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Early season utilization of mountain meadow riparian pastures

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Abstract

Observations suggest spring grazing of riparian areas is a good management strategy because of a reduced tendency for cattle to concentrate along streams during that season. In this study, June cattle distribution was examined within 4 experimental pastures located along Stanley Creek, Sawtooth National Recreation Area, Sawtooth National Forest, in central Idaho. Two pastures were grazed at a light stocking rate and 2 pastures were grazed at a medium stocking rate. Streamside graminoid utilization averaged about 24% under light stocking, while on the adjacent meadow graminoid utilization was 28%. Under medium stocking the average utilization at streamside was 37%, while that on the adjacent meadow was 50%. Residual herbaceous stubble heights under light stocking were 11 to 12 cm for both grazing locations, whereas streamside and meadow stubble heights were 10 cm and 7 cm, respectively, under moderate stocking. Cattle were not disproportionately attracted to the streamside areas during the June period. As stocking rates increased from light to medium, the cattle concentrated most of their additional use on the adjacent drier meadow. Utilization of riparian plant communities during this early summer period had no relationship to the amount of plant moisture content, but was negatively associated with surface soil moisture.

Key Words: percent utilization, stubble heights, plant moisture, soil moisture

Riparian areas, prized for their multiple-use values, are typically subjected to damaging stresses and impacts. In the Western United States the greatest impact on small stream riparian areas often has been from grazing by domestic livestock (Kauffman and Krueger 1984, Armour et al. 1991). This is particularly true for riparian areas within arid or semiarid rangelands (Swanson 1988, Szaro 1989). Various reviews have considered possible impacts of domestic livestock on riparian areas and grazing management approaches that might be more applicable (Skovlin 1984, Clary and Webster 1989, Kinch 1989). Many traditional grazing systems designed for upland ranges have been applied to riparian areas, but results have been erratic. While no one management approach is best for all situations, spring grazing has shown promise in many areas of the Western United States (Platts and Nelson 1985, Siekert et al. 1985, Goodman et al. 1989, Kovalchik and Elmore 1992). The combination of succulent upland forage, cool temperatures, and wet soils near water sources acts to encourage a more dispersed grazing pattern (Krueger 1983, Kovalchik 1987, Myers 1989). Others have pointed out potential benefits of late summer grazing (Kauffman et al. 1983, Marlow and Pogacnik 1986, Marlow et al. 1987).

In 1987 a grazing study was initiated on Stanley Creek located within the Sawtooth National Recreation Area, Sawtooth National Forest, in central Idaho. The general objectives were to determine vegetation, wildlife, fishery, and stream channel responses to grazing management. The analyses reported here include forage utilization and residual plant stubble heights within this mountain meadow ecosystem during early summer grazing periods. Results are based on herbaceous plants only. Utilization of willows (*Salix* spp. L.) and other woody species was negligible.

Study Area

Stanley Creek is a 3rd order, C4 stream (Rosgen 1985). The sandy loam soils on adjacent meadows are derived from granitic lake bottom sediments. At the site of the experimental pastures, Stanley Creek flows through a broad, flat valley with a westerly aspect. Elevation of the experimental pastures is 1,950 m. Summers are cool and dry, the winters cold and wet. Average annual precipitation at the study pastures is approximately 250 mm, although the surrounding mountainous watershed receives greater amounts. Average temperature during the June grazing period is 11° C. The area is representative of the mountain meadows ecosystem containing wet to intermittently wet sites in the forest zone of the mountain West (Garrison et al. 1977). Typical plant species along Stanley Creek included: Kentucky bluegrass (*Poa pratensis* L.), tufted hairgrass (*Deschampsia cespitosa* (L.) Beauv.), water sedge (*Carex aquatilis* Wahl.), beaked sedge (*C. rostrata* Stokes), Baltic rush (*Juncus balticus* Willd.), foxtail (*Alopecurus* spp. L.), timber danthonia (*Danthonia intermedia* Vasey), thick-stemmed aster (*Aster integrifolius* Nutt.), cinquefoil (*Potentilla* spp. L.), gentian (*Gentiana* spp. L.), Lemmon's willow (*Salix lemmonii* Bebb), and Drummond willow (*S. drummondiana* Barratt). At the edge of the riparian area Idaho fescue (*Festuca idahoensis* Elmer), western needlegrass (*Stipa occidentalis* Thurb.), and mountain big sagebrush (*Artemisia tridentata* Nutt. ssp. *vaseyana* (Rydb.) Beetle) were common.

