



~~WITHDRAWN~~

**Interior Columbia Basin
Ecosystem Management Project
Science Integration Team
Terrestrial Staff
Range Task Group**

REVIEW DRAFT

**Livestock Grazing in Riparian Areas in the Interior Columbia Basin
and Portions of the Klamath and Great Basin**

**STEPHEN G. LEONARD
Rangeland Scientist
USDI-Bureau of Land Management
Nevada State Office
Reno, NV 89520**

**MICHAEL G. "SHERM" KARL
Rangeland Management Specialist-Ecologist
USDA-Forest Service
Walla Walla, WA 99362**

1st Draft: September 11, 1995

QH
541.5
.R52
L4
1995

1950-1951

**Interior Columbia Basin
Ecosystem Management Project
Science Integration Team
Terrestrial Staff
Range Task Group**

BUREAU OF LAND MANAGEMENT LIBRARY
BLDG. 50,
DENVER FEDERAL CENTER
P.O. BOX 25047
DENVER, COLORADO 80225

REVIEW DRAFT

**Livestock Grazing in Riparian Areas in the Interior Columbia Basin
and Portions of the Klamath and Great Basin**

STEPHEN G. LEONARD
Rangeland Scientist
USDI-Bureau of Land Management
Nevada State Office
Reno, NV 89520

MICHAEL G. "SHERM" KARL
Rangeland Management Specialist-Ecologist
USDA-Forest Service
Walla Walla, WA 99362

1st Draft: September 11, 1995

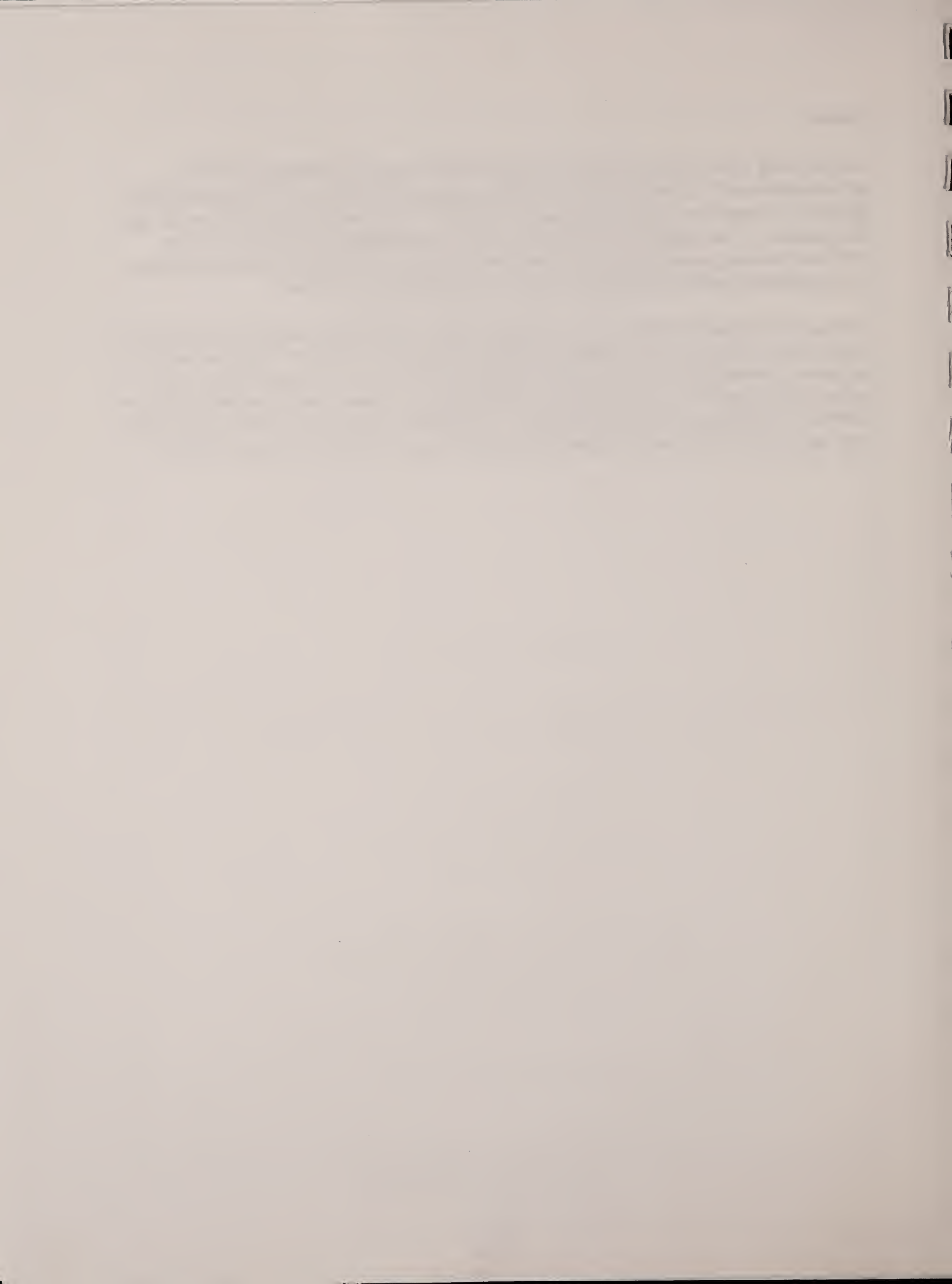
~~LIBRARY~~
~~BIOLOGICAL RESOURCES DIVISION~~
~~MONTANA ECOLOGICAL SCIENCE CENTER~~
4512 MCMURRY AVENUE
FORT COLLINS, CO 80525-3400



Preface

The following report was prepared by University scientists through cooperative agreement, project science staff, or contractors as part of the ongoing efforts of the Interior Columbia Basin Ecosystem Management Project, co-managed by the U.S. Forest Service and the Bureau of Land Management. It was prepared for the express purpose of compiling information, reviewing available literature, researching topics related to ecosystems within the Interior Columbia Basin, or exploring relationships among biophysical and economic/social resources.

