In: Humane Wildlife Solutions: The Role of Immunocontraception. Rutberg AT (Ed). Humane Society Press, Washington, DC. 107 Pp. 2005

thened the lives of
sful adoption pro-
phants. More, we
that people and
l in so doing pro-
rld.
chnology to spare
of sharpshooters
so too is pressure
since 1971, wild
slaughter in mas-
: (named after its
nibus Appropria-
es—now approxi-
ng facilities after
he BLM to sell at
d, as well as any
more than three
ge of the Burns
conomic analysis
f immunocontra-
per year—which
ire investment in

r organization of
h Salem for her
r her insightful

ontrol and associat-
e Report 2004–119,

1
CHAPTER

The Elusive Promise of Wildlife Contraception: A Personal Perspective

Jay F. Kirkpatrick

Introduction

During the first half of the 1990s, a great deal of excitement erupted over the promise of managing some wildlife populations with fertility control. Much of that excitement came from the breakthrough with immunocontraception of wild horses on Assateague Island National Seashore in 1988, where twenty-six mares were remotely treated with the porcine zona pellucida (PZP) vaccine and not a single foal was born a year later (Kirkpatrick, Liu, and Turner 1990). Interestingly, the public excitement was directed at the possibility of controlling white-tailed deer rather than wild horses. That is probably reasonable; in areas with large human populations, there are many more troublesome deer populations than there are troublesome horse populations.

In rapid succession it was shown that this vaccine was effective in captive white-tailed deer (Turner, Liu, and Kirkpatrick 1992) and even semi-captive deer (McShea et al. 1997), which only added to the interest among animal protectionists and public officials struggling to defuse deer controversies in their communities. During the early 1990s, requests for the

application of the vaccine to urban and suburban deer multiplied. Although it was not directly related to this expanding interest in deer contraception, the successful application of the vaccine to many different captive wildlife species in zoos (Kirkpatrick et al. 1995, 1996) only fueled the enthusiasm among those who objected to lethal controls.

The first in what would become a series of international conferences addressing this technology was initiated in 1987 in Philadelphia, a year before the breakthrough on Assateague. This was the first time that almost everyone with an interest in the field was brought together to review what was available and what might be developed. It was something of a surprise that so many people attended. It was clear that there was a strong latent interest in a diverse collection of animal welfare and rights groups, government agencies, and wildlife managers. This conference was largely a historic review of what had been accomplished with captive and free-ranging wildlife, but there was a conspicuous absence of successful applications in the field (Cohn et al. 1996). A second conference, in Melbourne, Australia, in 1990, provided little that was new in the way of field experience but focused its attention on the future and what might be possible. By 1993 the success with wild horses on Assateague, the mounting safety and efficacy data, and the captive studies with deer stimulated a third conference, in Denver (Kroeger 1997). There, however, the positive scientific results were greeted by skepticism, and there was open hostility to the very idea of wildlife contraception.

What led to this redirection of what had, until then, appeared to be a monolithic rush toward non-lethal control? The answers can best be understood by carefully studying the issues as they relate to deer.

Deer Contraception

In April 1988 a conference held on the outskirts of Princeton, New Jersey, examined the issues and problems of urban deer (Donald 1993). It barely touched on the possibility of contraception. Nonetheless, it was clear that both the hunting community and the state fish and game agencies perceived non-lethal controls for deer populations as a threat. There was some reasonably civil discourse on the subject but the lines were drawn—lightly, but drawn nevertheless—between opponents and supporters of deer contraception.

A year later, with the as-yet unpublished results of the Assateague horse work starting to make the rounds in wildlife management circles, interest in the possibility of applying the PZP vaccine to deer erupted. A group of citizens in Princeton became intensely interested and lobbied The Humane Society of the United States (HSUS) to sponsor a trial there. Just to the north, an arboretum in Morristown also pleaded to have deer contraception applied on its grounds. Animal welfare and animal rights groups rallied around these initial attempts to initiate deer contraception trials.

Driven by both internal politics and external lobbying from hunters, the New Jersey Fish and Game Department (NJF&G) responded by asserting flatly that deer contraception would not work and that it would never approve such trials. In reaction, several animal rights groups assumed equally radical but opposite, positions. One group repeatedly warned that contraception was the means by which "all sport hunting would be brought to its knees." Others joined the battle, and it has not abated in the years since. The hard-nosed stance by NJF&G even led to an effort by some citizens of New Jersey to change the composition of the Fish and Game Commission and thereby to dilute the influence of the hunting community. The PZP wildlife contraceptive research group left the state, for the time being, alone.

A citizen-driven invitation to examine a possible field site in New York was proffered in 1991. Despite its designation, Fire Island National Seashore (FIIS) includes nearly twenty small communities interspersed between the Seashore's natural areas. Deer populations in these communities had exploded. Many community residents and visitors fed the deer generously, named them, and worried over them. These people were also very wealthy and very influential. They had struggled through a number of legal battles associated with previous attempts to kill what they considered their deer on their island. Ironically, the same conditions that led to the growth of the deer population and the associated controversy made the site an excellent one for a PZP project. Human-habituated deer frequented backyards, boardwalks, and even sundecks, and, rather than fleeing people, approached them for handouts. The PZP research group eagerly agreed to start a project there.

The New York Department of Environmental Conservation (NYDEC), however, was as unenthusiastic about this project as the authorities in New Jersey had been about a project in their state. Because this was federal land, the political and legal issues were more complicated. The Seashore's enabling legislation permitted hunting, the state managed that hunting, and the NYDEC challenged the National Park Service (NPS) over its right to run a contraceptive project with a species managed by the state. The FIIS staff was ambivalent, caught between a vocal and powerful local constituency and an alarmed state agency. The NPS regional science office, however, was less hesitant and took on the state's challenge. Ultimately the NYDEC agreed to cooperate. New Jersey officials, stung by this decision, privately urged NYDEC officials to stop the project, but they did not prevail.

