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THE CONDITION OF THE NORTHERN WINTER RANGE IN YELLOWSTONE NATIONAL PARK - A DISCUSSION OF THE CONTROVERSY

by

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ABSTRACT

Proper management of the northern winter range in Yellowstone Park has been a controversial subject throughout the Park's history. Many dramatic changes in management policies have occurred, especially in recent years. The long established opinion that the range is deteriorating has been reversed. The elk reduction program designed to save the range has been discontinued. Reasons for these and other changes include: changes in personnel on the Park's management staff resulting in new interpretations of Park Service goals and ideals; a greater understanding of the ecology of the area; changes in research methodology used to determine the condition of the range; and political considerations. Important ecological changes have occurred on the range in response to a combination of natural and man-caused influences. Initial management programs had a moral bias and were designed to improve on nature. These were soon abandoned for programs that tried unsuccessfully to return the range to the way it was assumed to be prior to the coming of the white man. These programs reflected a high value being placed on a few highly visible species such as willow and aspen. The present policy of not intervening in the natural scene will mean a continued decline in number and vigor of these species. The appearance of the range will continue to change as the environment adjusts to the disruptions that have occurred.

CHAPTER 1

INTRODUCTION

An interesting facet of the Yellowstone Park landscape is a wide belt of predominantly treeless terrain stretching along the northern border of the Park. In the summer months the undulating topography typifies a floristic scene reminiscent of the pre-agricultural era of the west. Copses of douglas fir and aspen alternate with meadows of native forbs and grasses. During the extensive winter season the northern winter range, as this area is called, becomes the gathering place of many representatives of the large ungulate herds that reside in the Park. They migrate from the higher summer ranges in the fall in order to benefit from the comparative climatic mildness found on the northern winter range. The seasonal residence of these ungulates in the area, and the resulting interaction with the floristic component of this region, generates the management situation that dominates this discussion.

Noteworthy as a showcase of natural wonders, Yellowstone National Park carries the connotation of uniqueness. The management plans and problems involved with overseeing this interesting resource, including the northern winter range, are no less unique than the resource itself. In marked contrast with most of the other land management agencies of the government, the National Park Service, which administers Yellowstone Park, is not interested in any form of

"cropping" or harvesting of any element of the resource for economic return.

As stated in the congressional act that created it in 1916, the mission of the National Park Service is:

> "The service thus established shall promote and regulate the use of the . . . national parks, monuments, and reservations . . . by such means and measures as conform to the fundamental purpose of the said parks . . . which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (in Sutton and Sutton, 1972).

Perhaps because it is so highly visible, being bisected by a year-around road, the northern winter range in Yellowstone has been the center of a continuing controversy revolving around the propriety of the management policies designed to fulfill in this area the aforementioned goals of the Park Service. Opinion varies, as it has historically, as to whether or not the northern winter range is properly managed. Over the course of the Park's history this topic has received intensive management and research consideration.

Major ecological changes have occurred on the northern winter range since white man first arrived on the scene. Much of the controversy associated with this region lies in interpreting the cause and significance of these ecological changes and in determining corresponding appropriate management programs. The programs selected must not only fulfill the philosophy of the National Park Service but

be ecologically sound as well. Obviously, different interpretations of the ecological trends on the winter range would result in different opinions as to what constitutes appropriate management actions. This is exactly what has happened. One of the most interesting aspects of this controversy is the fact that Park management practices and opinions have changed so drastically over the years. Specifically, there are two schools of thought: (1) the condition of the northern winter range is steadily declining under the grazing pressure of an overly large elk herd that has been artificially concentrated on the range because of disrupted migratory routes; (2) the winter range is essentially an ecologically complete habitat and retrogressive succession or range deterioration is not evident. Presently, the Park Service embraces the latter opinion.

The development of the controversy is in itself of interest, however, discussing this topic also has a broader application. The northern winter range is a superb natural laboratory. Studying the northern winter range provides range and wildlife managers with conclusions applicable to other study areas.

The purpose of this paper is to trace the evolution of the management policies for the northern winter range in Yellowstone Park, one of our nation's most spectacular range and wildlife resources, and to gain some insight into the condition of that resource. The aspen on the winter range, a leading character in the controversy, has been

singled out to receive special consideration in this discussion. The effects of past and present management programs on this species will be observed as an indication of the appropriateness of the different programs implemented on the northern winter range.

Significant events or statements made in the development of the controversy will be examined on a year by year basis in chronological order. Specific points of contention or departures from present policy and opinion will be identified and discussed briefly as they emerge. This will be followed by an attempt to relate the assimilated information to one important facet of the northern winter range, the aspen stands.

CHAPTER 2

HISTORY OF THE CONTROVERSY

An abundance of reports, correspondence, and scientific literature exists concerning the northern winter range and the management of that area. Extensive records have been kept by the Park Service, the Forest Service, and other government agencies. Abstracts have appeared in the nationally known journals. Interested scientists and citizens have made their own observations and comments through the years. Opinions will be borrowed from all of these sources in developing this discussion.

Before 1872

In the sense of recorded history, Yellowstone is very young. About 165 years ago early explorers were making their first written records of the area from bits of information passed on to them by Indians. However, man has occupied the Yellowstone area perhaps for as long as 8,500 years. In the time frame relevant to this discussion the only important occupancy of the area was by a group of improvished Shoshone and Bannock Indians (Haines, 1966).

By present day standards, these Indians had only a minimal impact on the area. An important exception, but a difficult one to verify, is their use of fire. It is known that Indians used fire as a weapon in warfare, as a tool in hunting, and sometimes were simply careless enough to start a conflagration. In such cases they had a dramatic

influence on the environment depending on the frequency of the fires and the amount of land involved. Man-caused fires may once have been a common occurrence in the Yellowstone ecosystem (Houston, 1973).

John Colter, a fur trapper, was probably the first white man to see the Yellowstone area when he passed through in 1807. He was followed by other trappers who frequented the drainages with good hunting and trapping until 1840 when the fur trade collapsed.

Yellowstone remained a nearly forgotten wilderness until the discovery of gold in adjacent areas brought in exploring parties. A different kind of explorer, men interested in observing and documenting the natural wonders, came to Yellowstone as well. Exploration parties visited Yellowstone in 1869, 1870, and in 1871 as a U.S. Geological Survey party (Haines, 1966). For the most part, Yellowstone remained a place that people just passed through. The major impact on the land was in the form of localized hunting. The explorations brought recognition of the uniqueness of the area and the Congress was pursuaded to set aside 3 1/3 million acres as Yellowstone National Park on March 1, 1872.

1872-1916

The first national park had been created, but funding and regulations for responsible stewardship were overlooked. The wonders of Yellowstone had been much publicized and, once the fear of Indian attack was lifted around 1879, visitors began to arrive. The impact of

man on the environment increased dramatically. Haines, an expert on the history of Yellowstone, characterized the difficulties of managing the new park.

> "The history of the first decade in the new national park is mostly one of official frustration and indecision--a period during which visiting sportsmen and local hunters slaughtered the birds and animals; scientists, tourists and local guides defaced the geyser cones and petrified forests to the greater glory of parlor "what not" collections, and the beauty of timbered hills and valleys were marred by carelessly used fires."
>
> ". . . the ambiguous expression of policy toward wildlife implied that it should be protected only against "wanton destruction," or "capture and destruction for the purposes of merchandise or profit," without recognizing that the tourist and the frontiersman were alike unable to distinguish between shooting game for food while traveling through the Park and the killing of animals for sport, trophy, or salable meat and hides" (Haines, 1963).

After the establishment of the Park it was put under the managerial control of civilian Superintendents who were often lacking in authority and funding, as well as vision and sensitivity. Conditions probably reached their lowest ebb under Superintendent Conger, 1882-1884. An organization called the Yellowstone Improvement Company came into the park, built a hotel without a lease, cut timber indiscriminately, and killed elk to feed the workmen. Individuals, many with dubious intentions, were allowed to settle in the Park; especially in the Lamar Valley on the northern winter range.

News of the plight of the new Park reached some concerned congressional members who went to work to secure legislation to rectify

the situation. Senator Vest succeeded in passing an amendment which gave the Secretary of the Interior the authority to

> ". . . lease small portions of ground in the Park not exceeding ten acres in extent for each tract, on which may be erected hotels and necessary out buildings and for a period not exceeding 10 years" (in Haines, 1963).

It also excluded the building of facilities within close proximity to geysers and other curiosities and made all previous privileges granted in the Park invalid. Most importantly, it gave the Secretary of War the authority to dispatch troops to protect the wildlife and natural features, uphold the law, and remove violators if requested to do so by the Secretary of the Interior.

The provision allowing for the use of troops in the Park proved to be its salvation. The civilian management of the Park finally collapsed in 1886 and the U.S. Cavalry was called in. The Army was very successful in returning order to the area and managed the Park very ably until 1916 when the National Park Service was created by Act of Congress. Park rangers replaced the troopers at the job of policing the Park soon after (Haines, 1963).

Specific references to the portion of the Yellowstone area now called the northern winter range appear in journals of the early trappers and explorers. Their comments have been summarized in Houston (1976), Haines (1963), and Rush (1932). After the establishment of the Park more thorough and consistent records were kept. The northern

winter range and the wildlife of that area soon emerged as a high priority management concern. More and more attention was given to this subject in the Park's reports as the years passed. Rush (1932) summarized the statements pertinent to the northern Yellowstone elk study as they appeared in the early documents of the Yellowstone Park Superintendent's reports. The following are some of those statements:

1881

"The snowfall was unusually great and remained very deep high in the mountains, but the winds and hot vapors from the Fire Hole Basin at the foot of Mount Norris kept the snow pretty clear along its western slopes, where there were abundance of mountain sheep and some elk all winter. Elk to the number of about 400 wintered in small bands in the valleys of the East Fork and Soda Butte where the snow was about knee deep . . ."

"I found that very few of the deer or antelope wintered anywhere in the park; that a small band of bison wintered on Alum Creek and another on the South Fork of the Madison; that there were elk in nearly all the warm valleys and moose around the Shoshone and the fingers of Yellowstone lakes, bighorn sheep on all the mountain slopes . . ."

1886

"From the reports of reliable scouts familiar with the ranges of the elk, the deer, and the buffalo, there can be but little doubt that there is an abundance of game in the Park."

1890

"The number of elk in the Park is something wonderful."

"In the neighborhood of Soda Butte herds were seen last winter estimated at from 2,000 to 3,000. The whole country of the Park seems stocked to its capacity for feeding. Other varieties of game animals are thought to be increasing rapidly."

1891

"The elk have increased enormously and most conservative estimates place their number at 25,000 and I have no doubts

of the presence of that many. Their continuance in the Park is assured and their overflow into adjoining territory will furnish abundant sport for the hunter."

1892
"Elk. The elk are extremely numerous and I am not disposed to revise in the least my estimate of 25,000 made last year. The very severe winter was extremely hard on them, and I judge that from 2,000 to 5,000 perished. This is not an alarming mortality among so many when it is considered that the deaths the previous winter were unusually few. The worst feature of it is that owing to the starved condition of the mothers this spring a very large proportion of the calves perished. There are still as many as the winter grazing will accommodate and the loss of the old ones is not to be considered an evil."

1893
"Elk. For some reason the elk did not winter in the Hayden Valley in the same numbers as formerly. There were abundant signs of them in the autumn, and they reappeared again in the spring. Perhaps many of them stayed in the open valley of the Pelican. The usual large herd wintered in the valley of the East Fork, between Yancy's and Soda Butte. I still believe there are 25,000 in the Park. While fighting the fire at Norris a few days ago, the men saw a herd of about eighty with a large number of calves."

1894
"The elk wintered well and all reports show a large number of young this spring. A party sent out to Yancy's to investigate the subject in March last saw at least 3,000 of them at one time from a single point of view. This is also the portion of the Park to be cut off by the segregation bill. The valley of the East Fork of the Yellowstone winters more of them than any other portion of the Park, and should it be cut off, it is safe to say that their numbers would be diminished by at least one-half."

1895
"The elk have quite held their own or increased in numbers, and have been seen almost daily by tourists up to the present date. They exist within the Park in such great numbers that the question of their preservation is not one that causes any concern. A succession of open winters like the last

would possibly make them more numerous than the food supply could well support. That they breed and winter within the Park and wander outside of it to furnish sport for hunters is not an evil, and is perhaps one of the very excuses for game protection within its limits."

1897

"Elk. Notwithstanding the hard winter of 1896-97 which killed many elk and drove many more out of the park, there is no perceptible diminution in their number. I believe that more than 5,000 winter in the Park, and that at least 15,000 leave the Park in the autumn to winter in the lower country. . . . Of those that winter in the Park, the largest herd ranges north of the Yellowstone River, in the country that has been so often proposed to cut off from the Park. I doubt if any would ever winter in the Park under any circumstances, if this would happen. The Park furnishes an ideal summer range for 40,000 elk, but there is not enough winter range for one-fourth that number."

1899

"Elk. Are more numerous than any other animal in the Park. The scouts frequently report seeing herds of a thousand or more. While a great many died last winter, due to the unusually cold weather, yet they are without doubt rapidly increasing. Some of the scouts, from the number of dead ones seen by them, estimate that as many as 5,000 died during the past winter. It is estimated that there are at present from 35,000 to 60,000 in the Park."

1902

"An extract from the monthly report of the Soda Butte Station for the month of December, 1901, shows that on December 7, two men on horseback traveling between Slough Creek Cabin and Hellroaring Cabin saw 20,000 elk in good condition.

1905

"It has been only within the last two or three years that these animals could be seen in such close proximity to the Mammoth Hot Springs, and the reasons for this fact are due to a few simple changes in the Park management as follows:"

"First. No dogs are allowed to run at large in the park . . ."

"Second. A fence about 4 miles long has been built along the northern line of the Park, which excludes all stock that for a number of years has grazed within the limits of the Park and completely used up the grass, which is now preserved for the wild animals. No stock of any kind is now permitted to run at large in the vicinity of the Mammoth Hot Springs, and where they formerly grazed during the summer elk and deer can now be seen feeding during the winter."

"The elk also learned that forage for wild game was being issued at Gardiner . . ."

1907
"The number of elk in the park is estimated by persons of some experience at 40,000. From personal observations and information received from reliable scouts, also the daily reports of patrols and guards, 25,000 seems to be a safe estimate."

1908
"Elk. Information from all available sources seems to justify a conservative estimate of between 25,000 and 30,000 elk in the Park. Mr. Wells, in charge of the buffalo farm, an experienced hunter and man of good judgement, estimates the number to be between 40,000 and 50,000. The winter storms and deep snows cause large bands to drift out of the Park down the valleys of the Snake, Madison, Gallatin, and Yellowstone Rivers, where many are properly taken by the licensed hunters, . . ."

1909
"A conservative estimate would place the number of elk in the Park at between 30,000 and 40,000.

1910
"The estimated number of elk in the Park is from 30,000 to 40,000. Many of these elk wander out of the Park into adjoining states . . ."

1911
"Elk in certain portions of the Park are very numerous, and are numbered by the thousands both in winter and summer. Last winter the deep snows drove them down in large herds from the latter part of November on and many of them drifted into Montana where they did much damage to haystacks, fields and fences on the ranches near the Park."

1912
"During last April an approximate accurate census was taken of the elk that winter along the northern border of the Park. . . . a total of 30,101 that actually belonged to the winter herd of the Park.

1913
"A census of elk in and along the north line of the park was taken between April 9 and May 1. . . . a total of 32,967."

1914
"A census was again made of the elk, comprising the northern herd in the park, between April 11 and May 2 . . . making a total of 35,308. The condition of the herd could hardly be better."

1915
". . . careful estimates by experienced men placed the increase in the northern herd at 10 percent and the decrease from natural causes at 3 percent. . . . an estimated total of 37,192 in the herd."

1916
"As high as 7,000 elk were counted between Fort Yellowstone and a point about a mile west of Gardiner--most of them along the main road--on January 27, a day when the weather was particularly severe."

"In accordance with instruction from the department beginning April 5, 1916, a very careful census was made of the elk belonging to the northern herd in the north and northeast; 29,544 elk were found in this herd and 1,958 more were accounted for."

Park biologists currently involved in managing the northern winter range question the accuracy of the elk herd counts and estimates made during this portion of the Park's history (Houston, 1975). In their opinion, the methods that were used in making counts or arriving at estimates left much room for error. The elk herd in Yellowstone is divided into several distinct groups that traditionally winter in

different areas either in or adjacent to the Park. When counts were made in the early days of the Park and the numbers recorded in reports it is not always clear what portions of the total Park herd were included in the count. Present Park biologists see this as adding to the confusion and further discrediting these records.

In contrast, for much of the Park's history Park managers regarded these early counts to be accurate, at least in a general sense. They used them to get general impressions of what conditons were like during this period. Since the numbers given are often greatly in excess of present herd sizes, these reports could indicate substantial changes having occurred on the northern winter range; in fact, these records have often been used to prove exactly that point.

As an example of the large differences these counts would indicate, the records for 1902 mention two men counting 20,000 elk between Slough Creek Cabin and Hellroaring Cabin, a fairly small portion of the northern winter range. Presently, there are only approximately 13,000 elk in the entire northern herd.

References to the wildlife resource of Yellowstone and its habitat continued to become more numerous and detailed as an important understanding of their importance increased. Discussion of the issues involved made the transition to more formal management plans as the government agencies managing the lands of the northern winter range became more organized and sophisticated.

1917

With the memory of the harsh winter of 1916-1917 and the loss of an estimated 15% of the elk herd still fresh in their minds, Forest Service officials who administered the small, but important part of the northern winter range outside of Yellowstone Park collaborated to write a proposed management plan for the area. Because of poor growing conditions for range vegetation in 1917, a similar dieback was predicted for the 1917-1918 winter. Plans for preventing such a happening were worked on with a sense of urgency; elk that succumbed to the vigors of winter were considered wasted meat.

> "If these premises are correct, and it is believed they are, is the government justified in taking a chance of losing from 2,000 to 3,000 head of elk during the coming winter in view of the present meat crisis and food crisis throughout the country? Would it not be far better to butcher this meat at the present time when the elk are down in the open country on the fall range within the Park, where a fairly good selection can be made, where the caracasses can be approached by wagons, and while the meat is fat and in good edible condition?" (Forest Service, 1917).

A combined Park Service - Forest Service counting effort decided on 17,422 as the number of elk in the Gardiner (or northern) herd. By a rather loosely defined method the desired herd size was estimated to be 15,000 elk. A reduction of 2,000 was recommended; the carcasses to be given to the army as meat rations. The sensitive nature of this recommendation was anticipated;

> "Because the suggestion was a radical departure from any previous suggestions along the line of elk management, it

> was not believed too wise for the public to know that any such policy was even being tentatively considered" (Forest Service, 1917).

Justification for this recommendation was concern for the condition of the range. There was no mention in the report of any apprehension that long term damage to the range was occurring or might occur; rather, the lack of forage caused by unfavorable growing conditions in that year and the possibility of an unwanted winter casualty rate among the elk as a result was what was feared.

The perimeter of the northern winter range, as it is defined today, is substantially different than the way it was perceived in 1917. The upper area of the winter range along the Lamar River is now viewed by Park biologists as critical winter range, with the herd that winters there representing a naturally regulated herd operating in an ecologically complete habitat (Houston, 1971b). In 1917 the following opinion was held:

> "From personal observation it is believed that the range from Hellroaring east and from Tower Falls Soldier Station east and south along the Lamar River is not typical winter range that elk would normally use in the winter time if a more ideal range were provided. It is believed that this range is primarily a spring and fall range and is largely used for this purpose by this herd of elk" (Forest Service, 1917).

Also, in contrast with current opinion, the area from the Park line to Dome Mountain was considered to be of critical importance for the northern elk herd in 1917. Reputedly, large numbers of elk

migrated from the Park to winter in this area. References are made to elk migrations being made past Dome Mountain and northeast to Six Mile Creek. Because of this, recommendations were made to set aside as a game reserve as much land as could be obtained from the Park line to Dome Mountain. A game preserve designed to allow for hunting to regulate the herd size was preferred.

> "There is very little, if any, range on the Absaroka Forest suitable for winter use, and aside from the winter range in the Park the elk must depend on the public domain immediately adjoining where they now congregate. As settlement progresses upon this area of public domain, winter conditions for the elk will grow worse instead of better, and the government must ultimately face a feeding proposition. By proper steps now, feeding to any large extent could be materially delayed without serious injury to the animals. A long step in this direction would be the setting aside of all that area between the Absaroka and Gallatin Forests from Dome Mountain on the north to the Park boundary on the south as a winter ranger for all" (Forest Service, 1917).

On April 16, 1917, much of this land was withdrawn from further settlement by presidential order, pending legislation.

Plans for developing irrigated pastures for hay production to feed the elk herds were bantered about, but it was decided that it would be better management to try and expand the winter range as much as possible and then regulate the herd to fit the size of the range. Use of drift fences to regulate the distribution of the elk were considered. It was strongly recommended that the practice of grazing several hundred head of horses (estimated to be from 400 to 1,000 head) on Blacktail Creek by the Yellowstone Park Transportation

Company be curtailed. It was hoped that when the YPTC switched from horses to automobiles the situation would solve itself.

1919-1920

A report by Graves and Nelson (1919) of the U.S. Forest Service on the portion of the northern winter range on Forest Service land expresses the attitude in that era towards predators and their influence on the elk herds.

> "The predatory animal is a large factor in the annual loss of elk, particularly of the year's increase of calves. Such substantial progress is being made in the destruction of wolves and mountain lions that it is hoped in a short time they may be practically eliminated as a serious source of injury to the elk herds. Headway is also being made against the coyotes but they are still a dangerous factor in elk loss. They follow the migrating herds in numbers pulling down the calves, especially those weakened from any cause. Still more vigorous measures against them are needed."

By this, and other statements, it would seem that the ultimate management goal was to prevent the loss of life by elk by whatever means. Elk taken through hunting were part of population regulation; elk expiring by any other cause were wasted.

The events of the winter of 1919-1920 played a considerable role in the controversy over the condition of the northern winter range. It is traditionally considered that just prior to this time elk numbers had erupted to dangerously high proportions and then suffered a dramatic population crash during the winter. Prominent writers in the field of wildlife management such as Leopold et al (1963) and

Craighead et al (1972) have used these happenings as examples of classic population dynamics. Present Park biologists heartily disagree with these conclusions and instead maintain that the original information was incorrect and the errors were simply picked up and repeated by author after author. Knowing what actually occurred would be very valuable in correctly ascertaining the balance between the northern elk herd and its environment. In examining the records, it becomes obvious that there is a lack of any real degree of precision in recording the events of that winter. Forest Supervisor Shaw (1919a) of the Forest Service wrote the following:

> "The situation around the Park is extremely grave. The elk are coming out in greater numbers than usual and far earlier than is ordinarily the case or than has been the case for many years back prior to the time any record was kept by the Forest Service. I believe that approximately 3,000 herd of elk are now outside of the Park, and a heavy legitimate hunting kill can be anticipated. However, that particular feature is not serious. I believe that owing to range conditions, a legitimate kill of 5,000 would be a benefit rather than the reverse, and it is hardly to be hoped that more than 1,500 to 2,000 will be killed.
>
> "However, there is nothing to eat on the usual range area aside from aspen bark and sagebrush. Such feed is valuable feed if augmented by grass but when it becomes the entire winter forage, it is of no great value. The Park has approximately 900 tons of hay on hand and are about to purchase 275 to 300 tons more. This will be about four times as much as they have ever had before, and it is possible that a good many animals can be saved through feeding this winter. On the other hand, a very heavy loss can be anticipated.
>
> "Assuming the correctness of the count in the spring of 1917, at which time there were approximately 19,000 animals in the

> herd (or 17,442 in the northern herd), and assuming that there has been an annual increase of 2,500 calves, it will be seen that there are 24,000 head of elk to provide for during the coming winter. If the latter total can be assumed as correct, I feel quite sure that there will be a loss this winter of approximately 10,000 head of elk and I have reason to believe that the winter hunting is going to be carried on in a more systematic manner this year than ever before."

