4-22-1965

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April 22, 1965

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Abstract

Aspen stands on the Northern Yellowstone winter range have been deteriorating since 1930. Data from early range reports and exlosure studies show that overbrowsing by ungulates has been the primary cause of this deterioration. Current studies of aspen utilization and condition indicate that deterioration of aspen from overbrowsing continues despite reduction of the Northern Yellowstone elk herd to 5,000 animals during the winter of 1961-62. The situation is critical. If the elk herd is not reduced further, the aspen ecosystem will be essentially eliminated from the Northern part of Yellowstone National Park.

Relatively little is known about pristine ecological conditions or ungulate-habitat relationships in Yellowstone National Park. Neither is much known about ungulate population dynamics, seasonal distribution, and interspecies relationships. However, our best evidence indicates that in primeval times ungulates, particularly elk, were abundant in the park during the summer, but they used park ranges less during the winter then than they do now. Under pristine conditions elk and other ungulates probably migrated more extensively to lower elevations outside the park during the winter where forage was more easily available.

Sometime after 1880 the relative number of elk utilizing park ranges, particularly during the winter, began to increase. The primeval interplay of natality, mortality, and migration patterns in and around the park were seriously disrupted by the combined effects of hunting, predator destruction, and man's usurpation of low-lying valleys for agriculture, stockraising, towns, and highways.

Whether the increased use of park winter ranges resulted from an actual drastic increase in the herd or from a bottling up of an abnormally large number of animals on previously marginal winter range is not known. The results were the same--deterioration of soils and vegetation. Rush (1932) recognized this problem in the early 1900's. He estimated that between 1914 and 1928 the Northern Yellowstone winter range had deteriorated fully 50 percent.

While it is true that little is known about pristine ungulate-habitat relationships in the park, we do know they were such that progressive development of soils and vegetation took place through postglacial time until about 1900. We know that aspen stands developed and maintained themselves along with other plant communities on the Northern Yellowstone winter range under whatever ungulate pressure

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[1]Paper presented at the Western Association of State Fish and Game Commissioners Elk Workshop in Bozeman, Montana, March 2-4, 1965.

existed in primeval times. This is indicated by the very presence of aspen (Populus Tremuloides) in the area today and by early photographs which show that as late as the 1920's some aspen stands contained mature trees with relatively little elk barking damage and a variety of aspen age classes in the understory.

Although aspen probably never did make up a large part of the park's vegetation, available evidence indicates that stands were more numerous and extensive in primeval times than they are today. Some loss of aspen can be explained by natural succession to conifers. This loss may have been accelerated over what would have occurred under pristine conditions because of increasingly effective protection from natural wildfires. However, by the early 1930's it was recognized that overbrowsing, primarily by elk, was a factor that actually threatened the existence of aspen on the Northern Yellowstone winter range (Grimm, 1939). Almost without exception annual range reports from the early 1930's through 1958 refer to the excessive utilization of aspen by elk and the deplorable condition of stands throughout the winter range.

In 1937 it was reported (National Park Service, 1937) that:

> Overutilization of aspen on the winter game range has reached the extent where these trees have all but disappeared from large areas of that range and may only be found in the depressions and gullies where the deep drifted snow prevents the approach of foraging animals.

The 1941 range report contains the following statement (Gammill, 1941):

> Aspen browse plots indicate further deterioration of aspen reproduction. Apparently aspen, Populus Tremuloides, is being slowly, but almost completely eliminated from the northern winter range on areas which are available to elk.

And according to the 1943 report (National Park Service, 1943):

> It is evident that the browse plant species on the winter range have steadily deteriorated because of excessive utilization . . . The possibility that willows and aspen will be exterminated by overutilization on some areas of the winter range must be reckoned with . . .

By 1947 Kittams (1948) questioned whether many aspen stands could be rehabilitated because of their extremely deteriorated state and the limited occurrence of this much sought after browse species. In 1954 he stated that "Thinning and lessening of the aspen and willow types, as described in previous reports, are continuing."

And in 1957 he pointed out (Kittams, 1957) that:

> The pattern of heavy use of available current growth of aspen and willow throughout the range was unchanged from previous years, but a considerable removal of bark from the trunks of aspen exceeded the use of this item in several past years.

