Cattle and Salmon I: Cattle Distribution and Behavior in a Northeastern Oregon Riparian Ecosystem

Teena M. Ballard[1] and William C. Krueger[2]

Authors are [1]Hydrologist, USDA Forest Service, La Grande Ranger District, 3502 Hwy 30, La Grande, OR 97850; and [2]Professor, Department of Rangeland Resources, Oregon State University, Corvallis, OR 97331.

Abstract

This 2-year study was designed to quantify the influence of terrestrial and stream habitats on cattle distribution and behavior in a riparian pasture with access to active chinook salmon (*Oncorhynchus tshawytscha*) spawning. The active salmon redds accessible to cattle were at a density of 4.6 redds per km in 1996 and 6.1 redds per km in 1997. The stocking rate was maintained at 0.82 ha·AUM^{-1} for 28 days. Cattle spent approximately 94% of their time in the terrestrial habitats (meadow, disturbance, low shrub, tall shrub, and trees) that supported herbivory-type activities (travel, graze, and rest), the remaining time was spent in stream habitats, which consisted of gravel bar (5%) and in aquatic (< 1%) habitats. Cattle spent approximately 88% of their time on nonherbivory-type activities while in the aquatic habitat. Individual cows were observed during the daylight hours for 18 of 28 days each year they were in the pasture and were never observed in direct contact with a redd. Cattle spent over half of their time drinking and < 0.01% of their time defecating while they were in the aquatic habitat. Defecation was proportional to time spent in each habitat; so about 2% of the manure was directly deposited in the stream.

Resumen

Este estudio de dos años se diseño para cuantificar la influencia de los hábitats terrestres y de corrientes de agua en la distribución y comportamiento del ganado en praderas ribereñas con acceso a áreas activas de ovoposición (nidos) del "Chinook salmon" (*Oncorhynchus tshawytscha*). Los nidos del salmón accesibles al ganado tenían una densidad de 4.6 sitios por kilometro en 1996 y 6.1 sitios por kilometro en 1997. La carga animal se mantuvo en 0.82 UAM^{-1} por 28 días. El ganado pasó aproximadamente el 94% de su tiempo en los hábitats terrestres (pradera, sitios disturbados, arbustos bajos, arbustos altos y árboles) que sostuvieron las actividades del herbivoría (apacentar, descansar y viajar), el tiempo restante fue consumido en los hábitats de corrientes de agua los cuales consistieron en bancos de grava (5%) y hábitats acuáticos (< 1%). Cuando el ganado se encontraba en los hábitats acuáticos aproximadamente dedicó 88% de su tiempo a actividades diferentes a la herbivoría. En cada año del estudio en18 de los 28 días del periodo experimental se observaron vacas individuales durante las horas diurnas, ellas estuvieron en el potrero y nunca se observaron en contacto directo con los nidos del salomón. Cuando el ganado estaba en hábitats acuáticos uso más de la mitad de su tiempo tomando agua y < 0.01% de su tiempo defecando. La defecación fue proporcional al tiempo que pasó en cada hábitat, de tal forma que aproximadamente el 2% del estiércol se depositó directamente en la corriente de agua.

Key Words: redd, salmon spawning, plant habitats, aquatic habitat

INTRODUCTION

Grazing distribution patterns of large herbivores are affected by slope, distance to water, and quality and quantity of forage. Cattle production is optimized by the animal's ability to harvest nutrients in an effective and efficient manner (Stuth 1991). Cattle forage optimally by consuming the greatest quantity and quality of vegetation and expending the least amount of energy in doing so with a strategy to maintain fitness (Hanley 1982; Stuth 1991). The time animals spend in different areas of a pasture or habitat is based on the resource levels found there or quantity of nutrients available (Senft et al. 1985; Korpela 1992; Bailey et al. 1996).

Numerous studies have been conducted to evaluate cattle-distribution patterns relative to water and riparian areas and have found water to be an influencing factor (McIlvain and Shoop 1971; Roath and Krueger 1982; Gillen et al. 1985; Senft et al. 1985; Owens et al. 1991; Dickard et al. 1998). Results from the above studies indicated that distance from water is a key factor in cattle-distribution patterns. However, few have looked specifically at cattle behavior relative to terrestrial and stream habitats in a riparian zone.

