MONTANA CHAPTER
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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.

TABLE OF CONTENTS

MORTALITY PATTERNS OF ANTELOPE IN THE YELLOW WATER TRIANGLE

Duane Pyrah[1]

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 ($r = 0.91$; $p < .0005$) 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.

The authors wish to thank T. Lonner for assistance in computer analysis; and J. Swenson, G. Erickson, G. Brown and J. McCarthy for critical review of the manuscript.

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 inches^3 (Table 1). Horn volumes for all transplanted populations were larger than for any native population ranging from 184 to 285 inches^3 (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)

[1] Volume in cubic inches.

[2] Based on 1980-81 surveys.

[3] Bighorns per square mile.

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

[5] Includes 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) Trans-planted	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

[1]Volume in cubic inches.

[2]Based on 1980-81 surveys.

[3]Bighorns per square mile.

[4]Population 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 $inches^3$ for Absaroka rams to only 115 $inches^3$ 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 $inches^3$) to quite large for Absaroka rams (177 $inches^3$). 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 ($r = 0.91$; $p < .0005$) (Figure 2). Since historic minimum population levels are closely correlated with present population levels ($r = 0.81$; $p < .005$) (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.

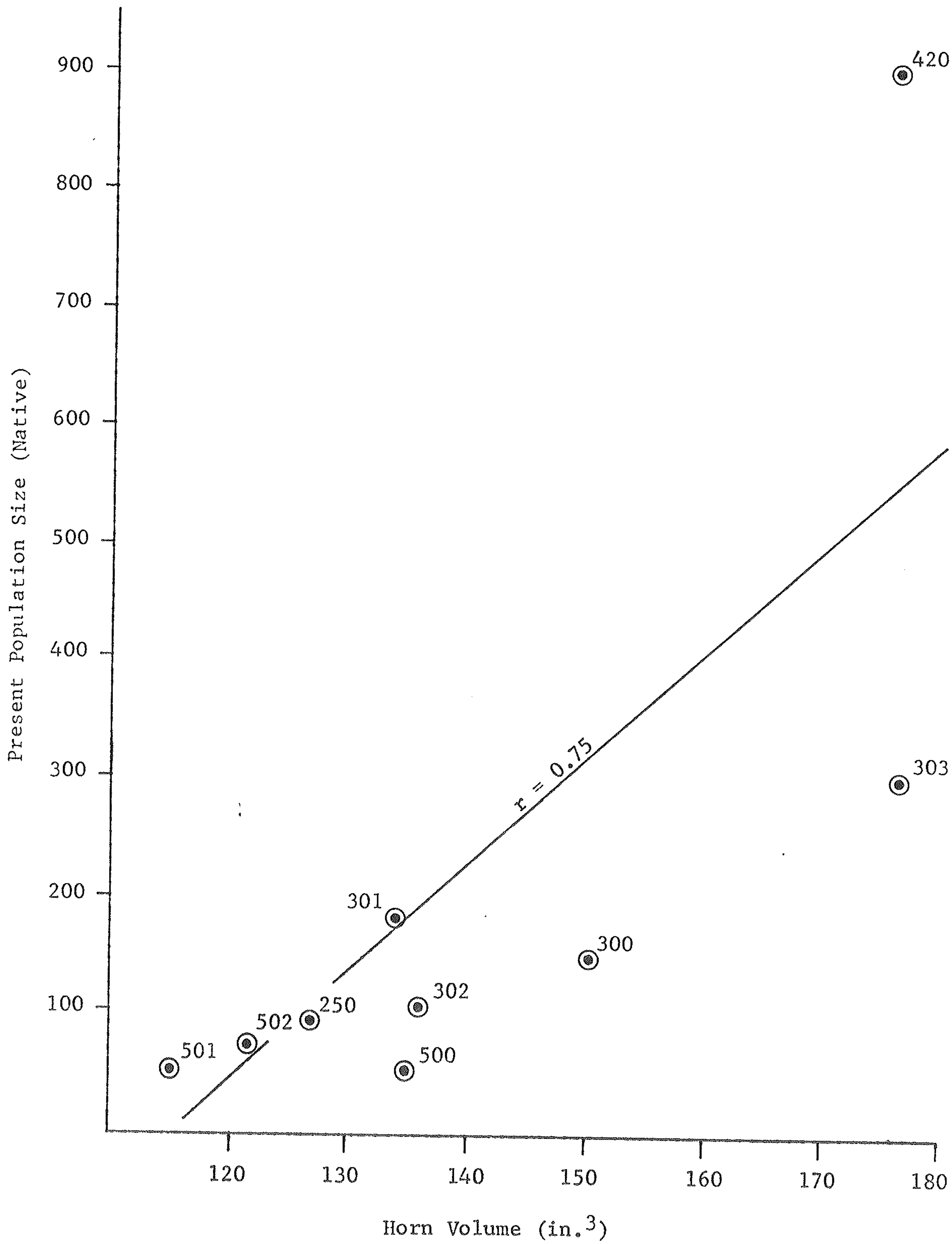

Figure 1. Relationship of horn volume and present population size for Montana's native bighorn populations.

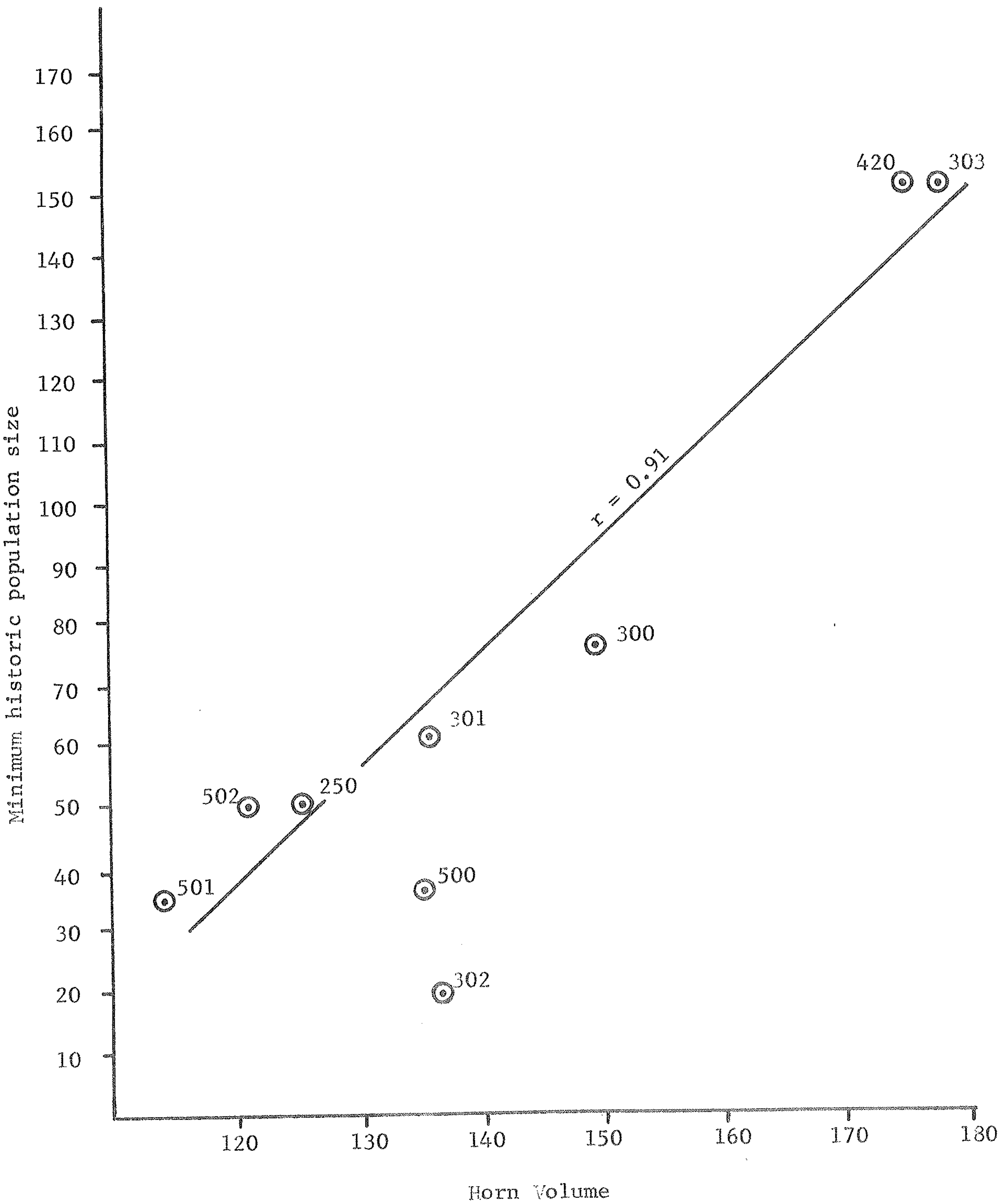

Figure 2. Relationship of horn volume and minimum historic population size for Montana's native bighorn populations.

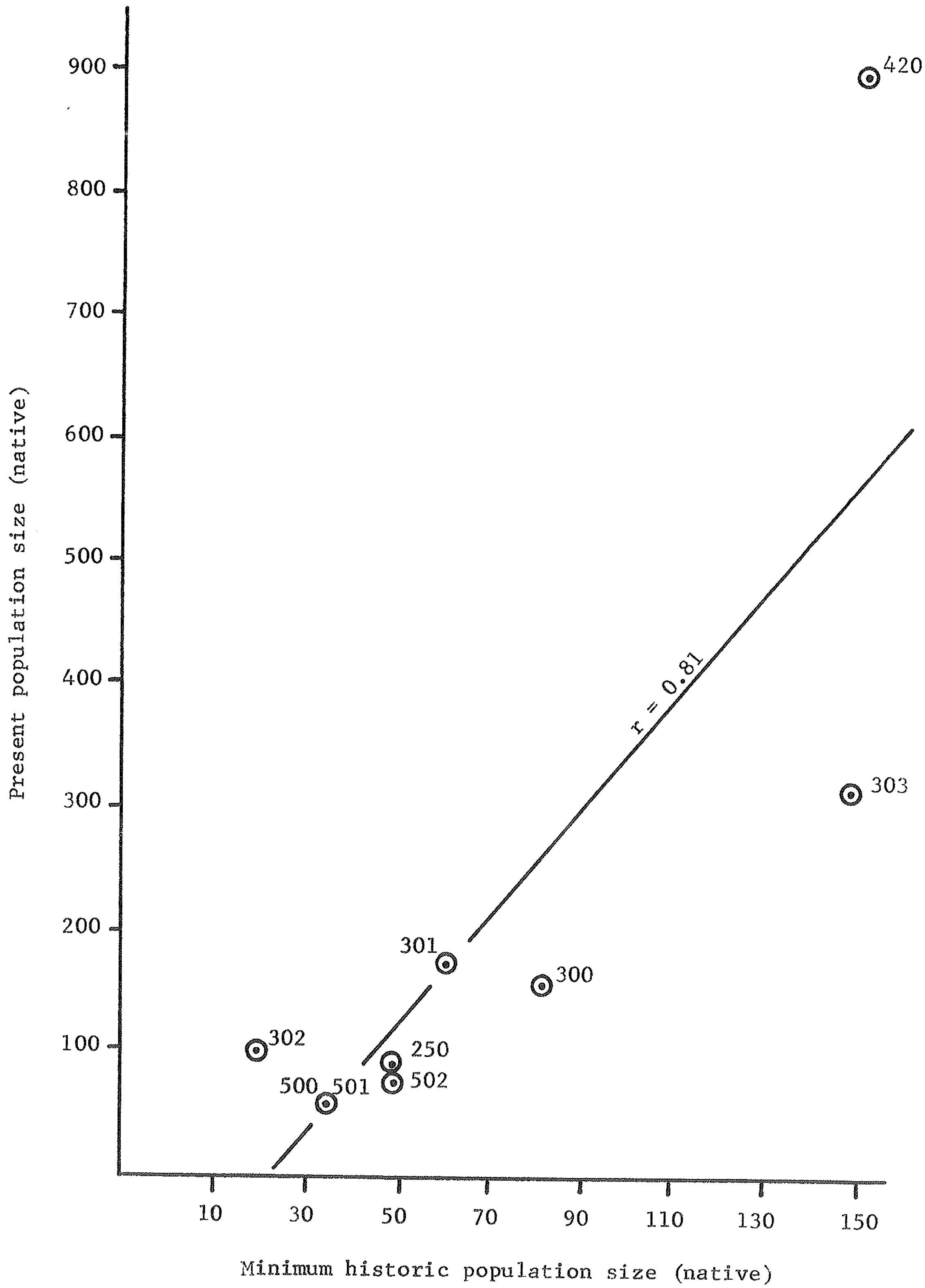

Figure 3. Relationship of minimum historic and present population sizes for Montana's native bighorn populations.

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 has 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 inches^3, Thompson Falls - 212 inches^3).

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 ($0.05 < p < .025$). 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, Cooperrider 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, subdividions, 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 equibibrium 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. Mundinger

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 (Mundinger 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 adaption 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. Riley[1]

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/km^2 during 1978-1980 (Pryrah 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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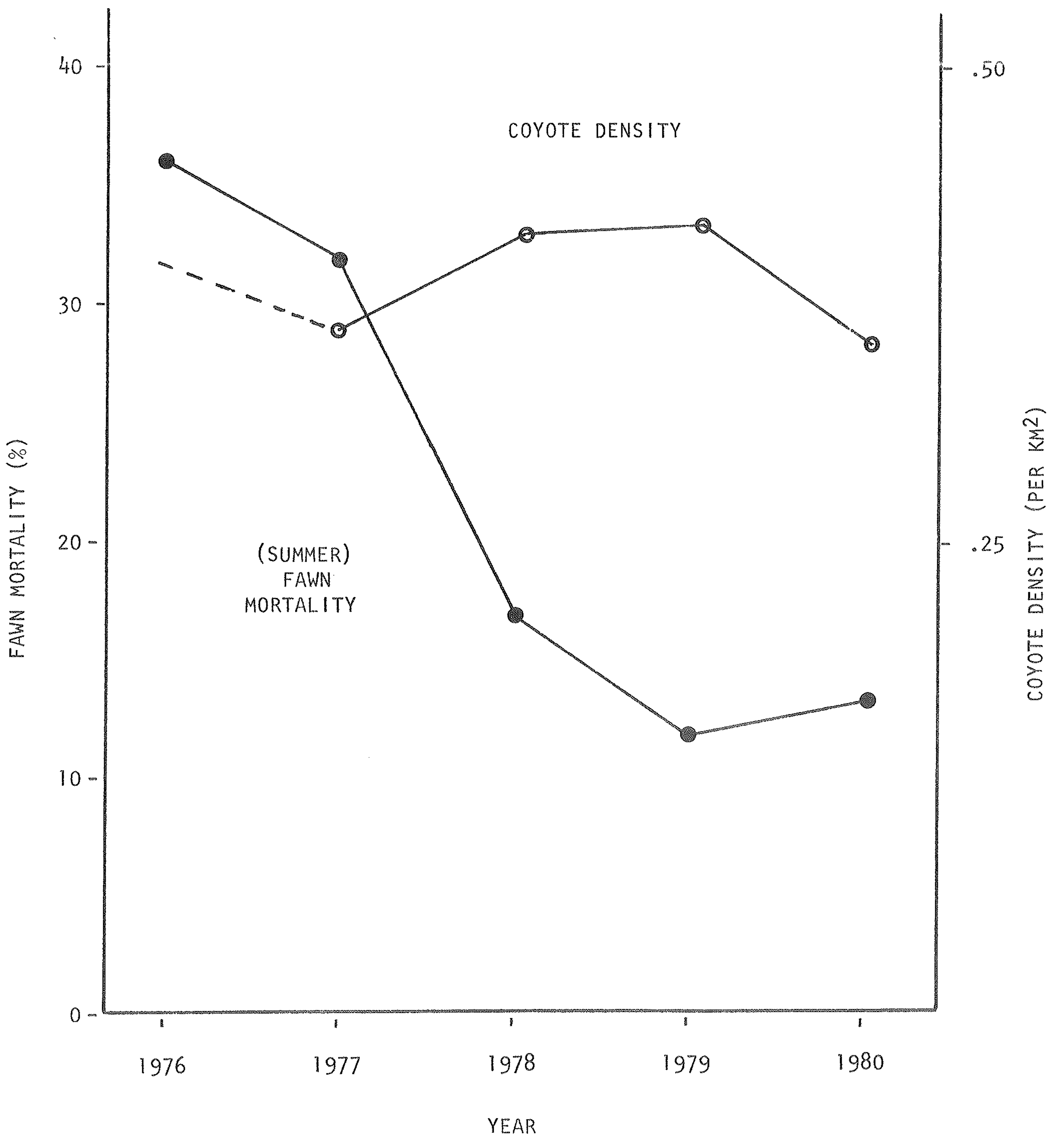

Fig. 1. Fawn mortality rates related to coyote densities during summers, 1976-1980, in the Missouri River Breaks, Montana.

