Recovery of Desert Plants in Various States of Vigor¹

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Highlight

Desert plants, when defoliated to the extent that vigor is even moderately reduced, require rather long periods of nonuse for complete restoration. Defoliation in the winter and again in the spring at only moderate intensities was considered deleterious to plant welfare. Late spring harvesting was significantly more harmful to plants than early spring harvesting.

In the Intermountain area, livestock graze on desert ranges mainly during the winter, but in some instances cattle graze on these arid lands yearlong. Desert ranges in the basins of the Intermountain area are in a delicate balance and if incorrectly used deteriorate rapidly.

Changes in plant vigor generally precede changes in the botanical composition and range deterioration. Relative plant vigor may also indicate the degree of range recovery from a lowered state of range condition. In general, vigor denotes health and vitality of the plant. For these reasons a study was conducted from 1959 to 1968 in desert ranges of western Utah to determine the recovery of desert range plants that were harvested during the first three years of the study at three different intensities during four different seasons. Plant vigor measurements were taken after seven years of rest to determine recovery from previous treatments.

Literature Review

Objective measures of vigor used by Cook et al. (1958) were number and leafiness of seed culms and basal area. Nelson (1930) used total length of each new twig, number of new buds produced after clipping, air-dry weight of leaves, and air-dry weight of twigs. Lyon (1968) found no single objective measure to evaluate vigor. He felt that

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perhaps subjective plant measures needed to be used more in evaluating ecological changes. Mueggler (1967) in Montana, used herbage production, flower stalk numbers and heights as measures of plant vigor. Vogel and Van Dyne (1966) used herbage yield, leaf and seedstalk heights, and basal area as measures of vigor.

Cook and Goebel (1962) investigated the association of plant vigor with physical stature of desert plants. Averages for all species showed that paired plants in high vigor, when compared to the paired plants in low vigor, covered about three times more surface area of ground, had leaves, seedheads, and current year growth almost twice as long, and possessed more than six times the herbage yield.

The rate of recovery of range plants depends largely on site and degree of lowered vigor. Relatively few studies have been reported in the literature concerning recovery of range plants from a lowered state of vigor. Laycock (1967) reported that desert ranges in poor condition grazed only in the fall and those protected from grazing improved in vigor and species composition, while those in good condition and grazed in the spring deteriorated.

Lang et al. (1956) and Rauzi and Lang (1967) working on short grass range found that after ten years of heavy grazing followed by ten years of light use, the major change was plant composition. The more desirable forage species increased while the undesirable forage species decreased during the period of light use.

Methods and Procedures

The dominant forage species used in the study included three browse species: black sagebrush (Artemisia nova), big sagebrush (Artemisia tridentata), and shadescale (Atriplex confertifolia); two suffrutescent species: winterfat (Eurotia lanata), and Nuttall saltbush (Atriplex nuttallii); and two grass species: Indian ricegrass (Oryzopsis hymenoides), and squirreltail grass (Sitanion hystrix). Exclosures were built to protect the study plots from livestock and rabbit use.

During the period from 1959 to 1961, these plants were clipped at three intensities during four periods. The three clipping intensities were 30, 60, and 90 percent of the available herbage and the four periods were winter only, about January 1; winter and again in late spring, about January 1 and May 1; early spring only, about April 1; and late spring only, about May 1.

In the browse and grass species, individual plants were treated as one sampling unit (Fig. 1). For the suffrutescent species the plants within a 9.6 square foot circular frame were used as a sampling unit.

Ten units of each species were clipped at each intensity during each period and at each of three locations. There were also ten control units at each location. During the summers of 1962 and 1968 vigor measurements on each sampling unit were made.

Results

In order to determine the recovery during the seven-year rest period it was necessary to separate changes caused by previous treatments from changes caused by weather and other environmental effects displayed by control plants. Assuming that climate affected both the controls and treated plants alike, the difference shown in the controls can be used to adjust the treated plants (Mueggler, 1967).



FIG. 1. Upper: Two plants of squirreltail grass harvested seven years previously (left) at 60% during late spring and (right) at 60% during winter. Lower: A plant of big sagebrush (right) with only sparse regrowth which was harvested seven years previously at 60% during late spring; and a plant (left foreground) with abundant growth which was harvested at 30% during winter.

As might be expected the amount of live crown cover was closely correlated with herbage yield for all seven species studied. Many investigators have suggested that either or both would be excellent indexes to vigor (Cook and Goebel, 1962; Cook et al., 1958; Hickey, 1961; Hyder et al., 1966; Mueggler, 1967; Voegel and Van Dyne, 1966).

