Tomorrowland

It had rained.

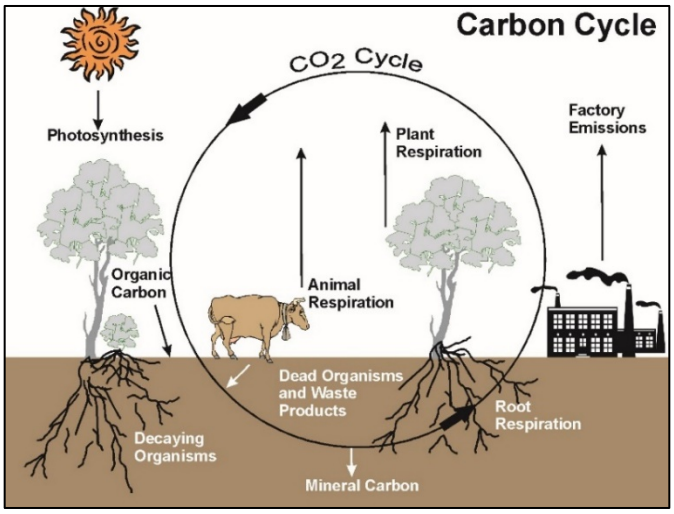
Peering out of the airplane as it approached Oakland in early spring 2012, I saw a carpet of velvety green stretched across the land. Was it grass? Later, as I drove a rental car south along the highway in heavy traffic, I studied the hills through the windshield. Yes, lots of green grass. This was good news. Winter is the wet season in California, but I knew the previous five months had been very dry all across the Golden State, making people nervous. Water is life in California, as it is all across the arid American West, and a diminished snowpack in the High Sierras has a disrupting effect on rivers, creeks, reservoirs, farms, and cities all the way down to the sea. A lack of rain also means the land can parch to the color of toast. Friends warned me that the country that I planned to see "looked tough" which is code for an ugly drought. One quipped "Maybe we should be called the Toasty Brown State instead."

It was a big contrast to the previous winter when snow levels in California's high country swelled to 135% of average. In 2012, the snowpack reversed directions, dropping to half of normal – whatever "normal" means anymore. Years ago, I heard a rancher in California talk about the amount of rain that fell on his place this way: "I've never seen a normal year in my entire life." Yet, it's likely he had never seen the meteorological seesaw that the state is experiencing now. Too wet, too dry, too much all at once. It's aggravating everyone from almond farmers to municipal water managers. Complicating matters, under climate change the Toasty Brown State's total annual precipitation is predicted to steadily decrease over time. Meanwhile, the state's population is expected to grow from thirty to fifty million people by mid-century. Already stretched by the needs of the eighth largest economy in the world, experts say California's water supply will struggle to meet demand.

For the moment, though, everything felt normal. As traffic thickened on the highway and tail lights began to appear in front of me, I lowered the window of the rental and rested an arm on the sill, recalling why Gen and I left California twenty years earlier – too many people – and why we missed it: the air. It was soft and cool, with a hint of sea. When the traffic came to a standstill, I closed my eyes, letting the soft air work its magic. I remembered the first time I felt it. I rode in the front seat of a friend's convertible as we cruised through palm-shaded lanes near UCLA looking for apartments to rent. It was 1983 and I was preparing to enter UCLA's graduate school

in filmmaking. I flew to Los Angeles full of expectation. What I didn't anticipate was the air. To a young guy raised in the hot and dry of Phoenix, Arizona, the moistness of LA was a lovely surprise, hinting at possibilities as endless as the freeways. I felt bedazzled, in fact. The palm trees, the soft sunlight, and the top-down convertible all seemed impossibly exotic. Even the traffic felt like an adventure. I remembered thinking as we cruised down another shady street "Welcome to California, the land of dreams."

I still feel that way. I had traveled to the Toasty Brown State from my home in New Mexico to research a book I planned to write on carbon. On a trip to California in 2010, I learned a secret: the miracle of photosynthesis meant plants could potentially soak up a huge amount of the troublesome carbon dioxide (CO_2) lurking in the atmosphere and store that carbon safely in the soil via their root systems – a process called *carbon sequestration*. It's a secret because few people were aware that soil is one of the four great natural carbon sinks on the planet, along with oceans, trees, and the atmosphere. Calculations by soil scientists suggested that additional sequestration in the soil via the carbon cycle as a result of improved land management could have a big impact on the unfolding climate crisis by reducing the amount of CO_2 in the atmosphere while growing healthy food and providing habitat for wildlife. Soils around the planet, especially grasslands, have lost much of their carbon – the stuff that makes garden soils rich and dark – as the result of poor management and subsequent erosion. But this unhappy condition also created an opportunity: carbon could be *restored* to the soil with good stewardship, including cattle ranching done right.



