Adaptive Management for Deer: A Case Study from Pennsylvania

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Abstract: *The Sand County Foundation, working with local foresters, biologists, researchers, hunters, and community leaders, developed an adaptive management program (Quality Hunting Ecology) to reduce the ecological impact of deer damage on a 74,000 acre demonstration area in north central Pennsylvania. Program goals were simple: produce healthy forests, healthy deer, happy foresters, and happy hunters. Tools (with helpful assists from the Pennsylvania Game Commission) included: 1) education - providing hunters and other interested publics information on deer quality, biology, and impacts with workshops and news releases; 2) access - providing better access and increasing awareness of access to hunting areas; 3) hunting regulations tweaking regulations to improve antler characteristics and increase antlerless harvest; 4) incentives - rewarding hunters for harvesting deer; and, 5) luck unforeseen assists from weather in the form of 3 successive harsh winters. Monitoring included: 1) spring deer density and impact (on forest vegetation) counts; 2) pre-hunt roadside counts of herd sex and age composition; 3) check station operations for harvest characteristics; and 4) evaluation of hunter success and satisfaction. Prior to the program, overwinter population was 40% higher than recommended by the state game commission, impact on forest vegetation was high, and deer were small with poor racks. Over the last three years, deer density and impact on vegetation have declined by approximately 50% and deer body weight and antler characteristics have increased significantly. The biggest challenge will be keeping hunters happy and actively participating (continuing to harvest antlerless deer) as numbers of deer decline and stay low.*

In Pennsylvania, as in other eastern states, deer have increased in abundance since the 1920's. Likewise, negative deer impact has increased on tree regeneration, and on shrub and herbaceous vegetation survival. The solution to these problems, reducing deer abundance by increasing antlerless deer harvest, has been thwarted by conservative harvest regulations, poor access, low hunter turnout and success rates, and reluctance of hunters to harvest antlerless deer. Enlightened management in deer in Pennsylvania, as in other eastern states, seemingly, could be enhanced by an adaptive management approach to the issue.

Adaptive management, as a paradigm for proactive management of wildlife species and communities, requires vision, including definitive goal statements, flexibility in tools and the ability to use them, and comprehensive monitoring to determine progress towards goal achievement and potential need for adjustments in management activities. Adaptive management is an established concept (Holling 1978, Walters 1986): recently Walters (1997) defined it as a

". . . structured process of learning by doing that involves more than ecological monitoring and response to unexpected management impacts."

More specifically, Walters stated that adaptive management should integrate existing interdisciplinary experience (in our case forestry and wildlife) and scientific information into dynamic modeling to make predictions about the impacts of alternative (management) policies. Further, the modeling is to serve three functions: (1) problem clarification and enhanced communication among scientists, managers, and other stakeholders; (2) policy screening to eliminate options that are most likely incapable of doing much good, because of inadequate scale

or type of impact; and (3) identification of key knowledge gaps that make model predictions suspect.

The British Columbia Ministry of Forests and Range (2000) more practically defines Adaptive Management and includes a diagram depicting a cycle of activity (Fig. 1):

"Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Its most effective form active adaptive management employs management programs that are designed to experimentally compare selected policies or practices, by evaluating alternative hypotheses about the system being managed."

