Surviving or Thriving in Drought

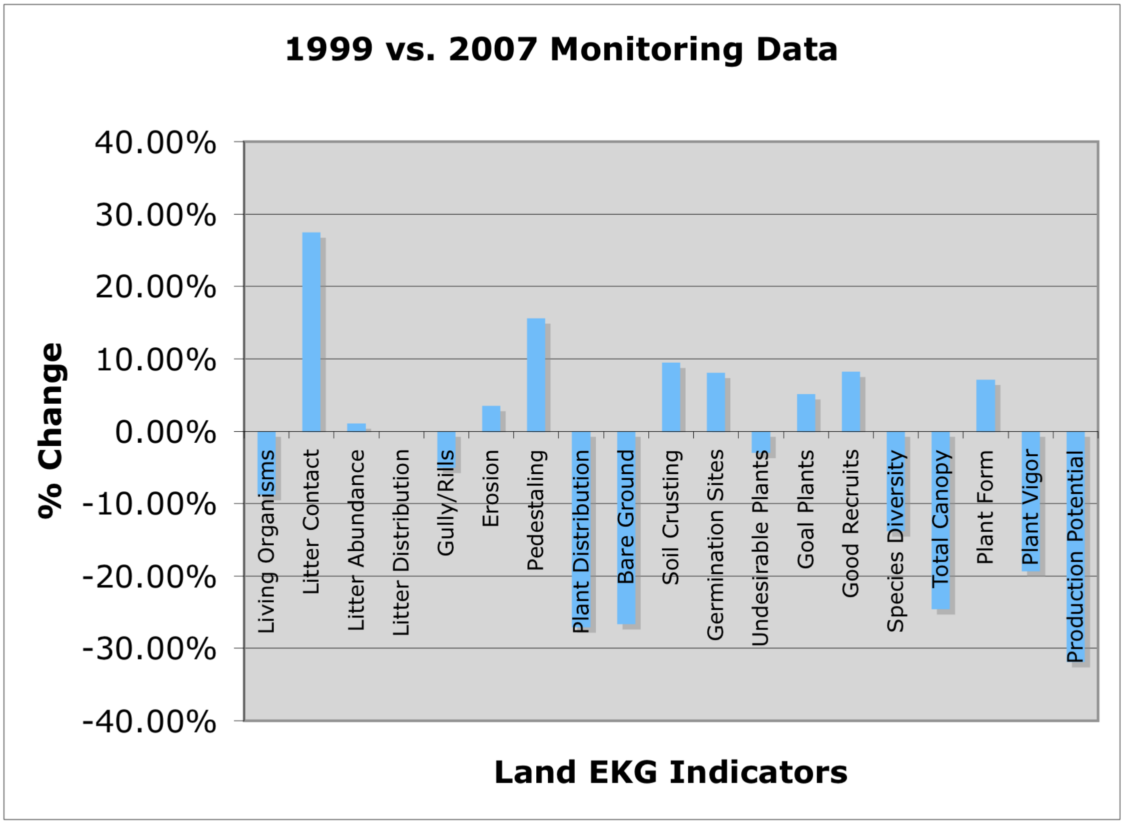
by Tony Malmberg & Jim Howell

From 1978 – 2009 Tony, Andrea, and KD Malmberg owned and managed Twin Creek Ranch, just a little southeast of Lander, Wyoming. At Twin Creek, a normal year sees a scant 8.5 inches (213 mm) of precipitation, erratically spread throughout the year, and temperature extremes from 105 to -25 F(41 to -32C).

In the process of managing their livestock and trying to make a living, found themselves scrambling to adjust to the worst eight-year drought in recorded history. Here is their story of how they arrived at this drought, how they've negotiated the drought, and how their ranch's ecological base has "weathered" the drought. Most importantly, it's the story of lessons learned throughout this tough period, and how those lessons will help all of us negotiate more tough times down the road.

We established four permanent trend and condition transects in 1999, so we have solid data on the health of our upland range prior to the drought. Since then, our monitoring has primarily been through close daily observation and informal step transects. But, this past summer, we hired Charlie Orchard of Land EKG (www.landekg.com) to come re-read our permanent biological monitoring transects. We felt it was time for a more objective reading of how our drought-induced management adjustments have enabled us to maintain the integrity of the ecosystem processes. We chose to use an outside monitoring professional to get third party objectivity and check on our own perceptions.