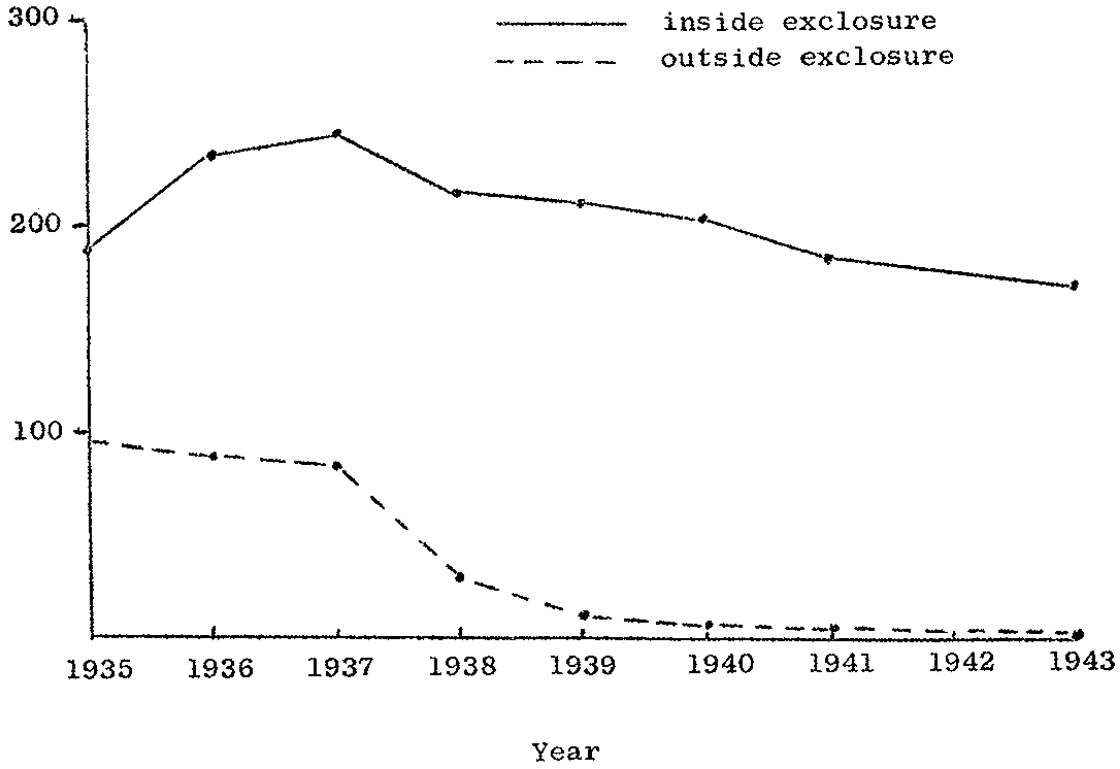
By 1962 the status of aspen stands throughout the Northern Yellowstone winter range was at a low point. After 30 years of continual abuse, many groves had disappeared entirely and most of those remaining were in poor vigor and were not reproducing themselves. In most stands the only aspen age classes present were decadent, overmature trees and root sprouts from one to a few years old that were browsed off to a height of one or two feet each winter. Overstory trees were dying out from overmaturity and insect and disease attacks that were probably aggravated by the decadent nature of the stands and heavy barking damage by elk. Some stands had apparently lost the potential to produce root sprouts after the death of all mature trees and suppression of reproduction by browsing resulted in the death of root systems. Once the root systems died out, the stands reverted to grassland. Only the rotting trunks of fallen trees indicate that these sites were once occupied by aspen. Since the distribution of aspen is similar to the fall, winter, and spring distribution of elk, a "normal" aspen stand could not be found anywhere on the Northern Yellowstone winter range by 1962.