Another project, at the Gaithersburg, Maryland, campus of the National Institute of Standards and Technology (NIST, part of the federal Department of Commerce), was even harder to get off the ground. After the Maryland Department of Natural Resources (MDNR) rejected a series of research permit requests from NIST and the research team, irritated NIST officials went to their Solicitor General for legal advice. The Solicitor General issued an opinion that, because NIST was federal land, the managing agency did not need the state's permission to manage the wildlife there. MDNR counterattacked by soliciting the help of the Congressional Spon-

's Caucus, several of whose members sat on the committee that autho-
NIST's funding. Caucus members wrote NIST to tell it that the cam-
deer population should be managed with a controlled hunt. After a
of the urban 570 acre, high-security, twenty-four-hour-a-day research
ty staffed by 6,000 federal employees and contractors—the Caucus
bers and MDNR agreed that a hunt was not feasible and backed off.
raceptive treatments of NIST deer began in 1996 (Rutberg et al. 2004;
erg, this volume).
the mid-1990s, other small projects began in Ohio, Morristown, New
y (following a legislative hearing in which contraception-friendly leg-
ors raked NJF&G officials over the coals), and in Connecticut. But pro-
d deer contraceptive projects in northern Indiana, Princeton, the Pitts-
h and Philadelphia metropolitan areas, and elsewhere came to naught
acrimonious exchanges between those for and against non-lethal con-
These battles drew in virtually every animal protection group, every
sman's group and even a few governors. In the end a combination of
ape and political maneuvering overcame rational discussions and none
ese projects was started (Kirkpatrick and Turner 1997). The Indiana
rtment of Natural Resources (IDNR) finessed a project in Beverly
es by granting a research permit but imposing conditions that under-
d the research objectives and would have introduced unacceptable
to the health and safety of researchers and animals alike. The state
cies continue to try to thwart projects at this writing; in autumn 2003,
DNR arbitrarily cancelled the research permit for one long-standing
and denied permits for two new deer studies by other contraception
rch groups.
1 years after the initiation of the FIIS study, the FIIS and NIST studies
now shown conclusively that certain deer populations can be managed
even reduced by contraception (Naugle et al. 2002; Rutberg et al.
). Despite these impressive successes in the field, the battle lines are
clear and well defined. State wildlife agencies and a significant portion
nters see deer contraception as a threat to hunting. Because of the
ol these agencies exert over deer research on all but federal lands, the
entum toward establishing contraception as an effective deer man-
ent tool in urban and suburban areas has been slowed dramatically.

e Opponents' Arguments

lor many years, opponents of deer contraception within state agencies
and the wildlife professions pinned their case on scientific issues. The
ears of contraceptive research with steroid hormones—which do pass
gh the food chain—allowed some opponents of deer contraception to
the public by blurring the distinction between steroids and immuno-
raceptive vaccines. They argued or implied that contraceptives pass
gh the food chain and thereby pose a serious risk to wildlife and

people that consume the meat of treated animals (Hanback and Blumig 1993; Guynn 1997). Some even alleged that women who consumed meat from treated animals would become sterile, and men might experience breast enlargement. Gradually the professionals reluctantly accepted that ordinary animal proteins such as PZP cannot pass through the digestive tract and remain biologically active. (Nevertheless, the argument is still posed by hunting groups and other opponents, e.g., Miniter 2001.)

A second argument contended that extended breeding seasons, which result from deer contraception, would deplete the energy resources of treated does (Guynn 1997; Nettles 1997). A Front Royal (Virginia) study directly contradicted this claim and showed that by summer treated does who did not fawn were on the average 15 kg heavier than untreated does who got pregnant and fawned (McShea et al. 1997). A more recent study showed no difference between the condition of treated and untreated animals by the subsequent fall (Walter, Kirkpatrick, and Gregonis 2003). A related concern was that, because of the extended breeding season, bucks would exhaust themselves chasing estrous females for two additional months (Hanback and Blumig 1993; Winand 1999). Again, the Front Royal study showed that there was no frenzied chasing or breeding activities associated with the extended breeding season. Older mature bucks did most of the breeding in the early and midseason periods and then stopped. The younger bucks showed some moderate but non-aggressive interest in the treated does. Informal observations at NIST, FIIS, and other sites confirm that there is some elevated winter breeding activity, but it does not seem to harm the animals involved.

A third argument focused on genetics. How would contraception affect the genetic integrity of the deer herd (Nettles 1997)? This is a legitimate question. However, the same people who were expressing concern about the genetic impact of immunocontraception appeared unfazed by the impact of hunting aimed primarily at pursuing the largest bucks in the land. Hunting of trophy males has caused grave harm in other ungulate populations (Coltman et al. 2003; Milner-Gulland et al. 2003). If America's deer herds had survived for a hundred years with such an intense focus on killing the biggest and the best of the animals, it was hard to imagine that inhibiting the fertility of a few hundred or few thousand selected does would do greater harm.

In one approach to the question of genetic impacts, it was argued that only healthy deer would respond immunologically and become infertile, while sick deer would not make antibodies and would therefore get pregnant. This would result in America's deer herd becoming progressively more unhealthy (Nettles 1997). This argument, supported by a single experiment with an inbred strain of chickens (Haddad et al. 1994), was founded on the more-than-dubious assumption that animals too sickly or feeble to mount an immune response to a simple vaccine could successfully assume the heavy physiological and behavioral burdens of birth and lactation. And the evidence didn't support it: the PZP vaccine has been used on

physiologically stressed herds of western wild horses and in zoos all over North America and Europe, sometimes in sick animals whose health might be compromised by another pregnancy. These stressed and sick animals raised normal antibody titers to PZP (Kirkpatrick et al. 1995, 1996).