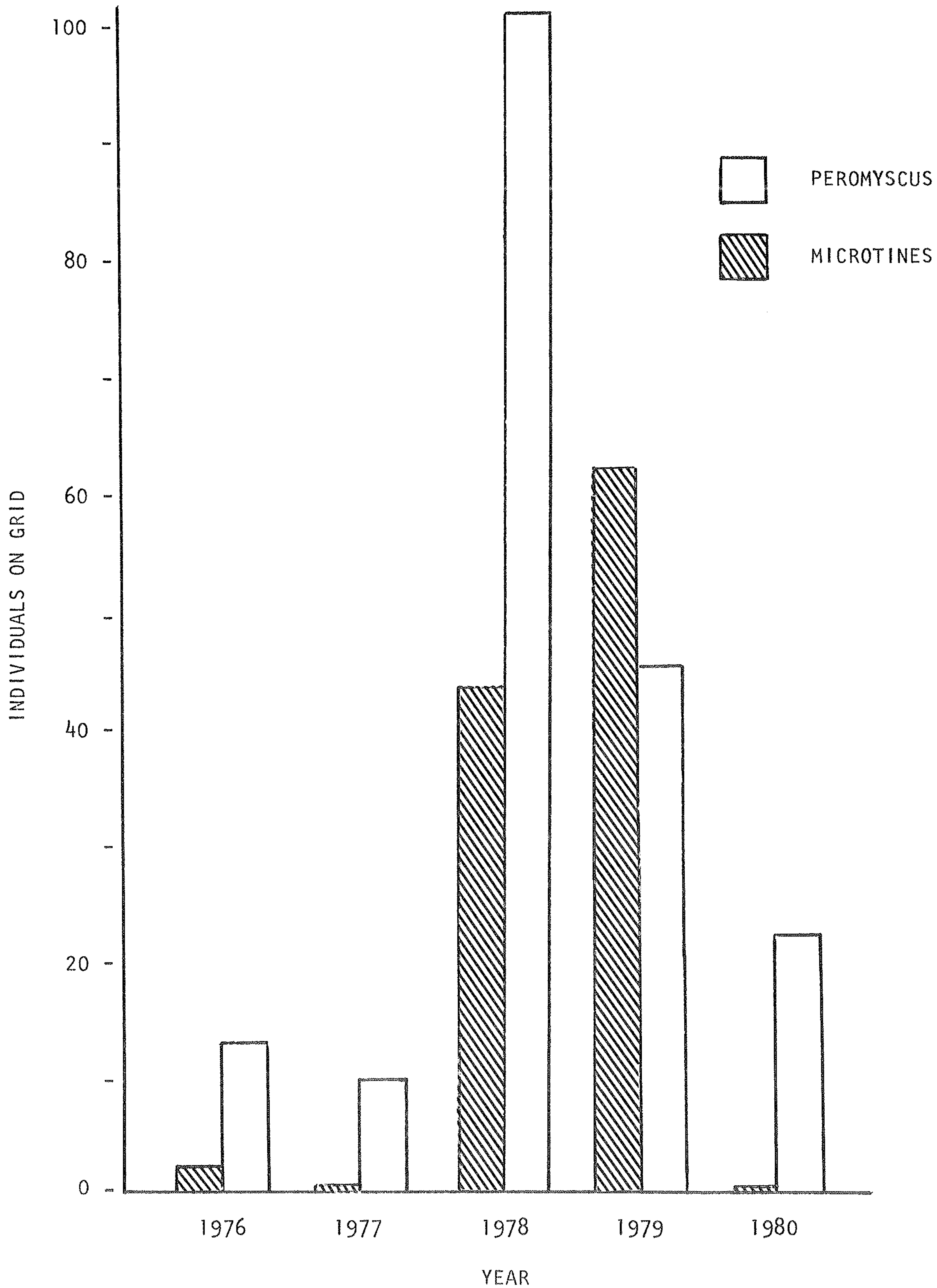

Fig. 2. Relative small mammal population sizes during summers, 1976-1980, in the Missouri River Breaks, Montana.

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. Dusek[1]

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 mi^2 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. Longivity 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 %

[a]Sample 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

Jon E. Swenson[1] and Shawn T. Stewart[2]

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*

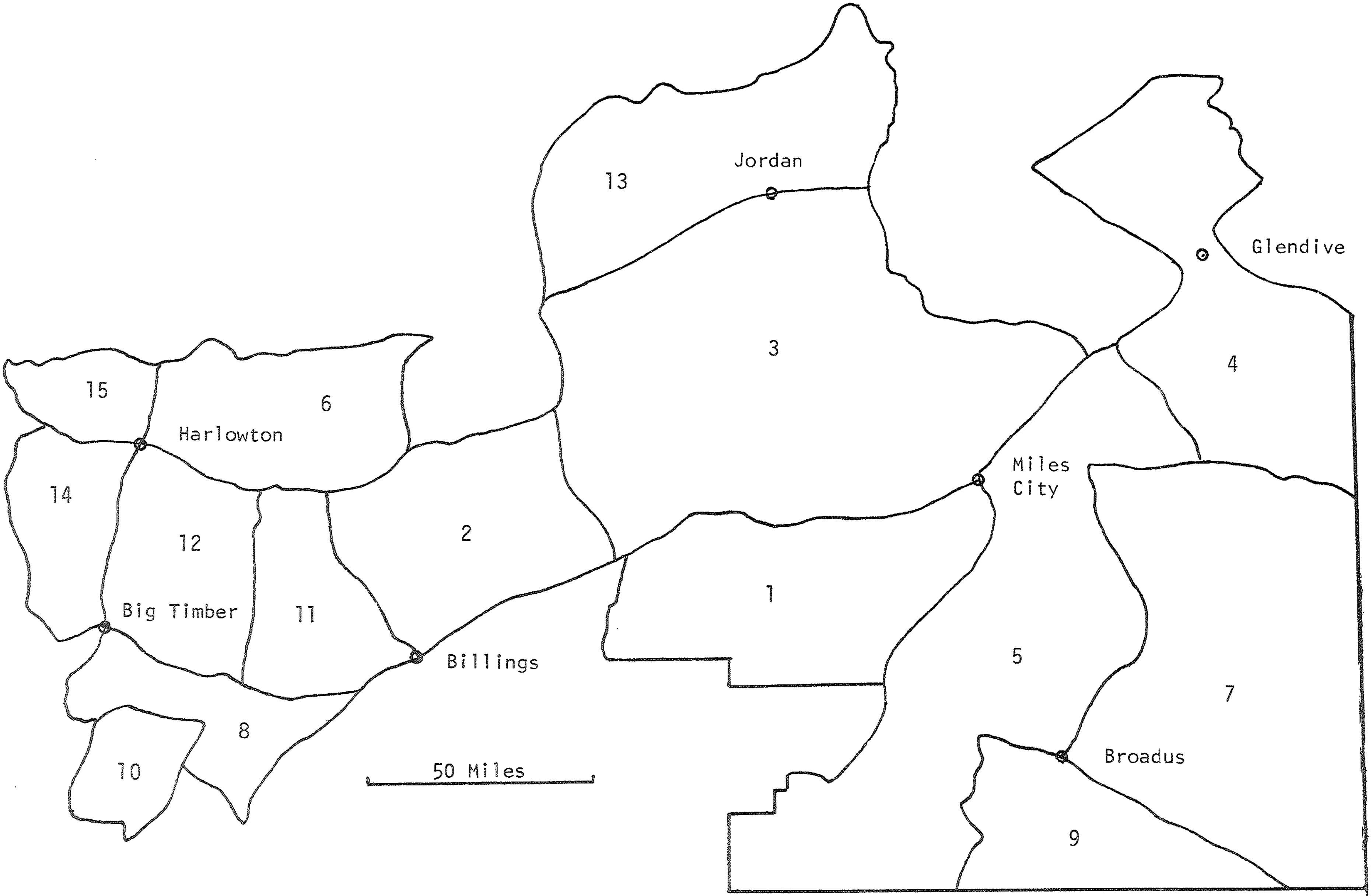

Fig. 1. Fifteen area in south central and southeastern Montana ranked according to mean antler main beam length for yearling mule deer bucks.

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] Mean (in)	S.D.	N	Mule Deer Density on Wintering Areas[2]
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	

[1]From 1981.

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

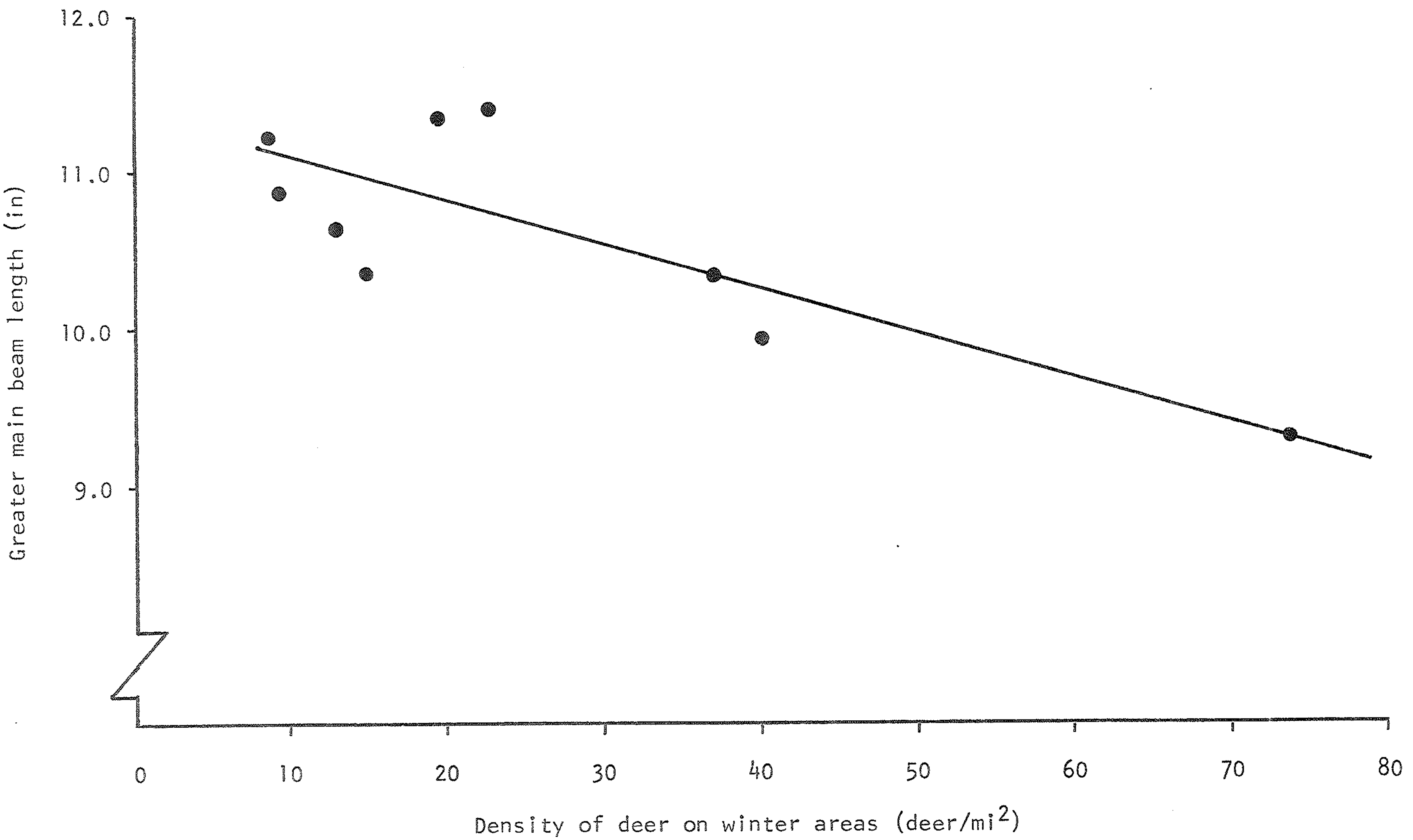

Fig. 2. Relation of greater main beam length of yearling mule deer (1981) and density of mule deer on wintering areas (1976-79).

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 Mean (in)	S.D.	N	Year of Last Population Decline and Reason
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

[1]Only 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)

[1]Sample 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 Hamlin[1]

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/mi^2. These are post-hunting season estimates. At present, we are at a historical post-season population high. The preseason estimates were 1,450 deer in 1960 and 1,375 deer in 1981, representing preseason population highs.

The trend line showing preseason 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

Females			Males		
Birth Year	Number Monitored	% Dispersed Off Area	Birth Year	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 preseason. This means that habitat fill was nearly achieved before the average hunter thought there were many deer.

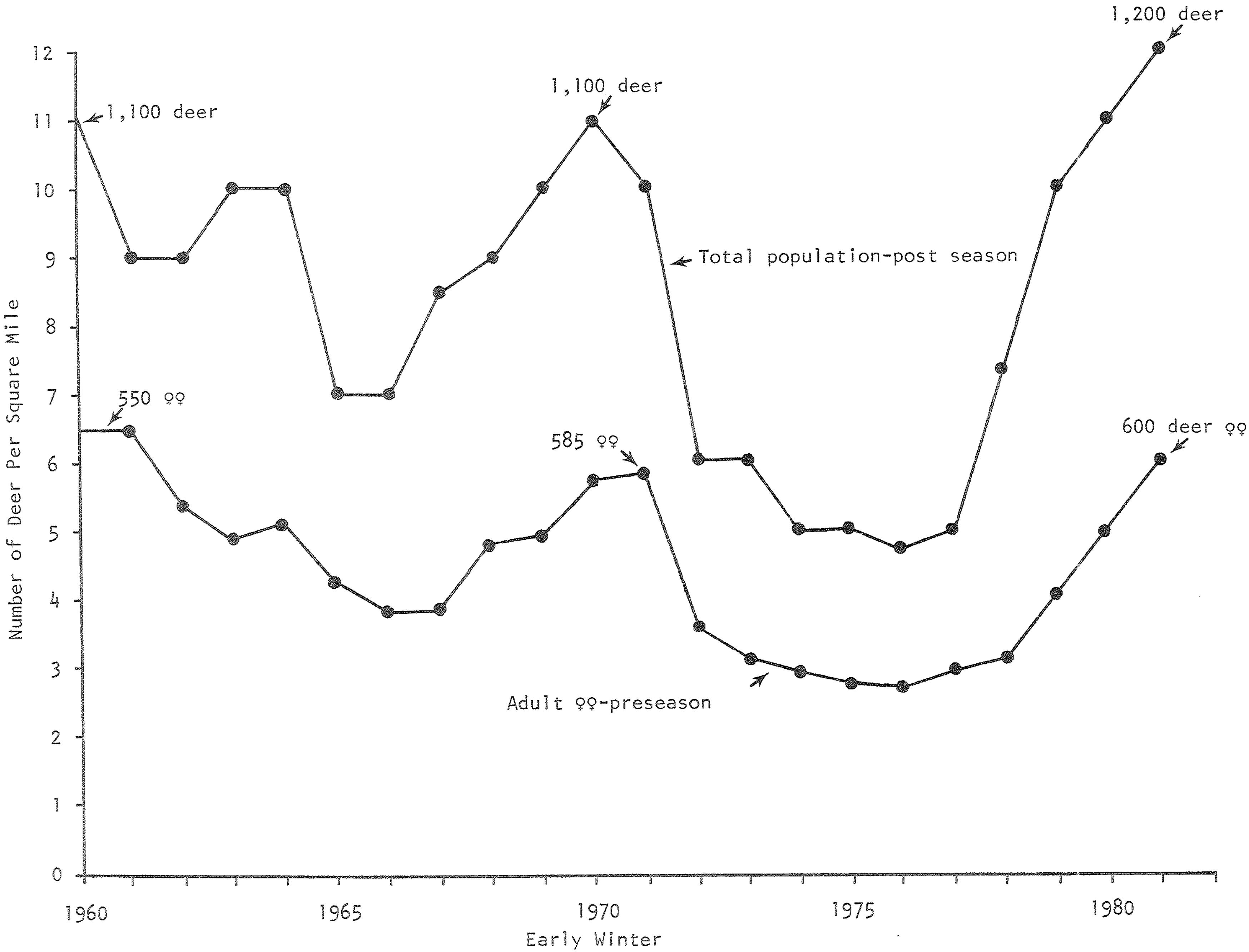

Fig. 1. Missouri River Breaks mule deer population trend.

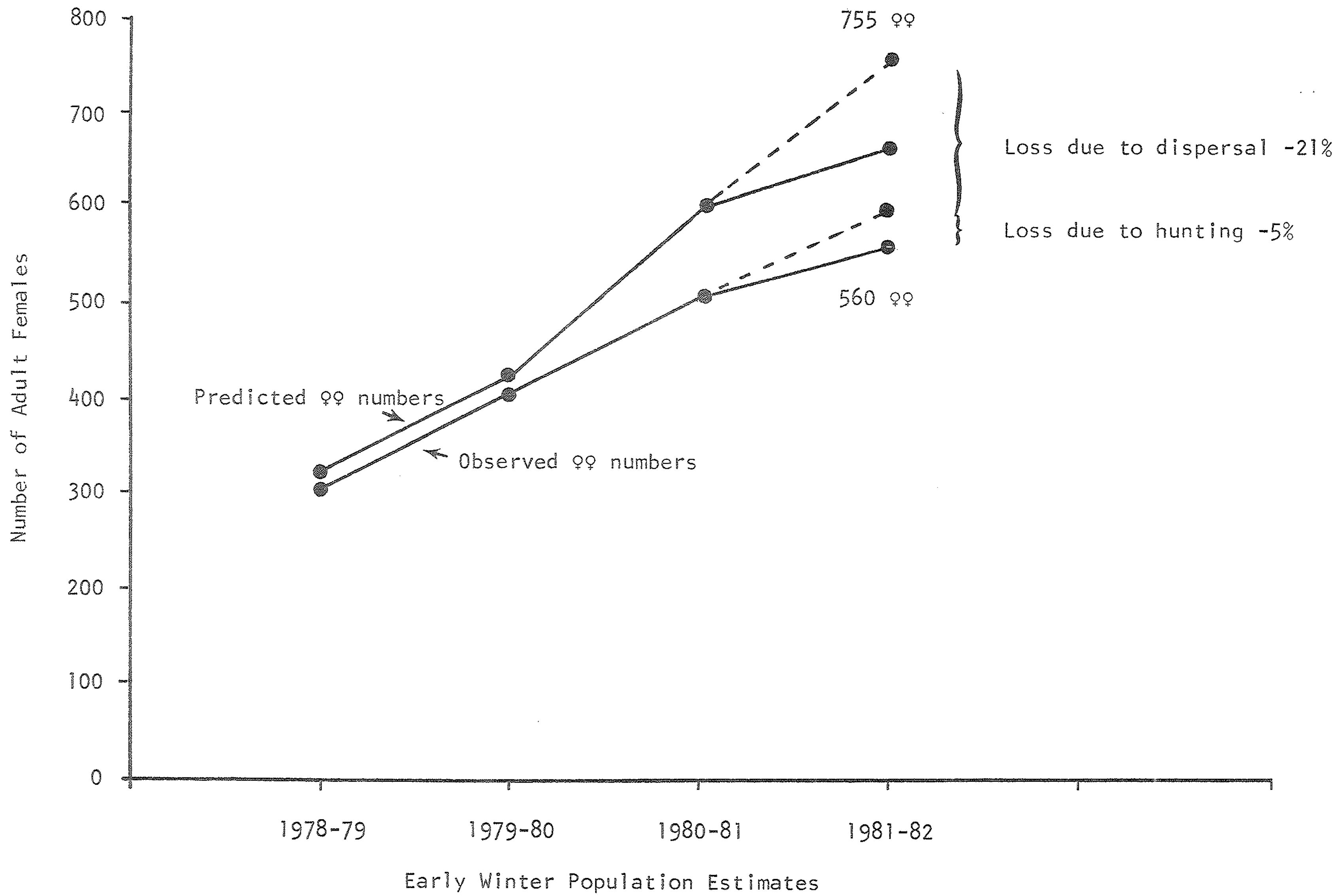

Fig. 2. Effect of dispersal on adult female numbers.

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

David Pac[1]

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 vacumms 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. Gruell[1]

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 effectual 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 Sneck 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 deline 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 curlleaf mountain mahogany *(Cercocarous 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 essentially fir forests. On many sites the successional sequence has been bunchgrass, followed by sagebrush, which was subsequently replaced by Douglas-fir *(Pseudotsuga menziesii)*.

Cutting of conifers for house logs, post and poles, fuel, mine timbers, railroad ties and small saw timber between 1870 and 1920 was also instrumental in initiating changes in vegetation. The level of logging varied regionally depending upon availability and need. In some mining localities such as Butte and Helena, extensive forests were cut for mine timbers and fuel. In other instances, such as limber pine *(Pinus flexilis)* stands along the east slope of the Rockys, heavy cutting occurred in localities where there was easy access, while remote areas were not cut. The net result of logging was disturbance of the soil surface and elimination of conifers that were competing with understory plants for space. In the years following, a marked reduction of wildfires allowed fuller development of shrubs than was possible prior to settlement.