To determine impacts of grazing on riparian areas, managers must develop an understanding of the grazing patterns utilized by the animals they are managing and intrinsic plant–animal interactions. Riparian areas tend to contain proportionally more available soil moisture than upland landscapes because of the natural drainage. This typically results in greater quality and quantity of forage, greater species diversity, and more complex plant-community dynamics than adjacent uplands.

Cattle are attracted to riparian areas for easy access to water, limited slopes, shade (McIlvain and Shoop 1971), thermal cover, and a high quantity and quality of forage (Kauffman and Krueger 1984; Bailey et al. 1996) relative to the adjacent uplands.

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At the time of research, Ballard was research assistant, Oregon State University, Eastern Oregon Agricultural Research Center, Union, OR 97883.

Correspondence: Teena M. Ballard, USDA Forest Service, La Grande Ranger District, 3502 Hwy 30, La Grande, OR 97850. Email: tballard@fs.fed.us

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However, few attempts to predict cattle-grazing patterns within a riparian pasture have been made (Krueger 1996).

This study was conducted to quantify a portion of the many plant–animal interactions that exist between cattle, terrestrial riparian habitats, stream habitats, and aquatic habitats that contain salmon redds. A salmon redd is an area in the stream bed where eggs are deposited. The objectives of the study were to determine if there were differences in cattle distribution and behavioral preference toward riparian terrestrial and stream habitats in a northeastern Oregon mountain rangeland meadow, to describe behavioral patterns of cattle as grazing progresses during the grazing season within terrestrial habitats in the riparian zone, and to determine the time cattle spend in the aquatic habitat relative to the likelihood of stepping on a salmon redd and/or defecating.

METHODS AND MATERIALS

During the 1996 and 1997 grazing seasons, we quantified the amount of time cattle spent on identified activities in terrestrial and stream habitats and the distribution of active spring chinook salmon spawning redds.

Study Area

The study area was located in the Blue Mountain Ecological Province (Anderson et al. 1998) 15 km southeast of Union, Oregon, in the southwestern foothills of the Wallowa Mountains of northeastern Oregon on the Hall Ranch of the Eastern Oregon Agricultural Research Center (EOARC). The stream was at lat 45°7′57″N long 117°42′31″W.

The study area consisted of a long, narrow pasture, approximately 41 hectares in size, located in a valley bottom along 2.6 km of Catherine Creek. The majority of the precipitation on the study area occurs as snow between the months of November and May. Data collected from 1970 to 1992 at 2 EOARC weather stations near the study area indicated mean annual precipitation for the study area of 604 mm. Air temperatures in the area range from below freezing to more than 38°C. Elevation of the study area averages about 1 018 m.

Catherine Creek is a third-order tributary of the Grande Ronde River, which eventually drains into the Columbia River system. The yearly mean discharge for Catherine Creek at the study location during the study was 2.12 $m^3 \cdot s^{-2}$ in 1996 and 3.37 $m^3 \cdot s^{-2}$ in 1997, with peak flows in June for 1996 and May in 1997 (US Geological Survey 1996, 1997). The weather pattern during the summer season varied between years (Oregon Climate Service 1998). In 1996, there were more precipitation and warmer temperatures early in the growing season, which enhanced forage production. During 1997, there were greater precipitation and warmer temperatures overall during the study, but these conditions occurred too late during the growing season to maximize growth by cool-season forage species.

The vegetation in the study area provides a mosaic of plant habitats. In mapping the vegetation within a 50-m strip on each side of the stream, Kauffman et al. (1985) identified 60 distinct plant habitats. The habitats ranged from meadow habitats dominated by Kentucky bluegrass (*Poa pratensis* L.), disturbance habitats dominated by cheatgrass (*Bromus tectorum* L.), to tree-dominated habitats containing 1 or more of the following: ponderosa pine (*Pinus ponderosa* Dougl.), grand fir (*Abies grandis* (Dougl.) Forbes), and black cottonwood (*Populus trichocarpa* T. & G.). Additional habitats included low-shrub habitats dominated by snowberry (*Symphoricarpos albus* (L.) Blake), tall-shrub habitats dominated by thin leaf alder (*Alnus incana* (L.) Moench) or black hawthorn (*Crataegus douglasii* Lindl.), and the gravel bars dominated by willow (*Salix* L. spp.).

