

MONTANA CHAPTER THE WILDLIFE SOCIETY

Practical Application of Recent Research Proceedings



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FOREWORD

The program theme for the 1982 meeting of the Montana Chapter of The Wildlife Society was "Practical Application of Recent Research." Research findings presented covered a wide variety of wildlife to include bear, deer, bighorn sheep, antelope, grouse and waterfowl. Other topics varied from car counters to computers.

These proceedings were compiled and edited by Charles Eustace. As always, however, the real brains behind the movement was provided by Secretary Eileen Bandle who was able to decipher incomprehensible handwriting, break secret codes known only to article authors, redraw figures which were originally drawn using lemon juice, and reconstruct sentences where formerly none existed. Dianne Cantrell assisted with the exciting part called proofreading. And last but not least, Vern Craig illustrated the cover with the classical administrator's conception of how field research data are gathered.

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MORTALITY PATTERNS OF ANTELOPE IN THE YELLOW WATER TRIANGLE

Duane Pyrah¹

A study of antelope in the Yellow Water Triangle suggested some new hypotheses about population dynamics, management strategies and harvest objectives for this species. The study consisted of annual aerial surveys during summer at which time yearling and mature males were classified in addition to the usual classification of does and fawns. It had been determined previously by horn/tooth examinations at checking stations that horn length could be used to identify yearling males during aerial surveys. It had also been determined by ground counts that yearlings existed in a 50:50 sex ratio. Major findings included 1) adult males averaged 52% annual attrition, 41% to hunting and 11% to nonhunting losses; 2) adult females averaged 19% annual mortality, 9% to hunting and 10% to nonhunting; 3) fawns (after summer) averaged 35% annual loss, 10% to hunting and 25% to other causes; 4) losses of adult males and fawns correlated positively with winter severity (heating degree days), whereas adult females had recurrent high mortality apparently unrelated to range/weather factors; 5) hunting mortality correlated with number of permits, indicating hunter success to be a poor indicator of population change; 6) fawn production correlated better with total females, during the incline phase, than with fawns/female, indicating that fawn/female ratios have limited value for assessing annual production; 7) recruitment of yearlings reached a plateau when adult females were at their average density; this may be the best indicator of carrying capacity; 8) aerial surveys every 3rd year were not adequate to keep pace with a rapidly changing population; 9) hunting more males to make room for more females doesn't work for antelope and may be less useful than we think for some other species and 10) it is necessary to change harvest rates to equalize the mortality of females and keep their number below carrying capacity.

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HORN GROWTH AS AN INDEX
TO LEVELS OF INBREEDING IN BIGHORN SHEEP

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ABSTRACT

Horn growth of 477 rams from 17 of Montana's bighorn (*Ovis canadensis canadensis*) populations was examined. Cumulative horn volume at 3 years of age could not be related to winter range densities for either native ($r = 0.03$) or transplanted ($r = -0.12$) populations. Horn volume was not correlated with population size for transplanted populations ($r = 0.04$), though it was significantly correlated to population size for native herds ($r = 0.75$; $p < 0.01$). Cumulative horn volume was closely correlated to historic minimum population levels for native herds ($r = 0.91$; $p < 0.0005$) and historic population size was correlated to present population size for native herds ($r = 0.81$; $p < 0.005$). Thus, horn volume appears to be related to present population size for native herds because both factors are closely correlated to historic population levels. We suggest that historic population lows resulted in high rates of inbreeding that are currently being reflected in low ram horn volumes.

INTRODUCTION

Horn growth in mountain sheep is influenced by nutritional and genetic factors. Several recent studies have demonstrated the relationship between horn growth and nutrition. Geist (1971) postulated that expanding sheep populations are characterized by more rapid horn growth than sheep in stable or declining herds. Shackleton (1973) compared horn growth characteristics of two bighorn populations and found that, indeed, the higher quality population was characterized by rams with more rapid horn growth early in life. Heimer and Smith (1975) demonstrated that horn growth was inversely related to population density for the Dall's sheep (*Ovis dalli dalli*) in Alaska. Bunnell (1978) found that horn growth of Dall's sheep was related to the

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quality and quantity of forage which was in turn directly related to the amount of spring precipitation. This paper examines the relative importance of genetics and nutrition to horn growth in 17 bighorn sheep populations in Montana.

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METHODS

Montana Department of Fish, Wildlife and Parks has enforced a mandatory examination of all bighorn sheep harvested since 1974. Examination of ram horns by department personnel included measurements of the length of each annual increment and the circumference at each annual ring. These data were used to calculate mathematical volume of horn grown each year of a ram's life (Heimer and Smith 1975).

Bunnell (1978) demonstrated that horn growth varied between years in Dall's sheep. To avoid possible biases of this type, a mean horn volume was calculated for each bighorn herd based on the total number of rams measured from that population since 1974. This should prevent the data from being skewed by any one particular set of weather conditions or by unusual horn growth of any cohort.

Mean cumulative horn volume for the first four growth periods was used as a basis for comparing horn growth among the 17 populations studied. Shackleton (1973) suggested that horn growth for superior quality rams was greater than that of inferior rams for only the first 4 years of growth. He further showed that the age of social maturation is advanced among animals from high quality populations. Thus, superior quality rams become socially active early in life and must budget less energy for horn growth. Inferior quality rams, being relatively less active socially, can have larger energy budgets for horn growth and can grow larger horn segments than superior quality rams during the latter part of their lives. However, Simmons and Stewart (1979) showed that this relationship held only when comparing populations of relatively similar quality. When comparing populations of vastly different quality, horn growth was found to be greater throughout the lives of superior quality rams. In any case, when a large number of populations are compared, only the first 4 years of growth should be used.

RESULTS

Mean cumulative 3-year-old horn volumes for native populations ranged from a low of 115 to a high of 177 inches³ (Table 1). Horn volumes for all transplanted populations were larger than for any native population ranging from 184 to 285 inches³ (Table 2). Since there was such a distinct difference in horn growth between the two types of populations, we treated them separately in further analysis.

Table 1. Mean cumulative 3-year-old horn volumes, population characteristics and minimum historic population levels for native Montana bighorn herds

Herd Name	Hunting District	Horn Volume ¹	Sample Size	Population Estimate ²	Winter Density ³	Historic Population Low	Historical Source
West Bitterroot	250	126	13	90	18	50 ⁴	Klaver (1978)
Yellowstone-Gallatin	300	150	25	150	28	75	K. Keating (Montana State University, pers. comm.)
Spanish Peaks	301	134	34	175	25	60	Couey (1950)
Hilgards	302	136	12	100	100	20	Buechner (1960)
Absaroka ⁵	303	177	16	300	20	150	Buechner (1960)
Sun River	420	174	159	900	13	150	Egan (1975)
Stillwater	500	135	28	50	17	35	Stewart (1975)
West Rosebud	501	115	17	50	4	35	Couey (1950)
Hellroaring	502	122	31	75	5	50 ⁴	Simmons & Stewart (1977)

¹Volume in cubic inches.

²Based on 1980-81 surveys.

³Bighorns per square mile.

⁴These populations may have actually been smaller, but data are lacking.

⁵Includes portions of Yellowstone National Park.

Table 2. Mean cumulative 3-year-old horn volumes, population characteristics and history of transplanted Montana bighorn herds

Herd Name	Hunting District	Horn Volume ¹	Sample Size	Population Estimate ²	Winter Density ³	Year(s) Transplanted	Transplant Source
Kootenai Falls	100	188	23	150	14	1954, 1955	Wild Horse Island
Thompson Falls	121	212	42	450	38	1959	Wild Horse Island
Berray Mountain	123	184	9	125	22	1969, 1975	Sun River, Wild Horse Island
Flint Range	213	208	26	150	30	1967	Sun River
Rock Creek	216	285	4	150	25	1975	Sun River
East Bitterroot	270	221	9	60	20	1972	Sun River
Highlands	340	192	7	115	7	1967, 1969	Sun River
Wild Horse Island	-	186	22	150 ⁴	75	1939, 1947	Sun River

¹Volume in cubic inches.

²Based on 1980-81 surveys.

³Bighorns per square mile.

⁴Population size from early to mid-1970's when horn volume data were collected.

Initially, we attempted to explain differences in horn growth, particularly among native populations, by relating them to various physical parameters of their habitat such as soil fertility, chinook frequency on winter ranges and winter range elevation. These factors could not consistently explain differences in horn growth for Montana bighorns, though Wishart (1969) found them to be important parameters influencing horn growth in Alberta bighorns.

Bighorns from the Hellroaring, West Rosebud, Stillwater, Absaroka, Spanish Peaks and Hilgard populations all occur on soils that are derived from the same geologic parent materials. Yet, horn volumes range from 177 inches³ for Absaroka rams to only 115 inches³ for West Rosebud rams. Three bighorn populations are found in areas of frequent chinooks: Stillwater, Sun River and Absaroka. Again, horn volumes range from very small for Stillwater rams (135 inches³) to quite large for Absaroka rams (177 inches³). Rams that winter in alpine areas (Hellroaring and West Rosebud) consistently have small horn volumes, but they do not differ significantly from rams from low elevation winter ranges of the Stillwater, Spanish Peaks and Hilgard herds.

Since Heimer and Smith (1975) had found that horn growth was correlated to population density for Alaska Dall's sheep, we tested for a similar relationship. However, no significant correlation could be established when bighorn horn volumes and winter range densities for Montana's native populations were compared ($r = 0.03$). In general, it appeared that areas capable of supporting a large bighorn population also supported rams with large horn volumes (Table 1). Indeed, population size and horn growth were significantly correlated for native populations ($r = 0.75$; $p < 0.01$) (Figure 1). However, it is also apparent from Table 1 that horn volume is closely related to historic minimum population levels. The correlation between these two factors is highly significant ($r = 0.91$; $p < 0.0005$) (Figure 2). Since historic minimum population levels are closely correlated with present population levels ($r = 0.81$; $p < 0.005$) (Figure 3), we assume that horn volumes are correlated with present population size only because both factors are highly correlated with minimum population levels.

Transplanted populations are all characterized by large horn volumes. As with the native herds, no significant relationship was found when horn volumes were correlated with winter density ($r = -0.12$). Unlike the native populations, no significant relationship was found between horn volumes and total population size ($r = 0.04$).

DISCUSSION

We suggest that minimum historic population size is the primary factor in determining horn growth rates for native bighorns. Those populations which at one or more times in their history dipped to 50 or 60 animals or less do not appear to be capable of supporting rams with rapid horn growth. On the other hand, rams from populations that never declined below 125-150 animals are generally characterized by rapid horn growth and large horn volumes.