In the chart titled *1999 vs. 2007 Monitoring Data,* we get a quick sense of how our measured indicators have changed over the course of the eight-year drought. This chart averages the change in all four transects. At first glance, we see that we had about the same number of indicators change for the positive as for the negative. But, if we look at the major changes (and disregard any change of less than 10 percent), we can get to the heart of the matter.

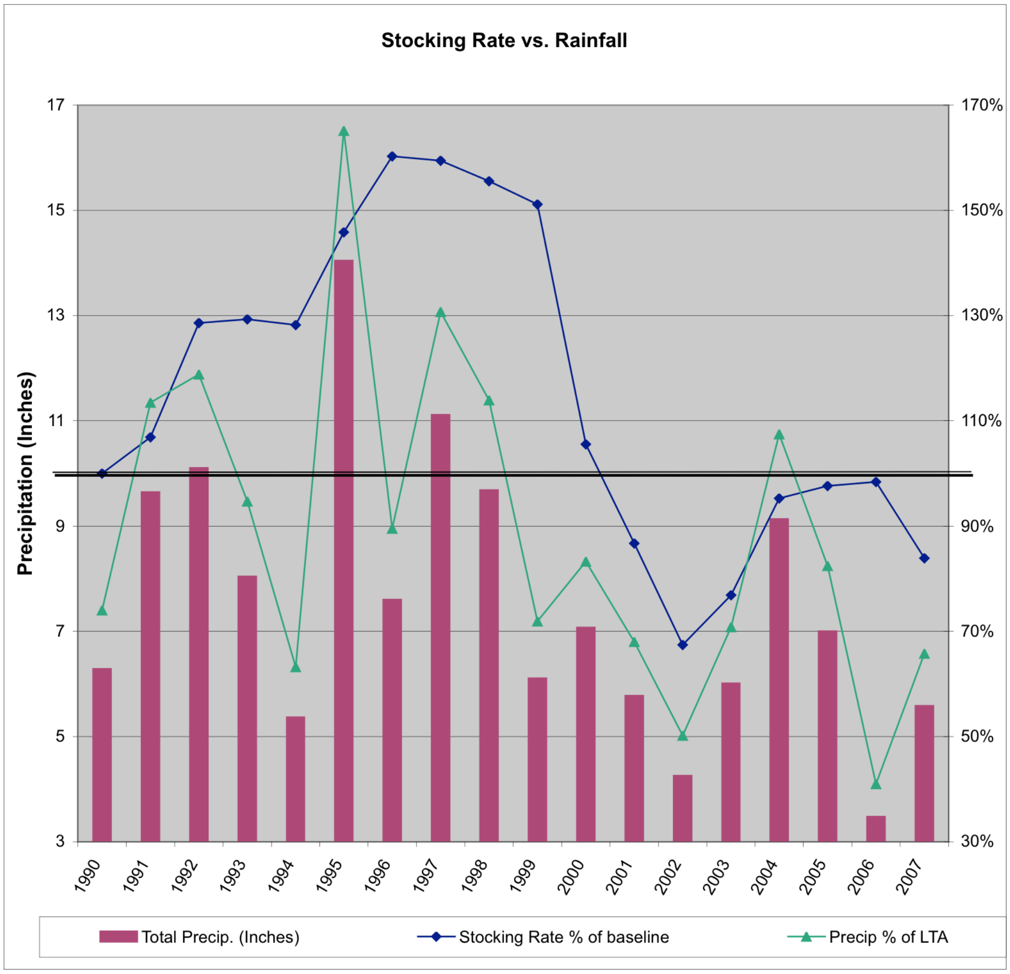


The two big positives, increased Litter Contact and reduced Plant Pedestaling, might be explained due to greater stock density and regular herding practices. Charlie Orchard suspects the forbs dried up early and before the transects were read, explaining a portion of the species diversity decline. Many of the negative trends, such as declines in Production Potential, Plant Vigor and Total Canopy, can be at least partially explained by drought and little precipitation. If it rains less, less forage is going to grow, no matter how good the state of the ecosystem processes.