Effect of Previous Seasonal Clippings

Crown cover alive from clipped plants compared with controls was the major criterion for measuring recovery from 1962 to 1968 (Table 1). Percent dead crown cover for the suffrutescent species in 1968 may have been somewhat underestimated because plants killed by previous treatments could not always be found in 1968 since the woody base occasionally disintegrated and disappeared from the plots (Table 2).

Plants judged to be in lowest vigor in 1962 were those harvested in the winter and again in late spring from 1959 to 1961. These plants had only about 42% as much live crown cover as the controls in 1962. The three browse species that were harvested twice a year produced only about 18% as much crown cover as controls in 1962 (Table 1). The two suffrutescent species and Indian ricegrass that were previously clipped twice a year had about two-thirds as much crown cover as the controls in 1962. Squirreltail grass had only about 45% as

	Intensity	Bl: saget	Black sagebrush		Big sagebrush		Shadscale		Winter- fat		Nuttall saltbush		Indian ricegrass		Squirrel- tail		Average	
Season	harvesting ²	1962	1968	1962	1968	1962	1968	1962	1968	1962	1968	1962	1968	1962	1968	1962	1968	
Winter (Jan. 1)	Light Moderate Heavy Average	78 54 19 50	94 60 30 62	80 46 06 44	102 84 22 60	99 68 20 62	104 89 30 74	99 96 77 01	93 96 92 04	76 70 70 79	91 94 101 05	82 87 58 76	105 114 94	60 65 56 60	106 84 69 86	82 69 44 65	99 89 63 84	
Winter & spring (Jan. 19 & May 1)	Light Moderate Heavy Average	34 07 04 15	45 26 02 24	36 10 00 16	57 14 00 24	56 18 00 24	70 38 00 36	90 73 29 64	100 99 98 99	76 66 51 64	96 96 101 98	68 71 38 59	78 83 67 76	46 48 41 45	56 69 39 55	58 42 23 41	72 61 44 59	
Early spring (April 1)	Light Moderate Heavy Average	96 71 12 60	80 71 22 57	79 44 08 44	113 77 11 67	82 73 18 58	96 82 45 74	102 86 75 88	101 94 102 99	83 75 68 75	101 104 98 101	85 79 72 79	103 80 85 90	57 48 44 50	78 63 56 66	83 68 42 64	96 82 60 79	
Late spring (May 1)	Light Moderate Heavy Average	70 41 01 38	66 70 05 48	70 61 02 44	104 86 05 65	48 32 05 28	99 50 10 53	86 70 46 67	98 105 96 100	81 67 64 71	96 100 102 99	94 55 44 64	117 90 54 88	52 41 44 46	56 31 19 35	72 52 29 51	91 76 42 70	
Average	Light Moderate Heavy Average	70 44 09 40	71 57 15 48	66 40 04 37	94 65 09 56	71 48 10 43	92 65 21 60	94 81 57 77	98 98 97 98	79 69 63 70	96 98 100 98	82 73 53 69	101 92 75 90	54 50 46 50	74 62 46 61	74 58 35 56	89 77 52 73	
Least sig. %3		85	79	78	73	75	71	86	94	75	92	83	80	70	78	70	81	

Table 1. Live crown cover expressed as a percentage of the control in 1962 one year after harvesting treatments ceased and in 1968 which was seven years following treatment.¹

¹ Completely dead plants in 1962 were still calculated as 100% dead in 1968 unless they were replaced by a new plant of the same species. ² On plants harvested at light, moderate and heavy intensity, 30%, 60%, and 90% of available herbage was removed, respectively.

^a Figures are significantly different from the controls at the .05 level of probability if they are below this least significant percentage value.

much crown cover as the control after being harvested twice a year for three years. In 1968 the browse species from these same treatments were producing about 28% as much crown cover as the controls, the suffrutescent species had completely recovered and grasses had from 55 to 76% recovery for squirreltail grass and Indian ricegrass, respectively (Table 1).

Clipping only in late spring about May 1 was the second most severe treatment from the standpoint of reduction in vigor of desert forage plants. The average of the seven species showed that plants previously harvested during late spring had only 51% as much crown cover as the controls in 1962. Plants, after seven years rest from late spring clipping produced only about 60% as much forage as the controls.

