WILLOW-MOOSE RELATIONSHIPS IN GRAND TETON NATIONAL PARK: A CONTINUING EVALUATION

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Introduction

Extensive riparian plant communities dominated by willow provide important wildlife habitat within and adjacent to Grand Teton National Park. High densities of moose are often associated with these willow communities. I studied the habitat relationships of the Jackson Hole moose from 1964-69 (Houston, 1968,1969). Findings suggested that although moose browsing influenced the structure and appearance of preferred willow species, their foraging did not cause progressive deterioration of these plants on major winter ranges. Here I report results from continued low level monitoring to evaluate these earlier interpretations.

Methods

Photography. I rephotographed 10 views of marsh willow communities on important moose winter ranges from established camerapoints. An explanation of these camerapoints follows:

1. In 1967 I established six transects to describe shrub species composition on moose winter ranges where the intensity of winter browsing on willows had been measured since 1964. All transects were marked with steel stakes. At five sites the stakes also served as camerapoints. (Vegetation was too dense at transect no. 4 to provide a camerapoint.) In addition, two sites initially photographed for other purposes in 1967 served as camerapoints. These include "Figure 3" in the monograph on the Shiras moose (Houston 1968:24), and a site adjacent to one of the vegetation transects described above (camerapoint 3a) where the original photo was taken to document beaver activity. These scenes were photographed in August and October 1967, October 1978, and August 1987. A tripod mounted 4x5 Crown Graphic camera with a 135 mm lens was used to take color transparencies in 1967 and 1978. 35 mm color transparencies were taken in 1987, using a Nikon SLR with a 50 mm lens. On the chance that color photos would eventually fade, black-and-white photos were taken from tripod mounted 35 mm cameras in August 1967, October 1978, and August 1987.

2. In 1987, I rephotographed two scenes of the Buffalo River originally photographed by Owen Wister in 1893 and rephotographed by George Gruell in 1969 (Plates 11 and 12 in Gruell 1980). 35 mm photos were taken as described above.

3. A winter scene of willows on the Buffalo River, originally photographed by N. R. Bassett in 1950, was rephotographed by me in 1967 (and used as Figure 6 in Houston 1968:34) and by Bob Wood in March 1987. Wood and I used the Crown Graphic.

The August 1967, October 1978, and August 1987 black-and-white photos of camerapoints in group one are presented in this report. However, my interpretations are based heavily on comparing the color transparencies, and by noting changes in the field at the time of the retakes. The locations of all camerapoints are shown on the attached map. As before (Houston 1978), all negatives and transparencies are filed for safekeeping with the Director of the University of Wyoming - National Park Service Research Center.

Vegetation Measurements. I attempted to repeat the 1967 "random pairs" measurements (Cottam and Curtis 1949) of shrub species composition, referred to above (see Houston 1969:16), during 1987. This was only partially successful. I was unable to locate the stakes for transect No. 4, transect No. 2 had been destroyed by the shifting Buffalo River. The four remaining transects were repeated by following a compass bearing from the starting stake. The terminal stakes were not relocated. Thus, the remeasurements are approximate. Fifty random pairs of shrubs (100 plants) were recorded at 3 m intervals on each transect.

Willow Taxonomy. The scientific names of some willows on the area have been changed at least twice since the 1960's. I rely entirely on Dorn (1975, 1977) for current nomenclature, but retain the common names used earlier. Thus, as used here, blueberry willow is now Salix boothii (formerly S. pseudocordata or S. novae-angliae), Geyer's willow is S. geyeriana (I did not distinguish this from S. drummondiana), and Bebb's willow (S. bebbiana), whiplash willow (S. lasiandra), and Wolf's willow (S. wolfii) remain unchanged. Interior willow is now S. exigua (formerly S. interior or S. fluviatilis), and I did not distinguish this from S. melanopsis or other closely related linear-leaved willows.

Additional Background Information

Moose. Moose are apparently a recent addition to the Jackson Hole fauna. They were not reported during the trapping and fur trading period of the early 1800's. Noticeably large moose populations occurred by at least 1950 (Houston 1968).

