Managed Grazing and Stream Ecosystems*

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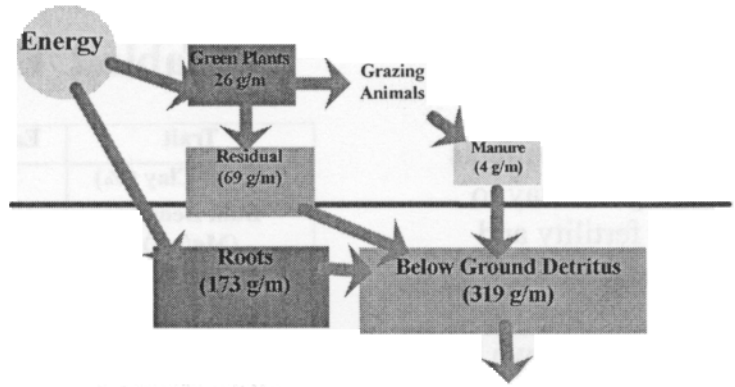
For many in the livestock industry, the word 'environment' has become a controversial term with a lot of negative implications. Can we co-exist peacefully? I believe the answer is 'yes.' The key is management. Just as management is the key to maximizing profitability, grazing management is essential to ensure environmental protection. And in many cases, the same sound management practices can achieve both goals.

For the moment, let's strip away the implied meanings and look at environment in the simplest terms; from the dictionary we learn that one's environment is "the surroundings, influences, and circumstances affecting the development or existence of a person or organism." Our environment on the farm includes physical features like soil, water, and climate as well as biological features such as birds, soil microbes, and fish. As livestock producers, we're harnessing these resources to produce meat and milk and it is in our best interest to take care of them in the best way we can.

The Pasture Ecosystem. Historically the vast grasslands of the North American continent were maintained through a combination of climate, fire, and grazing by native herbivores. Herds of bison roamed over miles of grassland in search of fresh, new growth, leaving grazed-down areas to rest and recover. We simulate this very natural rotational pattern when we use management-intensive grazing (MiG). Today, the characters are changed–we graze domestic herbivores on different types of grasses--but the way this ecosystem functions is the same. Our livestock, as part of the grassland ecosystem, perform the important function of converting energy stored in plants into food for people. Understanding how grasslands work can help us manage our pastures well, both for greater profitability and environmental quality.

Soil resources. Early settlers thought that the prairies, which grew only grass and could not support the growth of trees, could not be fertile enough to grow crops. In fact, the opposite is true and there's a lot more to a grassland than we can see on the surface (Figure 1). Underground, grasslands are full of life. The seemingly simple pasture sward is made up of a wide range of living things, with plants dominating, but

Figure 1. Grassland Ecosystems



Adapted from Breymeyer 1980.

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fungi, bacteria and worms also playing an important role. This complex soil community works to store massive amounts of organic matter underground, creating some of the most fertile soils in the world. In healthy grasslands, nearly 90% of the stored energy in the system is banked in the ground as soil organic matter. We can look on this material as a reserve, as a stockpile of nutrients and energy. This reserve is tapped when we till the soil and plant a crop. If we use the analogy of a savings account, tillage systems using annual crops utilize the principal to support production, while pastures and other perennial forages withdraw only the interest, leaving the principal intact. Grazed pastures return organic matter to the soil and can reverse losses of fertility and soil health that come from years of row crop production.

Table 1. Manure Nutrient Content

	Dairy	Beef
Tons/animal/year		10.95
N (lb/yr)	570	416
P (lb/yr)	166	153
K (lb/yr)	498	438
Ca (lb/yr)	332	285
Mg (lb/yr)	190	153

When cattle graze, they consume nutrients and energy from the pasture. While a proportion of these nutrients are removed in the form of meat, milk and other products, most are returned nutrients and organic matter to the system in the form of manure and urine. Manure is an important resource both for the health of the pasture and for the profitability of our operation. We can't afford to mismanage it. Table 1 shows the annual manure nutrient production of a typical dairy or beef cow. When we consider the cost of other sources of these nutrients, it becomes clear how important it is to manage manure as best we can.

Management intensive grazing is the most efficient way to spread those manure nutrients back on the pastures. The more uniformly we can distribute them, the better. That means being aware of the role of watering tanks, feeders, streams, and trees, for example, in concentrating animals, thus concentrating manure and nutrients. Ensuring the most uniform spread of manure and urine nutrients possible is a good way to enhance soil fertility and overall pasture health.