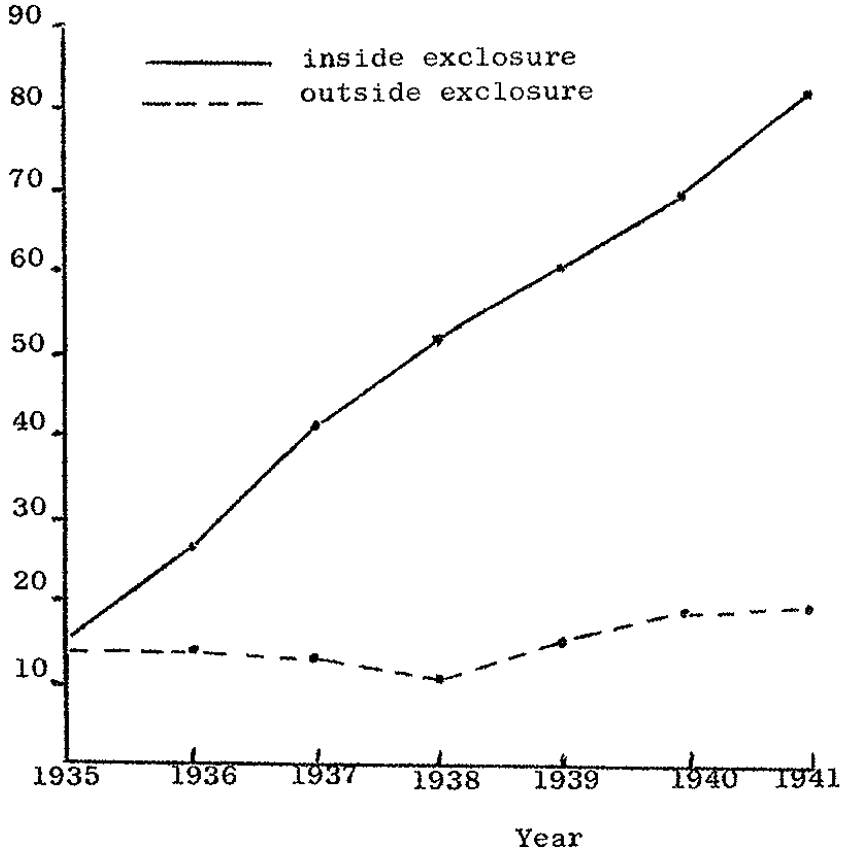
It is conceivable that other factors such as adverse climatic changes, disease and insect attacks, alteration of the primeval fire regime, etc., or these factors combined with overbrowsing were responsible for the decline of aspen. If this is true, then aspen may have deteriorated and disappeared even with little or no browsing. In order to objectively evaluate the impact of browsing alone and the response of aspen when relieved from browsing, several exclosure studies have been and are being conducted on the Northern Yellowstone winter range.

In 1934 an exclosure about 20 feet square was constructed around a stand of young aspen sprouts near Mammoth. A plot of equal size was marked out adjacent to the exclosure. The number and height of sprouts and the number of new and dead sprouts inside and outside the exclosure were recorded annually from 1935 through 1943 (Figure 1). During this 8-year period aspen sprouts inside the exclosure increased 447 percent in average height from 15 to 82 inches at an average rate of 11 inches a year, while sprouts outside the exclosure showed a slight increase in height some years and a loss in others for an average increase of 0.7 inches per year. Each winter sprouts outside the exclosure were browsed back to an average height of 10 to 18 inches.

The number of sprouts inside the exclosure increased 30 percent from 187 in 1935 to 243 in 1937, then declined 29 percent to 173 in 1943. The decline probably reflected normal thinning out of

Figure 1. Response of aspen root sprouts inside and outside an exclosure at Aspen Browse Study Plot No. 10 on the Northern Yellowstone winter range (Data from Gammill, 1941 and National Park Service, 1943).





some sprouts by competition as the stand matured. Sprouts outside the exclosure declined steadily from 97 in 1935 to none in 1943 (Figure 1). Today the exclosure contains a dense stand of aspen 20 to 30 feet tall with a variety of age classes in the understory, while the outside plot contains less than 10 sprouts that are browsed off to a height of 12 to 18 inches each winter.

At another site a stand of aspen sprouts grew up inside an abandoned hay corral during the 1920's. The stand was approximately 12 years old in 1936 when a new exclosure was built that included half of the previously protected aspen stand and an additional area of grassland that lacked any aspen. An equal-sized plot that contained the other half of the previously protected stand and some grassland was marked out adjacent to the exclosure. This setup provided an opportunity to study the impact of browsing on sapling-sized aspen, the amount of reproduction established in each plot, and the extent that protected aspen could reinvade aspen sites that had reverted to grassland. The number of trees in both plots were counted and charted annually from 1936 through 1943.