Critics also challenged the efficacy of immunocontraception. The initial argument was that wildlife contraception wouldn't work at all. The publication of the Assateague wild horse work and the captive deer work (Kirkpatrick, Liu, and Turner 1990; Turner, Liu, and Kirkpatrick 1992) deflated this change. Then the argument became contraception wouldn't work on free-ranging deer. After McShea (1997) and Kirkpatrick et al. (1997), it was that contraception worked on individual free-ranging deer but didn't control populations (Garrott 1995; Grund 1996; Seagle and Close 1996). The Fire Island and NIST studies finished off that argument (Naugle et al. 2002; Rutberg et al. 2004). One by one, the scientific arguments against deer contraception were countered, based on actual research and field application.

After this string of successful field tests, the opponents of immunocontraception then changed tactics and began to question the cost of immunocontraception. Sportsmen were resolute in the position that no license-generated state fish and game funds should ever be used for this technology. The state agencies agreed. But so, for that matter, did most of the advocates of deer contraception. At potential sites pledges for private money were almost always forthcoming and adequate.

Some hunters and agency staff also suggested that hunters might be deprived of recreation if immunocontraception replaced traditional deer management. However, the shooting of human-habituated deer in city parks has only a minimal connection to sport hunting and the concept of fair chase and, even for many opponents to deer contraception, this was not a legitimate argument.

By this point it was clear that opponents of immunocontraception needed to erect a new set of obstacles, outside of science, and they found them in the issue of regulation.

Regulatory Issues

In 1993 the U.S. Department of Agriculture (USDA) voluntarily bowed out of the regulation of wildlife contraceptives with the rationale that the legislative mandate of the USDA is disease prevention, and that pregnancy is not a disease. The Center for Veterinary Medicine (CVM), of the U.S. Food and Drug Administration (FDA) took over the responsibility for regulation of wildlife contraceptives. The agency issued Investigational New Animal Drug exemptions (INAD) to me for the use of PZP in deer, wild horses, and zoo animals. Lacking the resources required to deal with the ethical and regulatory issues at hand, I soon turned the sponsorship of the INAD over to The HSUS. Unfortunately, assumption of the INAD by The

and further polarized the entire wildlife contraception issue. In the mean time, the FDA insisted that the development of the contraceptive agent the PZP vaccine, be moved forward toward testing and licensing through a New Animal Drug Application (NADA). This is the standard process for the development of any commercial drug, human or veterinary. But it posed something of a problem in this case, because neither the scientific team nor The HSUS had intentions of developing the vaccine as a money-making proposition. In fact, by publishing the findings widely, the research team placed the technology in the public domain, thereby preventing the native PZP vaccine from being patented for use in wildlife. Thus, no single party could lock up access to the technology.

In supervising field trials under the INAD, the FDA insisted that animals treated with the PZP vaccine be captured and tagged with a clear warning not to consume the meat of the animal. (Because of its isolation and the absence of hunting on the island, FIIS has remained the lone exception. Unfortunately, the utility of immunocontraception really lies with remote delivery, and the cost and time involved in capturing urban deer, not to mention the stress and mortality associated with the capture process, may be too great for fertility control to achieve significant and practical results in urban settings unless the tagging requirement is lifted.

The second problem that came along with the FDA regulatory process was the immense cost of testing and clinical trials. By the early 1990s, after the success of PZP with wild horses was understood and accepted, it had become clear that there was no commercial potential for a drug that would only be applied to wildlife. Most pharmaceutical companies think in terms of millions of doses annually, if a profit is to be made, but it is unlikely that more than a few tens of thousands of wild animals, of all species, would ever be treated in a single year. So now, the problem became one of who would invest the millions of dollars necessary to get through the FDA regulatory process when there was no promise of profit at the other end.

By the mid-1990s, some of this pessimism was pushed aside by the prospect of using PZP in companion animals, domestic dogs and cats. This was a potential market that might make the PZP testing and trials cost effective, and the resulting commercial form of the vaccine would still be available for use in wildlife (although there is precious little money available for the purchase of wildlife contraceptives by the potential users). Unfortunately, the PZP vaccine has not worked well in canids and felids and that hope has receded for now (ACCD 2002; Gorman et al. 2002).

Finally, the prospects of developing an effective inexpensive synthetic or recombinant ZP have eluded just about all scientific efforts. A number of synthetic molecules have been developed that elicit impressive antibody titers but they do not cause significant contraception. The problem is that the carbohydrate groups attached to the ZP protein backbone are essential to the molecule's contraceptive effectiveness, and these have not been effectively mimicked in synthetics (Alexander and Schlaff 1996). The

high hurdles to meet the FDA's Good Manufacturing Process (GMP) requirements. Thus, native PZP has moved only slowly toward commercial development despite its success, and its use will remain "experimental" for the time being (even after sixteen years of application to wildlife and another thirty to non-human primates).

This "experimental" label has become a foil for opponents, who argue that we shouldn't be using anything experimental on the public's wildlife. A number of field projects have wilted in the face of agency hostility and associated public nervousness. As the story reached the end of 2003, the U.S. Sportsman's Alliance had selected as one of its two highest priorities putting a stop to deer contraception through federal and state legislation. (The other one is stopping animal rights terrorism.)

Who would have thought that such a simple concept could elicit such strong emotions?

Wild Horses

Wild horse contraception followed a convoluted pathway also, but more progress has been made with this species. The stimulus for wildlife contraception in general was the passage of the Wild, Free-Roaming Horse and Burro Act of 1971 (Public Law 92-195; 16 U.S.C. §133 et seq.), which banned the killing, capturing, and harassing of wild horses on western public lands. While the intent of the law was noble, the new regulations provided for almost no management, and wild horse populations increased dramatically within several years of the passage of the act (Rutberg 2003).

The initial attempts at wild horse contraceptive research, 1971–1976, were carried out with almost no federal support, and there was little interest on the part of the scientific community at large to become involved. In 1977 the Bureau of Land Management (BLM), the federal agency vested by the 1971 Act with the management responsibility for the western wild horses, offered about $300,000 for contraceptive research. To no one's surprise, several research groups immediately became interested and the competition for that money became intense.