Table 2. Earthworm Casts

Trait	Earthworm Casts	Soil
Silt and Clay (%)	38.8	22.2
Bulk Density (Mg/m3)	1.11	1.28
Structural Stability	849	65
Cation Exchange Capacity	13.8	3.5
Exchangeable Ca	8.9	2
Exchangeable K	0.6	0.2
Soluable P (ppm)	17.8	6.1
Total N (%)	0.33	0.12

From de Vleeschauwer and Lal (1981)

Manure is broken down by the many soil organisms that are present in healthy pastures. One of the most important of these is the earthworm. In an average acre of pasture, earthworms

outweigh livestock by over 1000 times. As they munch their way through up to 450 tons of soil per acre per year, they improve soil structure and water holding capacity. Table 2 shows a comparison of worm casts and soils and the value they have in improving soil structure and making soil nutrients available for plant growth. Earthworms can serve as one of our indicator species: dig down into the soil of your pastures. If you see earthworms, it's a sign that your soil is healthy.

Table 3. Soil Erosion From Pastures and Cropland

Crop	Soil Loss (T/A)	Rainfall Loss (%)
Bare Soil	51.5	54.6
Continuous Corn	59.9	66
Continuous Barley	12	61.2
Continuous Alfalfa	0.22	10.1
Pasture	0.003	10

From: Q.C. Ayres, 1972

Well-managed pastures not only help distribute manure nutrients back over the land, they also provide excellent protection from erosion of the soil itself. Table 3 shows soil erosion from pastures and cropland. Soil scientists tell us that it takes 500 years to form an inch of soil. With an inch of topsoil weighing about 166 tons, we're losing that much every three years from a continuous corn system. In contrast, soil and rainfall losses from pastures are practically non-existent. And although we often don't think of rainfall as a resource that we can control, we can maximize our capture of this resource with MiG.

Table 4. Surface Runoff From Pastures and Cropland
(mg/liter)

	Phosphorus	Nitrogen	Sediment
MiG Pre-Grazing	1.24	1.28	28.3
MiG Post-Grazing	1.58	1.1	47
Fescue/Spread Manure	3.61	3.1	0.93
Tilled fields	2.3	13.4	36400

adapted from Johnson and Ward, 1997

Protecting Water Quality

On our pastures, soil and manure nutrients are valuable resources, but those same nutrients become a pollutant if they are allowed to reach the local stream. Runoff water from farmland can and does greatly affect the quality of our surface waters. When we look at the nutrient content of surface runoff from MiG pastures compared to spread manure or tilled fields (Table 4), we can see that much more of the P, N, and sediment is retained, and this shows both the importance of the vegetation cover as well as the difference between animal deposited manure and spread manure. While manure spreading is necessary in most systems, the more of the manure that can be directly deposited on the pasture, the more of those nutrients we'll capture and the fewer will end up in streams.

Surface water is a farm resource that needs to be managed carefully. By implementing MiG on our farm, we've ensured that most of our soil resources stay where they belong. But grazing management in the stream corridor itself presents some special challenges. One of the issues we've been investigating is how grazing management can be used in stream corridors to protect

water quality. Our research looked at the potential of MiG as an alternative best management practice to fencing cattle out of stream corridors.

Stream Ecosystems Aquatic systems function in the same way that our pasture ecosystem functions: aquatic plants are the primary producers which convert the sun's energy to food. Aquatic insects are the grazers of the stream community, small fish consume the aquatic bugs, game fish eat the smaller bug-eating fish, and, if we're skillful or lucky, we eat the game fish. In the spring-fed streams that we studied, cold water temperatures limit the community to just a few species and we have a very simple ecosystem consisting of game fish (brown and brook trout), food fish (sculpins), and aquatic bugs (species such as mayflies and caddisflies). The presence of other fish species (white suckers, creek chubs, or carp) in cold-water streams are an indicator of less than ideal conditions.

One way to evaluate water quality in a stream or pond is to look at the composition of the aquatic insect community. Among the many species of aquatic insects, there is a range from some which can tolerate very high levels of pollution to those requiring very pristine water quality. The EPT index measures the proportion of intolerant or pollution sensitive bugs we find, giving an indication of how clean the water is. Figure 2 shows how our treatments rated for pollution sensitive bugs. Compared to high water quality (which would rate 100%), our data suggests that all of these streams had degraded water quality. But, we found that MiG pastures, grassy buffers, and woody buffers had more of these species than did pastures with unrestricted cattle access, suggesting that MiG pastures provided as good water quality protection as buffer strips.