The Carbon Cycle – How CO_2 Gets Into the Soil

That sounded like a dream worth pursuing.

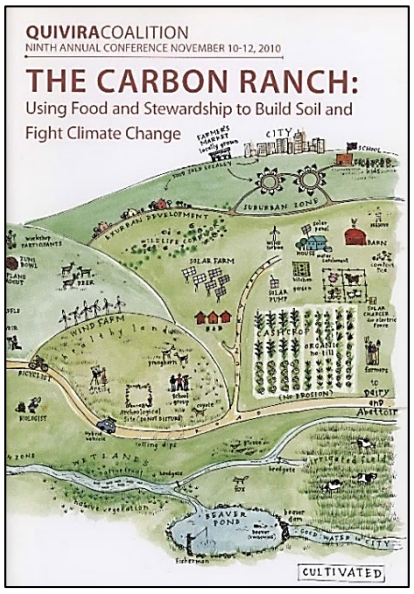
I learned all this when I visited the pioneering Marin Carbon Project, located on a ranch near Nicasio, north of San Francisco. The goal of the project was to determine if sequestering large amounts of carbon in rangeland soils grazed by cattle was a crazy idea or not. It wasn't. The data generated by the research convinced the ranch owners John Wick and his wife Peggy that soil carbon could stop climate change in its tracks since two-thirds of the Earth's landmass is covered

with grass and home to a large number of people who depend on livestock as a source of food and culture. They called it a *carbon ranch* and the idea was as radical – and hopeful – as it sounded.

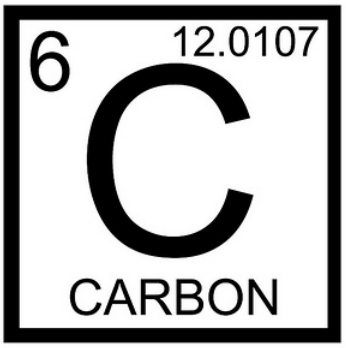
John Wick Talking to Chinese Scientists

From my work with ranchers, I knew that a wide variety of low-tech, low-cost, soil-building practices were both practical and profitable. However, until I met John Wick and Jeff Creque, the consulting lead soil scientist on the Maron Carbon Project, my focus had been solely on above-ground things, such as cows, grass, plants, and trees. The real action, I learned, is belowground. That's where soil microbes, fungi, plant roots, nutrients, and water work together to make all that above-ground activity possible. The connection is carbon, captured from the air by plants as CO_2 and transformed by photosynthesis into a protein that plant roots trade to microbes for essential nutrients in a complex and extraordinary biological marketplace that sustains all life on earth.

Driving away from John and Peggy's place in 2010, I felt like a door had opened to a whole new world. I decided to walk through it. My spirits had been sagging considerably over the previous two years, pushed down by the slow pace of social change and the quickening rate of climatic trouble. Carbon suddenly looked like both an antidote and an answer. Once back in New Mexico, I organized the Quivira Coalition's Annual Conference that fall around the idea of a carbon ranch and arranged for John Wick and Jeff Creque to be the principal speakers. It was a big step for the organization. Not only did we need to convince people to care about soil carbon, we also took the brave step of including the words "climate change" in the conference's title. That raised a lot of eyebrows, particularly among our rancher friends. Climate change had been in national spotlight for only three years or so as a result of Al Gore's eye-opening documentary *An Inconvenient Truth* but climate denialism was already in full bloom. Fortunately, ranchers came to the conference anyway, becoming part of the five hundred people that filled the large room for two days. The event lit a fire. Soil carbon soon became a hot topic nationally as its possibilities began to be recognized.