This report has been reviewed by agency scientists as part of the ongoing ecosystem project. The report may be cited within the primary products produced by the project or it may have served its purposes by furthering our understanding of complex resource issues within the Basin. This report may become the basis for scientific journal articles or technical reports by the USDA Forest Service or USDI Bureau of Land Management. The attached report has not been through all the steps appropriate to final publishing as either a scientific journal article or a technical report.



Livestock Grazing in Riparian Areas

Report by S.G. Leonard and M.G. Karl

This report is based primarily on a literature review performed by R.R. Kindschy¹ with inputs based on additional review by S.G. Leonard and M.G. Karl.

Riparian areas (USDI 1992) are "a form of wetland transition between permanently saturated wetlands and upland areas. These areas exhibit vegetation or physical characteristics reflective of permanent surface or subsurface water influence. Lands along, adjacent to, or contiguous with perennially and intermittently flowing rivers and streams, glacial potholes, and the shores of lakes and reservoirs with stable water levels are typical riparian areas. Excluded are such sites as ephemeral streams or washes that do not exhibit the presence of vegetation dependent on free water in the soil." Riparian-wetland areas are grouped into two major categories: 1) lentic, which is standing water habitat such as lakes, ponds, seeps, bogs, and meadows, and 2) lotic, which is running water habitat such as rivers, streams, and springs. A preponderance of literature on livestock grazing in riparian areas is associated with lotic systems because of their much greater aerial extent in the arid west and the potentially greater negative affects associated with increased energies of running water.

Historic evidence in general indicates that most riparian areas in the western U.S. have changed dramatically within the last 100 years. A major causal factor has been improper livestock grazing (Chaney, Elmore, and Platts 1990).

¹Kindschy, Robert R. 1994. Riparian restoration and management. 59 p. Contract report. On file with: Interior Columbia Basin Ecosystem Management Project, 112 E. Poplar, Walla Walla, WA 99362.

MEMORANDUM FOR THE RECORD

DATE: 11/15/54

RE: [Illegible]

[Illegible text block containing several paragraphs of a memorandum report.]

Very truly yours,
[Illegible Signature]

Other major factors are changes to flow regimes caused by dams, diversions, or pumping and, to a lesser extent, disturbances associated with other uses such as logging, roads, and recreational facilities.

Within the western U.S., livestock grazing likely will continue as a primary use of much of the land area of the Columbia Basin (Kindschy 1994). Cattle are the principal type of livestock that now graze rangelands of the Columbia Basin. Riparian areas constitute only a small percentage of these rangelands (Bedell ed. 1993), yet livestock (especially cattle) activity is disproportionately concentrated within riparian areas (Marlow and Pogacnik 1986, Kovalchik and Elmore 1991) compared with upland areas of watersheds. Excessive herbage removal and physical damage by trampling are visual effects of improper grazing in riparian areas resulting from this concentration of activity. Less noticeable are effects on water quality.

Ramifications of excessive herbage removal and physical damage can include reduced dissipation of stream energy, increased bare soil and soil loss through accelerated erosion, stream channel degradation resulting in reduced floodplain recharge and/or lowered water table and subsequently reduced riparian community size. Erosion and stream channel degradation also affect water quality by increasing suspended sediments and, in conjunction with absence of vegetation shading, water temperature. Simplification of structural layering of vegetation, and presence of early successional stages result in less diverse and often less productive floral and faunal assemblages. Direct influences of livestock concentrations in riparian areas on water quality also include bacterial and protozoal parasite contamination and nutrient enrichment from fecal material in and near surface waters (Larsen in press).

Riparian-wetland capability and potential is defined by the interaction of three components: 1) vegetation, 2) landform/soils, and 3) hydrology. When the

[The text on this page is extremely faint and illegible. It appears to be a multi-paragraph document with several lines of text per paragraph. The content is not discernible.]

interaction of these three components is functioning properly, the physical affects described above are not apparent and the capability to produce desired biological attributes is maintained. Riparian-wetland areas are FUNCTIONING PROPERLY when adequate vegetation, landform, or large woody debris is present to dissipate stream energy associated with high water flows, thereby reducing erosion and improving water quality; filter sediment, capture bedload, and aid floodplain development; improve flood-water retention and ground-water recharge; develop root masses that stabilize streambanks against cutting action; develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and support greater biodiversity (Barrett et al. 1993). Even though this definition emphasizes lotic areas, it can be applied to lentic areas with minor modification. For example, instead of "adequate vegetation...present to dissipate stream energies..." an assessment would determine whether adequate vegetation, etc., is present to dissipate wind and wave energies (Bridges et al. 1994).

Over 9,500 stream and shoreline miles of riparian areas have been assessed by the Bureau of Land Management for proper function condition in Oregon, Washington, Idaho, and Montana. Of these, 2944 miles (31%) were determined to be in proper functioning condition and 5,060 miles (53%) were determined to be functioning at-risk (USDI 1995). Riparian-wetland areas are considered functional at-risk when they function but are susceptible to degradation due to soil, water or vegetation characteristics. Functional at-risk also indicates areas that can respond rather quickly to improved management, whereas the remaining 16% in nonfunctional status may require stream channel evolution or mitigation of major alterations along with proper management to accomplish proper functioning status. The large number of miles assessed is probably indicative of conditions throughout the Interior Columbia Basin and is quite comparable to those reported westwide.