Figure 2. EPT Index

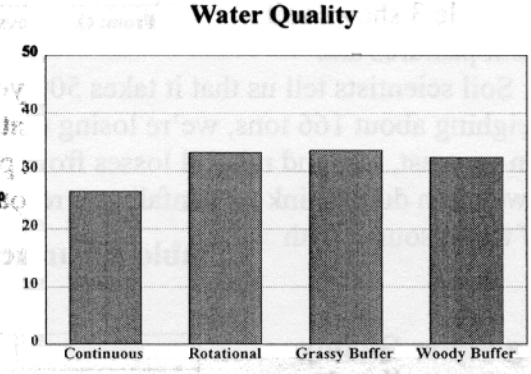
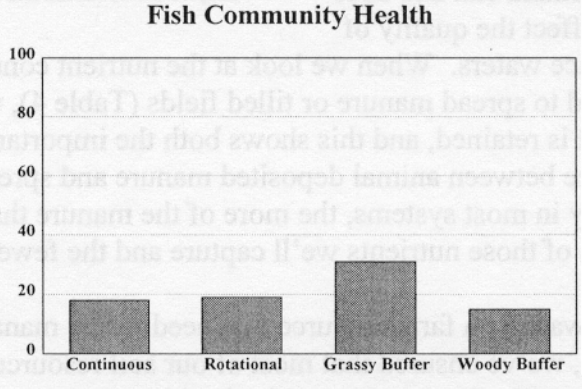


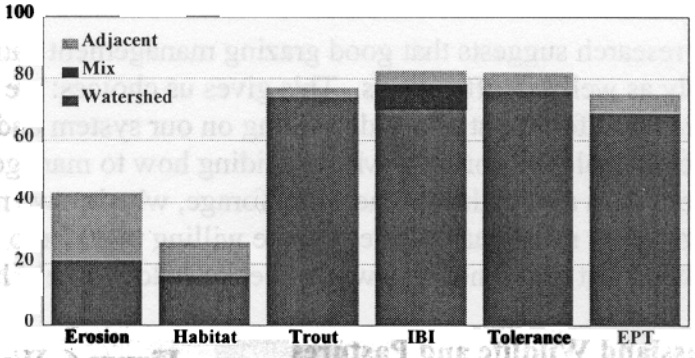
Figure 3. Index of Biotic Integrity



On the basis of these results, one would expect there to be little difference in the health of the fish community which depends both on water quality and on the aquatic insects for food. And that is what we found. Fisheries biologists use an index called the 'Index of Biotic Integrity', with a score of 100 reflecting the healthiest streams. And, as you can see in Figure 3, none of the streams had very healthy cold-water stream communities, with the grassy buffers rated 'fair' and the rest of the sites rated

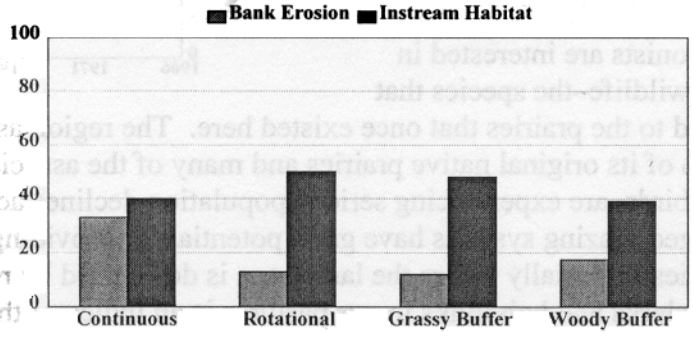
'poor'.

Figure 4. Influence of Watershed vs Adjacent Landuse



What does this tell us? Does it mean that MiG is not good for fish communities? Not really. The health of the stream is a result of not only adjacent land management, but of the condition of the whole watershed. If we look at the comparative impact of our local land use vs. the overall effect of the whole watershed, we can see that watershed condition dominates the response of the fish community (Figure 4). That means that improvements in the fish community will be gained only by having a lot of people within the watershed managing to protect the resource. And it means that we should do the things that can make a difference. As you can see, we can have a significant effect on streambank erosion and on instream aquatic habitat, which in turn will contribute to the health of the whole watershed.