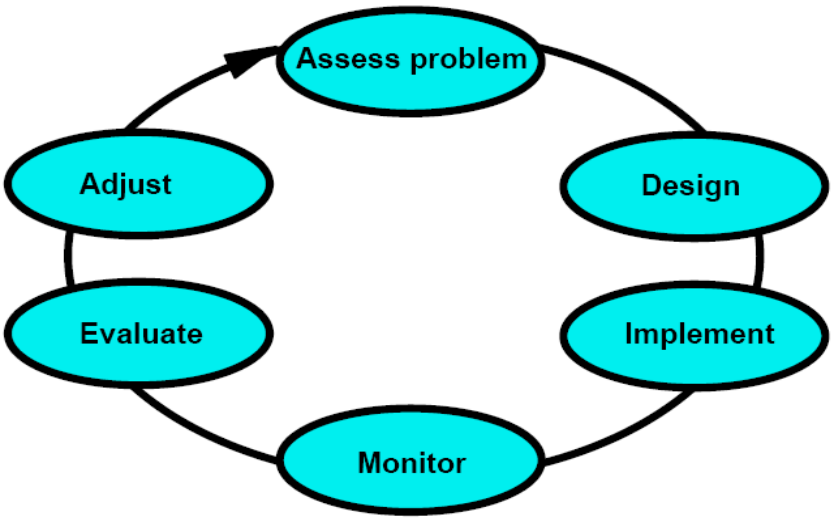

***Figure 1**. Six step cycle of adaptive management (BC Ministry of Forests and Range).*

The deer herd in Pennsylvania was perceived by wildlife managers to be causing negative impact on understory vegetation as early as the 1920s. The management strategy at that time was to allow hunters to harvest doe deer in an attempt to reduce reproduction, and herd density, below the (undefined) point where damage to understory vegetation was acceptable (also undefined). Antlerless tags were issued to hunters thereafter without monitoring of the result, excepting that in 1940 a harsh winter, coupled with liberal antlerless deer tags, resulted in a large crash in the deer population. Ever since, hunters were reluctant to harvest antlerless deer and lobbied to reduce doe hunting. Another population crash following a series of harsh winters (1978-79) was followed by an additional management step to increase doe harvest by management authorities (Pennsylvania Game Commission, hereafter referred to as PGC) in the late 1980s: hunters were allowed to apply for unused antlerless tags as bonus tags. The bonus system succeeded in stabilizing the state-wide deer herd at approximately 27 deer per square mile, but this density exceeded that necessary to permit successful regeneration of tree species and a diversity of structure and species of understory vegetation.

By 2000 it was well-established that deer density of approximately 27 deer per square mile state-wide, with a herd heavily weighted to females and yearling bucks continued to be associated with understory regeneration failures and poor quality deer across Pennsylvania. Accordingly, the PGC initiated an aggressive program of hunter education in a new management strategy: enlightened hunters would see the need for reducing the deer herd and would aggressively hunt and harvest antlerless deer. A further management step was added in 2002 to increase antler quality: a 3 point regulation whereby hunters could only harvest deer with at least 3 antler points on either side, the idea being to spare yearling bucks from harvest, allowing them to grow into 2 ½ year and older deer with larger antler characteristics. Finally, in 2004 a last management strategy was instituted: a Deer Management Assistance Program (DMAP) whereby forest and farm landowners could receive

additional antlerless tags to distribute to hunters to reduce deer density and impacts in selected areas.

All of these steps initiated by the PGC could be construed as *ad hoc* adaptive management. However, the PGC did not develop comprehensive and inclusive indicators for success in this program, as the primary indicators utilized were deer density and number of yearling bucks in the harvest. There was no monitoring of hunter satisfaction or education, nor was there monitoring of responses of understory vegetation (wildlife habitat).

In 2000 the Sand County Foundation (a not for profit organization), working with scientists, managers, and stakeholders (foresters, biologists, researchers, hunters, and community leaders), developed an adaptive management program (Kinzua Quality Deer Cooperative hereafter referred to as KQDC) on a 74,000 acre demonstration area in north central Pennsylvania. The program is administered by a Leadership Team comprised of scientists, managers, foresters, hunters, and representatives for the Sand County Foundation and local recreational and economic interests.

The KQDC Leadership Team enhanced the definition and accompanying graphic to include a statement of goals, a list of indicators of success for reaching goals, and quantitative enumeration and evaluation of the indicators (Fig. 2).