By 1962-66 legal harvests of moose averaged about 402 ± 25 from a ~ 4,600 mile^2 (12,000 km^2) "Greater Jackson Hole Area" (Figure 1). Actual removals averaged at least 440 moose annually when a conservative 10% of legal harvests was added to account for illegal kills and crippled animal losses. Moose hunting is prohibited in Grand Teton and Yellowstone Parks and the National Elk Refuge; about 1,100 mi^2 (3,000 km^2) of the area shown in Figure 1. Thus, harvests were drawn from about 3,500 mi^2 (9,000 km^2) and represented annual removals of about one moose/8 mi^2 (20.5 km^2). Dispersal of moose from the resident population in Grand Teton was thought to contribute to harvests outside the park (Houston 1968).

High sustained yield harvests have continued to the present. Legal harvests from the same 3,500 mi^2 area averaged 580 ± 132 moose from 1971-86 (G. Roby, J. Yorgason, unpubl. data Wyoming Game & Fish Department). Harvests exceeded 600/year from 1972-81, and were 704, 740, and 745 in 1973, 1975, and 1977, respectively. With a 15% correction for illegal kills and cripple losses (Roby 1987, pers. comm.), removals averaged 667 moose/year, or about one animal /5.3 mi^2 (13.5 km^2). At these removals, the ratios of adult males to females changed in winter populations. About 72 ± 16.5 males/100 females occurred from 1968-76 (including the Gros Ventre River drainage); about 47 ± 7.9 males occurred from 1978-86 (Roby unpubl.).

Aerial trend counts of moose have been conducted in December or January since 1963. Fixed-wing counts in Grand Teton and adjacent areas of the Buffalo River, Snake River, and Spread Creek averaged 294 ± 69.6 moose from 1963-80. Helicopter counts over the same area averaged 604 ± 114.9 moose from 1980-86 (Roby 1987 unpubl.). The Gros Ventre was added to trend count areas in 1968; fixed-wing counts for the overall area averaged 438 ± 79.2 moose from 1968-80, helicopter counts averaged 850 ± moose from 1981-86.

Willows. Gruell (1980) traces the history of willow browsing by ungulates in Jackson Hole. General increases occurred as moose colonized the area. Studies from the late 1940's, cited by Houston (1968), document heavy winter use of the willow sites reported here. My observations of these sites span 23 years from 1964-87. Range measurements showed generally heavy moose browsing for seven years from 1964-70. Less frequent observations since and discussions with Grand Teton Park and Wyoming Game and Fish Department personnel suggest that winter browsing has remained generally heavy.

All this information demonstrates that a substantial moose population occupies the Jackson Hole area and that these animals support an impressive sustained yield harvest outside the National Parks. Although moose remain unhunted within Grand Teton Park, the effects of moose on park willow communities have surely been influenced by harvests outside park boundaries. Willows on winter ranges photographed here have, however, received generally heavy browsing for many years.

