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Using Off-Stream Water Sources as a Beneficial Management Practice in Riparian Areas – A Literature Review

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INTRODUCTION

Soil and water quality must be maintained in order to have sustainable agriculture. One way of maintaining and possibly enhancing soil and water resources is through the use of Beneficial Management Practices. Beneficial Management Practices (BMPs) are encouraged to reduce the negative effects agriculture has on the environment. The goal of integrating BMPs into a management plan is to protect soil, water and air in an economic and environmentally friendly way. Many BMPs are encouraged for use in riparian areas. Healthy riparian areas are critical in protecting water resources but can suffer much degradation from livestock grazing and cropping practices. BMPs promoted to enhance riparian areas include: exclusion fencing, concentrated stream access areas, grazing management plans and remote (off-stream) watering. This paper looks at the use of off-stream watering, without exclusion fencing, as an effective tool to protect riparian areas.

RIPARIAN AREAS

Riparian areas are the transition zones between land and water environments. They are the "green" strips of land located beside a stream, lake, spring, coulee, pothole or any other water body. Riparian and wetland areas in western North America tend to have the following characteristics (Thomas et al. 1979): 1) they create well-defined habitat zones within the much drier surrounding areas; 2) they make up a minor proportion of the overall area (between 1-5 percent); 3) they are generally more productive in terms of total biomass than the remainder of the area; and 4) they are a critical source of biological diversity.

Surface water systems provide a source of water for agricultural, industrial, and municipal purposes. Riparian areas can improve the water quality of these source waters by trapping sediment, reducing erosion, storing nutrients and filtering contaminants before they reach the water source. Riparian area health is a key factor in a riparian area's ability to improve water quality.

Maintaining a healthy riparian system is essential for a productive landscape. When a riparian area is healthy it contains lush, abundant vegetation, provides habitat for wildlife and aquatic species and is a source of forage for livestock. Healthy, primary vegetation in a riparian area stabilizes streambanks, influences bank morphology, aids in reducing streambank damage and provides shade which in turn lowers water temperatures thus increasing the oxygen carrying capacity of the stream (Thompson and Hansen 2001). As well, riparian vegetation filters, utilizes and stores nutrients, thus preventing them from entering water systems. When a riparian area is properly functioning and healthy, it can influence an increase in groundwater recharge (Huel 1998, Fitch et al. 2003).

There are both natural and human-induced disturbances in riparian areas. Floods, hurricanes, tornadoes, fire, lightning, volcanic disruptions, earthquakes, insects, landslides, temperature extremes and drought are among the many natural events that can affect a riparian area (FISRWG 1998). Natural disturbances are sometimes agents of restoration and regeneration and as such, many plants have adapted to include disturbances in their life cycle. Grazing and browsing of vegetation in riparian areas can be considered a natural disturbance as it has occurred for thousands of years. Large herbivores, especially bison have helped to shape and develop the riparian ecosystem (Fitch and Adams 1998). The degree of damage that occurs to a stream once a natural disturbance takes place is directly related to the health of the stream. A healthy stream/riparian area will have greater resiliency, stability and resistance to disturbances.

Human-induced disturbances brought about by land use activities have the greatest potential to harm a stream corridor. Human-induced disturbances in a stream/riparian area may include: agriculture (crop and livestock production), urban practices (municipal waste and construction), industrial practices (mining), and recreational overuse/abuse. Physical disturbances can cause impacts locally as well as at locations far removed from the actual disturbance.

Livestock grazing is a land use activity that has potential to alter the condition of a stream and riparian area if not performed properly. Improper livestock use of riparian areas can negatively affect riparian areas by changing, reducing or eliminating the vegetation within them.

LIVESTOCK AND RIPARIAN AREAS

The direct effects of improperly managed livestock grazing include (Kauffman and Krueger 1984, Thompson and Hansen 2001):

- Change, reduction, or elimination of vegetation
- Decrease in vigour, biomass and alteration of vegetative species composition and diversity
- Change in channel morphology by widening and shallowing of streambed
- Gradual stream channel trenching or braiding depending on soils and substrate composition
- Altered water column by increased water temperatures, nutrients, suspended sediments and bacterial counts
- Altered timing and volume of water flow
- Bank sloughing leading to accelerated sedimentation and erosion
- Decrease in wildlife habitat and species