The first attempts at wild horse contraception focused on giving stallions a long-acting form of testosterone, which had the effect of reducing sperm counts to the point of infertility. This research had four outcomes worth noting. First, this approach was pharmacologically successful, reducing foaling rates by 83 percent, but it was cumbersome, expensive, and dangerous to man and beast alike (Kirkpatrick, Turner, and Perkins 1982; Turner and Kirkpatrick 1982). The stallions had to be immobilized from a helicopter and injected by hand with a huge dose of the drug. The second outcome was that public objections to horse contraception increased, because of this stress to animals. The third outcome was that the research experience allowed the scientists to develop, for the first time, a set of

characteristics of the ideal wild horse contraceptive. These included (remote delivery of the drug, (2) at least 90 percent efficacy, (3) reversibility in its contraceptive action, (4) safety when administered to pregnant mares, (5) minimal effect on social behaviors, (6) no long-term debilitating health side effects, (7) reasonably low cost, and (8) no passage through the food chain (Kirkpatrick and Turner 1991).

The fourth and final significant outcome was that it signaled to the la er scientific community a willingness of the government to put serio funding behind the effort. Nothing so charges the scientific commun with enthusiasm as money. The problem was, only a single research gro was conducting any work and somehow a larger segment of the resear world had to be permitted to get involved. To solve this problem, the Bl established an advisory committee to review research needs and reco mend appropriate research. The National Academy of Sciences (NA established the committee, which deliberated for a year or so and reco mended that additional money be put into wild horse contracepti research. Thus in 1985, after a five year hiatus, wild horse contracepti research was brought back to life (Wagner 1982).

In 1985 BLM allocated $750,000 for research, and appointed a thr person subcommittee of the NAS committee to screen the proposals a select a research group. There were only three responses to the request f proposals. One was from the stallion contraception group. Another w from the University of Minnesota, proposing to surgically place sterc implants into captured mares. The third, from the University of Californ Davis, was for the study of immunocontraception.

With 20–20 hindsight, it is clear that the immunocontraception propo al was the most meritorious, but it was the proposal for the sterc implants that won the day. A large scale research effort was initiated wi Nevada horses and steroid implants.

In a totally independent and unrelated event, our research group w contacted by the NPS and requested to produce a proposal (for $19,00 to develop a contraceptive approach to the wild horses of Assateague Isla National Seashore (ASIS), in Maryland. The UC-Davis group promoti immunocontraception was again ignored.

From 1985 to 1990, the Nevada and Assateague studies progressed, wi little or no communication between the groups. The steroid implant gro in Nevada showed, in rapid order, that the implants could reduce mare f tility, probably for up to five years per treatment (Eagle et al. 1992). (Assateague, we again showed that reproduction could be inhibited wi androgens, this time using remote delivery (darting) to treat stallions wi long-acting testosterone (Kirkpatrick 1995; chapter 5, this volume). Bc groups were successful in inhibiting fertility, but the shortcomings of bc approaches were again exposed. The animals given the steroid implar sometimes rejected and expelled the implant. The biggest drawback of t implants, however, was that the mares had to be captured and at lc lightly anesthetized before surgery could take place. The cost was high a

the stresses for the animals were significant. At this point, no one had even considered the passage of the drugs through the food chain, which the synthetic steroids used in implants will do. Nor did anyone consider the long-term pathologies associated with these hormones, which had already been shown in other species (Linnehan and Edwards 1991).

The stallion-based research on Assateague followed a similar path. While the approach worked, each stallion had to be darted three separate times just to receive a minimally effective dose—an approach that became increasingly difficult with each successive shot—and the cost of the long-acting steroids was extremely high. In short, it was impractical (Kirkpatrick 1995).

The Nevada project forged ahead despite the obvious impracticalities, but our group shifted gears, throwing out fifteen years of steroid research, and sat down to talk with the previously rejected immunocontraception group at UC-Davis. Fortunately, the NPS persisted, and offered a second chance to the research team. In 1988, after a marriage between the two research groups—our formerly stallion-based group and the immunocontraceptive group—the mares of Assateague were treated with the PZP vaccine.

By 1990 the competition between the two approaches was over. The steroid-implant approach collapsed, not so much because of its impracticality, but because of a disaster with the care and handling of the wild horses recruited for the research. For a variety of reasons, all preventable, nearly 50 of the steroid research group's horses died (Wagner 1992). Public outcry was loud and in little time the research support for this project and group was withdrawn, leaving the BLM with nothing but bad press. On Assateague Island, however, the PZP research was extraordinarily successful and the door was opened to a completely new approach to fertility control in wildlife, including horses (Kirkpatrick, Liu, and Turner 1990).

The Social and Political Response To Wild Horse Contraception

In the 1970s and 1980s, public opinions about wild horse contraception changed in interesting ways in response to the research progress and emerging issues.

When the Wild, Free-Roaming Horse and Burro Act was passed in 1971, there were an estimated 17,000 wild horses on public lands in ten western states. That number has been disputed and is probably, at best, a rough estimate. However by 1980 the estimated number had risen to 80,000 horses. Adopt-A-Horse, which had been the only reduction management tool in the 1970s, was obviously not succeeding.

In 1980 President Reagan appointed James Watt as Secretary of the Interior, which most conservation and animal welfare organizations viewed as hiring the coyote to guard the sheep. As a long-time Wyoming rancher, Watt harbored the time-honored regional dislike of federal government regulation of public lands in the west, and he sought to change th remove much of the protection afforded to wild horses by the 1 Secretary Watt was naive about the emotions evoked by wild horses reluctance of Congress to get into this battle, and his initiati nowhere. Nor did Watt last his full term as secretary. With his as the public lands in general, and wild horses in particular, Watt sing edly changed the complexion of the contraceptive research issue.