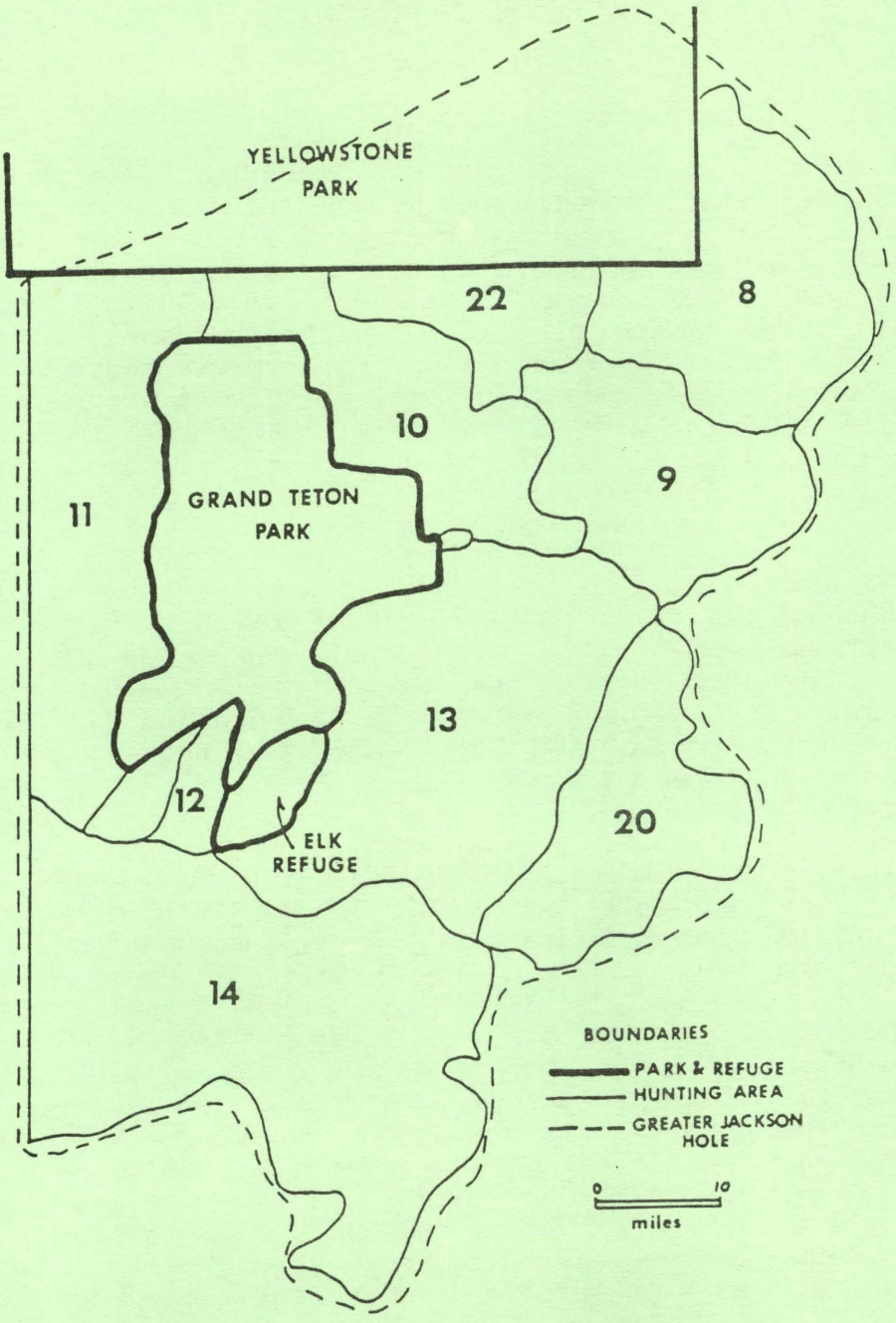

Figure 1. The "Greater Jackson Hole Area." Numbers designate early Wyoming Game and Fish Commission moose hunting area. From Houston 1968:75.

Results and Discussion

Photographs. Recognizing the limitations of the photo comparisons (different camera lenses, rephotographed in 1978 at a different season), 7 of the 10 photo comparisons suggest little or no change in willow density, vigor, or gross species composition over the 20-94 year intervals. Minor changes in these scenes seem to be associated with flooding or drying of sites that reflect beaver activity. Sites continue to be dominated by willows preferred by moose, namely blueberry, Wolf's, and Geyer's willows. The highly preferred blueberry willow may have increased on one site (the 1950 Bassett photo). As reported earlier (Houston 1968), the heavily browsed willow shrubs continue to be composed mainly of stems less than 5 years of age. Older browsed stems apparently die back.

Three photo comparisons show large changes in willow distribution as a result of shifts in the channels of the Buffalo and Snake Rivers. Established willows were destroyed and new stands have colonized bare gravel and sand bars. These comparisons demonstrate graphically the dynamic relationships between rivers and the riparian vegetation. Browsing by moose, elk, and beaver did not prevent willows from colonizing pioneer substrates.