Riparian degradation is often associated with the presence of livestock, which sometimes leads to the misconception that livestock must be removed from these areas. Poor management issues such as overgrazing, continuous grazing, poor water access, poor water crossings, overstocking of pastures and placement of streamside feedlots are the real issues. All of these poor management practices can lead to unhealthy riparian areas. Therefore a grazing management plan that incorporates range management principles and BMPs should be prepared and followed. The basic principles of range management are: 1) balance animal demand with available forage supply, 2) distribute livestock evenly, 3) avoid grazing during vulnerable periods, and 4) provide ample rest after grazing (Fitch et al. 2003). Water sources are an important variable in how these principles are applied. Properly managed grazing systems that follow these basic principles can actually promote improved riparian health through stimulating plant growth, removing excess litter and accelerating nutrient cycling (LaForge 2004).

Historically, protection of riparian areas was promoted through exclusion fencing, which is simply the fencing off of the riparian area from the cattle and providing an alternative water source. More recently, however, the use of an off-stream water source without fencing has shown promise as an alternative to exclusion fencing (Miner et al. 1992, Clawson 1993, Godwin and Miner 1996, Sheffield et al. 1997, Porath et al. 2002, Veira and Liggins 2002). This form of management allows the use of the riparian area for grazing while still maintaining its environmental functionality.

OFF-STREAM WATERING AS A BMP

In the Prairies, the majority of overland flow events occur during the spring runoff. Consequently during the summer and fall months, most fecal contamination in water channels occurs from an animal defecating directly into the water. Any practice that reduces the amount of time cattle spend in a stream will thus reduce the manure loading and decrease the potential for adverse affects of water pollution from grazing livestock.

Miner et al. (1992) evaluated the effectiveness of an off-stream water source in reducing the amount of time a group of hay fed, but free ranging cattle spent in or immediately adjacent to the stream during the winter months. Water from a nearby well was continuously pumped to a stock watering tank placed approximately 90 m away from the stream. Through visual observations they found that the animals reduced the amount of time spent in the stream by more than 90 percent. Even when the hay feed was placed equidistant between the water tank and the stream, the water tank was highly effective in reducing the amount of time the cattle spent in the stream.

Smith et al. (1992) emphasized the importance of water development in grazing management when he performed a study that monitored habitat selection by cattle along an ephemeral stream. As hypothesised, they found that a greater percentage of cattle selected channel and floodplain habitats over upland habitats and concluded that vegetation in or near channels could be protected by developing water points in the upland area, adjacent to the stream.

Clawson (1993) proved this assumption when he tested a hypothesis that an off-stream water development would reduce water quality impacts of grazing cattle in a mountainous riparian zone during the summer months. After the installation of a water trough, the cattle used the stream significantly less. The cattle preferred to drink from the watering trough over other sources of water available to them, watering 73.5% of the time at the watering trough, 23.5% of the time at the bottom area and 3% of the time at the stream. In comparison to their habits prior to the installation of the water trough, there was an 85% decrease in time spent in the stream and a 53% reduction in the time cattle spent in an adjacent stream side area.

Godwin and Miner (1996) used four beef cows to demonstrate that off-stream watering areas are an effective alternative to stream fencing. When given a choice of watering at the tank or at the stream, the total time spent near the stream was reduced by 75% during the summer months.

Sheffield et al. (1997) linked improvements in water quality and reductions in stream bank erosion with the effectiveness of an off-stream watering device. The study results observed that cattle drank from a water trough 92% of the time compared to the time which they spent drinking from the stream. As well, following the installation of the off-stream watering device, stream bank erosion decreased by 77% and concentrations of total suspended solids, total nitrogen and total phosphorous decreased by 90, 54 and 81%, respectively.

In more recent years (Ganskopp 2001, McInnis and McIver 2001, Porath et al. 2002) the linkage between off-stream water and supplements (i.e. trace mineral salt) was studied to determine the combined effect on cattle distribution in riparian and adjacent uplands. A change in the distribution pattern of cattle with these tools was evident in each study.

Ganskopp (2001) found that the movement of drinking water was the most effective tool for altering distribution of cattle. McInnis and McIver (2001) found that off-stream water and salt attracted cattle into the uplands enough to significantly reduce development of uncovered and unstable stream banks from 9% in non-supplemented pastures to 3% in supplemented pastures. Porath et al. (2002) found that not only were cattle influenced by the presence of off-stream water and trace-mineral salt, but that cows and calves also gained 0.27 kg/d and 0.14 kg/d more, respectively, than the cows and calves in the pasture without off-stream water and supplements.