Interestingly, while the greatest need for an effective managem belonged to the BLM, the NPS was the agency that took the scie new level. The news and publication (in 1990) of the NPS su Assateague Island spread rapidly and gathered interest and (in son support from a collection of diverse groups, including The HS National Institutes of Health, and the American Zoo and Aquariur ation. Suddenly wildlife contraception was not so bizarre.

In the meantime wild horses were still breeding on the western ra ranching interests were increasing their pressure to do somethi them. In June 1991 Senator Harry Reid (D-NV) led a Senate subcc hearing to find some way to get a grip on the problem of exploding w populations. This was not a minor problem for Reid, since most of th were in his home state. Because the previous contraceptive research steroid implants had ended in disaster, there was a deep natural sus any contraceptive approach. The general public and its elected p did not and, in reality, could not be expected to distinguish betwee based contraception and immunocontraception.

The Senate hearing focused on the research results from Assate how these might be applied to western wild horses. Because ea needed to be darted twice the initial year of treatment and once thereafter, this approach would be unworkable on the vast rang west. The proposed solution was to incorporate the PZP vaccine i gle treatment format that would result in at least two years of co tion. With Reid's backing, a large sum of money—perhaps a mi lars—was appropriated to the BLM over the next ten years development of a one-inoculation vaccine that would have cont effects for two to three years.

Battling Bureaucracies and Competing for the Research Dollar

When the National Biological Survey (which eventually posed into the Biological Resources Division [BRD] of Geological Survey) was created in 1991, it assumed ma research functions of the Department of Interior's three majo resource agencies, the NPS, the BLM, and the U.S. Fish and Wil vice. This included responsibility for wild horse contraception

Unfortunately, the transition was not smooth. The BRD fell almost two years behind in its payments of research funds, and several times the entire project was shut down for nearly a year at a time. And when experiments were planned, the BLM often was unable to gather a sufficient number of mares to meet the requirements of the research design.

In the meantime at least three other research groups were watching the research dollar figures with increasing interest. The "one-inoculation" PZP research group had such a lead, particularly in the field, that it was going to be difficult for the other groups to catch up. Both political and scientific approaches were taken to slow the momentum of the one-inoculation group. When the BRD created an advisory committee to determine the long-range direction of wild horse contraceptive research, it appointed members who were all linked to competing research groups. The one-inoculation PZP group was not represented. The long-term research plan that emerged recommended continuing the ongoing one-inoculation PZP research but also directing funds towards projects that were related to interests and activities of members of the committee. It was almost a replay of the 1980s era NAS advisory committee that awarded federal funds to the steroid implant group; key members of that committee also had strong ties to the research group that received the funds.

The one-inoculation opponents also attempted to muster scientific arguments against PZP, in particular arguing against the safety of the PZP vaccine. Two U.S. Department of Agriculture/Animal and Plant Health Inspection Service (USDA/APHIS) veterinarians working under contract with the BLM objected to moving ahead with PZP field trials on the grounds that the adjuvant (Freund's Complete Adjuvant, or FCA) used in previous field trials was dangerous to horse and researcher alike, even claiming (without any supporting data) that an accidental stick would result in the loss of a finger. That argument was debunked by referring them to sixty years of data by researchers using FCA as well as by fifteen years of experience with it on Assateague and elsewhere (Turner and Kirkpatrick 2002). The APHIS veterinarians also raised the possibility that the FCA would cause a false positive tuberculosis (TB) test in treated horses. (This can be a problem in other species, but there is no reliable test for TB in equids and not a single research group in the United States was even working on developing such a test.)

Ultimately, the BLM and the BRD rejected the scientific arguments. Under the revised strategic plan that emerged from the BRD, the one-inoculation group was allowed to go forward with field trials while the other three or four groups would continue using captive horses. As of 2004 no changes in normal behavior had been noted, no abscesses had been formed, and no one had lost any fingers from needle sticks. Other horses are still being actively managed on Assateague, Cape Lookout, Carrot Island, Return-to-Freedom, and Little Cumberland Island (Kirkpatrick, chapter 5, this volume), but the war rages on.

Role of Animal Protection Groups

Horse protection groups, animal welfare groups, and animal r groups have played shifting and sometimes contradictory ro the history of horse contraception.

In the 1970s, most wild horse advocacy groups, and even some a welfare groups, opposed the idea of wild horse contraception. Most of groups saw only two alternatives during those years: one was to leav horses alone; the other was to harass the animals, using darts, contr tion, capture, and removal. There was almost no recognition that a hunted animal that lives twenty years, has (in most locations) no n enemies, and reproduces impressively fast will ultimately need to be trolled. Driving that failure of recognition was the belief that the BL systematically overestimating the size of horse populations, and groups' deep suspicions of the agency's ultimate motives.

A turning point occurred in the 1980s. In the shadow of James Watt mal protection groups saw that the choices had been reframed. No l were the alternatives contraception versus hands-off; now, it was dart sus bullets. In May 1981, in a historic meeting in the HSUS library in ington, D.C., a coalition of conservation, animal protection, and advocacy groups came to the collective realization that wild horse agement of some kind was necessary. Only the American Horse Prote Association (AHPA) continued (at that time) to oppose the idea o management. Overnight, almost all those horse advocacy groups and mal protection groups, which had opposed contraception, took up its ner and promoted the idea.

The involvement of The HSUS proved both helpful and harmful in th tiation of the Nevada one-inoculation studies in the early 1990s. In The HSUS signed a Memorandum of Agreement (MOA) with the BL cosponsor the first western PZP trials. Although the BLM was ambiv about the MOA due to its history of antagonism with The HSUS, it sa choice; The HSUS provided it with the political cover it needed to pr contraception after the humane catastrophe of the 1980s steroid im studies. On the other hand, HSUS involvement was a mixed bles Because Senator Reid was from Nevada, the congressional appropri was channeled through the University of Nevada at Reno (UNR), though that institution had never been involved in wildlife contrace research. UNR balked, not because it didn't want its share of the m but because animal researchers at UNR had previously battled with humane society." UNR backed down because the BLM refused to pro without The HSUS, and UNR did not want to explain to Reid why the ject had stopped. (Ironically, "the humane society" that had raised U ire was actually a local organization unaffiliated with The HSUS.) De a decision to move ahead, the involvement of an animal protection g once again caused discomfort and polarization.