THE UNIVERSITY OF CHICAGO

PHILOSOPHY DEPARTMENT

PHILOSOPHY 101

LECTURE NOTES

BY [Name]

DATE

CHAPTER 1

THE PHILOSOPHY OF

PLATO

THE THEORY OF

FORMS

THE DIVISION OF

LABOR

Many negative effects of livestock grazing in riparian areas emanate from the vegetation, which has been viewed as a "common denominator" influencing ecosystem function in riparian areas (Clifton 1989). Vegetation functions in riparian areas to:

- 1) stabilize banks and shorelines;
- 2) form debris dams that create pools, channel diversion or sinuosity, which dissipate energy and subsequent erosion (Bilby and Likens 1980, Heede 1985);
- 3) shade water, which maintains lower water temperatures that are favorable for native fish and other aquatic organisms (Bowers et al. 1979, Theuber et al. 1985); and
- 4) insulate the system against extremes of cold (Bohn 1989).

Proper functioning condition may occur during earlier successional stages or not until potential is achieved depending on the particular characteristics of a system. However, advanced ecological status is usually the ultimate goal on federal rangelands (USDI 1990) to provide for the greatest combination of values. Successional advancement and/or increased cover, density, or structure of riparian vegetation is necessary for improvement of degraded systems. Livestock grazing can be implicated in impedance of desired vegetation changes in many instances. Livestock grazing needs to be modified or restricted when it is the primary limiting factor. Additionally, riparian area improvement hinges on concomitant improvement of degraded uplands or maintenance of healthy upland vegetation. Improving upland vegetation with proper livestock use can increase infiltration rates, reduce overland flows, and increase the water stored by stream systems (Elmore 1992).

Total exclusion of livestock from riparian areas, for example in livestock exclosures, has resulted in improved vegetative conditions and ecological functioning (Gunderson 1968, Claire and Storch 1977, Duff 1977, Wineger 1977, and many others since). However, total exclusion of livestock is not

[The text on this page is extremely faint and illegible. It appears to be a multi-paragraph document, possibly a letter or a report, with several lines of text visible but not readable.]

necessary to reduce the negative ramifications to functioning conditions (Krueger and Anderson 1985). Livestock grazing can be permitted in riparian areas concomitantly with stream system improvement (Chaney et al. 1990; Elmore 1992; Elmore and Kauffman 1994). Land managers can accomplish both with an increased emphasis on compliance to suitable grazing systems and practices.

Awareness of the limitations of livestock grazing for improvement of riparian areas should be emphasized; "... livestock are NOT a 'tool' to improve riparian ecosystems. Rather, they are a cost that may often be accommodated and still enable successional advancement of riparian vegetation and attendant functional values (Krueger and Anderson 1985)." Options for grazing management should be considered on a site-by-site basis because no single option will permit achievement of desired conditions on all sites. Several options may also need to be integrated into a prescribed grazing strategy. In general, these options require more intensive management compared with season-long grazing (turn out of livestock in spring and round up of livestock in autumn). These options range from being quite beneficial to occasionally beneficial to somewhat speculative based on anecdotal observations and include:

- 1) Change livestock type. Sheep may be considered instead of cattle because of potentially less herbivory and physical bank damage, particularly if the sheep are properly herded;
- 2) Change livestock class. There are behavioral differences between young and mature animals (Swanson 1985). Yearling cattle should be considered rather than cows with calves at side, or bulls, because yearlings are less apt to linger within riparian areas;
- 3) Change season of use. Spring, summer, fall, and winter grazing differ from each other in varying degrees in their effects on soils, and vegetation in riparian areas.

Spring -- Spring grazing, compared with grazing in other seasons, is possibly the least harmful to the majority of plant species in riparian areas (Platts



and Nelson 1985, Shaw 1991) partly because of opportunity for regrowth and partly because of avoidance. Removing livestock before the hot summer months permits vegetation regrowth for physiological maintenance of the plants. This regrowth functions as a filter for instream and flood flows, reducing water velocity and permitting sediment deposition. Riparian vegetation may receive a reprieve from spring grazing because livestock tend to avoid certain riparian areas characterized by wet soil, cold temperatures, and immature forage (Platts and Nelson 1985, Kovalchik and Elmore 1991). Cattle concentrate their foraging effort in uplands rather than riparian areas in spring because forage palatability and climate are more favorable in uplands compared with riparian areas (Platts and Nelson 1985). Soil moisture availability declines to unavailable levels for plant growth sooner in the growing season on upland areas compared with riparian areas, thus regrowth of upland vegetation and replenishment of root reserves is curtailed compared with riparian vegetation. Periodic year-long rest from grazing must be incorporated for upland vegetation in this instance.

Summer -- Grazing in summer is not recommended for riparian areas that contain a woody component. Woody riparian species such as willow (*Salix* spp.) experience rapid tissue elongation during the hot summer months. Removal of current year tissue growth results in reduced regrowth potential, at least for willow (Kindschy 1989) compared with unbrowsed willow or willow browsed during the dormant periods of the year. Herbaceous species such as sedges and rushes can tolerate summer grazing if periodic rest or deferment is provided for recovery of vigor and reproduction. However, the attraction of livestock to streamside areas during summer often means that 90 to 95% of the adjacent upland areas receive little or no use (Krueger and Bonham 1986). Several additional management practices discussed may assist in summer dispersal of animals from riparian areas but success may be extremely variable or limited in application.