Off-stream watering systems have also been proven to be effective in a lentic (still) water environment. Surber et al. (1996) performed a demonstration project that observed several aspects of a water source away from a dam/pit. Fencing was not used to limit cattle access to the dam/pit water source and yet 76% of the cattle (cows and calves) which approached the watering sources, watered at the tank. The overwhelming use of the tank left more vegetation on the shorelines of the dam/pit and created differences in the water quality between the water tank and the dam/pit, even though the same source water was used. The major water quality difference existed between the total suspended solids which were much lower in the tank (2 mg/L) as compared to the dam/pit (50 mg/L).

Many of the earlier studies (Miner et al. 1992, Sheffield et al. 1997) raised uncertainties that Veira and Liggins (2002) felt needed to be clarified. Veira and Liggins (2002) wanted to ensure that the overwhelming response of cattle to off-stream water sources wasn't attributed to the fact that in these former studies, water in the troughs was often from a supply other than the stream in question. Therefore, Veira and Liggins (2002) performed two trials that used the waterways of interest to feed the off-stream waterers. Although the two trials had different approaches, they both clearly showed that even without excluding cattle from waterways, it is possible to shift the drinking behaviour of cattle away from natural watering points. The first set of trials tested the individual response of cattle and found that 80% of drinks occurred at the troughs, the second set of trials found 91.6% of drinks occurring at the trough. Precautions were taken to keep the water as similar as possible (in terms of water quality) between the stream and troughs, to ensure that the animals were choosing between the sites at which water was available and not between types of water quality. Other notable results from this study are that nocturnal watering activity occurs very infrequently (as also noted by Miner et al. 1992, Clawson 1993 and Godwin and Miner 1996), and that cattle use the riparian area for resources other than water. These other resources included crossing points, additional forage, shade and grooming sites. Therefore Veira and Liggins (2002) concluded that good scratching locations can be easily incorporated into an off-stream waterer and as such these improvements may serve to further increase an animals' preference for off-stream watering locations.

It is important to note that the placement of troughs and minerals is very important in the level of effectiveness of these tools in reducing riparian area use (Gillen et al. 1984, McInnis and McIver 2001). The distance traveled to the water made a large difference in the amount of time the cattle spent in the stream. Research shows that cattle prefer to graze within 200 m of water (Gillen et al. 1984). Therefore in order to achieve optimum uniformity of grazing and greatest use of alternative water sources, cattle should not have to walk more than 200 to 300 m to water (Gillen et al. 1984, Gerrish et al. 1995, Pfost et al. 2000).

Season and time of day also have an effect on the effectiveness of an off-stream water source in reducing degradation to a riparian area. In the warmer summer months, riparian areas give shade and protection from the heat and the coolness of the water often draws the animals to the waters edge. Larsen (1998) found that the time spent in the creek and the number of direct fecal deposits varied by season, with the longest duration in the stream occurring during the summer months. Porath et al. (2002) found off-stream water and trace mineral salt to be most effective in decreasing riparian grazing pressure during the beginning of the rotation when forage is plentiful and during the afternoon hours when temperatures are warmer and water availability is crucial. Smith et al. (1992) noted that upland forage quality declined in summer and fall, thus attributing to animal forage preference in riparian habitats, where there is better quality forage available later on in the season.

MANAGEMENT PLANS

Riparian ecosystems are remarkably different in character and substantially more complex than upland systems and as such require special consideration in grazing strategy design (Fitch and Adams 1998). As with upland grazing practices, livestock in riparian areas should be managed to ensure that they optimize forage use, graze evenly across paddocks, and do not congregate in certain areas (Bellows 2003). Fitch et al. (2003) and Bellows (2003) give some tools and tips to follow when developing riparian grazing management plans:

1) Alter livestock distribution
   - Use salt/mineral and water placement as a means of luring cattle away from water sources and to even out grazing distribution
   - Use drift or temporary fencing to create paddocks
   - Provide an alternative means of shade and shelter
   - Use animal placement/herding techniques
2) Control access to water
   - Provide off-stream watering
   - Control crossing areas with gravel or concrete pads and fords, constructed bridges or ramps
   - Use corridor or exclusion fencing in areas in high risk or chronic problem areas
3) Seasonality of rotational grazing practices
   - Avoid wet and soft stream banks/shorelines when soil is vulnerable to compaction
   - Delay grazing in spring until vegetation completely covers the soil
   - Leave enough vegetation at the end of the season to allow for proper re-growth and to protect against spring runoff and erosion
4) Alter grazing duration to include more rest

- The length of time an area can be grazed and the duration of rest periods between grazing cycles depends on plant species, type of livestock, amount of prior degradation, environmental conditions and production objectives.
- Rest will give plants more vigour, help to stabilize banks and give vegetation more time to re-grow and reproduce, which will make them more resistant to future grazing.
- In areas highly degraded it is necessary to exclude livestock to initiate the recovery process. The duration of the rest cycle will depend on the amount of degradation.