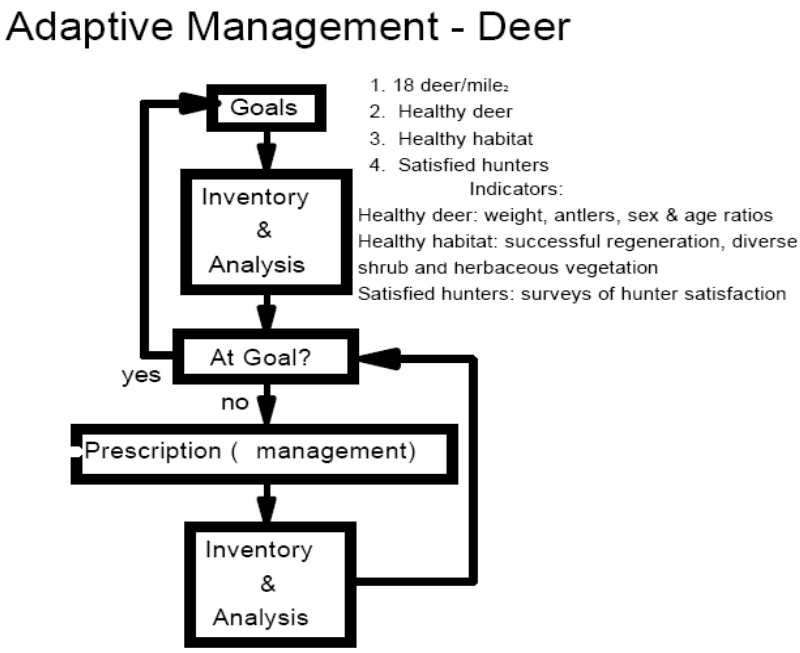

***Figure 2**. KQDC adaptive management illustration including goals and indicators.*

Goals were simple: drive deer density from an existing 28.7 deer per square mile to 18 deer per square mile (density associated with successful regeneration of tree species); produce healthy deer, and healthy habitat. Methods employed to achieve the goals were: launch an aggressive educational program for hunters; and lobby the PGC for additional regulations to increase harvest of antlerless deer and improve deer herd health. Part of the educational program involved incentives: hunters bringing deer to checking stations were issued tickets to a hunter appreciation banquet after the season. The tickets doubled as raffle tickets. Hunters were rewarded for harvesting antlerless deer by being issued two raffle tickets (hunters harvesting antlered deer received only one raffle ticket). Prizes raffled off at the banquet included hunting rifles and other hunting equipment as well as certificates for weekend get-aways.

Indicators for healthy deer were field dressed body weights of harvested deer (> 150 pounds for adult males, > 110 pounds for adult females, > 70 pounds for fawns), antler characteristics of harvested deer (sum of right and left antler averaging > 8 points, antler spread averaging > 16 inches; average beam diameter averaging > 30mm), and defined sex and age ratios of the pre-hunt deer herd (buck:doe ratio ~ 1:3-4; fawn:doe ratio > 1:2). The low goal ratio for fawns:does related to the finding that in Pennsylvania, bear, coyotes, and other predators reduce fawn abundance by approximately 50% prior to the hunting season.

Indicators for healthy habitat were successful regeneration of a diversity of tree species, and presence of a diverse structural and species rich understory of shrubs and herbs. Indicators evaluated by this study were impact levels on six selected indicator tree species (goal level = light), and % of field plots exhibiting no deer browsing impact (goal level > 50%), and % field plots exhibiting no regeneration of any tree or shrub species (goal level < 20). A separate study evaluated more comprehensive indicators of deer impact on regeneration, shrubs, and herbaceous vegetation.

Indicators of satisfied hunters were to be included in a hunter satisfaction survey that has yet to be completed.

The KQDC demonstration project was conducted on a 74,000 acre demonstration area in north central Pennsylvania and included lands of 5 cooperating agencies: two public landowners (the USDA Forest Service Allegheny National Forest and Bradford Water Authority); and three private timber-managing companies (Collins Pine, Forest Investment Associates, and RAMCO)(Fig. 3).

