Can cows and fish co-exist?

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Fitch, L. and Adams, B. W. 1998. **Can cows and fish co-exist?** Can. J. Plant Sci. **78**: 191–198. Our paper provides an ecological perspective on the interrelationship between livestock grazing and riparian areas through a review of topical literature. We also describe the Alberta Riparian Habitat Management Project (also known as “Cows and Fish”), and draw upon our experience to provide a perspective on future riparian management actions. Those actions should begin with an understanding that prairie landscapes evolved with herbivores, in a grazing regime timed and controlled by season and climatic fluctuations where grazing by native grazers was followed by variable rest periods. Prevailing range management principles represent an attempt to imitate the natural system and describe ecologically based grazing systems. Traditionally, range management guidelines have focused on grazing practices and impacts in upland, terrestrial rangelands, with a lack of attention devoted to riparian areas.

Three decades of riparian investigation have quantified the effect unmanaged livestock grazing can have on range productivity and watershed function. We contend that suitable grazing strategies for riparian areas will be developed first by understanding the function of riparian systems and then by applying range management principles to develop riparian grazing strategies. A key step towards determining the fit of livestock grazing is an understanding of the formation of riparian systems and their ecological function. We describe riparian structure, function and process to provide linkages between livestock grazing, riparian vegetation health and stream channel dynamics. We summarize the effects of unmanaged livestock grazing on riparian habitats and fish and wildlife populations. The general conclusion is that unmanaged grazing results in overuse and degradation of riparian areas. The literature provides several options for the development of riparian grazing strategies. We provide an overview of strategies suitable for riparian areas in Southern Alberta which should maintain ecological function and sustained use.

Key words: Riparian, grazing management, grazing systems, riparian grazing

Fitch, L. et Adams, B. W. 1998. **Peut-il y avoir coexistence entre les vaches et les poissons?** Can. J. Plant Sci. **78**: 191–198. Nous examinons dans une perspective écologique les interrelations entre la paissance par les animaux de ferme et les zones de rivage telles qu’elles se dégagent d’une analyse bibliographique. En outre nous décrivons le Projet de gestion des habitats riverains de l’Alberta (également connu sous le vocable « Des poissons et des vaches » et nous puisons à même notre expérience pour offrir un éclairage sur les futures mesures de gestion des rivages. Ces mesures devraient s’appuyer sur le postulat que les paysages pastoraux ont évolué avec les herbivores selon un régime de paissance réglé par les saisons et par les fluctuations climatiques et dans lequel les phases de pâture par les herbivores naturels étaient suivies de phases de repos plus ou moins longues. Les principes acceptés de gestion des parcours naturels constituent une tentative d’imitation du système naturel. Nous décrivons plusieurs systèmes de pâturage écologique. Depuis toujours, les théoriciens de la gestion des parcours se sont intéressés surtout aux pratiques et aux impacts de la pâture dans les parcours de bas-plateau, n’accordant qu’une maigre attention aux zones de rivage. Trois décennies d’étude en milieu riparien ont permis de chiffrer les effets qu’une pâture non contrôlée peut avoir sur la productivité des parcours et sur le comportement du bassin versant. À notre avis, des stratégies de pâturage fonctionnel les pour les zones ripariennes devront s’appuyer en premier lieu sur la compréhension du fonctionnement du système riparien et, en second, sur l’application des principes de conduite des grands parcours naturels. Une étape cruciale dans l’établissement du chargement animal est la compréhension de la formation des systèmes ripariens et de leur fonctionnement écologique. Nous décrivons ici les structures, le fonctionnement et les mécanismes d’un système riparien, afin de dégager les liens existant entre le pâturage, la santé de la végétation riparienne et la dynamique du chenal du cours d’eau. Nous récapitulons les effets d’une paissance non contrôlée sur les habitats ripariens et sur les populations fauniques et botaniques naturelles pour arriver à la conclusion générale qu’une paissance non régulée entraîne la surexploitation et, partant, la dégradation des zones ripariennes. La bibliographie offre plusieurs options de stratégies d’aménagement du pâturage dans ces zones. À titre d’exemple, nous présentons un survol des stratégies applicables au sud de l’Alberta qui devraient aider à maintenir l’intégrité écologique et l’utilisation durable des zones ripariennes dans cette région.