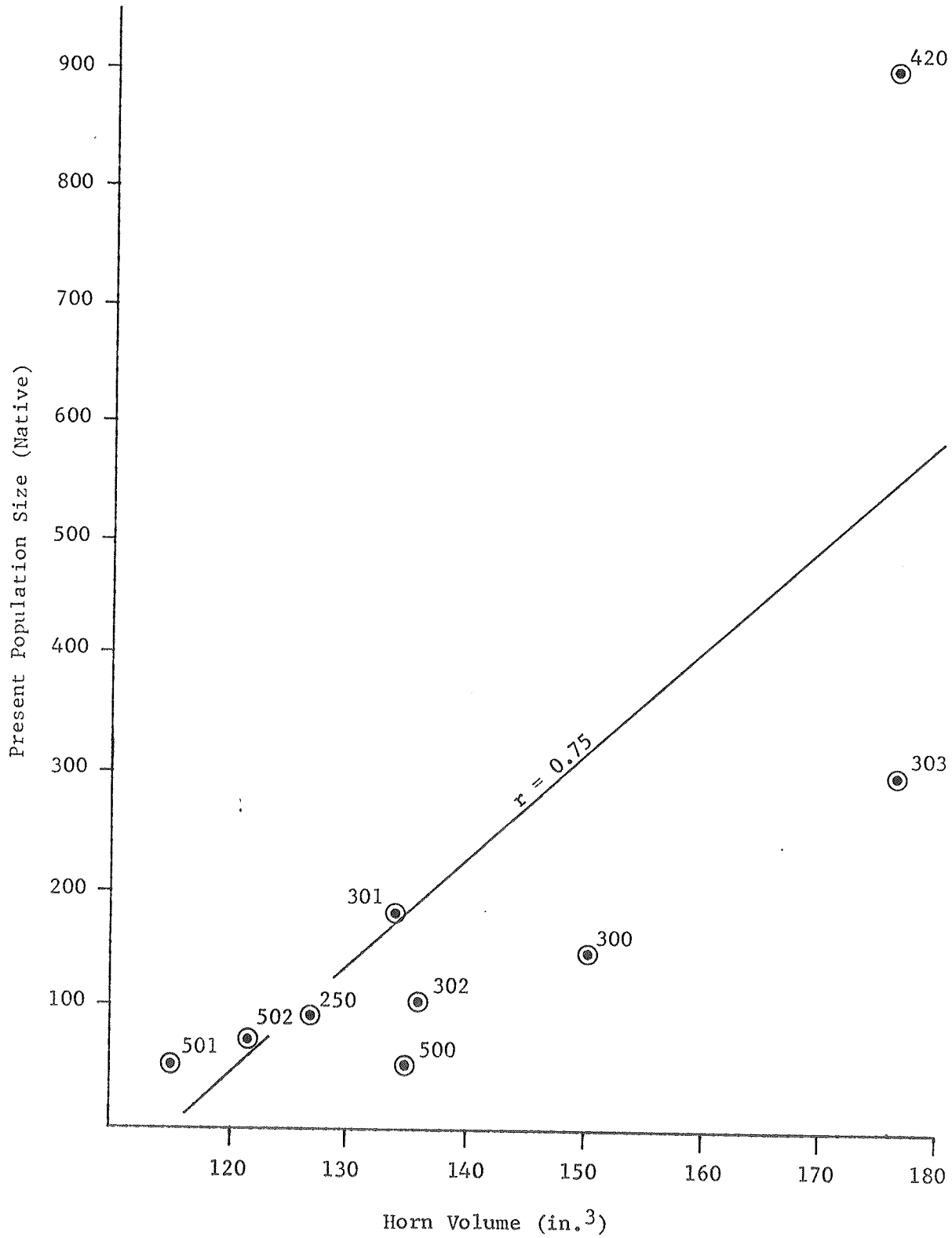


Figure 1. Relationship of horn volume and present population size for Montana's native bighorn populations.

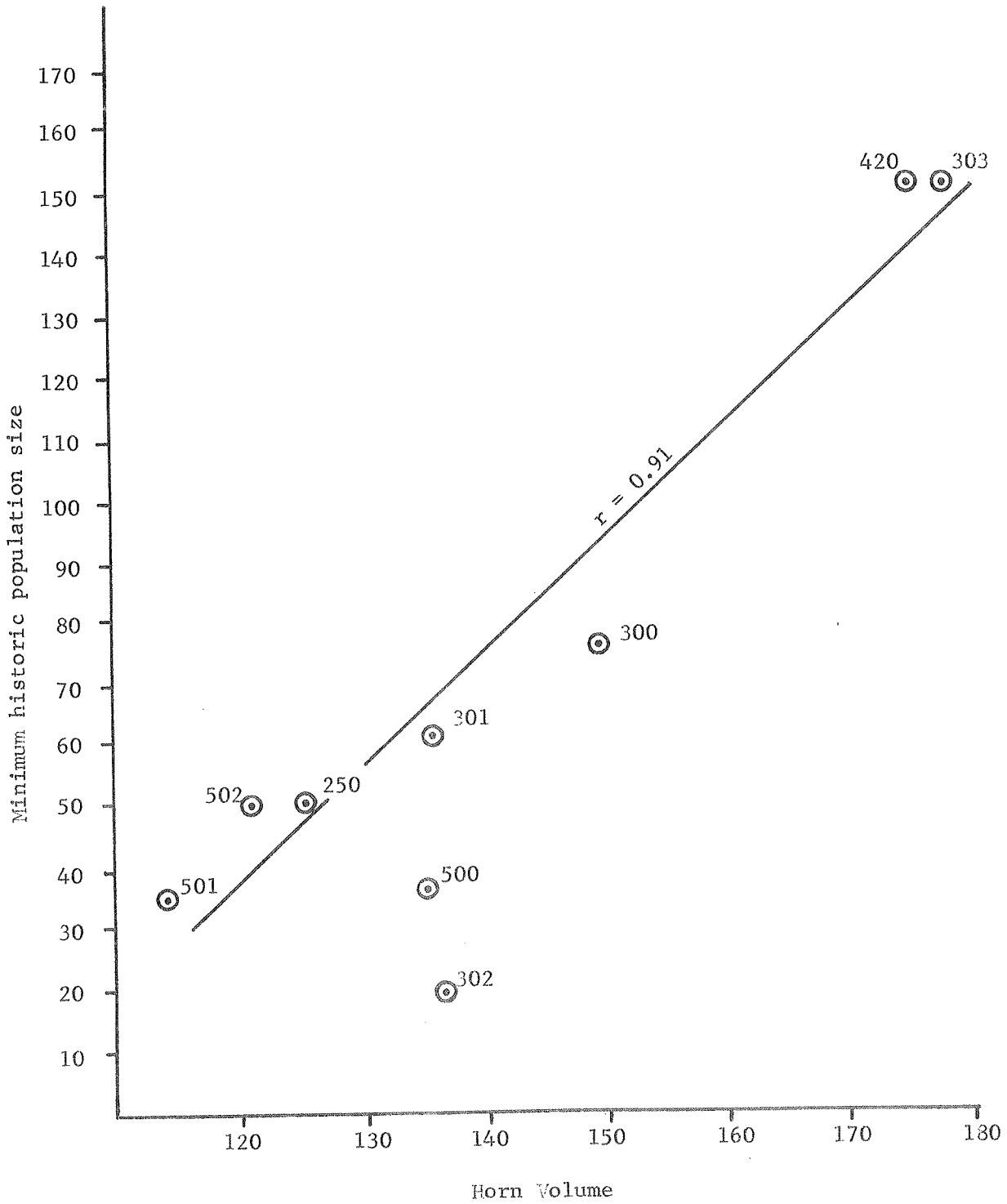


Figure 2. Relationship of horn volume and minimum historic population size for Montana's native bighorn populations.

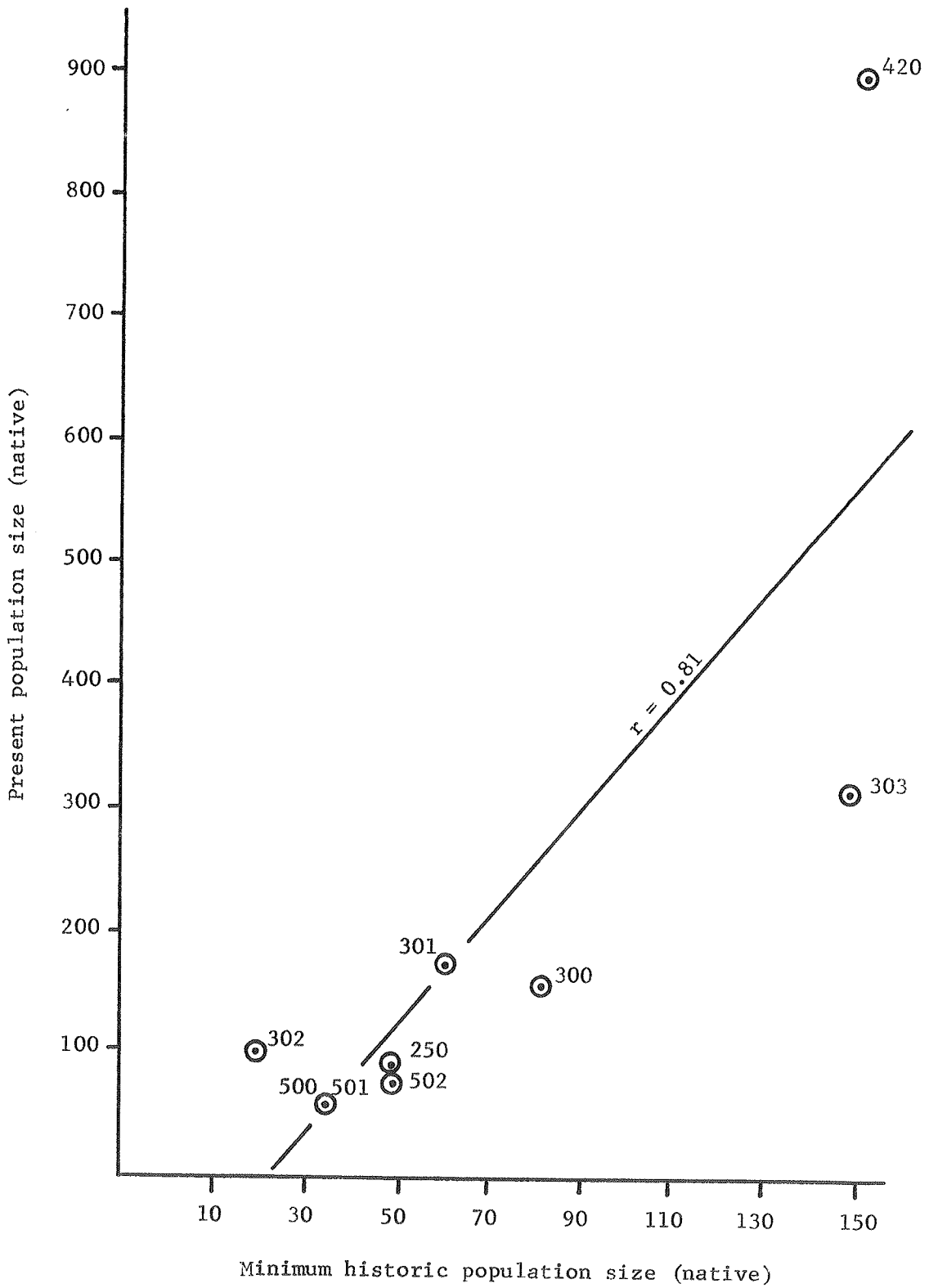


Figure 3. Relationship of minimum historic and present population sizes for Montana's native bighorn populations.

We hypothesize that differences in horn growth among native Montana bighorn populations can primarily be explained by genetics rather than nutritional differences. Most (six of nine) of these populations declined to 60 animals or less at least once during the first half of this century. During such low population periods, these herds were probably subjected to relatively high rates of inbreeding. This in turn may have affected ram horn growth in one of two ways. First, inbreeding may have reduced animal vigor which could result in decreased rates of horn growth for rams. Secondly, large horned rams may be more heterozygous than smaller horned rams. Since inbreeding increases the percentage of homozygosity, it would follow that there would be few large horned rams in an inbred population. Ryman et al. (1981) demonstrated that heterozygosity can be severely reduced in a short time in a population of 50 animals. Intensive harvest of males, such as occurred in most of these bighorn populations, would reduce the effective population size and further reduce genetic variability (Ryman et al. 1980). Population size bottlenecks have been suggested as the cause of low amounts of genetic variation in populations of elephant seals (*Mirounga angustirostris*) (Bonnell and Selander 1974) and moose (*Alces alces*) (Ryman et al. 1977).

Native populations which have always maintained in excess of approximately 125 bighorns were probably not subject to inbreeding. Thus, a heterozygous population of relatively vigorous bighorns was maintained. These are the populations which are now characterized by rams with large horn volumes.

The hypothesis that horn growth differences among native populations is related more to genetic than to nutritional differences is further supported by the history of bighorns from two areas in Montana: Rock Creek and Thompson Falls. Both of these areas supported native bighorn populations that were characterized by small tightly curled horns (Berwick 1968, Brown 1974). When the native populations died out, they were replaced by bighorns from Sun River. Range conditions remained relatively unchanged. The resulting populations have rams with extremely large horn volumes (Rock Creek - 285 inches³, Thompson Falls - 212 inches³).