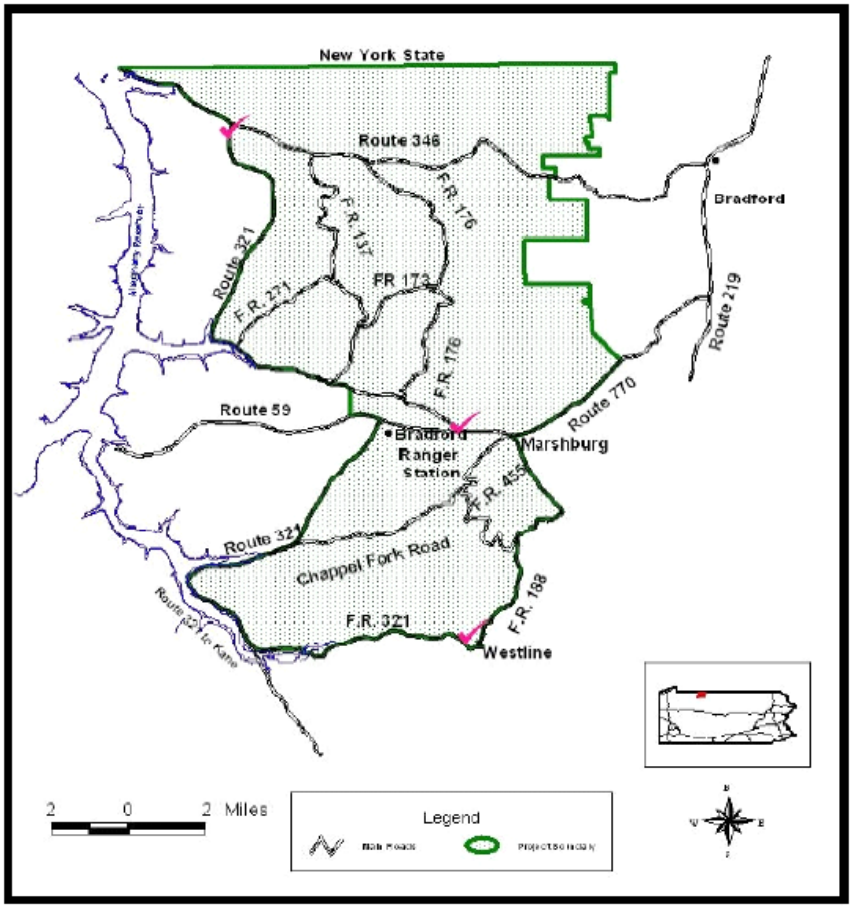

***Figure 3**. KQDC demonstration area.*

Monitoring

Monitoring consisted of three phases: springtime estimation of deer density and impact on selected indicator seedling species; pre-hunt estimation of sex and age ratios of the herd; and check stations to evaluate herd health, including antler characteristics. Data are presented for 2001-2004 when information was comprehensive and complete.

Deer density and impact. - Data for estimating overwinter deer density and deer impact on indicator plant species were collected from plots spaced 100 apart on five transects 5,280 long spaced 1,000 apart. Twenty-four grids of five transect lines were randomly located within the KQDC demonstration area; the figure below portrays a typical grid of five transect lines.

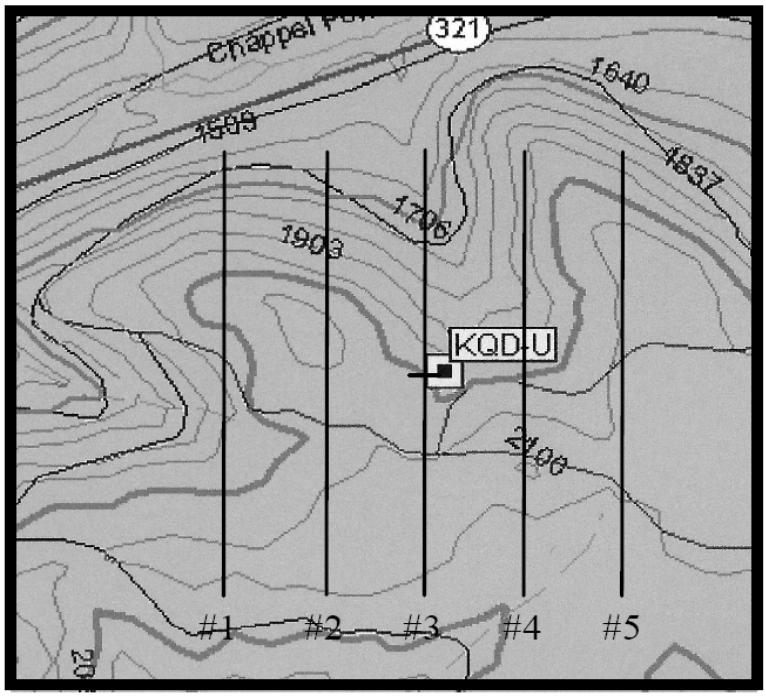

***Figure 4**. Typical deer density and impact grid.*

The middle transect line (line #3) runs through the center point of each randomly located grid. Deer density data (counts of deer pellet groups) were collected on every plot; impact data (five impact levels on five indicator plant species as well as number of plots with no regeneration and percent of plots with no impact) were collected on every other plot.

Density and impact data were collected by volunteers after the snow melted (to reveal presence of pellet groups) and prior to green-up of ground vegetation (after which pellet groups are covered by ground vegetation such as ferns and club mosses)(generally April 1 May 10). An annual workshop for training volunteers and other interested publics, including hunters, was conducted at one 24 of the KQDC grids (grid M).

The five transect lines at each of the 24 locations were each treated as replicates: for estimates of deer density and impact there were thus five replicate samples. Each replicate sample of 24 transect lines was derived by randomly assigning the numbers 1-5 to each transect line at each location. The first replicate sample was comprised of all transect lines randomly selected as # 1, the second replicate sample was comprised of all transect lines randomly selected as #2 and so on.

Sex and age ratios. - Data for estimating pre-hunt deer sex and age characteristics and ratios were collected from six roadside routes located throughout the KQDC demonstration area (Fig. 5). Routes are run two hours before sunset and two hours after dawn, August 1 September 15 by volunteer crews.