Historically, the riparian pasture along Catherine Creek was grazed heavily during all periods of the summer grazing season. Management of the riparian pasture changed in 1978 when 5 areas along the stream were fenced to exclude cattle from 50% of Catherine Creek in the study area. A late summer, short-duration grazing system was implemented in 1979 on the study area to minimize cattle impacts on riparian vegetation and wildlife. Cattle grazing in the study area usually begins in mid- to late August, after much of the forage supply in the uplands has been utilized, and continues for about 3 weeks until mid-September. The 41-hectare study area is stocked on average at 0.82 $ha \cdot AUM^{-1}$ and varies from 0.60 $ha \cdot AUM^{-1}$ to 2.45 $ha \cdot AUM^{-1}$ by targeting a 60%–70% utilization of Kentucky bluegrass in the meadow areas (Kauffman et al. 1983; Krueger 1983).

Terrestrial and Stream Habitat Designation

The habitats designated for this study were mapped consistent with the procedures outlined by Kauffman et al. (1985). Aerial photographs were used to delineate and determine the areal extent of the vegetation types (Korpela 1992). The study area was split into 5 terrestrial habitats and 2 stream habitats. A modification of Korpela's (1992) aerial extent for each habitat was used to calculate the weight of each habitat used in this study. The area occupied by different habitats was modified from that used by Korpela (1992) because of the vegetation changes that occurred over the 11 years since Korpela's study was conducted. The terrestrial habitats were delineated as meadow habitats (wet, moist, and dry meadows), disturbance habitats (e.g., old gravel bars not within the banks of the stream), low-shrub habitats, tall-shrub habitats, and tree habitats. The stream habitats were delineated as gravel-bar and aquatic habitats. The aquatic habitat included vegetated islands and multiple channeled reaches within the wetted areas of the stream channel. This resulted in widths ranging from 5 feet in some riffled and pooled areas to 30 feet where multiple channels and vegetated islands were combined.

Cattle Activities Designation

Thirteen cattle activities were quantified and consisted of the following: traveling (searching), grazing (harvesting), resting, defecating, playing, running from disturbance, crossing the creek, drinking, stepping on a salmon redd, salting, nursing, grooming, and missing data.

Activities including playing, running from disturbance, salting, nursing, and grooming were pooled into an other category for analysis because they comprised $< 1\%$ of the time spent on an activity when quantified individually.

Cattle Activity and Distribution

In 1996 and 1997, the study area was stocked with 40 cow/calf pairs on 13 August for the first 14 days and then 20 additional

cow/calf pairs were put in the study area on 27 August for the last 14 days at a stocking rate for both 1996 and 1997 of 0.82 ha • AUM^{-1}. This stocking rate is near the maximum cattle density that is usually encountered on a nonirrigated northeastern Oregon grazed meadow. Catherine Creek provided all water for cattle. Salt was provided ad libitum in 1 disturbance habitat. Cattle were moved to another pasture after the meadows within the study area attained about 60%–70% utilization, based on stubble height, resulting in a grazing period of 28 days for both 1996 and 1997.

The point source, or focal method, of visual observations was used to monitor cattle behavior and distribution relative to the 7 designated habitats (Martin and Bateson 1986). Cattle were observed for 18 days in both 1996 and 1997. In each year, cattle were observed for 6 days in the early one-third of the grazing season, 6 days in the middle of the season, and 6 days in the last one-third of the grazing season. Visual observations were used to measure physical distribution and activity throughout the day. Data were collected between 0700 and 1900 for 8 of 12 hours. Data were not collected at night for 2 reasons: 1) past research suggested that there is little activity by cattle during the night (Sneva 1970; Stuth 1991; Miner et al. 1992) and 2) data were collected on salmon behavior to coincide with the cattle observations and fish cannot be seen in the redd at night. Observations were made for 2 randomly selected 4-hour periods out of three (0700–1059, 1100–1459, 1500–1859) each of the 18 days. A randomly chosen, nonrepeated, single cow (identified by a numbered ear tag) was observed for each 4-hour period, giving a total of 36 observation periods for each year. Observations of the cow's activity and time spent in the habitat were recorded on a data sheet for each second of the 4-hour period, and the location of the cow within the habitat was recorded on an aerial photo. The observer followed the cow at a distance of about 20 m. The cows were accustomed to the presence of an observer and their behavior was not influenced by the observer's presence.