Mots clés: Riparien, conduite du pâturage, sustémes pastoraux, pâturage riverain

The transition areas between aquatic ecosystems and the adjacent upland terrestrial ecosystems are termed the riparian zone (Gregory et al. 1991). Soil characteristics and plant communities in riparian areas indicate the presence of free, unbound water, associated with the margins of streams, rivers, ponds, lakes, springs and other wetlands (Swanson 1986). As such, riparian areas give rise to unique plant communities that establish watershed function, provide diverse habitats for fish and wildlife, and a highly productive forage supply for livestock.

A wealth of literature ties riparian area condition and watershed function to healthy riparian vegetation. Abusive land management practices can degrade riparian vegetation and impair its stabilizing influence in the watershed

(DeBano and Schmidt 1989). Among such practices, range livestock grazing has been a focal point of nearly two decades of debate in the western United States. This debate has given rise to remedial programs among federal and state agencies, which include fencing to exclude cattle from riparian areas. Most distressing to the livestock sector, various campaigns have been mounted to remove livestock altogether from public rangelands. Initiatives to reduce or remove livestock often relate to overuse and degradation of riparian areas. The riparian grazing issue has been characterized by deeply entrenched conflict among interest groups and legislated solutions.

In this paper we address the question "Can Cows and Fish Co-exist?" by examining the literature and by reporting recent experience from the Alberta Riparian Habitat Management Project (also known as "Cows and Fish") in southwestern Alberta. We describe the relationships among riparian areas, livestock and the fish and wildlife populations that occupy these habitats. A perspective is provided on the tools and direction required to fully answer the question.

Grazing and the Prairie Landscape

Prairie ecosystems were shaped over thousands of years through the influence of large herbivores, especially bison (Bradley and Wallis 1996). Eyewitness accounts of early European travellers highlighted both broad and local impacts to the very limits of the bison's range. In general, impacts include heavy defoliation, trampling, wallowing, rubbing of trees, and fouling water with feces and urine (England and DeVos 1969). However, in that open, pre-settlement environment, with multiple choices for grazing, there is little to suggest that bison herds lingered, season long, on riparian areas. Epp (1994) contends that overall bison migration followed a seasonal pattern between summer ranges in the mixed grass prairie and wintering periods in the foothills and parkland where shelter and abundant forage could be found. Resident bands of bison may have occupied certain local areas year-round but the prevailing view is that the big herds tended to follow this seasonal pattern. The grazing strategy of bison was likely dispersal throughout a variety of landscape types, unlike domestic livestock (particularly cattle), which have an affinity for water. The natural system can be characterized as a grazing regime timed and controlled by season and climatic fluctuations, including periodic drought and fire, where periods of grazing were followed by variable rest periods. What the pre-settlement, natural system teaches is that after there was grazing there was rest, and prairie riparian communities evolved under such a regime for millenia.

Early Ranching and Range Science

European settlement brought with it sedentary grazing of the plains and foothills rangelands by domestic stock, first during the brief period of open range grazing in the late 1800s, and later through the early ranching system with pasture units defined by barbed wire fences (Breen 1983). No range management guidelines existed for the first western ranchers. Range science and the current philosophy of range management emerged first as an art, as generations of ranchers observed natural processes and the impacts of their grazing animals, and learned from trial and error. The effect of long and intense grazing periods, and grazing impact on range productivity, was noted and quantified by early range studies (Smoliak, personal communication) as ranchers learned to imitate the natural system and implement more ecologically based grazing strategies.

A prevailing criticism of modern range science is that it has focused almost exclusively on management systems, condition, and productivity of upland terrestrial rangelands. Critics believe this is reflected in the United States where indices of range condition are increasing in uplands while the condition of riparian areas continue to decline (World Resources Institute 1994).