The meadow was generally dry during the growing season, but bog-like areas and other areas of excess moisture occurred in the pastures. The streamside area was incised an average of 0.38 m below the surrounding meadow and averaged 16 m in width. Stanley Creek itself averaged 2.5 m wide and 0.15 m deep. The streamside area made up 7% of the pasture.

Methods

Six experimental pastures were established along Stanley Creek in the fall of 1986. The 4 used in this investigation ranged in area from 5.1 to 9.0 ha. A 100-point 4-ha sampling grid was established within each pasture with interpoint distances of 20 m. At each

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point a 0.25-m² plot was sampled for various vegetation and soil attributes. A second set of plots was concentrated near the stream to provide a more detailed sample of the streamside area. Twenty minitransects of four 0.25-m² plots each perpendicularly spanned the stream within each pasture. Within minitransects, 2 plots were located in the streamside area and 1 on each of the adjacent secondary banks. All transects and plots within transects were located systematically.

Grazing was conducted in the last half of June for 6 years (1987–1992). Phenological stage in that season was "flowering" for the primary grasses and "vegetative" for the sedges and rushes. Two pastures were assigned to each of 2 treatments: stocked at a light rate (average of 1.19 AUM/ha); and stocked at a medium rate (average of 2.08 AUM/ha). The average period of grazing was 2 weeks with 17 cow-calf pairs in the light rate pastures and 47 cow-calf pairs in the medium rate pastures. Percentage utilization was determined by ocular estimation (Pechanec and Pickford 1937) for the categories of graminoids, forbs, and shrubs on each of the 180 sample plots per pasture at the end of each grazing period from 1987 to 1992. Utilization was recorded to the nearest 5%, based on visual comparisons with 6 reference cages per pasture. The cages were relocated at the beginning of each grazing period. Observers trained for the data collection by estimating and weighing plants that had been manually defoliated until estimate precision was typically within 5%. Mean stubble heights were measured to the nearest centimeter for the same plant categories on all plots from 1988 to 1992.

Each plot was classified according to riparian plant community type following the general approach of Tuhy and Jensen (1982), except that plots were categorized by herbaceous composition only. Shrub cover on the pastures was approximately 8% and there was no statistical support ($P = 0.33$) for an association between percent utilization of graminoids and percent shrub cover. Riparian plant community types sufficiently represented to be included in the analysis were: thickstem aster-Idaho fescue, water sedge, tufted hairgrasses, Kentucky bluegrass, and Baltic rush.

Soil moisture was determined gravimetrically from the vicinity of every fifth plot. Samples were collected from the 0 to 15-cm depth mid-way through the grazing period from 1987–1991. The sequence of plots rotated. Thus, a soil sample was collected from each individual plot vicinity only every fifth grazing period. Plant moisture sampling also was conducted mid-way through each grazing period from 1987–1990. Up to 10 collections each of graminoid, forb, and shrub foliage were made for streamside and meadow locations within each grazed pasture. Collections were made from several individual species and species groups in 1990.

Differences in percentage utilization, residual stubble heights, and foliage moisture content between streamside and meadow locations were analyzed by analysis of variance using a General Linear Model. The value analyzed was the mean of the particular variable determined by location by stocking rate by year. Analysis of covariance was used for more detailed examination of the contribution of plant community type as a main effect and of soil moisture as a covariate in forage utilization analyses. The value analyzed was the plant community type mean determined by location by pasture by year. Data analysis was limited to plots with soil moisture data. Significant interaction effects were plotted in the manner suggested by Steel and Torrie (1980).

Probabilities of less than 0.10 were considered significant in all analyses. Significant differences among means were identified by use of a protected Fisher's LSD at $P<0.05$.