To compare the relative time cattle spent in each activity between years, the proportion of time spent on each activity was weighted by the time spent in each area when the activity occurred. This weighted average was the sum of the products of the percentage time spent on an activity within a habitat and the percentage time spent in that habitat, converted to percentage. This corrected for the bias of a simple average of time spent on an activity across habitats so that the disproportionate amount of time spent in each habitat was incorporated into the weighted average.

Kentucky Bluegrass Stubble-Height Designation

The Wallowa-Whitman National Forest in northeastern Oregon used a 35%–45% utilization standard in riparian areas in their grazing allotments. These utilization levels are monitored with site-specific height/weight curves established on the key species to the area. The height/weight curves established for the Catherine Creek area allotments for a Poa Complex were used to calculate the utilization levels in the riparian pasture study area (US Forest Service 1995).

Stubble heights of the most palatable species, Kentucky bluegrass, were measured at 100 points on linear transects located in each of the 4 grazing areas in the study pasture once a week. Cattle were removed from the study area when the criterion of a 0.75-inch stubble height measurement of Kentucky bluegrass was reached (Hall and Bryant 1995). This calculated to 70% utilization of Kentucky bluegrass. This was the same time salmon spawning became inactive in each year of the study.

Active Spring Chinook Salmon Redd Designation

Periodic observations were made along the study area of Catherine Creek in early August to detect the onset of spring chinook salmon spawning. After salmon were observed actively spawning, cattle were stocked into the study area. The locations of the salmon redds were placed on the overlay on aerial photographs used to record locations of cattle activity. The observer of the cattle was then able to note cattle distribution and activities in the aquatic habitat relative to the redd locations. The appearance of redds was monitored daily and the locations recorded on an overlay of an aerial photograph of Catherine Creek to record any direct contact of cattle stepping on redds. The active salmon redds accessible to cattle were at a density of 4.6 redds per km in 1996 and 6.1 redds per km in 1997.

Data Analysis

Observations were collected in seconds and averaged in minutes for each cow in each time period observed. The average minutes spent on each activity for each cow within each observation period was a sample. This gave 36 samples for each analysis each year of the study. Differences between time spent in each habitat and the area of each habitat, time spent on herbivory activities, and time spent on nonherbivory activities in each habitat and time spent grazing in early and late periods were analyzed with a t test. The time spent defecating in each of the 7 habitats was analyzed within each year and over years with a 2-way analysis of variance. All differences at $P \leq 0.05$ were considered significant.

RESULTS AND DISCUSSION

Cattle Behavior and Distribution in Terrestrial and Stream Habitats

Time spent by cattle was not evenly distributed among terrestrial habitats during the 2-year study (Table 1). Cattle spent 94% of their time in terrestrial habitats that could support herbivory (primary activities of traveling [searching], grazing, and resting). The remaining time was spent on gravel bars (5%) or in direct contact with the stream (< 1.0%). The low-shrub and tall-shrub habitats were preferred in the moist year and the tall-shrub and tree habitats were preferred in the dry year. The meadow and aquatic habitats were not preferred in either year. Disturbance areas and gravel bars were used in proportion to their availability. Even though the meadow was not preferred, it was an important foraging area because of its size and productivity.

Cattle spent most of their time (93%) in the meadow, tall- and low-shrub, and tree habitats. The combined area of the meadow habitats (38%), tall-shrub habitats (16%), low-shrub habitats (8%), and tree habitats (13%) comprised approximately 75% of the study area. Their activities within these habitats revolved principally around herbivory rather than

Table 1. Percentage of time cattle occupied each terrestrial and stream habitat in 1996 and 1997 compared with the area of the habitat.