Gifford and Hawkins (1976) concluded that the value of many of the common grazing systems, for watershed protection and riparian maintenance, was poorly understood. Platts (1991) also concluded that progress in managing grazed riparian areas is hampered by a lack of interdisciplinary effort and focus on grazing strategies that consider riparian areas.

Without knowledge and tools to manage riparian systems, initial efforts for riparian recovery have involved fencing programs to permanently exclude livestock from riparian areas. Exclusion fencing can provide rapid recovery and help to demonstrate a site's biological potential, often quickly; but it has proven to be costly and a source of conflict and resentment in the ranching industry. Exclusion fencing also conveys the notion that riparian areas and cattle are incompatible, and it falls short of a higher goal, that of total landscape management.

That brings us to the "Cows and Fish" project, in which we content that:

1. Enough experience and knowledge exists to recognize grazing impacts in riparian areas, and to begin to correct problems.
2. Progress will only come through interdisciplinary effort.
3. Suitable grazing strategies for riparian areas will be developed first by understanding the functions of riparian systems, and then by applying range management principles to develop riparian grazing strategies.
4. The "Cows and Fish" project provides an understanding of the linkages between livestock grazing, riparian vegetation health and stream channel dynamics.

The Cows and Fish Project

The Alberta Cows and Fish Project was established in 1992 through a partnership between the Alberta Cattle Commission, Trout Unlimited Canada, the Canadian Cattlemen's Association, Alberta Environmental Protection, Alberta Agriculture, Food and Rural Development, and Fisheries and Oceans Canada. Most important to the success of the partnership has been the cooperation of 11 southern Alberta ranches that have applied riparian grazing strategies to restore riparian condition, or have shared existing grazing practices that have been effective in maintaining riparian health. These organizations and ranch families are working together to foster a better understanding of how improvements in grazing management on riparian areas can enhance landscape health and productivity for the benefit of ranchers and others who use and value riparian areas.

A key feature that has empowered the Cows and Fish project has been a declaration of ownership of the riparian grazing issue by cattlemen, through the Alberta Cattle Commission and Canadian Cattlemen's Association. This declaration came before the project's inception through the Commission's environmental risk assessment, which identified riparian areas as a potential area of concern for Alberta cattle producers (Alberta Cattle Commission 1991). More recently, this ownership has been expressed through community leaders, dubbed the "riparian missionaries," who take an active role in steering the project and spreading the message.

Cows and Fish has evolved through three phases. The first was a team-building step to establish the partnership, provide opportunities for the new partners to become acquainted with the considerable body of technical knowledge available from mostly US sources, and to begin to consider the options. Next came a tool-building phase. Ranch demonstration sites provided a venue to apply and document several key riparian grazing strategies that have been used elsewhere. Experience from local demonstration sites was conveyed through a series of workshops, which allowed us to develop a riparian management message and evaluate this message through feedback from producers. The validated message was then incorporated into extension tools designed for livestock producers and other resource managers. The final phase is community-based action to take the message to the grassroots through the "riparian missionaries" and other groups and organizations. Local producers may simply share awareness material with neighbours, seek opportunities for local tours to demonstration sites, or organize local seminars. Cooperating land management agencies will also pursue riparian grazing strategies at the ranch level on both public and private lands.

Riparian Structure, Function and Process

The most important step towards determining the fit of livestock grazing is understanding the development of riparian systems and their ecological function. It must be acknowledged that streams and their watersheds function as units and are inseparable.

The number of hydraulic variables that define riparian form and function is large and the relationships between them are complex. Of this complex, Lane (1957) identified eight variables which he considered most important: 1) stream discharge, 2) stream gradient, 3) sediment load, 4) resistance of banks and bed to movement of flowing water, 5) vegetation, 6) temperature, 7) geology, and 8) human activity. The inter-relationships among stream gradient, sediment load and resistance of banks and beds to movement are particularly close and complex (Heede 1980). Stream systems develop a dynamic equilibrium with the variables of climate, geology, vegetation and surrounding land uses. Over geologic time, streams migrate back and forth over their floodplains, creating valley bottom types consistent with these variables. Changes in these variables, or an upset of a given dynamic equilibrium condition, will evoke an adjustment response in streams and their valleys. Obviously, changes in several variables are beyond our control. We cannot change climate, geology, stream gradient, or discharge, unless the stream is artificially regulated.