Results and Discussion

Utilization of Graminoids

The main effects of location (streamside vs. meadow), stocking rate (light vs. medium), and year (1987–1992) had highly significant impacts on graminoid utilization (Table 1). Utilization on the adjacent meadow ($\bar{x} = 43\%$) was greater than on the streamside area ($\bar{x} = 26\%$). The most meaningful result from the analysis, however, was a significant interaction. Graminoid utilization by cattle in pastures with light stocking was similar between streamside areas and the adjacent meadow. However, there was significantly greater use of graminoids on the meadows than streamside in the pastures stocked at a medium level (Fig. 1). This response is demonstrated

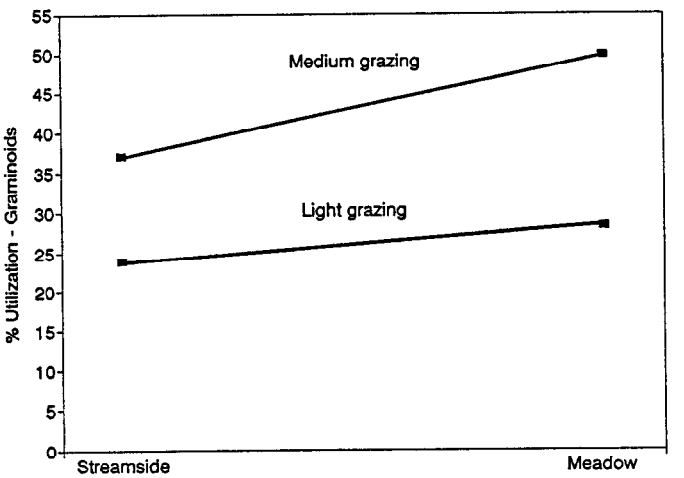

Fig. 1. Location by stocking rate interaction for percentage utilization of graminoids. Interaction was significant at $P = 0.060$.

by a significant interaction ($P = 0.060$) of location (streamside vs. meadow) by stocking rate (light vs. medium) (Table 1).

The residual stubble heights for streamside and meadow were quite similar under light stocking, although somewhat different growing conditions occurred between the 2 areas (Fig. 2). Under

Table 1. Analysis of variance for % utilization and residual stubble heights of graminoids and forbs.

		Graminoids				Forbs			
		% utilization		Stubble height		% utilization		Stubble height	
Source	df	Mean square	P value[1]	Mean square	P value	Mean square	P value	Mean square	P value
Location	1	884.083	<0.001	46.225	<0.001	180.188	<0.001	0.225	0.695
Stocking rate	1	3605.333	<0.001	126.025	<0.001	212.521	<0.001	18.225	0.002
L × S	1	208.333	0.060	9.025	0.024	77.521	0.002	1.225	0.365
Year	5	519.033	<0.001	27.725	<0.001	123.271	<0.001	5.288	0.020
L × Y	5	27.333	0.765	1.110	0.588	9.538	0.212	0.788	0.699
S × Y	5	81.183	0.221	0.900	0.674	12.371	0.113	0.038	0.998
L × S × Y	5	22.483	0.830	1.525	0.431	5.171	0.534	0.788	0.699

[1] P values less than 0.10 are considered to be significant.

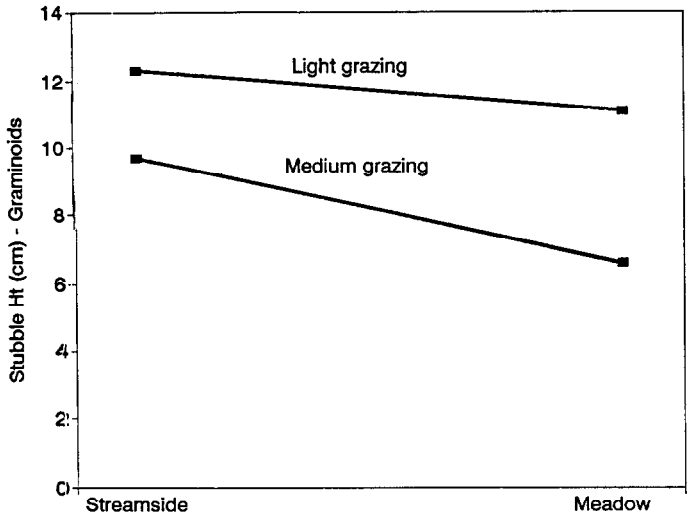

Fig. 2. Location by stocking rate interaction for residual stubble height of graminoids. Interaction was significant at $P = 0.024$.

medium stocking the residual stubble heights were significantly shorter in the meadow area. This is again reflected in the significant location by stocking rate interaction ($P = 0.024$) (Table 1). There appeared to be no particular attraction of cattle use toward the streamside area under light stocking and, when stocking rate was increased, the increase in percent utilization and corresponding reduction in stubble height occurred primarily in the adjacent meadow location.