In the post-Watt 1980s, animal protection groups largely supported the concept of horse contraception and enthusiastically urged it upon the BLM at every opportunity. But as the concept has turned to reality, and the BLM has increasingly embraced it, some of these same horse advocacy groups are backing away from the concept. Not trusting the BLM, they do not trust contraception in the BLM's hands. In 2002 The Fund for Animals blocked a wild horse contraception project at the Pryor Mountain Wild Horse Range by filing a formal appeal with the Interior Department. The Fund, which generally supports wildlife contraception, argued that the BLM's novel "humane use" justification for the project—the reduction of suffering and death among the horses by preventing pregnancies in very young mares—had been inadequately debated by the public, and moreover was too intrusive. In the end, The HSUS negotiated an agreement with The Fund and the appeal was dropped.

Zoo Contraception

Application of contraception to zoo animals should have been relatively simple. One of the largest problems zoos have is the production of "surplus animals" from unplanned pregnancies and births, and contraception is an obvious and seemingly easy-to-implement solution. But even this application was not to be simple.

The widespread application of contraception in zoos came into vogue in the 1970s, with the development of the progestin-based melengestrol acetate (MGA) implant. The MGA implants work quite well, but serious pathologies result from their use, and they are used today with a great deal of caution (AZA Contraceptive Advisory Group 2003 Recommendations, St. Louis Zoo; Frank, this volume). Nevertheless, the MGA implants have been among the most commonly used zoo contraceptives for the better part of fifteen years.

In October 1989 the success with PZP was described in a report to the annual meeting of the American Zoo and Aquarium Association (AZA). PZP was intriguing to zoos because, as opposed to the MGA implants, the vaccine could be delivered remotely. At this same meeting, AZA's first advisory committee on zoo contraception was created. The committee was first named the Steroid Contraceptive Advisory Committee, and its role was to advise zoos on contraceptive use. The recent PZP data from Assateague was of interest to some in AZA but the association of the PZP group with The HSUS, which had been at odds with AZA for many years over a variety of issues, cooled enthusiasm for the technology. In any case, there were no inquiries by the AZA committee regarding the use of PZP and there seemed to be little future for immunocontraception in the zoo world at that time.

In 1990, halfway around the world, zoo managers at the Köln Zoo (Cologne) in Germany were looking for a way to control fertility in Przewalski's horses and were considering MGA implants. By coincidence, Ron Keiper, a long-time wild horse researcher who established his repu Assateague Island, was visiting the Köln Zoo. Aware of the succes on Assateague, he passed the information along to the zoo's man

The Köln Zoo managers then invited me to a conference in Leip reintroducing Przewalski's horses into Mongolia. The invitation w text; from Leipzig, I was taken to Köln and initiated a PZP immun ception project with Przewalski's horses at the zoo. The zoo add banteng to the treatment list, and zoo immunocontraception was l with this modest start. Of course, it worked well (Kirkpatrick et al

Word about the trials at Köln filtered their way back to the Unite but interest in the PZP approach was slow to develop. The break ca in 1990. The executive director of the American Association of Zo narians (AAZV), who was following the immunocontraception with interest, encouraged one of the veterinarians at the Bronx Zo PZP a closer look. In December a number of sika deer, axis deer, Hi tahr, elk, and muntjac deer at the Bronx Zoo were treated with l once again, it worked (Kirkpatrick et al. 1996). It was a modest sta North American zoo world.

Again, The HSUS played an ambiguous role. The Bronx Zoo trials be jointly funded by the zoo and The HSUS. However, when the Br director discovered this arrangement, he balked and insisted that zoo pay for the project. As it turned out, both parties paid their sha ever, the Bronx Zoo did not continue with PZP contraception aft pletion of the study.

In 1991 several other zoos started trials with PZP and, in 1992, tl invited the PZP team to speak at its annual meeting in Oakland. A MGA implants are still the most widely used zoo contraceptive, vaccine today is used in more than 100 zoos and in more than 100 (Frank, this volume), and the PZP team is represented on the AZA ceptive Advisory Group.

Reliable Field Personnel

If the thirty-one-year experience of wildlife contraception has sho thing, it is that no fertility control project, regardless of the behind it or the particular technology employed, will be any bett the people in the field delivering the technology. That probably sou evident, but, along with fish and game agency resistance, the sca qualified field personnel is rapidly becoming the most important neck in the entire effort to manage wildlife through contraception al case studies make this point very clearly.

In the early 1990s, a member of the research team traveled to Virgin National Park to administer initial PZP treatments to burros (Turner, l Kirkpatrick 1996). Park personnel were trained to give the booster i tions at a later date. This project was difficult from the start, burden

poor delivery equipment, dense brush, and very smart animals. When the time for the booster inoculations arrived, the assigned personnel were diverted to another project by the park's administration and the animals were not boosted on time. The project ultimately succeeded only because the researcher repeatedly returned to the park to do the work himself.

A similar problem has plagued the deer contraception project on Fire Island National Seashore. After six or seven years of treating the deer there, The HSUS requested that the national seashore take over the responsibility for the project. The NPS has made significant efforts to assist the vaccination; but employee turnover, lack of committed resources, and NPS reluctance to make decisions have meant that, more than ten years after it started, the project is still heavily dependent on HSUS personnel to get the work done. Ironically, the reduction in deer populations brought about by the project has lowered public concern about the deer, which in turn has reduced pressure on the NPS to commit resources to the project.