Management activities can trigger or change channel adjustment processes (Heede 1980; Beschta and Platts 1986). How channels adjust is often a function of stream energy. Precipitation from snowmelt or rainfall on a watershed's surface begins a downhill journey with a certain amount of energy. Some of that energy is dissipated in bank erosion, bed scouring, and sediment transport; but much is consumed as heat loss during turbulent mixing (Morisawa 1968). Where stream channels are steep, straight, with hydraulically "smooth" banks and beds, and uniform in cross section, stream energy will be high. In such channels, relatively large amounts of energy will be available for reworking channel banks and bed materials. In general terms, a doubling of stream velocity, a concomitant feature of a decrease in roughness elements, will increase effective stream energy fourfold. Stream bank and bed frictional resistance is increased by roughness elements such as woody root systems, deep rooted grasses, logs and other organic debris, boulders or bedrock outcrops. Changes in energy affect erosion, transport and sediment deposition in riparian settings. Many land uses, including livestock grazing, change the energy balance in streams and produce negative effects on riparian equilibrium.

Riparian vegetation is one of the hydraulic variables that modifies stream energy and defines stream form. Livestock grazing has an effect on riparian vegetation although related actions may affect other channel features. The effects of other land use in the riparian area, such as cultivation, timber harvest, water management, urban development and flood or erosion control, can be cumulative and difficult to separate from livestock grazing.

For many stream channels, a combination of riparian vegetation with woody root systems, deep rooted grasses and other vegetation provides a physical barrier to the effects of high water velocities and stream energy. This vegetation combination and diversity create banks with considerable surface roughness and relative stability (Platts 1981; Beschta and Platts 1986; Elmore and Beschta 1987; Elmore 1992). In some instances, the root systems or the intact root wads and trunks of individual trees function as relatively large roughness elements. As reported by Beschta and Platts (1986), an individual tree, depending on species longevity, may influence channel characteristics for decades or centuries. As individual trees and shrubs senesce, die, and are replaced by others in succession, the effects on channel hydraulics and form can be perpetually maintained. This establishes an important vegetation influence on the maintenance of dynamic equilibrium in channels, streams and the riparian setting.

Riparian vegetation has a major influence on channel shape. Vegetation contributes to stream bank strength by binding the soil with roots, shielding banks from erosion, and repairing annual damage with sediment deposition (Platts 1990). Streams flowing through well-vegetated riparian areas are narrower and deeper than the same type of stream flowing through poorly vegetated areas. Channel shape defines water column depth and influences ground water levels (Beschta and Platts 1986). Channels with narrow, deep profiles maintain higher water columns; the influence extends laterally to maintain higher ground water levels over a greater portion of the floodplain. During low flow periods, well-vegetated streams carry more water because vegetation increases infiltration rates, attenuates flows, and increases ground water storage (Groeneveld and Griepentrog 1985; Ohmart 1996).

Bedload and suspended sediment capture is another feature of riparian vegetation. During floods, resilient riparian vegetation reduces stream velocities at the bank–water interface, which induces sediment to settle out and build stream banks (Platts 1990; Ohmart 1996). Over time, with accretion of sediments trapped by vegetation, stream banks are formed and maintained. Platts et al. (1985) observed that during floods, well-vegetated stream banks had reduced erosion rates and higher sediment capture rates; post-flood conditions were more stable than in poorly vegetated riparian areas. This establishes the value of riparian vegetation in spreading and slowing bank overflows and reducing flood damage.

The influence of riparian vegetation on channel pattern and longitudinal profile is not well understood; however, some authors have speculated about the interaction. Riparian vegetation can provide effective roughness on a floodplain, decreasing the velocity of overbank discharges (Sedell and Beschta 1991). Downed trees can affect channel features by influencing the amount and frequency of local channel scour, and retarding the downstream routing of sediments (Beschta and Platts 1986). In some situations the effect may be a positive interrelationship between living and dead riparian vegetation, sediment and bed load capture, and the creation of wider floodplains with a lower stream gradient.