To us, the primary concerns are the changes in Bare Ground and Plant Distribution. The significant drops in these indicators mean that we are struggling to retain what little moisture we have received (due primarily to evaporation off of the bare surface), and that plants are dying. Is our management causing this, or can we blame it all on the drought? Could our management adjustments have been more appropriate from the point of view of the effectiveness of the ecosystem processes?

Playing with Drought

To begin to answer these questions, and to help put these trends in the proper context, let's review our history of Holistic Planned Grazing on Twin Creek. In the chart titled *Stocking Rate vs. Rainfall,* we can get a quick sense of how our stocking rate has varied relative to our annual changes in precipitation. The stocking rate is shown as a percentage of the baseline stocking rate (which is based on our ten-year average 1990 before we started to plan our grazing, and which is represented by the heavy horizontal line in the chart). The precipitation is shown as a percentage of the long-term average (LTA) precipitation, which is 8.51 inches (216 mm).



Informal step transects revealed greater than 50 percent bare ground in 1990, the year we began to plan our grazing holistically. As we concentrated our cattle into one herd, the increased stock density immediately began knocking overrested plants onto the ground and created litter cover. We were benefiting from the abundant standing dead plant material, typical of season long grazing at low livestock densities. Our increased densities laid this material on the ground and improved the water cycle. In only a couple of years, our step transects showed our bare ground had been cut in half, and was down to 25 percent. Following a very dry year in 1994, a wildlife biologist told me that elk from all over the country were wintering on our ranch. We coasted through that year without cutting our stocking rate, which by that time was 30 percent more than before we started planning grazing five years earlier.

I felt like I was bulletproof and went back to whipping and spurring stocking rates, eventually building up to 165 percent of where we started. We coasted through another dry year in 1996 without dropping stocking rates, but then we began to struggle. Bare ground started increasing. In 1998, I shortened recovery periods in an attempt to get regrowth trampled into the ground and reduce the bare ground. In other words, I started grazing this low production country twice within the same growing season, thinking that the second time around with the cattle would get the little bit of new regrowth back onto the soil surface.

It wasn't working. The absence of litter supply started slapping me in the face by 1999. Our monitoring that year showed we were back up to 33 percent bare ground. In 2000, our production fell off significantly and bare ground increased even more. We cut our stocking rates, and I was frustrated because I couldn't figure out the problem. Looking back, I believe that, by 1996, we had "used" all of the standing litter that had built up from lower stock densities. By that point there was no longer any older material to serve as a source of litter, and bare ground started increasing because most of the plants were now vegetative and pliable. No matter how hard I pounded it with animal impact, the plants would not lie down as litter. This is characteristic of low production brittle environments. Once overrested plants are cleaned up, those plants are highly nutritious and palatable, even after they cure. So, I felt I knew why the litter was decreasing, but I wasn't sure what to do about it.

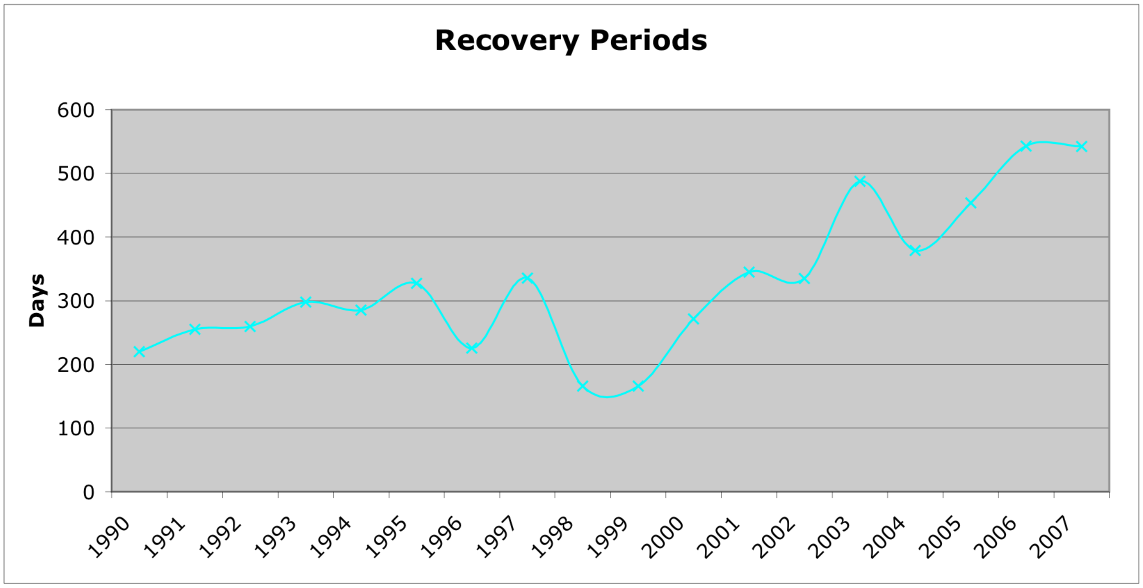
The Road to "Recovery"