From 1936 through 1941 the number of aspen inside the exclosure increased 56 percent from 99 to 154 (Figure 2). From 1941 to 1943 the number decreased 14 percent from 154 to 133. Observations indicated that normal thinning of the stand from crowding and competition caused this decrease. Most of the new trees established inside the exclosure were new sprouts that invaded the grassland adjacent to the original clump of trees. Between 1936 and 1943 the number of aspen on the outside plot decreased 80 percent from 86 to 17. By 1961 there were no sprouts outside the exclosure, but there was a dense stand of mature trees inside.

When half of the stand was exposed to browsing in 1936, the crowns of most of the trees were beyond the reach of elk. However, the trees were quickly highlined then killed by having their bark stripped off by elk. In 1943 only 5 of the original 86 trees outside the exclosure remained, and they survived only because they grew close to the exclosure fence where they could not be completely girdled.

In 1958 two five acre exclosures containing aspen were established--one near Mammoth and one in the Lamar Valley. Matching plots were set up in aspen groves inside and outside the exclosures. The plots consisted of permanent belt transects 5 feet wide and 100 feet long. In 1958 and 1962 the height of all aspen sprouts on both transects was measured and the number of sprouts were counted and charted.

During this 4-year period sprout density inside the Lamar exclosure increased 10 percent while it decreased 4 percent outside the exclosure (Table 1). Average sprout height inside the exclosure increased 67 percent from 25 to 42 inches for an average gain of 4 inches per year, while outside the exclosure average height decreased 7 percent from 16 to 15 inches.

Figure 2. Response of aspen sprouts and saplings inside and outside an exclosure at Aspen Browse Plot No. 25 on the Northern Yellowstone winter range (Data from National Park Service 1943)

At the Mammoth exclosure aspen sprout density decreased 53 percent and 67 percent on the inside and outside plots respectively between 1958 and 1962 (Table 1). The cause of this decrease is unknown, but since it occurred both inside and outside the exclosure, most of it must have been due to factors other than browsing. However, the greater decline outside the exclosure could be attributed to browsing.

Even though the number of sprouts decreased, average sprout height inside the exclosure increased 58 percent from 23 to 36 inches for an average gain of 3 inches per year, while outside the exclosure average sprout height decreased 36 percent from 15 to 10 inches.

During the winter of 1963-64, leader use averaged 67 and 76 percent on the outside plots at the Lamar and Mammoth exclosures respectively. This further strengthens the conclusion that excessive browsing accounted for the lack of height gain outside the exclosures from 1958 to 1962.

These exclosure studies bring out several important points about aspen ecology and aspen-elk relationships. They show that over-browsing is the primary cause for the deterioration and loss of aspen. Regardless of the impact of other environmental factors, once aspen stands are released from excessive browsing, they respond quickly. Aspen sprouts gain in height, decadent overstory trees are replaced, and stands grow to maturity and maintain themselves despite mortality from factors other than browsing. The studies also suggest that if excessive browsing is eliminated, aspen sprouts can and will reinvade areas once occupied by aspen that have reverted to grassland. However, since aspen regeneration from seed is rare in the west, reinvasion can only take place if living aspen roots and root sprouts are still present in the general area. In addition, these studies show that recovery and maintenance of aspen stands involves more than just allowing reproduction to grow beyond the reach of elk. Browsing pressure must be kept low enough to prevent girdling of saplings by elk eating the bark.

From 1947 through 1952 research biologist Walter Kittams studied aspen sprout survival and the effect of browsing on aspen at 20 sites on the Northern Yellowstone winter range. He photographed the sites and made fall and spring measurements of sprout height, annual leader growth, number of buds, percent leader use, and the linear loss of leaders from browsing on 20 sprouts at each site.