Currently, the count made in 1917, the estimated population size in 1919, and the estimated number of casualties for the winter of 1919-1920 are all questioned for their accuracy (Houston, 1971). The practice of providing artificial feed referred to in the above quotation was used extensively during this time period in an effort to "save" the elk. This practice is now condemned as an example of a poor wildlife management technique. Even as early as 1932 the disadvantages of artificial feeding were seen to outweigh the advantages (Rush, 1932).

The extensive hunting efforts carried out in the fall of 1919 in anticipation of a high winter-induced mortality rate created an emotional outcry that set the tone for reaction to future herd reduction efforts. The following statements were made by Forest Supervisor Shaw (1919b) of the U. S. Forest Service.

> "Of course violations are occurring. It is impossible to watch every hunter. The present day hunter does not go into the woods with a sense of individual personal responsibility, he goes in to kill something - anything - everything in sight. Some do not even go to kill, merely to acquire. There have been instances recited as facts within the past few years of men who went to the slaughter pen armed only with a knife, and the idea of picking up one that had been wounded and not followed, or that had been killed by some party in excess of their legal limit and THEY CAME BACK WITH THEIR MEAT!

> "With these facts in mind and admitting the deplorableness of the butchery, may it not prove after all to be a good thing that this reduction in herd numbers has taken place while the meat is prime and before the winter toll takes place? That thought is perhaps the only redeeming feature about the whole disgusting business. It is no more semblance to sport than a cottontail to a coyote.
>
> "There is the added possibility that this is the psychological moment for action toward the salvation of the northern herd. If not the salvation of the herd, it at least means much for their future welfare. Should a loss of 10,000 head occur as is possible, it might mean that the herd reach so low an ebb that it would suddenly and mysteriously disappear as did the blacktail deer in southwestern Colorado in 1900 and 1901, which passing I personally watched with wonder and awe from which I never fully recovered."

The Superintendent's report for 1920 discussed in detail the events that occurred on the northern winter range in an equally pessimistic tone. A special note was made of the weather conditions. A snowfall of 26.6 inches at Mammoth in October with a -6° temperature and 20 inches of snow in March with -25° temperatures were mentioned.

The following quotation echoes the concern expressed by Park authorites.

> "From the figures given, 19,345 elk in the northern herd in June, 1917, and the fact that the two winters following were quite mild in character with no apparent losses in the herd, it would not seem improbable that there were 25,000 in the herd a year ago. Last June after the most disastrous [winter] which our wild animals have ever had to face, our rangers estimated the survivors in the northern herd of elk at 11,000 and I am reliably informed that the southern herd fared, but little if any better. This loss of nearly 60 percent in one winter is alarming and indicates most forcibly the possible danger of complete extermination of this most noble race of animals. The story of the long winter of hunger and suffering is heartbreaking. The conditions which caused it were

anticipated and preparations on a scale thought to be beyond any possible necessity were made" (NPS, 1920).

1925

The question of whether or not the original migratory routes for the elk of the northern range have been disrupted is an important one in the controversy. Skinner (1925) summarized his investigations of migration routes and habits for Park elk. In his opinion, his work gave additional support to the theory that during the winter months the northern herd used to migrate to a lower elevation than they are presently able to do because of man's influence. He did not provide additional evidence for this theory; it was considered an obvious and indisputable fact. Rather, he traced the migratory routes of the elk as they had developed in response to a loss in habitat. He noticed that not all elk make the fall migration to low winter ranges, but some remain all winter around thermal areas and on wind swept ridges at higher elevations. He speculated that artificial feeding of hay in the winter had altered migratory routes and made isolated areas that ordinarily wouldn't have any elk in the winter months into wintering areas. An example he gave was of the high mountain valley of Slough Creek where hay was fed and the elk congregated as a result. The heavy hunting pressure along the Park line and subsequent removal of migration herd leaders has also been blamed for disrupting the usual flow of elk into the lower plains and foothills in the fall.

1926-1927

The elk did not suddenly and mysteriously disappear as Forest Supervisor Shaw had supposed they would during the winter of 1919-1920, or in subsequent winters, in spite of the fact that massive losses to hunting and starvation were reported. In fact, in the USFS winter report of 1926-1927 concern was expressed for the northern herd becoming too large. An estimated 700 head, or about 5% of the total population, were killed by hunters. A kill of from 5 to 10% of the herd yearly was considered necessary to keep the herd from increasing to such numbers that the winter range wouldn't support them.

Forage conditions were summarized by Assistant Forest Supervisor Rush (1927) as follows:

> "Forage conditions are critical on the elk range outside the Park. It has puzzled me all winter as to how the elk could exist on apparently nothing to eat . . . The winter range shows that sage, salt sage, willows to thickness of 3/8", aspen, douglas fir, choke cherry to a thickness of 1/4", rose brush and alder were consumed. Practically no grass was left on the range in the fall. Inside the Park conditions are somewhat better but the range from the north boundary up the Yellowstone River to Slough Creek is badly overgrazed in areas of considerable size."

Rush recognized the dearth of reliable information available, the very emotional nature of the issue, and the consequences both were having on the conclusions that were being reached. The quality of the information collected over the history of the controversy has certainly improved, although much of it has been questioned and rejected, but the controversy has retained its highly emotional flavor.

> "A great deal has been said and written about the Yellowstone elk herd. Much of it has had real study and close observation as a basis, but a large part of it probably has been more or less theoretical, sentimental, or prejudicial. The writer of this plan hesitates to add anymore to the mass (or mess) of material already on hand ..." (Rush, 1927).

It was instances such as the following which polarized people as to how the northern winter range should be managed and helped make the issue a political one.

> "An unusual sight was witnessed by Supervisor Abbot and myself on December 18. Forty-two head of elk were cornered against the Park fence west of Gardiner and slaughtered in a fusillade which lasted more than an hour. The average number of shots fired per elk killed was about 30, the average distance of the shots was probably less than 150 yards. Out of the first 60 to 80 shots fired only two elk dropped, one with three legs shot off and the other from excessive gut shots. At one time Abbot and I observed seven elk, each with one leg shot off" (Rush, 1927b).

1928

Managing the northern winter range became increasingly more complicated. As specific management dilemmas emerged and took shape, concerned managers and biologists with the government agencies began to monitor and observe the condition of the resource and articulate their findings. A particular interest was expressed at this time in determining the underlying cause for all of the problems on the northern winter range, such as the increasing amount of range land that appeared to be overgrazed.

A report by Skinner (1928), a Park naturalist, appeared in the Journal of Mammalogy entitled, "The Elk Situation." He continued to

elaborate on his theory that disrupting the migratory routes of the northern elk herd was the perpetrator setting into motion a chain reaction of disruptions in the natural balance of the northern winter range. He felt he was able to detect gradual but steady changes in the migratory habits of the northern herd over the years by personal observation. According to his observations, elk, motivated to seek lower ground by the deep snows in the higher country, were unable to complete their fall migrations. He blames the overstocking of the lower ranges by domestic livestock and the barriers such as fences and other man-made appurtenances that interrupted migratory routes for making the lower ranges inaccessible. With the natural migration movements thus disrupted, elk were forced to adapt to the unnatural situation of wintering in less than ideal conditions. Present Park biologists (Houston, 1974) have almost totally rejected this theory. In their opinion they have not found sufficient evidence to conclude that the densities of elk wintering in the Park have changed appreciably or that large numbers of elk used to move far north of the Park in the winter. Skinner quotes what he considered to be a dramatic decrease in the size of the Yellowstone elk herd with this man-caused disruption of things. He mentions a decrease in herd size from 75,000 in 1900 to 25,000 in 1925; figures representing the entire Yellowstone region not just the northern herd per se. To ameliorate this

situation he recommended providing supplemental feed to the elk during severe winter weather on the basis of this rationale:

> "Because these elk are held up there in an unnatural winter habitat they should be given the best of care and protection."

In a cursory examination of elk feeding habits, Skinner noticed a predilection of elk for aspen, cottonwood, and coniferous browse during the winter months. In the case of aspen, he questioned his previous convictions that heavy use of this species indicated a starvation situation for elk. Instead, he pondered the possibility that it was a preferred browse species that would receive significant use as long as it is available.

Additional noteworthy comments in this paper were directed towards the buffalo reintroduction program which he describes as "a new menace to the elk herds" that would reduce the amount of winter range available to the elk. The competition for forage with domestic livestock on the winter range was also viewed as a deleterious addition to the scene at a level of severity on the magnitude of "disastrous".

References towards herd reductions through human efforts often reflect a particular mind set or bias that occasionally permeates this controversy of how best to manage the northern winter range. Skinner considered losses to reduction efforts to be far too high. He sites the winter of 1919-1920 as an example in which he claims "at least

15,000 elk fell victims to rifle and starvation." The following narrative is particularly exemplary.

> "Over two thousand elk were secured, and another thousand were wounded and eventually died. Now, you may ask, why should not these hunters have these elk? When a man takes his rifle, hires guides and horses, and goes off into the mountains to hunt elk, he enjoys the change of scene, enjoys matching his skill and endurance against that of his quarry, and later comes home full of renewed life and energy. But if this is the picture you have of these five thousand Yellowstone hunters, dismiss it from your minds. The picture really is a scene in the cold gray morning light when a band of elk, half-starved because the snow covers the forage in the Park, starts up the mountain slopes across the Park boundaries. Nothing happens until the animals have gone a mile beyond the boundary and too far readily to get back again. Then the slaughterers and butcherers that have been waiting, rush out, surround the hopeless elk, and begin shooting with Winchesters and pump-guns into the bewildered, huddled band. At times an elk, perhaps wounded, dashes out and through the encircling line. But that encircling line closes in and mercilessly fires into the remaining elk until all have fallen. Sometimes the hunters even continue shooting into the fallen bodies "for fear one will get away." Then all these mighty "sportsmen" rush forward and each claims an elk, saying, "This is the one I shot." Naturally, each one refrains from claiming more than his license allows him. But often, there are more elk killed than there are licenses. In this case, the superfluous elk have merely been "unfortunate," and are allowed to lie where they have fallen! Such has been the scene of slaughter enacted over and over again this last winter, until more than three thousand elk have been killed."

1929

The disappearance of any well established species from an environment is indicative of substantial changes occurring. Skinner (1929) reported on the decline and disappearance of white-tailed deer in Yellowstone Park. He mentioned the very close tie between

white-tail and their habitat. They were only found in the dense brush and thickets along rivers and streams. Because of these specific habitat requirements and the limited extent of these areas, principally in the lowest areas of the northern winter range, they were not very numerous. He gives a population size of 100 prior to 1914. He claims that 1914 marked the beginning of a steady decline of white-tail that ended in their complete disappearance from Yellowstone in 1924.

> "It is unknown just what caused the extermination of the white-tailed deer, but no doubt accidents, cougars, coyotes and emigration all had their part. But since all these destructive forces had operated for years, it was more probable that man was responsible for finally turning the scale against them. That the white-tailed deer should be the first to disappear in the Yellowstone scene seems strange indeed for elsewhere they have been very resourceful and able to maintain themselves long after all other large animals have been locally exterminated. Over most of their range, the white-tailed deer withstood the improvements and changes wrought by man, and were often able to live in a comparatively small patch of wilderness ... It is my opinion that the previous tendency of the white-tails to leave the Park and wander north along the Yellowstone valley became stronger because of the presence of the wolves. Since all the land along the Yellowstone River north of the Park was cleared, and covered by farms and ranches, the white-tails had no thickets there in which to hide. Furthermore, the hunting of deer was allowed there at times."

It isn't possible to know unquestionably what caused the disappearance of white-tailed deer from the northern winter range. They haven't returned, although they are still found not too many miles down the Yellowstone River in the farming and ranching communities. It could be that they were responding to subtle changes in their habitat that became more pronounced in following years. The decline,

and even eradication, of aspen, willow and other shruby species that provide a critical component of white-tailed deer habitat on the northern winter range has been a subject of continuing concern. Their health and status has often been used to prove or disaprove that the condition of the northern winter range is declining. If the decline of the deciduous species from the area is used to point out the existence of some sort of imbalance on the northern winter range then the disappearance of the white-tails could be used to give credibility to this view.

1931

Investigations by Talbot (1931) of the U.S.D.A. Bureau of Plant Industry revealed that at least twenty-two nonforage weeds were growing in the Park, only six of which were native to Yellowstone. Several of these species, including cheatgrass (Bromus tectorum), were considered to be well established and growing vigorously on portions of the lower range. It was surmised that weedy species were introduced in the Gardiner area with the seed for forage and grain species planted at the game ranch, and introduced in other areas of the Park with hay and oats for feed. Toad flax (Linaria dalmatica) escaped from flower gardens where it was used as an ornamental species. Some insight into his opinion of the condition of the northern winter range are provided by the following:

> "On certain areas near Gardiner, Montana, overgrazing was clearly indicated by such signs as active erosion, a decrease

> in the stand of the best forage plants, and an increase in abundance of inferior forage plants and of range weeds. Downy chess, a very inferior, almost worthless grass, has overrun large acreages on the lower foothills. Definite information is lacking, relating to the possible further spread of this range weed onto higher slopes, and to the extent to which it may be controlled by methods applicable to rough lands. At the other extreme, at higher elevations near the lower margin of summer range, large areas appeared to be in good condition."

1932

Rush (1932) compiled the most extensive summary of investigations relevant to the condition of the northern winter range to that date. He begins his discussion with a review of the information supporting the idea that the migratory routes of the northern herd had been disrupted. He included an outline of work done by Skinner (1927) that appeared in the Roosevelt Wildlife Bulletin summarizing wildlife sightings gathered from the journals and reports of many of the early explorers of the Yellowstone region. Both Skinner and Rush were looking for additional evidence for their theories. They wanted to demonstrate through the use of these early journals that, although the western plains were well populated with big game animals in the pre-settlement days of the American west, the mountainous areas, such as (and especially) the area known as the Yellowstone region, were not. However, according to Skinner, this situation changed in the 1870's when remnants of the once great herds were forced by the pressure of hunting and settlements to take refuge in the mountainous areas such as Yellowstone. Due to the severity of the winters in such regions

they were unable to remain in the seclusion of the mountains and were forced to migrate annually to nearby low plains and valleys. This pattern, in his opinion, existed for a time, only to be disrupted by the continuing encroachment of civilization resulting in heavy winter losses from the elk herds.

Although Skinner and Rush made a good case for their theory by using exerpts from the old journals and diaries, present Park biologists give no credibility to these theories. They maintain that the specific excerpts used were chosen to prove a point and not to accurately present the total picture. The present opinion is that just as much evidence can be gathered to support the antithesis of the viewpoint held by Skinner and Rush (Houston, 1975).

Rush also included some direct observations of the condition of the northern winter range. During a trip on horseback through the area in 1914, he concluded that the upper part of the range from Blacktail Creek to the Lamar Valley and Slough Creek showed no signs of heavy use except for an area used by a domestic horse herd and an area where buffalo had concentrated the preceding spring. He described the winter range outside the Park boundary as being heavily overgrazed.

His opinion of the condition of the range changed considerably after another close look at the range in 1926. He was very pessimistic that the portion of the northern winter range outside of the Park

would ever recover without extensive artificial reseeding. This state of affairs was considered to have been brought into existence through overgrazing by livestock and by a new influx of elk migrating out of the Park onto the limited areas available to grazing. In his opinion, comparing his observations of 1914 with those of 1926, the ranges from Gardiner to Mammoth and those around Blacktail were badly overgrazed and topsoil erosion was occurring extensively from Gardiner to Lamar.

His conclusion concerning the condition of the winter range may be summarized by the following:

> "Practically all of this winter range is badly overgrazed to the extent that sheet erosion has occurred the past few years and much of the rich top soil washed away. The original stand of grass is badly disturbed and weakened and the reduction of root competition by the grasses for moisture has allowed such undesirables as Yellowbush (Chrysothamnus sp.) to become prevalent."

He goes on to quantify this damage by adding that the winter range had deteriorated a full 50% in his estimation from 1914 to 1929. More than half of the sheet erosion that occurred took an estimated one to two inches from the soil surface. He predicted the eventual loss of all browse species if the rate of use at that time continued, and the continual invasion of the range by already well-established undesirable plant species such as cheatgrass.

To remedy the situation, he recommended that all commercially used horses be kept from the winter range. The only practical way of

bringing the range back to a high forage producing capacity was seen to be by artificially reseeding areas of the range in a deteriorated condition outside the Park that had the potential of being managed in a basically agricultural approach. This would include using such practices as sagebrush control and irrigating all irrigable lands with existing ditches. The object being to induce the elk herd to stay longer on these intensively managed areas and perhaps, as a result, cause more elk to stay on suitable summer ranges outside the Park. Rush also recommended using extensive salting as a method of obtaining better distribution. Subsequent researchers have reported on the sporadic effectiveness of using salting for this purpose with elk (Picton and Picton, 1975). Rush did not recommend artificial feeding of the ungulate herds as Skinner did for a variety of substantial reasons.

Predators were regarded as having the potential of exterminating portions of the ungulate herds, specifically deer in localized incidences. Both rodent (range destroying) and predator control programs were deemed justifiable.

Rush's most underscored management recommendation deals with regulation of the elk herd through hunting pressure.

> "It is thought that an annual kill of 500 elk can safely be made in this herd with beneficial results, if the proper proportion of age classes and sexes is taken and it is the opinion of all the men who have considered the matter carefully that well regulated hunting outside the Park is the logical way to control the size of the herd."

With this he emphasized careful collaboration and good communication between the three agencies; the USFS, the NPS and the Montana Fish and Game Commission.

Using Rush's (1932) investigations as a starting point, Park Service personnel initiated an extensive long-term study designed to monitor the condition of the northern winter range. Park Ranger Grimm was responsible for much of the work on the annual summaries of the study for the years of 1933-1947 and Park Biologist Kittams for the years of 1948-1958. A variety of methods were used to determine range utilization, range plant densities and composition, successional trends and available forage. Some of the study plots established focused on browse species. Among the methods used for collecting data were square foot density transects, photo transects, Parker 3-step transects, chart quadrats, line intercept transacts, belt transects and square yard quadrats. Much of the data gathering was done in conjunction with exclosures or agronomy cages, while some was done on the open range. The methods used changed whenever one was thought to be more appropriate than another. Houston (1976) and Barmore (1975) summarized the data collected during these investigations.

Much of the information gathered from these studies and the conclusions reached from the information collected are presently questioned for their accuracy and applicability. Some of the transects and exclosures are criticized for their location. Trying to use the

transects and exclosures to determine specific successional trends for the entire winter range has also been criticized. It has been suggested that not enough attention or weight was given to variables other than grazing pressure that affect the range resource. Many of the data from these studies have been re-interpreted and many of the conclusions discredited.

However, for nearly three decades management decisions affecting the northern winter range were based on conclusions reached through these studies. Highlights of the annual reports for 1933-1947 will be included here to gain insights as to why some of the management practices such as the elk reduction program were deemed justifiable. The annual reports also serve to present changes observed on a yearly basis on the condition of the northern winter range. From examining a series of annual reports patterns began to emerge.

1933

NPS Annual Report:

The winter range was in part severly overgrazed. The basic problem was confirmed to be an artificial concentration of elk on the winter range due to disrupted migratory routes. An appreciation for the complexity of the problem was expressed by recognizing additional variables affecting the range such as the role of varying weather conditions. An increase in the size of the elk herd was discernible but the accuracy of the count was questioned. The elk were giving other

ungulates on the range considerable competition for forage. The reduced role of predators was noticed.

Estimates for the carrying capacity of the northern winter range were made by the Park Service and the Forest Service. It was determined that a maximum of 230,893 acres were available at any given time during the winter. Based on this the Park Service put the carrying capacity at 6,565, while the Forest Service estimated 5,341 for the six month winter period exclusive of animals other than elk. Recommendations were made for reducing the herd a full 50% to bring the herd more in line with the carrying capacity and allow the range to recover.

In an attempt to determine how many elk the northern winter range could actually support, Park managers calculated the "carrying capacity" of the range as they defined it. Through the history of the controversy the number arrived at went through several revisions, usually downward. Edwards and Fowle (1955) reviewed the general usage of the concept of carrying capacity in wildlife management and found it to often be so vague as to be meaningless. Park managers tried to make their calculations relevant to the actual situation found on the northern winter range by estimating the carrying capacity on the basis of the least favorable conditions in a year realizing that oscillations in climate and productivity would nevertheless cause the system to be alternately over or under utilized (Figures 1 and 2). Edwards

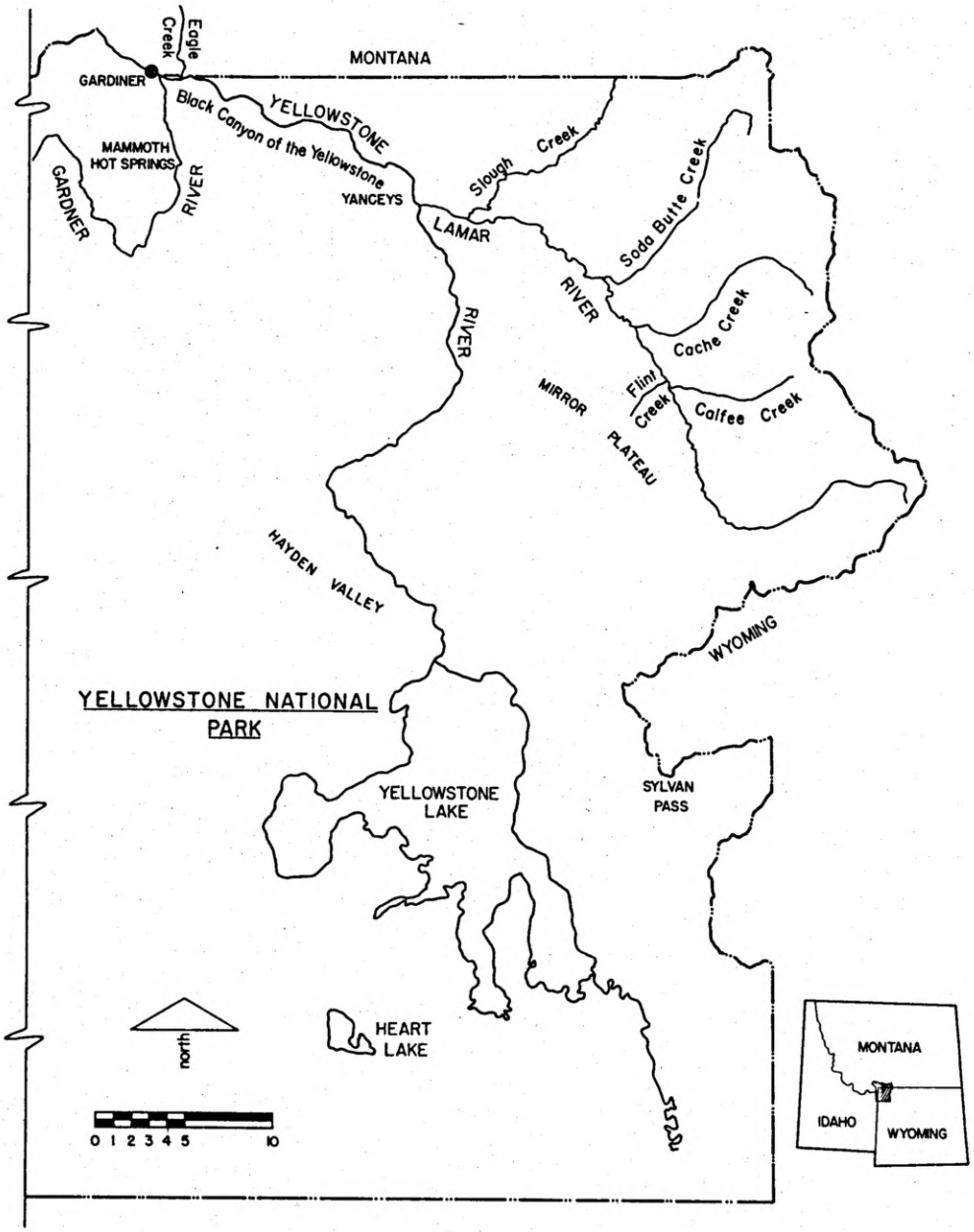


Figure 1. Map of area (Greer et al, 1968).

