Nonriparian Shade as a Water Quality Best Management Practice for Grazing-Lands: A Case Study

By Calvin Russell Clary, Larry Redmon, Terry Gentry, Kevin Wagner, and Robert Lyons

On the Ground

- Cattle within riparian zones can negatively impact water quality and riparian health, which are important environmental concerns for grazing lands.
- Best management practices (BMPs) help mitigate agricultural pollution. Since BMPs are primarily voluntary, stakeholder acceptance is critical, and agricultural producers need BMPs that are relevant to their operation and will not negatively impact production.
- Alternative shade has been suggested as a water quality BMP, with both environmental and agricultural benefits. After implementing the nonriparian shade structure, a 30% average reduction was observed in the time cattle spent within the riparian zone.

Keywords: best management practice, water quality, riparian zone, shade.

Rangelands xxx–xxx
doi 10.1016/j.rala.2015.12.006

Cattle loafing within riparian zones or waterways can negatively impact water quality and riparian zone health. Riparian health and stream water quality are intricately linked and important to the sustainability of in-stream contact recreation, aquatic life habitat, and fishing. Water pollution has been a prominent environmental concern since the late 1960s. According to the Environmental Protection Agency, there are 16,608 km (10,320 miles) of impaired rivers and streams known in Texas.[1] Over half of these streams are impaired from nonpoint sources, such as urban runoff, wildlife (avian and nonavian), grazing, irrigated cropland, mining, and others. Agricultural operations have been cited for contributing over 20% of all in-stream pollutants in Texas.[1] To help mitigate pollution, state and federal agencies have initiated total maximum daily loads (TMDLs) or watershed protection plans to target needed water quality best management practices (BMPs) to reduce pollutant loading. By studying and developing additional BMPs, agricultural producers and environmental conservationists may be able to more effectively mitigate degradation of water quality.

Contaminant Fate Modification

Much work has been done in examining the effects of livestock on riparian health and water quality.[2–5] Studies have examined the links between proximity of contaminant deposition and in-stream water quality. It is generally recognized that shorter distances between the contaminant deposition and the waterway have a greater negative effect on water quality.[6] In an attempt to control contaminant deposition and fate processes, structural BMPs have been implemented to modify animal behavior. Specifically, cattle travel and grazing patterns have been modified by using a variety of practices that alter fecal deposition locations. In the past, researchers were limited to visual observation to collect spatial positions of grazing livestock or fecal deposits.[7,8] With global positioning system (GPS) technology, not only can more data be collected, but they are often more accurate and allow cattle location to be observed in the context of a herd and at all hours of the day. GPS data points taken at evenly spaced time-intervals can be used to correlate the amount of time that cattle spend within a given area.[9] Fecal deposition is acknowledged to be directly correlated to the time that cattle spend at any given location.[10]

Some common BMPs used to reduce pollution from livestock grazing operations include riparian buffer strips, exclusion fencing, prescribed grazing, off-stream water sources, and rotational stocking. Despite the variety of BMPs available, the need to develop and test additional, cost-effective BMPs persists. This is because landscapes and operations, which BMPs are intended to facilitate, are highly diverse. Producers need BMPs that are relevant to their operation and will not negatively impact production. For this reason, there should be an assortment of BMPs that producers could select and implement as appropriate for their specific situations.

One BMP that has met much resistance from cattle producers is exclusion fencing.[11] Exclusion fencing is the practice of fencing off the stream and riparian zone to prevent livestock from grazing and watering within those areas. Although it has proven very effective in keeping livestock out of riparian zones and has been shown to reduce bacterial and nutrient loading in some cases,[4,12] its use has been highly unpopular among stakeholders. From a ranch management perspective, it is costly,[13] labor intensive, overly restrictive,[14] and not always effective.[15] Many stakeholders agree that environmental stewardship is very important, but opposition exists because this BMP offers little practical benefit from a ranch productivity or management standpoint.[16,17]

Water quality BMPs providing more practical and diversified benefits from a farm or ranch management context encourage higher adoption rates.[18] Since BMPs are primarily voluntary, stakeholder acceptance is critical. It is necessary to provide stakeholders with simple, cost-effective BMPs beneficial to the agricultural operation.[16] For this reason, alternative shade has been suggested as an attractive water quality BMP from the standpoints of both environmental quality and ranch management.[19] Alternative shade is thought to offer water quality benefits, without the drawbacks of exclusion fencing, as well as additional ranch-related benefits, such as soil conservation[20] and improved pasture utilization.[21] Still, relatively little is known about the effectiveness of alternative shade as a water quality BMP.