Fish and Wildlife Relationships to Riparian Areas

Riparian areas are the most critical habitat for fish and wildlife in rangelands used for livestock grazing. Reports emphasizing the importance of riparian ecosystems as fish and wildlife habitat are numerous (Thomas et al. 1978; Ohmart 1996; Kauffman and Krueger 1984). Wildlife use riparian zones disproportionately more than any other habitat type, and fish, especially cold water species, depend on the structure and inputs to this zone. In the Great Basin of Southeastern Oregon, 82% of the terrestrial species known to occur are either directly dependent on riparian zones or utilize them more than other habitats (Thomas et al. 1979). There are similar findings for nesting bird species (Johnson et al. 1977; Kauffman and Krueger 1984). Many aquatic and semi-aquatic species are found nowhere else. The water in the adjacent aquatic zone is the habitat for a variety of life forms, including invertebrates, fish, reptiles, amphibians, birds and mammals.

The relationships and values of riparian areas to fish and wildlife populations have been summarized by Thomas et al. (1979) and Platts (1990, 1991):

1. The presence of water is a fundamental element of habitat. Wildlife habitat is a composite of food, cover and water. All riparian areas provide water, and some offer all three elements. Sustained flow in streams determines fish survival; healthy riparian areas maximize groundwater status and later release.
2. Contrasts between the riparian area plant community complex and the surrounding upland range vegetation adds to structural diversity over a broader landscape. These attributes form part of a habitat matrix.
3. Riparian areas produce more “edge” within a small area than do other elements in a landscape. Vegetation may be layered with contrasting forms or heights. This variety of structure provides diverse nesting, feeding and cover opportunities for many species of wildlife.
4. The microclimate of riparian areas differs from surrounding uplands by having more humidity, a higher rate of transpiration, more shade, and increased air movement. Many wildlife species are attracted by these thermal cover elements, which minimize energy expenditure both in summer and winter. Streamside vegetation shades the stream and influences water temperature, a factor in determining the presence and distribution of fish species.
5. Riparian areas represent connectors between other habitat elements. Wildlife travel is enhanced by the cover provided, and many species use these secure routes for dispersal from their original habitats.
6. Stream channel and bank stability are often determinants of fish population presence and abundance. Riparian vegetation influences bank stability, channel pattern and longitudinal profile, which are all linked to fish habitat.
7. Riparian vegetation has a major role in producing fish food by providing habitat for terrestrial insects that fall directly into the stream. This vegetation also directly provides organic material, a major component of a stream’s nutrient energy supply for the food chain.
8. Water quality is usually maintained by riparian vegetation, which buffers the stream from incoming sediment and other potential pollutants.

Livestock Effects on Riparian Habitats

Riparian habitats occupy relatively small areas and are considered vulnerable to alteration from several land use activities, including livestock grazing. The impacts of livestock grazing on riparian areas are largely from unmanaged grazing (Ohmart 1996). Unmanaged livestock grazing is the practice of releasing livestock into an area without any planned riparian growing season rest or measures designed to protect vegetation health along the stream or on its floodplain.

Unmanaged grazing appears to always result in overuse of riparian areas, impairment of plant species vigor, and physical damage to the channel and banks (Ohmart 1996). If livestock are allowed to freely graze they will spend a disproportionate amount of time in riparian areas. The time spent may be five to 30 times longer than expected, based on the limited extent of the riparian area (Clary and Medin 1990).