Habitat	Dominant Species	Pasture % of Area	1996 Percent Time	1997 Percent Time
Meadow	Kentucky bluegrass	38	26.9**[1]	28.2**
Disturbed	Cheatgrass	2	1.4	0.1
Low Shrub	Snowberry	8	17.1*	12.3
Tall Shrub	Black hawthorn	16	32.8**	26.1**
	Thin leaf alder			
Tree	Grand fir	13	14.7	27.9**
	Ponderosa pine			
	Black cottonwood			
Gravel Bar	Willow	8	5.4	5.0
	Black cottonwood			
	Thin leaf alder			
Aquatic	Not applicable	15	1.5**	0.4**

[1]Significant differences between the availability of the habitat and time spent in each habitat in each year are noted for $P \leq 0.05$ as * and $P \leq 0.01$ as **.

Table 2. Percentage of time cattle spent on herbivory (travel, grazing, and rest) and non-herbivory-type activities while occupying each of the terrestrial and stream habitats in 1996 and 1997.

	1996		1997	
Habitats	Herbivory (%)	Nonherbivory (%)	Herbivory (%)	Nonherbivory (%)
1. Meadow	96	4**[1]	96	4**
2. Disturbed	64	36	44	66
3. Low Shrub	97	3**	94	6**
4. Tall Shrub	94	6**	97	3**
5. Tree	96	4**	95	5**
6. Gravel Bar	99	1**	93	7**
7. Aquatic	20	80**	4	96**

[1]Significant differences between herbivory and nonherbivory in each year are noted for $P \leq 0.01$ as **.

nonherbivory activities (meadow [96%, $P < 0.01$], tall shrub [96%, $P < 0.01$], low shrub [96%, $P < 0.01$], and tree [96%, $P < 0.01$]) (Table 2). This grazing pattern was consistent with that observed by Sneva (1970), Roath and Krueger (1982), and Gillen et al. (1985).

The different weather patterns between years did influence total forage production, inferred from the level of forage utilization in each year. The stocking rate of 0.82 ha·AUM^{-1} was constant across years, and utilization in the moist year (1996) was 57%, and in the drier year (1997) utilization was 74%. The patterns of distribution over years within and across habitats were generally similar. The average proportion of time spent on each activity by habitat weighted by proportional time spent in each habitat was similar across moist and dry years, for grazing at 52% and 51%; resting at 33% and 38%; and traveling at 10% and 4%, respectively. Within each herbivory-related activity, there were noticeable differences only in the low-shrub and tree habitats. Weighted grazing time in the low-shrub habitat was 10% in the moist year compared with 5% in the dry year. The weighted grazing time in the tree habitat was 4% in the moist year and 11% in the dry year. Cattle also rested more (14% weighted average) in the tree habitat in the dryer year than in the wetter year (4% weighted average). In the moist year, phenology was delayed compared with the dry year. The low-shrub habitat dried earlier in the year in the dry year and cattle switched their preference to the tree habitat for grazing and resting.

Cattle Grazing Within Habitats

In 1996 and 1997, there was an observable difference in the amount of time cattle spent on each activity while occupying the different habitats (Table 3). Stubble-height measurements of Kentucky bluegrass were related to the behavioral shifts observed in 1996 and 1997. The availability of resources at 74% utilization (1997) would be less than at 57% utilization (1996), and partitioning the study into early and late grazing periods suggested shifts in habitat preference for harvesting forage, although variability within years was high (Table 4). The time spent by cattle harvesting forage occurred predominantly within the meadow, low-shrub, tall-shrub, and tree habitats. However, the time spent harvesting appeared to change between years and between early and late grazing periods in each habitat. In 1996 (moist year), the greatest amount of time harvesting forage was spent during the late grazing period in the low-shrub habitat, which was the only significant difference between early and late periods in either year. Of the time cattle spent grazing the meadow, 42% was in the early period and 58% was in the late period, so in the meadow, there was 16% more time spent grazing in the late period. The relative amount of time used to harvest forage appeared higher for the low-shrub and tall-shrub habitats at 54% and 24%, respectively, in the late period. The tree habitat was not selected for grazing in the late period.