Then I heard Jim Howell discuss his hypothesis that low production, brittle environments most likely evolved under grazing patterns that incorporated longer recovery periods than high production, brittle environments (such as tropical savanna grasslands). Both brittle environments have large herds, but low production areas, like our sagebrush steppe, necessarily support much lower natural stocking rates, and the animals that are present tend to be highly migratory. It stands to reason that these large migratory herds in the low production environments would have most likely frequented a place less often.

He said if we look at the migratory patterns of herbivores in fairly low production environments (that have survived into modern times along with their associated predators—wildebeest of the southern Serengeti, Mongolian gazelle, Tibetan antelope, saiga antelope, caribou)—this is what we actually find. Multiple year intervals between grazing events tend to be the norm. Jim's presentation was an "Ah Ha" moment, and our history suddenly made more sense. I went home and began planning longer recovery periods.

Now, instead of twice per season grazing, I was determined to only graze each pasture one time per year, at the most. Gradually, we began to extend frequency between grazing periods out to 400+ days so a pasture grazed in spring wouldn't be grazed until the following summer. Then, it wouldn't be grazed until the following fall, and then not until the following spring a year and half later (with one whole growing season off in between).

Then in 2002 we had the worst drought anyone in our neighborhood could remember, and definitely the worst on record. But the longer recovery periods began paying off and our stocking rates stopped their free fall. In 2002 our stocking rates were 70 percent of our baseline, while most surrounding grazing allotments were 50 percent. I could see more litter in the areas that went longer than one year between grazings. I was hopeful.



The years 2003 to 2005 were still dry, but reasonable compared to 2002. We actually began to increase stocking rates once again. It was dry, but due to longer recovery periods, more litter on the ground, and a better water cycle, we were growing more grass again. In the fall of 2005, with good fall moisture in the soil profile, and believing the longer recovery periods were magic, I planned for a hefty stocking rate in 2006. And then, in the spring of 2006, for the first time in recorded history, we had no measurable precipitation in April or May (which typically are our “wet” months). I hung on until our last chance for rain at the end of May. When it didn’t come, I called the trucks and shipped 30 percent of the cattle. We got the rest of the cattle through, but it cost in reduced litter cover. When Charlie read our transects in 2007, bare ground had shot back up to 56 percent—ouch!