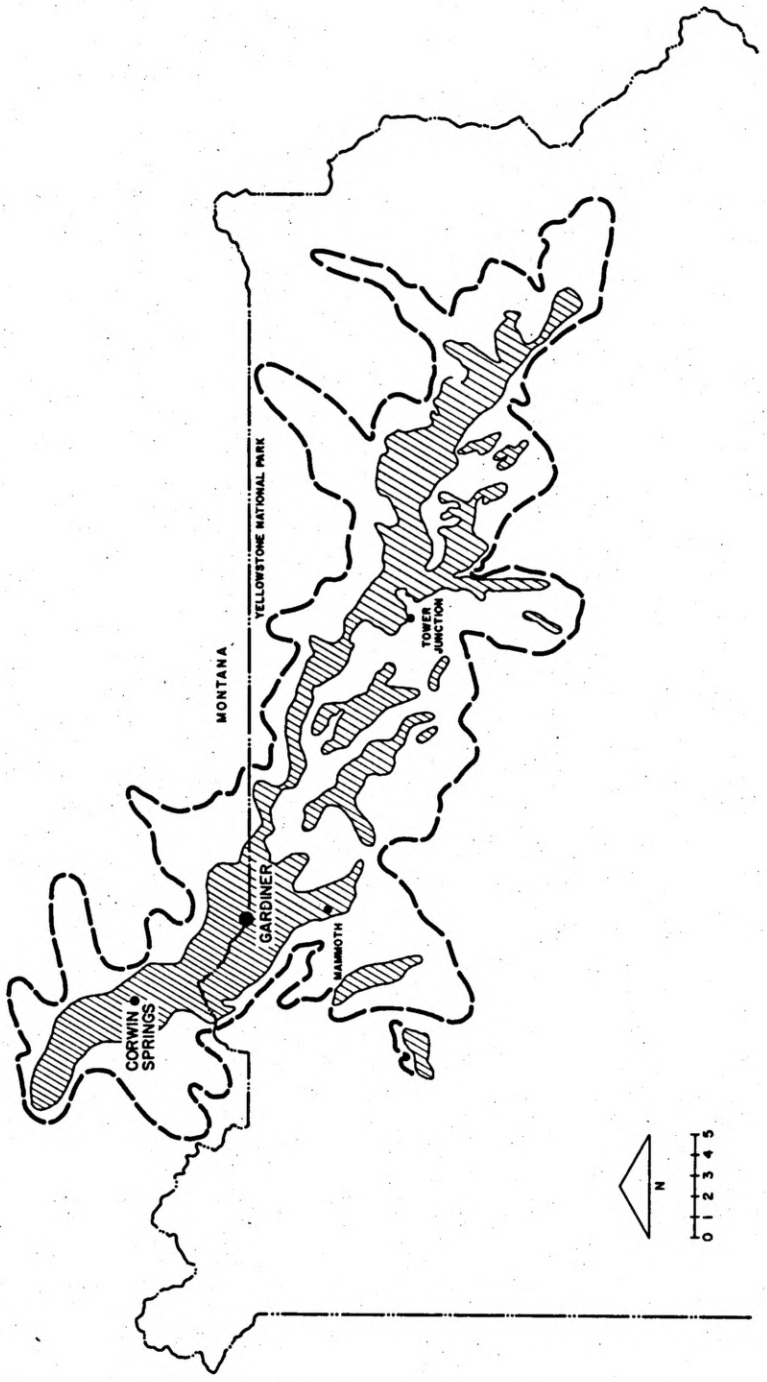


Figure 2. Approximate maximum and minimum wintering areas used by elk of the northern Yellowstone herd (Greer et al, 1968).

and Fowle suggest that calculating on the basis of the least favorable conditions is the minimum requirement for making carrying capacity calculations meaningful.

The accuracy of the carrying capacity estimates used on the northern winter range can be questioned for several reasons. Using a near-agricultural method for determining what is appropriate for wildlife in a wilderness setting is inherently a problem. Also, the technique implies that a constant level of utilization of the resource is appropriate; and this constant level of utilization limits the diversity of the ecosystem and may exclude important variables (Olmstead, 1977). At any rate, it has been speculated that Park managers put too much confidence in a number derived through methodology that may not have been all that precise or relevant.

Forest Service reports for 1933 mention a good distribution of elk across the portions of the range outside the Park. It was believed the use of 18 salt grounds accounted for this favorable situation. An estimated 50% (or 900#) of salt which had been distributed had been used. The report went on to say:

> "Owing to the fact that upward of 4,000 elk were on Forest Range from January 15 to March 10, when the migration to the Park began, the Forest Range was quite heavily used. On an average for the entire winter range under 6,500' it is estimated that the utilization was not less than 80% of available forage. Some sites were utterly denuded while others, covered with a greater depth of snow, are scarcely touched" (Coster, 1933).

1934

NPS Annual Report:

A lack of precipitation and elk herds in excess of the carrying capacity of the range adversely affected the condition of the northern winter range.

> "The direct result of this moisture deficiency was the reduced amount of forage grown. The game, principally elk, which are dependent upon this vegetation for subsistence, are forced to utilize the available forage to the very limit. This means that there is no vegetation left on the ground to decompose and form humus which is vital for the building up of the soil and retention of moisture. In consequence of this impoverished condition of the soil, the plant growth became stunted, producing none or very small seed crops. The resulting lack of reproduction opened up the original plant cover and permitted the intrusion of undersirable grasses and weeds. It also was the initial step in starting sheet and gully erosion, the former of which has become general over nearly all of the winter game range."

Willow, aspen and sagebrush continued to decline in numbers and vigor. An estimated 5% of the sagebrush in some intensively used areas was killed in one season. Concern for the plight of the aspen was expressed in this way:

> "It is known that moderate amounts of bark and twigs of aspen and other trees form a portion of elk's natural diet. However, when the consumption of this type of browse assumes proportions which exceed the reproduction of these trees, it is obvious that elk are forced to subsist on this type of forage by lack of other suitable forage, and it is indicated that the number of elk on that range exceeds its carrying capacity."

The carrying capacity was recalculated taking into account the critical three month midwinter period when the snows are deepest, and

the presence of other ungulates on the range. With this expanded view the carrying capacity was revised to 6,040. The portion of the winter range on the adjacent Forest Service land was considered capable of supporting an additional 970 bringing the total to 7,010 head. A discrepancy existed between this figure and the estimate of the actual size of the northern elk herd at 11,000.

1935

NPS Annual Report:

The range was described as being "in the most depleted condition of the writer's experience" primarily because of prevailing drought conditions.

> "In surveys made during the month of August, the major portion of the range was found to be in a prematurely weathered and burned up condition . . . Practically all of the grasses were stunted in growth and seedlings were practically non-existent."

As a remedial measure to protect the remaining forage, a sizeable reduction in the elk herd was called for.

> ". . . An acute forage shortage exists . . . given the most favorable climatic conditions, a large winter kill must occur this winter, unless the number of elk using the range undergoes a drastic reduction. The exact number of elk that a fluctuating range can support is difficult to determine; however, it is certain that no more than 7,000 head of elk can use the Northern Yellowstone Winter Game Range without further seriously depleting the plant life thereon, thus resulting in a still smaller carrying capacity. Therefore, the number of elk by which the Northern Yellowstone Elk herd, which now numbers approximately 12,000 head should be reduced must be at least 5,000 head."

1936-1937

NPS Annual Report:

Growing conditions were generally more favorable during the 1936-37 season. The snows came late in the winter and the snowpack stayed loose allowing for good distribution of the elk during much of the winter.

A decrease in plant density of 59% in the unprotected study plots and 42.6% in the protected study plots was estimated for the extended time period of 1930-1937. Of this 59% decrease, 72.2% was considered to have been caused by the drought conditions and 27.8% by excessive grazing.

Due to favorable climatic conditions during the 1937 growing season plant density in the protected plots increased 20.6% and 18.1% in the unprotected plots. Increases in weight in 1937 amounted to 85.4% over the preceeding year and 26.5% over that of 1935. The height of grasses in the plots was 53% greater than the year before.

Aspen stands in protected plots showed a loss of trees amounting to 3% as compared to a death rate of 32.4% in the unprotected plots. Protected stands were experiencing regeneration through healthy asexual reproduction. Unprotected plots showed a greater incidence of new trees although, because of the level of browsing pressure, they were unable to mature.

Using a study plot on the old Gardiner Road as an example, the protected plot had six new trees amounting to a 2.5% increase which was sufficient to compensate for the 0.4% death rate and perpetuate the stand. Growth in additional height of the new seedlings amounted to 15.1". The unprotected plot had ten new trees making an 11.6% increase which did not compensate for the 16% death rate. Growth of the new trees over the preceeding year amounted to a loss of 2.5".

A change in plant composition was noticed.

> "The better grasses, such as bluegrass (Poa) and Idaho bunch grass (Festuca idahoensis) have largely been replaced by western wheat grass (Agropyron smithii) an indicator of overgrazing where it becomes the dominant grass. To a smaller extent, especially in the Mammoth area, cheat grass and foxtail barely (Hordeum jubatum), both obnoxious grasses of little or no forage value, have taken over sizeable areas of the range, though the degree to which these two grasses have spread and increased is more noticeable on the range than within study plots. Other inferior forage plants that have noticeably increased are Pussytoes (Antennaria arida), Phlox (Phlox species) and Fleabane (Erigeron species). Rabbit brush (Chrysothamnus) and Fringed wormwood (Artemisia frigida) though fairly good forage plants, but indicators of overgrazing, are also intruding upon the range in increasing numbers."

All of the information collected seemed to indicate the necessity of reducing the size of the elk herd. Reducing the herd to 7,000 was recommended.

> "The practically complete utilization of all of the herbaceous cover on large areas of the winter range over a period of years has resulted in the destruction of a large portion of the better forage plants and opened the way for the intrusion of inferior plants and denudation. Unless this process is arrested it will result in the destruction of much

> winter range vitally needed during the critical February-March period of each winter and in a progressively smaller carrying capacity from year to year.
>
> "Though there was a marked improvement in the volume of forage produced on the winter range during the past growing season, which was brought about chiefly by favorable growing conditions rather than less intensive use of the abnormally large area of available winter range during the past winter, this increase in volume of forage will still fall far short of furnishing adequate forage and preventing over-utilization of the winter range by the approximately 10,000 head of elk counted on that area the past winter, much less the 1937 reproduction of these elk, which is not included in the count mentioned."

1937-1938

NPS Annual Report:

Temperature and precipitation were favorable for plant growth. The condition of the snowpack caused poor distribution of elk across the range.

Plant density increased by 36.7% and the weight of the plants clipped by 42.7%. Much of the increased growth was attributed to an increase in annuals and fast growing species of low forage value such as pussytoes and wild buckwheat (Eriogonum sp.).

Because of the deep and crusted snowpack, many elk were forced to the lower portions of the range, areas critical to the Park's deer, bighorn sheep, and antelope. Of the elk counted, 34.7% were on 14.9% of the available range. Utilization of the forage there was intense. On some portions of the lower range, sagebrush received 28.5% to 81.3% utilization and 65% of the sage were dead in some areas. Aspen was

severly browsed. Much of the range received a rest due to inaccessibility.

Ranger Olsen (1938) commented in a Forest Service report on what he interpreted to be a dramatic change in that agency's attitude towards managing their portion of the northern winter range.

> "During the past seven or eight years plans and ideas have changed radically with regard to the management of this elk herd. Ten years ago little thought was given to any heavy reduction in the herd through hunting, or at least they do not appear in the records. The solution was generally believed to be in the acquisition of a large amount of land to be reserved exclusively for winter elk range. Obviously, this in itself would not solve the problem. The plan was to include all land down to Yankee Jim Canyon and would include all of the Mol Heron Creek drainage, Cinnabar Basin and Green Lake Unit, Slip and Slide Creek and Cedar Creek. Although the herd is still several thousand head over the estimated carrying capacity of the range, it is becoming apparent that a considerable portion of these areas will receive but very little use even in severe winters. During the past winters the usable range was restricted to an area as small as may be expected in our most severe winters. Still only a handful of elk found their way as far down as Cedar Creek. Slip and Slide, Dome Mountain, and Cinnabar Basin was almost untouched."

As has been mentioned, it was speculated early on in the history of the controversy that because traditional migration routes out of the Park and down the Yellowstone River were disrupted elk were artificially concentrated on the winter range in the Park. In the context of long distance migrations present Park biologists do not consider this to be either accurate or significant. However, the earliest

Forest Service records refer to portions of the northern elk herd migrating as far down the Yellowstone drainage as Six-Mile Creek. Mention is also made of elk wintering in Slip and Slide basin and the basins north of there - Stands and Daily basins. These herds were considered large enough to warrant having at least one Forest Ranger stationed in the basins through the winter to protect the elk from poaching. According to the 1938 report just examined, by that time such occurrences were no longer commonplace. In looking at the Forest Service records prior to 1938 references to elk being found in the area mentioned became fewer and fewer until efforts were no longer even made to include the area in the annual counts of the northern elk herd. The information provided seems to indicate that important differences on a smaller scale do exist in the migratory capability of the northern herd. Because of a lack of records it would be difficult to verify those massive long distance migrations that early biologists thought occurred, but it does seem that important changes of a much smaller scale have taken place.

1939

NPS Annual Report:

Weather conditions varied considerably over the winter range; while being slightly below the 1938 average precipitation was still considerably above the 1937 average. Transects on the lower range showed an average increase in plant density of 12.7%. Portions of the

upper range showed decreases of 15% to 44%. Forage volume was 17% below the 1938 average but 18.5% above the 1937 average.

Annuals and weeds decreased slightly. Some of the good forage grasses such as the bluegrasses (Poa spp), Idaho fescue (Festuca idahoensis) and needlegrass (Stipa columbiana) showed an increase.

No significant successional change was interpreted from the study.

> "The indicated volume of forage this year is about average between that produced in 1937 and 1938. Range conditions have not improved materially and the carrying capacity of the range remains about the same as estimated during the past two years. There are considerably more elk, and other game animals, to use the available winter range this winter than the range is capable of supporting without serious injury. It is therefore, imperative, that the number of elk in the northern Yellowstone elk herd be reduced again this year."

1940

NPS Annual Report:

The range was showing improvements significant enough to materially increase the carrying capacity. However, even the expanded estimate was exceeded by the existing herd size. A reduction of 3,000 head of elk was called for.

The general tone of the report was optimistic. Reasons for optimism were attributed to favorable weather conditions resulting in good forage production and good distribution of the herds during the winter months.

Precipitation at Mammoth from March to July was 21% above the normal. The average mean temperature for the same area from March to August was 8% above normal.

After a long period of steady decline in the 1930's, plant density in the study quadrats increased. A trend in composition from grasses and palatable plant species to weeds continued. The total weight of clippings from volume plots were the highest measured. Survival and growth of aspen in protected browse study plots were considerably better than in unprotected plots. Utilization measurements on the sagebrush of the lower portion of the range averaged 70.5%.

A memorandum by Assistant Regional Forester Sandvig (1940) summarized the management policies of the USFS governing the role of domestic grazing within the boundaries of the designated game range. It underscored the growing potential for conflict between livestock owners and the Forest Service over forage allocations. He mentioned the desire of the government to set aside even more land for game range, but questioned the need to do so.

> "The range now open to grazing by domestic livestock will not be reduced in area and closed to grazing unless such action is necessary for the protection of the forage and soil, or increased use by game and recreation seekers requires more forage and more area. These latter uses will be regarded as dominant, but before additional restrictions are placed upon livestock grazing a real need to dedicate a greater portion of the area to these other purposes must be evident."

Murie (1940) made some statements relevant to this discussion while investigating the ecology of the coyote in Yellowstone. He questioned some of the major premises of the papers by Skinner (1927) and Rush (1932). As mentioned, they based many of their interpretations of the condition of the northern winter range on the assumption that the elk herds were artificially concentrated in the Park after being permanently forced into the mountains from their usual home in the plains. These conclusions reputedly were based on a careful perusal of early historic records. Murie used many of these same records to demonstrate that, although game was far more abundant on the plains, there were herds indigenous to such mountainous areas as Yellowstone. Contrary to earlier opinion, Murie maintained that many elk wintered in the Yellowstone area. However, he also concluded that, historically, more elk migrated out of the Park onto lower winter ranges, especially in response to severe winters, than were able to under current conditions. This would have allowed for a better balance between the number of ungulates and the ability of the range to support them. As an interesting aside, he also speculated that, just as the lower valleys out of the Park must have served as a critical wintering area during severe winters, the open areas in the Park might have served a similar function when the lower ranges were heavily grazed by buffalo herds.

An aspect of importance in this discussion is to what degree an artificial ecological situation has been created in Yellowstone Park. Murie cites the near eradication of predators from the Yellowstone ecosystem as a glaring departure from the norm. He made this comment about the relationship between the elk herds and the condition of the range:

> "The elk population in Yellowstone Park is unquestionably too large, resulting in a severely overbrowsed winter range. The depleted range is harmful to the deer, antelope, and bighorn over whose ranges elk wander and with whom they compete directly for food. The elk herd could safely suffer a loss of two-thirds of the present number, with benefit to the other ungulates, the ranges in general, and to the elk themselves. In an effort to improve the situation a program of elk reduction was inaugurated by the National Park Service in the winter of 1934-35."

1941

NPS Annual Report:

Even though the forage volume measurements were more than double the average of the years 1934-1938, an increase in the estimated carrying capacity was not recommended because of the density measurements. Density measurements were nearly the same as those of 1933 when the original carrying capacity estimates were made. The importance of the volume measurements was discounted because of their high degree of variability in response to changes in precipitation.

Total snowfall was 43.5% below normal during the 1940-41 winter at Mammoth. Total precipitation during the growing season was 31.8%

above normal. The average temperature for the months of March to August was 4% above the average mean.

The average plant density was 21% over the 1940 measurements. Forage volume was up 19%. Aspen browse plots indicated further deterioration of the aspen stands. A slow but continual eradication of this species from the range was predicted. Sagebrush utilization studies showed an average utilizaton of 71.5%. However, a sense of encouragement was expressed because in many locations an abundance of new sagebrush seedlings was found.

By this time, the probability of any report or article dealing with the condition of the northern winter range mentioning the decline of the aspen on the range was very predictable. The predicament of this species had become a central theme to the controversy. Although there were occasional references to the fact that other variables might have been involved, the blame for the decline of the aspen was placed squarely on excessive browsing by elk--an indication of too many elk on the range. It has been only in the last decade or even half dozen years that this opinion changed, as will be pointed out later in the discussion. Present Park biologists feel the decline of the aspen is more the result of the impact of the drought combined with the effect of browsing (Houston, 1976), and the effect of fire suppression efforts as it altered the asexual reproduction of the aspen stands (Houston, 1973).

The decline of big sagebrush, also used to establish the theory of an overstocked range, is now seen as the natural response of a species to a variety of man-initiated variables and drought. These variables include the introduction (and removal) of domestic livestock, fire suppression and artificial concentrations of elk through feeding and hunting pressure along the boundary.

1943

NPS Annual Report:

Because of the war effort, there is a break in the studies for 1942. Limited investigations commenced again in 1943.

Snowfall during the 1942-43 winter was 64% above normal at Mammoth. Snow depths were the greatest since the range studies were initiated. Temperatures were cool in the growing season. Because of the weather conditions, elk migration and foraging habits were severely affected. The importance of prevailing weather conditions on the condition of the winter range was expressed.

> "It has long been established and realized that weather conditions, as primarily expressed in the form of precipitation and temperatures, are the most important factors that affect the status of the range plant cover. These climatic conditions not only affect the growth of range plants, but also influences the degree of utilization of the range forage plants as the amounts of snow and its density determine the amounts of forage available to grazing animals on the winter range."

Forage volume measurements were 15% less than those of the preceeding year because of less than optimum growing conditions. Average

plant densities decreased by 5% for the same reason. However, on some portions of the lower range, plant densities increased by 14%. This was attributed to an increase in grasses, principally cheatgrass, and a decrease in weeds and shrubs. A decline in the amount of Russian Thistle (Salsola kali) was the main cause for a decrease in the weedy species. An increase in cheatgrass did not seem to be at the expense of native species.

Factors affecting the vegetation other than weather and grazing were recognized.

> "When one views the vegetative cover of the northern Yellowstone winter range it is found that, aside from certain trees and shrubs, the soil in its present condition is producing nearly the maximum amount of plant growth that prevailing climatic conditions will permit it to support.
>
> "In accepting this statement, consideration must be given to the fact that a certain amount of soil erosion has occurred on the critical winter range area in the past and largely during the drought years. On range areas thus affected, plant densities must necessarily be sparse because of the limitations of the remaining top soil to retain moisture and provide essentials for plant growth and it is evident that the process of soil rehabilitation here will be slow."

Browse species, including douglas fir, willow, and aspen, showed noticeable recovery where protected by deep snows. On all other sites, utilization was excessive and further deterioration occurred.

> "The status of aspen and certain other browse species on the winter range is unsatisfactory and it is questionable whether the now much smaller number of elk (because of reductions) using the winter range will permit the rehabilitation of these trees. It must rather be anticipated that as long as elk herds, though they may be much smaller in size than

> at present, utilize the winter range, aspen, willows, and other trees whose foliage and bark are palatable to elk, will flourish on this range only where natural and climatic features afford them protection from these browsing game animals and elsewhere their situation will remain precarious."

The summary included comments regarding study methods previously used; their accuracy and applicability were questioned. Some were deemed "not entirely satisfactory." With the types of inventory and analysis techniques being used, it was suggested that it might be unrealistic to label the measurements as being representative of the range condition considering the size of the winter range and the variability of the vegetation types. For this reason, and also the shortage of manpower, examination of the range relying more on ocular estimates and covering larger areas was recommended to augment or replace previous methods.

The accuracy of aspen study plot data was considered. The physical structure of the exclosures served as a windbreak creating snowdrifts that afforded young trees outside the exclosure unnatural protection from browsing animals. The same process accumulated moisture in and around the exclosures affecting the data. Absolute protection provided by the exclosures also eliminated the removal of some of the younger trees that would naturally die even under light stocking rates. The absence of this natural thinning process would produce artificially dense stands. As an additional variable, animals would be drawn to the exclosures because of the prolific forage there.

Being unable to graze in the protected site they would nevertheless graze and trample the immediate vicinity. With all this in mind, the data from the aspen browse plots were regarded in a slightly different light; i.e., exaggerated and artificial but still representative of general trends.

The importance of the portion of the winter range on the Absaroka (now Gallatin) National Forest was clearly demonstrated during the winter of 1942-43 when severe weather forced large portions of the elk herd out of the Park.

> "It is evident that the availability to elk of this range outside of the Park relieves the range within the Park of a heavy forage utilization load, especially during severe winters when available range within the Park becomes sharply restricted. Therefore, this range on the Absaroka National Forest is of vital importance to the maintenance of the northern Yellowstone elk herd, and as such must be given major consideration in the formulation of management plans for this herd."

Intensive herd reduction efforts were carried out during this winter. The estimated carrying capacity of 7,334 was probably attained. The report expressed anticipation at the possibility of the reduction being measurably observed on the resource. It cautioned that it might take several years for changes to become evident, and climatic conditions could either dampen or accentuate the results.

An NPS report written in 1943 on the elk reduction program on the northern winter range summarized the program for the previous nine years and expressed the current management opinion of the program.

The actual numerical results of the reduction program were given as follows:

Number of elk taken by hunters	20,531
Number of elk shipped alive	1,730
Number of elk slaughtered by NPS	1,308
Natural and miscellaneous deaths	2,127
Total nine year period	25,696
Average annual reduction	2,855

It was considered essential that the herd be artificially reduced annually to the estimated carrying capacity. Since hunters' kills accounted for 90% of the total reduction accomplished, it was hoped that it would not again be necessary for Park rangers to be involved in slaughtering operations.

Based on past counts, the herd size for the elk in the fall of 1942 was an estimated 15,500 before reduction efforts. In addition, there were 900 pronghorns, 300 bighorns, 1,200 mule deer, and 650 bison. It was speculated that in reducing the herd to 6,000, or more than 1,000 below the previously determined carrying capacity, the rate of improvement of the range could be accelerated. It was thought that such a reduction would also provide some margin to allow for a natural increase should hunting and live shipments not take all the surplus each year. Even though the herd was still above 6,000, the report for this year was optimistic.