Geist (University of Calgary, pers. comm.) suggested that during population crashes, such as he observed in mule deer in Waterton Park, Alberta, only phenotypically inferior (i.e., small antlered) males survive. He further suggested that a similar relationship could be responsible for small horned rams occurring in Montana bighorn populations that declined to 60 or fewer animals at one or more times in their history. We do not feel that this suggestion adequately explains the phenomenon we observed for several reasons: 1) The Sun River sheep herd has probably "crashed" (declined to 150 animals) more than any other Montana population with die-offs in 1924, 1927 and 1936 (Couey 1950). Yet horn growth for these bighorns remains excellent. 2) The surviving phenotypically inferior males would have the genetic potential that would allow their offspring to grow large horns when environmental conditions improve. Therefore, unless genetic change occurred during the crash, large horned rams would eventually reappear in the population. 3) During a mule deer population crash in Montana, nearly all bucks between the ages of 2 and 5 survived regardless of phenotypic expression (Mackie et al. 1980, R. J. Mackie, Montana State University, pers. comm.).

Thus, population crashes do not always result in the loss of phenotypically superior males.

The Sun River sheep herd has ultimately been the source for all successful bighorn transplants in Montana. Thus, all transplanted populations are from what we consider to be genetically healthy stock. Since all transplanted populations are genetically similar, variation in horn growth among these populations must be related to habitat conditions.

It is not, however, surprising that winter range densities were not correlated with horn volumes for transplanted populations. Such a relationship could only be expected if all of these populations had reached equilibrium with their environments. This is generally not the case as most transplanted populations are apparently still increasing.

Among transplanted populations horn volumes are largest for the Rock Creek and the East Bitterroot herds. These are also the two most recently transplanted populations. The two oldest transplanted herds, the Wild Horse Island and Kootenai Falls populations, both have relatively small horn volumes for transplanted sheep. In fact, the mean cumulative horn volume for Wild Horse Island rams is not significantly ($p < 0.05$) different from that of Sun River rams, and the difference in horn volume between Kootenai Falls and Sun River rams is barely significant ($0.05 < p < 0.025$). It appears then that when sheep are put into a new and relatively unexploited habitat, the rate of horn growth is exceptional - far surpassing that of the parent stock. As the population expands, the rate of horn growth declines. Eventually, carrying capacity is reached and horn growth is reduced to a level similar to that of the parent stock with minor differences, due to differences in productivity between the ranges.

Horn volumes are not significantly ($p < 0.05$) different between Berray Mountain and Sun River bighorns. The Berray Mountain population is only 13 years old, yet horn volume is already similar to that of the parent stock. We speculate that because of the small size of the Berray Mountain area, as well as its relatively harsh winter conditions, carrying capacity has already been reached and the rate of horn growth has stabilized.

Apparently, transplants of 20-30 sheep can develop into genetically healthy populations because they come from heterozygous parent stock (i.e., Sun River). These sheep would have a relatively diverse genetic makeup. If conditions are such that the population can expand quickly, this diversity is maintained and a healthy population develops. If, however, the herd stagnates at only 50-60 animals, the population will eventually become more homozygous just as a native population would if it was at such a low population level for any extended period of time.

MANAGEMENT IMPLICATIONS

The genetic health of a bighorn herd is normally a factor that is not considered by a wildlife manager because data are seldom available. Yet, such information may be important to the survival of the herd as the following example illustrates.

Rock Creek, in western Montana, originally supported a native bighorn population, the history of which is well documented (Berwick 1968, Cooper-rider 1969, Aderhold 1972). By the early 1900's, only eight bighorns were known to occur in the Rock Creek area. The population increased very slowly until 1965 when the herd was estimated at 175 animals. As we previously noted, rams from this herd were characterized by small tightly curled horns probably similar in volume to horns from other native populations that we have suggested were inbred. Indeed, Berwick (1968) demonstrated that the rate of inbreeding for the Rock Creek herd was relatively high. Between 1966 and 1969, this herd declined to only 10 animals and was for all practical purposes extinct by 1974. Numerous reasons for the decline were cited including overgrazing by domestic stock, competition from large numbers of mule deer and encroachment on the winter range by human development. However, as we have previously mentioned, when the Rock Creek area was restocked with Sun River bighorns in 1975, the population thrived though range conditions had not improved substantially (Butts 1980). We suggest that fundamental difference in ability to survive between the native and transplanted herds was genetically related. The inbred native population was unable to tolerate the stress of deteriorating habitat conditions, while the genetically healthy Sun River stock thrived under similar conditions.

Thus, inbred populations must be managed much more carefully than other bighorn herds. All efforts must be directed at minimizing stress for these populations whether that stress be from competition with native or domestic ungulates, or from human related activities such as mining, subdivisions, or even intensive studies by well-meaning biologists. We also suggest that horn growth can be used as one of the best indicators of when a transplanted bighorn population reaches equilibrium with its forage base (i.e., reaches carrying capacity) by comparing horn growth of the transplanted herd to that of the parent stock. Of course, this comparison is only valid if range conditions for the two populations are reasonably similar.

We are presently planning to further test the hypothesis presented in this paper by introducing rams from a high quality population into a low quality herd - probably the Stillwater herd. Horn growth will continue to be monitored to determine the effects of this action. A better approach to determining the horn growth potential of various populations would be to keep captive rams on a high quality diet. If our hypothesis is correct, rams from the populations that are thought to be inbred would continue to grow smaller horns than rams from populations thought to be more heterozygous. Unfortunately, budget limitations will undoubtedly prohibit this approach.

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APPLICATION OF WHITE-TAILED DEER RESEARCH IN THE SWAN RIVER VALLEY

John G. Munding

What is this business of wildlife research, anyway? To answer that question, we also must answer the companion question - what is this business of wildlife management, anyway?

Leopold (1933:3) said, "Game management is the art of making land produce sustained crops of wild game for recreational use." That definition is a good place to start, if we recognize that in Montana wild game is an important economic, as well as recreational, resource. Leopold distinguished between wildlife management and mere exploitation from a natural supply. A practice is management "... if it controls one or more factors with a view of maintaining or enhancing the yield." (Leopold 1933:4). Thus, I perceive management as the art of applying biological information to manipulate factors to resolve problems and effect desirable wildlife objectives.

Biological information is implicit to the definition of wildlife management. In Leopold's words, "... it is the task of science not only to furnish facts, but also to build on these a new technique by which the altruistic idea of conservation can be made a practical reality."

Wildlife management, thus embodies two complementary disciplines. Research is the business of developing biological information. Management, here used in a more restrictive sense, is the business of applying biological information.

Research has two responsibilities: It must provide information which is worth knowing and germane to the issues at hand. It also must provide information that, once known, is applicable.

Likewise, management has three responsibilities: First, it must recognize the problem. Then, it must recognize what information is necessary to resolve the problem, e.g., the biological and ecological attributes of the population of concern, which factors to manipulate, and the anticipated response to manipulation. Finally, as that information is made available, management must use it.

I would like to consider this model of wildlife research and management in relation to the study of white-tailed deer (*Odocoileus virginianus*) in the Swan Valley, northwestern Montana (Munding 1980). Briefly, the objectives of that study were 1) to determine the basic biological and ecological parameters of this population, 2) to relate those parameters to the coniferous forest habitats which are characteristic of the Swan Valley, 3) to determine those factors which limit this population and 4) to develop new criteria for deer management in coniferous forest habitats. These objectives were accomplished.

It was determined that the density of this population was stable. All population parameters functioned interdependently to maintain that stability. The female age structure was full and pyramid-shaped. That age structure was resilient because survival of 6-month and older females was high and uniform.

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Recruitment was sufficient to replace annual attrition. Also, the relationship between total fawn production and age structure tended to determine a stable recruitment rate. Stable recruitment, associated with high and uniform female survival, reinforced the stable age structure. Because density is stable, the total population perforce is determined by the amount of land area which is capable of producing deer at that density.

It also was determined that the distribution of white-tailed deer was closely associated with the mature, subclimax, coniferous forest. Diversity was the most prominent characteristic of deer habitat. It was an interspersion of two integral habitat components - timbered riparian areas and timbered uplands. Those components likewise were diverse. Riparian zones are classic examples of "edge effect" (Odum 1978:3). Uplands were forested communities in which habitat types, cover types and successional stages were interspersed.

Although classified as subclimax, white-tailed deer habitat exhibits many ecological characteristics of old-growth forests (Franklin et al. 1981). Old-growth forests are not stagnant systems, rather they are dynamic communities. Old-growth forests are heterogeneous, characterized by much greater horizontal and vertical diversity, relative to young growth. Old-growth forests also are, in the absence of major catastrophe, stable communities. Thus, old-growth has been described as a "shifting-mosaic steady state." (Bormann and Likins 1979:174-175).

White-tailed deer are well adapted to the mature coniferous forest. Recall that this population exhibits stability. Apparently, stability is one adaptation by which this population exploits a likewise stable habitat.

Timber production is the dominant land use and logging has impacted extensive areas in the Swan Valley. Recently logged areas are not essential components of deer habitat. In fact, they are little used by deer. The influence of timber management may be inferred from their distribution and habitat relationships. Deer occupy small home ranges which are mosaics of essential habitat components. Previous timber sales have reduced the total area of deer habitat because cover was removed, habitat integrity and diversity were disrupted, and logging units were large in comparison with home range size.

Total deer numbers in the Swan Valley are determined by the amount of land area capable of producing deer. Total area of effective habitat is determined by timber management. Timber management, therefore, is the factor which presently limits white-tailed deer numbers in the Swan Valley.

The implications of these findings for land management are clear. Timber management promotes the rapid conversion of old-growth forest to second-growth to be managed on a short-rotation with even-aged systems. That philosophy is wholly inconsistent with the habitat requirements of white-tailed deer because timber management also promotes the elimination of deer habitat. Further, harvest of the second-growth will occur before succession has progressed to the condition to which deer are best adapted.

Alternatively, timber management must consider historical trends in plant ecology and succession. Further, it must consider the diversity inherent to old-growth forest communities. Successful management will be that which promotes timber harvest complementary to that diversity.

Application of these findings poses a peculiarly difficult problem. It does so because research and management, by definition complementary disciplines, are antagonistic pursuits in the Swan Valley.

In part, this obtains because research was directed by one agency, while application requires the cooperation of other agencies. The Department of Fish, Wildlife and Parks is legally responsible for the welfare of white-tailed deer. It does not, however, control the factor which limits deer in the Swan. Therefore, it cannot "manage" that population. Land management agencies manipulate the limiting factor, but they do so without a view of maintaining or enhancing the population. Those agencies also do not "manage" white-tailed deer. In fact, their activities are contrary to management.

Prior to my study, land managers already were of the opinion that information was sufficient to improve deer habitat through multiple use programs; all we had to do was use it (c.f. Schneegas and Bumstead 1977). That opinion was based on the corollary that "good timber management is good deer management," and the assumption that white-tailed deer are very adaptable.

Schoen et al. (1981) eloquently refuted the aphorism that "good timber management is good deer management." Yet, the Northern Region Forest Plan stated that increased tree overstory on winter ranges was a major reason for recent declines in wildlife populations. Were that true, I should have been able to document substantial population increases because the tree overstory has been removed from half of the winter range in the Swan Valley. Rather, the population has declined by approximately one-third since the inception of intensive timber management.

As a species, the white-tailed deer certainly exhibits tremendous ecological amplitude. Yet, ecological amplitude is not a measure of adaptability. Rather, it is evidence for adaptive radiation, after the fact. White-tailed deer are well adapted to the coniferous forest habitat in the Swan Valley. That adaptation occurred at the expense of future adaptability.

My findings stand in opposition to these traditional concepts of deer-forest management. Rather than reevaluate those assumptions, land managers have rejected my recommendations because they do not conform.

Land management agencies have a legal obligation to consider threatened and endangered species. Through the cooperative logging study, they also have a vested interest in elk (*Cervus canadensis*). The watchword is "Holism," but note which species were mentioned in the Northern Region Forest Plan. By the Department's criteria, the white-tailed deer is the single most important managed wildlife species in northwestern Montana. The only reference to whitetails in the Plan was a number in a table. I am left to conclude that land managers really are not concerned for that species.