In 1997 (dry year), there were no significant differences between the time spent grazing in any habitat in early and late periods. Cattle in the meadow and low-shrub habitats appeared to spend a higher percentage of harvest time during the early period, which was 18% greater than the time spent harvesting in the late grazing period. Cattle in the tall-shrub habitat, however, showed an increase of 16% in the late period compared with the early period in 1997. These patterns of grazing are consistent with other research results that have shown moisture content or greenness of forage can influence the duration and timing of cattle grazing certain forage (Owens et al. 1991; Hall and Bryant 1995). In this study, cattle tended to browse more as grasses became drier and browned in color during the late grazing period. This was represented by the shift in grazing to the tall-shrub area over the meadow and low-shrub habitats in the drier year, 1997. A general decrease of grazing duration in the latter grazing period was also observed in 1997. Korpela (1992) also noted initial forage selection tended to maximize energy content; later in the season, selection was reduced and shifted toward dryer, less nutritious forage, as resources became less available.

The disturbed areas were seldom used even though a disturbed area was the only location where salt was available. This suggests that these cattle did not tend to congregate around the salt. They used the salt while traveling between habitats as part of their general pattern of movement.

Table 3. Percentage of time cattle spent on each behavioral activity within each of terrestrial and stream habitats in 1996 and 1997.

	Terrestrial and Stream Habitats						
Activities	Meadow (%)	Disturbed (%)	Low Shrub (%)	Tall Shrub (%)	Trees (%)	Gravel Bar (%)	Aquatic (%)
1996							
Traveling	10.6	22.3	13.1	9.6	8.7	8.3	2.5
Grazing	64.8	28.5	56.6	52.3	29.3	46.8	12.9
Resting	20.6	49.2	27.1	31.9	58.4	43.9	4.5
Defecating	0.6	0.0	0.5	0.7	1.2	0.5	1.23
Crossing the Creek	0.0	0.0	0.0	0.0	0.0	0.0	23.2
Drinking	0.2	0.0	0.0	0.04	0.0	0.4	54.3
Stepping on Redd	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	3.2	1.5	2.7	5.1	2.4	0.1	0.0
Total Minutes	1 968	101	1 255	2 397	1 078	412	105
1997							
Traveling	3.3	33.3	4.2	2.9	4.1	7.9	0.0
Grazing	65.0	11.1	39.8	61.4	41.1	71.8	4.1
Resting	27.4	0.0	50.0	32.9	50.0	13.2	0.0
Defecating	0.5	0.0	0.1	0.3	0.3	0.0	1.4
Crossing the Creek	0.0	0.0	0.0	0.0	0.0	0.0	32.4
Drinking	0.2	0.0	0.0	0.1	0.5	1.7	62.2
Stepping on Redd	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	3.7	55.6	5.9	2.4	4.0	5.4	0.0
Total Minutes	2 391	9	1 048	2 214	2 369	424	37

Cattle Defecation in Terrestrial and Stream Habitats

Cattle defecating in or close to a stream can be detrimental to aquatic organisms if manure is excreted at levels that cause excessive concentrations of organic matter and nutrients (nitrogen and phosphorus) that result in reduced levels of available dissolved oxygen (Meehan and Platts 1978). Cattle spent a significantly greater amount of time (96%) defecating in the terrestrial habitats compared with the time spent defecating in the stream habitats ($P < 0.01$; Table 5). The time spent grazing reflected the time cattle occupied each habitat (Table 1). It appeared time spent defecating was independent of habitat, which supported the findings of Hafez et al. (1969). Of the total fecal output expected to be produced by 50 cattle over 56 days, approximately 2% was input into the aquatic habitat and approximately 2% on the gravel bars, using Larsen's (1989) expected values for defecation rates.

Cattle and Salmon Redd Locations

It was the policy of the observer to note any contact of cattle with redds even if it was not the observation cow. This maximized the opportunity for the observer to note contact of cattle with redds. There were no encounters of cattle contacting redds during the cattle distribution and behavior observations.