> "The northern Yellowstone elk herd now numbers about 7,363 animals, which closely approaches the number of elk which the winter range is capable of supporting. An acute problem

> no longer exists and the management plan for the future to be formulated by the Montana Fish and Game Department, Forest Service, and the National Park Service will take into consideration new findings regarding forage requirements of elk; recently available facts pertaining to the carrying capacity of the winter range on the Absaroka National Forest and findings of those who will continue ecological studies of the winter range. The outlook for the future of the northern Yellowstone elk herd is most encouraging to those responsible for adjustments and revisions of the management plan. There is every reason to believe that with favorable growing conditions the range will continue to improve, the herd can be stabilized to insure such recovery, and such drastic and unpleasant action as was taken during the past winter will not be necessary in the future."

McDougall (1943), Assistant Park Naturalist, provided a supplement to the 1943 NPS report containing some hitherto unexpressed opinions of the monitoring being done on the winter range. McDougall suggested that some of the areas where sagebrush seemed to be declining might be from competition with native grass species and therefore represent natural successional processes instead of range deterioration. In the areas where the sagebrush is obviously being destroyed by overbrowsing, he doubted anything could be done to reverse the process. He pointed out sagebrush may have gotten established anyway on such sites by disturbances such as fire, drought, overgrazing, or soil disturbance.

He labeled the occurrence of aspen on the range as "incidental" it having been established through fire or other disturbances. His reasoning was that aspen, and most of the other browse species, were characteristic of the forest types and not the prairies. The browse

species exist on the northern winter range, predominately a prairie type, because much of the range is an ecotone or transition zone between the prairie and forest types. In his estimation, the only way to bring about any large scale recovery of the browse species would be to reduce the number of browsing animals to "a very low minimum." He expressed confidence if this was done for a series of years there would be a rapid recovery of aspen from root suckers.

In his opinion, it is impossible to determine the carrying capacity of the winter range because of a plethora of variables. In his words;

> "The climatic conditions vary greatly from year to year and with these varying climatic conditions not only the amount of forage produced but the total acreage of range utilized varies greatly. Indeed, climate seems to be a much more important factor in the fortunes of the range than numbers of elk, except that the numbers of elk is a controllable factor and the climate is not. Seemingly the most we can say is that when the range is found to be deteriorated there are too many animals and when it is not deteriorating there are not too many animals."

He was also skeptical of any real accuracy of explicitly stating whether the range is in a condition of declining or improving or neither; especially if the statement is based on a single year's observations. He would place credibility on such statements only if they were based on long periods of accurately recorded data. In his estimation, all he could conclude in this matter from his cursory examination of the range is the following:

> "It is evident that some deterioration has taken place at some time in the past . . . It is also evident that practically no where has deterioration gone so far as to prohibit reasonably rapid recovery under favorable conditions."

Portions of McDougall's report sound more like the reports written in the 1970's about the condition of the northern winter range than the reports of his contemporaries. His thinking may be described as "progressive." However, the introduction of these ideas into the controversy did not appear to influence management policies. Adoption of at least the essence of his reasoning did not come for another 25 to 30 years.

Cahalane (1943), of the NPS, provided a paper for the North American Wildlife Conference entitled "Elk Management and Herd Regulation - Yellowstone National Park." He reiterated the ills of the northern winter range as presented in earlier reports. He also reaffirmed the notion that the only way to bring about an improvement in the condition of the winter range would be to drastically reduce the size of the elk herd. In spite of public opposition to such actions, he felt reduction programs were completely justifiable.

> "Management of important game resources in the United States has been handicapped all too frequently by sentiment. Sometimes misinformed, sometimes completely uninformed, popular feeling has often overruled or postponed action based on scientific investigations. Opposition to reduction of the northern Yellowstone elk herd has been such an example . . . This unprecedented reduction of elk within a national park could not be considered a violation of national park protection policies. The condition was clearly a direct result of man's land use practices outside the Park boundaries. The

> adverse effects were evident not only on the elk, but on all other members of the fauna dependent on the area involved. Rarer species were starving and threatened with extirpation. Overuse of land by the too numerous elk was bringing about a definite alteration of the composition of the flora. Erosion was already widespread in certain areas. Continued overgrazing would result in such impairment that "normality" could not be restored for generations."

In fact, Cahalane suggested that the range had been so consistently overused for decades that any perception of what the area should look like had been lost. He advocated checking the present appearance of the range against early photos. As an interesting example of how badly man had disrupted the natural scene, he stated that annual winter migrations had once carried the Yellowstone elk 150 to 200 miles from the Continental Divide in the Park.

1944

NPS Annual Report

The annual range report for the 1943-44 season was the most optimistic to date. It was suggested that:

> "The herbaceous range plant cover of most of the northern Yellowstone winter range, consisting of grasses and forbs, is approaching or has attained relative stability of plant composition, plant type and a density that is commensurate with soil composition, soil fertility and prevailing climatic conditions."

The report concluded with:

> "It is felt that very satisfactory progress has been made toward restoring and maintaining a natural plant cover on the northern Yellowstone winter range."

Consistently favorable weather conditions were credited with causing the favorable condition of the range. Below-normal snowfall allowed the ungulates to graze usually inaccessible portions of the range. Very little migration to the lower ranges outside the Park occurred for the same reason. The powdery consistency of the snowpack and the lack of crusted layers further facilitated the even utilization of the forage resource. The amount of precipitation at Mammoth in the March to August period was 26.2% in excess of the 35 year mean, compensating for the light snowfall. Temperatures during the growing season were essentially the same as the mean.

Range studies were limited again because of a lack of manpower. The studies that were conducted showed a marked increase in the volume of range forage produced; the increased height of grasses was "particularly outstanding and conspicuous." Range plant density increased. The wheat grasses (Agropyron spicatum and Agropyron smithii) showed important increases. The wheat grasses invaded buffalo wallows and other areas where soil disturbance had occurred.

The stands of cheat grass on the lower range did not seem to be expanding their influence. Scattered representatives of native grass species were appearing in these stands.

Aspen suckers, which enjoyed substantial protection from browsing the previous year because of deep snow, were exposed to browsing pressure during this winter. The elk browsed some stands destroying the

new growth and missed others allowing the suckers to increase in height. Even though the increased growth of aspen was noticeable, it did not warrant any expectations of a comeback of aspen on the range.

Willow made "especially good growth." Fewer ungulates because of reduction efforts, better distribution of ungulates on the range, and more favorable moisture conditions were considered responsible. Indications that the water table was rising on the winter range were noted and regarded to be the greatest boom to willow production.

Sagebrush stands showing signs of deterioration not attributable to grazing pressure were reported. This decline was suggested to have been caused by pressure from competing grasses. No successional significance was attached to this occurrence because of its limited extent and the simultaneous expansion of sagebrush on other areas. While both of these occurrences were noted, a third trend of rapid deterioration due to browsing by antelope was recognized.

1945

NPS Annual Report

Conditions during the 1944-45 season continued to be favorable for the improvement of the range condition. Good distribution of the elk over the range and adequate moisture provided for an abundance of forage and moderate utilization.

Snow depths were comparatively shallow and the snowpack loose with little crusting. Precipitation during the growing season was

55.2% above normal at Mammoth. Temperatures were .84% below normal. A footnote to the weather data indicated that, although the statistics indicated generally favorable growing conditions, portions of the growing season were either too cold or dry for optimum conditions.

The volume of forage produced was second only to the amount produced in 1944 since the drought in the 1930's. The condition of the aspen, willow, cottonwood and the sagebrush of the lower range was essentially unchanged. In contrast, many young douglas fir trees (Pseudotsuga menziesii) showed "considerable recuperative growth." Small trees made it through the winter untouched and trees with pronounced browse lines had new growth partially obliterating past signs of heavy browsing pressure.

1946-1947

NPS Annual Report

The rapidity with which the condition of the northern winter range could change was demonstrated. Weather conditions were not favorable for good forage production. Conditions during the winter led to poor distribution of elk over the range.

> "The marked setback in condition of the lower range was reflected on the intermediate and upper range sectors by excessive use of available browse plants and by heavy use of the ground plant cover on exposed and southerly slopes. On the lower winter range, which in its greater area was available throughout the winter, uniform excessive ground cover and browse utilization resulted in depletion of practically all palatable herbaceous growth.

> "Excessive use and consequent destruction of browse plants is apparent. But extent of damage to ground cover (especially grasses and forbs), through severe degree of use to which subjected last winter, is of a less tangible nature and cannot yet be accurately appraised. It is generally recognized that, on the type represented by our lower winter range, 50 percent of current plant growth must remain unconsumed on the ground to prevent soil depletion and to insure proper maintenance and productiveness. Since utilization on this range during the winter of 1946-47 was approximately 90 percent complete, it is evident that future productiveness of the soil and the range plant growth will be impaired."

Research efforts and annual reports continued under the direction of Park Biologist Kittams from 1947 to 1958 in much the same manner as those previously discussed representing the years 1933 to 1947. As before, the purpose of the investigations was to determine the condition of the northern winter range and provide information on which to base management decisions.

The annual reports alternately express concern or optimism for the condition of the winter range as weather conditions oscillated from being favorable to forage production and good distribution of the herds to mild droughts or heavy snows that restricted movement of the herds. Periods when the condition of the range seemed to be improving were not seen as being significant enough to change the overall downward trend in the condition of the range. As with earlier reports, emphasis was placed on the continuing dramatic decline in the willow and aspen species. Kittams used photos taken early in the Park's history in comparison with current photos to demonstrate the extent of

the decline of willow and aspens. Blame for the poor condition of the winter range was placed on the elk herds. The annual reports usually pronounced the range to be overutilized and called for a reduction in the number of animals on the range.

1948

An NPS report (1948) entitled, "Problem of Surplus Elk in Yellowstone National Park," recalled the estimated carrying capacity of 7,000 calculated in the 1930's. The report pointed out that the actual herd size had seldom corresponded to the recommended number. In fact, from 1942 to 1948 figures showed an excess of 2,000 elk yearly. This surplus was seen as being the cause of a continuing state of decline of the condition of the northern winter range.

> "Direct effects of serious overgrazing are apparent in the reduction of the most tasty and productive grasses and browse plants. Quaking aspen and willow are making their last stand throughout the winter range. Sagebrush on the lower and more arid range is in a similar condition. Choice grasses have been reduced by heavy use and replaced by grasses which are less productive and generally shorter and less available during the winter. This has occurred extensively over the winter range."

Taking these observations into consideration, it was assumed that the carrying capacity had been significantly reduced over the years below the earlier estimate of 7,000. The report expressed the belief that once a point of equilibrium was reached, as indicated by a return to a "healthy" range condition, the herd could be maintained at appropriate levels by removing the seasonal surplus. A figure of 17.5% was

given as the annual increase at the current conditions; presumably that would be the approximate number that would need to be removed. However, until the "point of equilibrium" was reached, an estimated carrying capacity "substantially" below 7,000 was desirable. A surplus of 4,000 elk was anticipated in the fall of 1948.

An office memorandum from the USFS District Ranger Fahnstock at Gardiner to the Forest Supervisor relayed the NPS management decision concerning the reduction program of 1948. It expresses the particularly volatile nature of any decision concerning the northern elk herd of Yellowstone Park.

> "Now I have seen everything! Yesterday at a meeting in Mammoth the Park Service decided definitely to recommend an elk kill of 4,000 this season rather than the 3,000 set tentatively last spring, reasoning that the capacity of the range had been reduced enough to warrant getting the herd below 7,000. I was a little surprised. But the real shock came last night when the Upper Yellowstone Rod and Gun Club voted to support the Park Service figure."

1959

The opinion that the condition of the northern winter range was in a steady downward trend persisted into the 1950's. Perhaps the best expression of this is reflected by the periodic downward revision of the estimated carrying capacity. In 1943 it was suggested that the 1938 estimate of 7,000, which was in itself thousands below the actual population size, be reduced to 6,000. A 1948 report determined a still lower carrying capacity to be more appropriate. By 1959

reducing the herd to 5,000 and holding it there for about five years was considered an essential part of the long range management plan and the only way to improve the condition of the continually deteriorating range resource.

Of course the overall objective for reducing the elk herds was to bring them into some kind of balance with their environment. A critical factor, then, is what criteria was used as a standard to determine when that balance had been reached.

> "The elk population in Yellowstone National Park should be reduced to, and maintained at a point compatible with a rejuvenation of the vegetative cover on the northern range so that there will be a restoration of many decimated plant forms, especially deciduous shrubs and trees. The degree of restoration of plant cover is to be based on the available evidence of the fauna and flora that prevailed on the winter range prior to the adverse influence of too many elk utilizing the vegetation" (NPS, 1959).

The above statement is central in the philosophy that directed management policies for most of the duration of the controversy. The deciduous species, particularly aspen, were used as a barometer for determining the health of the range. Since they were steadily declining in numbers and vigor, it was assumed that the other components of the range were declining as well. Apparently the only evidence that would have conclusively demonstrated to those making decisions that the range condition was healthy, or at least improving, would have been a dramatic reversal in the downward trend of the deciduous species.

Much weight was also placed on returning the range to conditions as they were presumed to be prior to the beginning of the problems on the northern winter range, or roughly prior to the turn of the century; in some instances even earlier to pre-whiteman days. Obviously the difficulty in using such a criteria lies in being able to accurately ascertain what conditions were actually like some 60 to 100 years previous. Due to the scarcity, or complete lack, of detailed enough records, in many cases the potential for error in such speculations could have been great.

1961-1964

A series of reports in the early 1960's gave further definition to the philosophies developing in the National Park Service that were determining management policies. It was considered a fact beyond refutation that the northern winter range was not healthy and a plethora of elk were responsible for this malaise. Many other assumptions were based on this premise.

> "The National Park Service does not plan to continue to sacrifice its capital, the soil, in a vain effort to save a few hundred elk for a winter or two so they can die of starvation. No responsible authority questions the poor condition of the northern winter range or the fact that more elk will ruin it" (NPS, 1962).

Another philosophy already mentioned seemed to stabilize itself into gospel standing: using pre-white man ecological conditions as a standard by which to gauge progress or retrogression on the range.

The question became what management methods were acceptable to try and accommodate this standard. The Leopold report (1963), compiled by five of the most respected wildlife biologists of that day, approached this issue.

> "The goal of managing the national parks and monuments should be to preserve; or where necessary recreate, the ecological scene, as viewed by the first European visitors. As part of this scene, native species of wild animals should be present in maximum variety and reasonable abundance. Protection alone, which has been the core of Park Service policy is not adequate to achieve this goal. Habitat manipulation is helpful and often essential to restore or maintain animal numbers. Likewise, populations of the animals themselves must sometimes be regulated to prevent habitat damage; this is especially true of ungulates."

A Park Service report (1964) dealt with the same issues specifically for Yellowstone.

> "The major objective of the northern Yellowstone wildlife and range remains as it has for fifty years, to have a healthy herd of elk in balance with its range and with all other species which use the same range so that the natural ecological picture can be presented to Park visitors. When beaver can be restored to the Lamar Valley and find ample willow, aspen and cottonwood for their dams and food, and when bighorn populations regain vigor, then some Park officials believe the desirable balance will have been achieved. It will not remain static, it will fluctuate, but Park visitors will have a richer Park experience because of wise management."

The Leopold report opposed a strict interpretation of the protectionist ideal of the Park Service. They advocated intervening in the natural scene when appropriate with management methods designed to manipulate the different facets of the environment either to protect

areas in an unaltered condition or to try and return areas to such a state.

> "In essence we are calling for a set of ecological skills unknown in this country today. Americans have shown a great capacity for degrading and fragmenting native biotas. So far we have not exercised much imagination or ingenuity in rebuilding damaged biotas. It will not be done by passive protection alone."
>
> "Restoring the primitive scene is not easily done nor can it be done completely . . . Yet if the goal cannot be fully achieved it can be approached. A reasonable illusion of primitive America can be recreated using the utmost skill, judgement, and ecological sensitivity."

The Leopold report went on to recommend that fire suppression programs be curtailed where possible in Park Service areas and to endorse the management practice of reducing the northern elk herd in Yellowstone through slaughtering attempts by Park rangers when needed. Both of these were considered well within the limits of propriety for Park management policies.

Public sentiment favored transplanting excess elk to new locations in adjacent states. However, after a few years it became obvious to the government agencies that this option was of limited practicality at best.

> "A neighboring Fish and Game official stated quite bluntly that it costs them about $100 minimum to haul a live elk home, treat, test, inspect, and release it. This official comments wryly that, "you can't run a department long on that kind of economics!" Transplant of live animals today are seldom to establish depleted herds -- they are put-and-take-affairs" (NPS, 1962a).

Logically, the Forest Service seemed to be the agency most capable of assisting the Park Service with elk transplanting efforts. However, they were unable to offer much support. The following statement was made by an Assistant Regional Forester at a meeting hosted by the Park Service.

> "I would be the last one to say drop your trapping program because it has so much public sentiment. Plants have been made in the forests and have usually been under protest from the Forest Service. We allow planting on the basis of range conditions. Our elk ranges are fully stocked with elk now so there isn't room for any more elk to be planted. We investigate 15 to 20 areas each year and allow some planting because of public sentiment, but live trapping at least for planting on forest land in region one is out! Even the Red Lodge plant has to be dropped and all other regions tell me they are also fully stocked. So in looking for places to replant elk, it isn't going to be national forest lands" (NPS, 1962a).

Park Service officials at this stage of the controversy were politically in a difficult position. All of the research conducted pointed to the need to reduce the size of the northern elk herd. Transplanting was not a viable option. Hunting pressure out side of the Park was effective, but only sporadically depending on the severity of the winter as it effected migration habits. Many public groups were opposed to the type of hunting practices used to take large numbers of animals. The limited slaughtering of elk by rangers in the Park seemed a necessity, but public sentiment was running against it. "Stop the slaughter" or "save the elk" were rallying cries for sportsmen and conservation groups.

A letter from Lon Garrison, Superintendent of Yellowstone during this particular phase of the controversy, to John Hunter, the Superintendent of Bandelier National Monument dated March, 1980 is exemplary. Mr. Garrison is reminiscing to Mr. Hunter about the elk reduction days in Yellowstone and advising Hunter as to some of the difficulties he may encounter if he begins a similar program for burros in Bandelier.

> "I am pleased that your management plan for Bandelier's feral burros has come full circle with the NPS intention to get into a direct reduction program. For me, this is reminiscent of the Yellowstone elk management program in the late 1950's. For years everyone had agreed on an annual elk reduction plan for the Northern Yellowstone herd (States of Montana and Wyoming, USFS, NPS, and wildlife groups) with the implications that while we hoped we could live trap the agreed upon surplus, we would shoot them if it didn't work out - and it never did. Weather was usually the culprit, but for years we sadly reported in the spring that we still had a heavy overpopulation which would be increased by another calf crop that summer.
>
> "In 1959-60 a group of university biologists, mainly from MSC at Bozeman discussed this with me and expressed great disappointment about this "evasion" of our responsibilities in not using our direct reduction authority. Otto Brown was our Chief Ranger and he was convinced that park protection demanded that we "reduce" the Northern Yellowstone elk herd from about 10,000 animals to about 5,000. And, he had a plan ready to get it done. It had all the necessary approval.
>
> "So, we did it. It was a brutal, bloody, abusive process including threats on my life, threatening phone calls to Inger - Mrs. Garrison - in the middle of the night, I was arrested twice - once over the Northern herd and once over the Gallatin herd with both suits dismissed. But we got it done by hanging tough against every threat and every possible delay the opponents could imagine. At one time it threatened

> to become a real political battle as Tim Babcock, the Republican Governor of Montana attacked the Democratic Secretary of the Interior, Stu Udall in the press, but we were able to stay out of that angle and keep it basically a biological dispute.
>
> "Mainly our freedom to complete the task was due to the day-to-day support from the NPS Washington Office with Larry Cook and John Davis managing our defense. I had to carry out the program well aware that through political pressure the Service or the Department or even the White House might pull the rug out from under us - but it didn't happen.
>
> "However, Assistant Secretary John Carver in charge of Fish, Wildlife and Parks, and later the Under Secretary, was reported to call the Director's office each morning with the question - "What did that mad man in Yellowstone do yesterday?" After the furor subsided, we were ultimately commended by politicians and biologists for our courage in carrying out the disagreeable, but essential task since there really was no viable alternative."

The Park Service was willing to allow Park rangers to shoot elk for herd reduction purposes and not feel as if Park Service idealogies were being compromised. However, opening the Park to public hunting as a method of herd reduction was philosophically distasteful, although there was public pressure to do so.

> ". . . it follows logically that every phase of management itself be under the full jurisdiction of biologically trained personnel of the Park Service. This applies not only to habitat manipulation but to all facets of regulating animal populations. Reducing the numbers of elk in Yellowstone or goats on Haleakola Crater is part of an overall scheme to preserve or restore a national biotic scene. The purpose is single-minded. We cannot endorse the view that responsibility for removing excess game animals be shared with state fish and game departments whose primary interest would be to capitalize on the recreational value of public hunting that could thus be supplied. Such a purpose imputes a multiple use concept of Park management which was never intended,

> which is not legally permitted, nor for which can we find any impelling justification for today" (Leopold et al, 1963).

A report from Yellowstone dealing with the same issue listed several practical and logistical reasons hunters should not be allowed to hunt in the Park. Included were the presence of visitors in the Park during the fall and the harsh weather conditions in the winter. Its main argument was basically a philosophical one as well.

> "It is also impossible to say what other uses of Yellowstone National Park might be advocated once elk hunting were permitted. If elk, why not bear, deer, moose, bison, pronghorn and bighorn? If hunting, why not mining and logging or dams to raise the elevation of Yellowstone Lake? These hard questions make the National Park Service reluctant to accede to any breakdown of current policy. But the heart of the matter is simply this: Most people in America do not want hunting in their national parks any more than they want mining or logging and the parks belong to all America."

The management objectives and programs of this era had the support of the scientific community. Even if the "well meaning but ill informed citizens" were in opposition many wildlife biologists familiar with the controversy voiced their approval. An example of this is a written statement of support signed by, among others, John Craighead of the U.S. Fish and Wildlife Service and six professors from a nearby university.

> "As professional wildlife biologists, we are concerned with the current attempts by well-meaning but ill informed citizens to prohibit the National Park Service from carrying out sound, long range plans for managing the Northern Yellowstone elk herd. This issue is to vital to sacrifice well-established principles of resource management for expediency, or the self interest of minority groups.

> "The current controversy regarding the proposed reduction of the northern elk herd in Yellowstone National Park involves two basic considerations: should elk numbers be reduced; if so, how should this be accomplished? Over the years sufficient data concerning range conditions and elk numbers have been gathered to indicate that the elk must be drastically reduced to get and to keep them in balance with the available winter forage. This necessitates an annual reduction program . . . direct reduction is the most efficient and the only reliable method of achieving the necessary harvest" (Pengelly et al, 1962).

Concern for the condition of the winter range was expressed in some unique ways. Howe and Barmore (1962) examined the possibility of artificially reseeding portions of the range. This included areas thought to have been damaged as early as 1880. The report concluded that the most effective means of repairing or revegetating deteriorated portions of the range was through reducing the number of elk on the range, not by reseeding efforts. Determining the capacity of the range to reseed itself was a statement of the condition of the range. Payne (in Howe and Barmore, 1962) stated the following:

> "I would agree with Mr. John E. Taylor and Mr. Don D. Collins (Range Management Department; Montana University) that the range we saw in Lamar and Gardiner areas has not gone so far but that adequate reduction of numbers (of elk) should provide a relatively rapid recovery. The grass speciation is good on most of the grassland type range. This does not mean, of course, that recovery will take place in two or three years. The present situation has been developing over a great many years, and some time will be required to get adequate recovery."

1965

Barmore (1965), a park biologist, summarized the aspen stand studies conducted on the northern winter range. Almost without exception, the annual range reports from the early 1930's to 1958 mention the heavy, even severe, use of aspen by elk as a browse species. A survey in 1962 did not find any "normal" aspen stands on the winter range. Most were in poor vigor and incapable of reproducing themselves because of continual overbrowsing of young suckers resulting in the death of root systems and the overmaturity of the overstory. The only age classes represented were decadent trees nearing the end of their life span and young reproduction of one to two years old maintained at a height of several feet by browsing pressure. Mature trees were succumbing to disease and insect attacks. Heavy barking damage by elk was lowering the resistance of the trees.