Although his data have not been completely analyzed, it indicates the following: Percent leader use and linear loss of leaders was high each year with most of the loss due to browsing. Between fall and spring height loss occurred on about 70 percent of the sprouts with an average height loss of 20 to 40 percent. Throughout the study period aspen reproduction was suppressed by excessive browsing. Sprout mortality was also high, and about 50 percent and 67 percent of the sprout mortality in 1949 and 1950, respectively, was attributed to excessive browsing. This suggests that other factors contribute

Table 1. Response of aspen sprouts at two five acre exclosures on the Northern Yellowstone winter range from 1958 to 1962.

Exclosure	Number of Sprouts		Density (sprouts/ft^2)		Ave. Sprout Height (inches)		Percent Change 1958-1962	
	1958	1962	1958	1962	1958	1962	Sprout Density	Sprout Height
Lamar								
Inside	40	44	0.08	0.09	25.4	42.5	≠10	≠67
Outside	49	47	0.10	0.09	16.1	15.0	- 4	- 7
Mammoth								
Inside	78	37	0.14	0.07	22.9	36.3	-53	≠59
Outside	141	47	0.28	0.09	15.2	9.7	-67	-36

significantly to sprout mortality. But exclosure studies indicate that once stands are released from excessive browsing, they can overcome mortality from these other natural causes and regenerate themselves.

At the conclusion of the study, Kittams (1955) stated that he had not been able to determine the critical point where winter browsing results in tree loss. He also noted in 1952 (Kittams, 1952) that the "general appearance of the groves under study has changed little or indicates further decline due to death of old trees and abuse of replacing aspen reproduction."

Comparison of photographs of these 20 study plots taken in 1952 and 1964 show that all 20 stands were still in poor condition in 1964. Condition trend was down on 16 plots, static in poor condition on two, and up on two.

During the winter of 1961-62 the Northern Yellowstone elk herd was reduced from approximately 10,000 to 5,000 animals, the estimated carrying capacity of their winter range. The herd has been held at approximately this level since then. Since 1962 more intensive studies have been initiated to determine the annual impact of ungulates on aspen and the response of aspen to the reduced elk population. Twenty permanent transects have been established in typical aspen stands throughout the Northern Yellowstone winter range. Five transects were established in 1963, seven in the spring of 1964, and eight more in the fall. The following information has been recorded each spring from 50 to 100 plants at each transect by modified methods described by Cole (1963): (1) sprout height and diameter, (2) form class, (3) whether or not sprouts are decadent, (4) percent leader use, (5) damage by rodents and ungulate barking. Information obtained from these transects indicates what has happened to aspen since the elk herd was reduced to the estimated carrying capacity of its winter range.

Data from the five transects measured in both 1963 and 1964 (Table 2) show that leader use averaged 87 percent during the winters of 1962-63 and 1963-64. This high level of use was correlated with a high percentage of aspen sprouts in poor condition (severely hedged and/or decadent) and with no gain in the height of sprouts which averaged 14 inches in 1963 and 1964. It is apparent that excessive browsing kept aspen reproduction completely suppressed at the sites sampled during both winters.

By February 20, 1965, percent leader use averaged 71 percent on 8 transects that are being measured at monthly intervals throughout the winter of 1964-65 (Table 3). Total use on these same transects during the entire winter of 1963-64 averaged 77 percent. Percent leader use so far this winter may be biased upward because only sprouts projecting above the snow are being measured. Nevertheless, the data indicate that total aspen utilization this winter will probably be at least as severe as in previous winters.

Table 2. Comparison of aspen sprout utilization and condition on the Northern Yellowstone winter range during the winters of 1962-63 and 1963-64.

Transect Number	Average Height (inches)		Percent Sprouts Severely Hedged		Percent Sprouts Decadent		Percent Leader Use by Summer	
	1963	1964	1963	1964	1963	1964	1963	1964
A-1	20	16	76	60	10	18	72	75
A-2	11	12	22	80	10	32	91	96
A-3	13	14	40	72	14	46	97	91
A-4	14	14	32	66	22	42	96	96
A-8	--	--	--	--	--	--	78	76
Average	14	14	42	69	14	34	87	87

Table 3. Comparison of aspen sprout utilization on the Northern Yellowstone winter range during the entire winter of 1963-64 with utilization up to February 20, 1965.