Figure 5. Bank Erosion and Aquatic Habitat



We found that MiG pastures had significantly less bank erosion than continuous pastures and protected banks as well as buffer strips (Figure 5). The effects of grazing management on bank stability had consequences for instream habitat as well. What we found in our study was that MiG provided better instream habitat than unrestricted cattle access to streams, and better than wooded buffer strips as well. Rotationally grazed streams and grassy buffer strips had deeper, narrower channels than continuous pastures and woody buffer strips. They had less sediment covering the stones in the bottom of the stream and more hiding cover for fish.

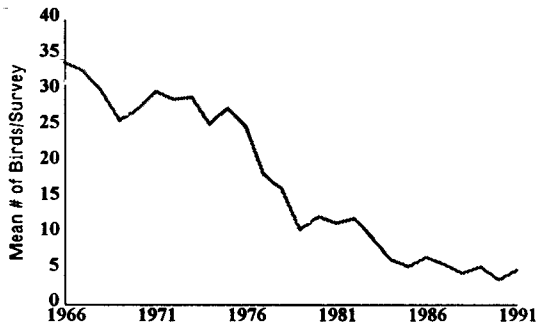
Managing Streamside Paddocks Management makes the difference between serious erosion problems and good, stable stream banks. In general our cooperators felt that the management that results in healthy, profitable pastures does a pretty good job of protecting streambanks and aquatic habitats as well. This includes maintaining a healthy sod, giving adequate rest periods, and avoiding overgrazing. No matter how carefully we manage, it's natural to have some erosion and we're going to have to adapt our management in response to storm events, cattle behavior changes, and many other factors. Because stream area damage can be worsened by the erosive effects of the flowing water, it's best to actively repair damaged banks by reseeding eroded areas

and fencing cattle out till the sod is restored, and to avoid grazing streamside paddocks under certain conditions such as during spring thaw or periods of rainy weather when the soil is saturated and on very hot days when cattle have the tendency to stand in the water.

Our research suggests that good grazing management can protect streambanks and riparian areas nearly as well as buffer strips. This gives us choices: we can choose one of several management approaches for our streams, depending on our system and what works best in that context. What factors should we consider when deciding how to manage? We need to consider a number of factors such as whether we need the forage, whether we need access to the water, whether we like to fish, how much management we're willing to put into the riparian area, balanced with what we'll get out of it, and even what types of wildlife we'd like to see.

Grassland Wildlife and Pastures

Figure 6. Western Meadowlark Populations



Vegetation has a profound influence on wildlife communities and how we manage both streamside and upland pastures will affect the composition of the wildlife community on our farms. Probably the biggest determining factor is the presence or absence of trees. In much of the Midwest, conservationists are interested in grassland wildlife–the species that are adapted to the prairies that once existed here. The region as a whole, including Missouri has lost 99.9% of its original native prairies and many of the associated wildlife species, such as grassland birds, are experiencing serious population declines across much of this region (Figure 6). Managed grazing systems have great potential for providing high quality habitat for some of these species, especially where the landscape is dominated by row crop production. The presence of meadowlarks and bobolinks in our pastures is an indicator that we're providing healthy habitat.

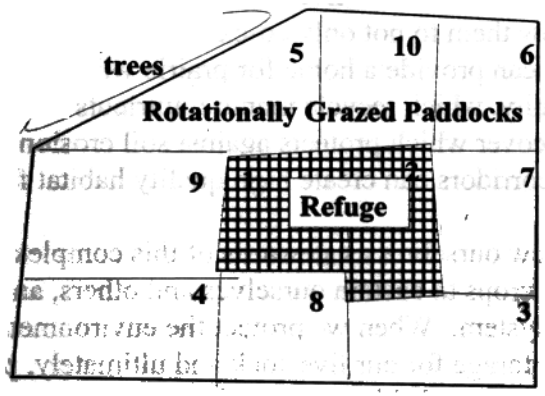
Habitat Edges. A buffer strip, especially a woody one, creates a habitat edge in the landscape and edges are important in wildlife habitat terms. Edges increase the diversity of wildlife you will see, because they are the intersection between two different habitats. You'll usually see members of both woodland and grassland communities. Edges also act as corridors for predators such as foxes, skunks, and coyotes which may prey on desirable species (possibly even livestock).

Edge habitats are especially important to many game species such as deer, quail, pheasant, Hungarian partridge, and rabbit. These species need different types of habitat during different seasons, so they tend to locate themselves at intersections of the habitats that they require. If one's goal is to encourage some of these game species, interspersion of woody and grassy habitats to create the greatest amount of edges would maximize the amount of high quality habitat for these species.