Thrilled, I decided to write a book. I organized a sabbatical for 2012 and hit the road. I knew where to start – California, land of dreams. My first destination was Midland High School, a boarding school located in the hill country north of Santa Barbara where the students chopped wood for hot showers and ate from an organic farm on school grounds. A herd of cattle grazed the property. A Midland teacher and a student had flown to New Mexico to attend our carbon ranch conference and I learned later the student was so excited by the hopeful things she heard she conducted an experiment on school grounds involving cows, grass, and soil for a Senior project. Although the student had graduated, the experiment continued, the teacher told me. I wanted to learn more. My own research into carbon had opened my eyes. Carbon is everywhere. It's the graphite in our pencils, the diamond in our rings, the sugar in our coffee, the DNA in our cells, the food on our plates, the cement of our sidewalks, the steel in our skyscrapers, the charcoal in our grills, the fizz in our sodas, the foam in our fire extinguishers, the ink in our pens, the plastic in our toys, the bugs in our gardens, the wood in our chairs, the leather in our jackets, the electrodes in our batteries, the rubber in our tires, the coal in our power plants, and the nano in our nanotechnology. It's all carbon. Climate is carbon, food is carbon, money is carbon, politics is carbon, land is carbon, we are carbon.



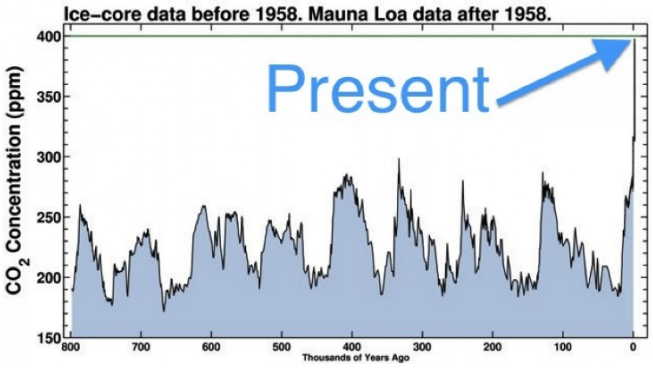
California is carbon. *Is it ever*. No state in the nation burns up more hydrocarbons. Californians drive over 350 billion miles each year, consuming 18 billion gallons of gasoline and diesel in their vehicles, according to 2010 government data. That translates into 4.25 million barrels of oil, one-fifth of the nation's annual consumption. That's a lot of CO_2 going up into the air. In fact, California's transportation sector alone accounts for roughly one-third of the state's total greenhouse gas emissions each year. There are good reasons why: the average one-way commute is thirty minutes (and getting longer); 70% of all cars on the road at any one moment have only a single occupant; and the average speed on a Los Angeles highway during rush hour has dropped to 11mph from a whopping 21mph when I lived there in the 1980s.

I bet this wasn't the *Autotopia* that Walt Disney had in mind in 1955 when he introduced his benevolent vision of the future at his amusement park in Anaheim. Called *Tomorrowland*, Walt's original vision intended to showcase the latest and greatest technology – a vision that only lasted twelve years before requiring an overhaul. Apparently, tomorrow arrived faster than anyone expected. By the 1990s, a second overhaul of Tomorrowland was required. I've been going to

Disneyland since I was a child (back when you needed a ticket to go on an E-ride) and it has been amusing to observe Today keep catching up with Tomorrow. With the rate of technological change happening in the world, I wonder if the Magical Kingdom's "Imagineers" were planning another overhaul anytime soon. If so, I doubt they will include any of the downsides to all this progress. Gridlock in Autotopia? A snowless Matterhorn due to warming temperatures? A prolonged water shortage closing the Finding Nemo Submarine Adventure? Not on your life. Not if Disneyland wants to maintain its reputation as the "Happiest Place on Earth."

Outside the park, however, Tomorrowland is starting to mean something else.

A few weeks prior to my trip, high up in the atmosphere above the Arctic, carbon dioxide levels surpassed 400 ppm (parts-per-million) for the first time in the three million years. CO_2 levels at the start of the Industrial Revolution floated around 275 ppm. During the previous 800,000 years, according to ice core studies, they rarely rose above 300 ppm. By the late 1950s, when Dr. Ralph Keeling began recording CO_2 concentrations at the top of Mauna Loa volcano in Hawaii, levels had risen to 315 ppm. In the late 1980s they hit 350 ppm, a level now considered by most scientists to be the upper limit of a stable climate. Then in April of 2012, they touched 400 ppm. Carbon dioxide is a heat-trapping gas and its steady accumulation in the atmosphere is causing temperatures to rise globally, with serious consequences ranging from longer droughts and bigger storms to steadily rising sea levels. A scientific study a few years ago said the last time CO_2 levels were this high the planet was 5-10 degrees F warmer and seas were seventy-five to one hundred-twenty feet higher than today. On our current emissions path by 2100 concentrations of CO_2 will increase to levels last seen when the Earth was 29 degrees hotter.