In pastureland, natural shade is often located along the riparian zone. In summer months, cattle seek shade to cool off.[22] Temperature and relative humidity have been found to be two of the main driving factors behind cattle seeking shade.[23] Byers observed that cattle spent 80% of their time in the shade while in the riparian zone.[24] Providing an alternative shade source outside of the riparian zone has been suggested as a potential water quality BMP for grazing lands.[24–26] However, few studies have evaluated the effectiveness of alternative shade in modifying cattle behavior; thus, this remains a BMP that should be studied to a greater extent.[27] Most shade studies have primarily focused on optimizing metabolism or milk production in cattle,[28] rather than providing water quality benefits.

One geographical information system (GIS) study testing the effectiveness of an alternative shade structure concluded that it "did not decrease the amount of time cattle spent along the streambanks."[25] However, Agouridis et al. conceded that the lack of treatment effects may have resulted from data constraints.[25] Another possible reason for this may be the shade configurations at the study site. The presence of nonriparian shade trees[9] may confound the results because trees act as a natural BMP. For this reason, control data from this study may not have varied significantly from treatments. This may explain why alternative shade BMP results of the study[25] were ineffective in reducing the time cattle spent in or near a stream. This underscores the importance of proper placement of alternative shade structures because abundant natural nonriparian shade may negate the necessity for, and compromise the effectiveness of, an alternative shade structure.

What We Did

The alternative shade BMP was evaluated at the Texas A&M AgriLife Research Center in McGregor, Texas. As shown in Figure 1, the study site was a 28.7-ha (71-acre) grazed pasture with an intermittent headwater stream of the South Bosque River flowing through it. An estimated 6% of the pasture area was vegetated by trees large enough for shade coverage. Shade was almost exclusively within the riparian zone. The pasture was provided with an off-stream water trough at the southeast corner of the pasture. The pasture had been heavily stocked, and there was evidence of erosion of the stream bank at sites where cattle frequently crossed the creek. We placed six to eight Lotek GPS 3300LR collars (Lotek Wireless Inc., Newmarket, Ontario, Canada) on randomly selected cows (Angus-Nelore cross) and used them to record the locations of cattle over three 21- to 23-day trials. Each GPS collar was calibrated to take a single locational data point every 5 minutes. The creek, pasture boundaries, and riparian zone were delineated by remote sensing.

Before beginning the trials, we placed the GPS collars on cattle and then released the cattle into the study pasture. We programmed the collars to begin collecting GPS data points on the midnight hour after cattle were turned into the pasture. Data points were collected at each 5- minute interval for the remainder of the trial. The first 10 to 12 days of each trial served as the control period, in which GPS collars were initiated to monitor cattle location prior to BMP implementation (Figure 2). Halfway through the trial, we implemented the BMP (i.e., erected the shade cloth), while the collars continued to collect data-points for another 10 to 12 days. This "postimplementation" period served as the treatment period, allowing cattle behavior to be compared between the BMP treatment period and the control period. We erected a 9.1 × 9.1 m (30 × 30 feet) SunBlocker Economy Shade Frame,[29] with shade cloth for the alternative shade BMP. The shade structure was placed approximately 541 m (1775 feet) from the water trough and 140 m (459 feet) away from the creek and from the riparian zone where other large trees could serve as potential shade locations for cattle. We conducted trials in October 2010, May and June 2011, and March and April 2012 (Table 1). We analyzed the alternative shade BMP by counting the number of data points within different buffer zones (i.e., riparian zone and shade pavilion) before and after BMP implementation. At the end of each trial, we removed the GPS collars and downloaded the data. We plotted the GPS data points in ArcMap and then counted the points within each buffer zone. Data points were normalized to account for the differences between the total number of data points collected before and after BMP implementation (see equations 1 and 2 in Figure 3). We calculated the percent differences between the pre- and post-BMP periods by using equation 3 (see Figure 3).