Utilization of Forbs

The pattern of forb use followed closely that of the graminoids (Table 1). Under light stocking, the utilization of forbs was similar between the streamside and meadow locations (Fig. 3). The interaction between location and stocking rate was again significant (P=0.002), showing greater utilization of the meadow in the medium stocked pastures as compared to the streamside areas. There were relatively few differences in forb stubble heights. The limited difference in heights resulted in part from the forb growth form early in the season. Many of the forbs were either prostrate or in rosette form, therefore, utilization of these plants did not greatly change the measured heights. Grazing livestock often fail to select apparently palatable forage if it is in a less accessible position within the plant canopy (Arnold 1964), which may partially explain the low utilization of forbs in the present study.

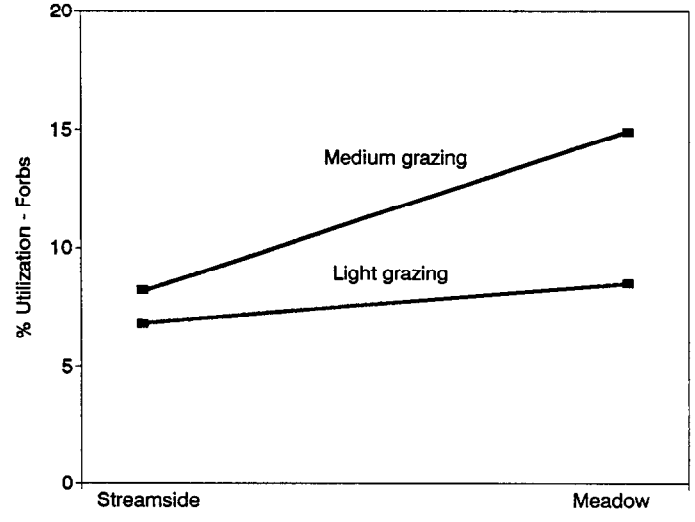

Fig. 3. Location by stocking rate interaction for percentage utilization of forbs. Interaction was significant at $P = 0.002$.

Utilization Related to Plant Communities and Soil Moisture

An analysis of covariance was employed to separate the effects on graminoid utilization of plant community type and surface soil moisture (Table 2). The factors, stocking rate and year, were included in the analysis to reduce unexplained variation. Both stocking rate and year effects were highly significant ($P<0.001$), as expected. The effect of plant community type on graminoid utilization was also higly significant ($P<0.001$). Average utilization varied from 19% in the water sedge community type under light stocking to 54% in the tufted hairgrass community type in the medium stocking pastures. Unadjusted plant community means averaged across stocking rate varied from 28 to 44% (Table 3).

Table 2. Analysis of covariance for contribution of plant community and surface moisture to graminoid utilization.

Source	df	Mean Square	P[1]
Soil moisture (covariate)	1	782.588	0.008
Plant community	4	609.792	<0.001
Stocking rate	1	12839.630	<0.001
P × S	4	174.592	0.167
Year	4	1093.262	<0.001
P × Y	16	95.869	0.564
S × Y	4	387.686	0.008
Error	100	105.732	

[1] P values less than 0.10 are considered to be significant.

Table 3. Graminoid utilization for the major riparian community types.

Riparian plant community type	Utilization: not adjusted for soil moisture[1]	Utilization: adjusted for soil moisture[2]
	(%)	(%)
Water sedge	28.4 a[3]	30.3 a
Baltic rush	36.1 b	39.6 bc
Kentucky bluegrass	37.2 b	35.6 b
Thickstem aster-Idaho fescue	38.6 bc	35.3 ab
Tufted hairgrass	44.0 c	43.2 c

[1] Least-square means.
[2] Means adjusted by analysis of covariance.
[3] Means not followed by a similar letter are different at $P<0.05$.