Deer herd health. - Check stations were located at the north, middle, and southern portions of the KQDC Demonstration Area. Check stations operated from 10am in the morning to 7 pm at night. All were open the first two days of the season (November 29th and 30th). Two of the check stations were open the first Saturday of the season, and one was open the last Saturday of the season. A paid worker supervised work at each check station, and an additional 10 unpaid volunteers helped collect data at the check stations. Data collected from deer brought to check stations included sex, weight, age, girth, antler characteristics (number points both sides and in aggregate, spread in inches, diameter in mm of right and left beam), location where deer was harvested, day of season deer was harvested, time of day deer was harvested, and time of day deer was brought to the check station.

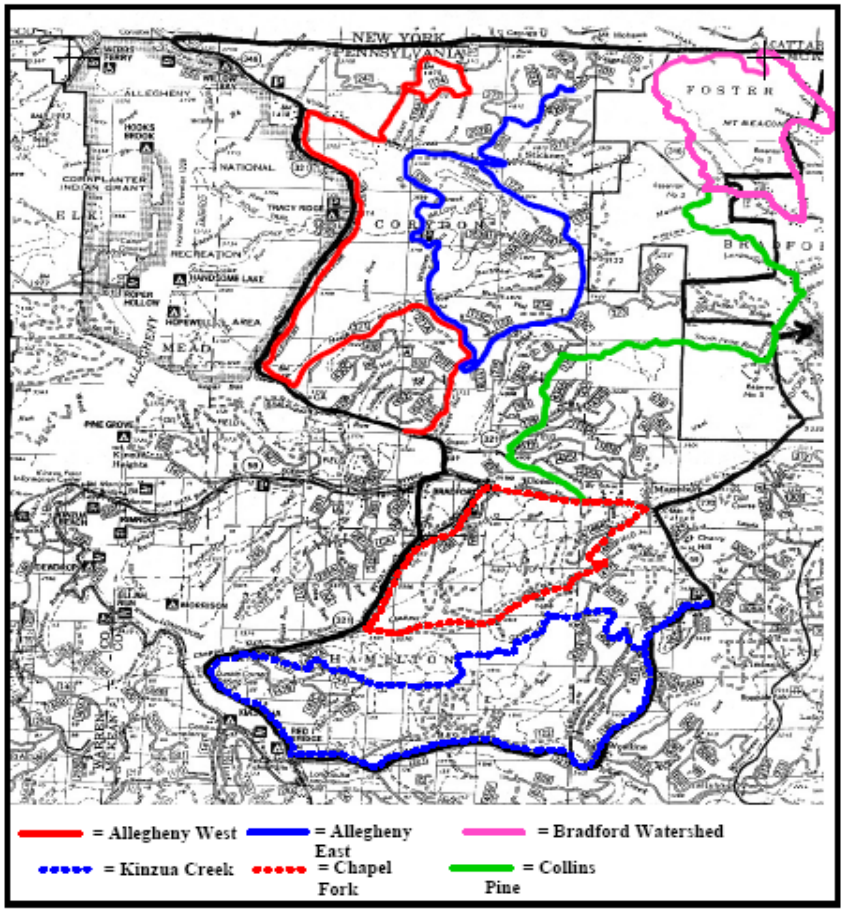

***Figure 5**. Deer roadside count routes within the KQDC demonstration area.*

Response to Adaptive Management

Deer density and impact. - Deer density and impacts were analyzed separately for the northern and southern halves of the KQDC demonstration area. Density declined on the southern half 2002-2004 as did impact: both declined after 2003, the year DMAP was initiated (Fig. 6). Of all PGC wildlife management areas in Pennsylvania (26) only two evidenced reduction in deer density following initiation of the DMAP program and the KQDC demonstration area was one of the two. Seemingly, the DMAP program, initiated in 2003, and perhaps the raffle-incentive programs, resulted in a significant decline in deer density and impact on both halves of the demonstration area. However, density and impacts are still high: the planned adaptive management strategy on the KQDC for 2005 was to provide hunters with maps indicating hot spots of high density, noting access roads into these areas, and encouraging hunters to focus

their hunting efforts there. The practice of inviting hunters to participate in density and impact workshops seemed to work as informal surveys after the conclusion of the workshops, wherein hunters collected density and impact data, and participated in the analysis and interpretation, indicated support for lower deer density and higher levels of harvest, including antlerless deer.

