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A Climate Dance on the Prairie

by Ken Lassman

1. Place and context

Scientists have tentatively estimated that there are 50 billion tonnes* of DNA and RNA spread over our planet's lands, oceans and atmosphere. These self-replicating strands of instructions stored in each cell hold information about not only how to build living organisms, but also hold information about the web of life in which each organism lives. Some scientists have ventured that this incredibly large data storage system, housed in each virus, bacterium, archaea, plant and animal on our planet is akin to an organic world wide web that dwarfs our own human constructed silicon-based Internet web. This information has complexities and intricacies that are poorly understood and to a surprisingly large degree outright mysterious. But what would you expect from a dynamic, adaptive living process that has been going on for over 4 billion years? (*one tonne, or metric ton, is equal to 2204.62 lbs. or 1.10231 US tons)

So when I ponder the future climate where I live in the central part of the North American continent, I try to put my questions and potential answers into the context of this intelligence and mystery of which we've only scratched the surface. We humans, self congratulating about being the uniquely self-aware part of the Earth, often overlook the ever-more-clearly emerging fact that our intelligence is just one slender thread of a much larger ecospheric fabric of intelligence/awareness that both predates and will outlive our own.

Not that we haven't come a long way in our understanding. In cosmology, it was less than 100 years ago when we definitively understood that our own Milky Way galaxy of stars was just one of many galaxies, and our understanding about the cosmos has figuratively exploded almost like the expansion of the universe itself with our uncovering its now-estimated trillions of other galaxies which in themselves are dwarfed by the even greater mystery of dark matter and dark energy, all of which is woven into an expanding space time continuum well over 13 billion years old. Similarly, the pioneering efforts of the first biologists and ecologists who studied the living web of life started by making species lists and teasing out the food webs in landscapes, eventually capping the effort with the description of the entire biosphere at around the same time (the 1920s) as Hubble proved that the Andromeda galaxy was outside our own Milky Way. The succeeding explosion of biological and ecological knowledge since then has been fueled by spectacular discoveries such as determining the mechanisms of inheritance through DNA/RNA, the complex processes of cellular metabolism and protein synthesis, and most recently the charting of an increasing number of species' entire genomes.

But just as with the cosmos, there is so much that we don't yet know, and as I stand in a field of restored prairie on the land that has been in the family since the 1860s, I attempt to not only understand my sensory surroundings as the only direct, unmediated access I have to the universe, but I also try to place those perceptions within the context of what we know about how this field nests into the landscape, watersheds, ecoregions, and ultimately into the planetary processes that we've begun to tease out through that cultural method of sorting the wheat from the chaff called the scientific method. So I literally stand in a field as a conscious, perceiving animal, trusting my senses while at the same time attempting to place those perceptions in the presence of a larger context, partly known and mostly unknown. Despite our technological and informational prowess, because of our inherent limitations that impacts our understanding of other species, this places us squarely in the middle of the awareness continuum that exists as an integral part of the web of life. We are not without peers on this planet in the most important ways of measuring the landscapes of intelligence, and the more we know, the clearer this becomes.

Of course, science is only one of the stories that humans relate to the landscape we are a part of. We are consummate storytellers, and before the written word the land held our stories, creating the first encyclopedia we as a species created, using the plants, animals, hills, rivers and mountains around us as pages on which we would compose stories and songs into to capture and share our observations, histories, and aspirations so that every time we walked down a path with our children, we would see a bumble bee and tell them the story about how it could communicate with the dead/spirit world, which would prompt us to tell a story about how a deer was hunted and killed just a little ways down the path and how important it was to thank an animal who gave its life to you so you could eat, and how your grandfather got over his illness by sipping on the soup prepared from that deer and so on. The landscape was a veritable treasure trove of knowledge about the history of your people, your beliefs, your history and aspirations, to say nothing about the intimate knowledge of what is edible and when.