Wildlife Implications: It is widely accepted that wildfires formerly enhanced wildlife habitat by creating vegetative diversity. This generalization is too broad, however, considering that fire environments and plant response to fire vary widely in the Northern Rockys. Vegetative patterns resulting from early fires were apparently optimal for some wildlife species, while for others conditions were marginal.

In moist habitat types infrequent fires benefit some big game species, such as ruffed grouse *(Bonasa umbellus)*, snowshoe hares *(Lepus americanus)*, and other species whose habitat requirements include early stages of forest succession (Dimock 1974, Leege and Hickey 1977, Scotter 1964). Although some wildlife species that require mature and old growth forest habitats are displaced and sometimes destroyed by wildfires, long-term habitat benefits result. Infrequent fire in moist habitat types assures regeneration of important seral conifers, and provides snags and down logs on which these species are dependent.

Dry ecosystem wildlife habitats respond differently to fire. The historical influence of frequent fire in these ecosystems has not been adequately investigated. It seems probable that grass and forb-eating herbivores, including bison *(Bison bison)*, pronghorn antelope *(Antilocapra americana)* and bighorn sheep *(Ovis canadensis)*, without strong requirements for abundant cover, were favorably influenced by fire. Fires in these ecosystems would have also had a favorable influence on elk *(Cervus elapus nelsoni)*, which are primarily grass foragers east of the Continental Divide (Kirch 1962, Rouse 1957, Stevens 1966). Small mammals, including deer mice *(Peromyscus maniculatus)* ground squirrels *(Spermophilus spp)*, raptors, and sharp-tailed grouse *(Pedioecetes phasianellus)*, that are dependent upon or are associated with grassy habitats would have been benefited by fire (Amman 1957, Baker 1940, Davis 1976, Dimock 1974, Firsh and Kruse 1972). Frequent fires in montane forests, forest/grassland ecotones, and on mountain slopes and benchlands were probably detrimental to cover dependent species such as cottontail rabbits *(Sylvilagus spp)* and Brewer's sparrows *(Spizella breweri)*. These fires inhibited the development of shrubs and young conifers important to wintering mule deer *(Odocoileus hemionus)* and white-tailed deer *(Odocoileus virginianus)*. Historically, mule deer frequented breaks and rough terrain where shrubs were available locally, while white-tailed deer frequented deciduous bottomlands.

Successional changes in the absence of fire have had profound effects upon the capability of habitat to support wildlife. In moist west side habitat types, elk, mule deer, white-tailed deer, bighorn sheep and other herd and shrub-dependent species no doubt benefited in terms of food and cover during early stages of forest succession. Where tree crown snow intercept and cover were critical, optimum habitat conditions may not have been reached for 30 years or more after fire. The absence of fire for 50 years or more, with subsequent conifer encroachment, canopy closure and deterioration of herbs and shrubs has resulted in a decline in forage condition on big game habitats (Lyon 1966). Successional changes, however, have been favorable for cavity-nesting birds that require conifer, aspen, or cottonwood snags for nesting. Advanced successional stages supporting high conifer densities are also essential habitats for small mammals, including red-backed voles *(Clethrionomys spp)*, red squirrels *(Tamiasciurus hudsonicus)*, pine marten *(Martes americana)* and porcupines *(Erethizon dorsatum)*. Closure of the forest canopy has been undesirable from the standpoint of other small mammals and birds, including deer mice, snowshoe hares, ruffed grouse and blue grouse *(Dendragapus obscurus)* (Bendell and Elliott 1967, Dimock 1974, Fox 1978, Gullion 1967).

The absence of fire in dry western and east side ecosystems has allowed successional development to proceed further than was possible historically. During earlier stages, diversity apparently improved in this vegetative complex because of development of woody plants on grassland sites and lightly stocked forests. The establishment of conifers and fuller development of fire-sensitive sagebrush, bitterbrush, or curlleaf mountain mahogany, and other shrubs was particularly beneficial to mule deer. Further successional changes, however, have resulted in a decline and loss of forage plants on many of these sites in recent years. Increased cover has benefited white-tailed deer, which now occupy heavily forested areas. These areas formerly supported few, if any, whitetails and apparently were marginal habitat because of cover limitations. Increases in cover probably benefited elk in many localities. Development of trees and shrubs on grasslands and lightly stocked forests would favor foliage feeders and nesters such as the Brewer sparrow, mountain chickadee *(Parus atricapillus)* and ruby-crowned kinglet *(Regulus calenduia)*. Continued long-term succession leading to continuous forest cover would displace grassland species, including the vester sparrow *(Pooecetes gramineus)*, savannah sparrow *Passerculus sandwichensis)*, sharp-tailed grouse and white-tailed jackrabbits.

Fire Treatment: From an ecological perspective, fire is viewed as a stimulus that converts vegetation from old stages or decadency to an early stage. Fire is the first and oftentimes essential step in long-term development of vegetation. Fire effects depend upon climate, plant species on the site and the fire characteristics. Fire severity is important because it influences plant species composition and landscape patterns. A severe fire will kill many plants, but it also allows regeneration of other desirable forage plants that require a seedbed of mineral soil for establishment. Frequent fires limit successional development because plants do not have an opportunity to put on accumulative growth. Modern fire suppression and changes in fuels will not permit recurrence of historical fire regimes. Land managers would not in fact want to replicate presettlement fire frequencies in some ecosystems. Nevertheless, prescribed fire can be used effectively to improve wildlife habitat and other resources. The challenge is to see that application of fire is consistent with demonstrated needs and predictable response.

Use of prescribed fire for purposes of improving productivity of wildlife habitats has varied among forest regions. Almost all the effort to date in

Montana has been confined to communities that support few if any conifers. West of the Continental Divide the primary effort has been in the productive seral shrub fields. Prescribed fire has also been utilized east of the Continental Divide in localities where big sagebrush has extensively invaded former grasslands. Most USDA, Forest Service burning in big sagebrush has taken place on the Beaverhead National Forest.

Progress is being made on several Northern Rocky Mountain Forests by applying surface fire beneath the overstory canopy in standing timber. Good results have been attained where ladder fuels have not been excessive. Over 20 years' experience in using surface fire beneath ponderosa pine, Douglas-fir and larch on the Rexford Ranger District, Kootenai National Forest, has resulted in considerable refinements in the fire prescription and application. This knowledge has been passed on to others.

Perhaps the greatest challenge for use of prescribed fire is on east side bunchgrass and juniper habitat types that have been invaded by Douglas-fir. These warm-dry and cool-dry habitat types are not programmed for harvest because of their low timber-producing potential. Here the increased distribution of early successional Douglas-fir should be of concern to land managers. Thinning of tree canopies by use of prescribed fire is appropriate, and reliable prescriptions are being developed. Past prescribed burning experience in this type and response of vegetation to earlier wildfires provide a basis for formulating prescriptions. It is evident that where trees are dense or of value as firewood, post and poles, small saw timber, or house logs, removal before ignition would be logical. Leaving unutilized material could enhance fuels and allow fires to carry across areas where fuel continuity was lacking. These treatments may require acceptance of short-term setbacks to achieve long-term benefits for wildlife habitat.

A large percentage of wildlife habitat in the mountains of the State is located in moist Douglas-fir habitat types and cool habitat types dominated by lodgepole pine. These habitat types have a high potential for production of shrubs and herbs during early and mid-succession. Aspen is a major component in various localities. Moist Douglas-fir habitat types and cool habitat types dominated by lodgepole pine are usually classified as commercial forests where timber harvests are regulated. Past logging practices on these lands have produced both detrimental and beneficial effects on wildlife. The principal detrimental effect has been on elk during early succession. Elk use of clearcuts has been severely depressed by the presence of roads and inadequate cover at the edge of openings (Lyon and Jensen 1980). Where roads have been closed, removal of timber has enhanced wildlife habitat by allowing establishment and growth of early successional plants.

There are numerous opportunities to utilize logging and prescribed fire to improve productivity of wild lands. Managers and others should become familiar with opportunities that exist in their area of concern. By properly applying prescriptions, long-term benefits can be realized. Priority areas would include aspen/conifer associations where aspen has deteriorated as a result of successional changes. Wildlife biologists working with silviculturalists can identify priority areas and the type of treatments that will yield the best results. Field input during the early stages of planning would allow placement of cutting blocks and roads to facilitate broadcast burning. Fire treatment should be considered an essential part of the prescription because it can create seedbeds of mineral soil that allow regeneration of pioneering species like Scouler willow *(Salix scouleriana)*.

Long-term increase in conifers and decline in herbs, shrubs and deciduous trees is an undesirable wildlife habitat trend. Control of conifer growth by timber harvests and prescribed fire can be a powerful means of achieving productive wildlife habitat. A major challenge in wildlife habitat management is bringing about a proper mix of young and old successional stages.

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DEVELOPING A RATIONAL FOR REGIONAL MANAGEMENT OF GRIZZLY BEARS IN NORTHWESTERN MONTANA

C. J. Martinka[1]

Grizzly bears *(Ursus arctos)* currently occupy less than half of their historic range in North America. Range recession most likely began in the early 1800's and has continued unabated for more than 175 years. Present status in Montana is generally considered tenuous, reflection of the human pressures which continue their expansion into occupied grizzly bear habitats. This paper addresses the nature of these pressures in and around Glacier National Park in northwestern Montana (Martinka 1982 a, b).

The continental population of grizzlies reaches its southern limit in Montana, Wyoming and Idaho. Distribution is characteristic of a retreating population in that isolation of the Yellowstone and Cabinet mountain segments is readily apparent (Joslin and Kapler 1977, Servheen 1982) and large areas of suitable habitat are unoccupied. At the same time, much of the population remains in genetic contact with grizzlies to the north in Alberta and British Columbia, Canada. Grizzly bears have been designated a threatened species south of Canada.

The presence of national parks and forest wilderness has helped to arrest grizzly bear range recession in northwestern Montana. However, the insularization process continues to act on these sanctuaries and status as ecological islands is a distinct possibility in future years. For example, access to bear habitats adjacent to Glacier National Park increased at an annual rate of 2.1% from 1938-68 (Martinka 1982 a). This rate is substantially greater than the 0.4% annual rate of habitat loss estimated for the continental population over the past 175 years.

The concept of sympatric imcompatibility is considered implicit when evaluating grizzly bear habitat loss. Grizzlies possess innate behavioral traits which often lead to aggressive interactions with humans. In turn, interactions frequently result in the death of bears and, perhaps more importantly, help to direct public sentiment against the presence of grizzlies in human habitats. Most certainly, this relationship has been of equal or greater importance than ecological degradation in reducing continental population numbers.

The grizzly bear population in the contiguous habitats of northwestern Montana is currently estimated to include 450-680 individuals (Servheen 1982). Confirmed annual losses averaged 22.6 for the 1971-80 period or 3.3-5.0% of the estimated population. Mortality exhibited a downward trend during the period, especially in areas greater than 10 km distance from the park. In contrast, an upward trend in park losses occurred as visitation continued to increase during the 1970's (Martinka 1982 b). However, park losses remained at a relatively low level, and tended to mediate regional mortality. An adult (3.5 years plus) mortality rate of less than 5% was considered acceptable by Sidorowicz and Gilbert (1981).

Specific reasons for the downward trend are not immediately apparent. One

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possible explanation involves recognition and treatment as a threatened species. A second points to the presence of fewer bears, especially in areas beyond the park boundary. The latter hypothesis merits serious consideration as regional losses, excluding the park, may be in excess of the 5% acceptable limit.

In general, the creation of access to and subsequent human activity within bear habitats can be directly correlated with mortality rates (Martinka 1982 a, b). For example, road and trail access within the park have changed little since 1938, but visitation, confrontations and bear deaths have increased in concert during recent decades. Mortality rates adjacent to the park are some 10 times greater, reflecting both more access and a broader spectrum of resource use activities. Mortality under park conditions was limited largely to situations involving human safety. Losses adjacent to the park were about 50% legal harvest with the remainder from various forms of human encounters.

Available data suggest that a fundamental relationship exists between human presence and unnatural grizzly bear mortality. This relationship has led to nearly 2 centuries of range recession, a trend which has been partially halted by the creation of large parks and wilderness. Unfortunately, it is now recognized that the extensive movements and low density potential of grizzlies may limit the effectiveness of those sanctuaries. It follows that regional conservation planning is essential if viable populations are to persist.

If regional management is to be successful, several issues are of immediate importance.

1) The current system of parks and wilderness provides an essential protective core for grizzly bear management.

2) The remote nature and restricted human activities in these sanctuaries promote minimal interactions between grizzlies and humans.

3) Conservation of grizzlies adjacent to or between sanctuaries will enhance the integrity and resilience of protected populations.

4) Mortality control and/or human management are critical elements in a program designed to recover and/or conserve a viable grizzly bear population.

In conclusion, grizzly bear numbers have continued to decline as humans occupied their habit in North America. Creation of protective sanctuaries has been an effective form of conservation, but expanded management needs are now apparent. Regional plans to include areas adjacent to and between sanctuaries are considered appropriate.

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AN EVALUATION OF GRIZZLY RELOCATIONS
IN THE BORDER GRIZZLY PROJECT AREA, 1975-1980

Tim Thier and Dennis Sizemore[1]

Introduction

Under the provisions of the Endangered Species Act of 1973, all federal departments and agencies are directed to carry out programs for the conservation of endangered and threatened species (section 7). A pertinent program for the preservation of the grizzly bear *(Ursus arctos horribilis)* is the relocation program for nuisance bears.

Montana's current relocation program involves both state and federal agencies. Guidelines have been established determining nuisance status and what control actions should be taken if necessary (USFWS Operational Plan for Grizzly Bear Depredation Management 1981). Under the present system, the sex and age of the bear, as well as its aggressiveness displayed toward man, are the main factors in determining where and if problem bears are relocated. Potential release sites have been identified, and restrictions on the types of bears that will be accepted at each release site have been determined by the agencies involved.

In order to assist agencies in their future relocations of grizzly bears, the Border Grizzly Project (BGP) has assessed the relocation efforts conducted in northwestern Montana from 1975 to 1980. Examined were factors which may be important in determining successful relocations. The following report presents the results of the BGP assessment and possible management guidelines.

Methods

Beginning in 1975, records on grizzly relocations from northwestern Montana have been collected by BGP personnel. Records include grizzlies handled by the Montana Department of Fish, Wildlife and Parks; U. S. Fish and Wildlife Service; Glacier National Park, Bureau of Indian Affairs and the BGP. Grizzly bears released within Glacier National Park have not been included in this report. Bears were individually marked with numbered ear tags, with the majority also receiving a number tattooed to the inside of the upper lip. Of the 26 relocations, 15 involved bears instrumented with telemetry devices. For aging purposes, the majority of the bears were aged according to the cementum annuli technique described by Stoneberg and Jonkel (1966). Ages of the remaining bears are estimates by the handlers based upon tooth wear.

Age classes for data analysis were divided into cubs (< 1 year), yearlings (1-2 years), subadults (2-4 years) and adults (> 4 years). Successful relocations were defined as follows:

Successful - The bear is not known to have returned to the area of capture or come into conflict with people during the 1975-1980 period.

If an individual bear was relocated more than once, each relocation was considered separately. Relocation factors examined include 1) sex and age of the bear, 2) type of offense, 3) distance relocated, 4) time in captivity and

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5) season of release. In order to evaluate which relocation factors and combination of factors were the most influential in determining a successful relocation, statistical testing was employed. Stepwise inclusion, multiple regression analyses, and analysis of variance and covariance tests (Nie et al. 1975) were used.

Relative frequency distributions were also computed for each of the relocation factors. Nonparametric statistical tests, the binomial distribution sign test and the Wilcoxon's signed rank test (Mosteller and Rourke 1973) were employed to establish significance levels for each of the computed frequency distributions. The 95% level of significance was used in all cases with an assumed probability of success equaling .5. The University of Montana DEC 20 computer was used for computation purposes.

Results and Discussion

Twenty-two individual grizzly bears relocated 26 times during the 1975-1980 period were analyzed. Following the described criteria of success, 16 (62%), a significant portion of the 26 relocations, were considered successful, with 10 (38%) considered unsuccessful. Table 1 summarizes the 26 relocation attempts.

Distance of Relocation: The distance individuals were relocated from 12 miles (19 km) to 170 miles (272 km). All relocations greater than 75 miles (120 km, n = 8) were successful (Fig. 1). Forty-four percent (n = 8) of the relocations were successful when the distance moved was less than 75 miles. Seven of eight (87%) of the successful relocations involved animals less than 4.5 years old (Table 2).

Distance of relocation was the most important factor determining the relocation outcome. It was the first significant variable identified by the stepwise multiple regression analysis (Table 3).

Type of Offence: Type of offense was the second most important factor in determining the outcome of a relocation attempt. Types of offenses were grouped into five categories (Table 4). These are 1) livestock predation, 2) proximity to campgrounds or residences, 3) cabin depredations, 4) proximity to garbage dumps or dumpsters and 5) orphaned cubs.

Individuals involved in livestock depredations and cabin break-ins were negatively correlated with success. The reason for this is not known; however, the aggressive nature of these offenses may play a part. The near-residences-or-campgrounds-offense and orphaned cubs were significant factors contributing to the success of a relocation attempt. The influence of being near garbage was not a significant factor (Table 5). Frequency distribution for each of the offenses follow.

Livestock Predation was significantly the most common offense and resulted in the least successful relocations. Ten of the 26 relocations (38%) involved livestock predations. Forty percent of these relocations were successful, compared to a 75% rate of success for all other offenses. A significant portion of these relocations involved subadults (six of ten), of which only two were successful. Males and females were equally involved in such offenses.

Proximity to Campgrounds or Residences: Four of the five relocations that occurred for this reason involved animals 1.5 years of age. Relocation success for the five individuals was high (80%).