Barmore recognized that, in addition to overbrowsing, adverse climatic changes, disease and insect attacks, and the disruption of the natural fire cycles played a part in the decline of the aspen. Browsing pressure was long regarded to have the greatest influence on the aspen stands. The significance of the other variables was not known. Barmore proposed that controlled situations where browsing was eliminated should still result in aspen stand decline if grazing pressure was playing only a minor or even secondary role. Information

collected from aspen exclosures and study plots representing long periods in the Park's history provided insights.

> "While there is much we do not know about aspen ecology and aspen ungulate relationships, the evidence discussed in this paper clearly indicates that long term overbrowsing is responsible for the present deterioration of Park stands."

Stands protected from browsing showed dramatic increases in the number of new shoots and in the annual growth of these shoots. Eventually, such stands contained representatives of a diversity of age classes. When protected from browsing aspen demonstrated the ability to invade open grasslands formerly occupied by aspen. When again subjected to browsing once protected stands reverted back to a decadent condition with only a few age classes represented. In some instances unprotected stands showed a significant degree of mortality not attributable to browsing, but when protected these stands seemed capable of overcoming the effects of other detrimental agents and producing healthy stands. This suggested that continual browsing pressure of the degree experienced on the winter range was lowering the resistance of the individual aspens and even whole clones to the point that they were more suceptible to other factors.

The effect on the aspen stands of the intensive reduction efforts during the winter of 1961-62, which brought the herd down to the estimated carrying capacity of 5,000, was seemingly inconsistent with what was known about elk-aspen ecology. After the reductions the aspen

stands showed no marked improvement. Data indicated that total aspen utilization was at least as severe during the 1964-65 winter as previous winters. In an attempt to account for this inconsistency additional studies were carried out to determine the degree of use received by aspen during the progression of a winter season.

The studies concluded that elk begin utilizing aspen almost as soon as they migrate onto the winter range even when grass forage was still readily available. Snow depth and drifting patterns played a deciding role in determining the likelihood of new aspen regeneration survival. By the middle of February aspen reproduction was basically unavailable because of the snow depth and the diminutive stature of the stunted saplings. Because of these feeding trends questions were raised concerning the amount of browse species required in an elk's diet and the actual forage preference that could be associated with aspen. It was speculated that while an elk's diet consists predominantly of forage, particularly grasses, a small amount of browse is also essential. Since the northern winter range has a very limited amount of available browse species, aspen receives the brunt of use by elk to satisfy a dietary requirement.

In a concluding statement, Barmore suggested where the priorities should lie in managing the northern winter range and how to save the aspen.

> "While the prospects of additional cuts in the elk herd may be highly unpalatable from an administrative, public relations, and political standpoint, it must be remembered that once lost, the aspen ecosystem cannot be replaced. In contrast, an elk herd can rebound with astonishing and often disconcerting rapidity from a low population level under improved habitat conditions such as would result if the Northern Yellowstone elk herd was reduced further. Can we afford to gamble? After such a long period of serious abuse of soils and vegetation as has occurred on the Northern Yellowstone winter range, it would seem wise to end on the side of the more fragile and irreplaceable resources, such as the aspen ecosystem, rather than on the side of the elk herd which has run rampant for so many years."

1968

Barmore (1968) discussed the need for keeping wildlife exclosures in Yellowstone. He was writing in response to the suggesion that they had outlived their usefulness and should have been torn down. The first exclosures were probably built in response to Rush's recommendation in 1932 for consistent monitoring of the condition of the northern winter range. Through the years some exclosures were abandoned while others were added in better locations. They were used by the Park Service to determine the condition of the northern winter range and to determine the need for appropriate management programs. For this reason, the validity of their use is an important issue in the history of the controversy. Barmore included in his report a review of the literature explaining and justifying the use of exclosures.

> "It is apparent from the above review that exclosure studies are almost universally accepted by ecologists as a reliable

> and valuable method for use in both basic and applied ecological research. To be sure, exclosure studies just as any other method for studying ecological relationships must be set up and used with care, and care and "wisdom" must be used in interpretation of data obtained from the studies. Several of the researchers cited above mentioned factors such as the barrier effect, and possibility of rodent concentrations that must be considered and overcome in exclosure studies. However, it seems certain the chance for erroneous interpretations and conclusions about herbivore-vegetation relationships can be significantly reduced through proper use of exclosure studies. In none of the information at my immediate disposal could I find any statements that exclosures not be used because they provide misleading information."

Due to their size, the larger exclosures were considered more useful because they minimized the potential for error. Ten exclosures approximately five acres in size were constructed on the northern winter range in 1957 and 1962. Exclosures located in close proximity to each other had the unique value of being able to verify ecological changes. Changes in one could be substantiated by checking it against the other. The five acre exclosures and 26 exclosures 20 feet square built in the 1930's were used as an integral part of research efforts on the winter range.

> "Reference to the Research Goals, Yellowstone National Park, shows the following research projects where exclosure studies can provide valuable information that may not be obtained any other way and that will increase the precision of conclusions about past and current ecological phenomena in the Park:
>
> I. Classifying and describing natural units of Park vegetation and documenting successional processes.
> II. Development of criteria for assessing allowable intensities of use on important food plants and physiographic sites.

III. Map ungulates winter ranges, delineate areas of use by species and classify vegetation and site conditions with respect to site potential, biotic influences and conflicts with attempts to portray natural or primitive conditions."

After reaching a point at which Park Service management philosophy for the northern winter range was seemingly well defined and geared towards long range management goals, it began to change. The overall management objective for the northern elk herd as stated in an NPS information paper (1967) remained the same as past years.

> "The primary purpose of Yellowstone National Park is to provide present and future visitors with the opportunity to see and appreciate the natural scenery and native plant and animal life as it occurred in primitive America."

However, the methods for accomplishing this objective began to differ radically with past methods. A new emphasis was placed on allowing the environment to regulate itself by interfering as little as possible in natural processes instead of trying to accomplish the same ends by intensive management practices.

> "Primitive scenes with a variety of wildlife species only result from allowing natural regulatory process between plant and meat eating animals to take place. Where natural processes have been lost from a park, attempts must be made to re-establish them. The following management objectives for the northern Yellowstone elk outlines a program to encourage the natural regulation of elk numbers within Yellowstone Park and the re-establishment of historical migrations to lands outside Park boundaries" (NPS, 1967).

The specific points of this program centered around relying upon the combined action of native predators and periodic harsh winters to

naturally regulate elk numbers. Hunting outside of the Park was seen as the second best method of herd control; trapping and selective control by rangers the very last resort.

> "The removal of one animal under these conditions simply results in the survival of subsequent birth and survival of another" (NPS, 1967).

Management practices of the past were seen to be not entirely in keeping with Park Service ideals. The point was raised that, instead of accomplishing management objectives, control efforts had so disturbed elk distribution and behavior that chances were reduced for visitors to see elk and a "natural" scene on the northern winter range.

A Park Service information paper (1968) stressed that portions of the northern herd remain in the interior of the Park even during severe winters and needed no artificial regulation. Park managers admitted that their practices differed from those of the past, but by their own definition:

> ". . . only to the extent that, (1) the herd size will be allowed to vary within a range (instead of hold herds to a set number, which is all but impossible under variable weather conditions) and, (2) the use of a variable quota system, which is necessary if hunting outside Park boundaries is to function as a substitute for controlling the migratory segment of the northern Yellowstone elk herd by trapping. The resident segment of this herd would not be managed if natural controls can be restored."

For those who had stood by the Park Service under considerable opposition while the Service was involved in what was heralded as a

valiant last chance attempt through direct reduction efforts to save the northern range from certain destruction it must have seemed as if things had taken an ironic twist. The condition of the northern winter range had not changed sufficiently to warrant such drastic changes in management practices. Rather the interpretation of the entire ecology of the northern winter range had changed as well as the prevailing philosophy towards the acceptability of certain management practices when compared with Park Service ideals.

Patten (1968) investigated the dynamics of the shrub continuum along the Gallatin River in Yellowstone. Although the area where he conducted his research is not technically part of the northern winter range, the two areas are in close proximity and are nearly identical in the sense of topography, climate, vegetation and management problems. Included in this similarity is the steady decline in numbers and vigor of the willow in both areas.

Patten found a transition zone of stunted and dead willows along the Gallatin River between an area where no willows existed and an area upstream with vigorous willow thickets. He considered the transition zone to mark the upper region of winter browsing by elk. By examining photographs he was able to determine that most of the willows in the transition zone died out between 1924 and 1964. He detected a successional change from willow to silver sagebrush (Artemisia cana) as the willow succumbed to browsing pressure.

Willows closest to the river were the last to die out because of the advantage of favorable soil moisture availability.

Patten's work verified the opinion held by Park biologists since research efforts began on the northern winter range. Present Park biologists do agree that riparian vegetation may have declined on the winter range--an estimated decrease of 50% from 0.8% of the area to 0.4% during the past century. However, they disagree that this decline represents successional deterioration or retrogression. They feel that willows have decreased outside of the winter range as well as inside and this decrease is in response to climatic changes that resulted in a decrease of available soil moisture on riparian sites that decreased the ability of riparian vegetation to survive browsing. Much of the decrease occurred during the drought of the 1930's. Some of the changes in soil moisture relationships may also have been the result of fire suppression. Herbivores are now seen as being capable of affecting the rate of successional changes in riparian sites but not determining the direction of successional changes.

1969

The years 1968 to 1970 may be seen as a brief period of transition and adjustment to new management policies. Some Park Service reports for this period contain an interesting mixture of "old" and "new" ideas. The following report is an example.

In 1969 Cole was the supervisory research biologist in Yellowstone. In his report "Elk and the Yellowstone Ecosystem" are provided insights into the attitudes dictating management decision for this phase of the controversy. For many years reports and papers discussing the condition of the northern winter range mentioned the deterioration of the range and the need to reduce the size of the elk herd. Cole broke from this format and emphasized that the northern winter range was an area where the natural ecological relationships had been disturbed. Since past management practices were at least in part responsible for disrupting the natural balance, he recommended changing these practices to allow for a return to a healthier balance. He called for good communication between the cooperating agencies to:

> ". . . avoid the misunderstandings and controversy which led to elk control within Yellowstone becoming a substitute for properly designed hunting seasons outside [Park] boundaries."

Apparently he considered the management practices of the past something of a mistake.

Cole did agree with past biologists that, besides the effects of misguided management practices, serious imbalances existed on the northern winter range. Recognizing that elk had existed in harmony with their environment before the arrival of white man, Cole stated:

> "It is unlikely that the animals would suddenly become a "problem" unless disrupting influences occurred. Modern man appears to have been responsible."

Cole identified several man-induced disrupting influences in the natural balance of the northern winter range. One was the near elimination of the grey wolf and mountain lion that disturbed the mutually beneficial relationship between predators and plant eaters. According to Cole, 134 wolves and 121 mountain lions plus an unknown number of coyotes were killed in the Park since the early 1900's.

As nearly every other report on the northern winter range has done, Cole mentioned the significant impact of disrupting the migratory routes of the elk with political boundaries. The result is the unnatural concentration of elk within the Park and the excessive use of the resource there. He hastened to add that in his opinion much of the northern winter range is an ecologically complete habitat. He likened it to the geyser basins and warm river areas in the Park where elk herds reside all winter. In spite of heavy snows and harsh winter weather, they take advantage of whatever areas are suitable for foraging instead of migrating to a lower elevation. Consequently, the kind of reduction efforts used in the past at the higher end of the winter range where the ecosystem was intact were unnecessary. Only the lower end of the range, that had been bisected by the political boundary of the Park, needed any artificial regulation of the herd size. He stated that the necessary regulation could be provided by a hunting season that allowed for migration out of the Park before the

hunting season opened. Trapping and selective killing by rangers were unnecessary.

1970

Hendrickson (1970) discussed the alternatives of controlling Dalmatian toadflax on portions of the lower range. Toadflax, a native of southeast Europe (Shaw, 1974), was introduced into the Mammoth Hot Springs area. It has been speculated that the rapidity with which it became established and spread across the range around Mammoth is indicative of the poor condition of the range in that area. It is particularly aggressive and has an affinity for rocky and barren sites, which describes much of the terrain between Mammoth and Gardiner. Because of its recorded ability to occupy more favorable sites and to coexist with nearly any plant community around Mammoth, it was feared that it had the potential of spreading to the Lamar Valley. In 1970, Dalmatian toadflax was found on 12 sites outside its original area of occurrence between Mammoth and Gardiner. Five of these sites were located on the northern winter range. Attempts to control it by chemical and biological methods were unsuccessful.

1971

Meagher (1971) investigated the free-ranging bison in Yellowstone. She found portions of the Park's bison herd to be naturally regulated and wintering in intact ecosystems, a situation similar to what Cole found among the Park's elk. The best example of this

phenomenon is the herd found in the Pelican Valley, a high valley well within the boundaries of the Park. Meagher speculated that a bison herd has always used the valley. By following population sizes and the severity of winter weather through the years she surmized that severe winter weather was the main regulatory influence on the Pelican Valley bison herd. The herd never exceeded the capacity of its environment to support it because of this limiting factor. She found parallel situations in evidence with other portions of the Yellowstone bison herd, although this relationship of population size to winter weather was not quite as apparent. One such area was the Lamar Valley at the upper end of the northern winter range; the area where Cole suggested the elk herd was self-regulatory.

Cole (1971) put forth in his report, "An Ecological Rational for the Natural or Artifical Regulation of Native Ungulates in Parks", the justifications for abandoning the management programs practiced on the northern winter range for many decades. He stated that programs for artificially regulating the elk herds were inconsistent with Park management policies, were the result of a lack of sound ecological data, and were based on a set of general assumptions that were not correct. These assumptions were:

> "1. that ungulate populations need to be artificially regulated to compensate for insufficient native predators, prevent progressive habitat deterioration and/or

maintain interspecies equilibriums (mean numerical stability) between large herbivores,

2. that "low" rates of increase in ungulate populations or periodic high overwinter mortality were unnatural phenomenon; and,

3. that the artificial regulation of ungulates would retain the esthetic or scientific values of biological systems to a greater extent than doing nothing."

Cole supports the antithesis of the above conclusion. In his own words:

> "An appropriate summary may be: Over a series of years, naturally regulated ungulate populations were self-regulating units. They regulated their own mortality and compensating natality in relation to available winter food and then population size. Predation on either wintering or newborn ungulates seemed a nonessential adjunct to the natural regulation process because it did not prevent populations from being self-regulated by competition for food.
>
> "Low realized natality, with the recruitment of young in a replacement relationship to low adult mortality, appeared to represent the "best system" for a naturally regulated ungulate population to maintain relatively stable numbers in a frequently harsh environment. The latent potential for high natality allowed populations to compensate for periodic higher than usual mortality that was partly due to severe weather. This mortality, as well as the more consistent density influenced deaths of animals with low energy reserves, was predestined to occur in naturally regulated ungulate populations. Such mortality would not represent a loss of biologically essential population members and it, as well as loss realized natality, are not unnatural phenomenon."

Cole, with the support of additional literature, stated that populations of free ranging native ungulates, including the elk of the northern winter range, cannot progressively reduce food supplies that

limit their own densities. He argued that any such consistently harmful relationships where the ungulate herds do have the capacity to damage their environment would not survive the test of time. An exception to this would be when substantial successional influences were in operation or when man imposes habitat limitations. Which brings up again a crucial question in this discussion, whether or not man has imposed significant habitat limitations on the northern elk herd.

He maintained that native ungulates, unless artificially concentrated, do not have the ability to halt primary successional trends or cause secondary succession. Areas of greater and seemingly damaging use such as ridge tops and areas where trees are high-lined, areas that used to cause previous researchers on the northern winter range considerable consternation, were labeled by Cole as stabilized biotic disclimaxes.

According to Cole, the kinds of herd reduction methods used on the northern winter range served only to maintain herd levels in relation to human-determined habitat security levels instead of forage carrying capacities. Reduction efforts resulted in instilling unnatural conditioned avoidance behavior towards humans that restricted the normal pattern of utilizing the habitat and caused problems rather than solving any.

Cole (1971) investigated the relationship between grizzly bears and elk, specifically the effect of grizzlies on elk population

dynamics. This gives some insights into the role of predators in the ecological balance of the northern winter range. He noted that grizzlies had a "culling" effect on the elk herds that apparently dampened and extended the interval between elk population fluctuations. The role of the predator on the northern winter range has traditionally been misunderstood; either their importance has been overstated or overlooked.

A Park service information bulletin (1971) discussed the use of exclosures in Yellowstone to assess the effect of herbivores on the range. In an obvious reference to the consistent use of exclosures for many years in the Park, specifically on the northern winter range, to determine the condition of the range, the report cautioned against trying to determine departures from natural conditions by this method. The series of exclosures set up early on in the history of the controversy played an important role in aiding biologists in making their decisions as to how to manage the northern winter range. Biologists in 1971 felt they had played too much of a role.

> "Exclosures are commonly used to assess the biotic effects of large herbivores. This usually involves photographing, measuring, and comparing protected vegetation with that which is used by the excluded herbivores. Interpretations from such comparisons require an awareness that protected vegetation represents an artificial "standard" which increases in artificiality over time. Long established exclosures in seral vegetation may simply show that the rate of primary succession is slower without the biotic effects of large herbivores. Exclosures in climax grassland may only show "site potential" without large herbivores. Interpretation

> that such exclosures illustrates how things should be in a park would more often than not be confusing artificial with natural conditions."

The report recommended comparing old photographs with the present day landscape for the most accurate portrayal of vegetational changes that have occurred.

Houston (1971), a biologist in Yellowstone, gave insights into how Park service biologists were interpreting the philosophies of their agency in 1971 and how they thought these philosophies should be translated into management policies. In "Ecosystems of National Parks", he stated that a quality peculiar to Park service philosophy, a central theme of which is to limit man to nonconsumptive uses of the land but not at the exclusion of man, is its uniqueness. He emphasized that this uniqueness often requires a kind of mindset when approaching management questions that is foreign to land managers' usual way of thinking. He used an example that related directly to the management of the northern winter range.

> "This approach to the management of vegetation and native ungulates illustrates the uniqueness of Park ecosystems. It follows that the criteria used in forestry or range and wildlife management where vegetation and wildlife are harvested as a crop, do not necessarily apply to national parks. For example, having an elk population with a low rate of reproduction on ranges that appear temporarily overgrazed may be poor game management but it is excellent management of a park ecosystem, as long as it is essentially natural. It is evident that the usual concept of "waste" does not apply in Parks; that is, the death of trees and ungulates is necessary to maintain ecological relationships.

Houston (1971) applied the above line of reasoning specifically to the northern winter range in a report entitled, "The Status of Research on Ungulates in Northern Yellowstone National Park". He reiterated that the entire approach to managing Yellowstone Park is different from the conventional goals of land management.

He continued the discussion started in other papers on the hypothesis that a portion of the northern herd wintered on an ecologically complete habitat. He theorized that a "migratory segment" wintered in the lower portion of the range both in and outside of the Park. A "resident segment" of 3,000 to 4,000 elk was believed to occupy the upper portions of the Yellowstone and Lamar River drainages. He described his theory in this way:

> "Research designed to test the hypothesis that the resident segment occurs on "ecologically complete habitat", and will be "naturally regulated" was initiated in 1968 when the periodic artificial regulation (involving trapping and shooting) was terminated. Natural regulation of ungulate populations has been defined as regulation of numbers without human influence. The actual mechanisms involved in natural regulation are difficult to document, but appear to be primarily due to the effects of density--influenced intraspecific competition for winter forage and the partially density-independent effects of severe weather on mortality and natality. Ecologically complete habitat for elk appears to consist of complexes of physiographic sites with interpersions of vegetation types that provide contingencies to obtain forage and maintain relatively stable populations in variable and periodically harsh environments."

Those interested in the history of the management of the northern winter range are fortunate in having a wealth of historical information to draw on in tracing the development of research efforts for the

area. With the accumulation of years of information at his disposal, Houston opened a new dimension in research efforts by critically examining these records to gain insights into the important issues of the controversy. Examining the many photographs documenting the history of the northern winter range, some taken very early in the history of the area, proved especially valuable. Houston put much emphasis on this phase of his research:

> "It has become apparent that without this background framework, any assessment of problem situations can be little more than personal judgments which may vary with the training and experience of individuals."

Using these records, Houston felt he could give credibility to his idea of a resident segment to the northern herd. Additionally, he could find no documentation to support the much-discussed population eruption and crash that reportedly occurred in the winter of 1919-1920. Many management decisions through the years were based on interpreting the events of that winter as an indication of severe ecological imbalance. Should Houston be right in reinterpreting the occurrences of the 1919-1920 winter by using the early documents it would have far-reaching ramifications in accurately understanding the condition of the northern winter range. He believes the error occurred through inaccurate methods employed in early censuses, a system used to calculate herd size increases, and variations in defining what elk in Yellowstone Park should be included in what is specifically the "northern" herd.

> "The population crash appears to have been suggested in administrative reports as an explanation for the discrepancy between counts and calculations, and has subsequently been accepted as factual."

Houston put forth the hypothesis that the migratory segment of the herd could be maintained at from 3,000 to 5,000 animals by hunting pressure outside the Park designed not to result in conditioned avoidance behavior which would cause unnatural concentrations in the Park. He contended that the other species of ungulates, such as the pronghorn and the bighorn sheep, would not suffer from interspecific competition in the naturally regulated area or the area where elk were controlled by hunting. Past opinion had been that elk, as the more aggressive competitiors, were detrimentally influencing the other ungulate species. Another hypothesis Houston was anxious to test was his conclusion that in areas of harsh environmental conditions like Yellowstone, predation functions as an assisting but non-essential adjunct to the regulation of ungulate population size. In 1967-68, the year the artificial reduction efforts were terminated, the northern elk herd was counted at less than 4,500. Houston predicted a count of 8,500 to 9,000 elk for the 1971 fall herd, which was an indication for him that the validity of these and other hypothesis would soon be tested.

Hypotheses concerning the condition of the forage resource and corresponding habitat relationships included:

> ". . . the density, composition and successional trends of vegetation on the range do not depart from natural conditions, or that departures have not resulted from grazing by native ungulates." (He excludes the area adjacent to the north boundary which has seen many man-caused alterations). "The corollary under study is that native ungulates on ecologically complete habitat do not have a capacity to progressively deplete food supplies that ultimately determine their own densities. Stated more specifically, no unnatural effects upon vegetation will result from the natural regulation of the resident segment of the elk population."

In relation to the above statements, sites so consistently labeled "overgrazed" in the past, Houston emphatically describes as "naturally occurring vegetation patterns". He mapped out the plant communities showing 60% bare ground and arrived at 6,000 acres, including adding some acres to compensate for areas not located. About 1,100 of these acres he decided were unmistakably the result of "peculiar topodaphic conditions." Another 4,800 acres he labeled "natural zootic climax," and some "retrogressed disclimax vegetation" near the northern boundary line area. In all, only 3% of the range as he saw it fit into what was once considered to be overgrazed range.

Houston offered new interpretations of the condition of some of the other components of the flora. The decline of the aspen and willow, historically considered to be classic examples of retrogressive succession, were considered indicative of natural primary and secondary succession. Willow were seen to be responding to secondary succession that reflects fundamental changes in the hydrology and alluviation of streams, perhaps related to a change in the frequency of

fire. The disruption in the frequency of fire was also held responsible for the decline of the aspen. Another variable Houston interjected was the possibility of "climatic changes dating from the Gannett Peak stade [sic] of neoglaciation."

The decline of big sagebrush on portions of the lower end of the winter range has often been cited as another indication of range deterioration. Houston suggested that just the opposite is true:

> "High densities of big sage at this low elevation represented a disclimax community which resulted primarily from grazing by domestic livestock and its reduction represents a return to more natural conditions."

1972

Craighead et al (1972) conducted research similar to that done by Skinner (1928) on the migration routes and habits of the elk in Yellowstone. However, in contrast to Skinner's methodology, they increased the accuracy of their research considerably by trapping elk and tagging them to facilitate monitoring their movements. Comparing the observations of Skinner with those of Craighead et al gives valuable insights into the impact of 44 years of management programs on the migration patterns of the elk in Yellowstone. The main focus of the research done by Craighead et al was to delineate the summer and winter ranges of the northern herd and to determine the patterns of movement between the two ranges. A priority of secondary importance was to assess the relationship of the summer and winter ranges of the other herds of elk in the Park to the northern herd.