Fine-tuning Stocking Rate

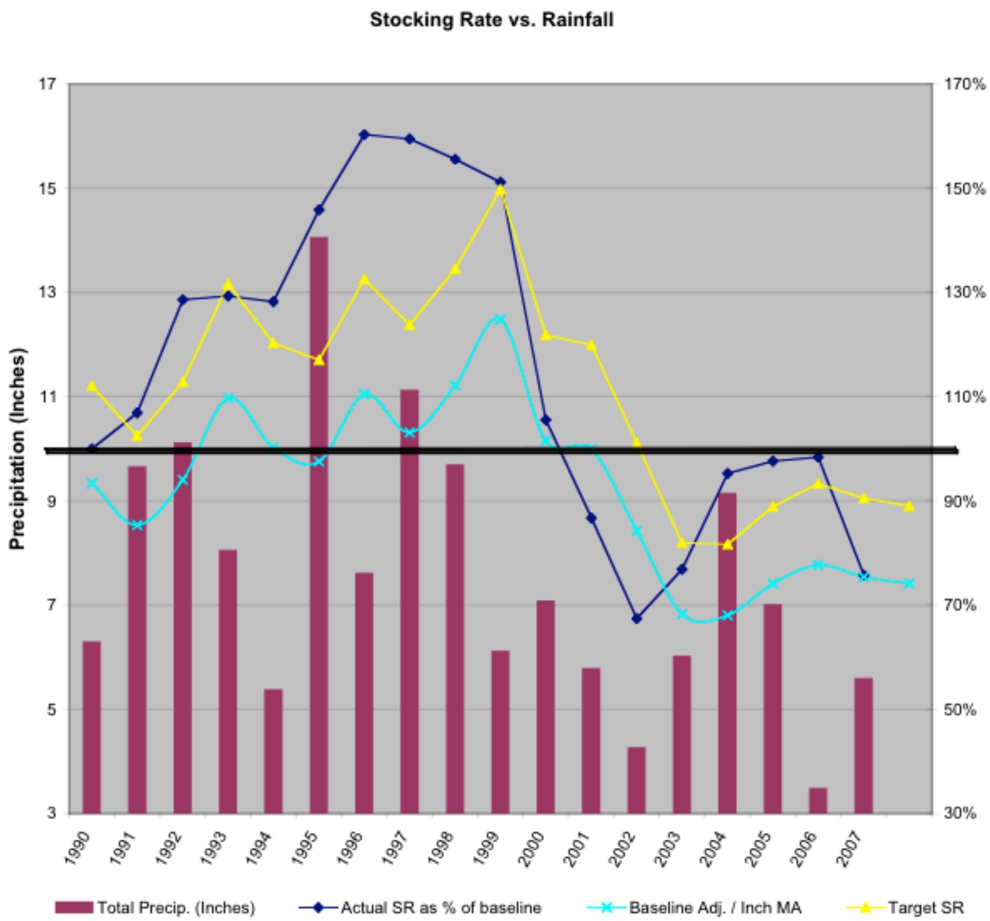
Anytime we get into a bad situation it's urgent that we survive. Aggressive stocking rates are necessary to keep profits high, and in the midst of lots of financial pressures, we needed to make money. But, could we have managed our situation differently—to result in both healthy profits and increasing ecological resilience, even during this tough string of dry years? This is where hindsight is good.

First, look at the dark line which is our actual stocking rates in "Stocking Rate vs. Rainfall" chart. To recap, we were doing great increasing stocking rates and covering the soil surface through 1996. Then our bare ground started increasing just before we went into the long term drought beginning in 1999. Our free fall in stocking rates stabilized in 2003 after increasing our recovery periods. It was really dry in 2006, and there was insufficient growth for both litter supply and livestock feed. Our bare ground increased again, and now we’re trying to sort out what indicators, or decision making benchmarks, we could have used to have responded more quickly and prevented the deteriorating conditions.

Determining stocking rate is always tricky in our cold steppe environment. In year round grazing environments (hot and mild steppes, tropical and sub-tropical savannas, mild temperate prairies), stocking rates are always controlled by the amount of standing vegetation going into the dry (or non-growing, or dormant) season. If, after the growing season (when overstocking is seldom an issue), your assessments of forage on hand indicate that there is insufficient quantity to make it to the next likely precipitation and new growth, then you’ve got to destock. The decision is fairly straightforward.

In seasonal grazing environments like ours, where it is only feasible to graze during the growing season due to winter snow cover, this determination of stocking is less straightforward. Here, we aren't attempting to build a bank of forage to take into the dry season. If we want to graze it, we have to graze it before the snow flies. But, at the beginning of the season, it's really hard to know how much grass we'll have, since none (or least very little) of it has grown yet. We typically have predictable early growth thanks to stored soil moisture which has accumulated through the cold winter, but the amount of growth we actually end up having is hugely impacted by the amount of moisture that arrives through the spring and early summer. By that time, we've already got all our cattle on hand.

So, is there a benchmark we can use to help us make these stocking rate decisions? In the past, our stocking rate decisions were largely based on "hope", as in "let's hope it rains." With bare ground back up to 56 percent, we realize we have to do better than that.



Mimicking Nature

Now notice the gray line, which is the baseline stocking rate adjusted for precipitation, titled "Baseline Adj. / Inch MA." This gives us an idea what our stocking rates would have looked like if we had adjusted them for the moving average (MA) of the actual precipitation for four years preceding that year's turnout. Charlie Orchard suggested this as a benchmark that we think might lend more rationality to our stocking rate decision making.