Surface soil moisture content (%) was included as a non-categorical covariate in the analysis. This variable was highly significant (P=0.008) (Table 2). The covariance coefficient of –0.350 suggests that, when the main effects (plant community type, stocking rate, year) are accounted for, the observed utilization on a given plot is reduced by an average of 3% for each 10% increase in grazing period surface soil moisture. This implies that under conditions of the study, where over a 5 year period the 5 riparian plant community types experienced a range in surface soil moisture of 11–56%, a difference in graminoid utilization among plots of 15% may have been due to surface soil moisture conditions alone. When mean plant community utilization was adjusted for differences in soil moisture content, the range in forage utilization was reduced (Table 3).

Plant Succulence

Plant moisture content is a measure of succulence and is correlated with greenness and fiber content—several factors influencing

forage selection (Arnold and Dudzinski 1978). The mean foliage moisture averaged across 5 years of study was similar between the streamside plants and those of the adjacent meadow for both graminoids and forbs. The moisture content, however, was significantly different ($P<0.001$) between graminoids and forbs (Fig. 4).

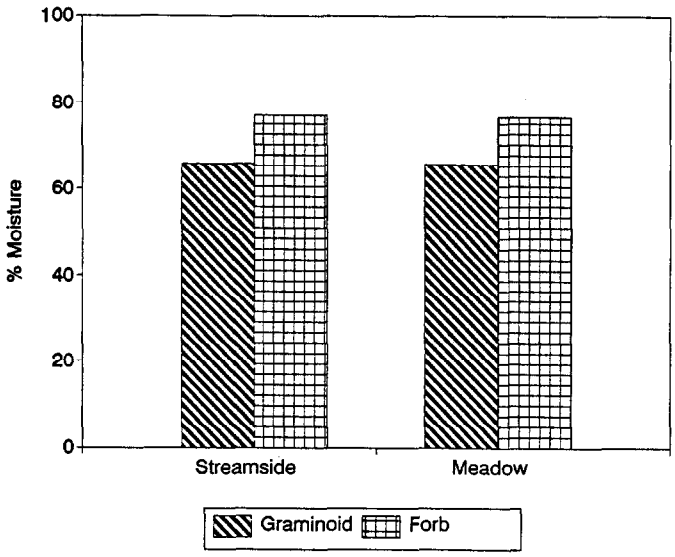

Fig. 4. Herbage moisture contents at streamside and on the adjacent meadow. Graminoid and forb percentage moisture did not differ between locations ($P = 0.94$ and $P = 0.64$, respectively), but differences between graminoids and forbs were highly significant ($P<0.001$).

A more detailed collection of plant moisture samples was made in 1990. The amount of moisture during the early season in several major species and species groups is displayed in Table 4. The only significant difference among graminoids was between Kentucky bluegrass and mixed other sedges. No relationship was found between percentage utilization and plant moisture.

Table 4. Plant moisture for individual species and species groups, June 1990.

Plant species or group	Moisture
Kentucky bluegrass	67.4a[1]
Beaked sedge	70.3 ab
Mixed other grasses	70.4 ab
Water sedge	70.7 ab
Mixed other sedges	75.8 bc
Mixed forbs	80.5 c

[1]Means not followed by a similar letter are different at $P<0.05$.

Even if plant succulence is an influential factor in the distribution of grazing use as suggested by Smith et al. (1992a), succulence provided little reason for the cattle to be attracted to the streamside areas during these June grazing periods. The average moisture contents of graminoids and forbs were virtually identical between the streamside and meadow locations. The 1990 data suggest that during June most or all of the major forage species and groups were succulent with relatively high moisture contents. Forage quality among species is typically less variable in the early growing season as compared to the remainder of the year, and less selection preference is normally exercised during this period (Arnold 1960, Smith et al. 1992b).

Conclusions

Many concerns expressed about the impact of grazing upon riparian areas are actually concerns of livestock distribution (Severson and Medina 1983). Although topography or some other factors may severely restrict livestock to near-stream areas in some situations, mountain meadows have considerable potential for being grazed in a nondamaging manner. Distribution of cattle grazing use on the Stanley Creek pastures during early summer was different than typically occurs with seasonlong grazing (Kauffman and Krueger 1984, Skovlin 1984, Swanson 1988). The evidence provided by utilization rates and residual stubble heights suggested that cattle were not noticeably attracted to streamside areas during early summer grazing. In fact, as stocking rate was raised, the use of streamside areas increased only modestly, while use of the adjacent meadow increased substantially. It is apparent, however, that this trend can not continue as stocking rates become very high. When stubble heights become short and most leaf material is removed (Chacon and Stobbs 1976), livestock will be forced to move to where forage is more abundant, such as along streamsides and other wet site areas within riparian pastures, if adequate forage intake is to be maintained (Allden and Whittaker 1970, Spalinger and Hobbs 1992). Thus, utilization rates need to be carefully monitored on the drier meadows as well as on streamside areas.