Deer sex and age ratios. - Ratio of fawn:antlerless deer has steadily increased since 2001, meaning that for every year since 2001 it took more does every year to produce one fawn that survived to fall (Table 1). Each doe should produce 1-2 fawns every year, but on the KQDC it took approximately 2 does to produce one fawn in 2001, and by 2004 the rate increased to 3 does required to produce one fawn. Similarly, recruitment (percent increase of herd due to fawn production and survival) has steadily decreased since 2001. In 2001 the deer herd increased by

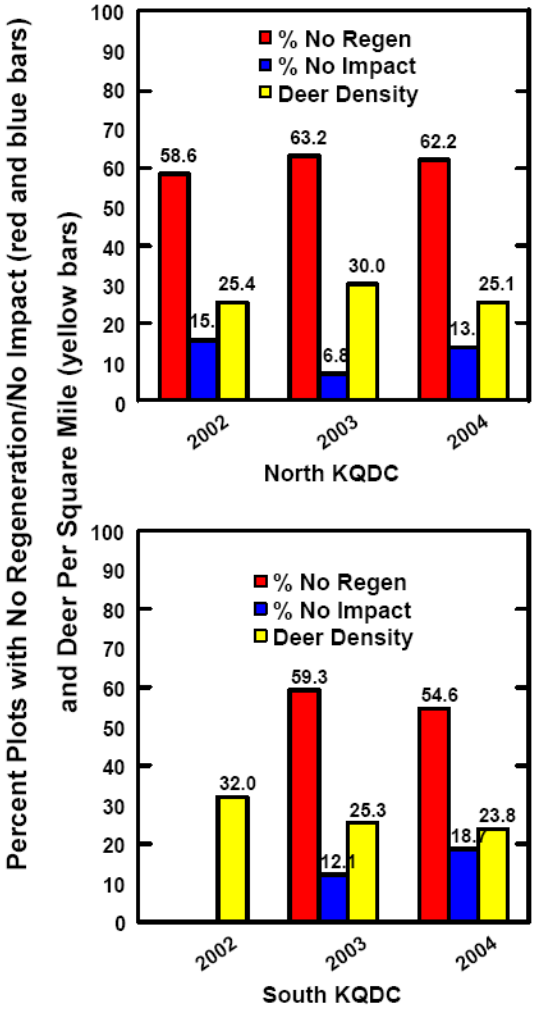

Figure 6. *Deer density and impact on north and south halves of KQDC.*

47% from spring to fall; by 2004 the increase (recruitment) was nearly halved, falling to 25%. Recent research conducted in Pennsylvania by the Pennsylvania Game Commission and Pennsylvania State University suggests that predators (primarily black bear and coyotes) kill about half of the fawns prior to fall; it is reasonable to assume that the same predation rate exists on the KQDC where bears and coyotes are plentiful.

Buck:doe ratios did not improve 2001-2004 despite attempts by the PGC and KQDC to encourage hunters to harvest antlerless deer. Likewise, fawn:doe ratios got worse instead of better. Additionally, fawn pre-hunt recruitment dropped almost by half in 2004. The general

interpretation of these data is that three harsh winters in a row resulted in poor fawn birth and survival rates, especially in 2004.

Table 1. Ratios of fawns:antlerless deer; older bucks: antlerless deer; recruitment rates.

Year	Fawns:Antlerless	Recuitment	Older Bucks:Antleress
2001	1:1.8	47%	1:8.2
2002	1:1.9	41%	1:6.3
2003	1:2.2	40%	1:11.8
2004	1:3.3	25%	1:9.5