Humans stored knowledge and wrote their stories on the very heavens as well. Cultures around the world tested their eyesight by seeing how many stars they could count in the Pleiades open star cluster, but they also projected their own stories onto that little asterism, like they did the rest of the sky, clustering stars into culture-specific creations called constellations. The Greeks saw the 5-12 stars visible to the naked eye in the Pleiades and projected onto them stories about the 7 Muses, the goddesses of creativity.

I stand next to what I was taught is called a compass plant, which my granddad told me that the settlers and the prairie tribes used to orient themselves as they traveled since the leaves generally align themselves in a north-south direction. I later learned in my botany class that the plant evolved this characteristic, along with its tough, lobed leaves to minimize exposure to the direct rays of the sun when it is highest in the sky, collecting what light it needs for photosynthesis in the morning and afternoon hours, and how the most drying winds also come from the south in the summer, so that the north-south orientation helps keep water loss through transpiration to a minimum, reinforced by the tough, hairy, lobed skin of the leaves that break up the desiccating wind currents on the leaf.

My gleaned understanding, partly passed down, partly instructed or self taught, partly experienced directly, does not necessarily add to the vetted canon of scientific knowledge and yet it deepens my relationship to the plant and its place in the landscape in these ways. My life is enriched with these relational hooks that pull me close to the land in a two way embrace, since I also impact the landscape by my activities and inactivities, much as two dancers rotate more effortlessly around a common center of gravity between them when they hold each other. Wisdom is the slowly emerging product of such endeavors, as I learn how to perceive the relevant signals around me, helping me to frame the questions worth pursuing, worth pondering through the pursuit of understanding and participating in the dynamics of the land, in participating responsibly in public and private discourse, in influencing the political realm, as well as grounding other human pursuits such as philosophy and a spiritual life.

A butterfly stops at a blood-red butterfly milkweed flower to uncoil its proboscis, seeking nectar. A grasshopper's staccato clicks extend its hop with energetic wings. A sunflower flower disc droops and is shriveled up prematurely, the victim of an unknown predator which has nibbled at the base of the seed/flower head. Eastern gamagrass seeds are maturing like a miniature corn cob, while some nearby big bluestem is starting to send up its seedheads and two beetles copulate on the brown disk of a sunny black-eyed susan flower. A cicada begins to drone in the heat and two rock doves fly to the power line. Some unknown animal startles in the grass; probably some sort of rodent. Humidity bears down like the hot breath of a dog. Much of what I can learn from the prairie is made possible just by being present, something I feel is a direct gift from the entire universe, and it is as accessible to me as it is to a Nobel laureate. The collective DNA of the living landscape provides me portals of awareness to the land around me that I could never understand without their help, and I stand thankfully, humbly in their debt.

2. NATURE AND NURTURE: THE PHYSICAL AND BIOLOGICAL CONTEXTS OF CLIMATE

Kansas is located at the core of the northern portion of the continent that lies between the Atlantic and Pacific oceans, on the western edge of the primordial basaltic craton that underlies the eastern United States. Over hundreds of millions of years this craton has repeatedly been dipped into shallow and deeper oceans only to rise up again, with layers of limestone, sandstone shale and even coal to mark those events like a wax candle repeatedly immersed in paraffin. These sedimentary layers have provided nutrient rich bedrock for temperate plant and animal communities to flourish, thickening the soils thanks to the carbon sequestering properties of the North American grassland and Eastern woodland biome flora and fauna.

If "temperate" describes the location on the planet midway between tropical and arctic, then "continental" describes the long distance we are from the moderating maritime influence of the oceans on the local climate. We like to say that there is nothing between us and the north pole but strands of barbed wire, but "Kansas" also means the "people of the south wind," and so we live in continental weather patterns that are perhaps better characterized by the extremes than the means: floods and tornadoes, droughts, heat waves and blizzards that create climatological barriers to some species while allowing for reduced competition for others. Extremes are important as a biological limiting factor for many species attempting to live in the local ecosystem, so they are worth paying attention to when we ponder the climate of the future. Observations of the changes in grass and tree species populations during the drought of the 1930s has relevance for our future, where there is increasing probability of extended droughts. Botanists of that time observed that more wet-loving plants retreated to the east, with dry-tolerant species increasing and moving down the slopes of hills from the drier ridges where they were previously limited to.[i]