A wide range of factors interact to determine the composition of a grazing animal's diet at any particular time (Arnold and Dudzinski 1978). Although analyses demonstrated differences in utilization of different riparian areas, we don't know how much of this difference is due to the animals preferring particular plants or how much is due to their preference to graze in certain areas. Both factors are likely to be important because plant community type and surface soil moisture each demonstrated highly significant statistical effects on utilization rates. Forage succulence, however, was not an influential factor in plant utilization during early season grazing.

At Stanley Creek and other similar meadow locations, the distribution of cattle grazing use within riparian pastures apparently can be influenced by matching the season of grazing to local soil moisture conditions.

Literature Cited

Allden, W.G., and I.A. McD. Whittaker. 1970. The determinants of herbage intake by grazing sheep: the interrelationship of factors influencing herbage intake and availability. Aust. J. Agr. Res. 21:755–766.

Armour, C.L., D.A. Duff, and W. Elmore. 1991. The effects of livestock grazing on riparian and stream ecosystems. Fisheries 16:7–11.

Arnold, G.W. 1960. Selective grazing by sheep of two forage species at different stages of growth. Aust. J. Agr. Res. 11:1026–1033.

Arnold, G.W. 1964. Supplementation of *Phalaris tuberosa-Trifolium subterraneum* pasture in summer with urea and molasses. Field Sta. Rec. Div. Plant Ind., CSIRO (Aust.) 3:37–44.

Arnold, G.W., and M.L. Dudzinski. 1978. Ethology of free-ranging domestic animals. Elsevier Scientific Publishing Co. New York.

Chacon, E., and T.H. Stobbs. 1976. Influence of progressive defoliation of a grass sward on the eating behaviour of cattle. Aust. J. Agr. Res. 27:709–727.

Clary, W.P., and B.F. Webster. 1989. Managing grazing of riparian areas in the Intermountain Region. USDA Forest Serv. Gen. Tech. Rep. INT-263. Intermountain Res. Sta., Ogden, Ut.

Garrison, G.A., A.J. Bjugstad, D.A. Duncan, M.E. Lewis, and D.R. Smith. 1977. Vegetation and environmental features of forest and range ecosystems. USDA Agr. Handb. 475. Washington, D.C.

Goodman, T., G.B. Donart, H.E. Kiesling, J.L. Holechek, J.P. Neel, D. Manzanares, and K.E. Severson. 1989. Cattle behavior with emphasis on time and activity allocations between upland and riparian habitats. p. 95–102. *In:* R.E. Gresswell, B.A. Barton, and J.L. Kershner (eds.). Practical approaches to riparian resource ranagement: An educational workshop. USDI Bureau of Land Manage. Billings, Mont.

Kauffmann, J.B., and W.C. Krueger. 1984. Livestock impacts on riparian ecosystems and streamside management implications—a review. J. Range Manage. 37:430–438.

Kauffman, J.B., W.C. Krueger, and M. Vavra. 1983. Effects of late season cattle grazing on riparian plant communities. J. Range Manage. 36:685–691.

Kinch, G. 1989. Riparian area management: grazing management in riparian areas. Tech. Ref. 1737-4. USDI Bureau of Land Manage., Serv. Center. Denver, Colo.

Kovalchik, B.L. 1987. Riparian zone associations: Deschutes, Ochoco, Fremont, and Winema National Forests. Ecol. Tech. Pap. 279–87. USDA Forest Serv. Reg. 6. Portland, Ore.

Kovalchik, B.L., and W. Elmore. 1992. Effects of cattle grazing systems on willow-dominated plant associations in central Oregon. p. 111–119. *In:* W.P. Clary, E.D. McArthur, D. Bedunah, and C.L. Wambolt (compilers.). Proc.—Symp. on ecology and management of riparian shrub communities. USDA Forest Serv. Gen. Tech. Rep. INT-289. Intermountain Res. Station, Ogden, Ut.