The 800,000-year Record of CO_2 Concentration

"This is huge warming, unprecedented in human history," said Professor Scott Elias of the University of London in one of the news stories about crossing the 400 ppm line. "It is a frightening experiment we are conducting with our climate."

"It's an important threshold," said Chris Field, a scientist with the Carnegie Institution for Science in Washington, D.C. "It is an indication that we're in a different world."

I shifted in my seat. Brake lights were disappearing ahead of me. Time to get going. When I finally broke free of the traffic jam, I pushed the rental car way over the speed limit, rolling effortlessly through oak-studded hills and garlic-filled farm fields under glorious sunshine. South of Salinas, the fields gave way to a sea of vineyards. Mission bells flew by. I was cruising down US 101 which tracked the old Camino Real, or Royal Road, that connected this region to Mexico City during the heady days of the Spanish Empire. By the mid-1700s, Franciscan padres had built a string of missions from the tip of Baja California to north of San Francisco, each roughly separated by a day's horseback ride. Leaving Mexico City, it took an intrepid traveler four months of hard riding and hard beds to reach this spot in *Alta California*.

A few miles past King City, a memory caused a sudden pang in my heart. The last time I traveled through here was Christmas 2006 with Gen, Sterling and Olivia. We were on our way to Monterey to visit the famous aquarium on a long drive from Santa Fe via Los Angeles. Curious, we detoured to the Franciscan mission near here called San Antonio de Padua, which I had never visited. It turned out to be a pretty place with a quiet history. As the exit approached, the pang hit again. December 2006. Gen had recently recovered from major cancer surgery. Sterling and Olivia had just turned eight. They were halfway through second grade. We needed a vacation, so I assembled a good one involving a medical stop in Los Angeles, a visit with friends in Santa Barbara, two ranches, one aquarium, and a drive home via the Big Sur Coast. We saw sea lions, condors, cows, otters, seagulls, sharks in tanks, and miles of gorgeous California coastline. Of all the memories from our wonderful excursion, however, the one that stayed with me most was the unplanned visit to the mission. It had been a quick stop. The kids played peek-a-boo among the mission columns. We briefly visited the main building before walking the grounds under a bright sky. The ache in my heart grew. Second grade. Where did the time go? I knew where – it just goes. The kids were thirteen now. Sterling had grown two feet since our trip and Olivia's hair had turned purple. Today, they were middle-schoolers. Tomorrow, they would be high schoolers. In 2006, they were still our goslings.

The exit slipped past, but the ache remained. *Yesterdayland*.

Needing a break, I exited the highway south of San Ardo and parked in a pull-out with a pretty view of the placid Salinas River. I climbed out to stretch. Beyond the water, I saw an oil field dotted with old horse-head pumps frozen in mid-bob. There was a sign for the oil company. It looked new. Sure enough, returning my gaze to the field I saw eight new wells glowing in the sunlight. Fracking. New technology had made it possible to extract oil and gas from hard-to-exploit deposits using materials injected into the ground under intense hydraulic pressure, fracturing the seams. Old fields are tantalizing because they were not completely drained of their bounty the first time. Alas, fracking is nasty business. It pollutes ground water with its chemicals and has even been linked to earthquakes. Fracking fields also leak methane, a potent greenhouse gas. Methane (also called natural gas) is often found trapped in shale deposits that were too difficult to exploit until fracking came along. The quantity of methane trapped in shale around the planet is huge, so it was only a matter of time before someone invented the technology to get at it – our human ingenuity (and greed) being what it is.

I turned my gaze away from the oil field. The river was lovely and serene. A hawk cruised high in the sky. My mind drifted back to Sterling and Olivia playing hide-and-seek at the mission. I hadn't heard of fracking when we passed by here in 2006. If we had stopped here, the field in front of me probably would have looked dead, with the same group of horse-head pumps stuck in mid-bob. Six years later it was very much alive, like a modern Frankenstein. How much havoc would it cause, I wondered? My eye caught a sudden movement in the river – a fish striking at an insect. Then all was calm again. I scanned the sky. The hawk had moved on.