5) Riparian Pastures
   - Differentiate between riparian pastures and non-riparian pastures as they need separate management objectives and strategies
   - Graze riparian pastures only when both the riparian and upland have good quality forages and temperatures are moderate.
6) Adapt Grazing Management Practices to Local Conditions
   - Adapt grazing management to the type of livestock being raised, local environmental conditions and seasonal climate changes. A good grazing management plan fits the ecological conditions of the grazing area.
   - Understand how different livestock species graze and design grazing management practices to work with an animal's preference and instinct.

Following these tips will enhance livestock production and maintain or improve the plant community within a riparian area.

CONCLUSIONS

The key to maintaining healthy riparian areas is to understand how they work and function. Streams and watersheds function as units and as such must be considered inseparable (Fitch and Adams 1998). Once this understanding is achieved one can manage riparian areas to restore and maintain their functions. Riparian areas are an invaluable source of forage for producers and as such are an important component in a rotation, especially during times of drought when other forage sources are less readily available.

As the above research indicates, improved water quality, ease of livestock distribution and increased livestock performance can all be provided without fencing by supplying an alternative off-stream water supply. Fencing, although very effective at controlling livestock access to streams and water sources, is costly, not always practical depending on the landscape features, and often a source of conflict in the ranching industry. Exclusion fencing also suggests that riparian areas and cattle are unable to coexist. This idea falls short of a higher goal, that of total landscape management (Fitch and Adams 1998). However, exclusion fencing is still required in areas that are significantly degraded and need extended rest to regenerate, or areas that are very sensitive to livestock grazing.

The literature suggests that off-stream water sources without the use of exclusion fencing are upwards of 90% effective at keeping animals out of a stream, whether the water in the trough is from the stream or alternative source. The degree to which livestock can be attracted away from riparian areas depends on season, topography, vegetation, weather and behavioural differences (McInnis and McIver 2001).

Protection and proper management of riparian areas are clearly needed to make them as productive as possible. Off-stream watering by itself is not a BMP if the four basic principles of range management are not adhered to. Following a well thought out grazing management plan that includes rotation, rest and alternate water sources will aid in the protection of riparian habitats.

Many speculations have been identified as to why cattle tend to choose off-stream watering sources over natural stream sources (Veira and Liggins 2002, Miner et al. 1992, Clawson 1993, Sheffield et al. 1997). Some of these conclusions are that off-stream watering sources provide improved footing, reduced physical effort and instability, increased visibility and security and a preferred water temperature. Both Miner et al. (1992) and Veira and Liggins (2002) suspected that footing played a role in the cattle's preference for the off-stream water source. The sites in these studies located the alternative water source on level ground and had overflow water flowing away from the watering area. This kept the area surrounding the trough relatively dry and firm as compared to the muddy, rough access at the streamside. Clawson (1993) noted that due to the trough's elevation less stretching of the neck was required by cattle, this translates into less effort on part of the animal and a more stable orientation. Veira and Liggins (2002) also concluded that for animals such as cattle that respond to threats by fleeing, areas of awkward or unstable footing would be undesirable from a security standpoint. An elevated, level trough may appear to be more desirable for drinking as many natural watering points tend to orient cattle across or down slopes, and have decreased visibility due to depressions and/or bushy vegetation.

FUTURE WORK

The fact that off-stream watering locations are effective in attracting cattle away from the riparian area has been clearly shown throughout this literature review. Therefore possible future studies could include:

1) A comparison of the economic costs and environmental benefits between off-stream water sources without fencing and stream bank fencing (Sheffield et al. 1997).
2) A comparison of the water quality and stream bank erosion between fencing vs. non-fencing.
3) An experiment to link cattle grazing intensity and in-stream habitat effects to stream bank breakdown, sediment release (McInnis and McIver 2001).
4) Effects of using water as a distribution tool on range and riparian health.

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