Past harvesting treatments during the winter only and during early spring only were less detrimental to the welfare of desert forage species than harvesting only in late spring or harvesting during the winter and again in the late spring. There were no significant differences (P < .05) in vigor measurements during 1968 between harvesting in the winter only compared to harvesting only in the early spring. The crown cover in 1968, after seven years of rest from previous clippings during the winter season and the early spring season, was approximately 81% of the control plants. Herbage yield in 1968, after seven years of rest for the plants previously clipped only in winter and only in early spring, was about 73% as much as control plants (Table 2).

Effect of Intensity of Clippings

The overall effect of past treatment at various intensities showed that normal plant cover, even after seven years rest, was less for each increased increment of harvesting (Table 1). The crown cover for previously clipped plants was 89, 77, and 52% of the controls in 1968 for light, moderate and heavy clipping intensity, respectively. The yield in 1968 from the previously clipped plants at 30, 60, and 90% was 81, 61, and 40% as much as controls, respectively.

The most severe treatment was harvesting during the winter and again in the late spring at 90% intensity. In 1968 after seven years rest, these plants were producing only about 23% as much forage as the controls and their crown cover was only about 44% of the controls. Previous harvests at 90% during late spring were the second most severe treatment for all species. These plants in

Scason	Forage class	Current growth (cm)	Length scedstalk (cm)	Seedstalks/ plant	Live crown cover (¼ ft ²)	Dead crown (%)	Yield (g)	Seedstalks/ live area
Winter	Browse	1.7	5.2	43.1	2.49	60.1	45.9	5.5
(Jan. 1)	Suffrutescent	6.0	10.8	6.7	27.00	2.6	76.6	3.4
	Grasses	10.8	13.0	17.1	0.68	52.0	19.5	21.2
	Average	6.1	9.7	22.3	10.10	38.2	47.3	10.0
Winter & spring (Jan. 1 & May 1)	Browse	1.9	2.8	17.3	0.95	79.3	16.5	5.4
	Suffrutescent	5.7	10.3	5.3	24.50	2.1	57.4	4.5
	Grasses	9.0	9.5	15.8	0.50	68.0	15.3	15.6
	Average	5.5	7.5	12.8	8.60	49.8	29.7	8.5
Early spring (April 1)	Browse	1.8	5.4	40.7	2.39	59.9	44.0	5.8
	Suffrutescent	6.2	11.2	7.8	23.10	2.9	81.9	2.7
	Grasses	10.3	11.4	15.5	0.60	59.0	16.8	18.5
	Average	6.1	9.3	21.3	8.70	40.3	47.6	9.0
Late spring	Browse	1.5	5.0	39.4	2.04	68.6	37.8	6.4
(May 1)	Suffrutescent	5.9	10.6	6.2	23.40	2.5	64.4	3.8
	Grasses	8.6	9.6	13.3	0.51	68.0	14.7	14.2
	Average	5.3	8.4	19.6	8.65	46.4	39.0	8.1
Controls	Browse	2.4	7.1	62.9	3.79	36.7	77.1	10.9
	Suffrutescent	6.6	12.1	9.1	23.00	3.2	90.6	3.0
	Grasses	11.4	14.1	22.5	0.86	42.0	25.8	22.7
	Average	6.8	11.1	31.5	9.22	27.3	64.5	12.2

Table 2. Average vigor measurements for three forage classes that had been harvested at three intensities during four seasons for a three year period (1959-61). Data were taken seven years after treatments ceased (1968).

1968 were producing only 32% as much forage as the controls and they had only about 42% as much crown as the controls.

In 1968 there were no significant differences (P < .05) in vigor between the controls and those previously harvested at 30% during any season except those harvested twice a year during the winter and again in late spring. For all practical purposes and for sustained optimum yield the plants harvested at 60% or less during winter and early spring were not harmed (Cook, 1971). He pointed out that harvesting any plant at 90% during any season and at 60% twice a year (winter and spring) and during late spring was detrimental to sustained yield.

Thus any past treatment that lowers vigor, even moderately, has a rather lasting effect upon vigor of desert plants.

Recovery of Individual Species

Shadscale appeared to make better recovery during the seven years rest following defoliation than did black sagebrush or big sagebrush (Table 1). Black sagebrush made somewhat less recovery compared to the controls than big sagebrush but this was not consistent among treatments.