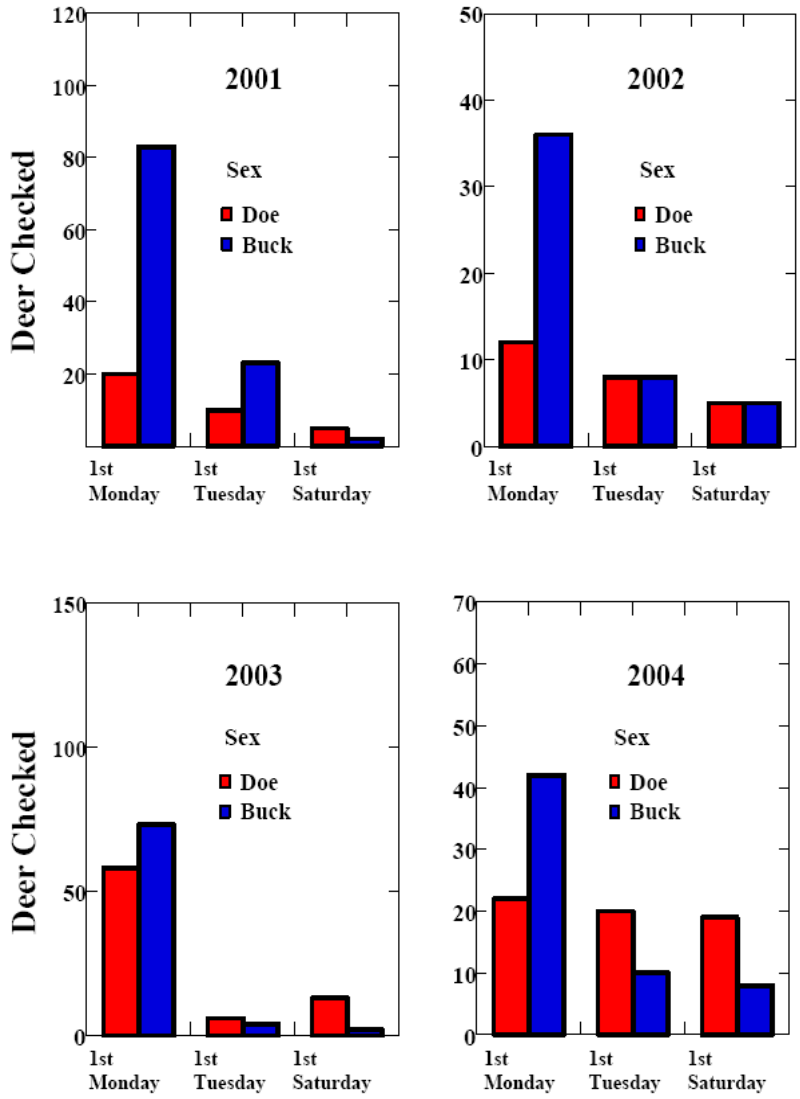

***Figure 7**. Numbers of adult bucks and does brought to check stations 2001-2004.*

The PGC had no additional management initiates to increase harvest of antlerless deer, indeed intense political pressure by hunters resulted in no changes in hunting regulations and antlerless tag regulations. The KQDC has no political leverage over the PGC to increase harvest of antlerless deer save requesting a similar number of DMAP tags for 2004 as it did in 2003.

Deer herd health. - Number of does harvested relative to bucks improved in 2003 the year DMAP was initiated. Bucks continued to be harvested in greater numbers that does on opening day, but after that number of does brought to checking stations was higher than the number of bucks (Fig. 6). In this regard, the DMAP program appeared to be working.

Weight of buck fawn weights increased significantly between 2001-2004; 2002-2004; and 2003-2004: female fawn weights increased slightly 2001-2004 but were not significantly different from year to year (Fig. 7). Adult buck weights increased significantly over time for bucks between 2001and 2003; 2001 and 2004; and 2002 and 2004. Forage quality/quantity affect fawns and adult bucks more than other deer. Fawns are balancing demands of growing and storing fat for survival during winter and adult bucks deplete fat reserves during the rut. Increases in adult buck and fawn weights, especially in 2004, may reflect a response to the slight increase in overwinter forage in 2004.