Prevailing winds and remnant Pacific low systems from the west come up over the Rocky Mountains and drop back down, generating and deepening low pressure systems with counterclockwise winds in eastern Colorado and the 4 corners area that pull up humid Gulf of Mexico air masses north, dry desert air east from the southwest, colder drier air in from the northwest and colder, moister air in from the northeast, creating ideal conditions for spawning severe thunderstorms and tornadoes in the spring and summer months, and heavy snow and blizzards in the winter months. An alternate pattern of stable high pressures can build up in response to stable, weaker jet stream patterns, creating extended droughts and heat waves in the summer, or allow arctic lows to drift south resulting in cold "polar vortex" winters.

What will happen to these weather dynamics in a shifting climate with warmer, wetter AND dryer atmosphere over warmer land? The jury is still out about which patterns are more likely, but currently, warmer and more humid years mean more tornadoes and flooding, while warmer and dryer mean droughts and heat waves. Most models for the future indicate that it's entirely possible that things could get more extreme in both of these ways. Projections for the central Plains note that there is a significant probability of 10- or even 30-year long droughts for this region by 2100, for instance.[ii] But it is important to understand that we aren't just standing on the cusp of climate changes; we are already immersed in the changes in a process that will continue to accelerate.

In 2006, Camille Parmesan, professor in the Integrative Biology section of the University of Texas at Austin, wrote an influential paper titled "Ecological and

Evolutionary Responses to Recent Climate Change"[iii] that not only provided a great overview of what the research was already indicating in terms of terrestrial and oceanic changes in ecosystems, populations and organisms; it has since been cited by over 5200 other peer reviewed journal articles in an explosion of science that has been chronicling the changes occurring all over the planet as well as teasing out the dynamics and developing testable hypotheses on what to expect for a variety of future scenarios.

Biologists, ecologists and other scientists have been looking closely at what happens when the biological parameters for organisms, ecosystems, biomes and the biosphere itself begin to change, ranging from the intracellular to the biospheric, in light of the documented place-based changes in the climate parameters to the frequency, intensity and duration of weather events. Understanding complex, interconnected relationships is never easy in the laboratory; in the real world of an environment already going through many changes from the climate PLUS things like habitat fragmentation, degradation and outright destruction, the task is downright daunting. Nevertheless, trends are clearly emerging and they provide important clues and bases for the questions I have already posed so far and will continue to formulate as a human animal embedded within the cultural, economic biological and ecological realities of which I am a part.

There is evidence that genetic variation can accommodate some of the selective pressures that are occurring due to climate change, but it is hard to predict which species can keep up with those changes and those who can't keep pace with the rapidity of those changes. The complexity of landscapes provides for the possibility for plant and animal microhabitats even in the face-value sameness of the Kansas landscapes when compared to more mountainous or ocean-dominated vistas found elsewhere. Taoist philosophers in China canonized the concept of microhabitats in their observations of the hilly landscapes they lived in thousands of years ago: the concept of Yin evolved from observing the darker, cooler, moister, more fertile northern slopes of hills, with Yang describing the warmer, dryer, harsher southern slopes of those same hills. Scientists are suggesting that the degree of temperature and precipitation changes may overwhelm these localized refuges in the future, so that the coolest, moistest slopes may sometimes not be cool or moist enough for some species located at the edge of their habitat range.

Where do plants and animals taking refuge in these microhabitats go in our future? Will the species comfortable on the sunny south slopes have to take refuge on the northern slopes of the future climate, and how will those species currently on the north slopes make it? Sometimes species adapt by following the conditions they are most comfortable under, resulting in a shift in resource and habitat usage patterns into new territories. Many species have attempted to shift their "homes" in a poleward and up-the-mountain-ward manner in an attempt to avoid the warmer, moister/drier/more extreme conditions. This has led to disconnects between predator and prey, plant and herbivore/pollinator in some situations, as different plants and animals react to the changes at different rates. For instance, some mountainous bumblebees have shifted up the mountainside to attempt to maintain their optimal metabolism temperatures as the air temperatures have warmed, but the plants they frequent migrate uphill at a slower rate, resulting in food shortages and reduced bumblebee populations, which reduces the seed production of the flowers they visited.