Table 1. Information on each of 26 grizzly relocation attempts during the 1975-1980 period

Date Captured	Number	Sex	Age	Capture Site	Success Yes	Success No	Offense[1]	Distance Moved mi	Distance Moved km	Additional Comments
4/21/75	A1151	F	1.5	Columbia Falls	x		4	34	54	- not seen since release
5/23/75	4007/4008	M	1.5	Coram	x		4	30	48	- not seen since release
7/31/75	118	F	9 mo	Ford Station	x		5	12	19	- in area following spring
8/2/75	2197/4043	M	10.5	Geifer Creek		x	2	26	42	- returned 1 year later, resumed cabin depredation
10/17/75	2198/2184	M	7.5	Salmon Prairie		x	2	30	48	- killed 4/1976, while breaking in cabin
7/20/76	2197/4043	M	11.5	Geifer Creek		x	2	64	102	- resumed cabin depredation N. Fork area in 1 week
10/11/76	200	F	9.5	Post Creek		x	4	16	26	- returned to vicinity of captue 1 month later
10/14/76	191	F	10 mo	Post Creek	x		5	22	35	- remained with cub, caused no trouble for 3 years
10/14/76	50/404	M	10 mo	Post Creek	x		5	22	35	- remained with cub, caused no trouble for 3 years
5/27/77	110	F	2.5	Muddy Creek		x	1	22	35	- returned in 5 days and resumed sheep predation
6/7/77	110	F	2.5	Muddy Creek	x		1	164	262	- killed by coyote getter - 1978, caused no problems
7/6/77	258	F	1.5	Sprague Creek	x		4	100	160	- killed illegally 10/1977
7/6/77	222	M	1.5	Sprague Creek	x		4	100	160	- monitored for 7 months, lost contact spring 1978
5/21/78	351	F	3.5	Muddy Creek	x		1	48	77	- monitored 14 months, lost radio contact summer 1979
10/31/78	119/265	F	10.5	Teakettle Mtn.	x		3	130	208	- not seen since release
5/17/79	332	M	16.5	Elk Creek	x		1	160	156	- was monitored, lost contact in 1 week
7/26/79	347	M	4.5	Codotte Creek		x	1	72	115	- returned, killed 1 year later
8/23/79	50/404	M	3.5	Arlee, Montana		x	1	16	26	- returned in 2 days and was killed
9/1/79	191	F	3.5	Arlee, Montana		x	1	16	26	- returned in 3 days, believe was killed

Table 1. Information on each of 26 grizzly relocation attempts during the 1975-1980 period (cont.)

Date Captured	Number	Sex	Age	Capture Site	Success		Offense[1]	Distance Moved		Additional Comments
					Yes	No		mi	km	
9/13/79	69	F	7.5	Milk River Ridge	x		1	34	54	- not seen since release
6/8/80	430/431	M	3.5	Palookaville		x	1	42	67	- returned, was recaptured after more sheep kills
8/14/80	223/333	M	5.5	Palookaville		x	1	42	67	- returned 1 week later
10/8/80	512/247	F	2.5	West Glacier	x		3	67	107	- being monitored, denned in S. Fork Flathead
10/9/80	249	F	10/5	West Glacier	x		3	170	272	- not seen since release
10/9/80	246	F	4.5	West Glacier	x		3	170	272	- not seen since release
10/13/80	510	F	10.5	West Glacier	x		3	64	102	- has 2 cubs, denned in vicinity of release

[1]1 = livestock predation, 2 = cabin depredation, 3 = near garbage, 4 = near residences, 5 = orphaned cubs.

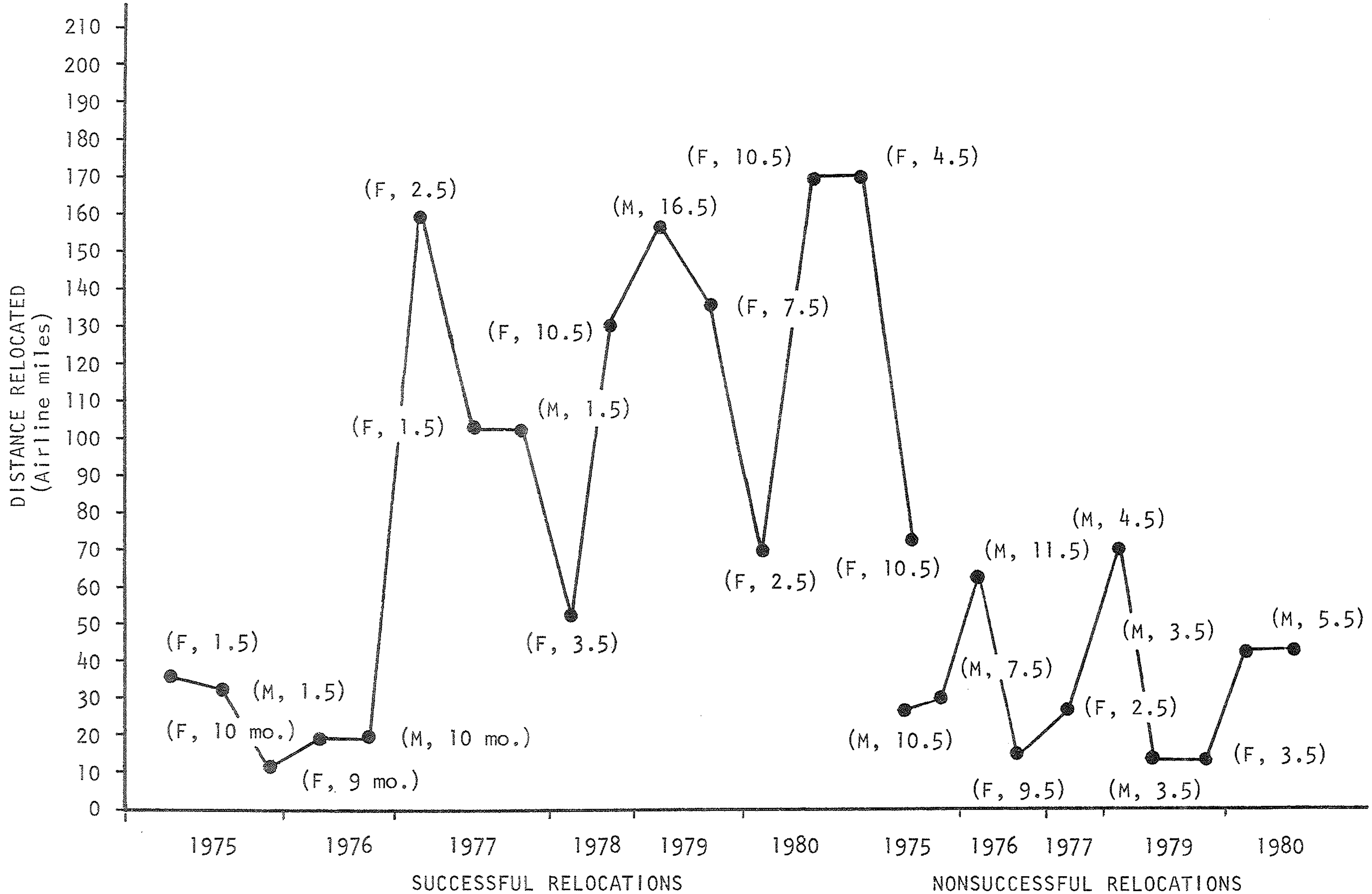

Fig. 1. Distances of relocation and success of 26 grizzly relocations.

Table 2. Distances of relocation (in miles) according to sex and age groups

Cubs		Yearlings		Subadults		Adults	
Male	Female	Male	Female	Male	Female	Male	Female
22	12	30	34	16	22	26	16
-	22	100	100	42	164	30	130
-	-	-	-	-	48	64	34
-	-	-	-	-	16	160	170
-	-	-	-	-	67	72	170
-	-	-	-	-	-	42	64
			Averages				
22	17	65	67	29	63	66	97

Table 3. Stepwise multiple regression and analysis of variance

Relocation Factors	Regression Coefficients (R)[1] Individual	Multible	F. Statistic[2]
Distance	.44783	.44783	5.448*
Offense	.58755	.83432	16.392*
Livestock predation	-.44313		5.012*
Cabin depredation	-.42174		4.012*
Near garbage dumps	.22032		.297
Near residences	.30928		2.811
Orphaned cubs	.37643		3.971*
Age and Sex	.22488	.95922	3.778*
Adult females	.28427		.000
Subadult females	-.17474		.817
Yrlg. & cub females	.41786		9.291*
Adult males	-.45483		25.637*
Subadult males	-.33710		.000
Yrlg. & cub males	.24721		7.000*
Season	.17434	.96554	1.320
Spring	-.00675		.001
Summer	-.28311		.001
Fall	.29581		1.165
Time in Captivity	.30284	.96683	1.800
0-1 days	-.38925		1.261
2-5 days	.41786		3.835*
5 days	.02279		2.090

[1]Regression factors are listed in the order they were included into the regression model by the stepwise procedure.

[2]Degrees of freedom equal: regression = 14, residual = 11.

*Significant at 0.05 level.

Table 4. Bear/human conflicts that resulted in 23 relocation attempts as related to sex and age groups[1]

All Bears	Livestock Predations (n = 10)	Near Campgrounds and Residences (n = 5)	Cabin Depredations (n = 3)	Near Garbage Dumps (n = 5)
Males	5	2	3	0
1.5 years	0	2	0	0
2.5 & 3.5 years	2	0	0	0
4+ years	3	0	3	0
Females	5	3	0	5
1.5 years	0	2	0	0
2.5 & 3.5 years	4	0	0	1
4+ years	1	1	0	4

[1] Does not include three relocated orphans.

Table 5. Relocation success as related to season

Season	Number of Relocations	Number Successful	Percent
Spring	7	5	71
Summer	8	3	38
Fall	11	8	73

Cabin Depredations: This relocation factor resulted in only three actions, of which two involved the same individual. Each of the relocations involved adult males and none were successful.

Proximity to Garbage Dumps or Dumpsters: Five relocations involving this offense occurred during the 1975-1980 period. All of the relocations involved females, four being of adult age.

Orphaned Cubs: Three grizzlies less than 1-year old were relocated, of which all were successful. Each of the three are known to have survived the first winter.

Sex and Age: Fifteen (58%) of the total relocations involved females and 11 (42%) involved males. Of the relocations involving females, 12 (80%) were successful. Four (36%) of the 11 male relocations were successful. Fig. 2 illustrates the results of the relocation attempts according to sex and age groups. The relative number of male relocations to female relocations were not significant; whereas the computed success level of females vs. males was significant. This may be partially explained in that females were relocated significantly greater distances than were adult males.

Table 2 shows the mean distance of relocation according to sex and age groups. Excluding the two greatest relocation distances for each of the adult classes, an even greater disparity in the relocation distances is realized: 34 miles (54 km) for males vs. 83 miles (133 km) for females.

Adult males were negatively correlated with success. Whether this correlation is due to the shorter distances males were relocated, or is an inherent sex characteristic, is unknown.

Subadult males were significantly more successful than adult males. No similar age separation was noted for females where adults were as equally successful as subadults. Of the five relocations involving males less than 4 years of age, three (60%) were successful, compared to only one of six (16%) successful relocations involving adult males. Among females, seven of nine (78%) relocations involving bears less than 4 years were successful, as were five of six (83%) of the adult relocations. Seven relocations involving bears less than 2.5 years of age were all successful. Of the 26 relocations, 14 (54%) involved animals less than 4.5 years of age. An individual being a yearling or cub, or female was positively correlated with success.

A relationship between the sex and age of the animal and the type of offence committed is suggested by the data analysis. For example, the majority of the bears involved in livestock predations were subadults, those involved with garbage were largely adult females, and four of the five bears relocated because they were near residences or campgrounds were yearlings. These results may provide insight as to which bears are likely to commit certain types of offenses.

Season of Release: Grizzly relocations for the 1975-1980 period were somewhat evenly distributed over the spring, summer and fall seasons (Table 5). A significantly lower success rate was noted for the summer season. However, the regression analysis indicated that the individual seasons were not significant contributors to the relocation outcome. Of the unsuccessful relocations during the summer, three involved livestock predation and two were cabin break-ins. Since these two types of offenses were negatively correlated with success,

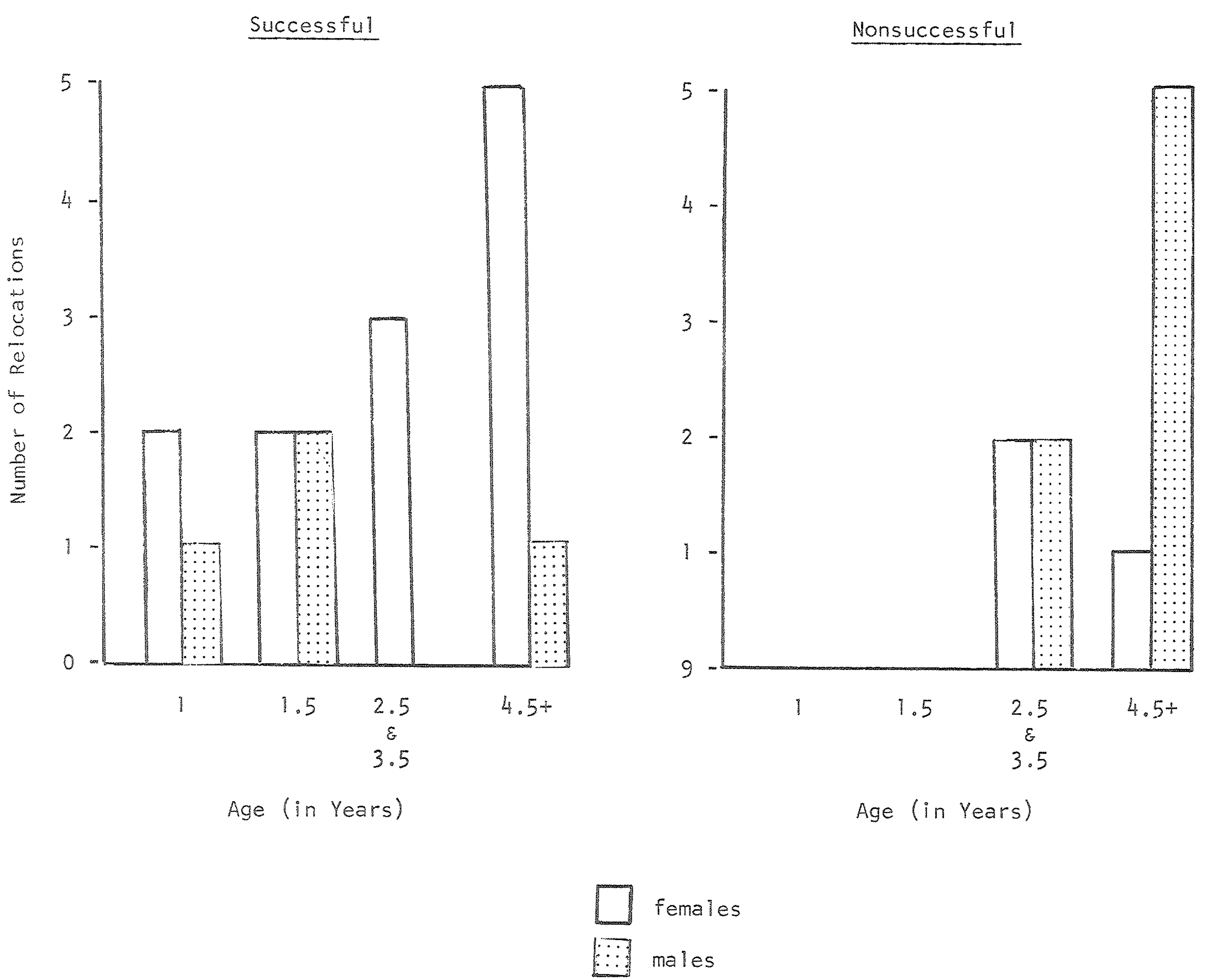

Fig. 2. Age and sex in relation to the success of 26 grizzly relocations.

it was suggested that they were primary determining factors in the result of the summer relocations.

Days in Captivity: The time individual grizzlies were held in captivity before release varied from less than 1 day to 103 days/ Table 6 summarizes the results according to various units of time.

Table 6. Time in captivity as related to success

Days in Captivity	Sample Size	Successful	(Percent)	Nonsuccessful	(Percent)
0-1	11	3	27	8	73
2-5	5	5	100	0	0
5	5	4	80	1	20
Unknown	3	2	67	1	33

A significant disparity is apparent for the 0-1 days in captivity category. This disparity is believed to be attributed to other relocation factors. Days in captivity wasn't a significant contributor in the relocation regression model.

Management Recommendations

Potential release sites that have been agreed upon in advance by all concerned parties should be described as to the presence of possible conflicts, such as sheep, garbage, residences, cattle, etc., for at least a 20-mile radius of the release site. Bears should be relocated as soon as possible, but if there is a lapse of several days, this should not be a determining factor in whether or not to relocate. Any bear captured committing an offense for the second or third time should be removed from the population, only if the previous relocations were conducted properly. An effort must be made to relocate grizzlies, especially adult males, greater distances. Selecting release sites greater than 100 or even 70 miles is a problem, and often British Columbia may be the only option. For this reason, sites such as the Selway-Bitterroot Wilderness Area need to be reevaluated for possible grizzly relocations.

When possible, orphaned cubs 9 months or older should not be captured and relocated. Placing them in an unfamiliar area will result in unnecessary stress. Instead, they should be captured and relocated only when 1) they are involved in some type of bear/human conflict, or 2) they are in an area where some type of bear/human conflict is likely to occur. Orphaned cubs that are less than 9 months old should be captured and 1) an attempt should be made to have them adopted by another mother, or 2) they should be kept in captivity - with a minimum of human contact - and then released just prior to denning in an unroaded area (Jonkel et al. 1977).

Cubs and yearlings that have been separated from their mothers often do not appear to be especially wary of people. As a result, they have a greater tendancy to linger near residences and roads, making them more susceptible to poaching or some type of bear/human conflict. Releasing them only in unroaded areas would help to alleviate these problems.

Table 7 contains recommended distances of relocation according to the type of

Table 7. Recommended management alternatives as related to the age and sex of the bear and the type of offense committed

Age and Sex	Type of Offense[1]	Management Alternatives[2] 1st Offense	2nd Offense
Adult males	1	3,4	5
	2	5	-
	3	3	4
	4	3	4,5
	5a	5	-
	5b	1,3	5
Adult females	1	3,4	3,4
	2	3,4,5	5
	3	3	3
	4	3	3
	5a	3,5	5
	5b	1,3	3,5
All subadults	1	3	4
	2	3	5
	3	3	4
	4	3	4
	5a	4,5	5
	5b	1,3,4	3,5
All yearlings	1	2	3
	2	2	3
	3	2	3
	4	2	3
	5a	2	3
	5b	1,3	3,5
All cubs	(see text)		

[1]1 = livestock predation,
2 = cabin depredation,
3 = near garbage dump,
4 = near residences,
5a= aggressive towards people without apparent provocation,
5b= aggression towards people may be justified.

[2]1 = do not capture,
2 = relocate at least 25-50 miles,
3 = relocate at least 70 miles,
4 = relocate at least 100 miles,
5 = do not relocate.

offense and the sex and age of the animal. It should be emphasized that the suggested distances of relocation are in airline miles, and that a map should be consulted to insure proper relocation distance. In several past relocations, bears were moved considerable road distances, but airline distance was not great.

When considering various sites for relocation purposes, it does not appear necessary that these sites be totally free of potential conflicts such as those listed in Table 4. The reason for this is due to the fact that none of the bears were known to have committed more than one type of offense. As an example, it may be possible to relocate a bear involved with garbage into an area occupied by cattle. With this in mind, the number of potential release sites should increase.