As one who has done research in the Yellowstone ecosystem for many years and has witnessed the dramatic changes in Park policies, Craighead's interpretation of the relationship between the northern elk herd and their habitat is significant. Like Houston (1971), Craighead et al questioned the accuracy of early elk population counts. They stressed that these counts were estimates only and that the definition of what elk should actually be counted as part of the northern herd has changed over the years. They repeated the accounts given during the early days in the Park of a spectacular crash in the population of the northern herd. Unlike Houston, they seemed inclined to agree with comments by Skinner (1928) and Cahalane (1941) of elk migrating out of the park as far as 70 miles down the Yellowstone Valley prior to the disruption of these routes by the white man; the eventual effect being the unnatural concentration of the elk on the winter range in the park. They also mentioned the opinion expressed by Murie (1940) and Cahalane (1941) that through intensive hunting along the Park line, elk with migratory tradition and experience were destroyed, thus reducing the migratory movements of the northern herd north of the Park. As so many other authors have done, they reiterated the much-repeated story of how these disruptions in the migratory habits of the northern herd ultimately led to range deterioration in the Park and the need for an elk reduction program. It is interesting that they made no mention of the alternative interpretations of these

incidences provided by Cole (1969) and Houston (1971). They did not directly answer the important question as to whether or not they considered the area to be a traditional winter range for the elk but did cite references to large herds being seen in the vicinity of Mammoth as early as 1874. However, they were of the opinion that the lower valleys of the winter range served only as fall and spring range for much of the northern herd - those that migrated down the Yellowstone River Valley. Thus, Craighead et al seemed to be of the opinion that elk traditionally wintered in Yellowstone but important migrations which have been disrupted took place to lower ranges now outside the northern winter range as it is defined today. Although they did not categorically state their position, their interpretation of the relationship of the northern herd to its habitat would seem to be somewhere between that of Skinner and Rush and that of Houston and Cole, but much closer to the former.

Craighead et al concluded that some of the objections to the elk reduction program and reasons for it being discontinued were the lack of effectiveness, the impracticality, and even outright distastefulness of the methods used. With some qualifications, they stated that a reduction program could become a viable alternative again because of better methods for implementing the program.

> "Direct reduction can be very effective because it can be focused on particular sex and age classes as well as on specific herd segments. In addition, it can be stepped up or

> down as the situation warrants . . . Helicopter herding and trapping procedures used between 1963 and 1968 increased the average number of elk taken each year from 242 to 895. Prior to the use of helicopters, success depended on the effectiveness of baiting elk into the traps. In turn baiting was dependent on the severity of the winter and on the availability of native grasses and browse to elk. Herding with helicopters with experienced pilots can drive several hundred animals as much as 5 miles to a trap. This technique, like hunting and direct reduction, is also dependent on proper snow conditions. However, the snow and weather conditions necessary for successful helicopter drives prevail during most winters. A major problem appears to be the procurement of sufficient funds and manpower to take the increment of elk each year.
>
> "Control of the Northern herd is now entirely feasible using various combinations of the methods mentioned above, although problems may occur in snow-free winters when animals are less accessible. Nevertheless, a poignant question remains: do the methods used to control the number of elk disrupt traditional movement patterns?"

Comparing the results of their research with those of earlier observers suggested that several segments of the northern herd had been eliminated by reduction efforts in the past. Migration routes used heavily in Skinner's time and used only sporadically during their research efforts gave evidence to this. It would seem that this also answered their question about the impact of reduction efforts on traditional migration patterns.

> "Another segment of the Northern herd that migrates up Slough Creek to Buffalo Plateau was nearly eliminated by direct reduction during the winter of 1961-62. Historic accounts indicate that Dunraven Pass was once used by large numbers of migrating elk. Although most of the elk still using the route were killed in 1961-62 a gradual increase in use of this historic migration route was noted from 1963 to 1968."

Skinner (1928) considered it a mistake to try and manage the elk of Yellowstone as if they were divided into distinct segments such as the "Northern herd" or the "Jackson Hole herd" because of the intermingling he surmised was occurring on the summer range. Craighead et al disproved this theory. Although some mingling did occur on the summer range, the majority of the elk repeatedly returned to specific winter and summer ranges.

Craighead et al observed some interesting migration habits among the elk of the northern herd which seem both supportive and contradictory to the ideas of Cole (1969) and Houston (1971).

> "Animals wintering in the Lamar River Valley and the Yellowstone River Valley were all migratory, but they maintained two relatively distinct populations. However, some elk moved from the Lamar River Valley to the Yellowstone River Valley during each winter of the study; during severe winters, there was considerable mixing of the 2 segments of the herd near Gardiner, Montana. The Lamar River Valley elk moved down the north side of the Yellowstone River to Deckard Flats and beyond. During this movement, rough country was a barrier to the mixing of the two groups, until they were downstream from Gardiner, Montana."

1973

Houston (1973) recognized the importance of investigating the role of fire and fire suppression in determining the condition of the northern winter range. His perception of the effect of these influences on the range differed considerably from the traditional perspective.

> "Interpretations of "overgrazing" or of departures from natural conditions of vegetation due to foraging by native ungulates cannot be valid in a natural area until the influences of wildfire have been evaluated."

Using fire-scarred trees Houston tried to determine the frequency and the size of fires occurring on the northern winter range during the past 300 to 400 years to evaluate their impact on the ecology of the area. With the exception of the past 80 years in which fires have been actively supressed, his research indicated a frequency with a mean interval of 20 to 25 years between fires. He felt he was also able to substantiate that eight to ten extensive fires had occurred during this same time interval of the past 300 to 400 years.

As far as the source of these fires, he mentions the common practice among the Indian cultures that could have traveled or hunted the Yellowstone area to intentionally set fires for their advantage. Historical accounts record several incidences of Indians setting fire to portions of the Yellowstone area, but it is not possible to fully assess the impact of Native Americans on the frequency of fires on the northern winter range.

Modern man has replaced the Indians in being responsible for man-caused fires in the area. Ninety-six man-caused fires occurred on the portion of the winter range in the Park from 1931-1971. Successful suppression action was taken against all of these. Only four burned four or more hectares (Taylor, 1973).

Houston was able to more accurately determine the significance of lightning-caused fires.

> "Records show that suppression action was taken on 99 lightning caused fires on the study area from 1931-71. Fires occurred in 78% of these 41 years; four or more fires were reported on 32%, with six reported in each of 1936, 1949, and 1966; seven in 1953 and 1971; and 11 during 1958. Over 80% of the fires were suppressed before reaching 0.10 ha in size, with the three largest reported at 65 ha in 1939, 735 ha in 1949, and 19 ha in 1971. In addition to fires that originated on the area, an additional 39 lightning fires were suppressed within 7 km of the south and west perimeters during the same period, some of which might otherwise have burned onto the area because of prevailing winds. These records, of comparatively short duration, show that lightning is potentially a major source of natural fires on the area, and that, under the climatic conditions that have prevailed, suppression attempts have been quite successful."

If these fires had not been suppressed Houston predicted that "much of the area would have burned at least one to four times since establishment of the Park were it not for the actions of modern man."

The impact of fire suppression on the ecology of the northern winter range has been significant, but, as Houston emphasizes, its influence must be considered in conjunction with a variety of other factors.

> "Changes that have occurred in the vegetation seem best explained by a reduction in fire frequency but have also occurred within a fluctuating climatic regime (Bray, 1971) and with concomitant foraging by herbivores. Separation of these various influences is not entirely possible, and the following interpretations are regarded as tentative."

Specifically, fire-sensitive big sagebrush has increased on the range with fire suppression and that there is probably less total

herbaceous vegetation. Coniferous forests have changed in density and distribution. Aspen, another fire sensitive species has decreased. Houston states, "In general, the reduced fire frequency has resulted in greater expression of "climatic climax" vegetation."

Preliminary steps were taken in 1972 to return the influence of fire to the ecology of Yellowstone Park and the northern winter range. In a radical departure from traditional management policy, over 122,000 hectares of Yellowstone including 12,000 hectares of the winter range were designated as an area where natural fires were allowed to burn unchecked (Houston, 1973).

1974

Following the ongoing discussion of the condition of the northern winter range from the first written records until 1974 has at least revealed that Park management policies and even the entire interpretation of the ecology of the area have changed dramatically. Moreover, the majority of this change occurred in the last few years of the history of the area; 1969-1974. The new interpretations and management policies have not gone unchallenged. Which is understandable, considering many of the new interpretations are diametrically opposed to traditional interpretations.

Beetle (1974) expressed his opinion that many of the conclusions about ungulate-habitat relationships had gone awry because of a failure on the part of current Park biologists to understand the

difference between the terms zootic climax and zootic disclimax and the relationship of both to climatic climax. He expresses his opinion of current Park biologists interpretations in this way:

> "These concepts have some rather unusual aspects which deserve to be discussed fully, since many of them are contradictory to current textbook teachings in curricula of range or wildlife management in which climatic climax is considered to be natural."

In his article he reviews some of the information collected by several agencies from 1911 to 1960 testifying to overgrazed conditions and destruction of the soil and vegetation resource on the summer and winter ranges in Grand Teton and Yellowstone Parks. He then points out what are for him departures in present Park biologists interpretations from good range and wildlife management. Some excerpts of this portion of his discussion are provided here. Because Beetle is one of the most outspoken critics of the current management policies for areas such as the northern winter range, his views deserve particular and extensive attention.

> "No matter how vigorously protested or ignored, it can hardly be considered a secret that throughout this century many reports of poor range conditions in Wyoming have involved the ungulate populations in two national parks, Yellowstone and Grand Teton."

> "As will be shown, to advocates of the zootic disclimax [present Park biologists], these things may be quite natural, if not unavoidable." (This is in reference to the descriptions of deteriorated range).

> "The assumption of the new school is that in national parks, in national forests, and on big game ranges such disclimax

stability is more natural than a climatic climax. It is created and maintained by native ungulates regardless of whether they are occupying their traditional range (as the elk are), or are occupying greatly enlarged ranges (as the moose are); and whether or not the balance has already been upset by the elimination of a native ungulate such as the bison."

"With range exclosures eliminated as evidence of what is pristine, the void is filled by the use of old photos. When one uses old photos, one soon finds that what one has been led to believe is "aesthetic" is not really compatible with "scientific values." Such unaesthetic habitat features as bare ridges, browse line, and fire scars become quite acceptable."

"Overwinter mortality acts as a natural check on population, and even if this mortality is high, it is still natural," (i.e., it is considered natural by Park biologists, not Beetle).

"If the forage deteriorates and leads to poor nutrition in the ungulates, and if this in turn leads to low rates of ungulate increase because of infant mortality, either prenatally or post-natally this is also natural."

"This means that if associated animals (even associated grazing ungulates like the deer) are forced into marginal situations and decrease in numbers, this is natural. If the plant populations become disclimaxed permanently, this is natural."

"On this basis, there should be concern for aspen as a community in this area. Those concerned with the survival of rare and endangered species will find little comfort in this "rationale" which can account for the elimination of a whole community."

"At this point one is faced with the question as to whether "wild" fires can undo the ecological changes caused by ungulate grazing."

Beetle also provides some specific objections to what he perceives the current Park biologists to be saying.

> "Since this group advocating the acceptance of the zootic disclimax is new, traditionalists should be tolerant while some of the inconsistencies are worked out. It appears that, (1) Cole (1971) has offered two ecologically different definitions of zootic climax: (a) "stabilized seral stage"; and (b) stabilized biotic disclimax", and which is meant should be clarified; (2) with fire and ungulate grazing assuming the roles as the only natural forces in ecosystems, it will be necessary to show how climates and fragile soil mantles fit into the scheme of things; (3) aspen regenerate without fire in all exclosures in the Teton County area. The latter is not an important fact since quaking aspen is no longer an important food source. But if not an important food source and not an intrinsic climax type, why try to regenerate quaking aspen with fire? (4) Granting that management decisions and objectives may differ in a national park, research in a national park is not "unique". Aren't the laws of natural science universal? (5) A more definite statement on how an "ecologically complete habitat" is identified needs to be developed, especially since the new school chooses to apply the principals equally to Yellowstone and to Grand Teton National Parks and it is not clear how the unlimited winter feeding of elk in the national elk refuge contributes to an ecologically complete habitat."

Beetle concludes his article with a question he has obviously already answered for himself.

> "Is the whole zootic disclimax concept a whitewash of elk management policies, or does it deserve a place in our textbooks?"

In 1974 Houston completed the first volume of a two volume work on the northern elk herd entitled, "The Northern Yellowstone Elk, Parts I and II - History and Demography". It dealt primarily with the population dynamics of the northern herd. In it he summarized and expanded on the interpretations expressed by himself and his colleagues on the Park Service Research Staff in the scientific literature during

the five years previous. In its extent and detail it marks a milestone in research efforts dealing with the northern winter range.

1975

Houston (1975) used an article in Bio Science to emphasize that major changes had been made in the interpretation of the history of the northern elk herd and to point out the "far reaching implications of this changed interpretation." In what he calls an "intriguing detective story," he point by point identifies the specific departures from information traditionally used as a basis for management decisions.

> "For the past half-century nearly every account of the population dynamics of the northern elk, every interpretation of habitat conditions, and many interpretations of the relations of elk with associated herbivores have been based upon one or more of the following premises: (a) the park area did not serve as historical winter range; (b) following establishment of the Park the population erupted to 35,000 by the early 1900's; (c) the population crashed to 10,000 to 12,000 between 1917 and 1920 - attendant range deterioration is often suggested. My review of the historical data shows that these premises and interpretations were incorrect."

The numbers given for the yearly counts during the first decades of this century indicate dramatic population changes. It is difficult to imagine how such enormous errors in population estimates could have been made. Houston suggested three areas where these errors could have occurred.

> "First, gross estimates of numbers of elk summering in the entire Park were misinterpreted as referring to just those wintering on the Yellowstone River. Summer herds are

> composed of animals from many discrete winter herds surrounding the Yellowstone Plateau. Second, the early definition of the "northern herd" included elk wintering on the Yellowstone River and its tributaries within and adjacent to the Park (the current definition). Third, some early census attempts and calculations of increase rates were clearly faulty.
>
> ". . . The reported population "crash" resulted from accepting as established fact the administrative suggestion of large scale winter mortality to explain discrepancies between two population estimates."

Houston pointed out how these "erroneous interpretations," as he calls them, became fact through false assumptions and repetition and became the basis for decades of management decisions as erroneous as the interpretations.

> "These accounts were then used to support, in part, various management programs for the northern elk which have ranged from predator control and winter feeding to large scale population reductions within the Park."

Owing to the stature of Yellowstone Park as an extraordinary natural area and the world's first national park, its history is often studied and its management closely scrutinized. Because of this, these errors in observation and management have had a wider sphere of influence than just Yellowstone Park.

> ". . . I have observed that the traditional "history" of the Yellowstone elk, often complete with graphic accounts of the population eruption and crash, has been (a) used (sometimes with the Kaibab deer story) to buttress the need for ungulate population reductions in other national parks of the world, (b) used to caution against establishment of new national parks, (c) used as the rational to support the "need" for sport hunting of ungulates, and finally, (d) taught to students as examples of ungulate habitat relations, the role of predation, and so on."

The sight of elk starving to death or carcasses of "winter killed" elk on the northern winter range has often aroused public sentiment. As has been mentioned earlier in this discussion, it motivated Park managers during the first decades of the Park's history to provide artificial feed for the elk herds during the winter months. The wisdom of this practice was questioned and it was eventually discontinued. Although the public may not fully understand the rationale, artificial feeding will undoubtedly not be practiced again on the northern winter range. Early Park managers sensed the damage that artificial feeding could do to the elk and the range, but as an understanding of the natural regulating factors operating on the elk herds was reached, Park biologists were able to be more specific about the harm that artifical feeding could do and already had done on the northern winter range. Cole (1975) briefly discussed some of these points on an NPS information paper.

> "Wild animals have social systems where individuals and groups use different portions of an environment according to their sex, age and social rank. Such systems are the results of long periods of natural selection for what works best in the wild. The practice of artificially feeding populations of wild animals collapses these social systems by concentrating (crowding) animals that would otherwise be separated or occur in smaller groups. Such crowding increases competition for space and food to the extent that both the production and survival of young and the mean size of populations are reduced from what they would otherwise be. An additional effect of crowding is that it increases the incidence of communicable diseases . . . Contrary to popular beliefs, artificial feeding does not reduce death rates in wild animal populations. This is because feeding intensifies competition

> between week and strong animals for space and food above what it would otherwise be. Thus, feeding adds an additional regulatory effect on a wild animal population.

Concentrating the elk by artificial feeding affects distribution patterns and feeding habits which in turn alters successional trends and the overall impact on the range. Because artificial feeding was practiced on the northern winter range all of these factors need to be added to the list of variables considered in attempts to determine the condition of that range.

1976

Houston concluded his exhaustive summary of the northern elk herd in, "The Northern Yellowstone Elk, Parts III and IV: Vegetation and Habitat Relations". His research supported the conclusions about the condition of the northern winter range presented by himself and Cole in early papers. An extensive collection of old photographs compared with recent photographs taken at the same locations is included in the report. For Houston they provide additional evidence for his ideas about successional trends in the study area. This particular report provides the most thorough statement of the current Park service interpretations of elk - habitat relations on the northern winter range to date.

1977

Olmsted (1977) discussed the effect of large herbivores on aspen in Rocky Mountain National Park. Although this paper does not

specifically deal with the northern winter range, he makes several references to the work done by Houston and Cole in Yellowstone and often likens the situation on his study area with conditions on the northern winter range.

His research seemed to indicate that on his study area the aspen population was controlled by the browsing utilization of the ungulates which he says "contradicts Houston's (1973) comment that the aspen are not controlled by the ungulate population." In another statement directed at Park-administered areas in general, he made references applicable to Yellowstone.

> "The decline and potential disappearance of these aspen stands on the winter range does not seem consonant with either "natural" ecosystem processes or the Park management goal of the maintenance of pristine ecosystems as discussed by Houston (1971)."
>
> "If the aim of the Park Service is to attempt to maintain the aspen stands within the winter range then effective management practices will have to be put into effect without delay."

1980

Forest Service management policy for the winter range has also gone through some changes, although they have not been as drastic as those of the Park Service. Conflicts between livestock and wildlife interests have increased. Controlled burning has become an integral part in Forest Service efforts to minimize these conflicts and to relieve some of the grazing pressure on the winter range in the Park.

Approximately 2,000 acres have been burned in the last 3 years.[1/] Justification for the use of controlled burns is given in the following quotation from Gardiner District Ranger Lewis:

> "In recent years, we have heard increasing numbers of complaints about the adverse impacts that the wintering big game are causing to private land resources and students. . . . Our management objective on the proclaimed winter range above Gardiner is to improve range conditions to encourage the elk to remain on the area longer; thus lessening the impact on the private land down the valley. . . . It should also be understood that we are not managing the habitat to increase the elk numbers, but to encourage those animals that migrate from the Park to remain in this area for a longer period of time.
>
> "One way to improve the forage on the winter range is to reduce the sagebrush competition by use of fire. We attempt to create a mosaic pattern of sagebrush covered areas where the sagebrush competition has been reduced. The area in Eagle Creek which was burned in 1979 responded with an increase of over 1,500 pounds green weight per acre. These areas are also being heavily used by elk and deer."

[1/] Adkins, R. Fire management specialist U. S. Forest Service, Personal Communication.

CHAPTER 3

THE CONDITION OF THE ASPEN STANDS

One of the most controversial aspects concerning the condition of the northern winter range involves the health and status of the aspen stands. Aspen has decreased from covering 4% to 6% of the area to covering only 2% to 3% (Houston, 1976). Almost every report or paper throughout the history of the controversy has mentioned the plight of the aspen stands. Opinion has changed considerably concerning the specific ramifications of the various ecological trends noted to have occurred in the aspen stands during the course of this history. Because the condition of the aspen on the winter range has so consistently been linked with the condition of the range, it has been singled out in this discussion to compare the conclusions of past and present Park Service personnel with relevant literature.

A literature review of this nature brings fresh input into the discussion from researchers not directly involved with studying the northern winter range. A similar approach could be used to investigate other facets of the discussion of the condition of the northern winter range that appear to be controversial, such as the condition of the willow, the role of drought in determining ecological changes on the winter range, and the significance of the grazing disclimaxes or erosion areas.

Whether or not the condition of the aspen stands should be viewed as a significant indication of overall range condition and proper stocking is a point of contention in itself. Present Park biologists would probably deny its use as such, while past observers, as already mentioned, frequently went to the aspen groves for trend indications.

Houston (1954) with the Intermountain Forest and Range Experiment Station in Ogden, Utah compiled a condition guide for the aspen ranges of Utah, Nevada, southern Idaho, and western Wyoming. Although he mentions instances where aspen is used as a guide to proper stocking, he warns that this is not always a reliable practice, especially where more preferred forage is available. In particular, the presence or absence of aspen reproduction has been used as an indicator of range condition, the presence of aspen reproduction indicating satisfactory condition and the absence unsatisfactory condition. Houston comments that the complexity of additional variables makes such generalizations invalid. If, however, a notable absence of aspen reproduction can be linked to browsing pressure the generalization holds true and the range is in unsatisfactory condition. Obviously, an absence of reproduction not linked to grazing or an abundance of reproduction does not indicate any particular condition class.

Julander (1937) discussed the importance of browse on big game range. He concluded that "browse holds a more critical place than any other class of forage on a great many big game ranges in the United

States." The principal reason for this being that available forage on the winter range is considered to be the limiting factor regulating the population size of most herds, and browse species constitute much of the available forage on winter ranges.

Julander goes on to state:

> "since the available forage resource of any range is the foundation upon which rests the maximum big game population, the perpetuation of the important forage plants is of utmost importance, counts to determine population of big game are often only estimates, and even where accurate counts can be made, utilization of forage on the critical areas is the ultimate criterion as to the maximum or optimum game which should be permitted on the range.
>
> Too often the choice forage plants of our game ranges have suffered severely and the carrying capacity of the range has been gently reduced before the situation is realized and corrected.
>
> In actual big game management three fundamental things must be ascertained, (1) what plants do game eat and which are the principal species, (2) what constitutes proper use of these species, and (3) how can degree of use be measured and used as a guide to proper stocking."

Past opinion has been that the aspen on the northern winter range eloquently express that they are overutilized and this in turn indicates that the carrying capacity of the range is in Julander's words being "gently reduced." It is this attitude that was partially responsible for initiating plans for systematic elk reductions on the range. Present opinion would line up more accurately with Houston's qualified statement that the complexity of the situation with its multivarious variables does not allow for such a direct correlation to

be drawn. Regardless of the absolute accuracy of either opinion, the dramatic changes that have taken place in the aspen stands since the Park's inception speak of major changes in the ecology of the northern winter range that bear investigating; and intuitively with the aspen serving as a browse species to the elk they should provide some window into the relationship between these ungulates and their environment.

What is often overlooked is that aspen, even if they are not indicators of range condition, have value in themselves and their exit from the landscape will represent a loss, albeit an unquantifiable loss. Range "condition" or "health of the range" implies more than forage quantity and quality but should also include the less tangible values of aesthetics - especially in an area managed under the banner of the Park Service philosophies. However, paradoxically, to be consistent with these philosophies, the demise of the aspen stands is only a loss if it is the result of man's intervention and mismanagement. If it is not, then the departure of the aspen is merely another event in the ongoing drama of an everchanging natural world. Much of the role of the aspen in this controversy then revolves around the establishment of the origin of the influences that are causing their decline. An examination of the effect of ungulates on aspen in other areas and situations would be apropos.

As a practical application of his statements, Julander studied the Kaibab National Forest in Arizona and its deer population hoping

that this example could be applied to other big game ranges as well. He decided that aspen was the most important key species on the summer range, and its overuse and resulting decline represented an overpopulation of deer and a subtle undermining of carrying capacity of the range. He implies that an indication of the deer population returning to its proper size would be when the aspen reproduction is again allowed to make gradual increases in height to replace the mature trees without being continually browsed to the ground.