I climbed back into the rental car thinking about thresholds. In ecology, there is a concept called 'state-and-transition' which describes the forces that push ecosystems from one state to another – from a grassland to a desert, for example, or a pine forest to a meadow. These forces include drought, wildfire, overgrazing, and pest infestation. Think of a ball in a deep bowl. Normally, it rolls around within the confines of the bowl. A force may push the ball way up a wall but thanks to gravity it rolls back down. A mighty push, however, can send the ball out of the bowl entirely, never to return. The critical moment happens when the ball reaches the lip – will it stay in the bowl or will it cross over into a new bowl? In ecology, this tipping point is called a *threshold*. Once crossed, it's

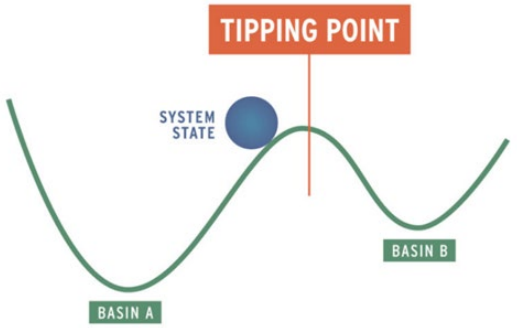


Illustration by Andrew Bernier, adapted from Walker, B. & Salt, D. (2006) Resilience Thinking: Sustaining Ecosystems and People in a Changing World. Island Press: Washington, DC.

nearly impossible to return to the original state. Some crossings are slow, like a prolonged drought. Some happen at the speed of a forest fire. It's not just ecology. Thresholds come in all shapes and sizes. Fracking crossed a threshold, and quickly – as the San Ardo oil field demonstrated. In the atmosphere, 400 ppm of CO_2 is a threshold, as Chris Field, the Carnegie scientist, pointed out. It's likely the lip of our planetary bowl. Crossing this threshold will have dire consequences. We'll only know for certain in hindsight – when it will probably be too late.

Driving south again on the freeway, I comforted myself with the thought that thresholds don't necessarily signify a crisis. Many are positive. The passing mission bells reminded me that the Hispanic population of California will surpass the Anglo population as the state's largest ethnic group. And the Hispanic slice of the demographic pie will continue to grow, creating a ripple effect that will be felt politically, culturally, and economically all across the Golden State. This is a good thing. For starters, it represented the *recrossing* of a historical threshold. Two centuries ago, the Spanish ruled Alta California, having taken it away from the Native Americans. The evidence was plain to see as I drove: San Miguel, Paso Robles, Santa Margarita, San Luis Obispo, Santa Maria. Spanish settlers followed the Franciscan friars, founding towns, and dreaming golden dreams in this lovely place. Recrossing this threshold feels like justice served and is likely the achievement of a golden dream for many underrepresented citizens of the state.

It reminded me that dreams and thresholds have long been a part of California's history. It began when Christopher Columbus went west in 1492 in pursuit of a shortcut to the Indies followed by legions of Spaniards, Englishmen, Frenchmen, Dutch and Portuguese and their unquenchable dreams of conquest and plunder. Soon, the Spanish empire reached a mysterious region in the far north named for a character in a popular 1510 romance in which Queen Calafia ruled an island paradise overflowing with gold and female warriors. Hernan Cortes, the infamous conquistador who destroyed the Aztec Empire, explored the area in the 1530s. He failed to discover the mythical island, but it didn't matter – the dream of California was born. By the early 1700s, fantastical hopes of riches and glory were replaced by steadier dreams of salvation and settlement. When the Mexican Revolution vanquished the Spanish in 1821, California became a distant frontier of cattle and sheep *ranchos*. In the 1840s, the region's fertile valleys,

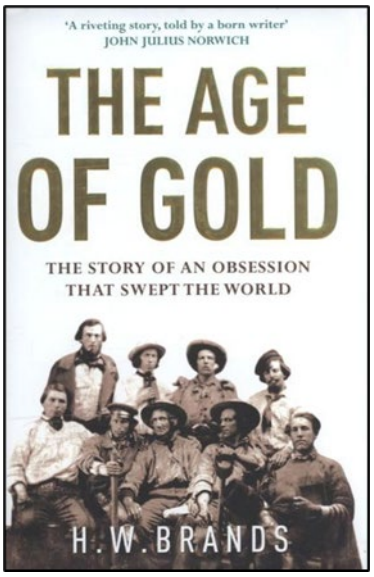
California Rancho

rich timberlands and deep harbors provoked the leaders of a growing and aggressive nation to the east to dream – a dream of manifest destiny. They weren't the only ones. Anxious about American territorial ambitions, a British minister in Mexico at the time urged his government "to establish an English population in the magnificent Territory of Upper California" as quickly as possible, saying that "no part of the world offers greater natural advantages for the establishment of an English colony."