My data indicate that, indeed, there is a serious conflict between white-tailed deer and timber management. This conflict results because timber management is, by definition, rapid old-growth conversion, short-rotation, even-aged management. Further, that definition is immutable. Land managers can consider only those wildlife recommendations which are consistent with this philosophy and do not compromise the annual cut. My recommendations satisfy neither of these criteria and, therefore, are not applicable.

The benchmark for ungulate/timber management was established during the early years of my study. Now, cover/forage ratios are state-of-the-art. Land managers understand cover/forage ratios and response curves derived therefrom. Unfortunately, white-tailed deer do not.

I cannot describe deer habitat with cover/forage ratios. But, I have defined the philosophy appropriate for successful management, consistent with Leopold's definition of wildlife management, of white-tailed deer in a multiple-use program. That philosophy is not applicable because it conflicts with the present direction of timber management. Further, philosophy does not translate very well to quantifiable objectives, such as pounds of forage, acres of habitat improvement, etc.

I began this paper with my perception of the roles of research and management. I did so because that model identifies the principle problem with white-tailed deer in the Sun Valley - wildlife management there has been a resolute failure. It has failed because the disciplines of research and management likewise have failed.

Research failed because I provided information which management did not want or need to know. Moreover, it was information which could not be applied. Management failed because it did not recognize problems with white-tailed deer. If it did not recognize the problem, management could not know that it needed information, nor could it use that information.

Wildlife management is the art of applying biological information to resolve problems. I assert that land management has ignored biological information and thereby created problems for the white-tailed deer.

This meeting's theme is "Application of Recent Research." I have no justification for a paper with that title because there has been no management practice by which my findings have been applied, nor do I anticipate their future implementation.

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FLUCTUATIONS IN MULE DEER FAWN SURVIVAL AS RELATED TO
THE CULINARY HABITS OF WILD CANIDS

Shawn J. Riley¹

The mule deer population in the Missouri River Breaks, of north central Montana, declined sharply during 1971-1973 and remained low through 1977. An apparent symptom of the slow population recovery was low fawn survival and recruitment (Hamlin 1978). An intensive study, utilizing radio telemetry, was initiated in 1976 and continued through 1980 to determine the extent and causes of summer fawn mortality as a factor in low fawn recruitment. This paper presents information on fawn mortality rates during the summer periods 1976-1980 and how they may have been related to coyote densities and food habits.

Seventy-seven fawns were equipped with radio transmitters - 10 in 1976, 18 in 1977, 15 in 1978, 18 in 1979 and 16 in 1980. The marked fawns were located on regular 2-3 day intervals from mid-June to September 15 each year (Dood 1978, Riley 1982). Food habits of coyotes during the summers 1977-1980 were determined from analysis of scats collected on the study area (Schladweiler 1980, Hamlin unpubl. data). Indices of small mammal abundance were calculated from live trapping (Trout 1978, Hamlin and Riley unpubl. data). Trends in coyote density were determined by siren response surveys and high den counts (Pryah 1980).

The summer fawn mortality rates observed in the Missouri Breaks between 1976 and 1980 ranged from 12 to 36% (Fig. 1). Coyotes were known or suspected to be involved in 93% of the total natural mortality. Moderate to high mortality occurred during 1976 and 1977. The mortality rates reported for 1978-1980 were among the lowest ever reported for a free-ranging deer population. This occurred despite a stable to slightly increasing coyote population that ranged in density from minima of 0.36 to 0.42 and averaged 0.39 coyotes/km² during 1978-1980 (Pryah 1981). Published data from other studies around North America have indicated considerable variation in summer fawn mortality between populations and between years. However, most studies of deer populations subject to coyote predation have reported fawn mortality rates greater than 25% and as high as 90% (Carrol and Brown 1977). Conversely, mortality rates can be quite low in the absence of predators (McGinnes and Downing 1969).

Small mammal populations were very low on the study area during 1976 and 1977 (Trout 1978). In 1978, however, a tremendous increase in microtine rodents occurred and lasted through 1979 (Fig. 2) (Hamlin and Riley unpubl. data). General observations indicated that cottontail rabbit numbers also increased in 1978, but persisted through 1980.

Food habit studies suggested that coyotes ate few fawns in the Missouri River Breaks during the summer period. During the summers 1978-1980, deer made up less than 1% of the coyote diet. Analysis of coyote scats from the study area (Schladweiler 1980, Hamlin unpubl. data) indicated that rodents and lagomorphs constituted 20.9, 40.1, 78.2 and 23.1% of the total coyote diet during 1977, 1978, 1979 and 1980, respectively. Fruit (primarily chokecherry) was also an important food item, especially during 1977 and 1980 when it made up 54.3 and 39.8% of the coyote diet, respectively.

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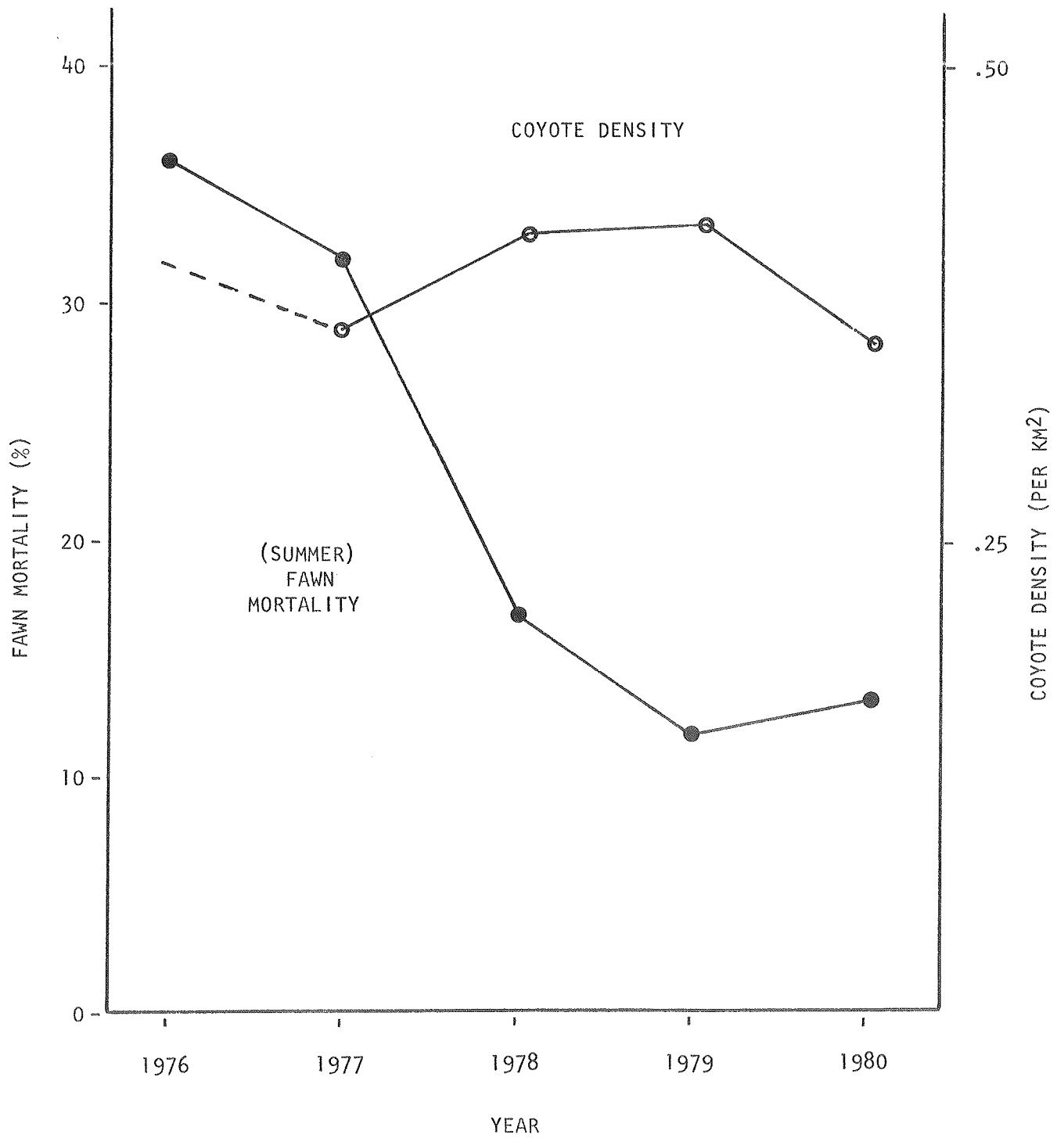


Fig. 1. Fawn mortality rates related to coyote densities during summers, 1976-1980, in the Missouri River Breaks, Montana.

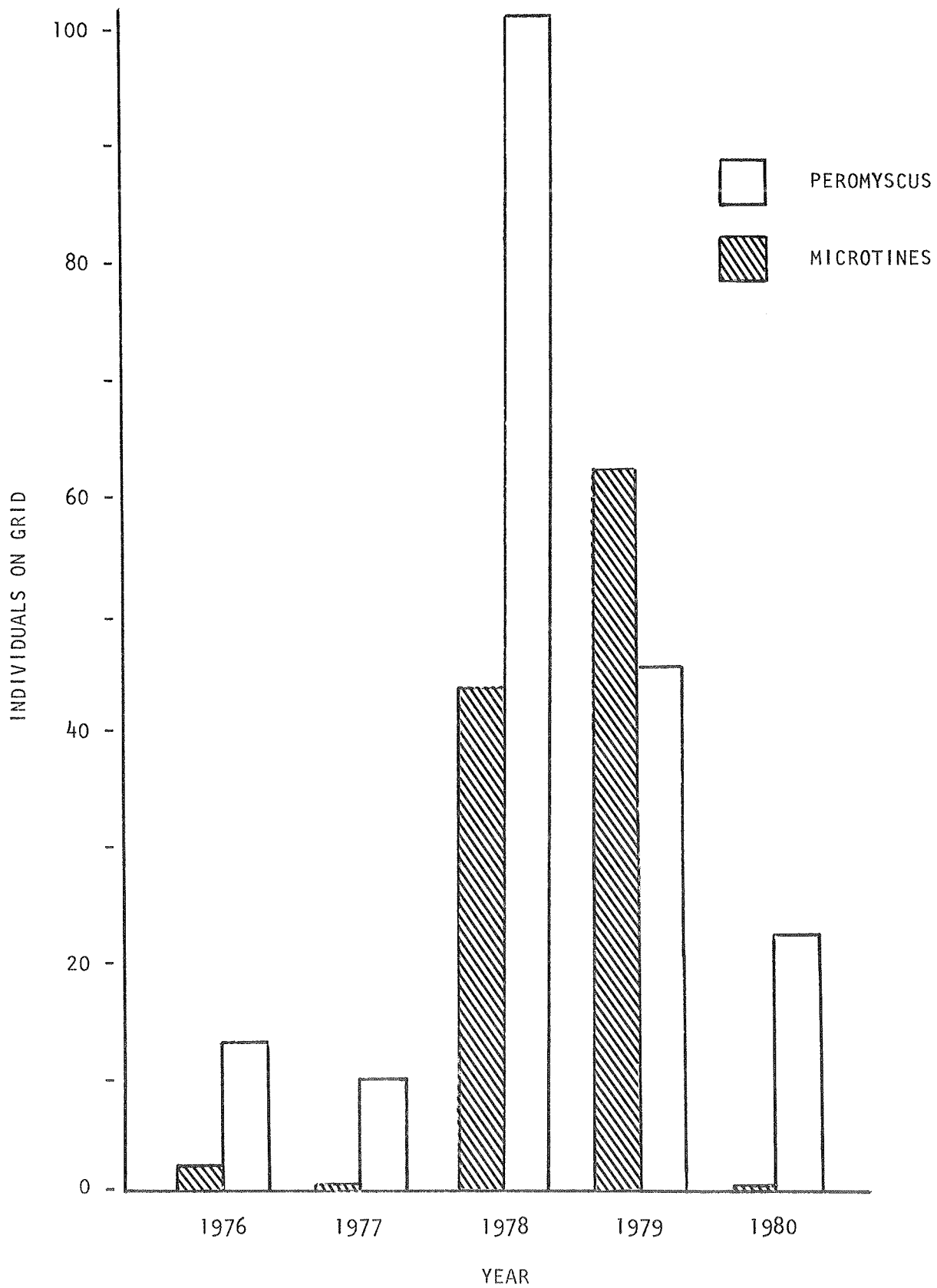


Fig. 2. Relative small mammal population sizes during summers, 1976-1980, in the Missouri River Breaks, Montana.