This is how it's calculated. First, we have to know what our baseline stocking rate is. Again, this was determined as the historical long term average stocking rate based on traditional set stocking and average precipitation. From this stocking rate (expressed as total number of Stock Days harvested in the year), we can divide by the average precipitation, which gives us an Average Stock Days per Inch of Precipitation (ASDIP). Yearly adjustments to stocking rate can then be made by taking the average precipitation of the previous four years, and multiplying that by ASDIP.

We selected four years in an attempt to mimic nature. When a drought hits, nature doesn't destock immediately. Nature destocks gradually with lower conception rates initially. If the drought persists, stocking rate further reduces with higher rates of winter (or dry season) starvation of the old and weak. When nature comes out of the drought, it takes a few years to get the stocking rates up again as reproductive success increases. In other words, when it starts raining again, it takes the herbivore populations a while to catch up to the new forage abundance, and nature "stock piles" a supply of litter for herding animals to lay on the soil surface. For this reason, a four year average gives us a guideline to mimic this process on our ranch (and it might even need to be longer than that). This methodology isn't as precise as it could be, since timing of precipitation, not just total precipitation, has a big impact on the amount of grass we grow, but it's a good place to start. If we had planned our stocking rate this way, the result would have been the gray line on our chart.

But notice that our actual stocking rate was much more after we started planning our grazing in 1990. Of course we minimized overgrazing after we bunched our herds. But we were also covering bare ground because our increased stock density trampled the large supply of overrested plants to cover the soil surface with litter. In effect, we had created a more effective water cycle. As a result, we coasted through the 1994 drought, even with 30 percent higher stocking rates than our baseline stocking rate and had grass left for wildlife, as noted by local wildlife biologists. So let's use that as the stocking rate baseline, (with the understanding that we must come back to our pre-grazing planning baseline stocking rate baseline if we lose improvement in the ecosystem processes that allowed for the increased production,) and adjust our average stock days per inch of precipitation (ASDIP) up by 20 percent to arrive at the third line on the graph, titled Target SR (stocking rate), the white line.

Benchmarks & Projections

Based on hindsight, these two lines are what I propose to assist us in the future as our benchmark for determining stocking rate. When our ecosystem processes are performing well, with a covered soil surface, we will use the Target SR. When we make mistakes get bare ground and need to replan, we can start with the Baseline Adj. / In. guideline. Both based on a four year average of actual precipitation (the previous four years). For example, the 1993 stocking rate would have been determined at 132 percent of the baseline because the previous four years of precipitation was 9.34 inches (234 mm). This average, multiplied by 17,675 stock days per inch (our ASDIP), equals 165,082 total stock days, which is 132 percent of the baseline stocking rate. 9.34 inches (precipitation average) X 17,675 (stock days per inch) = 165,085 total stock days, which is 132 percent of the baseline stocking rate.

As discussed earlier, we started increasing bare ground in 1997. If we would have had this methodology in place, the chart shows how we wouldn't have increased our stocking rates from 1995-1999 as aggressively as we actually did. They would have increased more gradually, and if we had been planning longer recovery periods during this time, we likely wouldn't have picked up an increase in bare ground in our monitoring. Now let's proceed and see what would have happened next.

Based on this methodology, our stocking rates still would have peaked out in 1999, close to where they actually were, but with a covered soil surface, and we could have coasted down to 2003, with higher stocking rates than we actually had (as modeled in the chart). Then, rather than responding so exuberantly to improvements made due to longer recovery periods in 2004, we would have continued to use the four-year precipitation average as our guide, which would have kept our stocking rates lower, which would have had a positive impact on litter supply. And that brings us to the pivotal year of 2006.

We went into 2006 planning to graze 25 percent more than we actually did. We planned this stocking rate based on a four year upward trend in stocking rates and improving ground cover (due to longer recovery periods). Adequate moisture in the fall of 2005 combined with euphoric anticipation of a better year kept me leaning towards a higher stocking rate. If we would have had the four-year average precipitation benchmark, we would not have even been considering increasing stocking rates (due to a good stretch of moisture in the fall). As we got into the bad spring, with no moisture for the first time in recorded history during April and May, we could have begun destocking from a lower level. Who knows—if we had planned our stocking rates this way through this whole time period, destocking in the spring of 2006 may not have even been necessary, because our soil cover and drought-resilience would have been greater.