In the interpretation of Table 7, personal discretion may be necessary, depending on individual cases. For example, an adult female grizzly captured after breaking into 10 cabins is not as likely a candidate for relocation as in an individual that broke into one cabin. In all relocation decisions, the opinions of several people from several agencies should be included in the evaluation, thereby insuring a more accurate conclusion.

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ANALYSIS OF CENTRAL MONTANA PRAIRIE GROUSE SURVEY DATA

C. Robert Watts[1]

Central Montana's long-term (1958-1981) management data is providing a preliminary basis for developing predictive population models. Sharp-tailed grouse *(Pedioecetes phasianellus)* productivity from wing analysis correlates to spring (April, May and June) precipitation ($r = +.87$, $P > 0.01$), better than to other monthly or phenological time periods. Significance increases as the area discussed becomes more specific. Productivity of sage grouse *(Centrocercus urophasianus)* correlates to spring precipitation ($r = +.68$, $P > 0.05$) only after removing those years when precipitation exceeds average (1 inch) during the egg laying period. Productivity is negatively correlated to egg laying precipitation ($r = -.68$, $P > 0.05$). Productivity does not correlate to fall hunter success with either sharptails ($r = +.11$) or sage grouse ($r = +.04$). However, productivity of both, weakly correlates to hunter success 1 year later ($r = +.57$, $P > 0.05$ and $r = +.54$, $P > 0.05$, respectively). Total numbers of spring males on leks correlates to fall hunting success with both sharptails and sage grouse. A single sage grouse study area showed a spring-fall correlation between lek surveys and both check station and questionnaire estimates of harvest ($r = +.67$, $P > 0.05$). Three sharp-tailed grouse areas showed correlations varying from $r = +.61$ ($P > 0.05$) to $r = +.97$ ($P > 0.001$). Correlations improved as the intensity of spring surveys increased and when the fall survey most closely measured the same area surveyed in the spring.

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APPLICATION OF WATERFOWL RESEARCH IN DEVELOPING THE CANYON FERRY WILDLIFE MANAGEMENT AREA

Jeff Herbert[1]

Canyon Ferry Reservoir is located in southwestern Montana on the Missouri River between Townsend and Helena. Canyon Ferry Dam was constructed in 1953 by the Bureau of Reclamation as a multi-purpose power, flood control, irrigation and recreation project. During the first 12 years, water levels were kept high to maximize power generation. Drawdowns, which did occur, were of short duration.

In 1966, in order to meet flood control needs, the water level management policy of the reservoir was changed. This would entail an overwinter drawdown which could expose, dependent on instream flows, anywhere from 4,600-9,100 acres of mud flats at the upper end of the reservoir. Complaints related to blowing dust began almost immediately.

By the late 1960's complaints had intensified from both the residential and agricultural sectors and numerous county based groups were demanding a permanent solution. A study was initiated by the Bureau to determine the most feasible solution to dust abatement - a search that was given further impetus when the Bureau was cited by the Department of Health for exceeding air pollution standards.

In 1971 Congress authorized the Bureau to start the Canyon Ferry Conservation and Wildlife Enhancement Project. This was a long-term project which would involve the construction of four dikes that would enclose approximately 2,000 acres of the exposed area and the excavation of an additional 2,700 acres. The material excavated from the reservoir side of the dike would be deposited by a dredging operation in the four sub-impoundments.

The department became involved with the project as administrators of the Bureau lands around the reservoir. In addition to the ponds, approximately 5,000 acres, including agricultural leases, at the upper end of the reservoir are managed as a wildlife area under an agreement with the Bureau. The construction of the west side dike began in 1972 and the initial construction phase of the dikes and supply canal system was completed in 1978.

The basic project layout is this: a west side pond (#4) and supply canal and three east side ponds (1-3) with a main supply canal and a secondary diversion on a creek at the north end for pond 1. Each canal has a headgate on the river, gated inlets to the pond and from 2-4 gated outlet structures on each of the dikes. This control system enables us to manipulate water levels for management purposes. Additional design specifications called for the construction of 350 islands within the pond system. These are of two types: dredge islands and haul islands. Artificial nest structures were placed on these islands. The bottom contour of each individual pond was varied in order to provide a wide range of water depths for a diversity of vegetation types.

This project offered a unique opportunity to monitor ecological changes from the inception of the project and to follow these changes as the area developed

[1]Wildlife biologist, Mont. Dept. Fish, Wildl. and Parks, Townsend, Mont.

into a marsh situation. In light of this, a cooperative waterfowl research study involving the Bureau of Reclamation, Dr. Robert Eng of Montana State University and the Department was initiated. The major emphasis of the study was to be placed on tracking the expansion of the goose flock and to document vegetation changes associated with the pond system and how they affected the waterfowl use and distribution. This information would then be incorporated into the management and development of the project.

Historically, Canada geese have nested on this portion of the Missouri River and with the completion of the dam, this nesting has been concentrated in the delta where the river enters Canyon Ferry Reservoir. Past and present water management policies have impacted the nesting success of these geese by reducing the security of the river islands, either in terms of predator accessibility or flooding.

Survey work of nesting geese began in 1974 on the river and in pond 4. It was documented that as soon as islands were available in the pond for nesting, breeding pairs quickly became established. As the construction phase progressed and the ponds and islands were completed, more recruitment into the pond system occurred. This line graph depicts the contribution made by both the river and pond system to the overall goose production on the project from 1974 to 1981. Through the mid-seventies, nest densities on the river remained fairly constant and most pioneering of the ponds occurred in pond 4. The sharp decrease in 1979 in the river segment may have been due to habitat conditions at the time of nest selection; many of the river islands had extensive ice cover during this period. What is noteworthy is that this reduced level of nesting on the river has remained consistently low for the last 3 years and that recruitment into the ponds has accelerated. Pond 4 has become saturated with approximately 39 nests/60 islands (1981) and the sharp increase noted on the graph for 1981 is the result of increased nesting in pond 3. The 1981 total of 114 nests on the ponds was an 83% increase over the 1980 total.

This map depicts the distribution of river nesting geese in 1978 when nest densities peaked at 50. Notice the pattern of distribution - obviously several of the islands were very attractive to the geese and colony-like situations resulted. The distribution during the 1981 season has not changed, but the densities have been reduced.

This information generates a number of management implications. In 1978, a 2-week delay in the opening of the goose season was imposed and was still in effect through the 1981-82 hunting season. This was done in order to reduce the mortality on the local birds, which at that time was significant. Those year classes that have been produced and protected by this delay have been recruited into the 1980 and 1981 breeding populations and probably have contributed significantly to this dramatic increase.

The pattern of nest distribution also stresses the importance of water level management. Adequate water levels are necessary at the time of nest site selection and through the incubation period. Older, established pairs are the most competitive and generally occupy the preferred sites leaving less secure areas to the younger hens. In order to attract these younger pairs and to maximize island availability, spring water levels are critical. Furthermore, once a hen has become established on an island (or a section of dike), she shows a strong homing tendency to that particular location in the future. This may result in entrapment of the hen or her clutch if water levels are low enough to allow access by predators to these sites.

Finally, in 1981 we documented multiple nesting on dredge islands within the ponds for the first time. This is related to vegetation development on the islands, primarily willow, and the visual barriers that it provides. These large dredge islands in both ponds 3 and 4 were constructed during 1977. It is interesting to note that this multiple nesting occurred at the same time in pond 4 where nest density appears saturated and in pond 3 where many islands are still available. The potential for accommodating nesting pairs on these large dredge islands with vegetation maturation should be similar to the river island situation.

Another aspect of this work is a comparison of average clutch sizes of the river nesting geese vs. the pond nesting birds. The river nesting segment has averaged consistently larger clutches throughout the study period. We feel this is an indication of the continued recruitment of younger-aged hens into the pond system andthe fact that they will generally produce a smaller clutch. The river nesting segment is relatively stable, is dominated by older hens and has little turnover occurring. Also note that in 1978 when the river density peaked at 50 pairs, the average clutch size dropped.

Production estimates for the same period are presented in this table and include both pond and river nesting contributions. We have arrived at these estimates by various methods, including marked vs. unmarked samples. Due to the large number of goslings being produced the last 2 years, we have simply estimated production by multiplying the total number of active nests by the average clutch size. Essential to this is data on nest success which has been running about 100% the last 2 years.

Finally, review of the spring breeding ground survey flown each year in April further documents the increasing trend in Canada goose numbers. The survey unit includes Lake Helena, the Regulating Reservoir, Canyon Ferry and the Missouri River from Townsend to Three Forks. Notice that the different sections were nearly equally represented during the 1974 survey and that by 1981 Canyon Ferry is contributing the majority of the geese to the observed increase. The number of geese observed during the 1974 flight was 282 and the total for the 1981 flight was 889. Dispersal throughout the unit and outside the unit is undoubtedly occurring. This also points out that secure nesting areas are at a premium in these other locations.

In terms of management problems facing us, one of the most critical aspects is the development of relatively secure brood rearing and/or grazing areas for geese. With the increased gosling load that is being produced each year, this is imperative. The biggest deterrent to this has been environmental conditions and the geese themselves. We need to monitor dispersal and/or congregation by broods during the summer period and also dispersal by the geese off the project prior to the opening of the waterfowl season. The recommendation for the 1982-1983 season will be to drop the 2-week delay and to implement some type of closure on the west side pond.

Documenting changes in both aquatic and terrestrial vegetation types is very important in understanding and predicting waterfowl use of the project. This information, when combined with management objectives, clarifies what work or needs should take priority.

One important point to remember when analyzing vegetation development on the project is that the dike system and associated weather conditions presented a harsh environment for plant establishment. But the key factor in development of different vegetation zones, ranging from the submergent to dry upland sites, has been the stabilization of water levels.

Quantitative information on plant establishment has been collected on a number of permanent transects on both dikes and islands where species composition and canopy coverage have been recorded. Willow, sweet clover and other invader species have been the most successful at pioneering these sites. The establishment has led to a change in micro-habitat and allowed some of the desirable species to become established. Ultimately, we would like to see many of these areas dominated by a grass-legume cover type that would serve as nesting areas for ducks and/or grazing areas for geese.

The establishment of submergent vegetation types has been monitored with aerial infrared photography flown during the summer period. The obvious importance of these plant communities to an area of this type should be stated: they provide a highly preferred food source in terms of seeds, tubers, winter buds and other plant parts. They reduce water turbidity and stabilize bottom soils. Submerged plants provide important habitat for aquatic insect populations and crustaceans. Finally, their decomposition provides a great deal of organic material to the system.

These slides (taken from an elevation of 5,000 feet above target) show the development of various pondweeds in pond 3. Pond 3 was completed in 1977, and in 1979 the first substantial occurrence of sago occurred. By 1981, submerged stands of elodea, sago, variable leaf, pondweed and watermilfoil were extensive. Vegetation maps have been constructed annually for each of the ponds (1-3). The most noteworthy response by waterfowl to the presence of this vegetation has been a significant increase in the duck and coot population during the late summer period. Especially interesting has been the increased use of the ponds by divers as a molting area for drakes, primarily redheads, canvasbacks and scaup.

The development of an emergent vegetation zone has received considerable attention. Natural establishment of cattails, spike-rush and water smartweeds has been occurring and artificial propagation of hardstem bulrush has been attempted. Again, high water levels and grazing by geese have been major deterrents to the expansion of these types. However, the development of suitable seed sources within the ponds, combined with a prescription for water level management through the growing season, should be enough to increase the distribution ofemergents within the pond system.

The final aspect has been the development of suitable grazing areas for geese during the brood-rearing period. This has included numberous seeding and transplanting efforts on the dike areas and the manipulation of shoreline areas by burning and grazing to make them more attractive to the geese.

AVIAN MORTALITY FROM POWERLINE COLLISIONS AND BOTULISM ON AN INTERMITTENT MONTANA WETLAND

Jon M. Malcolm[1]

Approximately 4,100 birds were killed from May 1, 1980 through September 29, 1981 by flying into a 230-kv, double-circuited power transmission line over a large wetland in south central Montana. Dead bird searches yielded 3,218 birds of 55 species with externally obvious injuries indicating collisions with the powerline. Eared grebes *(Podiceps nigricollis)* were the leading victims, comprising 29% of the confirmed powerline mortality. Ducks of 14 species, mostly commonly blue-winged teal *(Anas discors)*, accounted for 44% of the line strike losses.

A severe outbreak of avian botulism intoxication killed approximately 5,200 birds, mostly ducks, in 1980. In 1981, efforts to clean up line strike bird carcasses were intensified, and botulism losses were estimated at less than 200 birds. Tests indicated that birds were not afflicted with botulism at the time of striking the powerline, but botulism toxin was found in maggots later collected from the decaying carcasses. Decaying animal carcasses can be a source of botulism toxin regardless of the original cause of death, and powerline casualties aggravate botulism problems on this marsh. Botulism losses would likely have been more severe without regular and thorough clean-up of dead birds.

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USING LOOP DETECTOR TRAFFIC COUNTERS
FOR DETERMINING HUNTER DENSITY AND DISTRIBUTION

Michael R. Frisina[1]

During the past several years hunting pressure on many of Montana's big game populations has increased dramatically. Coupled with this, a variety of land use practices have improved hunter access and reduced security cover for wildlife populations. As a result, game harvests occur more rapidly and habitats are often unable to hold game populations during hunting seasons. In order to initiate management strategies to solve this problem, collection of density and distribution data for hunting activities is essential. This data is presently unavailable for many of Montana's hunting districts.

The most precise method for obtaining information concerning hunter density and distribution is by manning check stations. However, check stations are not always practical since they are labor intensive and extensive road systems cannot be adequately covered. The loop detector traffic counter offers a cost effective alternative to manning check stations.

The traffic counter I have used and will describe is the model 355 loop detector-counter, manufactured by Safetran Traffic Systems, Inc. This counter is compact, portable and battery powered. The counter mechanism is equipped with solid state circuitry and enclosed in a weatherproof, metal, lockable case. A plexiglass window located on top of the counter case allows reading without unlocking the unit (Safetran Traffic Systems, Inc. 1981).

The counter is powered by four 6 VDC, NEDA 918 batteries. The four batteries will provide power for approximately 6 months at 1,000 counts per day (Safetran Traffic Systems, Inc. 1981).

The design, installation and maintenance of inductive loops is described by DeLand (1977). Inductive loops are constructed using number 12 or 14-gauge stranded copper wire encased in a special weatherproof plastic coating. The loop operates by exploiting the electrical property of inductance (DeLand 1977). "Inductance measured in microhenries can be defined as that property of an electric current, whereby electromotive force is induced in a circuit by change of current" (DeLand 1977). The loop is constructed by laying one or more turns of copper wire in a roadbed in a rectangular pattern (DeLand 1977). DeLand provides formulas for determining inductance and number of wire turns necessary for roads of varying dimensions. I have found a loop constructed of three wire turns with an 8-foot separation will provide adequate inductance on most gravel roads or "jeep" trails. The loop should be buried 6 to 8 inches below the road surface. A trench is dug using a pick or "polaski." When burying the loop, one must be careful to remove sharp rocks and electrical connections must be tight and waterproof. If installed properly, a loop can be expected to last for several years. I have several loops that were used for 6 years and are still functional.

The inductance of a loop can be measured by using a special test meter (Traffic Data Systems, Inc. 1976). I have found as long as the meter reads approximately

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180 microhenries - the loop is functional.

A special aircraft type connector is used to connect the loop to the counter to complete the surveillance system.

The loop test meter is also valuable for trouble shooting problems with the surveillance system. If the system is not functioning, the problem lies with either the loop, batteries, counter or a combination thereof. The test meter isolates problems with the loops; a battery tester isolates battery malfunction. If the loop and batteries are functional, the problem must be with the counter.

When a vehicle passes over the counter, one digit is registered on the recorder. A tally of total vehicles over a main access route during a specified time period can be recorded for trend comparison between years. More specific data can be obtained by placing counters on main access roads and side roads connecting these main travel routes. When this is done, it is often possible to compute the number of vehicles in certain drainages or portions of a hunting unit. It is often useful to operate the counter a few months prior to the hunting season in order to have data for comparison of prehunting with hunting season traffic. Counters can be used most efficiently by monitoring traffic on a road for 1 or 2 years and then moving the counter to another location. It is not usually necessary to monitor traffic on the same road every year. A system whereby counters are rotated from one portion of a hunting district to another annually works very efficiently. How often a counter is read is a matter of individual judgment concerning the degree of detail desired. If check station data concerning the average number of hunters per vehicle are available, it is often possible to convert the number of vehicles to number of hunters using a particular area during a specified time period. For collected data to be properly analyzed, a detailed map of the road system for the area of concern is essential.

The United States Forest Service (USFS) has developed a computer program for analyzing data collected from loop detector counters. If data is recorded on a special form available from the USFS, the computer program can be easily used. The program provides basic summary statistics and graphically displays data in a variety of ways.

Many national forests use loop detector counters and publish the data in an annual traffic surveillance report. These reports often contain information for important hunting access routes.

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DeLand, L. F. 1977. Inductive loops: their design, installation, and maintenance for road traffic surveillance. U. S. For. Serv. Equip. Dev. and Test Rept. No. 7700-9, 19 pp.

Safetran Traffic Systems, Inc. 1982. Loop detector counter model LDC 355 (descriptive brochure). Colorado Spring, Colo., 4 pp

Traffic Data Systems, Inc. 1976. Loop test meter model LT 350 (descriptive brochure), 2 pp.

COMPUTERS AND WILDLIFE - HOW TO RETRIEVE YOUR GAME WITHOUT EVER GOING INTO THE FIELD

Raymond R. Hoem[1] and Alex Hoar[2]

Information management in our evergrowing world is becoming a tremendous problem. We are constantly bombarded with new facts, figures and other information from which we are asked to make decisions in less time and with less money. Someone once told me that the human mind, while capable of storing myriads of information, usually becomes confused when it has to make a decision involving more than three or four pieces of information. What generally happens then is a subtle sorting of those facts which a person deems important and a convenient sort of forgetting of those facts to which "importance" is not considered strong enough to hold on to.

So, how can we utilize more and more facts to make better decisions? First, we need a convenient storage facility. Second, we need to be able to conveniently analyze the facts. Third, we need to be able to present the results in a form we can understand. Such a description fits the capabilities of a computer system. You'll notice nowhere in the above description is it stated that the computer will make a decision or even ask the right question. It merely provides a data handling system that is often more powerful than the ones I have used in the past.

In today's world we are constantly bombarded with computer information. Your bank statement is entirely a product of a computer. Your telephone bill, your Sear's bill, practically all larger businesses have their billing systems set up on a computer. Even information about the budgets of most big companies is stored in computers. It keeps track of the incoming as well as the outgoing money and any other information that we decide is important to track.

Everybody is using computers these days; why don't we as wildlifers? The computer can serve us in a variety of ways. The first is through the use of tabular data. Many of you already use the computer for tabular data.