In examining the actual effect of browsing on aspen, Julander found that aspen "will not recover nor maintain itself if utilized 75 percent or more. Aspen will almost maintain itself when browsed 70 to 75 percent but will not recover from overbrowsing. Browsing aspen 65 to 70 percent will permit fairly good improvement from an overbrowsed condition and greater improvement might be expected under lighter use." A totally protected plot showed "a rapid and steady increase in aspen growth by every measurement."

Gysel (1960) reported on the ecology of the winter range for deer and elk in Rocky Mountain National Park. He seemed to be able to substantiate from early reports and journals that historically, big game wintered in only very small numbers within the Park, most of them choosing to migrate to the adjacent plains country instead. Subsequent events saw an apparent marked decrease in the number of elk at the turn of the century, and reintroduction efforts and establishment

of the Park in the early 1900's. By 1941 overpopulation of the range was considered a serious problem. The aspen groves found on the winter range were noted as victims of the high concentration of elk.

Without taking time here to mention any of the methodology, exclosures set up to maintain the influences of elk on the aspen over a 25 year period revealed healthy aspen reproduction in the exclosures and no aspen in the adjacent plot that could be reached by elk. In other exclosures around mature trees the protected trees had many 8-10' stems around them while the unprotected trees had none.

Banfield (1949) reported on the irruption of the elk population in Riding Mountain National Park of Manitoba. A study in 1947, an especially hard winter, showed that the high elk population caused severe damage to the aspen stands. As high as 76% of all the aspen under 10' in height in the area studied were killed and 69% of the aspen over 10' had part of the bark removed.

Concerning the role of big game species on aspen, Graham et al (1963) had this to say:

> "The interactions that occur between aspens and deer have profound effects on both the trees and the animals. When the deer are overabundant they can completely destroy all aspen reproduction following a logging operation, whereas when their numbers are moderate they may exercise a beneficial influence by thinning over-dense sucker stands. Aspen suckers are a much needed source of food for deer, and when the herd is of moderate size there need be no ill effects on the development of good aspen forests. A complex set of interactions determines when and where deer will cause damage and when and where their effects will be mutually advantageous. These include not only those things that occur

> between deer and aspen within the stands, but also the influence of adjacent types on food habits, movements, and concentrations of the animals. Therefore, the habits and requirements of deer and their interactions within the entire locality over which they range affects their influence upon stands of aspen suckers."

Along the same lines, the authors found that when other palatable shrubs and low trees are available the effect of deer on aspen stands is reduced. Aspen is not considered to be a highly preferred browse species. Although the above comments are in reference to deer use, certainly they are applicable to elk use as well.

As an example of the complexity of the relationship between a big game species, aspen, and the environment a much higher incidence of browsing was found in aspen stands close to coniferous stands. The need for shelter concentrated the animals near the conifers and, as a result, the aspen nearest the sheltered areas were most heavily utilized. Conversely, aspen stands separated from necessary shelter by deep snows and distance can be spared from damaging browsing. This particular situation is important in the fate of the aspen on the northern winter range in Yellowstone.

The most important criteria for adequate utilization of aspen were not considered to be on the basis of individual suckers but on the basis of whether or not the stand as a whole is making sufficient growth to put new suckers beyond the reach of deer within three to five years. There also seemed to be a direct correlation between the diameter of the twigs browsed and the number of deer feeding in the

area. "If on the average, the twigs browsed are not more than 1/4 inch in diameter the suckers will grow above reach of the deer without ill effects." If suckers are grazed beyond 1/4 inch in diameter it is an indication that the area is overpopulated and forage is inadequate in either quality or quantity. Another reported indication of overbrowsing is when the stand is reduced to less than 4,000 evenly distributed suckers per acre over a five year period and insect and fungus injury is evident. Under such a situation where it is unlikely that a healthy stand will be able to develop the authors consider the only recourse to be attempting to establish a new and denser stand from the roots of the damaged stand. To accomplish this the destruction of the remaining above ground structure is recommended, but a mandatory prerequisite of these actions is a reduction of the number of browsing animals using the area.

Sampson's (1919) work involved the effects of sheep and cattle on aspen reproduction - information which can be extrapolated to fit this discussion. He found that sheep are considerably more deleterious to aspen reproduction than cattle. One reason is that sheep have a marked tendency to consume greater portions of the woody stems, a characteristic they share with elk. Three years of successive grazing by sheep after clear cutting an aspen stand to stimulate reproduction is sufficient to destroy the entire stand. Under similar conditions and normal stocking rates within the carrying capacity, cattle will

not destroy more suckers than are needed to replace the stand. The factor that emerged as being the most critical in ensuring the survival of a sucker is its ability to quickly attain a height at which it can no longer be browsed. With an average annual growth increment of 15 inches, sprouts are relatively safe from damage by sheep at three years and safe from cattle at four to five years.

Sampson found that aspen is not necessarily permanently injured by the removal once or twice of the terminal shoot as it can readily be replaced by shoots arising from adventitious buds near the shoot apex. It is the removal of both the lateral branches and the terminal shoot to such an extent as to interfere with photosynthesis and nutrition of the plant that puts the plant in jeopardy. With growth thus slowed, either death will occur outright, or the plant will be continually weakened by repeated browsing until it dies, since it is unable to grow past the height beyond which it can no longer be damaged.

Smith et al, (1972) discussed the effects of deer and domestic livestock on aspen regeneration in Utah. Two kinds of damage to young sprouts resulting in significant attrition rates were directly attributable to large mammals - trampling and removal of the terminal bud. Additional sources of injury were pocket gophers and disease, both of which were reputedly capable of "substantial" amounts of injury. Damage due to frost was also considered a factor.

> "These studies provide no evidence that big game animals are primarily responsible for failure to obtain adequate aspen reproduction."

Although this conclusion at first glance seems to be of importance to this discussion, its relevancy is somewhat diminished by the fact that the amount of big game using the area is only vaguely referred to as "normal" and "substantial". In addition, there is no indication of the intensity of use on a seasonal basis. Their conclusions further stated:

> "Nothing in the data suggests that regeneration of aspen is not possible even under heavy use by domestic livestock. Stocking in the controlled sheep and controlled cattle paddocks varied from 0.75 to 2.0 acres per AUM, which can be considered only as heavy use. At the same time, utilization of the herbaceous forage was heavy. Despite this, aspen regeneration was deemed adequate in these two treatments and percentage wise, the survival of sprouts was as good in the fourth year after cutting as under protection."

This, of course, refers to areas radically modified to promote aspen regeneration.

Additional comments of significance included the following:

> "Reproduction was adequate on the treatments in which the initial number of sprouts was large - clear and partial cutting. Conversely, where few sprouts appeared and sprout vigor was poor, damage was severe."

> "Sheep are potentially a more severe threat to aspen regeneration than are cattle, since they browse aspen more readily than cattle, especially after the first year of sprouting."

> "The first year following cutting is critical to successful regeneration, for that is the year when most of the sprouts emerge. They appear to be most palatable to all browsing animals then, although Sampson (1919) thought otherwise."

Three factors were mentioned that operate to lessen the impact of use:

> "1) an apparent decline in palatibility, 2) an increased volume of aspen herbage available, which provides some buffering to leaders, and 3) increase in height of sprouts."

Gaffney (1941) studied the effects of winter elk browsing on the South Fork of the Flathead River of Montana. The area he was investigating was, in his opinion, experiencing an overpopulation of elk, resulting in deterioration of the range. He found that aspen was one of the most severly damaged species. In the spring of 1937 at least 50% of the young aspen between 15 inches and 6 feet tall were killed by browsing. Aspen were frequently found to be browsed to diameters of more than 3/8", an indication according to Graham et al (1963) of overpopulation and inadequate forage. In areas where grass and other forage was still abundant aspen was not heavily utilized. Gaffney concluded, "it is believed that the rate of elimination of aspen through succession is being rapidly increased by the browsing; little of the reproduction survives."

After the preceeding review of literature dealing with the effect of grazing animals on aspen one rather simplistic observation that becomes readily apparent is that many researchers in a wide variety of locations and situations have found that grazing animals, elk in particular, can cause the gradual destruction of aspen through browsing pressure. Olmsted (1977) investigated a winter range situation in Rocky Mountain National Park very similar in many respects to the

northern winter range in Yellowstone and concluded that the aspen population there is controlled by the ungulate populations. Present Park biologists will agree that browsing in combination with drought killed some stands in the 1930's, but the pressure of browsing is not considered to be presently or historically the determining factor in the fate of the aspen on the northern winter range, rather the decrease in aspen is considered to be directly correlated with the suppression of natural fires, a practice started early in the history of the Park and carried out fairly successfully to the present (Houston, 1976). Herbivores are credited with being capable of "affecting the rate of post-fire succession, but not with being the force which determined the direction or timing of events." The very dense low stands of aspen once common to the range, as revealed by early photographs, are considered to be of fire origin. The fact that individuals of these stands were able to survive and mature into the present stands is also cited as an example of the minor role played by browsing pressure. Successful reproduction from suckers in protected stands admittedly occurred but this occurrence apparently is not considered significant because "densities and growth rates often did not approach those suggested by early photos." Perhaps one of the most substantial arguments used by present biologists to refute the claims of those who have argued that the decline of the aspen demonstrates that the elk are overutilizing this species is the fact that during the elk

reductions of the early 1960's when a 50 to 70% reduction in the population occurred, aspen reproducton did not increase nor did already established new growth manage to increase in size.

After expanding the depth of this particular facet of the controversy with these additional details, it becomes obvious that an understanding of aspen regeneration and the role of fire on aspen is necessary to understand both sides of the issue.

A substantial amount of literature supports the opinion of a close, even inexorable, link between aspen ecology and fire (Loope and Gruell, 1973); Graham et al, 1963). The importance of fire in aspen ecology is linked to the role that fire plays in the rejuvenation of aspen stands. Aspen is capable of reproducing sexually by seeds, although this is considered to be an irregular occurrence in the eastern United States (Graham et al, 1963) and rare in the Rocky Mountains (Olmsted, 1977). In fact, reproduction of aspen by seed in the Rockies is so atypical that the location of a seedling by Ellison (1943) at high elevation near a swamp in southeastern Utah and a large cluster of seedlings by Larson (1944) on the bank of a reservoir, again in Utah, was considered noteworthy. Contrary to earlier opinion as expressed by Baker (1918), aspen can produce an abundance of healthy, viable seeds capable of germinating (McDonough, 1979). In spite of this, aspen seedlings easily succumb to the pressures of competition and dryness. They appear to be incapable of gaining a

foothold if forced to compete for root space or light; in addition, moist soil for a prolonged period of time is required. With these constraints, opportunities for seedling survival are slim, although in a controlled environment seedling establishment and rapid growth can be achieved (Graham et al, 1963). Consequently, the only significant reproduction of aspen is not sexually by seed but asexually from suckers. The actual mechanisms responsible for stimulating the production of suckers and the effectiveness of these mechanisms are much discussed topics. Along with other methods of destroying the above ground structure of the aspen plant, such as clearcutting, fire seems to have a pronounced effect on aspen in favor of prolific sucker information.

Graham et al (1963) compiled an extensive review of literature dealing with aspen, principally around the Lake States. The initial topic concerns aspen reproduction. The authors mention the potential of aspen to reproduce by seed considering the plethora of viable seeds it can disseminate. However, they qualify this by mentioning the almost complete inability of aspen seedlings to endure either dryness or competition. "Thus, the reproduction of aspens from seed is an uncertain matter requiring a combination of conditions; namely a supply of seed deposited on bare soil where favorable moisture and temperature prevail for a few weeks required for germination and establishment" - a rare occurrence.

The production of suckers then is referred to as the primary means of aspen reproduction, a process the authors consider to be closely associated with the separation of the roots from the influence of living crowns. This ability to produce suckers is said to vary considerably from clone to clone; and the number of suckers produced to be directly related to the health and vigor of the parents. Apparently, when trees become decadent and die their ability to produce suckers is greatly diminished. Age also seems to be a factor. The authors found that trembling aspen reached its maximum ability to produce suckers at 35 years of age, at least on the lower penninsula in Michigan. From a practical standpoint, however, age seemed to be only of minor importance, particularly the age of maximum sucker production ability, since trees of all ages, even 100 year old trees, were observed producing suckers in sufficient numbers to replace the stand if cut or killed by fire.

Aspen is considered to be an intolerant species, i.e., poor competitors unable to withstand the encroachment of more tolerant species. Aspen stands being invaded by other species are reputedly more susceptible to destructive agents than pure stands. In this perspective, the authors describe aspen as a seral stage to climax, at least in the context of Michigan. "Aspen, then as now, must have been a temporary species, seldom if ever surviving on the same areas for more than one generation without fire."

As an interesting aside, the presence of a heavy herbaceous ground cover was found to have a marked effect on aspen stands. Young trees grow more slowly in dense sod than those that are in open soil because of the competition for moisture. A dense sod cover can aggravate the conditions present during drought.

Horton and Hopkins (1965) investigated the effects of fire on aspen root suckering, primarily its potential in deterring rather than stimulating suckers production. They found that fire could be used to reduce sucker production but only with very intense fires - fires of an intensity that it would be impossible to generate in an aspen grove environment without large additions of supplemental fuel. Through the course of their investigations they ably demonstrated that "moderate intensity" burning stimulates vigorous aspen reproduction; i.e.:

> "one which kills all canopy and underbrush stems, removes the litter and much of the duff layer, leaving a half inch or less of humus and ash with patches of exposed mineral soil."

A light burn, one which "kills only part of the vegetation and removes the litter and top duff layer in patches" was considered to be undesirable in that it, "fails to induce sufficiently dense and vigorous suckering for a future aspen stand of good quality." It did reduce the effective development of conifers - a beneficial or deleterious consequence depending on the management objectives. An increase in soil temperature combined with the destruction of above ground stems were viewed as the principal agents stimulating aspen suckering.

Maini and Horton (1966) looked specifically at the role of temperature following cutting and burning in stimulating sucker production. They concluded that insolation-induced increases in soil temperature is the most important factor in sucker stimulation.

Schier and Cambell (1978) found that the best time to stimulate aspen suckers by cutting or burning is when clones are at an age where they are growing vigorously. Rapidly growing clones have an abundance of small roots which, as this study shows, have a high sucker-producing potential. The health and vigor of the clonal root system was considered to be of primary importance in aspen management because "suckers not only are initiated on parent roots but are dependent on them for a period of time afterward." Wide clonal variation was found in some of the variables affecting sucker production and survival, namely "in the depth and diameter of parent roots and in the ability to initiate new roots around the base of suckers."

Farmer (1962) investigated the physiological mechanisms which control sucker formation. He concluded that the phenomenon of apical dominance is the primary controlling factor to sucker formation thus giving credence to the understanding that physically damaging the aspen plant is necessary to stimulate asexual reproduction.

Sampson (1919), in studying the effects of grazing on aspen reproduction noted what in his opinion is the relative inability of aspen to reproduce under its own shade. He recommended clear cutting as

a means of stimulating reproduction and obtaining a timber crop as well if that is a management priority. He also mentioned the high susceptibility of new sprouts to damage. Even on the most favorable sites a large proportion succumbs during the first three years to pressures other than browsing, such as frost damage and rodents.

Julander (1939) reached similar conclusions. In his studies the destruction of the mature aspen trees through cutting produced aspen reproduction, but three years after cutting very few new sprouts were produced. If very heavy browsing occurs at this time, the aspen gradually disappears from cut over areas.

Schier (1976) explained the role of fire in aspen ecology in that its repeated occurrence:

> "has enabled clones to increase in size because it resulted in the successive generation of shoots on a continually expanding root system."

However, he also comments that drastic damage to the aspen by fire or logging is not a prerequisite for sucker initiation as is evidenced by the common occurrence of suckers around undisturbed aspen clones. There may be subtle environmental changes that weaken apical dominance and lower the levels of auxins that prevent sucker formation. This could occur in the spring when temperatures are high enough for the initiation of suckers and prior to the bursting of buds. Schier also reports a wide clonal variation in sensitivity to factors that induce suckering. Apparently some clones are so sensitive that chemical

balances are easily swayed in favor of sucker production and, as a result, mortality is quickly replaced by new plants creating stands with a wide variety in age groups represented.

The production of suckers is also related to carbohydrate reserves. Aspen, as Schier explains, has a high capacity to reproduce vegetatively, but there are limits to how much abuse it can take. Repeated destruction of aspen reproduction by burning, cutting or heavy grazing has the capacity to drastically lower carbohydrate reserves and reduce the amount of suckers produced.

Smith et al, (1972) concluded that girdling standing trees or disturbing the root system are relatively ineffective ways of stimulating aspen regeneration compared with clear cutting. The authors also concluded from the results of various portions of the study that aspen has the capacity and the propensity to send up sprouts continually.

Schier and Smith (1979), while investigating different methods of stimulating aspen reproduction, also looked at the effects of girdling mature trees. This is of particular interest because of the similarities between this process and the effect of elk stripping the bark from trees for forage (a habit of elk referred to frequently in the Park Service range reports). Schier and Smith found girdling to be a good method for eliminating aspens rather than ensuring replacement. Girdling seemed to produce an initially poor response and the suckers

that were produced were unhealthy and short-lived. The explanation given for this occurrence accounts for the production of suckers because the action of girdling the tree disrupts the flow of growth-inhibiting auxins through the phloem to the roots, but at the same time the xylem is not disturbed and growth-promoting auxins produced in the roots are not forced to accumulate there and stimulate growth but are transported up into the tree. The roots died back rapidly because the tree continued to drain root reserves while not being able to resupply the below ground structures. The total effect of girdling then is to destroy the trees in one to three years after the treatment but without producing healthy suckers to replace the stand.

Schier (1975) suggested that fire, in addition to its role in aspen regeneration, could operate as a controlling mechanism in the spread of pathogens. Since aspen reproduces asexually it is possible to continually reinfect the stand. Fire, as it destroys the diseased vegetation, at least reduces the amount of inoculation source and thus cuts down on some of the agents that hasten aspen stand decline.

Of special interest is a paper by Basile (1979) dealing with the relationship between elk and aspen on a prescribed burn in the Jackson Hole area of Wyoming. Apparently fire serves as a temporary deterrent to elk use. Elk use dropped significantly in the first year following the burn, but returned to preburn levels the second and third post burn years as indicated by pellet group counts. An 87% increase in

suckering occurred as well in the first year following the burn. However, this increase was by no means uniform among the nine burned clones comprising the study.

> "Suckering decreased 62% on one clone, remained unchanged on three clones, and increased on a fifth clone by only half the percentage rate that suckering on the control clone did. Thus, suckering on only four burned clones increased proportionately over that of the control in the first year; however, a somewhat more uniform response was noted on the second and third years."

Basile could not directly account for the different responses but conjectured that preburn vigor of the clones, the density of the parent stems, and the intensity and completeness of the burn are all possible variables. Genetic variation was also considered. Basile cited from Jones and Trujillo (1975), Egeberg (1963), and Farmer (1962) and Tew (1970) respectively to show that genetic variation has been observed in aspen for susceptibility to major decay fungus, susceptibility to frost damage and for suckering ability and varying optimum conditions for suckering. Figures in the report indicate that sucker numbers were greatest in the second year following burning. A decline in these numbers occurred in the third year, but all the clones excluding one were showing a quantity of reproduction greater than preburn amounts. A seemingly incongruous observation further emphasizing the amount of variation that can occur was exhibited in the control plot which more than doubled its number of suckers produced in the three year study period in spite of the fact that it received no treatment.

Basile was quick to point out that sheer numbers of suckers does not guarantee the survival of a stand. Stand survival is only possible where a sufficient number of suckers survived the impact of browsing by elk to reach a height making them inaccessible to further browsing pressure.

He concludes the study by suggesting that, because of the variability from clone to clone in response to fire, the chances of fire having a significant beneficial effect on aspen reproduction would be greatly enhanced by burning large areas and involving many clones rather than having small fires in isolated clones. As for whether or not it is possible to perpetuate aspen stands using fire considering the present levels of elk browsing he surmised that it is still only a matter of broad speculation.

It is a commonly held opinion that aspen is basically a fire dependent seral species to the shade tolerant and less fire resistant conifers. This viewpoint has helped lead present Park biologists to conclude that it is the absence of fire not grazing pressure from elk that is determining the successional direction of the aspen stands on the northern winter range. Mueggler (1976) reiterates this opinion and, although this view is easily supportable, he suggests that there are enough exceptions to this to be noteworthy. Even where aspen is a seral stage over 1,000 years may be necessary even in the absence of fire to achieve a conifer climax; and under certain conditions aspen

stands can be self-perpetuating as evidenced by stands with trees of uneven age distribution. Mueggler calls such stands "defacto climaxes." Although the presence of conifers in an aspen stand is often used as an indication that the stand is of the seral type, Mueggler says this diagnostic tool is not always accurate. Rather, it is more specifically the presence of a multiaged conifer understory that is a fairly reliable indicator of a seral aspen site. At sites unsuitable for conifers aspen stands may give way to grassland or shrub types where the mechanism of apical dominance or heavy browsing prevents the replacement of mature trees by suckers.

Severson and Thilenius (1976), while investigating the aspen stands of the Black Hills and the Bear Lodge Mountains of South Dakota and Wyoming found examples of both seral and stable aspen types.

Reed (1970) discussed the synecology of the aspen forests of the Wind River Mountains of Wyoming. He identified a Populus tremuloides - Symphoricarpos oreophilus association he considered to represent a distinct climax community. Some of the characteristics of these communities included a marked lack of conifers, a complex understory of a shrub layer and an herbaceous layer, and an apparent ability to replace the aspen overstory as it matured. A literature search by Reed revealed a fairly wide distribution in the western states of the occurrence of other stable aspen communities that could be considered as climax in nature.

It is interesting to note that Reed found ample evidence of aspen reproduction having the potential to mature and regenerate the stands without the stimulus of a radical disturbance of the stands being necessary. In a series of soil profiles examined, no evidence of charcoal was found indicating an absence of the influence of fire on these same stands.

Lynch (1955) examined the ecology of the aspen groveland in Glacier County, Montana. He discovered a situation in which the grove-grassland ecotone is in a stable position. The aspen groves continue to exist and perpetuate themselves without showing any real increase or decrease in size. The inability of aspen to advance into the grassland type was considered to be the result of inadequate seed production because of unfavorable weather and the inability of suckers to become established and mature under a combination of biotic, climatic, and edaphic factors. The biotic factors included elk, sheep, rodents, insects and fungi. Annual precipitation was considered to limit the extent of the aspen groves in a broad sense while the desiccating effect of the seemingly constant winds common to that area were thought to be a prohibiting factor for the establishment of individual suckers. Lynch considered the most important limiting factor to be an edaphic one - the exhaustion of available moisture for plant growth in the grove-grassland ecotone. Grazing by domestic sheep

appeared to be another critical factor by preventing the development of aspen suckers in the openings within the groves.

Lynch did not consider the aspen groves in the study area to be a fire climax because of the lack of burn scars on the trees and the unevenness of tree ages within the stands. The absence of fire did not seem to affect the ability of the groves to maintain themselves, but neither were they able to expand without its influence.

CHAPTER 4

SUMMARY AND CONCLUSIONS

The Condition of the Aspen Stands

Olmsted (1977) supports the view that aspen has persisted and reproduced vegetatively in the areas we find it today for a long period of time; perhaps since the end of the Pleistocene age several thousand years ago. If this is the case, then the rather dramatic decrease of the aspen stands on the northern winter range in the past 80 years is of special ecological significance. Keeping this time perspective in mind, it is only natural to question present Park Service opinions that the replacement of aspen, "does not represent retrogressive succession, but instead indicates types of natural primary and secondary succession" (Houston, 1971). Until about 12 years ago it was almost unanimously accepted that the antithesis of the above statement described the reality of the situation. The elk herds of the northern winter range were considered to be the primary agents involved in upsetting the ecological balance to such a degree as to jeopordize the future of the aspen stands. Relevant literature indicates that ungulates, specifically elk, have the capability of destroying aspen stands. Apparently ungulates are even capable of destroying the large quantity of vigorous suckers produced after some of the dramatic measures to stimulate the regeneration of aspen stands such as clear cutting or burning have been used.

The important role that fire, or rather the lack of it, has played in the successional processes at work on the northern winter range is heavily underscored by present Park biologists. The literature makes plain the important part that fire can play in ensuring the continued health and vigor of aspen stands. Along with the influence of such climatic incidences as the drought of the 1930's, this is a factor the importance of which has often been overlooked in past range reports.