Table 4. Total amount of time cattle spent grazing in each terrestrial habitat during the early and late grazing periods. Each period was sampled for 6 days in each period in 1996 and 1997.

	Grazing Periods 1996		Grazing Periods 1997	
Habitats (% area)	Early (min)	Late (min)	Early (min)	Late (min)
Meadow (38%)	397	549	622	435
Low Shrub (8%)	85	286*[1]	203	142
Tall Shrub (16%)	290	483	431	600
Trees (13%)	246	0	337	237
Total	1 018	1 319*	1 593	1 414

[1]Significant differences between early and late grazing periods within years at $P \leq 0.05$ are indicated by *.

Table 5. Percentage of time cattle spent defecating in each of the terrestrial and stream habitats in 1996 and 1997. Differences between terrestrial and stream habitats were significant ($P \leq 0.01$) in both years.

Habitats	Pasture % of Area	1996 Percent	1997 Percent
1. Meadow	38	24	42
2. Disturbed	2	0	0
3. Low Shrub	8	13	2
4. Tall Shrub	16	31	26
5. Tree	13	25	28
6. Gravel Bar	8	4	0
7. Aquatic	15	3	2
Terrestrial (Habitats 1–5)	77	93a[1]	98a
Stream (Habitats 6 and 7)	23	7b	2b

[1]Means with different letters within years, contrasting terrestrial to stream habitats, are significant at $P \leq 0.01$.

The majority (70%) of the time that cattle were in contact with the stream (gravel bar and aquatic habitats), they spent their time on nonmoving activities (i.e. drinking, grazing, and resting) and less time (30%) on activities where they were moving around in the stream (Table 3). This movement of cattle in the stream was typically limited to crossings, which make up a small portion of the stream. Cattle went to the stream to get a drink or cross over to different vegetation, and they did not integrate many other activities while in the stream. They would do what was necessary and leave the area. Sneva (1970) observed that cattle in eastern Oregon on the high-desert province drank an average of 17 minutes per day, which is comparable with McInnis (1985), who observed a mean drinking time of 26.6 minutes per day. In this study, cattle spent an average of 3 minutes each time they were observed drinking and had 1–2 drinking events per observation period. These results were similar to a study done by Wagnon (1963), where cattle spent an average 3–4 minutes each time they drank.

CONCLUSIONS

Cattle distribution observed in this study showed highly significant differences in the amount of time cattle spent in each habitat. Cattle spent a significantly greater amount of time in the terrestrial habitats (94%) compared with stream habitats (6%). Within the stream habitats, cattle spent approximately 5% in the gravel bar habitats and $< 1.0\%$ of their time in direct contact with the aquatic habitats. It is often a concern that cattle in the stream channel can have a negative effect on water quality and aquatic organisms by defecating in the water or stepping on salmon redds. In this study, cattle spent $< 0.01\%$ of their time defecating in the aquatic habitat during the entire time of the study. This was equivalent to about 2% of the feces put into the aquatic habitat. Distribution of cattle defecation in the identified habitats appeared independent of habitat and reflected the time cattle occupied each habitat. Consequently, 96% of defecation time was in the terrestrial habitats. There were no observations of any cows contacting a redd during the cattle-observation studies.

Cattle grazed predominantly in the meadow, low-shrub, tall-shrub, and tree habitats throughout the study. However, the amount of time cattle spent grazing appeared to change between the early and late grazing periods. Cattle-grazing activity may have been influenced by the quality and quantity of forage produced in each year of the study. In 1996, forage production was greater and contributed to cattle spending more time harvesting forage in each of the grazed habitats as the season progressed. In 1997, when forage production was less, there was a shift toward grazing in the tree habitat.

This study is a case history and its general applicability is not known. Many larger meadows in northeastern Oregon are similar to the meadow at Catherine Creek. Presumably, as the conditions of this study, such as even topography, high stocking density, 70% utilization of key forages, palatable forages throughout the meadow, monitoring of forage utilization and removal of cattle when utilization is achieved, mix of community types, and livestock class are similar, the conclusions from this case study would be useful in evaluating management strategies. As local conditions deviate from the conditions of this study, transferability of our findings would be less likely.

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