Transect Number	Percent Leader Use by Summer 1964	Percent Leader Use by 2/20 1965
A- 1	75	72
A- 2	96	98
A- 3	91	75
A- 4	96	83
A- 6	92	56
A- 9	67	89
A-10	56	86
A-12	42	12
Average	77	71

These studies and supporting field observations conclusively show that aspen reproduction continues to be suppressed over most of the winter range by excessive browsing despite the reduction of the Northern Yellowstone elk herd to 5,000 animals. Only a few stands near Mammoth, along the highway between Mammoth and Tower Junction, and at transects on Elk Plaza, the Southeast side of Bunsen Peak, and in the Upper Blacktail Deer Creek drainage, show any signs of recent upward trend in condition. Most of these stands are located along highways, near developments, or in areas of greater than average snow depths where ungulate use would be expected to be less than on most of the winter range.

In the fall of 1965, the density of aspen sprouts was estimated at 12 transects by the point-centered-quarter method (Cottam and Curtis, 1956). Density averaged 3,187 sprouts per acre and ranged from 436 to 8,059. While some of the groves are lightly stocked with reproduction, studies indicate that they will respond favorably to protection from browsing. Although the exact reasons for the low sprout density in many groves are not known, the decadent nature of the stands and low vigor of mature trees that have resulted from years of abuse could be factors of major importance.

Park range reports indicate that aspen is often heavily utilized early in the winter--sometimes as early as December (Kittams 1950, 1957, and 1958). During the fall and winter of 1964-65 percent leader use, aspen sprout height, snow depth, and presence or absence of ungulate sign have been recorded at monthly intervals on 16 permanent transects in order to determine the time and rate of aspen utilization (Table 4).

Some elk moved down to the upper fringes of the winter range by late October, and they were dispersed over a much wider area by early November. Permanent snow was not found at any of the transects through the first part of November and excellent grass forage was still easily available throughout the winter range. Although ungulate sign was present at 50 percent of the transects by early November, essentially no utilization of aspen occurred until later in the month.

General field observations indicated that aspen utilization increased considerably in late November. This seemed to be correlated with the first permanent snow and increased movement of elk onto the winter range. On November 24, estimated leader use was 25-50 percent in groves on Specimen Ridge, and measured leader use was 52 percent in a grove near Jasper Creek. This use occurred when only 4 to 6 inches of snow were on the ground and grass was easily available in highly productive areas in and around the groves.

By the first part of December, leader use averaged 37 percent compared to 5 percent a month earlier. Leader use on 5 of 13 transects examined was in excess of 50 percent and ranged as high as 86 percent (Table 4). Average snow depth had increased to

Table 4. Aspen utilization on the Northern Yellowstone winter range during the fall and winter of 1964-65 in relation to time of the year, snow depth, and aspen availability.[a]

Date	Oct. 1	Nov. 7	Dec. 7	Jan. 12	Feb. 20
No. of transects measured	10	16	13	16	16
Transects with elk sign Number Percent	None	8 50	11 85	9 56	6 37
Transects with aspen available Number Percent	10 100	16 100	13 100	10 62	4 25
Snow depth (inches) Average Range	None	None	13 8-16	23 16-35	30 18-42
Percent leader use Average Range	2 0-8	5 0-25	37 3-86	58 12-98	58 19-89

[a]Aspen availability was based upon whether or not sprouts projected above the snow regardless of snow depth.

13 inches, and most of the groves were being used by ungulates. Grass forage was easily available over most of the winter range, and elk were still able to forage in the more productive swales and on slopes with a northerly exposure.

By the first part of January, leader use averaged 58 percent, and was in excess of 50 percent at 10 of the 16 transects. Snow depth averaged 23 inches, and aspen sprouts were unavailable (not projecting above the snow) at six transects. Groves where aspen sprouts were largely covered by snow or where snow depths exceeded about 30 inches showed little or no use by ungulates. Grass forage in the more productive swales and on slopes with a northerly exposure became largely unavailable during the latter half of the month, and elk were forced to feed on less productive ridgetops and south-facing slopes where there was less snow.

By the middle of February, aspen was largely unavailable throughout the winter range, partly because of deep snow and partly because much of the aspen reproduction was so short it was covered by snow that elk could normally travel through. Only 4 of the 16 transects still had aspen sprouts projecting above the snow which averaged 30 inches deep. Elk sign was found only in groves where the snow was less than 2 feet deep.