Autumn -- Autumn grazing use is mixed in its effects on soils and vegetation. Riparian vegetation may improve if fall use occurs when temperatures are cool,

fall green up has occurred, or utilization is closely monitored. Removal of herbaceous material in autumn may not be detrimental because physiologically, herbaceous species in uplands and riparian areas have completed (or nearly completed) their current year growth and have replenished root reserves by this time. There is a risk that livestock will browse woody species though, if the herbaceous component is coarse and mature (Roath and Krueger 1982) or heavily utilized and unavailable for further consumption (Kauffman et al. 1983, Kovalchik and Elmore 1991). Recruitment of willow and black cottonwood (*Populus trichocarpa*) can be jeopardized by fall grazing (Kauffman et al. 1983). Sedgewick and Knopf (1991) also noted that willows responded negatively to fall grazing.

Stream banks can remain in a disturbed condition through winter depending on severity of herbage removal and trampling. Without vegetative regrowth before winter, riparian areas are comparatively devoid of vegetative cover to protect banks and dissipate energy from high volume flows during late winter and early spring snowmelt.

Winter -- Winter grazing or dormant season grazing generally promotes riparian area recovery and maintenance. Herbaceous species have completed current year growth and have replenished root reserves. Woody species may be utilized to some extent (Elmore 1992), and undesirable consumption of woody tissue by livestock can happen if the herbaceous component is snow covered. However, Kindschy (1989) reported that willow cut during the time of dormancy to simulate use by beaver maintained vigor and growth characteristics similar to trees with no history of beaver use. This indicates that dormant season herbivory may not be as detrimental or that other factors related to livestock use need to be evaluated. Additional research may be needed to clarify our understanding of herbivory on dormant woody riparian vegetation. Winter grazing can also be concentrated on upland areas if cold air drains into riparian areas. Riparian vegetation thus may benefit, not from the winter grazing, but rather from a concentration of grazing in uplands (Elmore 1992). Livestock trampling effects on soils is less detrimental in winter for areas

[The text on this page is extremely faint and illegible. It appears to be a multi-paragraph document with several lines of text per paragraph. The content is not discernible.]

where soils are frozen during the period of use (Sedgwick and Knopf 1987);

4) Change duration of use. Short duration grazing, characterized by high intensity, low frequency use (long rest period relative to the use period) can permit limited successional advancement of the herbaceous component, but is less beneficial to the woody component. Growth of the woody component during the rest period can be nullified by consumption by livestock during the high intensity use period. Particular attention must also be given to physical damage to banks with this option;

5) Change in livestock numbers. The "change" here is actually a reduction in numbers that theoretically has a positive effect on riparian areas. Typically, riparian areas continue to experience excessive utilization unless numbers are reduced drastically (i.e. the carrying capacity of the riparian area alone). The uplands receive diminished use relative to the riparian areas and thus receive a benefit. Reduction of livestock numbers in this magnitude is not feasible for maintaining economically viable livestock ranching operations in the long term nor does it address the more likely problems of distribution, season of use, or duration of use. This option is not often feasible in a long term operational sense, but should be considered in conjunction with other prescriptive measures to allow initiation of recovery if total rest is not an option in this context.

6) Livestock exclusion. This option should be considered to improve highly sensitive riparian areas, such as critical spawning areas for sensitive fish species, etc. in the fastest possible manner. It should also be considered as a temporary measure to allow initiation of recovery mechanisms in degraded systems. However, livestock exclusion will result in immediate improvement of non-functional systems only if channel evolution is at a stage where improvement is possible. Downcut systems that have only recently reached a new base level will not benefit immediately from any option until widening has occurred sufficiently to allow vegetation establishment sufficient to resist higher flows (Barrett et al. 1993);

7) Livestock selection. Swanson (1985) and Roath (1980) indicated that within

[The page contains extremely faint, illegible text, likely bleed-through from the reverse side of the document. The text is arranged in approximately 15 horizontal lines across the page.]

breeds, or even herds, certain individuals tend to spend more time in the bottoms while others tend to forage out. Culling has been suggested to rid herds of individuals that spend disproportionate times in the bottoms (George 1995 draft). Speculation is that this behavior may be either genetic or learned, as by a calf from its dam. Documentation on this option is primarily anecdotal and research is needed.

8) Attraction of livestock out of riparian areas. George (1995 draft) provides a review of practices that tend to reduce the time livestock spend in riparian areas. Upland seedings (Storch 1978, Durbin 1977), seeding and fertilization or recently burned areas (Swanson 1985) can reduce pressure on riparian zones. Supplemental feeding away from water can also improve distribution (Mcdougald, Frost, and James 1989) in winter pastures. Water developments apparently have had mixed results. Stockwater development can significantly reduce use of stream and spring areas (Clawson 1993) although Gillen et al. (1985) found cattle preferred the quality of free flowing water. Miner et al. (1992) observed a 90% reduction in the time a stream area was used in the winter by placement of a watering tank, presumably because of the warmer water in the tank.

9) Herding. Herding has been used successfully to help distribute livestock away from riparian areas (Claire and Storch 1977; Storch 1978; Cheney, Elmore and Platts 1990). However, herding is labor and time intensive and many operators cannot make the necessary commitment to make this practice effective.

10) Barriers. Various types of barriers can be used to discourage livestock use of particularly sensitive areas (George 1995 draft). Prototype electronic (fenceless) control also has been tested with positive results (Quigley et al. 1990) to discourage or exclude livestock; however further research is needed on equipment development and testing.