Many are familiar with the USDA Plant Hardiness maps[iv] that have shifted the optimal plant zones northward, which is useful for deciding what kind of plant to establish in your yard. But if the recommended plant varieties you are supposed to be planting and growing in your yard are changing, what about the native plants found in remnant tallgrass prairies, oak-hickory and cross timbers woodlands and floodplain forests supposed to be doing? Are we thinking about creating plant migration corridors to allow them to adjust to the changing climate as well? Should we be having conversations with our friends to the north and east about providing them with plants that will be adapted to their region in the coming decades, and in a similar fashion, be planting species currently adapted to Oklahoman climate for this area? In our landscapes of fragmented remnant prairies and woodlands, it seems to me that we cannot count on the same migratory vectors as the ones that got the current mix of plants to where they are today to work as well in the future—they will need our conscious, deliberate assistance.

Changing temperature and precipitation patterns mean other complex changes that are hard to predict the importance of. In the face of increasing frequency of warmer days and/or nights, some plants create smaller flowers while others grow larger ones; some become less fragrant while others become more fragrant; some grow taller while others respond by growing shorter.[v] What does this mean to the pollinators of those plants, or the consumers of the fruits and seeds, which are dispersed by the animals who eat them? The best science so far indicates that insects in our temperate, continental climate will be able to adapt to changes better than the more diverse insect species mix found in the tropics, since insects here are already adapted to a wider fluctuation of temperatures and moisture patterns than those who live in the tropical rainforest environment.[vi] But places like the grassland biome of North American may be more susceptible to other insect issues: invasives and pestilence.

Milder winters tend to increase the survival of many frost-sensitive insects, and the earlier springs tend to allow for higher rates of growth and reproduction in insect herbivores.[vii] Studies of aphids and moths have indicated that increasing temperatures can allow insects to reach their minimum flight temperature sooner, aiding in increased dispersal capabilities and northward shifts in insect range. As species move north, there are a number of minor players who have the potential for becoming major pests, preying on plants which are stressed by the changing climate and may not have the full complement of other species in place which help keep the herbivorous insects in check. Which insects will become the new gypsy moths or the new emerald ash borers, and what plant communities will face the greatest threats from their population explosions? There is also evidence that plant community diversity may suffer with predicted climate change pressures, which decreases the community resilience[viii] and increases vulnerability to invasive pests described above.

Another emerging perception: there is a high correlation between bird species richness and the diversity of the plant community as expressed in the "Dynamic Habitat Index," which rates a plant community by its cumulative productivity, its minimum productivity and inter-annual variation. In other words, the more plant species diversity, the greater the avian species diversity, at least when it comes to temperate grassland and woodland avian species.[ix] Do we have sufficient numbers of well-spaced "diversity islands" to support migratory songbirds in the grasslands and woodlands all up and down the Central Flyway (and other flyways, too, for that matter)? What incentives can be made for private landowners to create migratory way-stations on their properties, helping to reverse the declining acreage of such habitat? Can we create programs like what Monarch Watch is doing to create adequate habitat for monarch butterfly migration, only for migratory songbirds?

Microbial soil decomposers are more active when there is ample moisture, as is evidenced by the durability of abandoned ghost towns out west, and the persistence of mummified or skeletonized of dead animals in desert habitats. There is also an increasing body of research that indicates that the soil fauna and flora have a major impact on the success of prairie and woodland restoration efforts as well as providing important roles in sustaining still-intact, healthy native ecosystems. This may be one factor why introduced native species from other areas initially often do not do as well as the local natives, even if at face value the introduced variety is supposed to be better adapted to the changing climate. These soil factors are very important to better understand if we want to succeed in assisting plants in their poleward migration.[x] In this light, is there a role for inoculating the soils with microbial mixes as part of any plant migration initiative?