Kauffman and Krueger (1984) reviewed 64 papers to determine livestock impacts on riparian areas, fish, wildlife and vegetation. Platts (1991) reviewed 21 papers to determine the responses of riparian habitats and fish populations to livestock grazing. Ohmart (1996) reviewed similar references, including 30 newer works. These authors concluded that inappropriate livestock management results in overuse and subsequent degradation of riparian and stream ecosystems in the following ways:

1. There are effects on stream channel morphology, the shape and quality of the water column, and soil stability and structure in the riparian zone. Streams become laterally or vertically unstable. The water column is altered by increasing water temperatures, nutrients, and suspended sediments, and by altering the timing and volume of flow. Soil compaction on the floodplain, from hoof action, decreases infiltration rates and leads to increased runoff, accelerated erosion and sedimentation rates.
2. There are considerable effects on vegetation, resulting in decreased vigor and biomass, and an alteration of species composition and diversity and losses of some vegetation components, especially trees and shrubs.
3. There are decreases in fish and wildlife species and numbers following overgrazing of riparian areas.

Riparian Grazing Strategies

Both riparian and upland ecosystems can be damaged by long grazing periods with heavy forage utilization (Holechek et al. 1995). Range managers have been successful in devising grazing strategies for upland ecosystems with homogenous vegetation, but far less successful where riparian ecosystems are part of the landscape. These ecosystems are remarkably different in character, substantially more complex, and require special consideration in grazing strategy design. Platts (1991) highlights three major considerations for maintaining or restoring riparian areas. First, grazing management must consider the needs of those plant species that establish riparian function. Species with deep, fibrous-roots provide sod mats; plant diversity provides multilayered vegetation cover, and woody species provide roots and large woody debris. Second, there must be adequate plant cover and residue to attenuate high flows. Third, protection from grazing is required during vulnerable periods when banks are saturated and easily damaged, or in autumn when woody species are most vulnerable to browsing.

The literature emphasizes several options (Platts and Nelson 1989; Kinch 1989; Clary and Webster 1989) for developing riparian grazing strategies that address the conditions Platts (1991) has highlighted. These include:

1. Control of animal distribution and access to water.
2. Control of grazing intensity (forage utilization).
3. Control of grazing frequency and rest periods.
4. Control of timing of grazing use (season).
5. Total exclusion of grazing.

Riparian grazing strategies must be developed for a broad range of landscape conditions and livestock production systems. Figure 1 provides a simplified overview of major riparian grazing strategies that we feel may be suitable for southern Alberta. These have been derived from the literature and from initial experiences with the Cows and Fish Project (Adams and Fitch 1995). These strategies incorporate one or more of the options listed above.

Season-long Grazing

Season-long or continuous grazing is generally considered to be a poor grazing strategy for most rangelands (Adams et al. 1994). In a homogeneous mixed-grass prairie landscape, where riparian areas are mostly ephemeral, season-long grazing can be successfully applied by grazing at proper stocking rates and through effective livestock distribution practices. In more complex range landscapes with well-developed riparian areas, season-long grazing will fail to protect riparian vegetation (Marlow and Pogacnik 1985). Long grazing periods allow livestock preference for riparian vegetation, grazing is intense, there is no provision for rest periods, and livestock graze through all of the vulnerable periods.

Livestock Distribution

Livestock distribution tools will normally be part of any riparian grazing strategy. Traditional practices such as off-stream watering sites and salt placement may only be effective in protecting riparian areas in the most homogeneous of prairie environments. All other landscapes will require additional measures. Other options include herding, upland vegetation manipulation (fertilization, burning, reseeding), placement of supplements, and permanent or temporary fences (Kinch 1989).

Grazing Systems

Grazing systems define recurring periods and patterns of grazing and rest for two or more pastures (Holecheck et al. 1995). Grazing systems provide rest and deferment periods to offset the impact of cropping and trampling during the grazing period. In general, any grazing system will be beneficial to riparian vegetation if it changes from season-long use to a regime that adds deferment, shortens the grazing period and provides longer rest periods. Grazing systems like deferred rotation grazing will enhance plant vigor and productivity, and provide a better sod root mat and more protective plant cover in riparian areas.