Prescribed grazing strategies for riparian areas typically integrate several of the options above, to permit successional advancement of the vegetation while satisfying management requirements of the livestock enterprise. A

[The page contains extremely faint, illegible text, likely bleed-through from the reverse side of the document. The text is arranged in approximately 15 horizontal lines across the page.]

description of several prescribed grazing strategies (which will be referred to from now on as grazing systems) follows:

1) **3-pasture, rest rotation system** -- The typical grazing timing for a pasture in this system is for grazing in spring of year 1, summer of year 2, and rest in year 3. Shrub consumption is light in year 1 because upland herbaceous material is green and palatable in the spring. Grazing in year 2 is timed to begin after upland grasses have produced ripe seed (usually mid July). The desired utilization for upland grasses is 60% or less but because the upland vegetation has dried and has lost palatability, concurrent utilization of riparian herbaceous vegetation may be 80 to 90% or more. Shrub utilization escalates concurrently with riparian herbaceous utilization levels exceeding 45%. The benefit of this strategy is that it promotes plant vigor, seed production, seedling establishment, root production, and litter accumulation of the HERBACEOUS component (compared with season-long grazing). The detriment is that shrub utilization in the 2nd year of the cycle can outweigh the growth accruing from year 1 and 3 of the cycle. In a nutshell, this prescribed grazing strategy was designed to satisfy the physiological needs of herbaceous species and does not satisfy the same needs for the woody species. Excessive shrub utilization can be prevented by restricting utilization of riparian herbaceous vegetation to 50% or less in the 2nd year (seed-ripe year) of the cycle (Clary and Webster 1989). Additional favorable practices include separating the riparian area into a separate pasture, managed according to its special physiological needs, or adding more pastures to achieve additional rest (Elmore 1992);

2) **3-Pasture, deferred rotation system** -- In Elmore (1992), deferral of grazing is rotated among pastures and years. A pasture on a 3 year cycle would be grazed in early spring in year 1, late spring in year 2, and summer in year 3. (There are other deferred rotation systems, for example a 4 pasture system in Heitschmidt and Taylor 1991). This system does not promote growth of woody species, because of summer utilization. The herbaceous component benefits from

[The page contains extremely faint, illegible text, likely bleed-through from the reverse side of the document. The text is arranged in approximately 15 horizontal lines across the page.]

the periodic growing season rest. Thus, with respect to the response of the herbaceous and woody components, this system is similar to the rest rotation system above;

3) **Early rotation grazing system** -- In Elmore (1992), a pasture in this system is rested for a portion of the growing season. A pasture may be grazed in early spring in year 1 and late spring in year 2. Effects on the herbaceous vegetation are mixed. Benefits to herbaceous vegetation accrue from the regrowth after livestock are removed. Seed and root production are not always enhanced and this represents a detrimental effect. Woody species can benefit by escaping summer browsing by livestock;

4) **Rotation grazing system** -- In Elmore (1992), a pasture in this system is rested for a portion of the growing season, similar to the early rotation grazing system above. A pasture may be grazed in spring in year 1 and summer in year 2. Again, herbaceous plants typically benefit but the woody species decline as a result of the summer utilization. An acceptable use of this system would be on low gradient, wide valley sites dominated by herbaceous grasses.

Season-long grazing, spring and fall grazing, and spring and summer grazing are not recommended grazing strategies for producing successional advancement of riparian vegetation. Table I. presents generalized relationships between stream system characteristics, riparian vegetation response, and grazing season or grazing system.

Faint, illegible text, possibly bleed-through from the reverse side of the page. The text is arranged in several paragraphs and appears to be a formal document or report.

Table I. Generalized relationships between grazing strategy, stream system characteristics, and riparian vegetation response (adapted from Buckhouse and Elmore 1991).

Grazing Strategy		Steep, Low Sediment Load	Steep, High Sediment Load	Moderate, Low Sediment Load	Moderate, High Sediment Load	Flat, Low Sediment Load	Flat, High Sediment Load
		No Grazing	Shrubs	+	+	+	+
	Herbs	+	+	+	+	+	+
	Banks	0	0 to +	0	+	+	+
Winter	Shrubs	+	+	+	+	+	+
	Herbs	+	+	+	+	+	+
	Banks	0	0 to +	+	+	+	+
Early Growing Season	Shrubs	+	+	+	+	+	+
	Herbs	+	+	+	+	+	+
	Banks	0	0 to +	+	+	+	+
Deferred	Shrubs	-	-	-	-	-	-
	Herbs	+	+	+	+	+	+
	Banks	0 to -	0 to -	0 to +	+	+	+

Year	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910
Population	1,000,000	1,050,000	1,100,000	1,150,000	1,200,000	1,250,000	1,300,000	1,350,000	1,400,000	1,450,000	1,500,000
Area (sq. miles)	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Population Density	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15
Area (sq. miles)	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Population	1,000,000	1,050,000	1,100,000	1,150,000	1,200,000	1,250,000	1,300,000	1,350,000	1,400,000	1,450,000	1,500,000
Area (sq. miles)	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Population Density	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15

3-pasture rest rotation	Shrubs	-	-	-	-	-	-
	Herbs	+	+	+	+	+	+
	Banks	0 to -	0 to -	0 to +	+	+	+
Deferred Rotation	Shrubs	-	-	-	-	-	-
	Herbs	+	+	+	+	+	+
	Banks	0 to -	0 to -	0 to +	+	+	+
Early Rotation	Shrubs	+	+	+	+	+	+
	Herbs	+	+	+	+	+	+
	Banks	0 to -	0 to +	+ to 0	+	+	+
Rotation	Shrubs	-	-	-	-	-	-
	Herbs	+	+	+	+	+	+
	Banks	0 to -	0 to +	0 to +	+	+	+
Season- Long	Shrubs	-	-	-	-	-	-
	Herbs	-	-	-	-	-	-
	Banks	0 to -	0 to -	-	-	-	-
Spring and Fall	Shrubs	-	-	-	-	-	-
	Herbs	-	-	-	-	-	-
	Banks	0 to -	0 to -	-	-	- to 0	0 to +
Spring and Summer	Shrubs	-	-	-	-	-	-
	Herbs	-	-	-	-	-	-
	Banks	0 to -	0 to -	-	- to 0	- to 0	0 to +

Date	Description	Debit	Credit	Balance

Note: - = decrease; + = increase; 0 = no change. Stream gradient: steep = >4%; moderate = 2 to 4%; flat = 0 to 2%.