However, just as past researchers have not given sufficient weight to this variable perhaps present researchers have the unwarranted tendency to view it as a panacea to the ills of the aspen stands. It is evident from the literature that aspen is capable of producing suckers in sufficient numbers to adequately replace the stand without killing the mature trees by burning or clear cutting being necessary. In other words, burning is not a prerequisite for successful regeneration, but it is essential for the grazing pressure to be light enough to allow the suckers to reach a sufficient height to escape the adverse influences of browsing. Apparently there is a great deal of clonal variation in the capacity to produce suckers and even in the response to the stimulus of fire. Some clones seem to have the ability to produce suckers prolifically without fire while others cannot, and the effect of each fire is not always predictable.

Houston (1973) noted that a 60 to 70% reduction in elk had no effect on the aspen reproduction, and therefore concluded that the aspen are not controlled by the ungulate population. In light of literature investigated here, the result of the reduction could just as easily have indicated the pronounced impact of ungulates on the aspen. It could mean that the aspen stands had been browsed so thoroughly and consistently that productivity and vigor were so greatly reduced from lowered carboyhydrate levels that a positive response was impossible. Or it could show that the carrying capacity of the range, at least as far as the aspen were concerned, was still exceeded even with a 60 to 70% herd reduction (Olmsted, 1977). It is also possible that the period of several years the literature indicates is necessary for aspen reproduction to become well established was not allowed. Olmsted (1977) drew a parallel with a similar situation in Rocky Mountain National Park.

> "In the study area in Rocky Mountain National Park, a 50% reduction in herd size permitted successful regeneration of one quarter of the stands examined. The herd was reduced to 700 which was still above the estimated carrying capacity of 530 elk that was estimated by Radcliff (1941). The elk population figures have not been below the estimated carrying capacity for the eastern winter range since 1934. If the scale of the reduction discussed by Houston was similar to that of Rocky Mountain National Park and the stands were the less vigorous ones, then it is not surprising that he found no effect created by reduction. Even if the stands were vigorous, a resurgence of the elk population to its higher levels following the reduction program would cause a loss of the regeneration established during the low in the ungulates population and a diminution of the effects of the respite from herbivory."

Houston (1973) uses the age range of the existing clones as further evidence that it is fire suppression and not browsing pressure that is causing the decline of the aspen. He explains that the advanced age of the clones, from about 75 to 120 years, would not have been found formerly because younger age classes would have been maintained by frequent burning. Olmsted (1977) replies to this by pointing out that 120 years is generally the upper age limit for aspen clones and 75 years corresponds to a time slightly prior to the earliest mention of range utilization problems in Yellowstone. Thus, this example could give additional evidence to the more critical role of ungulate browsing pressure.

The reports by Reed (1971), Lynch (1955), Mueggler (1976) and Severson and Thilenius (1976), demonstrate that fire is not necessarily needed to prevent aspen stands from being replaced by conifers. Aspen can be a climax species in certain instances - by definition capable of replacing itself. It can be inferred that overbrowsing can disrupt this and the clones will be replaced by grasslands.

Generally speaking, fire has a very beneficial effect on aspen stands, but in the case of the aspen stands on the northern winter range it might actually be deleterious. In order to stimulate vigorous sucker production, it would be necessary to burn the stands with a fire hot enough to kill the mature trees. This would prevent further input of energy into the root system. The amount of suckers produced

will be dependent on the extent of the energy reserves at hand, and the number of suckers surviving will be largely dependent on browsing pressure. If the energy reserves are low or the browsing pressure high, or both, the stand will not be replaced. The result would be the elimination of the stand (Olmsted, 1977). A light intensity fire, a distinct possibility in natural conditions, could also be harmful. Graham et al (1963) indicated that where a dense sod cover exists, sucker establishment can be difficult because of the competition for water and light. A light intensity burn could stimulate more prolific herbage production in the understory to the detriment of normal sucker production without providing any stimulus for additional sucker formation.

Aspen stands on the northern winter range are characterized by mature decadent trees with only scattered, stunted reproduction. Grazing pressure is high. The understory in many of the aspen stands is dense herbaceous vegetation. Predictably, burning the aspen stands would spell their demise, not insure their survival. As the literature points out, this situation could be even further intensified if only scattered stands were burned at a time, which is the probable pattern with natural fires. The additional browse provided by the new suckers in the burned stands would be quickly consumed by an elk herd capable of fully utilizing many times the amount of browse provided by a few stands. It would be necessary for a very large portion of the

winter range including many aspen clones to burn to allow for the survival of even a comparatively few number of suckers.

Although they occasionally made observations that indicated the contrary, biologists and Park managers investigating the condition of the northern winter range prior to 1969 underestimated the complexity of the ecology of the aspen stands. Because of an inability to properly discern a variety of variables affecting the aspen stands, an inordinant amount of emphasis was placed on a single easily isolated factor - browsing pressure. Such a narrow perspective could only lead to the conclusion that there were too many elk on the range.

Biologists in recent years have demonstrated a greater awareness of the details of aspen ecology. This has enabled more accurate insights to be made into the condition of the aspen stands on the northern winter range that more closely resembles the information presented in the literature.

> "Clones that have been entirely replaced by conifers or that are now represented by only scattered overmature trees have almost certainly been lost. It seems improbable that other remnant stands with understories now dominated by the exotic grass Phleum pretense would respond to burning. This grass has completely altered composition of the understory vegetation and perhaps affected the pattern of ungulate foraging. Certain of these stands which occurred on forest steppe ecotones and along flood plains may well have represented seral communities whose replacement was a natural event, but the reduction in fire frequency, no doubt hastened the process. Finally, there are clones that might be expected to regenerate following fire, although this could be complicated on some sites by the foraging of herbivores. The relations between aspen and herbivores in this area are complex and controversial . . . a variety of information suggests the

> hypothesis that reduction in aspen has been primarily a function of reduced fire frequency, rather than of foraging by ungulates, particularly elk" (Houston, 1973).

As demonstrated by the above quotation, this new awareness has legitimately led to an emphasis being placed on the importance of natural fires in the ecology of the aspen stands. A review of the literature demonstrates that a truth about aspen ecology is that each aspen clone may respond very differently to the same environmental variable, specifically fire and the lack of it. Generalizing about the role of fire in the ecology of the aspen stands may at times be as inappropriate as generalizing about the effects of browsing pressure.

In the pre-white man era of the history of the northern winter range, aspen, as a preferred browse species, must have existed in the area in a very delicate balance with its environment; either that or aspen is not as sensitive as we think and man's impact on the northern winter range has been even more environmentally disruptive than we imagine. The former is probably more accurate. Owing to the importance of wide clonal variation in response to environment variables, it should not be ruled out that many clones may have declined due to excessive browsing pressure brought about by even small or local variations in elk distribution and migration habits caused by man's activities. Even fire suppression as it affected forage production changed distribution patterns. Probably the most realistic approach to identifying the reason for the decline of the aspen on the northern winter

range is to realize that the ultimate causative agent for the decline of the aspen whether it was disease, drought, browsing pressure or fire suppression seldom operated alone and varied from clone to clone.

It is ironic to note that when the suggestion was first made to reduce the elk herd to save the winter range, including the aspen, what was actually needed was a "let burn" policy allowing for natural fires, not an elk reduction program. Through this miscalculation the aspen has been brought to the point where in order to manage the northern winter range to save the most number of aspen stands the discontinued elk reduction program is what is now needed. The literature seems to indicate that a massive elk reduction program in conjunction with a let burn policy (or more realistically, controlled burns) is the most accurate prescription for improving the condition of the aspen stands, although even these drastic measures may now be too late. We have reached a level of understanding of aspen ecology in time to discover that it is too late to actually do anything in a management sense to implement this understanding to restore a natural balance in the aspen stands short of using very drastic measures. In light of all this, the present Park Service policy of interfering in the environment of the northern winter range as little as possible, including allowing natural fires to burn, is the most politically palatable and ecologically sound alternative, although it will still

result in the unnaturally rapid decline in the aspen stands barring the most favorable of circumstances.

Changes in Management Policies

Present and past management policies for the northern winter range could not be more different. The difference is especially apparent considering the preponderance of data gathered by a long list of researchers over many decades supporting the same set of conclusions. In the course of a few years these conclusions were almost totally reversed even though the common goal of protecting the Park's resources remained the same. The year 1969 stands out as a point to divide the management policies into past and present. This does not mean that significant changes did not occur before and after that date.

Tracing the history of the management of the northern winter range reveals four main reasons for this reversal.

First, management philosophy has changed with changes in personnel in the Park's staff. Park Service philosophy is by nature flexible enough to be adapted to a variety of mindsets towards the proper way to manage the resource. To begin with, there is an inherent quality of tension built into trying to implement Park Service ideals. Its purposes, as stated in the congressional act that created it (see Introduction) are contradictory. Management policies for natural areas in the Park Service must be tailored to serve the diametrically

opposed purposes of that agency - use and preservation. In other words, Park managers are called to walk a tight rope between preserving the resource in a pristine condition while making it an enjoyable and accessible recreation facility for the visitor. The balance to be struck between use and preservation in any management decision is to a degree a matter of personal interpretation. As an expression of this, for many years saving the aspen stands was given a high management priority. Using the hope that the elk reduction program would improve the condition of the aspens as a justification for that program indicated a value judgement and a placement of priorities.

> "An elk herd can rebound with astonishing and often embarrassing rapidity from a low level under improved habitat conditions, but plant communities can be literally wiped out by over use. Recovery is often very slow. In the case of aspen, which is dependent on vegetative reproduction, there is little chance of replacement once existing stands are lost. After such a long abuse of vegetation and soils as has occurred on the Northern Yellowstone winter range, it would seem wise to favor the more fragile resource for a change" (Barmore 1967).

The aesthetic value, especially the visual enhancement aspen provided, was given as an important justification for trying to halt their decline.

> "Few people question the great aesthetic value of elk, and some recognize the beauty and value of aspen. But how many would equate aspen with elk? After all, elk are warm-blooded; have big, understanding eyes; magnificent antlers; and move around with great dignity. Trees just stand there! However, in an area dominated by coniferous forest, aspen contributes disproportionately to the beauty and interest of

> the Park. It is the only deciduous tree of any major importance. Its growth form, light-colored bark, and the sight and sound of its leaves trembling in the breeze add a special charm to the summer landscape. Of course, during the fall season aspen comes into its own. Splashes of gold pattern the slopes in sharp and beautiful contrast to the endless green of conifers. Golden leaves falling and rustling underfoot add enchantment to a lazy stroll in the woods" (Barmore, 1967).

The above quotation does much to identify what values and philosophies were motivating the actions of past managers. It is as if Park managers were using the argument that the northern winter range would be a poorer place for the public to visit without the aspen as part of the landscape. Therefore, it became the duty of the Park Service in the best interest of the public to uphold the ideals of the agency by doing what was necessary to save the aspen stands. This included the elk reduction program. No such rationale can be found today in the writings of present Park managers.

As another facet of the change in attitude or philosophy toward managing the resource, some of the difference lies in how "manage" is defined. For some it carries the connotation of maximum control and manipulation of the resource at its extreme expression, while for others it involves maintaining a low profile of minimum intervention in the natural scene. Both camps may be just as enthusiastically committed to Park Service ideologies but have very different interpretations as to how these ideologies should be served. As an example of how these differences can be translated into widely varying management

practices, wolves have been both shot and protected by Park Service personnel on the northern winter range in the name of responsible management during different eras in the Park's history. The elk reduction program is another example.

The Leopold report of 1963 did much to provide more concrete direction for the managment of natural areas in the Park Service system. To repeat a highlight of that report

> "As a primary goal, we would recommend that the biotic association within the park be maintained, or where necessary recreated as nearly as possible in the condition that prevailed when the area was first visited by the whiteman. A national park should represent a vignette of primitive America."

These ideas were not especially new but, stated as they are, the report gave some old ideas a new sense of priority and helped establish what kind of management practices were appropriate for realizing those ideas. The general tone of the report is that the end, as it is defined in the quotation, justifies the means; "management may at times call for the tractor, chainsaw, rifle, or flame thrower but the signs and sounds of such should be hidden from the visitor in so far as is possible." This put the killing of elk on the northern winter range by rangers well within the boundaries of propriety. The report recommended an end to the fire suppression practices in national parks where appropriate, and endorsed the direct reduction of the northern herd in Yellowstone. Both of these recommendations were made on the basis of doing what was the most sound ecologically and in the name of

protecting the natural scene. Within a few years after the report, the recommendation to allow natural fires to burn had been heeded in Yellowstone. However, also in just a few years, the reduction program of the northern elk herd had been terminated for the same reasons it had been endorsed.

This identifies the second reason for the significant changes in management policy for the northern winter range - an increased understanding of the ecology of the area; especially in the late 1960's and early 1970's. Ending the predator control program back in the 1930's, the natural burn policy, and reexamining the elk reduction program have all been a part of a maturing process in evaluating the ecology of the winter range. The key to this maturing process has been the recognition of variables in addition to grazing pressure that play a part in determining the condition of the range. After a review of the annual range reports it is evident that researchers had identified many factors affecting the condition of the range early on in the research efforts, but were unable to apply an appropriate level of importance to these variable. Actually, they were unable to do so because they were conducting all of their research on the basis of several erroneous conclusions presented to them as fact that left no room to consider any influence other than browsing pressure as dominant. It was not until researchers in the 1960's and 70's re-examined the information and disregarded the "facts" that elk were not previously

found in Yellowstone in any great numbers prior to the 1870's, and that an important population eruption and crash occurred during the early 1900's that they were able to more objectively examine the ecology of the northern winter range.

A third reason for the abrupt change in the management policies - the new appraisal of the many variables that determine the condition the winter range occurred concurrently with a complete change in research methodology. Classic methods of range research such as determining the carrying capacity and observing exclosures to determine range trend were deemed inappropriate in the context of monitoring the condition of rangeland in a wilderness setting utilized by wild ungulate populations. Questioning the research methods used was nothing new, but in the past there had never really been any more appropriate methodology available to replace them. Abandoning the more traditional research methods enabled Park biologists to gain a fresh perspective from which to examine the ecology of the northern winter range. That perspective led them to make radically different interpretations about the ecology of the area. This issue, the applicability of traditional range inventory and analysis techniques in determining the condition of northern winter range, is at the center of current disagreement with Park interpretations by outside researchers. Park biologists argue that using research methods designed for an agricultural setting involving livestock on highly manipulated

rangeland can not be applied to the northern winter range. Other researchers contend that rangeland in Yellowstone functions under the same natural laws as any other area of rangeland.

Politics could be listed as the fourth factor that has influenced the direction of management policies for the northern winter range. The actual influence or role of this factor can only be a matter of speculation, it is sufficient to say that the Park Service can be a very political agency. Past management policies frequently came under vigorous public scrutiny and objection. Dropping the elk reduction program removed the Park from a very uncomfortable position. Barmore (1967) reveals the dilemma of trying to reconcile the ecologically acceptable with the politically acceptable.

> "Aspen is a "fire species". Use of fire as a management tool would be reintroducing a long suppressed environmental factor that might benefit aspen. Even if prescribed burning should prove beneficial and practical, reduction of elk browsing to a level that will permit aspen regeneration remains the key to success. Current studies suggest that we have not yet reached that point. How far do we need to go? How far <u>can</u> we go? This latter question has real meaning when dealing with a subject as emotional and controversial as management of the Northern Yellowstone elk herd. Can we afford to keep the herd at a level low enough to permit aspen regeneration? Can we afford not to? It is a "damned if you do, damned if you don't" situation!"

Park managers carried out the elk reduction program because they thought it was the only responsible alternative. To have done so in the face of severe opposition reflects a high commitment to duty.

Politics will continue to play a part in the management of Yellowstone Park.

The Condition of the Range

In-field observations of the northern winter range are beyond the scope of this paper, although they do provide some useful impressions. Portions of the range appear to need a long rest. Much of it looks as though it would benefit greatly from being burned. All browse species in nearly every instance look severely over utilized. It is easy to see why the most common manner of describing the range for most of this century has been to say that it is overgrazed. Yet such a generalization, even on a cursory basis, does not seem consistent with all of the information the range offers by visual inspection. Some portions of the winter range are impressive in the quality and quantity of forage produced. Although the complete deterioration of the range has been predicted for decades, it has never come to pass.

Examining the literature makes it clear that trying to determine the condition of the northern winter range increases in complexity with attempts to increase the accuracy of that determination. In fact, trying to make a determination with enough accuracy to be relevant increases the complexity to the point where the determination looses much of its meaning. In the same sense that trying to determine the carrying capacity of the range as one would for a cattle

allotment seems inappropriate, trying to determine the condition of the range also seems ill suited. Expectations of deriving useful information from attempts to determine the condition of the range might not be realized. The northern winter range is a dynamic system where a wide variety of variables that fluctuate considerably on a yearly and even seasonal basis determine the "condition" of the range; examining the annual range reports proves that. All of this does not negate the applicability of monitoring ecological trends and events on the range.

Determining the condition of the range loses its meaning in the context of relating the determination to the actual management of the range. This is true if the winter range is essentially an ecologically complete habitat for the elk. This is also true because the Park Service, for the most part, has no management options open to it to respond to whatever the condition of the range is determined to be, and no desire to respond. Should it be determined in some way that the range is in poor condition, an elk reduction to reduce the stocking rate would be too politically volatile. Efforts to improve distribution of the elk for better utilization of the range would be impractical. It is fortunate that the only option really open to the Park Service, minimum intervention, also appears to be the most ecologically sound.

The northern winter range is not overgrazed in the sense that past Park managers thought it was. Neither does it fit Leopold's description of a "vignette of primitive America." Major disruptive changes have occurred on the range. It is not the same country Osborne Russell traveled through in 1835. Assessing the impact of these disruptions, especially the possible disruption of migration routes, has played an important part in managing the winter range. It is unlikely that Yellowstone has not always been a traditional wintering area as well as summer range. Such an ecological void is inconceivable. It is also unlikely that elk from the Yellowstone area once migrated down the Paradise Valley to the Livingstone area (Koch, 1941). That range would have been occupied by other ungulate herds. Migrations as far as Dome Mountain, though, to ranges now no longer available were probably common. The loss of that winter range could have had a significant impact on the distribution of Park elk and the utilization of the range which should not be overlooked. It would have been the initiator for some of the ecological changes that have occurred.

Drought, grazing pressure, disruption of the fire cycles, and many man-caused disturbances have altered the ecology of the northern winter range. These factors acted together and undoubtedly accentuated each other. Trying to separate the factors and trying to speculate as to which one was the most dominant where is in most cases

meaningless. Concluding that elk were responsible for the demise of aspen stands or willow thickets because of disruptions in traditional elk distribution patterns does not mean a return to the elk reduction program is necessary. The important issue is whether or not the environment can absorb these disruptions and continue to function. It has proven that it can. The environment of the northern winter range will adjust to a new equilibrium, but it will be one without the white-tail deer or the bank beaver. Many willow thickets and aspen stands will be gone. In some places the productivity of the range will be less than it was formerly. Introduced grasses and forbs will occupy sites where native species should be found.

That is not to say these changes aren't important. The loss of plant and animal species means a lowering of the diversity of the environment. Losing aspen stands is especially important in this respect. A continual decline in willow thickets will significantly alter riparian sites and thus affect the ecology of entire streams (Armour, 1978; Kennedy, 1977). The loss of browse species will change ungulate feeding habits (Greer et al, 1970). The loss in aesthetic value is not quantifiable.

Aldo Leopold had this to say (in Leopold, 1953):

> "The last word in ignorance is the man who says of an animal or plant: "What good is it?" If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of aeons, has built something we like but do not understand, then who but

> a fool should discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering."

In the case of the northern winter range, the price of keeping every "cog and wheel" is too high to pay. It would require intensive manipulation of the resources, a course of action that would more than likely be self-defeating in the amount of additional trauma inflicted on the resource. (Controlled burning is one management tool that might be an exception). Perhaps it is more correct to allow natural processes to make the selections as to which "pieces" will be kept. Now that man has taken the role of the observer rather than the manipulator in managing the range that is what will happen. The area will continue to change. With the right combination of weather and fire it might begin to look more like it did before the Park was established, more than likely, it will not.

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APPENDIX A

NORTHERN YELLOWSTONE ELK HERD
ESTIMATED POPULATION, 1892-1965 (NPS, 1965)

The following estimates of the number of elk in the Northern Yellowstone elk herd for the years shown are the most accurate available. It must be understood that these are estimates, and that over such a long period correspondence, news releases, etc., may have included figures somewhat varied:

Year	Estimated number	Year	Estimated number	
1892	25,000	1940	12,000	
1893	25,000	1941	12,500	
1897	15,000	1942	11,700	
1907	25,000	1943*	9,100	
1908	25,000	1944	10,500	
1909	30,000	1945	11,500	
1910	30,000	1946*	10,700	
1912	30,100	1947	9,600	
1913	32,200	1948	12,400	
1914	35,300	1949	11,000	
1916*	29,500	1950	12,000	
1923*	14,500	1951	12,000	
1926	14,000	1952	9,200	
1927*	13,000	1953	10,600	
1928*	14,200	1954	11,500	
1929	13,300	1955	11,800	
1930	10,600	1956*	8,300	
1931	10,600	1957	8,200	
1932	10,600	1958	9,000	
1933	12,500	1959*	7,200	
1934*	13,000	1960	7,600	
1935*	11,000	1961*	10,000	(helicopter)
1936*	11,000	1962*	6,800	(helicopter)
1937*	9,700	1963	6,100	
1938*	11,000	1964	6,700	
1939	10,800	1965*	6,900	(helicopter)

*Years in which actual count was made; figure printed is estimate based on count.

APPENDIX B

NORTHERN YELLOWSTONE ELK HERD
RECORD OF REDUCTIONS, 1934-1966 (NPS, 1966)

Period	Hunter Kill	Direct Field Reduction	Live Trapping	Winter Kill	TOTAL REDUCTION	Actual Spring Count
1934-35	2,598	223	444		3,265	10,647
1935-36	2,237	6*	551	89	2,933	10,112
1936-37	257	394	180	15	846	10,281
1937-38	3,587	11*	225	89	3,912	8,794
1938-39	2,971	--	307	533	3,811	10,976
1939-40	122	--	16	68	206	
1940-41	275	--	12	10	297	
1941-42	2,071	--	145	108	2,324	
1942-43	6,539	691	--	872	8,102	
1943-44	125	--	10	100	235	8,235
1944-45	403	--	--	300	703	
1945-46	2,094	--	73	250	2,417	
1946-47	3,069	--	76	475	3,620	8,513
1947-48	970	--	39	375	1,384	
1948-49	2,837	--	49	300	3,186	7,815
1949-50	40	518	316	184	1,058	
1950-51	1,265	500	312	217	2,294	
1951-52	3,198	52	563	500	4,313	
1952-53	110	7*	165	50	332	
1953-54	422	171	216	241	1,050	
1954-55	763	13*	593	289	1,658	
1955-56	3,900	1,974	645	?	6,519	6,963 (helicopter)
1956-57	345	717	227	?	1,289	
1957-58	50	536	--	?	586	

Period	Hunter Kill	Direct Field Reduction	Live Trapping	Winter Kill	TOTAL REDUCTION	Actual Spring Count
1958-59	372	1,051	319	?	1,742	4,848 (fixed-wing)
1959-60	50	674	135	?	859	
1960-61	25	1,287	147	?	1,459	8,150 (helicopter)
1961-62	125	4,309 [2/]	310 [1/]	476	5,220	5,725 (helicopter)
1962-63	530	619 [5/]	671 [3/]	negligible	1,820	
1963-64	30	215 [5/]	906 [4/]	Do.	1,151	
1964-65	1,012	205 [5/]	687 [6/]	Do.	1,904	4,865 (helicopter)
1965-66	30	181 [5/]	1,059 [6/]	Do.	1,270	
TOTALS	42,472	14,354	9,398	5,541	71,765	

* Taken for museum specimens or biological studies.
1/ Includes 13 trap loss.
2/ Includes 215 for biological studies.
3/ Includes trap loss of 40.
4/ Includes trap loss of 22.
5/ Biological studies only.
6/ Includes trap loss of 35.