It is apparent from these data that relatively heavy aspen utilization occurred early in the winter when grass forage was still easily available. It appeared that elk began utilizing aspen almost as soon as they moved on to the winter range. This suggests that aspen is a highly preferred forage plant, but we cannot be certain of this without further study. It is possible that elk normally take, and perhaps require a relatively small amount of browse along with a preponderance of grass forage so long as grass is available on the winter range. Browse may be so sparse that minimum needs cannot be satisfied without heavy overutilization of the meager supply available. It is certainly clear that by the time grass forage became less available (in January and February) practically no aspen browse was available to elk.

While there is much that 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. Even more disturbing is the fact that overbrowsing and deterioration are still occurring despite the reduction of the Northern Yellowstone elk herd to approximately 5,000 animals. Apparently 5,000 elk is still beyond the current "aspen carrying capacity" of the winter range. Considering the extremely poor condition of our aspen stands, this raises some tough questions concerning the management of the herd that urgently need answering.

One of the goals in the management of natural, wilderness type parks such as Yellowstone is to maintain or where necessary recreate

as nearly as possible the primeval ecological conditions as they would have developed without the direct or indirect influence of modern man. (Leopold, et al., 1963) The aspen ecosystem was part of the pristine park scene, and apparently the direct and indirect influence of modern man has been responsible for the near elimination of this ecosystem from the Northern part of Yellowstone National Park. Deterioration is continuing despite the reduction of the Northern Yellowstone elk herd. Further reduction of the herd is needed if the aspen ecosystem is to be preserved. The situation is critical. If excessive browsing of our remaining aspen stands is not terminated soon, we will not have any aspen to preserve.

The problem may be more complex than merely choosing between elk and aspen. It is possible that elk and other ungulates depend on aspen and other browse species more than we realize. Perhaps they require a certain amount of browse. In addition, we know that other important members of the park's fauna, such as beavers and other small mammals and birds will be adversely affected if the aspen ecosystem is lost.

While the prospect 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 err 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.

Literature Cited

Cole, G. F. 1963. Range survey guide. National Park Service, 22 p.

Cottam, G. and Curtis, J. T. 1956. The use of distance measures in phytosociological sampling. Ecol. 37:451-460.

Gammill, W. H. 1941. Yellowstone National Park range studies, 1941. Nat'l. Park Service, 14 p. (typewritten)

Grimm, R. L. 1939. Northern Yellowstone winter range studies. J. Wildl. Mgmt. 3:295-306.

Kittams, W. H. 1948. Northern winter range studies, summer 1947-spring 1948, Yellowstone National Park. Nat'l. Park Service, 81 p. (typewritten)

———————. 1950. Northern winter range studies, spring 1949-spring 1950, Yellowstone National Park. Nat'l. Park Service, 45 p.

———————. 1952. Northern winter range studies, spring 1951-spring 1952, Yellowstone National Park. Nat'l. Park Service, 39 p. (typewritten)

———————. 1954. Northern winter range studies, spring 1953-spring 1954, Yellowstone National Park. Nat'l. Park Service, 32 p. (typewritten)

———————. 1955. Northern winter range studies, spring 1954-spring 1955, Yellowstone National Park. Nat'l. Park Service, 38 p. (typewritten)

———————. 1957. Northern winter range studies, spring 1955-spring 1956, Yellowstone National Park. Nat'l. Park Service, 44 p. (typewritten)

———————. 1958. Northern winter range studies, spring 1956-spring 1958, Yellowstone National Park. Nat'l. Park Service, 35 p.

Leopold, A. S., Cain, S. A., Gabrielson, I. N., Cottam, C. M., and Kimball, T. L. 1963. Wildlife management in national parks. Dept. of the Interior, 13 p. (mimeographed)

National Park Service. 1937. Yellowstone National Park range studies 1936-1937. Yellowstone Nat'l. Park, 25 p. (typewritten)

———————. 1943. Yellowstone National Park winter range studies, 1943. Yellowstone Nat'l. Park, 30 p. (typewritten)

Rush, W. M. 1932. Northern Yellowstone elk study. Montana Fish and Game Commission, 131 p.