3. NATURE AND NURTURE: THE CULTURAL ASPECTS OF CLIMATE

Speaking of time, it is worth looking more closely at the cultural construct that we call "the climate." Simply put, climate is weather with the added dimension of time. The most common use of the term refers to the decision made by the US Weather Bureau in the 1920s to use the accumulated weather data from the previous 3 decades to determine the "climatic average" temperatures and precipitation for a given location. They determined that 30 years of data evened out the extremes enough to give a very representative average or "mean" set of temperatures for a given place. So every 10 years ever since, the re-named Weather Bureau (for years named the NOAA National Climate Data Center but recently re-renamed and subsumed into the newly formed National Centers for Environmental Information/NCEI) has recalculated these averages/means and so the latest dataset used across the country includes the daily data from the years 1981-2010, to be updated next in 2021.

But looking at the just the averages leaves out important information regarding climate trends and extremes, so climate scientists also look at the climate from more sensitive vantage points. For instance, the NCEI calculates monthly average temperatures for each year for both the US and the entire planet, and ranks them with previous averages for that same month from state records that go back to 1894, or global monthly rankings from records that go back to 1880. As I write this, June 2017 ranks as the 20th warmest and 56th wettest June in the 123 year old US dataset, but it is also the 4th warmest June globally in the 138 year-old set of global land temperatures, and if you include the oceans, the 3rd warmest.[xi]

Another important way to view the data is to look at the anomalies. Climatologists do this by calculating the 100 year average of the 20th century and compare the incoming data to this longer average. For instance, the June 2017 average global land temperature was 2.07 degrees Fahrenheit warmer than the 20th century average, while global land and sea combined temperature was 1.48 degrees warmer.

Finally, these varied measurements and analyses are important to do science, i.e. to develop causal testable mechanisms that can do more than describe the weather so that we can understand the "how" behind the what of climate. By creating models that can be tested for validity and consistency with what we understand about the physics of gases, fluids and heat transfer and the biology of metabolism among other things, we test and improve those models by using them to reproduce the past dynamics of the climate, and, if we can develop reliable "attribution" numbers for the various components of the climate, then we can project our models to see what might happen in the future, if, for instance, we increase the amount of atmospheric carbon another 40% like we have already done. The current best estimates are that doubling the atmospheric carbon from pre-industrial levels will increase global temperatures around 3 degrees Celsius/5.4 degrees Fahrenheit, but remember that we're already at 1.4 times preindustrial levels and land temperatures go up faster than ocean temps, so that projections for "business-as-usual" emissions rates have resulted in projections of 8-10 degrees F. warming for the central plains states by 2100.[xii]

So what do all of these climate statistics mean? I think one good way to view the changes is to think of sports statistics. Let's take a baseball player's batting average, which for example could be .333, which means that one out of every 3 times he comes to face a pitcher, he hits the ball and gets on base. If his average increases to .400, it means that he has been doing considerably better than that, so that across the season his chances have improved to a 4-in-10 chance that he'll get on base, which, by the way would make him player of the year. Now everyone understands that if his average improves, that his batting average does not CAUSE him to hit the ball better, rather it is merely a statement of probability that the next time he comes to bat, he has an improved probability of hitting that ball into play, and every time he makes another hit, it adds to his season-long statistic. Everyone understands that his improved probability is a reflection of some causal factors that have improved his odds: maybe he has been spending more time with a better hitting coach, or increased his strength training, or is sleeping better, or has resolved some stressors in his life, or improved his nutrition, or is taking performance enhancing drugs--the potential "attribution" list is long and in the case of a baseball player, just as with the climate, it is always a mix of factors at play. But ask the player after a good game what it is, and chances are you'll get a generic, oversimplified response: "I'm following through with my swing better."