During the 1990s intense one-week training workshops were organized in Maryland for potential participants in deer contraception projects, and in Montana for BLM personnel assigned to administer the PZP vaccine to wild horses on their own ranges. But, in both cases, unless workshop participants dealt with the vaccine and the delivery systems on at least a weekly basis, the details were quickly forgotten.

Several successful examples of developing field personnel exist. Placing a high priority on field competence, The HSUS employs a person who has little other responsibility than to conduct field work and treat deer, and in some cases wild horses, remotely, with darts. This person is the single largest reason why the Fire Island and NIST deer projects have been so successful. Likewise, Assateague Island National Seashore and Cape Lookout National Seashore each assigns a full-time employee major responsibility for the management of horses. These rangers keep the inventory of horses, monitor band composition, home ranges, and behavior, dart the animals every year, and collect urine and fecal samples for remote pregnancy testing.

In all three success stories, the common thread is that there are personnel dedicated to the field aspect of wildlife contraception. Making this issue even more difficult is the number of other qualities, aside from skill with a dart gun, that field personnel should have. These particular individuals need to be sensitive to the animals they pursue and should not be willing to risk shots that might injure the animal. They need an intimate knowledge of the animals' behaviors and their home ranges. They need to know how to deal tactfully with an inquisitive public. And they need the patience of Job.

Where will these field personnel come from and who will support them? This is a critical question if wildlife contraception is to reach its full potential. At present there are no more than ten people available with the proper training and approach. At least four of them are government employees with little opportunity to work outside their own agencies. Those interested in moving wildlife contraception ahead must assure that this need for

Conclusion

Beyond the wild horses, urban deer, and zoo animals, PZP l applied to African elephants, elk in a national park, water bi a military reservation, and a few other species. In every case animals showed sharply reduced fertility. Most of these other app were accompanied by their own strange brand of politics, suggest the whole topic of wildlife contraception invites multifaceted con Today wild horse contraception moves steadily along but not nearl as the horses reproduce or the problem requires. Urban deer contr is progressing sluggishly, and most of the ongoing projects are or land where state agencies have limited authority. Only zoo contr moves ahead, growing annually, and (for now) relatively unscathec political battles.

Several outstanding factors lie behind the failure of wildlife co tion to advance. By far the largest is the official opposition of fish a agencies, which see contraception as a threat to hunting. They ha a masterful job of convincing the larger hunting community tha people with dart guns may ultimately destroy public hunting. Few scientific arguments hold water and, in many cases, deliberate r mation has been the primary weapon against contraception.

The most probable explanation, but certainly not the universal a this mystery, is the polarization between the animal protection gro particularly The HSUS, and the hunting community, official or ot Even when the population of deer at the center of a particular dis never, *can never*, be hunted, the deep animosities between hunters animal protection groups keep the feud hot and lively.

A second failure of the wildlife contraceptive movement lies with ure (to date) to have any particular contraceptive agent approve FDA for general use. The lack of FDA approval concerns the public cern that is fanned into fright by the misinformation circulated b nents. The extensive published record of safety and efficacy demo for immunocontraceptives suggests that the failure to gain FDA a is less a scientific issue than a process issue; currently, immense re are needed to move a new drug through the FDA's formal test approval process. Because demand for wildlife immunocontracept be limited, there are no economic incentives to do so. There are ecological, and social incentives, but no one will make money pr immunocontraceptives for wildlife.

Finally, the challenge of finding, training, and supporting field pe must be overcome. This is particularly pertinent because it is emb of the larger problem of wildlife contraception—that there is no ec incentive to solve it. Personnel must be able to pick up and travel eral weeks at a time, while being able to support themselves in oth for the better part of each year. They must possess their own deliver ment, even when they are not in the field, in order to keep skills

must have a sense of caring and ethics that are consistent with those of the animal protection community.

Wildlife contraception has a future, but the emotional, knee-jerk reactions that hunters, fish and game agencies, and animal protection organizations have to one another will have to be overcome. In addition, either some form of concession will be needed from the FDA, or the PZP vaccine and its adjuvants must be taken through the entire FDA New Animal Drug Application process. Some plan for the identification and training—and funding—of field personnel will have to be developed. The development of wildlife contraception technology must be distanced from politics, and decisions about whether (and where) fertility control should be applied to a particular species, and which technology will be used, must be reached not on the basis of political favoritism and factional nonsense, but on proven science.

Literature Cited

Alliance for the Contraception of Cats and Dogs (ACCD). 2002. *F*
ings of the International Symposium on Nonsurgical Methods for I
ulation Control. Pine Mountain, Ga. April 19–21.

Alexander, N.J., and W.D. Schiff. 1996. Highlights of the symposiun
nal of Reproduction and Fertility Supplement 50: 191–194.

Cohn, P.N., E.D. Plotka, and U.S. Seal. 1996. *Contraception in*
Lewiston, Me.: The Edwin Mellon Press.

Coltman, D.W., P. O'Donoghue, J.T. Jorgenson, J.T. Hogg, C. Strobe
M. Festa-Blanchet. 2003. Undesirable evolutionary consequenoes
phy hunting. *Nature* 426: 655–658.

Donald, R.L., ed. 1993. *Deer management in an urbanizing regior*
lems and alternatives to traditional management. Washington, D.
Humane Society of the United States.

Eagle, T.C., E.D. Plotka, R.A. Garrott, D.B. Sinoff, and J.R. Testei
Efficacy of chemical contraception in feral mares. *Wildlife Society*
20: 211–216.

Garrott, R.A. 1995. Effective management of free-ranging ungulat
lations using contraception. *Wildlife Society Bulletin* 23: 445–452

Gorman, S.P., J.K. Levy, A.L. Hampton, W.R. Collante, A.L. Harris, a
Brown. 2002. Evaluation of a porcine zona pellucida vaccine
immunocontraception of domestic kittens (*Felis catus*). *Theriog*
58: 135–149.