Montana Department of Fish, Wildlife and Parks has a computer printout for their hunting statistics. It has its stream inventories on a computer and the Bureau of Land Management is slowly beginning to utilize data in a tabular method. For instance, on a certain habitat site in New Mexico, the BLM has computer printouts of wildlife species found there, the improvements in the area and species benefited (Table 1).

This is a means of handling information. Another tabular display of data would be the use of a statistical package whereby the computer will do your calculations for you, although you must enter the facts and figures yourself and ask the computer for the answer you want.

One place where the computer has helped me, and I believe can be a boon to all of us as wildlifers, is in terms of computer graphics. Computer graphics are nothing more than pictures; for instance, Fig. 1 is a picture of the State of Montana depicting antelope high use areas, prospective developments (black),

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[2]Fish & Wildlife Biologist, USDI, Fish and Wildl. Serv., Billings, Mont.

Table 1. Computerized listing of Lava habitat site showing wildlife species present, developments in area and species benefited by developments

STANDARD HABITAT SITE NAME	: LAVA
STANDARD HABITAT SITE CODE	: NM017
PHYSIOGRAPHIC REGION	: 07
SUB PHYSIOGRAPHIC REGION	: ---
ASSOCIATION	: 05B
BIOME	: D
USFS ECOREGION	: -3211-

SPECIES	\COMMON NAME	\ST\DEN\S\GE\S\SP\C\H\VERIFIED OCCURRENCE
AIRU	SPARROW RUFOUS CROWNED	OT YLU YLEA YLEA _ _ SIGHT RECORD
AMBI	SPARROW BLK-THROATED	OT YLC YLEA YLEA _ _ SIGHT RECORD
AMIN	ANTLPE GRD SQURL TEXAS	OT YLU YLEA YLEA _ _ TRAPPED
ANAM	PRONGHORN	OT YLU YLEA YLEA _ _ SIGHT RECORD
ANPA	BAT PALLID	OT YLA YLEA YLEA _ _ CAUGHT
BAAS	RINGTAIL	OT YLU YLEA YLEA _ _ SIGHT RECORD
BUJA	HAWK RED-TAILED	OT YLC YLEA YLEA _ _ SIGHT RECORD
BUSW	HAWK SWAINSONS	CT FAC FAMA FASM _ _ SIGHT RECORD
BUSW	HAWK SWAINSONS	CT SSC SSMA SSFE _ _ SIGHT RECORD
BUSW	HAWK SWAINSONS	CT WIR WIMA WIMA _ _ NO SIGHTINGS
BUVIR	OWL GREAT HORNED	OT YLC YLEA YLEA _ _ SIGHT RECORD
BUWO	TOAD WOODHOUSES	OT YLU YLEA YLEA _ _ CAUGHTSTOCK

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SPECIAL HABITAT FEATURE CODE	: STOCK WATER POND
MERIDIAN	: NEW MEXICO
TOWNSHIP	: 0200S
RANGE	: 0020W
SECTION	: 011
QUARTER SECTION	: SW
QUARTER,QUARTER	: --
ACREAGE	:
GENERAL DESCRIPTION	: DRINKING TUB & PIPELINE SO SEC
SPECIES BENEFITTED	: LECA
ENCOURAGED GENERAL USE	: YLMA
ENCOURAGED SPECIFIC USE	: YLWA
COMMENTS	: ----

GENERAL DESCRIPTION	: DRINKING TUB AND PIPELINE
SPECIES BENEFITTED	: SYAU
ENCOURAGED GENERAL USE	: YLMA
ENCOURAGED SPECIFIC USE	: YLWA
COMMENTS	: ----

SPECIES BENEFITTED	: ZEMA
ENCOURAGED GENERAL USE	: YLMA
ENCOURAGED SPECIFIC USE	: YLWA
COMMENTS	: ----

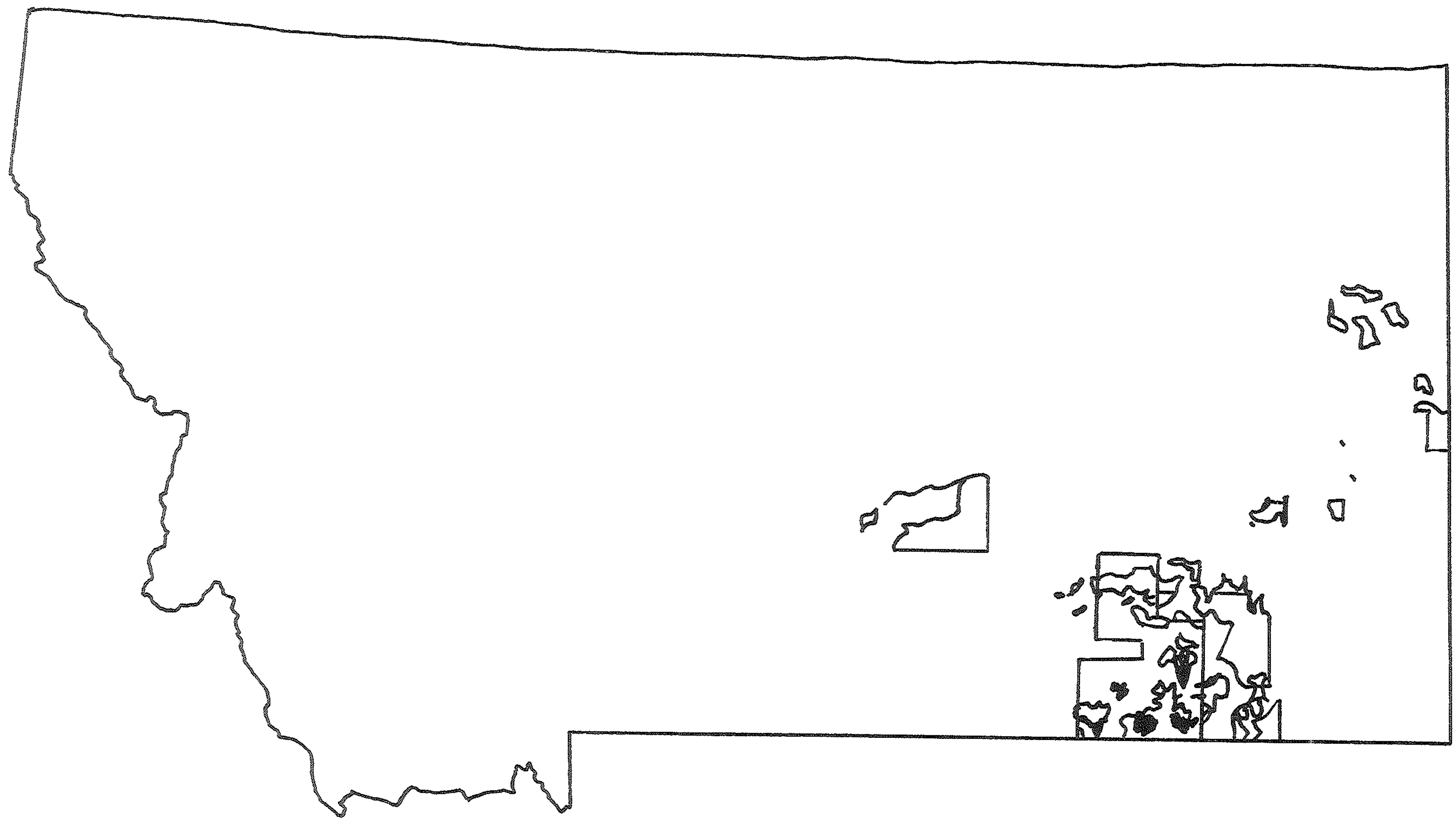

Fig. 1. Computer graphic depicting antelope high use areas, prospective developments (black) and an outline of a study area.

and an outline of a study area. We can make it larger, reinput the development areas to demonstrate potential problems with antelope use areas (Fig. 2). Fig. 2 illustrates something that is obvious with graphics such as this. These data were gathered by biologists in the field, but note the rectangular borders in these areas. One would have to believe these data were gathered on an artificial boundary - such as a county line - to get a distribution like this. Let's run through a sample problem to illustrate the utility of graphics and display some data that have been gathered on this study area. Fig. 3 and 4 illustrate overall distribution of antelope and sharp-tailed grouse, respectively. Fig. 5 and 6 illustrate class 1 sage grouse habitat and riparian habitat, respectively.

These are two reasons to illustrate data in this manner. First, and most obvious, is that it gives the viewers a visual perspective of the magnitude of the area. The average person, if a biologist says there are 90,000 acres of sage grouse habitat in a certain study area of 700 square miles, it doesn't mean a lot. Ninety thousand acres is a large area, but compared to the study area, it is a mere pittance. Fig. 6 which illustrates riparian habitat makes it appear as if it's all over. How much riparian habitat do we have? Actually there are less than 10,000 acres. How long would it take to determine that? It would take days, weeks, a lot longer than the 2 or 3 minutes it took the computer to calculate it. The second reason to illustrate these data is to show the magnitude of a potential impact on a wildlife habitat.

Fig. 7 illustrates a hypothetical study area which has 13 or so potential developments. The antelope distribution for that same area is shown in Fig. 8. The amount of antelope range impacted by the potential developments is shown in Fig. 9 (impacted area in black). There are 104,946 acres of potential development and 81,162 of these acres impact wildlife, in this case antelope habitat. There is one bright spot, however. One of the proposed development doesn't impact any "known" habitat. Let's look at this same example a little differently - still a graphic display.

Fig. 10 admittedly shows there is still a great deal of habitat impacted, but for illustrative purposes, and putting things in their proper context, this graphic display indicates, at least visually, far less impact to antelope habitat than did the previous display. Obviously, such a display could be used to show cumulative impacts. The computer could stack all of the above wildlife habitat on the proposed developments and determine the impacts in a very short time.

Just as obviously, impacts from proposed impacts could easily be depicted in a graphic manner. Proposed roads, coal mines, streambank developments, powerlines, pipelines, etc. are all candidates for such a record-keeping system.

This brings us to data bases, the information, what it is and where it came from (Table 2). In this table the column on the left merely identifies to the computer the map the user wants. The middle column identifies to the user what the map is. The last column identifies the source. The source file is kept where the data is stored in the computer, but may be accessed and read by the user. For instance, I just happed to know that Source 01 in this data base is from MDFWP's. The particular source is Pete Martin in Forsyth and is one of the many publications of which he is the primary author. So in looking up this data, one verifies the source, the realiability - is Pete reliable? - and then can decide whether to use the data. In this case, we decided to use the data because it was for illustrative purposes only!!!

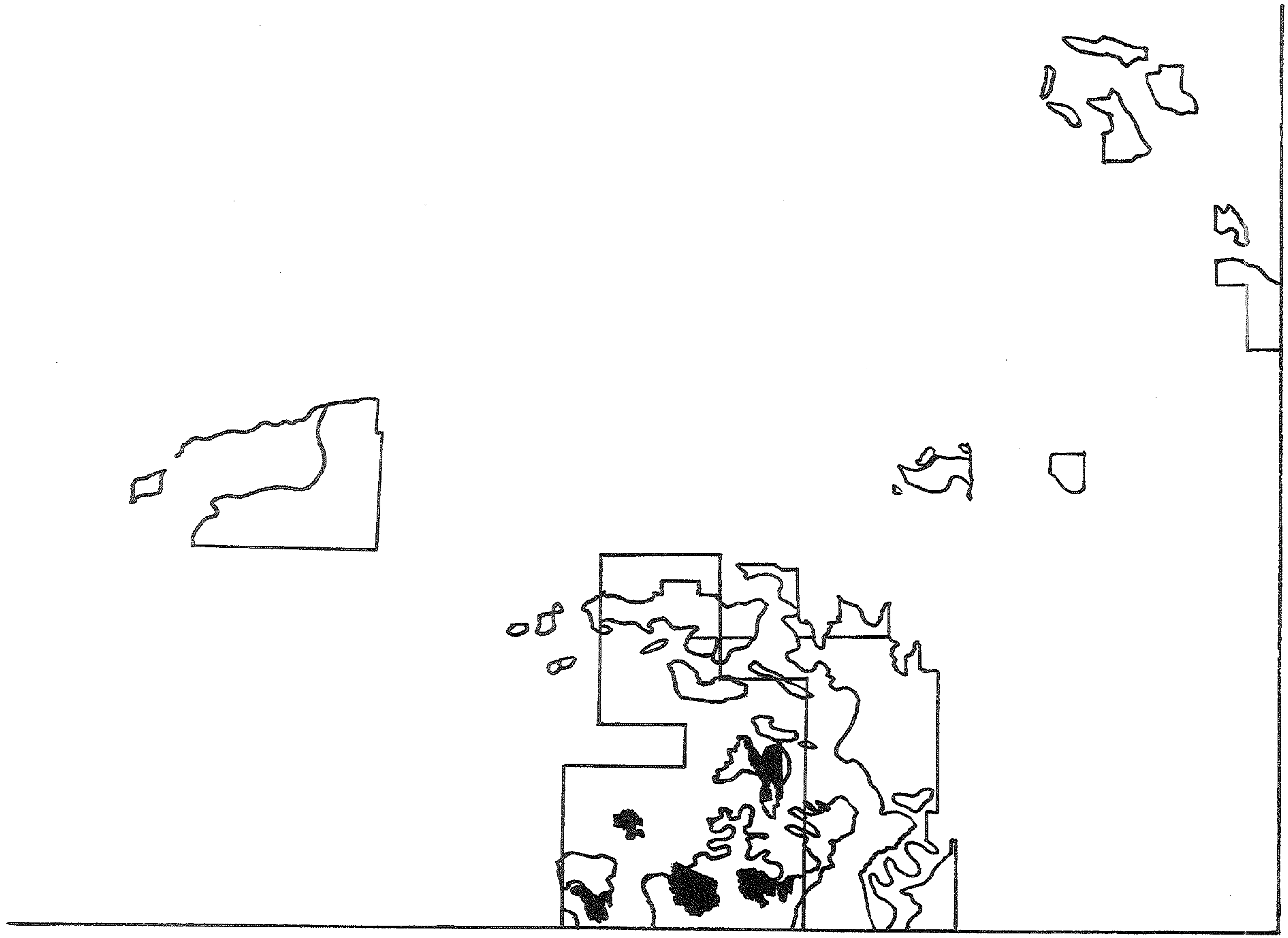

Fig. 2. Enlarged computer graphic depicting antelope high use areas from Fig. 1.

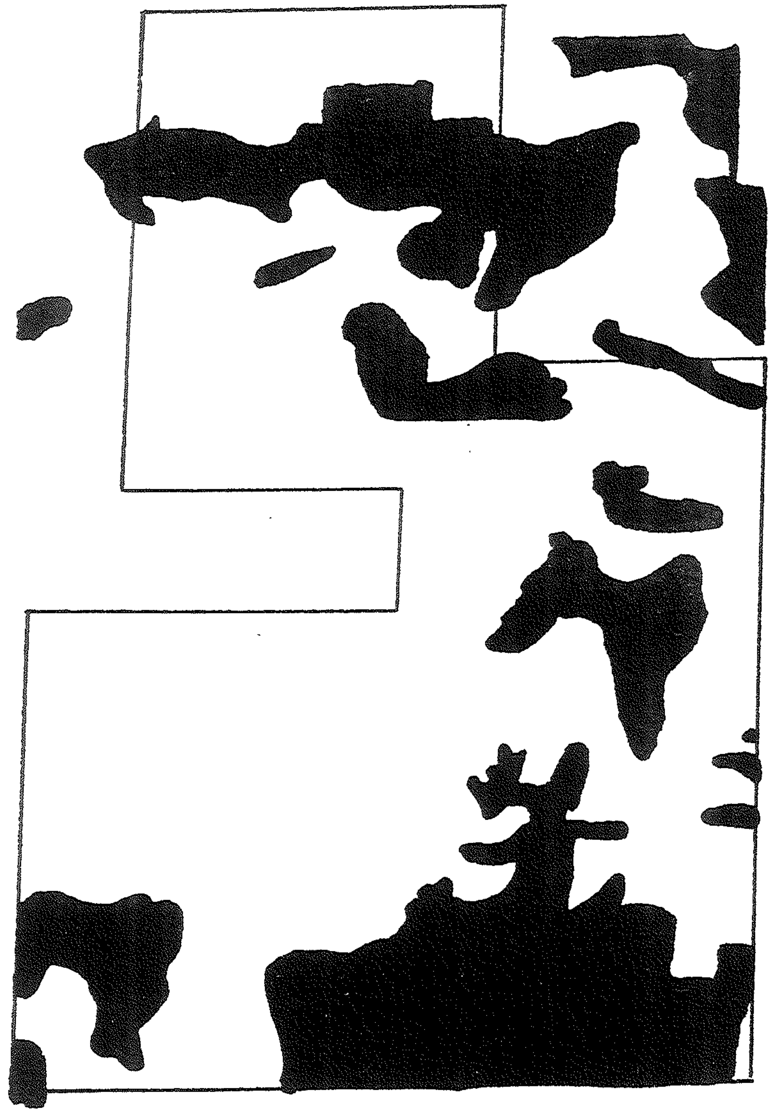

Fig. 3. Overall antelope distribution.

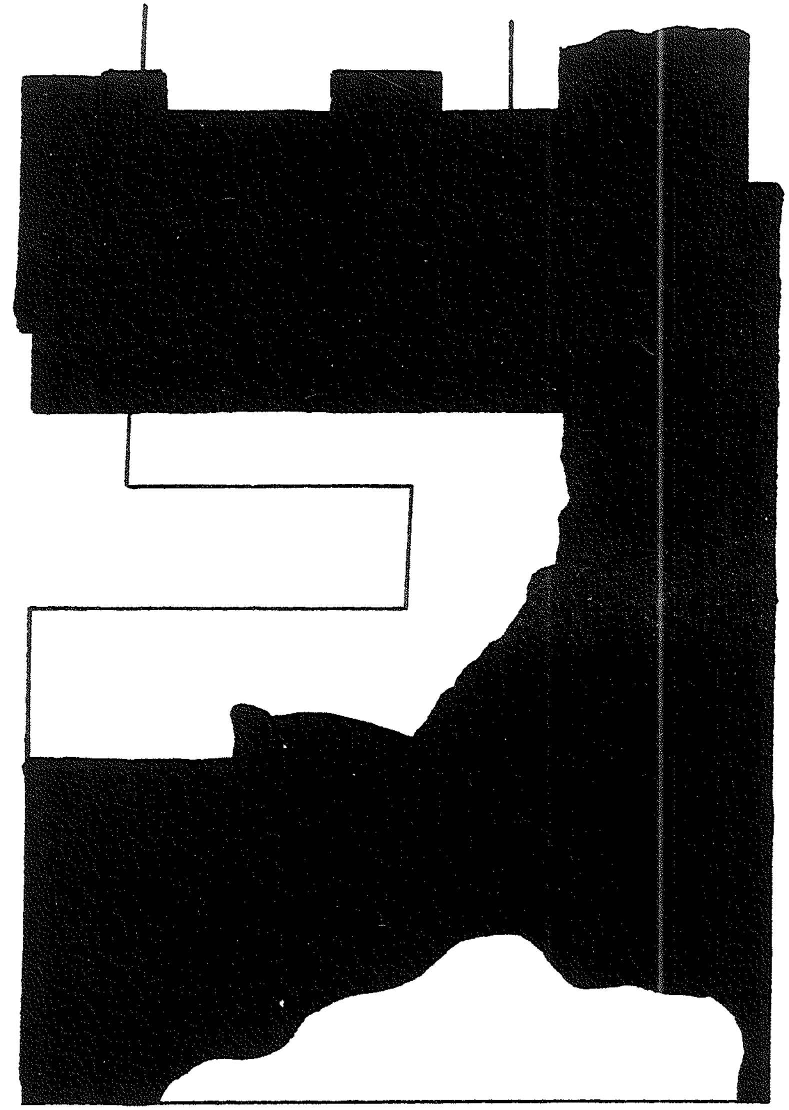

Fig. 4. Sharp-tailed grouse distribution.