In 1846, American President James Polk settled the issue by provoking a war with Mexico and seizing California and the rest of the vast region south of the Oregon Trail for the United States. Politicians and boosters proclaimed the dream of manifest destiny fulfilled. America now extended from sea to shining sea. As the war concluded, California suddenly and unexpectedly crossed another threshold – one that changed both it and the nation. It began on January 24, 1848, when James Marshall discovered gold in the mud of the South Fork of the American River, east of Sacramento. Soon, the nation was gripped with its first delirious bout of Gold Fever. The afflicted came from Virginia, Hawaii, Georgia, Texas, New England, Mexico, Australia, China, and Europe. Over 300,000 "49ers" made the arduous journey to California, swamping the 12,000 Hispanics who lived there like a tsunami. Most immigrants failed to get rich, though a few did in spectacular fashion. Some returned home, their dreams broken, but many stayed. San Francisco grew from a backwater of two hundred people in 1846 to a bustling metropolis of 36,000 six years later. By 1870, its population climbed to 150,000 and never looked back. Neither did California. Roads, towns, farms, and railroads raced across the state like wildfire, often at the violent expense of Native and Hispanic residents. Historians say 100,000 Indigenous people died between 1848 and 1870 as a result of disease and displacement in a tragic clash of dreams that reverberates to this day.

The effects of the Gold Rush were felt far beyond California. For starters, the gold itself gave the national economy a substantial boost and ensured California's inclusion in the federal family as an anti-slavery state in 1850, pushing the nation toward civil war. In 1869, the nation's first transcontinental railroad linked both coasts and opened up the interior West for exploration, settlement, and exploitation. Perhaps just as importantly, the get-rich-quick nature of the Gold Rush set a pattern for the culture and economy of the state that continues today. The golden list includes land speculation, oil booms, agricultural empires, housing developments, manufacturing

centers, Hollywood movies, the computer industry, and the digital economy. Speculation, risk, disruption, easy living and fabulous wealth became synonymous with the Golden State.



According to historian H. W. Brands in his book *The Age of Gold,* the events set in motion by John Marshall in 1848 became a transformative moment in the nation's history. "A new American dream began to take shape," he wrote. "The old colonial dream of thrift, sobriety, modesty, and yeoman-like steady toil as the path to financial success gave way to a new dream of instant wealth, won by audacity and good luck. The Puritan vision of a shining city on a hill was rudely shoved aside by the dream of El Dorado." A new entrepreneurial spirit took flight and once in motion, it soared all over the nation.

It is still soaring. The oil field near San Ardo is the latest El Dorado and fracking is the new dream of instant wealth, won by audacity and computer modeling. In the new El Dorado, however, great wealth is accumulated not by individuals toiling in a backwoods creek, gold pan in hand, or by an industrious shopkeeper selling picks and bags of flour to luckless miners. In this El Dorado great wealth accrues to the managers and stockholders of a handful of large corporations. Whatever democratic leanings the original Gold Rush embodied in the free-for-all scramble to get rich, the beneficiaries of the new Oil Rush are deliberately confined to a select few, embodied in a locked gate and a shiny sign. This doesn't bode well, of course, for slowing the production of greenhouse gases. Carbon sequestration in farm and ranch soils can help, but we'll need to turn down the heat as well. Maybe the 'Imagineers' at the big tech firms in Silicon Valley are working on an answer to this dilemma. I hope so.

That's a *Tomorrowland* that definitely could use an overhaul.

■

At the mid-afternoon ring of an iron bell, I joined forty Midland students and faculty as they circled up in front of the dining hall to share news, instructions, and plans for upcoming activities. When I arrived at the school, located on 2800 acres of rolling foothills, I thought I had taken a wrong turn. I knew Midland was an elite college preparatory boarding school whose annual tab ran well above $40,000 per student, but it looked like a summer camp. A large grove of friendly trees sheltered a cluster of wooden buildings, each exuding rustic charm, reminding me of a camp

in the mountains I once attended. I half-expected a camp nurse to step smartly into the circle to deliver a lecture on how to avoid poison ivy and spider bites. Instead, I heard details about an upcoming student exchange trip to Mexico and plans for a sailing adventure during Spring Break.