Grund, M.D. 1996. Deer contraceptives: What's the real price? *D*
Deer Hunting, October, 155 ff.

Guynn, D.C., Jr. 1997. Contraception in wildlife management: Re
illusion? In *Contraception in wildlife management*, ed. T.J. K
241–246. USDA/APHIS Technical Bulletin 1853, Washington, D.

Haddad, E.E., N.B. Anthony, R. Bridges, C. Whitfill, J.K. Skeeles,
Thoma. 1994. Evaluation of the humoral immune response to d
antigens in Arkansas Regressor and Progressor chickens. *Poultry*
73: 341–345.

Hanback, M., and C. Blumig. 1993. Now it's deer on the pill. *Outdc*
July, 68 ff.

Kirkpatrick, J.F. 1995. *Management of wild horses by fertility cont*
Assateague experience. National Park Service scientific mon
National Park Service, Denver, Colo.

Kirkpatrick, J.F., and J.W. Turner, Jr. 1991. Reversible fertility co
nondomestic animals. *Journal of Zoo and Wildlife Medicine* 22: 3

———. 1997. Urban deer contraception: The seven stages of grief.
Society Bulletin 25: 515–519.

Kirkpatrick, J.F., I.K.M. Liu, and J.W. Turner, Jr. 1990. Remotely-d
immunocontraception in feral horses. *Wildlife Society Bulle*
326–330.

Kirkpatrick, J.F., J.W. Turner, and A. Perkins. 1982. Reversible fertility control in feral horses. *Journal of Equine Veterinary Science* 2: 114–118.

Kirkpatrick, J.F., P.P. Calle, P. Kalk, I.K.M. Liu, and J.W. Turner. 1996. Immunocontraception of captive exotic species: II. Formosan sika deer (*Cervus nippon taioucanus*), Axis deer (*Cervus axis*), Himalayan tahr (*Hemitragus jemlahicus*), Roosevelt elk (*Cervus elaphus roosevelti*), Reeves' muntjac (*Muntiacus reevesi*), and Sambar deer (*Cervus unicolor*). *Journal of Zoo and Wildlife Medicine* 27: 482–495.

Kirkpatrick, J.F., W. Zimmermann, L. Kolter, I.K.M. Liu, and J.W. Turner, Jr. 1995. Immunocontraception of captive Exotic Species: I. Przewalski's horses (*Equus przewalskii*) and banteng (*Bos javanicus*). *Zoo Biology* 14: 403–416.

Kreeger, T.J. 1997. *Contraception in wildlife management*. U.S. Department of Agriculture, APHIS. Technical Bulletin No. 1853. Washington, D.C.

Linnehan, R.M., and J.L. Edwards. 1991. Endometrial adenocarcinoma in a Bengal tiger (*Panthera tigris bengalensis*) implanted with melengestrol acetate. *Journal of Zoo and Wildlife Medicine* 22: 358–363.

McShea, W.J., S.L. Monfort, S. Hakim, J.F. Kirkpatrick, I.K.M. Liu, J.W. Turner, L. Chassey, and L. Munson. 1997. Immunocontraceptive efficacy and the impact of contraception on the reproductive behaviors of white-tailed deer. *Journal of Wildlife Management* 60: 23–34.

Milner-Gulland, E.J., O.M. Bukreeva, T. Coulson, A.A. Lushchekina, M.V. Kholodova, A.B. Bekenov, and I.A. Grachev. 2003. Reproductive collapse in saiga antelope harems. *Nature* 422: 135.

Miniter, F. 2001. Mad science: Will scientists replace hunters? *Outdoor Life* 208 (4), November, 74 ff.

Naugle, R.E., A.T. Rutberg, H.B. Underwood, J.W. Turner, Jr., and I.K.M. Liu. 2002. Field testing of immunocontraception on white-tailed deer (*Odocoileus virginianus*) on Fire Island National Seashore, New York, U.S.A. *Reproduction Supplement* 60: 143–153.

Nettles, V.F. 1997. Potential consequences and problems with wildlife contraceptives. *Reproduction, Fertility, and Development* 9: 137–144.

Rutberg, A.T. 2003. Wild horses and burros in the United States. In *The State of the Animals II: 2003*, ed. D.J. Salem and A.N. Rowan, 217–222. Washington, D.C: Humane Society Press.

Rutberg, A.T., R.E. Naugle, L.A. Thiele, and I.K.M. Liu. 2004. Effects of immunocontraception on a suburban population of white-tailed deer (*Odocoileus virginianus*). *Biological Conservation* 116: 243–250.

Seagle, S.W., and J.D. Close. 1996. Modeling white-tailed deer (*Odocoileus virginianus*) population control by contraception. *Biological Conservation* 76: 87–91.

Turner, A., and J.F. Kirkpatrick. 2002. Effects of immunocontraception on population, longevity, and body condition in wild mares (*Equus caballus*). *Reproduction Supplement* 60: 187–195.

Turner, J.W., Jr., and J.F. Kirkpatrick. 1982. Steroids, behavior, and ty control in feral stallions in the field. *Journal of Reproduction a tility Supplement* 32: 79–87.

Turner, J.W., I.K.M. Liu, and J.F. Kirkpatrick. 1992. Remotely-de immunocontraception in captive white-tailed deer. *Journal of Management* 56: 154–157.

Turner, J.W., Jr., I.K.M. Liu, and J.F. Kirkpatrick. 1996. Remotely de immunocontraception in free-roaming feral burros. *Journal of duction and Fertility* 107: 31–35.

Wagner, F.H. 1982. *Wild and free-roaming horses and burros*. Final National Academy Press, Washington, D.C.

Walter, W.D., H.J. Kilpatrick, and M.A. Gregonis. 2003. Does immu traception improve condition of free-ranging female white-tailed *Journal of Wildlife Management* 67: 762–766.

Winand, C.J. 1999. Deer contraceptives. *Buckmasters Whitetail Ma* October, 92 ff.