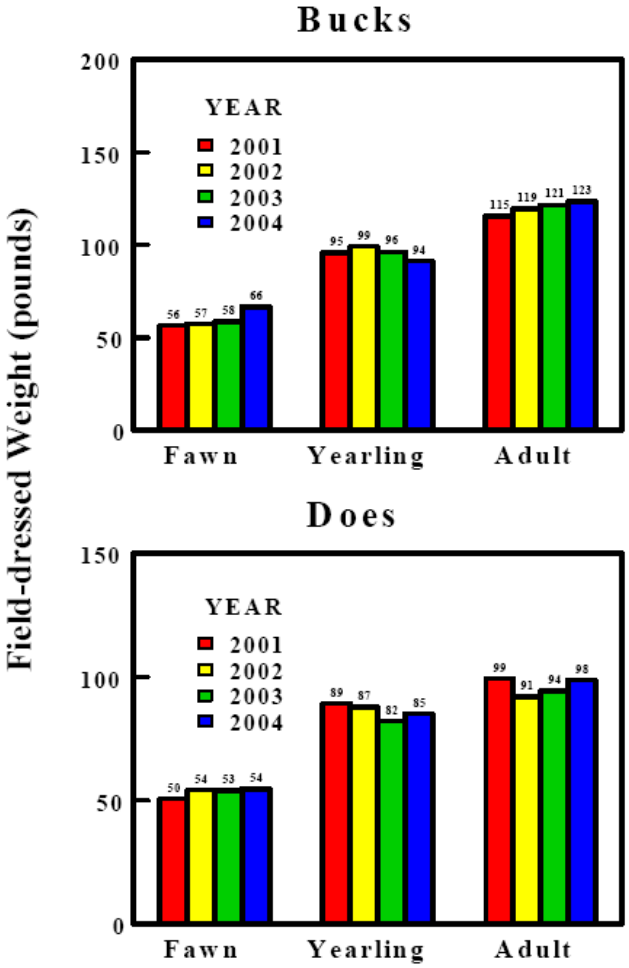

***Figure 8**. Field-dressed weights of deer brought to check stations.*

All measured antler characteristics (spread, total points, right and left beam diameters) were significantly greater between 2001 and the following years (Fig. 8) but did not increase after 2002. Increase in antler characteristics ceased after 2002 because hunters were shifting harvest from yearling deer to 2 ½ year old deer. Thus, the initial strategy by PGC to increase antler characteristics was successful initially, but failed to improve after 2002 because hunters continued to harvest young deer (primarily 2 ½ year old bucks).

Herd health characteristics suggest that strategies employed by the PGC to reduce herd density and improve herd health and antler characteristics met with initial success but need to be followed up with additional changes in hunting regulations/opportunities to further reduce deer density and improve deer weight and antler characteristics. KQDC is mulling a request to the PGC increase antler point restrictions to 4 points on either side on the KQDC demonstration area in an attempt to increase the age of harvested bucks.

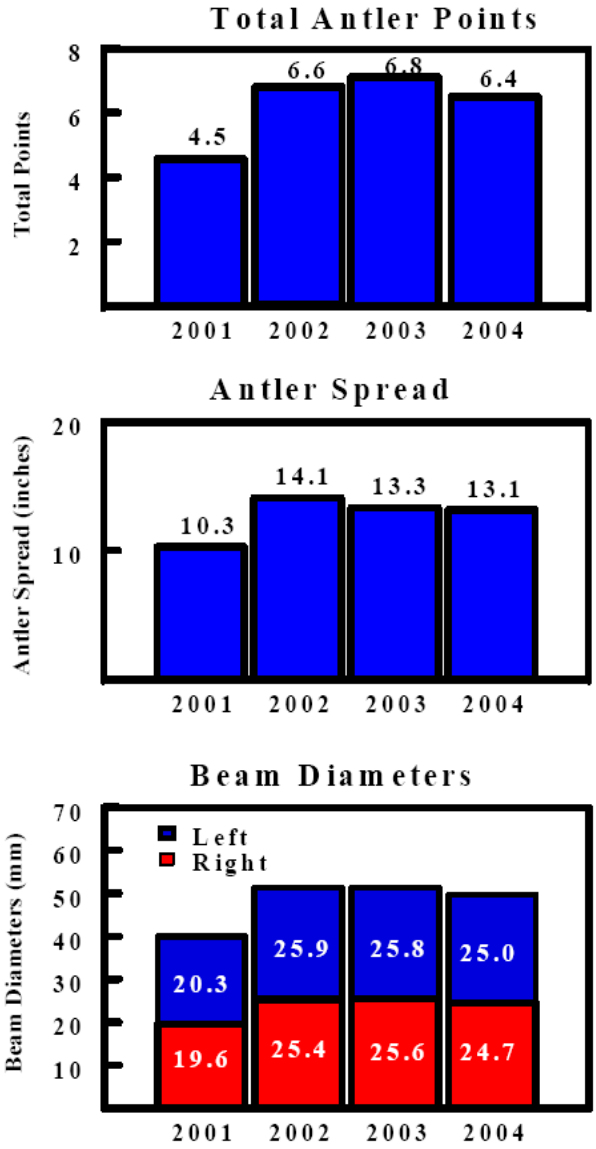

***Figure 9**. Antler characteristics of harvested bucks.*

Summary

The KQDC leadership team was limited in adaptive management strategies for reducing deer density and impact and for improving deer and forest health. All regulations (DMAP program, antler point restriction) for improving deer and forest management were effected by the PGC. The KQDC leadership team merely enhanced these two programs by educational and incentive efforts. However, based on monitoring, the KQDC leadership team was able to demonstrate quantitative progress toward some goals, and had the

information needed to support continuation of the DMAP program to make further advances toward goals.

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