Discussion and Conclusions

Results from studies in the Missouri Breaks indicated that summer fawn mortality rates were not a function of coyote numbers alone. Fawn survival did not appear to be related to the density of coyotes on the study area. The data indicated that fawn survival increased as buffer species, particularly microtine rodents, increased.

Coyotes are extremely versatile and adaptable with regard to the foods they will consume. Reported coyote food habits are as variable as mortality rates for fawns. Generalizations are dangerously misleading. If valid conclusions are to be reached about the effect of coyotes on fawn survival, each area of concern must be individually examined.

Most studies of fawn survival arise because of a suspected problem, and cease when the problem has been resolved. Hence, reported fawn mortality rates generally emphasize how high they can be. However, there is a paucity of information on fawn mortality rates in healthy situations. The low mortality rates reported for the Missouri River Breaks during summers 1978-1980 may give managers an example of what summer fawn survival can be like in a healthy, expanding deer population.

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MANAGEMENT IMPLICATIONS OF RESEARCH ON WHITE-TAILED DEER
IN THE LONG PINES, SOUTHEASTERN MONTANA

Gary L. Dusek¹

Research on white-tailed deer (*Odocoileus virginianus*) in the Long Pines was part of a baseline study to evaluate wildlife and recreational resources in light of renewed interest in uranium deposits in southeastern Montana (Dusek 1980). Although the overall effort embraced a wide variety of wildlife species, this paper deals with deer in general and more specifically with white-tailed deer. Whitetails are numerically the most abundant big game species occurring in the Long Pines and are a major factor attracting both resident and non-resident hunters to the area (Dusek 1980).

Intensive field work was conducted from September 1976 through November 1979. The study was conducted through the Ecological Services Division of the Montana Department of Fish, Wildlife and Parks. Funding was provided under a contract with the U. S. Fish and Wildlife Service through the Office of Biological Services.

The Long Pines are one of several tracts of conifer dominated uplands in southeastern Montana and northwestern South Dakota which comprise the Sioux District of the Custer National Forest. The Long Pines unit encompasses approximately 100 mi² in east central Carter County, Montana, lying 13 miles southeast of the small rural community of Ekalaka.

The study area consisted of several ridges and mesas, of sedimentary origin, rising to roughly 1,100 feet above the surrounding prairie. The area is drained by the Little Missouri River and its tributaries.

Ponderosa pine (*Pinus ponderosa*) forest constitutes a major community in the upland portion of the study area. Pine habitat types occurring in the area are representative of those described for southeastern Montana by Pfister et al. (1977). Pine occurs in relatively continuous stands in the southern half of the Long Pines, broken by a few large grassland parks. In the northern portion, pine occurs in a more "savanna-like" situation or in relatively dense stands on north exposures. In addition to grassland parks, other communities that are well represented include hardwood draws and badlands.

Methods of data collection are described in detail elsewhere (Dusek 1980). Habitat and population data were obtained largely by direct observation from vehicle survey routes. A sample of 110 whitetails were captured and individually marked, of which 17 were equipped with radio transmitters, to further evaluate habitat use. Deer were collected to evaluate population phenomena. Hunter-killed deer were examined for the same purpose.

I'll briefly discuss findings from this research that I feel are most significant from a management perspective. These findings fall into two categories: population phenomena and dynamics, and habitat selection and utilization.

With regard to population phenomena and dynamics, populations of whitetails and mule deer operated independently of one another within the Long Pines

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ecosystem. This was at least partially attributable to behavioral differences between species regarding strategies of habitat selection and use, to species' differences in vulnerability to various kinds of mortality and to differences imposed by respective population densities. Mule deer numbers and annual production were characteristically low in the Long Pines during the mid-1970's, a trend which was observed throughout southeastern Montana (Eustace and Swenson 1977). Both production and population numbers of mule deer increased by 1979, although slowly at first. White-tailed deer numbers peaked during 1977 and then declined as a result of relatively high winter mortality during the ensuing two winters, combined with a die-off resulting from an epizootic of hemorrhagic disease (EHD) during late summer 1978. The EHD virus is selectively lethal to white-tailed deer and was identified as the organism causing the die-off during 1978 (Feldner 1980).

Population numbers of white-tailed deer were influenced primarily by winter severity, and recruitment depended upon overwinter survival of fawns born the previous summer. Summer fawn production was uniformly high through the period of study, and immediate postnatal mortality was suspected to be uniformly low. It's important to note that the proportion of adult females ($1\frac{1}{2}+$) producing fawns varied inversely with the proportion of that segment consisting of yearlings which were nonproducers. The lowest fall fawn:adult doe ratio was observed during 1976 (89/100), when recruitment of yearlings was presumably high, and highest during 1979 (111/100), which followed a severe winter resulting in comparatively high fawn mortality and subsequent low recruitment.

Adult females were least vulnerable to winter mortality; whereas fawns and adult males ($2\frac{1}{2}+$), in that order, were most vulnerable. Such mortality claimed as much as 40% of early winter numbers during the most severe winters, while hunting mortality never exceeded 8% of fall numbers during the study. Winter mortality was not necessarily density-dependent, nor compensated for by hunting mortality, due to differences in selectivity by hunters and vulnerability to winter mortality by sex and age. Longevity of both sexes of deer in the Long Pines was high when compared with the same species on bottomlands of the lower Yellowstone River (Tables 1 and 2). This may be an artifact of hunting pressure, but may also reflect differences in vulnerability to hunting imposed by structure of the respective habitats.

Ponderosa pine habitat types provided the keystone of white-tailed deer habitat in the Long Pines, and use of such areas is highly significant during winter. Most wintering sites consisted of relatively dense stands of pine characterized by crown closures exceeding 70%. Such sites most likely offered deer some respite from cold weather by reducing loss of body heat by windchill, etc. As a rule, they did not move from timbered cover to forage, particularly during the most severe winters. As snow cover reduced availability of preferred browse, deer shifted their diet to items that were readily available such as pine needles. Nudds (1980) suggested that deer in temperate latitudes are habitat specialists but forage generalists during winter, but again become forage specialists as resource levels increase.

These observations suggested that white-tailed deer in the Long Pines have adopted a strategy of winter habitat use that favors conservation of energy in the form of body fat accumulated the previous summer and fall. Such a strategy of habitat use by deer in northern latitudes is well documented in the literature (Ozoga and Gysel 1972, Drolet 1976, Euler and Thurston 1980).

Table 1. Longevity of white-tailed deer in the Long Pines and along the lower Yellowstone

Age Classes	Males		Females	
	Long Pines	Yellowstone River	Long Pines	Yellowstone River
	(52) ^a	(71)	(35)	(37)
2½-4½	79 %.	90 %.	66 %.	68 %.
5½-7½	21 %.	10 %.	17 %.	30 %.
8½+	-	-	17 %.	2 %.

^aSample size in parentheses.

Table 2. Percent of fall populations of white-tailed deer consisting of antlered males in the Long Pines and on the lower Yellowstone River

Age Classes	Long Pines	Yellowstone River
1½	6.7 %.	11.7 %.
2½+	7.8 %.	5.5 %.
Total Antlered	14.5 %.	17.2 %.

An alternative to a strategy favoring energy conservation is one of selective foraging during winter months as observed on the lower Yellowstone. There, whitetails continue a pattern of observed yearlong use which involves daily movement from riparian forest cover to nearby agricultural areas to feed. Again, this may reflect physical and biological differences between the respective habitats.

In summary, data from this research effort underscores a need for species management rather than "deer" management in a broad sense. Such an endeavor will require some statutory changes. There is also a demonstrated need for a better understanding of deer/population habitat relationships for refinement of species management. There are demographic differences within a species regarding strategies of habitat use and population potential. Such differences are likely, due to physical or vegetative attributes of individual environments and may be further influenced by local land-use practices.

Hunting regulations regarding harvest of white-tailed deer in the Long Pines should take into consideration the relative vulnerability of various sex and age classes to winter mortality.

Efforts to manage land resources which constitute white-tailed deer habitat in the Sioux Ranger District should take into consideration the thermal cover value of uncut stands of pine to white-tailed deer during winter and to a lesser degree during summer. It would appear that the structural aspect of winter habitat for white-tailed deer overrules that of forage quality.

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ON THE USE OF POPULATION CONDITION INDICES IN DEER MANAGEMENT

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A critical evaluation of the winter browse survey has indicated that this method is not as useful in determining the relationship between big game and their winter forage as was once believed (Mackie 1965). Since knowledge of the relationship between big game and the carrying capacity of their range is essential for proper management, we sought other methods to quantify this relationship. Here we describe the parameters we chose to measure to evaluate the condition of deer populations, our reasons for doing so and a preliminary analysis of some of our results.

Measures of Population Condition

Through literature review, we learned that the condition of an ungulate population should be reflected in physical measurements of the animals themselves. We started taking the following measurements of mule deer (*Odocoileus hemionus*) and white-tailed deer (*O. virginianus*) in 1978: diastema length, main antler beam length, number of points (brow tines recorded separately) and antler circumference 1 inch above the bur. After 2 years we decided to limit our data collection to yearling males because: 1) they had been subjected to only one winter, which reduced weather effects on the results; 2) they are socially inferior to older males (Geist 1981), which gave a better reflection of social pressures and 3) yearling males are usually the most abundant age class in the harvest. We also abandoned the antler circumference measurement because this parameter was significantly correlated with main beam length ($P < 0.05$), but less variable, thus less sensitive, and less accurate to measure in check station situations.

We chose diastema length because it is significantly correlated with mandible length, which is a high-priority growth area (Reimers 1972). Also, skeletal measurements appear to be more reliable indicators of growth in wild ungulates than body weight (Klein 1964). Therefore, nutritional deficiencies severe enough to retard body growth would be reflected in diastema length, as has been found in reindeer (*Rangifer tarandus*) (Reimers 1972).

Antler growth is related to the nutritional status of mule deer and white-tailed deer (French et al. 1955, Robinette et al. 1973). French et al. (1955) found that a body growth took precedence over antler development in captive yearling white-tailed deer, indicating that antler measurements would be more sensitive to nutritional and other factors affecting body growth than diastema measurements. Variations in antler measurements, including number of points, have been correlated with the relationship of deer populations to carrying capacity in white-tailed deer (Severinghaus et al. 1950) and mule deer (Robinette et al. 1977).

Using physical parameters as an indication of population condition is not a new idea. It was advocated by Park and Day (1942) and was first tried in Montana by Taber and Rognrud (1958) in 1957.

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Results and Discussion

Mule Deer: In this preliminary analysis we discuss the mule deer antler main beam length data from 1981. We chose 1981 because the 1980-81 winter was uniformly mild throughout south central and southeastern Montana. Weather effects would therefore be minimized and population effects would be maximized.

Antler measurements of yearling mule deer were compared for 15 areas in south central and southeastern Montana by grouping hunting districts of similar habitat types (Fig. 1). Estimates of mule deer densities on wintering areas were available from nine areas which consisted of relatively uniform habitat types (Table 1). A comparison of greater main beam length with density on wintering areas showed a significant correlation ($r = -0.730$, $P < 0.025$, (Fig. 2)). The variation in winter densities explained 53% of the variation in greater main beam length in yearling mule deer even though the comparison spans habitat types varying from mountain-foothills to agriculture/mixed-grass prairie with differing levels of carrying capacity and even though the density estimates were made several years prior to the antler measurements. This strongly indicates that antler measurements reflect real biological differences in population condition among areas.