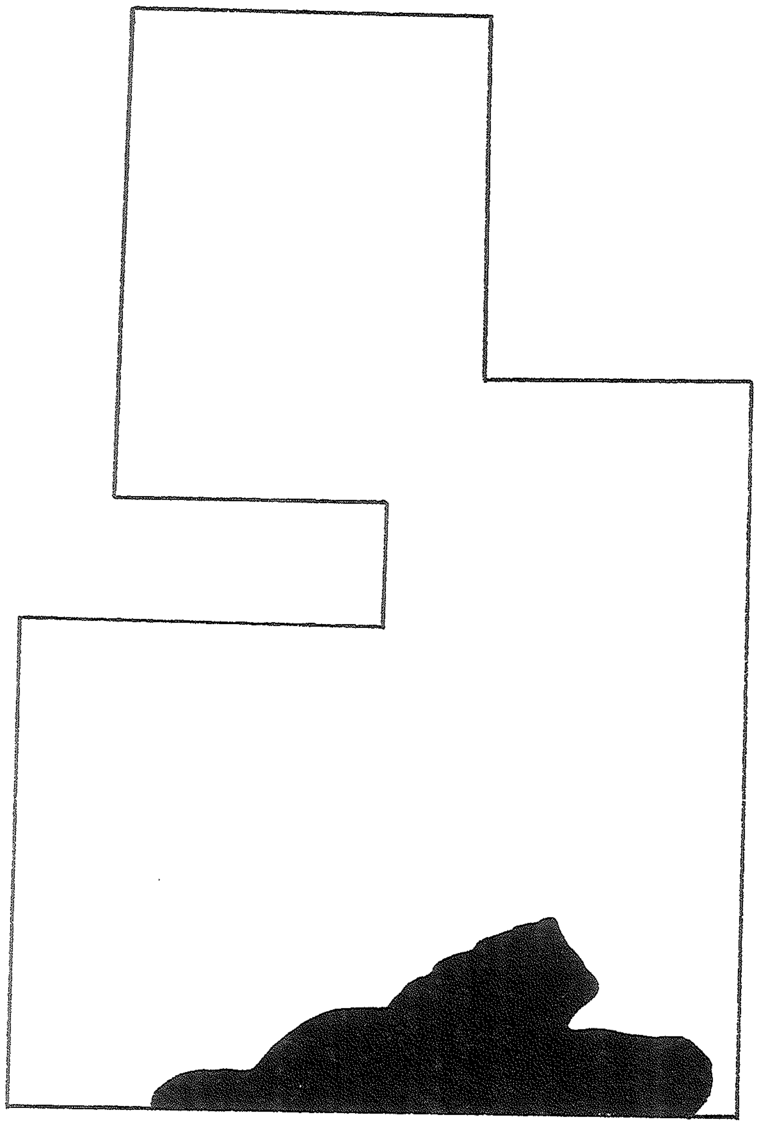

Fig. 5 Class 1 sage grouse habitat.

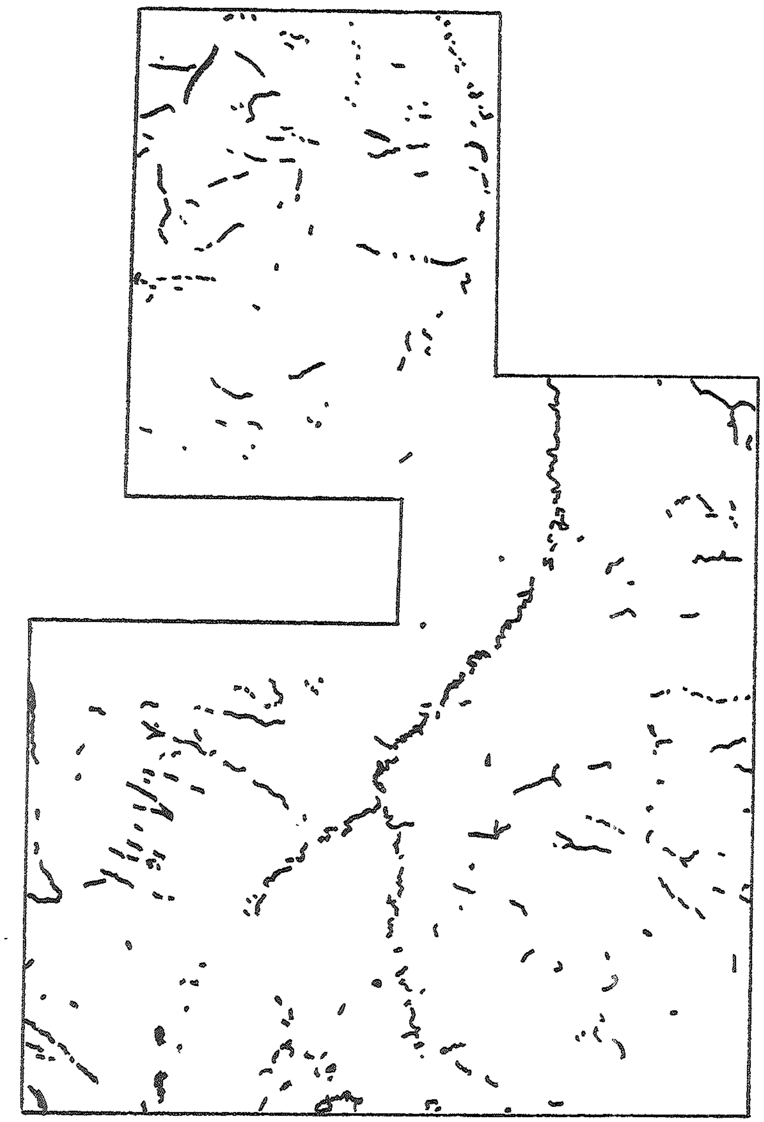

Fig. 6. Riparian habitat.

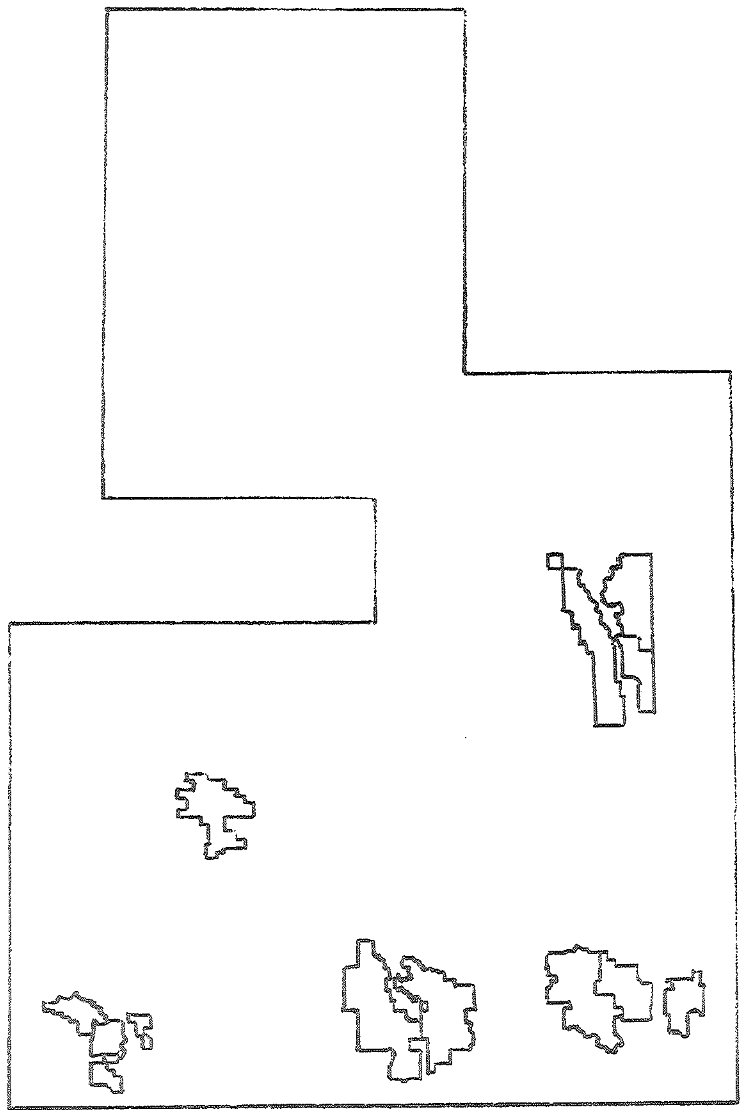

Fig. 7. Hypothetical study area with 13 areas of potential development.

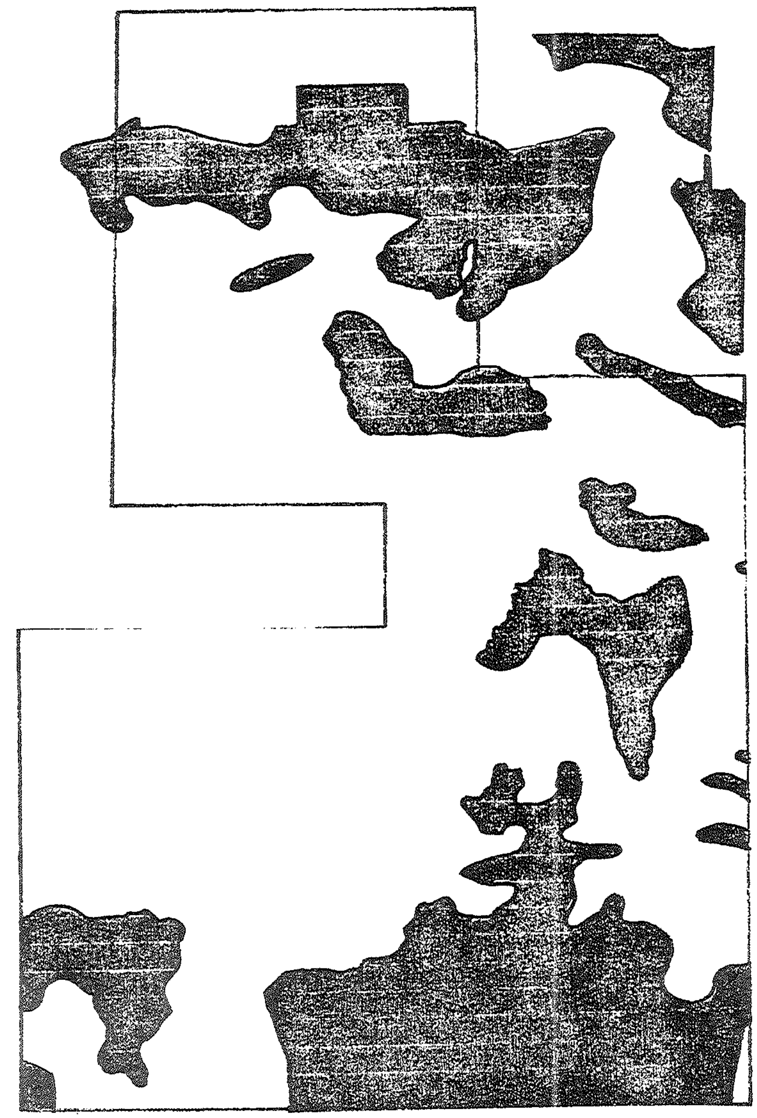

Fig. 8. Antelope distribution or hypothetical study area.

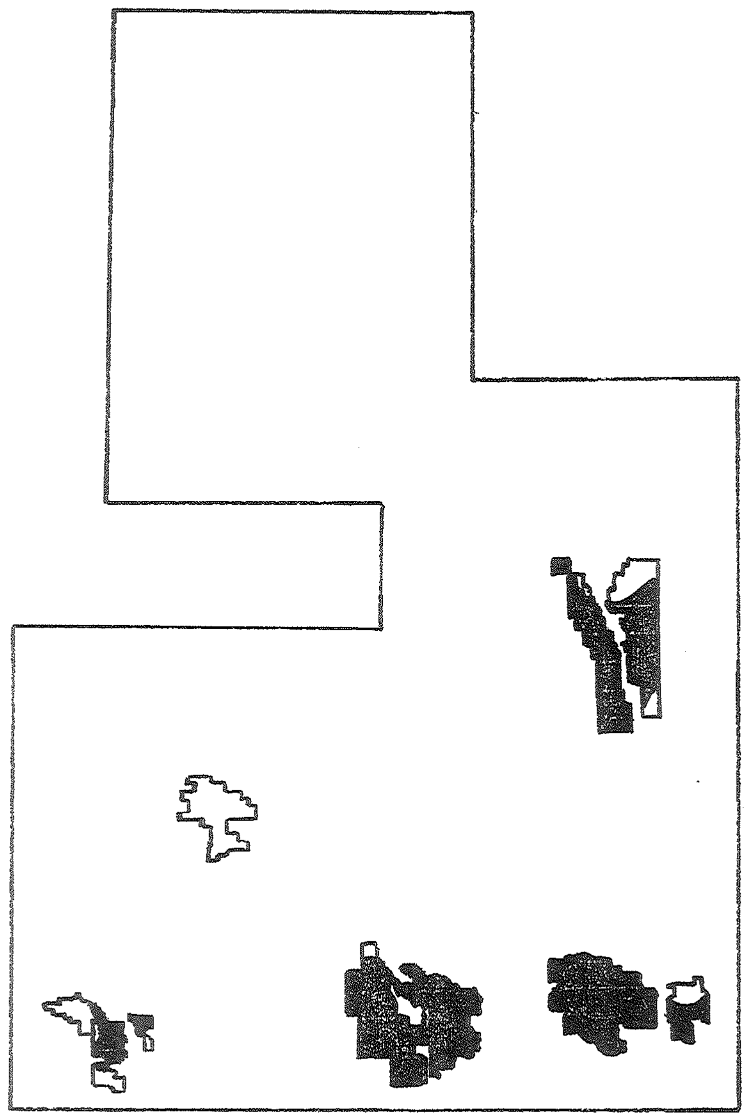

Fig. 9. Antelope range impacted by potential development.

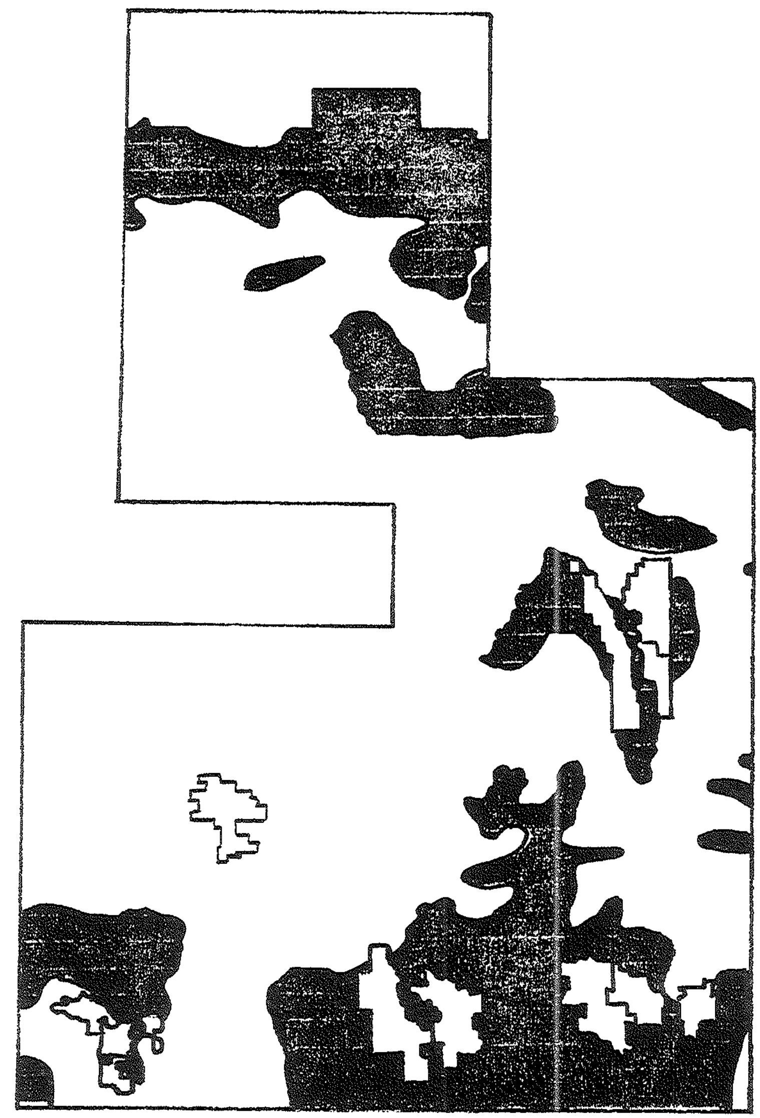

Fig. 10. Antelope range impacted by potential development as compared to total antelope range.