Managing Pastures with Grassland Birds in Mind In contrast, true grassland species, such as many of the songbirds avoid edge areas and are more attracted to broad, open landscapes. We found few of these species at our buffer strip sites. We found more grassland birds at pastures sites and the larger the pasture and the more open the surrounding landscape, the more attractive these habitats are to grassland birds. In another study, we found that rotational management provided higher quality habitat for more species of grassland birds than continuously grazed pastures. Rotational pastures had larger, more diverse communities of grassland birds than did the continuously grazed pastures, although neither provided the tall dense habitat required by some species such as pheasants.

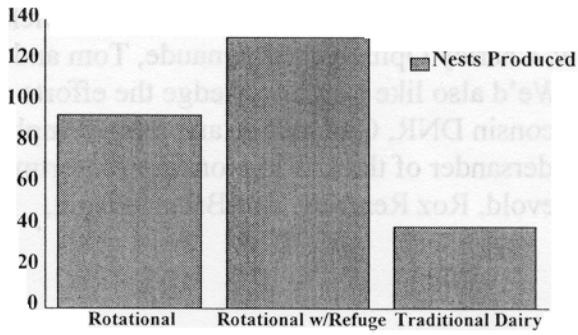
Grassland birds, including game species like pheasants and quail, nest on the ground in May and June. Nesting birds often take 4 or more weeks to build a nest, lay eggs and raise their young to the point at which they can leave the nest. Until that time, the nest is vulnerable to cattle trampling or other disturbance like predation. This is a time of year when we're attempting to make the most of plentiful forage supplies. Our growing season here in the Midwest provides us with a very challenging grass growth pattern. More than half of our pasture growth occurs during these months. To manage pastures well, we must use a combination of methods including flash grazing, stockpiling and mechanical harvesting.

Figure 7. A "Bird-Friendly" Pasture System



The cooperating farmers in our study often set aside paddocks at this time of year for about 4 weeks to make hay. For the study, we asked them to set aside groups of paddocks for a couple of extra weeks (total of 6 weeks) to provide some undisturbed habitat for nesting birds (Figure 7). These paddocks created a nesting 'refuge' within the pasture system. We found that both the rotational paddocks and the refuges attracted many grassland birds to nest and that the paddocks where grazing was deferred in May and June had much higher nest survival than the rotational pastures.

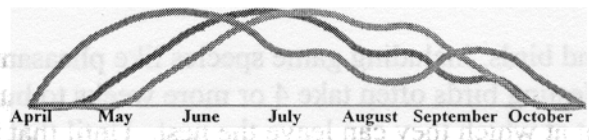
Figure 8. Potential Nest Production on MiG and Traditional Dairy Farms



From this research, we can determine that grass farms with the refuge can potentially produce sustainable populations of birds although grass farms even without refuges can provide a home for many more grassland birds than conventional confinement/feedlot style livestock farms (Figure 8). Does setting aside paddocks fit with graziers' systems? It can. We found that the hay our cooperators

made from the refuge paddocks was not the highest quality, but it was adequate for dry cows or stockers. Overall forage production in these paddocks was similar to paddocks in a normal rotation, and later in the season, the forage quality in these paddocks was better than that of adjacent paddocks that had not been rested.

Figure 9. Summer Saved Pastures



Another approach to providing wildlife habitat in a managed grazing system is to restore some native prairie grasses to the landscape. Prairie grasses are 'warm-season' species, which grow slowly in spring and fall when the fescues and other cool season grasses do well, and are ready to graze during July and August when the cool seasons have gone dormant (Figure 9). These warm season paddocks can provide an undisturbed place for grassland birds to nest while ensuring that you'll have plenty of forage for those dry months. Once again, the same practice that can help us be more profitable can also enhance the environmental quality of our land.

Can grazing and the environment peacefully co-exist? Grazing lands have inherent qualities that allow them to not only co-exist but enhance the environment. As grassland habitat, pasture systems can provide a home for prairie wildlife. Pastures support and nourish an active soil community, which recycle manure nutrients and protect soil fertility. They provide perennial ground cover which protects against soil erosion and runoff. Intensive grazing management of stream corridors can create high quality habitat for aquatic communities.

If we view ourselves as stewards of this complex ecosystem, we can manage in a way that will produce crops to sustain ourselves and others, and still return enough to the land to sustain that natural system. When we protect the environment, we are protecting the same resources that produce forage for our livestock and ultimately, provide us with a living. Of all the resources at our disposal, probably our most important is our own creativity, combined with knowledge and acute observation skills. Through management, we'll always have something nutritious for our stock to eat as well as something left over to give back to the land.

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