A number of case study examples of riparian area improvement using one or a combination of the options and strategies discussed here are presented by Kinch (1989) and Chaney, Elmore, and Platts (1990, 1993). There are many more in the Columbia Basin and throughout the west. Each is unique in its own particular setting: stream characteristics, valley bottom type and soils, potential vegetation, relationship to upland topography and vegetation, etc. Therefore, most are unique in the particular strategy to accomplish the observed improvement. There are no cook book or "one size fits all" prescriptions for livestock grazing in riparian areas.

At a minimum, Chaney, Elmore, and Platts (1993) propose that any successful grazing strategy will:

- Limit grazing intensity and season of use to provide sufficient rest to encourage plant vigor, regrowth, and energy storage;
- Ensure sufficient vegetation during periods of high flow to protect streambanks, dissipate energy, and trap sediments;
- Control the timing of grazing to prevent damage to streambanks when they are most vulnerable to trampling.

For many of the successes documented, complete livestock exclusion for two years or more allowed initial recovery to begin, thus enhancing the effects of improved management implemented thereafter.

Incorporating practices that limit concentrations of livestock, promote avoidance, or lure livestock away from riparian areas help accomplish the requirements listed above. In addition to the often cited water quality benefits of filtering sediments and ameliorating temperature extremes, these

1. Introduction

2. Methodology

3. Results

4. Discussion

5. Conclusion

6. References

7. Appendix

8. Acknowledgements

9. Contact Information

10. Author Biographies

11. Declaration of Interest

12. Funding Sources

13. Data Availability

14. Ethics Approval

practices have a positive affect on bacterial and protozoal contamination from feces. Larsen (1995 draft) indicates that only feces that land in, or very close, the water have a major impact on water quality. Fecal concentrations in the stream are lowered by practices that help keep livestock away from or limit the time near a stream. Water quality and quantity, as well as productivity of riparian and wetland systems are identified as major issues to be addressed by the Interior Columbia Basin Ecosystem Management Project.

Literature Cited:

- Barrett, Hugh; Cagney, Jim; Clark, Ron [and others]. 1993. Riparian area management: Process for assessing proper functioning condition. TR 1737-9. U.S. Department of the Interior, Bureau of Land Management, BLM/SC/ST-93/003+1737, Denver, CO: Service Center: 60 p.
- Bedell, Thomas E., ed. 1993. Watershed management guide for the interior Northwest. EM 8436. Corvallis, OR: Oregon State University Extension Service: 67 p.
- Bilbey, R.E.; Likens, G.E. 1980. Importance of organic debris dams in the structure and function of stream ecosystems. Ecology 61:1107-1113.
- Bohn, C. 1989. Management of winter soil temperatures to control streambank erosion. In: Gresswell, R.E.; Barton, B.A.; Kershner, J.L., eds. Riparian resource management. U.S. Department of the Interior. Bureau of Land Management. Billings, MT: 69-71.
- Bowers, Wayne; Hosford, Bill; Oakley, Art; Bond, Carl. 1979. Native trout. In: Thomas, J.W.; Maser, C. eds. Wildlife habitats in managed rangelands-the Great Basin of southeastern Oregon. Gen. Tech. Rep. PNW-84. Portland, OR:U.S. Department of Agriculture, Forest Service: 16 p.

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

- Bridges, Clay; Hagenbuck, Warren; Krapf, Russ [and others]. 1994. Riparian area management: Process for assessing proper functioning condition for lentic riparian-wetland areas. TR 1737-11. U.S. Department of the Interior, Bureau of Land Management, BLM/SC/ST-94/008+1737. Denver, CO: Service Center: 37 p.
- Chaney, Ed; Elmore, Wayne; Platts, William S. 1990. Livestock grazing on Western riparian areas. Denver CO: U.S. Environmental Protection Agency, Region 8: 45 p.
- Chaney, Ed; Elmore, Wayne; Platts, William S. 1993. Managing change: livestock grazing on western riparian areas. Denver, CO: U.S. Environmental Protection Agency, Region 8: 31 p.
- Claire, E.W.; Storch, R.L. 1977. Streamside management and livestock grazing in the Blue Mountains of Oregon: a case study. In: Menke, J.W., ed. Proceeding of the workshop on livestock and wildlife fisheries relationships in the Great Basin, 1977 May 3-7; Sparks, NV. Berkley, CA: University of California, Berkley: 111-128.
- Clary, W. P.; Webster, B.F. 1989. Managing grazing of riparian areas in the Intermountain Region. Gen. Tech. Rep. INT-263. Ogden, UT: U.S. Department of Agriculture, Forest Service.
- Clawson, J.E. 1993. The use of off-stream water developments and various water gap configurations to modify the watering behavior of grazing cattle. M.S. Thesis. Corvallis, OR: Oregon State University: 80 p.
- Clifton, C. 1989. Effects of vegetation and landuse on channel morphology. In: Gresswell, R.E.; Barton, B.A.; Kershner, J.L., eds. Riparian resource management. Billings, MT: U.S. Department of the Interior, Bureau of

[The page contains extremely faint, illegible text, likely bleed-through from the reverse side of the document. The text is arranged in several paragraphs across the page.]

Land Management: 121-129.