For the most part the two suffrutescent species (winterfat and Nuttall saltbush) made recovery of crown cover comparable to the controls for all treatments (Table 1) but yields, in some cases, were still significantly lower than the controls (Table 2). The differences between extent of recovery for winterfat and Nuttall saltbush over the seven years of rest were not substantially different. For some vigor measurements Nuttall saltbush appeared to have made better recovery but for others winterfat recovery was somewhat better.

The two grass species, like the three browse species, appeared to have suffered some long lasting damage from defoliation treatments over the three year period from 1959 to 1961. Squirreltail grass had significantly lower percent crown cover and herbage yield (P < .05) than Indian ricegrass when compared to the controls in 1968. Both grass species harvested at 90% were significantly lower in crown cover and yield (P < .05) than the controls during all seasons. Indian ricegrass appeared to tolerate 30% use during all seasons and 60% use during winter and possibly during early spring.

Indian ricegrass plants made vigor recovery comparable to the controls when previously harvested at 60% at all seasons. Squirreltail grass vigor in 1968 was comparable to the controls only for 30% use during the winter or during early spring.

Black sagebrush, big sagebrush, and shadscale had the lowest recovery in vigor after seven years rest compared to the controls; whereas, Nuttall saltbush, winterfat, and Indian ricegrass had the highest. The slow rate of vigor recovery of black sagebrush might have been the result of the rather low level of vigor following defoliation in 1962 and the rather harsh sites supporting this species compared to other species. In 1962, one year after cessation of clipping treatments, black sagebrush and big sagebrush had the lowest vigor measurements of all species and shadscale and squirreltail grass were only slightly better in this respect. Nuttall saltbush, winterfat, and Indian ricegrass were less affected by defoliation treatments from 1959 to 1961 than the other species as shown by vigor measurements in 1962 (Table 1). Indian ricegrass was somewhat less resistant to treatments than the two suffrutescent species, however.

By 1965 Nuttall saltbush, winterfat, and Indian ricegrass had made full recovery from all treatments except when clipped at 90% in late spring and when clipped heavily in winter and again in late spring (Fears, 1966). The most rapid recovery therefore was made by these three species but they also had a higher state of vigor when clipping was discontinued in 1962. Nuttall saltbush made the most extensive recovery since it had 98% of normal crown cover in 1968. Big sagebrush and shadscale recovered from 37 and 43% of normal crown cover respectively in 1962 to 56 and 60% normal crown cover in 1968 (Table 1).

The data within a species suggest that the lower the vigor the longer the recovery period. It takes progressively longer for increased vigor through increased crown cover to occur when plants are in extremely low vigor compared to recovery of plants that have had their crown cover only slightly reduced. This is not necessarily true among species however, since big sagebrush had only 37% of normal crown cover in 1962 and gained at the rate of 2.7%/year during the seven years of rest. Black sagebrush had 40% of normal crown cover in 1962 but gained only 1.1%/year in crown cover over the 7-year period of protection. These were made at a rather constant rate over the 7-year rest period. Indian ricegrass gained crown cover at the rate of 3.1%/year but most of this recovery was made from 1962 to 1965. Squirreltail grass gained at the rate of only 1.6%/year during seven years of rest.

Summary

From 1962 to 1968 a study was conducted on the desert ranges of western Utah to determine the recovery of desert range plants that had previously been subjected to three years of harvesting at three different intensities during four different seasons.

The three clipping intensities used were 30, 60, and 90%. The four periods were: (1) winter only, about January 1; (2) winter and again in late spring, about January 1 and May 1; (3) early spring only, about April 1; and (4) late spring only, about May 1. Vigor was measured during the summers of 1962 and 1968.

Rate of recovery within a species was proportional to the state of vigor, the lower the vigor the less rapid the recovery. Plants that were in lowered vigor had a smaller area of live crown cover, shorter and fewer seedstalks, less current year's growth, a larger percentage of dead crown cover and produced less herbage than did plants in higher vigor.

It was found that desert plants clipped heavily during any season or harvested even moderately during late spring or twice a year, in winter and again in late spring, still differed significantly in vigor measurements from untreated plants even after seven years of protection.

Shadscale made faster and more complete recovery than either of the other two browse species, black sagebrush and big sagebrush. Winterfat and Nuttall saltbush made complete crown cover restoration for all clipped plants during a seven year rest period. Indian ricegrass had restored crown cover comparable to controls for all previous defoliation treatments except when clipped at 90% during late spring and twice a year during winter and again in late spring. Squirreltail grass made only slight recovery and this was made at a very slow rate.

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