But, that's not what we did. With no spring moisture in 2006, we started shipping cattle, but not early enough or fast enough. We ended up with very high utilization, and we increased bare ground considerably. In 2007, despite reasonable moisture, our water cycle was much less effective, we didn't have a cushion, and had to make a drastic reduction in stocking rate. Stocking rates can coast through a dry year or two, if we have deep rooted plants and a covered soil surface. When faced with long term drought, we simply have to adjust stocking rates down so we can keep the soil surface covered. Once we let the ground go bare, decreases in stocking rate become exponential, which really stinks from the point of view of our bank account.

If we can stick to this new methodology, we should steer clear of getting ourselves into this situation again. This won't be enough, of course. Remember, we always assume we're wrong when making land-based management decisions. To make sure we're staying on track with maintaining ground cover, our on-the-ground biological monitoring will have to continue. But, if we can make initial stocking rate decisions based on a rational methodology (as opposed to "hope"), chances of getting into a bare ground wreck are much less.

Drought Insurance

But, getting back to our biological monitoring data from 2007, there actually are signs of hope. For the most part, our environment is still intact. We have more bare ground and fewer plants, but evidence of erosion hasn't worsened (so we aren't losing soil), the litter we do have is contacting the soil better, germination sites have slightly increased, our most desired plants have increased, etc. We still have our basic ecological resource base to support our forms of production, and with the changes in pre-season planning outlined in this article, combined with continued careful monitoring (and hopefully a little help from nature with the 4-year precip average), we are poised to heal quickly and continue generating solar dollars.

Another bright side of this story has been the resilience of our riparian areas. Healthy riparian areas and grassy creek banks catch sediment during high flows and narrow the creek channel. Eventually the bed elevation of the creek rises. Like pinching off a water hose, the water table rises to the flood plain. Two good things happen with high water tables. Spring thaws and summer cloudbursts run out and across the flood plain, carrying sediments, nutrients, and an effective dose of irrigation. Water seeps into the creek bank and sub-irrigates plants far away. Sub-irrigated ground grows many times more grass than the uplands. In fact, 35 percent of our total production grows on these narrow ribbons of riparian corridors comprising only 2 ½ percent of our ranch.

And, during the last eight years of drought, that 2½ percent of our ranch has produced 100 percent of its long-term average. With higher water tables and lateral bank storage, there was no drought! Healthy creek channels are the best drought insurance we have. In terms of increasing the drought resistance and ecological resilience of our ranches, improving creek channels is our best ***marginal reaction*** for the time and money spent.

By-products of healthy riparian areas are better fisheries, waterfowl habitat, and vertical vegetation diversity. Increased willows provide food and dam building material for beavers. Beaver dams raise the water table and slow flows for even more production. Moose have year-around habitat, and migratory songbird populations increase (we've measured a 40 percent increase on Twin Creek). In addition to cleaner water, fish benefit from thermal refuge sites, where water that's cooled from lateral bank storage returns to the creek system.

So how do we improve creek channels? The same way we do everywhere else—by controlling time and keeping stock density as high as possible. We have found that grazing periods of less than 21 days allow the creeks to keep improving. We use temporary electric fences to keep grazing periods less than 21 days as our cattle move up and down creek corridors. It takes about 30 minutes to put up a mile of temporary fence and one-hour to roll it up. The key is having our cattle trained to the electric fence and daily checks of the cattle. It's the best marginal reaction we have.

We hope this eight-year drought is a historical anomaly and not the trend of the future. But, given the vagaries of climate change consequences, we can only guess what awaits us. Most information suggests that the trends that certain environments and regions are currently experiencing are the trends that are likely to continue under global warming. If that's the case, the last eight years have taught us some important survival lessons. Keep those water tables high in the creek beds, keep the soil covered in the uplands, and always look to nature's model for guidance.

In Low-Production Brittle Environments

Pause *after initial success*—increased stock density will result in immediate gains in production that will not continue to increase. Don't take success seriously.

Observe *litter supply*—after a few years most of your plants will be vegetative. You may need longer recovery to stock pile.

Coast *through a dry year or two*. Good ground cover and deep-rooted plants will carry your stocking rates for a year or two.

Replan *if you lose your ground cover*. Go back to pre-planned grazing stocking rates, or less. Building litter is slow in low production environments.

Protect *and improve your riparian areas.* They are great drought insurance.