White-tailed Deer: Antler measurements were available from four white-tailed deer populations in southeastern Montana (Table 2). We combined 1980 and 1981 data to improve sample size because the winters of 1979-80 and 1980-81 were both very mild. The main beam lengths in each area were significantly different from the other areas ($P < 0.05$). Food is probably abundant in the first three areas in Table 2, but it is limited in winter in the Long Pines (Dusek 1980). The data strongly suggest that the Long Pines whitetails exist on an inferior plane of winter nutrition compared with the other three populations. Besides the short antlers, these deer exhibited significantly shorter diastema and fewer points than the other three populations ($P < 0.05$) and they weigh about 30% less than the statewide average (Dusek 1980).

In the other three areas, antler length may be related to different positions of the deer populations in relation to carrying capacity. In fact, antler length appears to be closely related to the number of years since the last die-off ($r = -0.785$, $P < 0.05$), rather than to broad habitat type (Table 2). This may have predictive value.

Management Implications

We stress that condition indices are not the ultimate parameter needed for each population for proper management. However, we feel that condition indices are important and should be obtained for as many deer populations as possible along with other management data, such as age and sex structure, fawn production and survival, trends, harvest and hunter success.

In 1981, we used condition indices along with our other management data in recommending seasons and quotas in southeastern Montana (Region 7). Our other data indicated that deer were at or above carrying capacity east of the Powder River (areas 7 and 9 on Fig. 1). This was supported by our antler length data. Therefore, we recommended concentrating most of our antlerless mule deer "B" tags in this area.

Condition indices can also reveal aspects of a population that are not evident from other management data. For example, area 13 is sagebrush (*Artemisia*

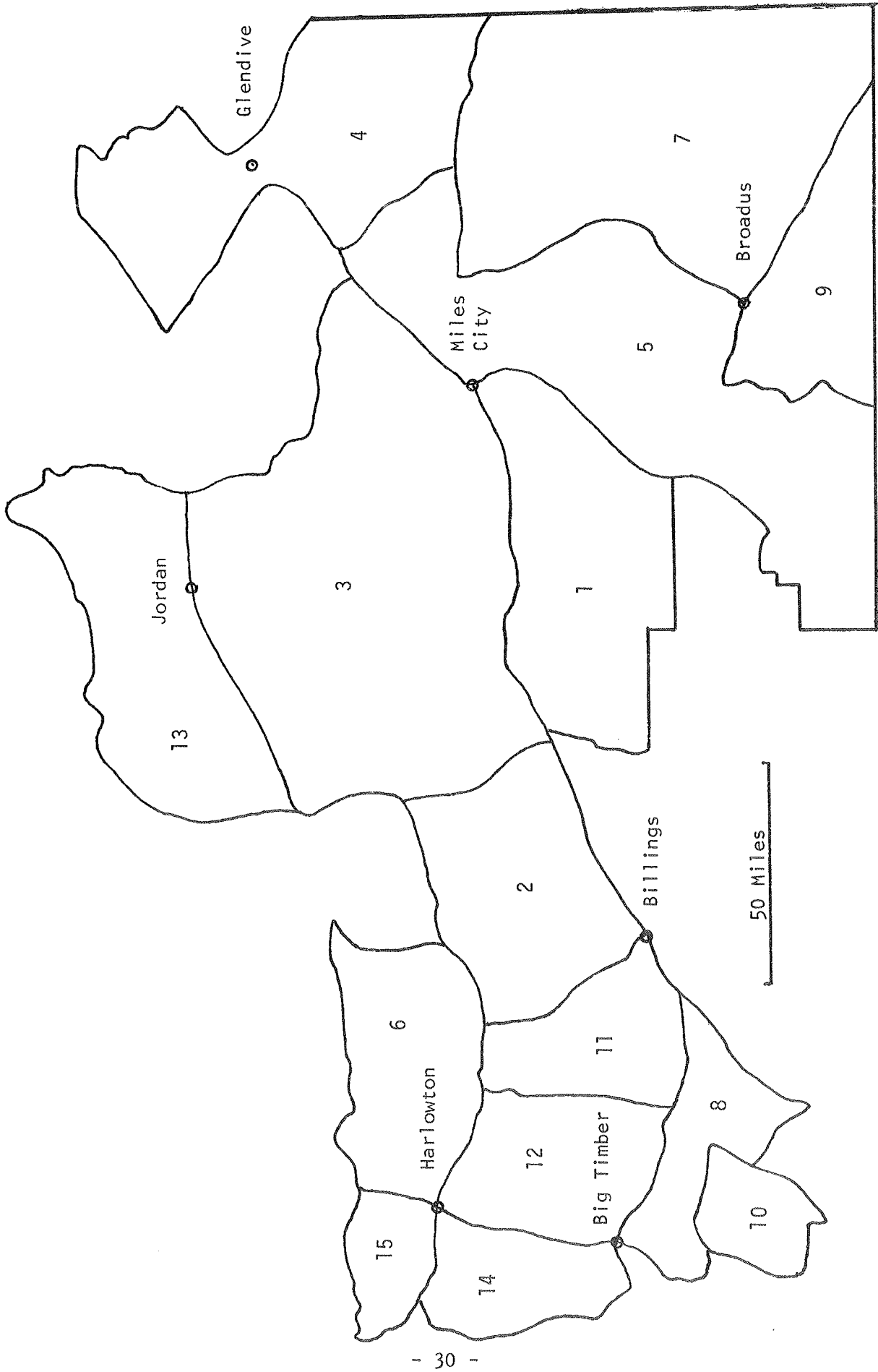


Fig. 1. Fifteen area in south central and southeastern Montana ranked according to mean antler main beam length for yearling mule deer bucks.

Table 1. Relationships between mule deer densities on wintering areas and greater main bean length of yearling bucks

Area	Hunting Districts	Greater Main Bean Length ¹			Mule Deer Density on Wintering Areas ²
		Mean (in)	S.D.	N	
1	720-722	11.91	1.91	15	22.6
2	590-591	11.36	1.62	26	19.3
3	710, 712-714, 730	11.23	1.95	38	8.6
4	733, 761	10.89	1.95	19	9.3
5	740-742	10.65	1.25	11	12.9
6	511, 514	10.49	1.46	30	
7	770-782	10.41	1.47	54	
8	562, 573-574	10.38	1.80	48	36.9
9	790-792	10.35	1.48	24	14.7
10	520-521, 572	9.95	1.69	70	40.0
11	500-501	9.86	2.07	13	
12	570-571	9.58	1.83	80	
13	700	9.58	1.47	27	
14	580-582	9.32	1.92	64	73.4
15	540	9.16	1.82	12	

¹From 1981.

²Winter deer densities from total aerial counts (1976-79), corrected for observability bias by habitat type (Mackie et al. 1980; Mackie, pers. comm.).

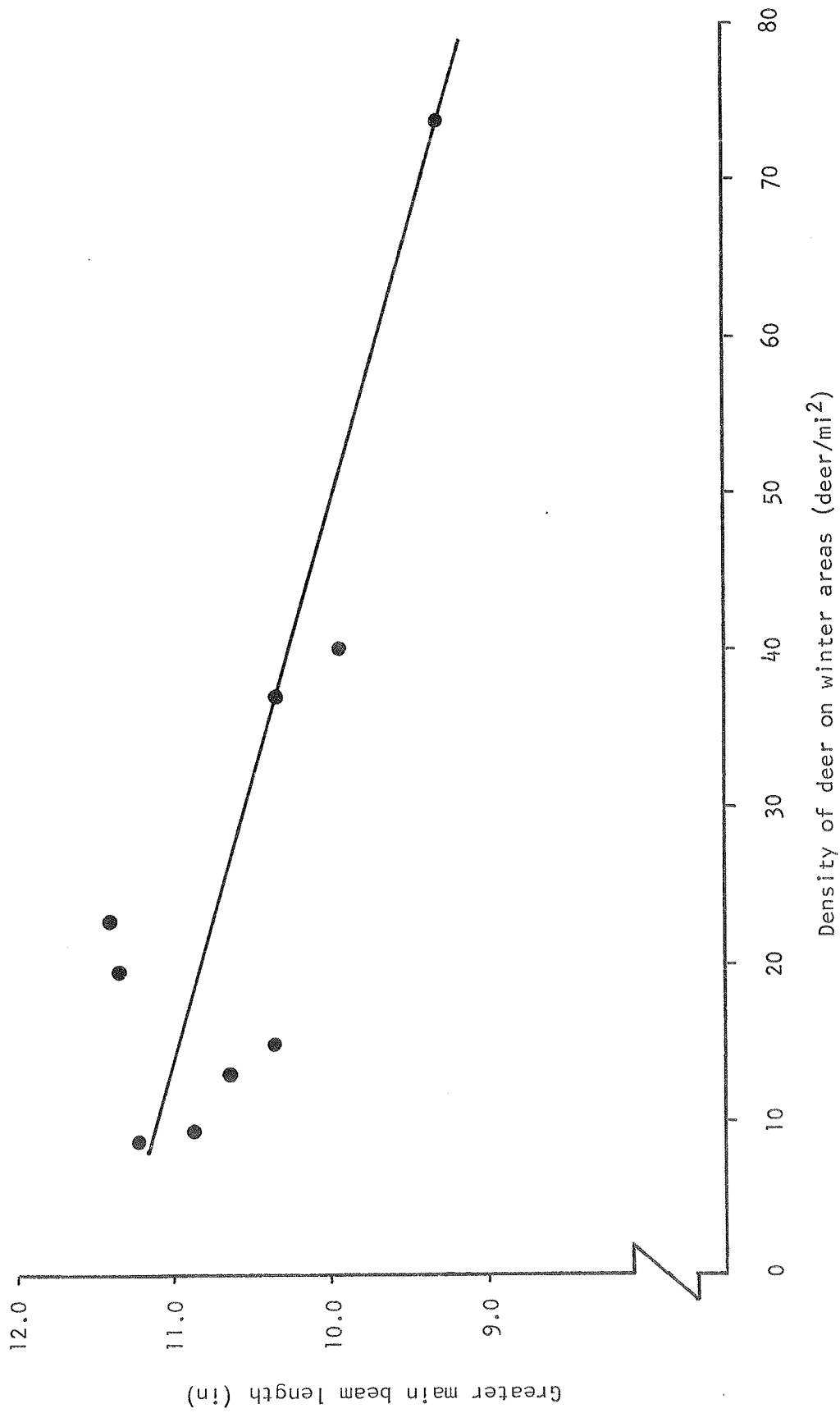


Fig. 2. Relation of greater main beam length of yearling mule deer (1981) and density of mule deer on wintering areas (1976-79).

Table 2. Comparison of antler main beam length of yearling white-tailed deer in four areas in southeastern Montana, 1980-81

Hunting District	Habitat	Greater Main Beam Length		Year of Last Population Decline and Reason
		Mean (in)	S.D. N	
714	Yellowstone River bottom	12.48	1.60 19	1980 - EHD epizootic
731-733	Prairie-agriculture	11.22	1.48 40	1978-79 - severe winter
750	Yellowstone River bottom	10.43	2.15 51	1977 - EHD epizootic
781 ¹	Ponderosa pine	7.09	2.64 9	1978 - EHD epizootic 1978-79 - severe winter

¹Only the Long Pines portion of hunting district 781.

tridentata) steppe surrounded on three sides by river breaks, mostly timbered by ponderosa pine (*Pinus ponderosa*) and/or Rocky Mountain juniper (*Juniperus scopulorum*). Adjacent area 3 is predominately sagebrush steppe with a few areas of treeless rough breaks. Both areas have some dryland agriculture. The traditional management data show no basic differences between the mule deer populations in the two areas, but the main beam lengths are significantly larger in area 3 ($p < 0.05$) (Table 3). The only other indication of differences between these two areas is that 20-25 mule deer are known to have starved to death at the edge of the breaks in area 13 in the exceptionally mild winter of 1980-81. No mule deer are known to have starved anywhere else in southeastern Montana that winter. The condition index may be the most sensitive indicator of population condition under these circumstances. The winter was too mild to affect fawn production or recruitment of yearlings in area 13. We will be watching these areas closely. A moderately severe winter would give us a definitive test to the hypothesis that mule deer in area 13 are at higher population levels relative to their carrying capacity than those in area 3.