Table 2. Computerized listing of maps, their contents and sources

LMONTANAQK	MONTANA LINE WEEDED 318 PTS	SOURCE 03
LRALIFEDER	RALI AREA FEDERAL LAND OWNERSHIP	SOURCE 60
LRALIMINFE	RALI AREA FEDERAL MINERAL RIGHTS	SOURCE 60
LRALIMININ	RALI AREA INDIAN MINERAL RIGHTS	SOURCE 60
LRALIMINPR	RALI AREA PRIVATE MINERAL RIGHTS	SOURCE 60
LRALIMINST	RALI AREA STATE MINERAL RIGHTS	SOURCE 60
LRALINDIAN	RALI AREA INDIAN LANDS	SOURCE 60
LRALIPRIVA	RALI AREA PRIVATE LAND OWNERSHIP	SOURCE 60
LRALISTATE	RALI AREA STATE OWNED LAND	SOURCE 60
LRETABOUND	REG. ENVIRON. TEST AREA BOUND	SOURCE DD
LWYOMINGQK	WYOMING LINE WEEDED 78 PTS.	SOURCE 03
MAREA1	MAP OF AREA1 (REGION 6)	SOURCE --
MBDGRIDLB	LABELS FOR BD 7.5 MIN. QUADS	SOURCE 07
MBDGRID	7.5 MIN. TOPO GRID FOR BD AREA	SOURCE 07
MBDREHRESH	BIRN-DECK HIGH SENS. REHAB. RESPO. UNITS	SOURCE 73
MBDREHRESM	BIRN-DECK MOD. SENS. REHAB. RESPO. UNITS	SOURCE 73
MBDSCENIC2	BD SCENIC AREAS CLASS 2	SOURCE 81
MDECKERSA	ELEVEN MILE RADIUS CIRCLE-DECKER,MT	SOURCE 07
MDECKERSA	11 MILE RADIUS CIRCLE AROUND DECKER,MT	SOURCE 07
MONTSTUDYA	MONTANA WILDLIFE STUDY AREAS	SOURCE 01
MPHILLIPSM	PHILLIPS SMALL STUDY AREA	SOURCE 80
MPHILLIPS	BOB PHILLIPS (FWS) STUDY AREA	SOURCE 80
MRALIBOUND	RALI STUDY AREA BOUNDARY	SOURCE 60
MRLATLONG	LATITUDE LONGITUDE LINES IN COAL REGION	SOURCE 03
MWSYNWINDO	ASHERIN'S TOPO MAP DATA WINDOW	SOURCE 07
PBDRAREII	BIRNEY-DECKER S.A.- RARE II AREAS	SOURCE 10
PBDROADLES	BD ROADLESS AREA FROM WORKSHOP DATA	SOURCE 81
PMBALFLAND	FEDERALLY OWNED SURFACE ? (LIMITED COVER.)	SOURCE BLM
PMBALNOMIN	FEDERAL OWNERSHIP (NO MINERALS-LIMITED C.)	SOURCE BLM
RDKEXBRED1	EXCLU. BREED. SPEC.(1-19)VALUE 1	SOURCE 92
RDKEXBRED2	EXCLU. BREED. SPEC.(20-39)VALUE 2	SOURCE 92
RDKEXBRED3	EXCLU. BREED. SPEC.(40-59)VALUE 3	SOURCE 92
RDKEXBRED4	EXCLU. BREED. SPEC.(60-79)VALUE 4	SOURCE 92
RDKEXBRED5	EXCLU. BREED. SPEC.(80-101)VALUE 5	SOURCE 92

Graphic data is much more expensive, but its benefits are also far more reaching in terms of illustrating what actually is happening in a given area with given data. It will answer two additional questions not able to be answered by tabular data, how much and how many.

Computer terminology is with us now. It's true that the sophistication level is growing almost daily, but shouldn't we as wildlifers get on the bandwagon now before we fall so far behind we cannot get on? The ease of handling data on a statewide basis, regionwide or whatever becomes only a very small problem with a good data management system. In addition, if, we as wildlifers, cooperate with one another, we can share our data with one another.

I have included Fig. 11-13 to illustrate how a computer can visually depict impacts of a given program on wildlife. These charts only took the computer about 5 minutes to construct. Think of the impact these charts would have on a manager.

Fig. 13 denotes that the impacts on sharp-tailed grouse virtually eliminate all the habitat. This is graphically depicted. Combine this graph with a pictorial representation of what is happening in an area and you should definitely well get the manager's attention.

Remember, the machine doesn't know good data from bad data - garbage in - garbage out. Just because it's in the computer doesn't make it good - just ask Pete!!!

Obviously, there are a variety of applications of such an information handling system. Research, cumulative impacts of development on wildlife habitat, data analysis and finally, presentation of data to managers.

Many researchers, laymen for that matter, routinely use computer technology for literature search. However, it is just as practical to utilize in data analysis outside of statistical analyses. Data on geographic distribution, behavior and other wildlife research could use such an information storage facility.

How many times have you heard or made the statement, "This development itself is not too bad, but over the past 20 years this same type of development has virtually eliminated wetland habitat." How easy it would be to actually show managerial types what cumulative development is doing!

I've rattled on long enough about some of the things I've seen that offer new uses for wildlifers, but what do they cost? A great deal is a safe answer, but let's look closer.

The Hardware - Terminal, copies, printer, etc. could probably be obtained for between $2 to $3,000. This will get you set up for handling tabular data. Of course, you'll need access to a larger computer, but usually you can rent time from any of several large computers, but this too will cost, as will rental of a telephone line and phone time. This could go as high as $200 to $2,000 per month. Already we're beginning to get the manager's attention.

Graphics is very expensive; because of the many different combinations of hardware, software (tapes, programs, etc.), an estimate of costs is not practicable. Suffice it to say, they don't give it away. However, as the

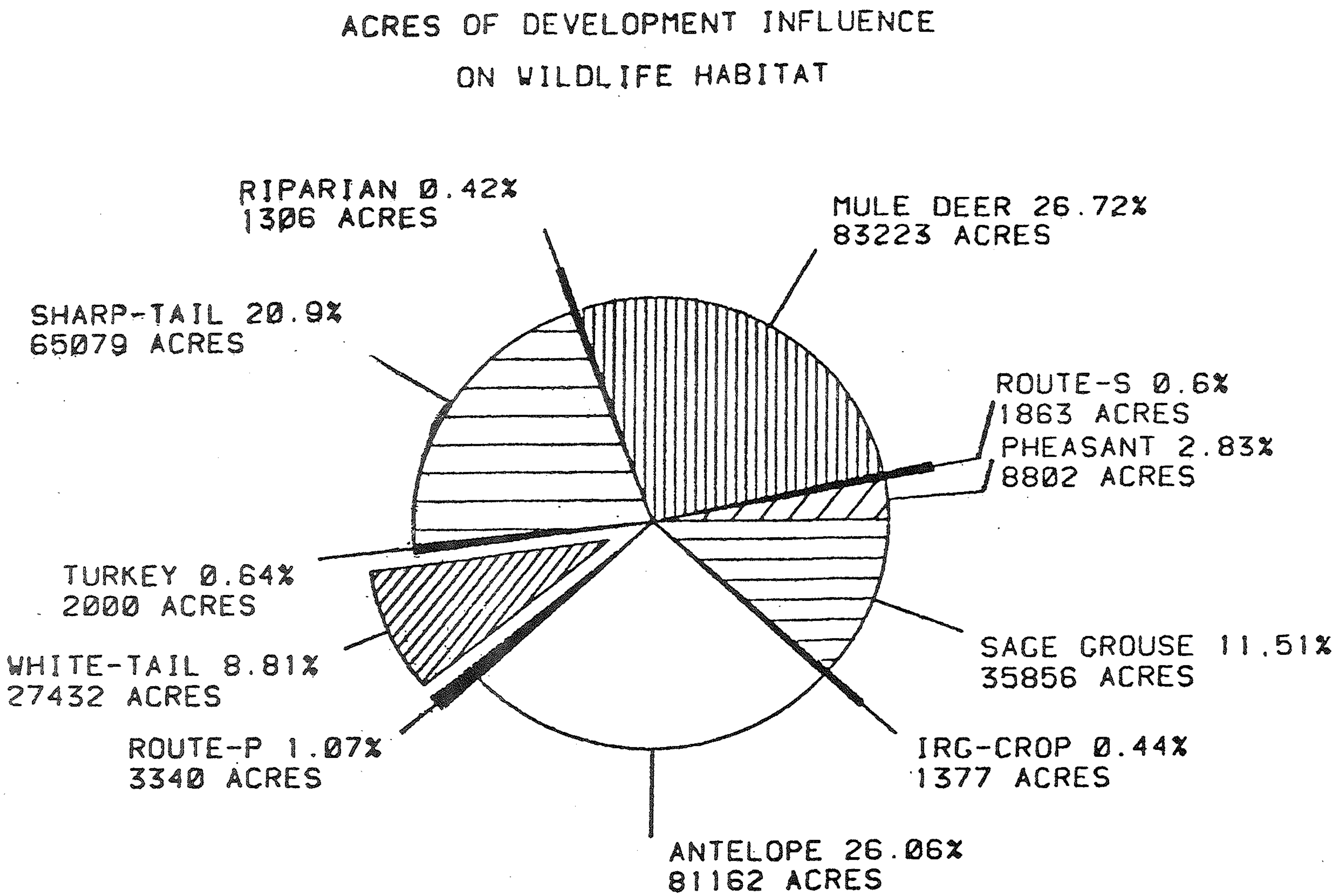

Fig. 11. Acres of development influence on wildlife habitat.

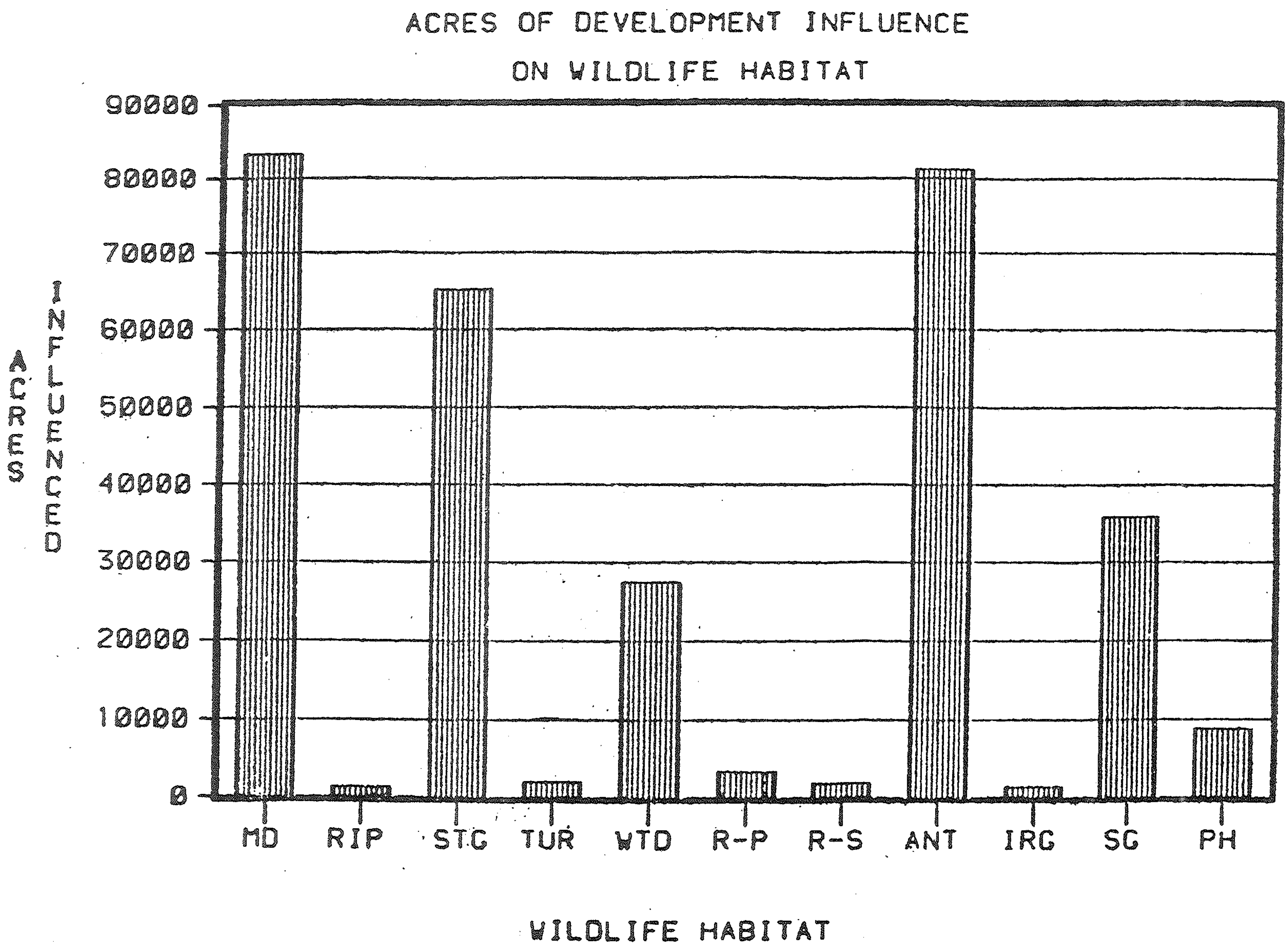

Fig. 12. Acres of development influence on wildlife habitat.

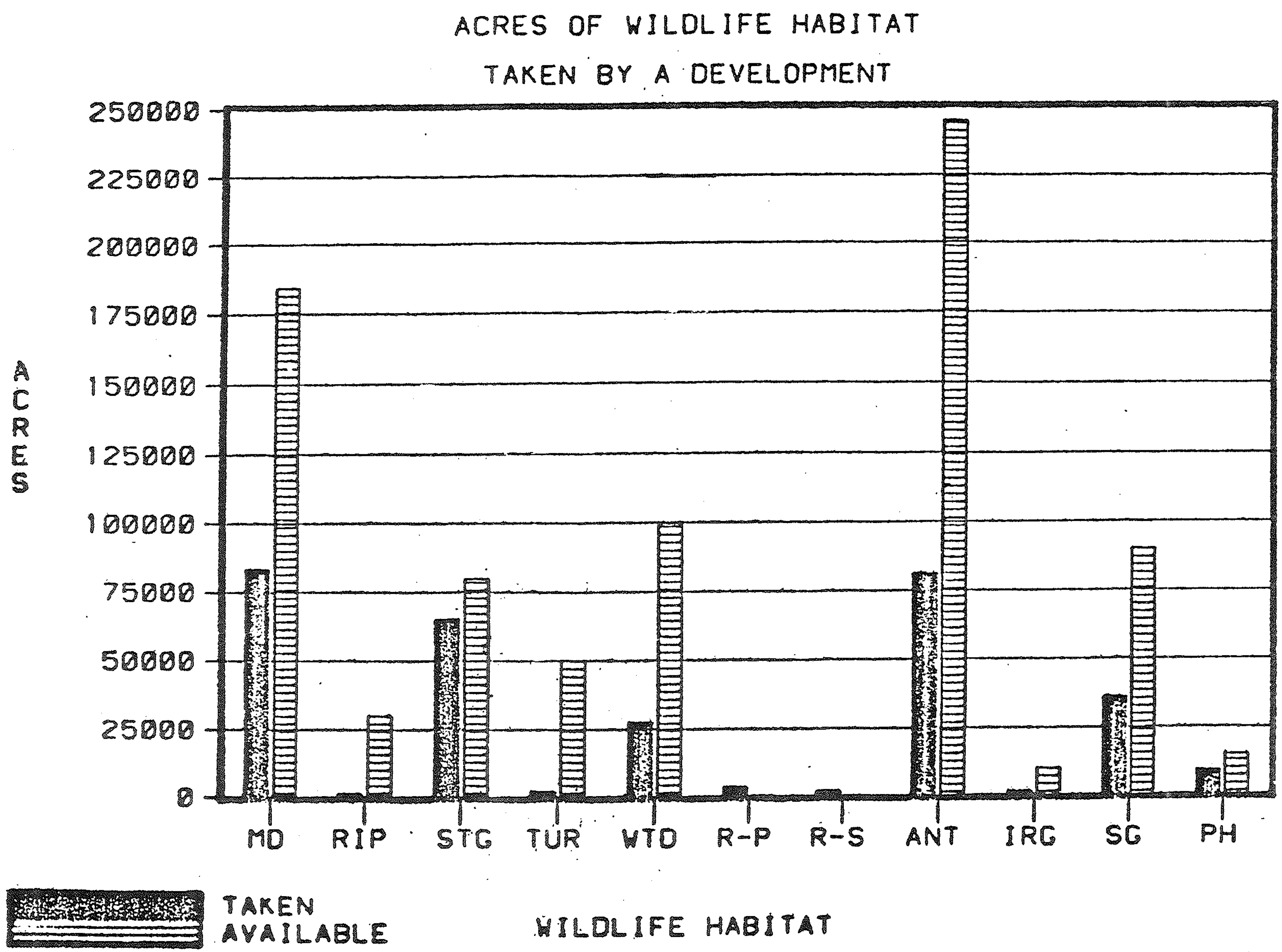

Fig. 13. Acres of wildlife habitat taken by a development.

data are used more and more, it becomes less and less expensive. That's not to say it's ever cheap, but it is cheaper than doing it manually. But finally, the most expensive part of a computer technology, data entry. Data entry, particularly those data associated with graphics capability, require some type of computer technician for entry and adjustments of the various software (programs, etc.) to accommodate answers to questions which may be put to the computer.

This, in itself, raises three questions: cost, manipulation and interpretation.

Data entry costs are phenomenal, not because of the hardware involvement, but because it is labor intensive. These costs, however, are mitigated as the data becomes used more and more.

Data manipulation is another story. Because their software is constantly "looked after or updated," the computer programmer becomes a very influential cog in the wheel of data analysis. Often, because of the training necessary, they are the youngest and least experienced personnel in an agency or company and, unfortunately, those who have a storehouse of wisdom, experience, personal contact with the land and who have lived long enough to apply a certain amount of perspective to their personal enthusiasm, find themselves playing a smaller role in decision making.

Data interpretation, again is another ball game. As I stated earlier, data, when entered into a computer system, tend to gain an air of authority that tends to vastly outstrip their utility and inherent good sense. Data amounting to best guesses and approximations gathered on a district or some area, when combined with computer hardware and programs, achieve a sophistication that far exceeds the capability of these same data. Thus, when the computer machinery finishes arranging, tugging, pulling, graphing, weighing, weighting and measuring them, the results may be applied to a problem for which they may have never been related and the results could be disastrous.

So, sensing the utility of this marvelous information handling systems, costs vs. available manpower should be assessed, and a training program should be considered as part of the initial investment. Generally speaking, a great deal of training is not necessary, but the user should understand what the machinery can do, which questions it cannot answer and they should develop some familiarity with the hardware and the software. Familiarity with the software will allow the user to dispel some of the concern related to the computer's ability to manipulate data as well as, by not asking sophisticated questions of unsophisticated data, alleviate application of data to unrelated problems.

In summary then, there are two different kinds of data that are suitable for information storage and retrieval in a computer system:

Tabular data and data suitable for graphical display. Tabular data are much cheaper to obtain in terms of hardware, software and other capability. Tabular data can answer the questions: what, when and where.

I've taken enough of your time this morning; however, I would encourage you to seek out and utilize computer storage facilities to the best of uour budgetary ability. I would leave you with this parting shot:

A manager, whom you all know but shall remain unnamed, told me once - Hoem, he said, you wildlifers will never get computers as long as I'm around for one very good reason. If you and three or four other resource-type people come to my office to discuss a resource use, and you have your data all neatly assembled from a computer-based system where the other people do not, your data would be much more organized than their and usually you would be able to more efficiently answer questions than would they. How could I be expected to ignore your data and make a decision for another resource use? With this computer stuff, you take away my option of making a political decision.

Given our current political climate, wouldn't it be nice just to take the edge off political decisions once in a while?