Krueger, W.C. 1983. Cattle grazing in managed forests. p. 29–41. *In:* B.F. Roche, Jr. and David M. Baumgartner (compilers). Forestland grazing. Symp. Proc., 1983 February 23–25, Spokane, Wash., Washington State Univ.

Marlow, C.B., and T.M. Pogacnik. 1986. Cattle feeding and resting patterns in a foothills riparian zone. J. Range Manage. 39:212–217.

Marlow, C.B., T.M. Pogacnik, and S.D. Quinsey. 1987. Streambank stability and cattle grazing in southwestern Montana. J. Soil and Water Conserv. 42:291–296.

Myers, L.H. 1989. Grazing and riparian management in southwestern Montana. p. 117–120. *In:* R.E. Gresswell, B.A. Barton, J.L. Kershner (eds.). Practical approaches to riparian resource management: An educational workshop. USDI Bureau of Land Manage., Billings, Mont.

Pechanec, J.F., and G.D. Pickford. 1937. A comparison of some methods of determining percentage utilization of range grasses. J. Agr. Res. 54:753–765.

Platts, W.S., and R.L. Nelson. 1985. Impacts of rest-rotation grazing on stream banks in forested watersheds in Idaho. North Amer. J. Fish. Manage. 5:547–556.

Rosgen, D.L. 1985. A stream classification system. p. 91–95. *In:* R.R. Johnson, C.D. Ziebell, D.R. Patton, P.F. Ffolliott, and R.H. Hamre (tech. coords.). Riparian ecosystems and their management: Reconciling conflicting uses: First North American Riparian Conference. USDA Forest Serv. Gen. Tech. Rep. RM-120. Rocky Mountain Forest and Range Exp. Sta., Ft. Collins, Colo.

Severson, K.E., and A.L. Medina. 1983. Deer and elk habitat management in the Southwest. J. Range Manage. Monogr. No. 2.

Siekert, R.E., Q.D. Skinner, M.A. Smith, J.L. Dodd, and J.D. Rodgers. 1985. Channel response of an ephemeral stream in Wyoming to selected grazing treatments. p. 276–278. *In:* R.R. Johnson, C.D. Ziebell, D.R. Patton, P.F. Ffolliott, and R.H. Hamre (tech. coords.). Riparian ecosystems and their management: Reconciling conflicting uses: First North American Riparian Conference. USDA Forest Serv. Gen. Tech. Rep. RM-120. Rocky Mountain Forest and Range Exp. Sta., Ft. Collins, Colo.

Skovlin, J.M. 1984. Impacts of grazing on wetlands and riparian habitat: a review of our knowledge. p. 1001–1103. *In:* Developing strategies for rangeland management. Westview Press, Boulder, Colo.

Smith, M.A., J.D. Rodgers, J.L. Dodd, and Q.D. Skinner. 1992a. Declining forage availability effects on utilization and community selection by cattle. J. Range Manage. 45:391–395.

Smith, M.A., J.D. Rodgers. J.L. Dodd, and Q.D. Skinner. 1992b. Habitat selection by cattle along an ephemeral channel. J. Range Manage. 45:385–390.

Spalinger, D.E., and N.T. Hobbs. 1992. Mechanisms of foraging in mammalian herbivores: New models of functional response. The Amer. Natural. 140:325–348.

Steel, R.G.D., and J.H. Torrie. 1980. Principles and procedures of statistics. Ch 15. McGraw-Hill Book Co., N.Y.

Swanson, S. 1988. Riparian values as a focus for range management and vegetation science. p. 425–445. *In:* P.T. Tueller (ed.). Vegetation science applications for rangeland analysis and management. Kluwer Academic Publ., Boston.

Szaro, R.C. 1989. Riparian forest and scrubland community types of Arizona and New Mexico. Desert Plants 9:70–138.

Tuhy, J.S., and S. Jensen. 1982. Riparian classification for the Upper Salmon/Middle Fork Salmon River Drainages, Idaho. Final Rep., contract from U.S. Forest Serv., Region IV. White Horse Assoc., Smithfield, Utah.