We would encourage all biologists working with big game to seriously consider using condition indices, especially in management. We point out that these indices do not identify limiting factors for populations, but rather give a reflection of the entire range of factors which are important enough to the animals to affect their growth.

Table 3. Comparison of mule deer population data from adjacent areas 3 and 13, 1981

Parameter	Area 3	Area 13
Fawns/100 does preseason	91 (894) ¹	91 (744)
Bucks/100 does preseason	29 (894)	25 (744)
Percent yearling bucks preseason	61% (117)	61% (85)
Percent yearlings in buck harvest	53% (77)	67% (43)
Increase in trend areas 1980-81	67% (1)	51% (1)
Main beam length	11.23 (38)	9.58 (27)

¹Sample sizes.

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RUNNING AWAY FROM HOME - A BEHAVIORAL MODIFICATION
IN ADOLESCENT MULE DEER DESIGNED TO ASSUAGE SOCIAL
STRESSES ASSOCIATED WITH BURGEONING SIBLING DENSITIES

Ken Hamlin¹

Population estimates have been obtained since 1960 for a mule deer population in the Missouri River Breaks of Montana. The study population occurs within "breaks" habitat in northeastern Fergus County in the area between U. S. 191 and the Fergus-Petroleum county line.

Population trend and high and low numbers are presented in Fig. 1. Historical population highs have been 1,100-1,200 deer, or 11-12 deer/mi². These are post-hunting season estimates. At present, we are at a historical post-season population high. The pre-season estimates were 1,450 deer in 1960 and 1,375 deer in 1981, representing pre-season population highs.

The trend line showing pre-season estimates for number of adult females indicates that population highs were approximately 650 females in 1960 and 1961, 585 females in 1971 and 600 females in 1981. The main point of Fig. 1 is that we are presently at or near historical population highs.

Since 1978 population estimates have been in July, September-October, December-January and March. These estimates are the result of Lincoln Indices utilizing marked deer present. In order to be valid, estimates must be consistent with each other when known mortality and production between estimation periods are taken into account. The number of males predicted to occur during early fall was always observed, consistent with known mortality and recruitment since the previous March. Since 1979-80, however, the number of adult females observed in early fall has been considerably less than was predicted, based on known recruitment and mortality since the previous March (Fig. 2). Since 1979-80, the adult female population has not been growing at the rate that yearling females were recruited.

Information on the movement patterns of 1-year-old deer may provide an explanation for the "missing" females (Table 1). During 1977-79, only 1 of 10 recruited yearling does moved out of the population unit. This one dispersal occurred during 1979. During this period, approximately 300 adult females were in the population (Fig. 1). In 1980, 3 of 11 (27%) of the recruited yearling does moved out of the population unit. The population contained approximately 400 adult females at that time. In 1981, 5 of 14 (36%) of the recruited yearling does moved out of the population unit. Approximately 500 adult females were in the population at the time this dispersal occurred. The percentage of yearling females leaving the population increased as the adult population increased. This was apparently not balanced by other yearling females moving into the population unit (Fig. 2).

In contrast, the data in Table 1 shows no relationship between the dispersal of yearling males and population level. The movement of yearling males out of the population was apparently balanced by yearling males from other populations moving onto the area. The number of yearling males on the area during early

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fall was the number predicted to occur (within 12 animals), based on known recruitment. Males apparently have more of a natural tendency to wander and are more willing to settle in "marginal" habitat.

Table 1. Dispersal from population by marked yearling mule deer

Birth Year	Females		Birth Year	Males	
	Number Monitored	% Dispersed Off Area		Number Monitored	% Dispersed Off Area
1976-78	10	10	1976-78	9	78
1979	11	27	1979	11	45
1980	14	36	1980	11	55

Dispersal occurs when adult females are ready to have fawns. At that time, they chase their previous fawns away (or any other deer that approaches them) until these deer leave the area. At low population densities, yearlings will be able to find sites to occupy near their mother's home range. At progressively higher densities, yearlings will encounter other parous females at the edge of their mother's home range. They then must move increasingly long distances to more marginal habitats to find areas where they are not harassed by females with young fawns. Dispersal appears to be a function of maternal territoriality and habitat complexity.

Dispersal distances in this study have ranged up to 55 airline miles. Some deer dispersed, but remained within the population unit, finding an unoccupied area before they left the population area.

Management Implications

- 1) Deer will begin to appear in marginal areas when female densities in core habitats begin to increase to levels where home ranges excessively overlap during summer.
- 2) Dispersal is a true self-regulatory mechanism in core habitats, since it begins before populations reach their highs.
- 3) Dispersal is a contributing factor in game damage complaints.
- 4) Dispersal by yearling males at all population levels leads to continuous genetic interchange.
- 5) Hunters did not consider deer abundant, nor did the harvest increase significantly until the population increased to about 1,175 deer pre-season. This means that habitat fill was nearly achieved before the average hunter thought there were many deer.

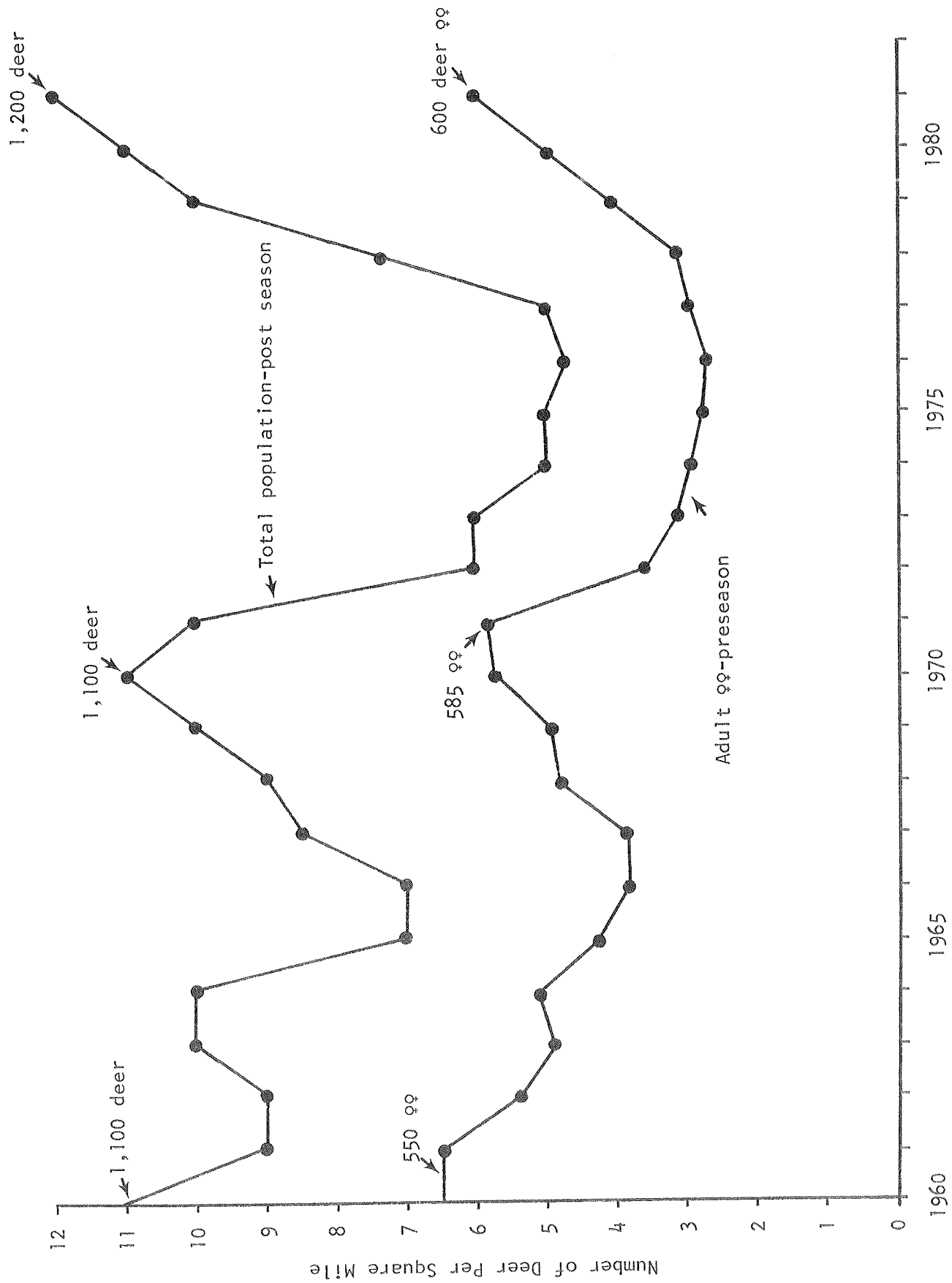


Fig. 1. Missouri River Breaks mule deer population trend.

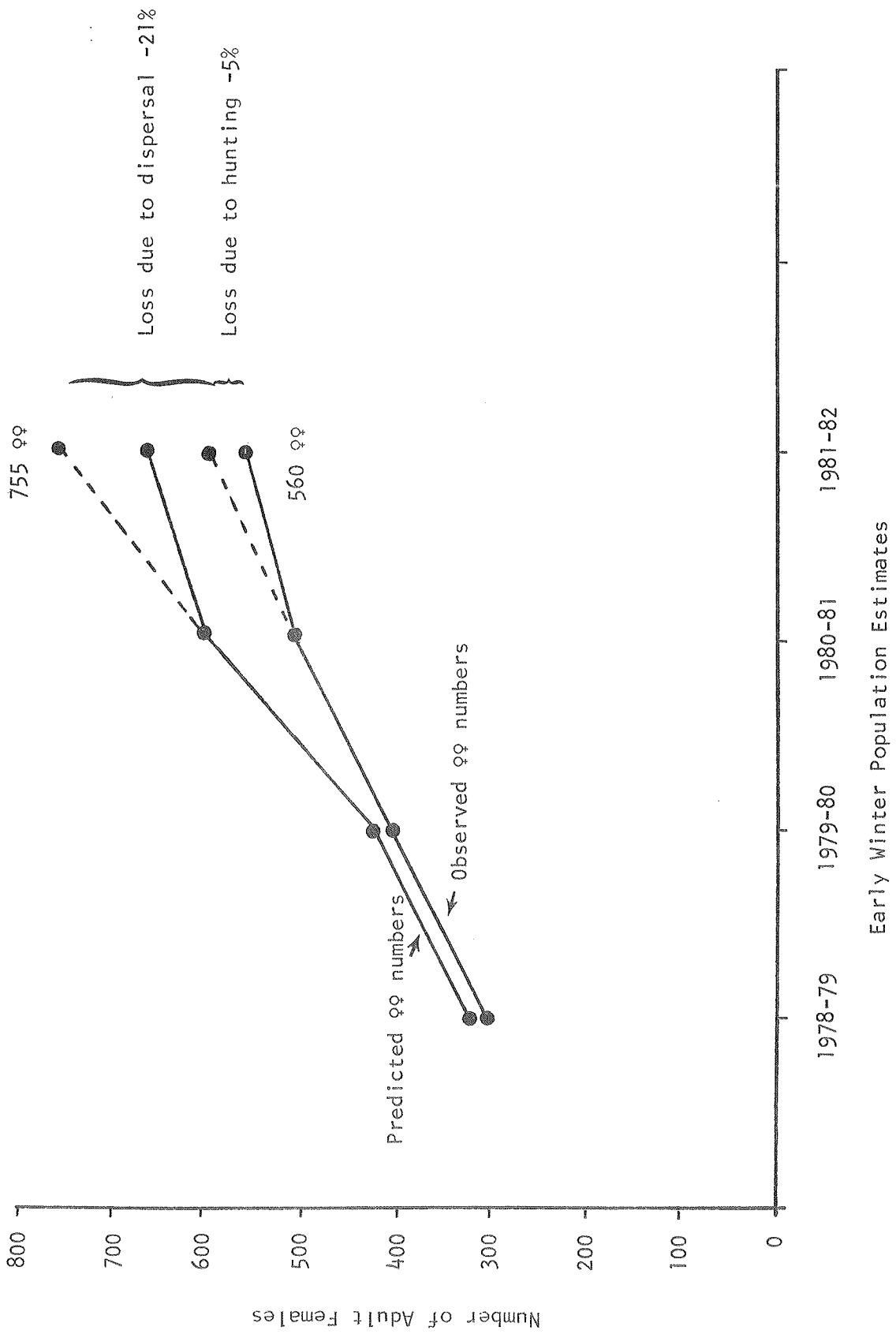


Fig. 2. Effect of dispersal on adult female numbers.