In a similar fashion, "climate change" or "global warming" does not CAUSE the extreme weather event we are experiencing in this moment, any more than the hitting average CAUSED a player to hit the ball. But every severe thunderstorm or warmer-than-average day or night, or dry spell is added to the record, which changes accordingly. The changes in the averages are abstract, measurable ways of indicating that something is changing and the decreased glacial mass or shift of a species poleward, or increased acidity of the ocean, or increased ocean heat content at different depths, or increased amounts of atmospheric carbon and other greenhouse gases, or increased sea levels, or increased intensity and frequency of extreme weather events etc. are caused by something, with a whole mix of factors at play. But ask the scientific community what is going on, and chances are you'll get a generic, oversimplified response: "It's climate change."

4. THE FUTURE

So it's hot out here, and I head back inside where I can watch the trees and grasses from the comfort of my air conditioned home. I take a shower to wash off the chiggers and look for ticks and find one crawling away from the sock I just took off, despite spraying my pants and socks before my walk. There is some evidence that disease-bearing ticks are increasing in numbers as the deer and, perhaps more importantly, the white footed mouse populations increase. There is evidence that some if not most of the black plague outbreaks were preceded by back-to-back warm winters and good acorn production years, which increased not only rat populations, but more importantly, the gerbil, who created an even better disease vector. Could the same be happening with ticks? There is some evidence of this.[xiii]

As a human with deep connections to the land, what is my role in the changing weather patterns, which result in unpredictable changes in the landscape ecosystems around me? Clements and other ecologists at the beginning of the 20th Century were enamored with the idea of prairies and other plant-animal associations coming into a type of "climax" mix of species, creating a type of "superorganism" that provided ecological services to all participants in much the same way as our bodies provide oxygen, nutrients and remove waste products from each of our cells. Over time, such "top down" structures have fallen out of favor as the details of ecosystems have shown a much more loose and dynamic relationship between the parts, driven more by species population dynamics as it relates to the specifics of place than by some identifiable superorganismic structure.

But those "specifics of place" are indeed a reflection of larger processes that are part regional, part hemispheric, part biospheric/ecospheric in nature, and as such those larger processes are worth my being aware of and help inform what I see and experience in the local landscape.

So yes, the life in the land has always changed, and is perhaps more dynamic now than it has ever been in the human experience. And yes, the role of the scientific endeavor in teasing out the specifics of those dynamics is greater than it ever has been. But I find that being embedded in this time, in this place, my role as a relational animal with the ability to connect to the specifics of place, and to act or not act, to observe and to share, is a good place to be. One measure of a human's worth is her or his ability to increase the planet's awareness of itself, and this is done not by accumulating knowledge for ourselves so much as it is done by creating a shared awareness by interacting with it. As I wrote in my book *Wild Douglas County:*

> "If we, as humans can increase the number of interactions between species, then, indeed, we can assist in the Earth becoming more self-aware. But by reducing biodiversity through habitat destruction,

> we, as a species, do just the opposite. We need to spend more time increasing local biodiversity, improving native habitat, and otherwise improving our own self-awareness of the local ecosystems we live within. Then and only then can we claim to improve the Earth's self-awareness. Otherwise, our cultural transformation of the Earth makes it *less* self-aware, not more."

In a time when the changing atmospheric chemistry is putting unprecedented pressures on our landscapes, the opportunities to witness and to respond to changes in ways that will help our other-specied kin to get through this bottleneck of change are practically boundless. To take advantage of those opportunities, all we have to do to start is to show up. Reports from the field will be more important than ever, and I can think of no more exciting and gratifying occupation than helping the rest of humanity to meet the challenges of climate change by providing those reports from the field as to what is happening.

Ken Lassman is one of the founding members of the Kansas Area Watershed Council, is an occupational therapist at Topeka Independent Living Resource Center, author of *Seasons and Cycles: Rhythms of Life in the Kansas River Basin* and *Wild Douglas County*. His weekly nature notes can be found at www.kawvalleyalmanac.com . He lives in central Douglas County in the Osage cuesta ecoregion with Caryn Goldberg and a host of other plants and animals.

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