Duff, D. A. 1977. Livestock grazing impacts on aquatic habitat in Big Creek, Utah. In: Menke, J.W., ed. Proceeding of the workshop on livestock and wildlife fisheries relationships in the Great Basin, 1977 May 3-7; Sparks, NV. Berkley, CA: University of California, Berkley: 129-142.

Durbin, K. 1977. Rx for a stream. Oregon Wildlife 32:3-5.

Elmore, Wayne. 1992. Riparian responses to grazing practices. In: Naiman, Robert J., ed. Watershed management. New York, NY: Springer Verlag: 442-457.

Elmore, Wayne; Kauffman, Boone. 1994. Riparian and watershed systems: degradation and restoration. In: Vavra, Martin; Laycock, William A.; Pieper, Rex D., eds. Ecological implications of livestock herbivory in the West. Denver, CO: Society for Range Management: 212-231.

George, Melvin. [In press]. Management practices to change livestock behavior in grazed watersheds. In: Swanson, Sherman; George, Melvin; Buckhouse, John; Larsen. Draft report: Evaluation of effectiveness of livestock and range management practices in grazed watersheds. U.S. Environmental Protection Agency: 42 p.

Gillen, R.L.; Krueger, W.C.; Miller, R.F. 1985. Cattle use of riparian meadows in the Blue Mountains of Northeastern Oregon. J. Range Manage. 38:205-209.

Gunderson, D.R. 1968. Floodplain use related to stream morphology and fish populations. J. Wildlife Manage. 32:507-514.

[The page contains extremely faint, illegible text, likely bleed-through from the reverse side of the document. The text is arranged in several paragraphs and is not readable.]

- Heitschmidt, R.K.; Taylor, C.A. 1991. Livestock production. In: Heitschmidt, Rodney K.; Stuth, Jerry W. eds. Grazing management. Portland: Timber Press: 161-178.
- Heede, B. 1985. Interactions between streamside vegetation and stream dynamics. In: Proceedings-Riparian ecosystems and their management: Reconciling conflicting uses. 1985 April 16-18. Gen. Tech. Rep. RM-120. Tucson, AZ: U.S. Department of Agriculture, Forest Service: 54-58.
- Kauffman, J.B.; Krueger, W.C.; Vavra, M. 1983. Effects of late season cattle grazing on riparian plant communities. J. Range Manage. 36:685-691.
- Kinch, Gene. 1989. Riparian area management: Grazing management in riparian areas. TR 1737-4. U.S. Department of the Interior, Bureau of Land Management. BLM/YA/PT-87/021+1737. Denver, CO: Service Center: 44 p.
- Kindschy, R.R. 1989. Regrowth of willow following simulated beaver cutting. Wildlife Soc. Bull. 17:290-294.
- Kovalchick, B.L.; Elmore, W. 1991. Effects of cattle grazing systems on willow-dominated plant associations in central Oregon. In: Symposium on ecology and management of riparian shrub communities. 1991 May 29-31; Sun Valley, ID: 111-119.
- Krueger, H.O.; Anderson, S.H. 1985. The use of cattle as a management tool for wildlife in shrub-willow riparian systems. In: Proceedings-Riparian ecosystems and their management: Reconciling conflicting uses. 1985 April 16-18. Gen. Tech. Rep. RM-120. Tucson, AZ: U.S. Department of Agriculture, Forest Service: 300-304.
- Krueger, W.C.; Bonham, C.D. 1986. Responses of low cattle densities on large

THE UNIVERSITY OF CHICAGO

PHYSICS DEPARTMENT

PHYSICS 311

LECTURE 1

MECHANICS

1.1

1.2

1.3

1.4

1.5

1.6

1.7

1.8

areas of forested pastures. In: Statistical analyses and modeling symposium proceedings. 1986 February 11; Kissimmee, FL. Denver, CO: Society for Range Management: 67-73.

Larsen, Royce. [In press]. Managing nutrient and pathogen loading in grazed watersheds. In: Swanson, Sherman; George, Melvin; Buckhouse, John; Larsen. Draft report: Evaluation of effectiveness of livestock and range management practices in grazed watersheds. U.S. Environmental Protection Agency: 42 p.

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

McDougald, Neil K.; Frost, William E.; Jones, Dennis E. 1989. Use of supplemental feeding locations to manage cattle use on riparian areas of hardwood rangelands. In: Abell, Dana, ed. 1989. Proceedings of the California riparian systems conference: protection, management, and restoration for the 1990's; 1988 September 22-24; Davis, CA; Gen. Tech. Rep. PSW-110, Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station.

Platts, W.S.; Nelson, R.L. 1985. Impacts of rest-rotation grazing on stream banks in forested watersheds in Idaho. *No. Am. J. of Fisheries Manage.* 5:547-556.

Quigley, T.M.; Sanderson, A.R.; McInnis, M.L. 1990. Livestock control with electrical and audio stimulation. *Rangelands* 12:152-155.

Roath, L.R. 1980. Cattle grazing and behavior on a forested mountain range and their relationship to acute dietary bovine pulmonary emphysema. Ph.D. Diss. Corvallis, OR: Oregon State University.

[The text on this page is extremely faint and illegible. It appears to be a multi-paragraph document with several lines of text per paragraph. The content is not discernible.]