WHEN YOU'RE ON TOP, IT'S HARD TO REMEMBER THE BOTTOM

David Pac¹

Research is often initiated and conducted when a group is unsatisfied with the present state of knowledge. If research is successful, then it will provide 1) basic facts about the topic of concern; 2) new techniques and opportunities for management; 3) an evaluation of currently applied concepts, facts and techniques and 4) a new conceptual framework for collecting and interpreting data and making decisions.

The statewide deer research study was initiated in 1975 at a time when philosophy that was followed in Montana from the early 1950's to the 1970's began to break down. We believed in a conceptual framework that failed to provide important answers when they were needed. The Fish and Game Department was forced to sit down and reevaluate its deer management program and the effectiveness of existing concepts and methods.

The management strategy in practice was strongly influenced by the measurement of browse conditions on key winter range areas. Monitoring the trend and condition of browse supplies would permit the determination of general population levels relative to carrying capacity. This would establish the number of deer that could or should be harvested. It was a philosophy that worked in Montana as long as deer were abundant, pressures and demands on the resource were light, and the margin for error was great.

The concepts underlying this philosophy reflected the state of knowledge to this point in time. That they were not entirely valid should come as no surprise. Any scientific discipline is constantly evolving toward the goal of absolute truth. The current state of knowledge should always serve as a springboard toward improvement of the state of the art.

The incentive for improvement of deer management in Montana came in the early 1979's, when the scene began to change rapidly. Deer populations began a natural decline phase. At the same time, license sales began to climb and a concentration of hunting pressure occurred in many areas because of access problems. Liberal hunting seasons were the rule in the belief that heavy harvests would help deer ranges and increase production and recruitment. Within existing philosophies, we found ourselves watching browse plants more than deer, when the bottom fell out. The philosophy and therefore the monitoring techniques were not sensitive enough to put out any warning signals. As a result, deer management strategies in practice at this time probably amplified a natural population decline.

In 1975, the Montana Chapter Meeting was exclusively concerned with this deer decline, its causes and possible solutions. Incidentally, that was the first meeting of wildlife professionals that I ever attended. I was rather stunned - no one had any idea what happened to all the deer. The principles of wildlife management that I had just jammed into my head seemed to be jeopardized already and I hadn't even had the chance to use them. At the meeting, the deer decline was attributed to everything under the sun or a combination of everything under

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the sun, and sometimes even the sun itself. About the only thing anyone agreed on was that the basic understanding of deer populations was not all that great and new, more sensitive techniques for monitoring populations and their habitats were needed. The outcome of these concerns was a statewide deer study that intensively and comparatively researched representative populations within major habitats across the state. Since then, it has become clear that deer populations are naturally regulated through the interaction of animal behavior and the habitats they occupy. If the reverse were true, deer would have been long gone by now. This basically means that habitat does not always have to be protected from deer activity.

Deer populations occupying different habitats exhibit different population dynamics. Habitat measurements alone are not capable of revealing these differences, nor are they capable of predicting population trends. The only way an effective management strategy can be formulated and applied to a population is through characterizing and monitoring the population itself. This will define the relationship between a deer population and its habitat, and identify the management opportunities and constraints that exist. Without good historical population trend data, there will be no prediction of the next deer decline until after the fact. Trend information means population size estimates, not just ratios. We have demonstrated that mule deer can be counted and reliable population parameters can be collected. This is the only way we can ever come close to actually managing deer populations. That is our job - to be prepared to manage for the maximum recreational opportunity the resource will support. An alternative to real management is playing it safe and setting our goals far below the potential, but professional wildlife biologists are not necessarily needed for that.

In 1975, wildlife biologists in Montana had a problem and were looking for direction. Habitat measurements had failed and it wasn't known if deer populations could be measured directly. In fact, it was widely believed that they couldn't be measured - so we didn't even try! Five years later, the deer research study progressed to the point where practical application of results can be made. A new set of guidelines for deer management have been outlined by the Montana Department of Fish, Wildlife and Parks deer research group. They are based on direct measurement of populations.

It is ironic that now that answers can be given to questions raised when a problem existed in 1975, there doesn't seem to be a problem anymore. Now the only problem is just like the good ole' days - trying to shoot all the deer. But just as sure as deer have gone up, they will also go down. The true test of our research results, management effectiveness and public credibility will come with the next deer decline. Each one of us responsible for monitoring and managing deer populations must ask ourselves if the kinds of data we are presently collecting will permit us to anticipate the next deer decline in time to respond in a responsible and effective manner. Let's hope that we, not the public, will be the first to recognize the next downward trend in deer numbers. Are we locked into a boom-and-bust deer management program, or is there a chance to smooth out the population peaks and troughs through efficient management?

It is difficult to sell a new mode of operation to any group, particularly if the group may have forgotten that the old mode of operation had serious drawbacks.

To carry out the new deer management guidelines on a large scale will not be easy. First, it will take recognition of the need for change and recognition that a better way has been offered. It will take lots of time and money, both of which are in short supply, so the importance of deer in relation to other species must be decided. Then it will take strong leadership and decisive planning to marry research results and management activities into one operation.

At the 1975 Montana Chapter Meeting, Don Quimby said new research and management direction is needed, but he said that takes planning and the trend in Montana has been a lack of planning at all levels because planning limits individual freedoms. The organization of MDFWP reflects this, as individual freedoms have been top priority. All of us value this freedom, but we pay for it through a department structure that tends to create vacuums which stifle statewide goals and the standardization of activities.

A reason that progress comes slowly to our profession is that many of us are insecure about our understanding of wildlife and its role in our socio-economic system. In the future, let's avoid being too eager to believe, too quick to apply, and too busy to think.

FIRES' INFLUENCE ON VEGETATIVE SUCCESSION--WILDLIFE HABITAT IMPLICATIONS AND MANAGEMENT OPPORTUNITIES

George E. Gruell¹

Introduction

The purpose of this paper is to illustrate how wildlife habitats change over time and to provide a basis for managing toward desirable wildlife habitats. Contents are an overview of a photographic study of vegetative change that is being reported in an upcoming Intermountain Station publication. This material establishes a baseline from which land managers and the public can determine how current wildlife habitats compare with those of the past. This frame of reference should facilitate formulation of management direction that will maintain productive wildlife habitats.

Over the past several thousand years, wildlife habitats have been influenced by various biotic and abiotic agents, including insects and diseases, wild ungulates, climate, wind and wildfire was the principal disturbance in pre-settlement environments; domestic livestock grazing has been the most effective post-settlement disturbance.

Study Approach

Several thousand early photographs were screened and examples selected that depicted various forest and range vegetative types at lower to mid-elevations on national forests. A primary requisite for photo selection was that the scene contain sufficient land features to reasonably assure that the approximate camera point could be relocated.

Good photo resolution was a prime consideration. Nevertheless, a few very early photos of marginal quality were included because they depicted conditions in plant communities of importance and better photos were unavailable. No photographs depict presettlement conditions. Several scenes dating from 1871 to about 1900 do, however, show early stages of settlement when human impacts had been minimal. Post-1900 scenes reflect human impacts, especially livestock grazing, mining and in some instances logging.

Emphasis was placed on documenting vegetative conditions in a variety of ecosystems, thus allowing interpretation of fire effects. The frequency of past fires has been determined by study of fire-scarred trees (Arno and Sneek 1977). Placing fire in historical perspective should help determine the place of prescribed fire in future management of lands utilized by wildlife. Analysis of changes have been facilitated by grouping scenes having similar environmental characteristics. Nonforested scenes have been placed in one of three vegetative types. Those in forests are segregated into "fire groups" (Davis et al. 1980). Fire groups are comprised of "habitat types" (Pfister et al. 1977). These groups are structured from the driest to the more moist conditions and are based on the response of the tree species to fire and the roles these tree species take during successional stages. Interpretation of fire effects has been aided by use of historical references to fire, fire records and appropriate fire history studies.

Results and Discussion

Vegetative Relationships: Table 1 summarizes retake photographs by Vegetative

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Table 1. Historical photographs retaken in Montana

Fire Group or Vegetative Type	No. of Photos	Region
Sagebrush/grass	5	Southeast and southwest
Mountain mahogany	4	Southwest, central, southeast
Juniper	3	Southwest, south central
Dry limber pine	6	North central, southwest, south central
Warm, dry ponderosa pine	3	Northwest, central, southeast
Warm, moist ponderosa pine	1	Southeast
Warm, dry Douglas-fir	9	West central, central, south central
Cool, dry Douglas-fir	15	North central, central, southwest, south central
Moist Douglas-fir	31	Northwest, west central, northwest, north central, central, southwest, south central
Moist lower subalpine fir	2	Northwest

Type or Fire Group. These scenes provide visual evidence of vegetative and cultural changes during the period 1871-1981. This photo record has shown that early stages of plant succession were common 40-110 years ago. Moist conifer forests exhibited fire mosaics of young growth interspersed within mature forests. Conifers in drier forests were widely spaced with open understories. Rangelands had a "smoother" appearance with continuous grass cover and fewer shrubs and trees than in later years.

The evidence that vegetation was repeatedly disturbed by wildfire is convincing. Most early photographs show evidence of wildfire. Early narratives document wildfires in various regions of Montana and studies of fire scar patterns have recorded the dates of many fires (Arno 1976, Gabriel 1976, Sneck 1977). From these studies, fire frequencies have been determined. The data show that except for double burns in northern Idaho, fires were infrequent (70-250 years) in cool-moist habitat types such as those in the *Abies grandis* series. Warm-dry and cool-dry habitat types in the *Pinus ponderosa* and *Pseudotsuga menziesii* series burned frequently (5-40 years).

The historical effect of fire on vegetation largely reflected local weather patterns and fuels. In moist habitat types in northern Idaho, western Montana, and at higher elevations elsewhere in Montana, infrequent surface of stand-destroying fires thinned the forest and produced openings. This process resulted in early successional vegetation where shrubs and herbs flourished. Aspen and tall shrubs were particularly well represented in early succession.

In contrast, in dry habitat types frequent surface fires inhibited development of shrubs and conifers and favored grasses. The net result was a landscape where woody cover was limited.

European settlement resulted in a marked reduction in frequency and extent of wildfires' influence on the landscape. Cultural practices including road building and development of irrigated pastures broke up fuel continuity. Introduction of domestic livestock on rangelands resulted in yearly consumption of fine fuels that formerly allowed fires to spread over extensive areas. Indian ignitions were effectively eliminated by relocating tribes to reservations. Fire suppression became effective in the 1930's.

Significant changes in vegetation have occurred apparently in response to the marked reduction or absence of wildfire. The photographs show that the most striking change has been the widespread increase in distribution and density of conifers. In moist habitat types, this resulted in tree canopy closure that tends to shade out early successional herbs and shrubs. This change is often subtle because it occurs slowly. The decline in condition of aspen has been of particular importance. On most sites aspen are seral, and without disturbance deterioration is inevitable.

The photo record shows the absence of fire in warm-dry and cool-dry habitat types allowed establishment and massive increases in conifers. Fire-sensitive shrubs including big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), and curleaf mountain mahogany (*Cercocarpus ledifolius*) also increased in the absence of fire. These and other shrub species have died out or are declining in many localities because of biotic factors and competition from conifers. Perhaps the most striking change has been the widespread encroachment of Douglas-fir into former grasslands or sagebrush/grass types. Extensive areas that formerly supported few, if any, trees have become