Forage Utilization

Forage utilization (Holechek et al. 1995) is a critical consideration in any grazing system (Platts and Nelson 1989). The literature stresses the need for managers to monitor the percentage of forage utilized to ensure that the necessary amount of vegetation is present to attain vegetation-dependent objectives (Kinch 1989). Recommended utilization levels tend to fall in the range of 25 to 65% of annual production and should be set to maintain both herbaceous and woody vegetation, leave adequate protective cover during high runoff periods to protect banks, filter or trap sediment, and dissipate stream energy. Platts and Nelson (1989) evaluated 17 grazing strategies and concluded that forage utilization had a major bearing on the strategy's success. Strategies with heavy or heavy-to-moderate forage utilization levels, received the lowest overall ranking as suitability for riparian grazing. Clary and Webster (1989) stated that

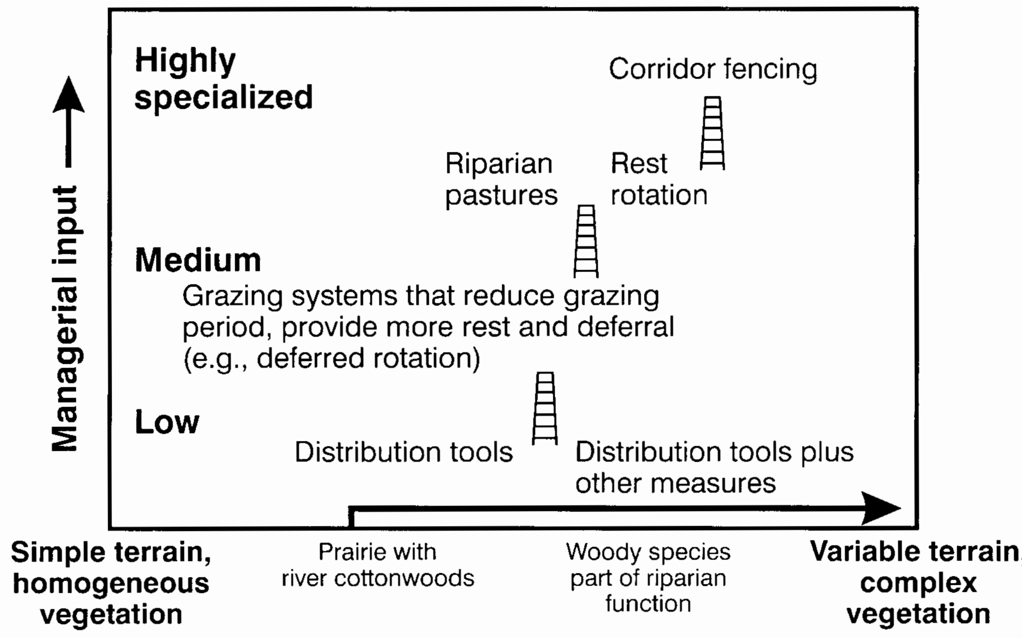

Fig. 1. Riparian grazing strategies (adapted from Platts [1991]).

utilization level was the most important factor in determining riparian area health.

Special Practices

The grazing strategies outlined above address animal distribution, duration of grazing and rest, and grazing intensity. Where these strategies most often fail is in the control of timing or season of grazing. Marlow et al. (1985) reviewed the effects of four grazing management alternatives and concluded that stocking control alone was not effective. To prevent bank shearing, grazing needed to be restricted to times when streambank moisture was low. Myers (1989) suggested that grazing strategies must be specifically geared to the needs of riparian vegetation. Many rotational strategies will allow trampling or grazing of regenerating woody species during late-summer or fall. The most effective riparian grazing strategies will incorporate protection from grazing during these critical periods.

REST-ROTATION GRAZING. Rest-rotation grazing requires multiple pasture units and must include a full year's rest in a grazing cycle (Platts 1991). Rest-rotation does not necessarily provide riparian area benefits unless rest is sufficient to restore fragile stream banks or allow woody species to be maintained. Where the goal is to regenerate new trees like cottonwoods, several years of rest may be required.