Midland School

This incongruity is a big part of Midland's appeal as I learned from my gracious host Ben Munger, a Midland alumnus and former U.S. Forest Service archaeologist who had returned to the school to oversee the land management aspects of the school's mission. Take the ringing of the iron bell, which creates a framework by which students build their daily routine. It signals the start of the day, breakfast, the commencement of lessons, lunch, the end of lessons, suppertime, and rings once more at 10pm. In addition to classes, a student's routine includes mandatory jobs focused on meeting a basic campus need, such as collecting food from the farm, gathering wood, tending to the horses, mucking the corrals, fixing things, washing dishes, and cleaning up. Seniors become department heads and take charge of meting out jobs. There's even a Fire Crew, ready for any incendiary emergency.

Ben led me on a tour of Midland, including the ten-acre farm which provides a generous amount of organic food to the school. Working by hand, students participate in nearly every aspect of the farm operation, from digging, planting, weeding, mulching, harvesting, washing, and delivering the food to the school kitchen to composting the scraps or feeding them to the school pigs. By learning how to grow their own food and work in a closed loop from farm to table and back to farm again the students gain a deep understanding of what it takes to provide healthy food for themselves rather than simply being consumers in an industrialized food system. Nearly all of the

Ben Munger Teaching a Class

students who arrive at Midland as freshmen have no clue about where food comes from (other than a store) or how it is produced, Ben said. By the time they graduate, however, they've acquired a lifelong appreciation for all the issues involved in their cheeseburger or organic salad. It's the same with electricity. Since 2004, every sophomore class is required to expand the school's solar power capacity by 3%. At the time of my visit nearly a quarter of Midland's electrical needs were being met by the sun. It's not just a work project, however. Science, math, and other aspects of the school's academic curriculum are being met by the complicated analysis involved in expanding the solar array. This incremental approach is affordable financially and it engages students at an emotional level, making them feel a sense of pride and ownership in the success of the project.

The farm and the solar array are part of the school's mission to integrate education with service, leadership, and responsibility. Midland School was founded by Paul Squibb and his wife in 1932 as a Depression-era paean to the ideals of hard work, self-reliance, rigorous intellectual development, and close proximity to nature. Hot showers, for example, have to be heated by wood gathered by the students from the forested foothills. In this way, the school is deliberately trying to accomplish Squibb's dream of fostering future citizens emboldened with unflinching moral character and an unstoppable work ethic. Ben said it was these ideals that attracted him to Midland as a young man along with the prospect of working closely with teachers in a six-day-a-week schedule (students get week-long breaks), all symbolized by the ringing of the iron bell.

Ben admitted that Midland's philosophy seems anachronistic today, especially the strict requirement that students 'unplug' themselves from their electronics during the school year (the library is the only place where gadgets are allowed). However, Midland is not so out-of-place as it first appears. The founders insisted that students behave as though they lived in a world of limited resources. In particular, Paul Squibb wanted young people to understand their relationship to the resources that sustained them. "Money, light, heat, and water are not things that flow naturally out of pipes," he wrote, "but are things for which somebody has to spend time and thought and energy…the [student] who has learned not to take the material blessings of life for granted will live a more vivid and interesting life and will be the better citizen."

Squibb insisted Midland teach personal responsibility along with math and science. The way to do this was to make the "invisible visible" by working with one's hands, which is where the wood-chopping and stall-mucking come in. Squibb believed that America had lost much of its original character as "waves of prosperity were accompanied by groundswell habits of insulation from the elements, passive consumerism, and wastefulness." This is why students today track their personal water use, participate in an intensive recycling program, and plant native oak trees.

After the tour, I followed Ben into the empty dining room where we settled down at a table, cups of coffee in hand, to talk carbon. For decades, a large part of Midland's acreage had been grazed by cattle under contract to a neighboring rancher, Ben told me. However, the neighbor's conventional cattle management style had been hard on the land with signs of overgrazing visible in places. When Ben took over, he decided to go in a different direction, toward what he called a "carbon ranch future," using a term he picked up at our conference. The basic idea was to graze a pasture with cattle for a short time, measured in days, before moving them to a new pasture – a process that gives the plants plenty of time to recover and grow, mimicking the way bison forage naturally across landscapes. It was Ben's belief that increased grass vigor would translate into increased carbon storage. When the rancher neighbor refused to go along with the new plan, Ben cut him loose and found a lessee who was willing to manage for ecological goals. It's been going great ever since. Even in a drought he has seen a positive ecological response to the new management. "We haven't looked back," he said with a smile.