Vegetation Measurements. The four random pairs transects suggest that species composition of shrubs has changed little over 20 years (Table 2). Willow species dominant in 1967 remained dominant in 1987. In all cases, the less abundant species present in 1967 (bag birch, Bebb's willow, etc.) were still present in the stands in 1987, but were sometimes not encountered on the remeasured transects. The increase in unidentified willows represents my waning ability to distinguish species rather than changes in composition. All transects suggest a decline in shrubby cinquefoil, a species that is relatively unpalatable to moose. Beyond that, little can be gleaned from the measurements because they could not be duplicated exactly. The random pairs method may be appropriate for descriptive studies, but, in retrospect, it was an inappropriate choice to monitor trends in composition and density (among other failings it's hard to even determine just what constitutes an individual willow shrub). These things considered, the photos provide the more valuable records.

Interpretation and Recommendations

The photo comparisons and limited measurements continue to support earlier interpretations that moose browsing has not resulted in progressive deterioration of willows on major winter ranges. Comparisons show the resiliency of willows to generally heavy winter browsing and the influence of stream dynamics on the turnover of riparian communities. Apparently, willows can withstand heavy browsing if soil moisture remains optimum (Patten 1968). Moreover, snow depths

Table 1. Summary of vegetation changes recorded at 10 camerapoints established on marsh willow communities in and adjacent to Grand Teton National Park.

Location	ID No.	Original Photo Date (Interval in years)	Comment
Buffalo River	RP-1	1967 (20)	Minor changes in a dense stand of blueberry willow.
	*RP-2	1967 (20)	Major change in willow distribution from shifting river channel. Sand and gravel bars colonized by new willows.
	RP-3	1967 (20)	Minor changes, site may be drying.
	RP-3a	1967 (20)	Minor changes, increased vigor and density of willows as pond area declined.
	*PL-11 (Gruell 1980)	1893 (94)	Major change in willow distribution due to shift in river channel. Marsh willows still dominate the site.
	*PL 12 (Gruell 1980)	1893 (94)	Remarkably little change in a heavily browsed site. Channel shift reduced foreground willows.
	Fig. 6 (Houston 1968)	1950 (37)	Minor changes including a possible increase in willow density on a heavily browsed winter range.
Spread Creek	RP-6	1967 (20)	Little or no change in willows.
Snake River	RP-5	1967 (20)	Minor change, possible increase in Wolf's willow.
	Fig. 3 (Houston 1968)	1967 (20)	Major change in willows followed shift in river channel. Willows colonizing new gravel bars. Minor decreases and increases in willow are associated with reduced beaver activity.

*= Outside Grand Teton National Park.

Table 2. Relative density of shrub species on four moose winter ranges in Grand Teton National Park, 1967 and 1987.

Species	Relative Density (%)							
	RP-1[a]/		RP-3		RP-5		RP-6	
	'67	'87	'67	'87	'67	'87	'67	'87
Blueberry willow	65	76	61	70	36	44	68	60
Geyer's willow	4	2	26	13	10	18	21	26
Wolf's willow	15	9	8	14	36	28	3	3
Bebb's willow	1	2	1	0	1	1	0	1
Whiplash willow	1	1	1	1	0	1	0	0
Unid. willow	0	4	0	2	0	4	0	4
Shrubby Cinquefoil	13	5	3	0	14	5	8	3
Bog birch	1	1	0	0	3	0	0	0
Big sage	0	0	0	0	0	0	0	3

a. Random pairs transect No. see map for locations.

in the Jackson Hole area are often sufficient to protect young stems from ungulate browsing.

Recommendations and Suggestions

1. Camerapoints should continue to be rephotographed at 10 year intervals.

2. The random pairs transects could be replaced by well marked "belt" transects that yield measures of shrub cover or stem density by species.

3. Studies elsewhere suggest that annual production of riparian shrubs, including willows, might be greater when plants are browsed (e.g. Wolff 1978, Danell et al. 1985). The relationships of soil moisture, browsing, and burning on willow productivity would be an important study. A series of prescribed burns have been conducted in the area by the U.S. Forest Service and Wyoming Game and Fish Department. These appear to have produced striking increases in willow production at some sites.

4. If moose are radio-collared in Jackson Hole in the future, then these animals could be used to calibrate the aerial counts by measuring "visibility bias" (Floyd et al. 1979, Samuel et al. 1987). Calibrated counts would provide a more useful measure of moose population density and trends. If necessary, willow condition and utilization could then be correlated with absolute densities of wintering moose.

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