivery of immunocontraceptive vaccines developed at the National Wildlife Research Center. Previous trials conducted at Penn State University in cooperation with Dr. Gary Killian, demonstrated a successful antibody response following hand-injection of captive White-tailed Deer with NWRC vaccines. The primary goals of this project are to: (1) learn whether immunocontraceptive vaccines can be cost-effectively delivered to free-ranging deer by dart-gun injection, and (2) compare the efficacy of both GnRH and PZP vaccines in the same herd of deer under semi-controlled conditions.

Study Area and Methods

The study site is the 750-acre (303-ha) Quarantine or Q-Area on post, which is surrounded by a triple, 8-foot-high security fence. The GnRH vaccine is experimental and has not been approved by the Federal Food and Drug Administration (FDA) for use on completely free-ranging deer. Consequently, the Q-

Area provided a large-scale, deer-proof enclosure where we could evaluate remote delivery of the vaccine via dart gun.

Deer were captured primarily with rocket nets or tranquilizer-dart guns at bait stations supplied with apples, apple pumice, shelled corn, and salt. Blinds were placed near old buildings and brush for concealment. Rocket-netting was more cost-effective when there was snow cover, as deer attended the bait piles in groups of 2-6 animals. The mesh on rocket nets was designed to entangle the animals as the net was propelled over the deer. Once under the net, the deer were immobilized immediately with xylazine hydrochloride (Rompun™) for handling and processing. This prompt action reduced animal stress and the possibility of deer injury. Once vaccinated and equipped with identifying tags, yohimbine was administered to promptly reverse the effects of the xylazine.

Deer were also captured using a Pneu-dart™ gun (Pneu-dart Inc., Williamsport, PA) for immobilization. This same gun was also used to deliver contraceptive vaccines. A mixture of xylazine, ketamine, and telazol was used for deer immobilization with the dart gun. Capture darts were loaded via a syringe with the appropriate dose of tranquilizing drugs based on deer weight. Usually the immobilizing drugs were effective in 4-17 minutes, yet we allowed at least 25 minutes after a confirmed hit before conducting a search. The distance traveled by deer after darting was variable, and directly influenced recovery rates. Given the thick brush at Seneca Army Depot, we found only about 50% of the deer that were darted with immobilizing drugs.

Once captured by either method, deer were blind-folded with a soft mask and transferred to a truck for processing and transport to the fenced enclosure (Q-Area). We recorded data on deer condition, age, sex, and weight. Each deer used in the experiment was fitted with a unique number- and color-coded collar. This provided for recognition of individual animals so that we could accurately monitor the efficacy of the contraceptive vaccines in each treated or control deer. Additionally, 21 deer (16 females and 5 males) were fitted with radio collars to monitor survivorship, movements, and behavior.

Thirty-five does and 5 bucks have been treated with both a prime and booster dose of the GnRH contraceptive vaccine during fall 1996. Also 10 control bucks and 25 control females were collared and transported into the Q-Area. An additional 25 females will be collared and treated with the prime dose of PZP vaccine during February 1997.

Future Research Plans and Challenges

This research project is in the early stages, and preliminary results will not be available before fall 1997. We plan to trap GnRH-treated deer during winter in early 1997 and draw blood to measure antibody titers. The 25 does which received their prime dose of PZP during February 1997 will receive a booster dose of PZP, administered in September or early October each year during 1997-99. Also deer injected with the GnRH vaccine in 1996 will receive a single booster dose each fall during 1997-99.

Our first real measure of success will occur during summer 1997, when we compare fawning rates for GnRH-treated and control does. During summer 1998 and 1999, we plan to examine fawning rates for both PZP- and GnRH-treated females. Overall results and conclusions will be available after the year 2000.

There still are several hurdles to overcome before contraception can be widely used to manage deer numbers in

suburban communities. A maze of regulatory requirements must be sorted out at several levels before the first deer can be treated at a specific study site. The FDA must review and approve the research protocol for each research area before free-ranging deer can be treated with PZP vaccines under the current Investigational New Animal Drug (INAD) Permit held by the Humane Society of the United States. The USDA-National Wildlife Research Center is also developing INADs for both PZP and GnRH vaccine use with free-ranging deer and other wildlife. This process should be completed in 1997. Once federal guidelines are met, state wildlife agencies must also approve the study design and issue state permits for trapping, marking, and treating deer with vaccines. Also, local ordinances may require modification to discharge dart guns (technically firearms) or rocket nets in suburban areas to capture and treat deer.

Our initial data analysis indicates that dart-gun delivery of vaccines is time-consuming and expensive, limiting practical applications to areas about a square-mile in size. Current vaccines also require a two-shot protocol, which can be difficult to achieve under field conditions in suburban landscapes with completely free-ranging deer. Moreover, our ability to accurately recognize those animals requiring a second dose of vaccine is currently a serious limitation. Development of a one-shot vaccine and/or an oral delivery system are needed to reduce costs and overcome some of these delivery problems.

Communities need to develop ways to provide a long-term funding base for managing deer herds with contraceptives. Once implemented, deer management with contraceptive drugs will require either annual or biannual booster doses for some portion of the females or males in the herd to achieve a stable population size. Given a sustained-yield model of deer population growth, this could be either a small proportion of a low-density herd, or a relatively high proportion of a high-density herd (McCullough 1979). Seagle and Close (1996) reported that contraception rates of <50% of female deer will curb population growth over a 30-year planning horizon, however, this level of contraception will not reduce population size. Further, their model shows that even with contraception rates exceeding 50% of the female deer, a 5- to 10-year planning horizon was necessary to see significant declines in a closed population.

Access to deer on private lands may be limited if some homeowners choose not to allow deer capture or treatment on their property. Depending on the distribution of winter cover, summer deer ranges, and the ability of managers to attract deer to baited stations, access may pose a problem for achieving management goals with contraceptive vaccines.

In summary, while the technology is available for selective disruption of reproduction, the application and feasibility of this approach for free-ranging wildlife (i.e., White-tailed Deer) still poses a significant challenge for researchers. It may be several years before contraceptive vaccines become a widespread and practical tool for deer management.