RIPARIAN PASTURE. Riparian pastures are created by fencing riparian landscape units separately from upland terrain (Swanson 1986). A more uniform grazing environment is created by reducing the amount of variation in vegetation and topography within the riparian pasture. The practice improves animal distribution and allows the manager to effectively control the timing of grazing relative to bank stability, or to periods when woody species are vulnerable to damage and trampling. Platts and Nelson (1985) suggest that riparian pastures can satisfy both livestock production and fisheries goals by allowing a more intensive and efficient grazing of forage. This provides better control over forage utilization and timing, and protects riparian vegetation.

CORRIDOR FENCING. More than 25 years ago, Gus Hormay, the pioneer of rest-rotation grazing, stated, "Vegetation in meadows and drainageways is closely utilized under any stocking rate or system of grazing. Where this is the case, about the only way to preserve recreational values is to fence the area off from grazing" (Armour 1977). Although recent experience has clearly demonstrated the effectiveness of grazing strategies for riparian areas, there are many circumstances where corridor fencing may be the only effective option. Corridor fencing involves fencing of the riparian area immediately adjoining the stream or river system and permanently excluding livestock grazing (Platts 1991). Corridor fencing will provide the most rapid recovery of riparian vegetation and help exhibit riparian site potential. This is a valuable first step toward a positive change in grazing practices. Riparian fencing is very costly, prevents use of a valuable forage resource, and is usually resisted by livestock producers (Swanson 1986). Furthermore, corridor fencing fails to address management needs of the broader landscape.

Benefits of Riparian Grazing Strategies

To date, the principle focus of riparian grazing strategies has been to restore riparian areas to functioning status. Riparian recovery may bring with it improved habitat for wildlife and aquatic organisms, more stable channels, improved water quality, and a shift toward perennial streamflow (Elmore and Beschta 1987). Benefits for livestock producers are not well defined. The obvious primary benefit of a successful riparian grazing strategy is that the rancher can retain access to a dependable and productive forage supply. With appropriate management, plant succession will proceed to a more productive and healthy ecosystem (Elmore and Beschta 1987). This will improve both the quality and quantity of forage for livestock. On rangelands in southern Alberta, degraded floodplains are considered to produce less than half of the forage of healthy floodplains (Wroe et al. 1988). Conversely, improved management may more than double forage availability. The percentage of total forage yield from riparian areas will tend to be disproportionately greater than the percentage area of a pasture that they occupy.

SUMMARY

Riparian areas, like the adjacent upland ranges, evolved under use by grazing ungulates. Considerable controversy has raged over the validity of assuming domestic livestock as an analogue for natural, pre-settlement use patterns. Under a ubiquitous pattern of unmanaged livestock grazing, riparian areas over a broad geographic area have been degraded, with significant impacts on riparian structure, function and use. In many cases, recovery of riparian structure and vegetation is required to restore natural levels of productivity, for use by both livestock and fish and wildlife populations.

Recovery strategies may require temporary decreases in livestock use, variable periods of rest, and changes in time of use. When recovery efforts have allowed riparian ecosystems to reach a new equilibrium, careful grazing management strategies must be employed to maintain these productive areas. In the long term, grazing management strategies need to address the fundamental items of utilization and season of use, specific to the riparian zone. If done on a landscape basis, in concert with careful upland grazing strategies, cows and fish can co-exist.

To ensure they co-exist, we need to expand the monitoring of several parameters to provide guidance on grazing levels that maintain riparian structure, vegetation and, fish and wildlife. What we do not need is the expenditure of more energy on whether a problem exists. A modest effort might be expended on determining where problems exist, but the bulk of our attention must be addressed to solutions. The solutions will involve many disciplines and the practical wisdom of livestock operators. It is unlikely that the solutions will be prescriptive. Riparian areas, the landscapes they exist within, and ranch operations have different features; each has unique qualities and together are so variable that solutions will need to be tailored to each situation. The first step is to regain the ecological form and function of riparian areas, and then, with suitable feedback monitoring, develop and use grazing strategies that maintain these riparian processes.

In the end, it will be livestock producers who will make these crucial management decisions, select a variety of monitoring parameters, and choose to maintain healthy, productive environments. In all likelihood, the decisions will be made on the basis of enlightened self interest, to maintain grazing opportunities on an exceptionally productive portion of range landscapes.

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