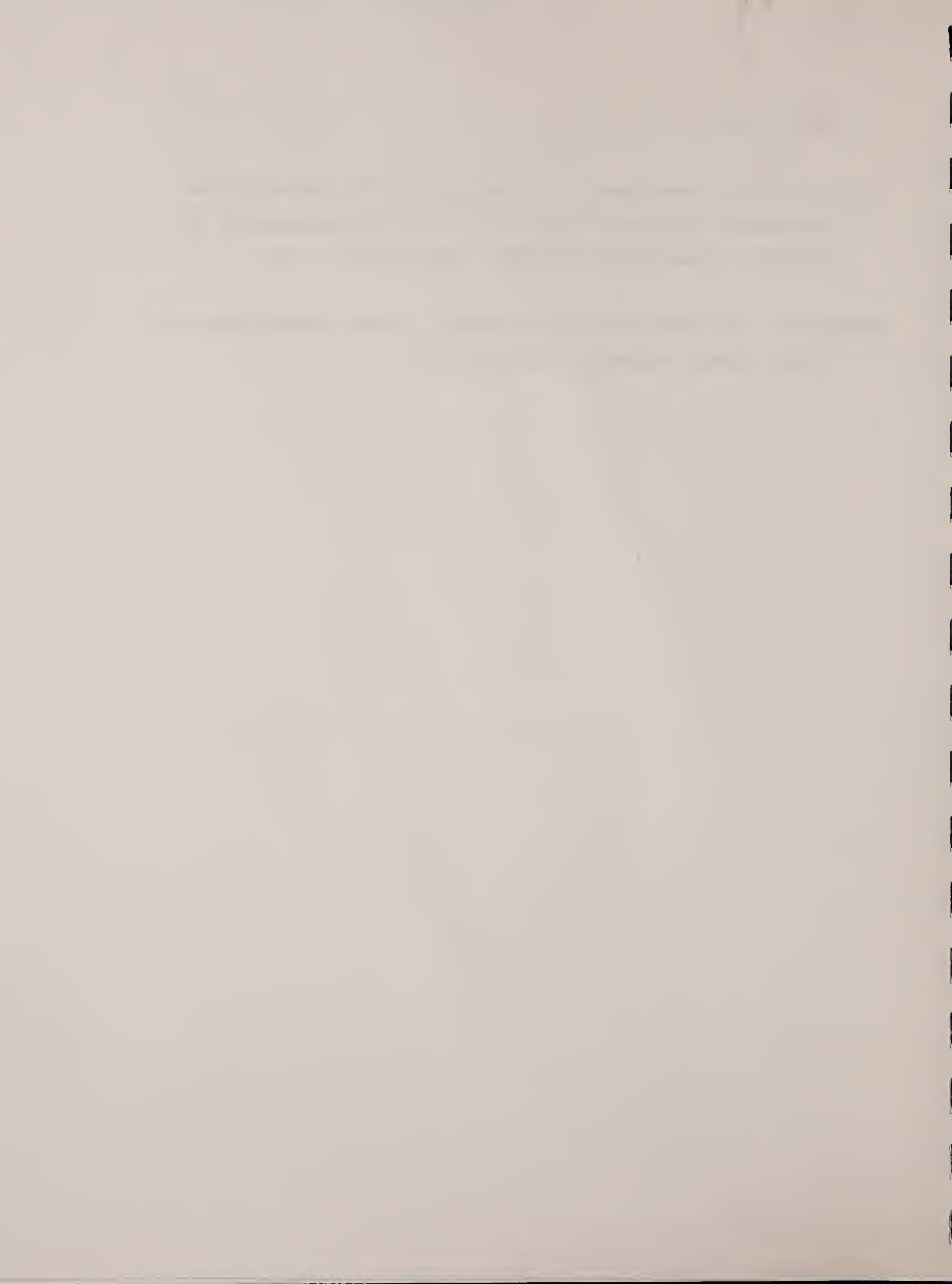
- Roath, L.R.; Krueger, W.C. 1982. Cattle grazing influences on a mountain riparian zone. *J. Range Manage.* 35:100-102.
- Sedgewick, J.A.; Knopf, F.L. 1987. Breeding bird response to cattle grazing a cottonwood bottomland. *J. Wildlife Manage.* 51:230-237.
- Sedgewick, J.A.; Knopf, F.L. 1991. Prescribed grazing as a secondary impact in a western riparian floodplain. *J. Range Manage.* 44:369-373.
- Shaw, N.L. 1991. Recruitment and growth of Pacific willow and sandbar willow seedlings in response to season and intensity of cattle grazing. In: *Symposium on ecology and management of riparian shrub communities*. 1991 May 29-31; Sun Valley, ID: 130-137.
- Storch, R.L. 1978. Livestock/streamside management programs in eastern Oregon. In: Cope, O.B., ed.; *Forum-grazing and riparian/stream ecosystems*, 1978 Nov. 3-4; Denver, CO: Trout Unlimited: 56-59.
- Swanson, S. 1985. Management of riparian areas: workshop report. *Nevada Range Review* 3:2-6.
- Thueber, F.D.; Lines, I.; Nelson, T. 1985. Interaction between riparian vegetation, water temperature, and salmonid habitat in the Tucannon Tiver. *Water Re. Bull.* 21:53-64.
- U.S. Department of the Interior. 1990. Riparian-wetland initiative for the 1990's. U.S. Department of the Interior, Bureau of Land Management. Washinton D.C.: 59 p.
- _____. 1992. Manual handbook 1737 - Riparian-wetland area management. U.S. Department of the Interior, Bureau of Land Management. Washington

[The page contains extremely faint and illegible text, likely bleed-through from the reverse side of the document. The text is arranged in several paragraphs and appears to be a formal document or report.]

D.C.: 38 p.

_____. 1994. Annual report of accomplishments-the riparian-wetland initiative for the 1990's-fiscal year 1994. U.S. Department of the Interior, Bureau of Land Management. Washington D.C.: 65 p.

Winegar, H.H. 1977. Camp Creek channel fencing - plant, wildlife, soil, and water response. Rangeland Journal 4:10-12.



BLM Library
Denver Federal Center
Bldg. 50, OC-521
P.O. Box 25047
Denver, CO 80225