Enter student Mariah Chen. After attending our carbon ranch conference, she designed a Senior project that established a ten-year experiment in various pastures to study the impact of short-duration cattle grazing on the carbon and nitrogen content of the soils. Her goal was to put numbers to Ben's hypothesis about short-duration grazing and carbon sequestration. She went a step further by postulating that the ideal duration of cattle in any single pasture was five days, which is the amount of time it takes for the next generation of microbes in the soil to be regenerated. I'll quote from the last paragraph of her senior thesis: "The potential to mitigate climate change through carbon sequestration through rotational grazing and its effects are enormous…Midland School is playing an astronomical role: producing a study, committing 2000-plus acres to rotational grazing, and proving that all you need to do to contribute is to start." I love that last part: *all you need to do to contribute is to start*. Imagine what the world would be like if everyone started something positive instead of creating another negative daily news headline!

I wouldn't see Ms. Chen on my visit. Ben said she graduated a year earlier and is studying environmental policy at Columbia University. However, he had arranged an interview with the heirs to Chen's carbon project: Miles, a junior with a strong interest in chemistry, and Wallace, a freshman from a ranching family in northern California. They arrived in the dining room later in the afternoon and we talked for an hour about carbon, Midland, and the future. They were bright, eager young men, impressive in both their composure and frankness. Ben told me Midland students were aware of the big challenges coming down the pike this century and accepted their responsibilities – as Miles and Wallace both demonstrated to me in our talk. Miles told me he intends to purse chemistry into graduate school, while Wallace plans to return home to the family cattle ranch. Wallace said he hoped to take everything he learned at Midland and apply it to the ranching operation, including the idea of sequestering carbon in the soil.

"I know things are going to be difficult," Wallace said of the future, "but I'm optimistic we can figure it out somehow."

After Wallace and Miles departed, I replenished my coffee. As I settled back into my chair, the iron bell suddenly rang out, signaling supper. Soon, the dining hall would become a chaotic swirl of noisy teenage energy. In the last few minutes of calm, I wondered if Midland School represented an early draft of an academic curriculum kids will need to study as we cross the 400 ppm CO_2 threshold. I knew the school's hopeful approach to food and energy production could already be found in agricultural and educational pockets around the nation, led by young people who are combining progressive stewardship with smart phones, laptops, and the Cloud. There's even a name for it: *new agrarian*. I've seen it in action in a variety of places and I'm inspired by the vision and dedication of these young leaders, some of whom I intended to profile in my carbon book. As I sipped my coffee, the first wave of hungry students noisily burst into the hall. Just maybe, I thought to myself amidst the energetic din, Disney's Imagineers will include carbon farmers and ranchers in their next version of *Tomorrowland*.

What Maria, Ben, Wallace, and Miles are trying to do with their carbon sequestration project at Midland is just the tip of the iceberg as I learned later on my trip when I visited soil scientist Jeff Creque at his day job on the McEvoy Ranch, a 500-acre organic olive operation located near Petaluma, north of San Francisco. Among his many duties, Jeff was trying to determine the answer to a consequential question: can the carbon content of soil be doubled in less than ten years? Many experts say it's impossible. They insist that the rate of carbon accumulation in the soil is too slow, that it's too restricted by factors outside our control (like drought), and that soil can only hold just so much carbon. But doubling the carbon content is exactly what has happened on the McEvoy Ranch – which is why I made the drive to Petaluma.

For a tiny place, it had a big story to tell. It begins in the mid-1800s when Swiss Italian immigrants settled in the area and opened small-scale dairies. Many of the abundant oaks on the property were harvested for firewood to help meet the growing demand for fuel in San Francisco. Hay was harvested from the meadows and cattle grazed the hills. All of these activities reduced the amount of carbon in the soil over time. Enter Nan McEvoy, an Italian cuisine maven, who purchased the ranch in 1991 with the lofty goal of producing one of the finest olive oils in the world, and to do so sustainably. In 1997, she hired Jeff to address the question of what to do with the waste products from the ranch's olive mill, which he accomplished by implementing a comprehensive composting program. With a PhD in agroecology and decades of experience as an organic farmer, Jeff wanted to help Nan McEvoy accomplish her olive dream with one of his own: double the carbon content of the soil from 2% – the level in 1997 – to 4%, which he estimated to be the amount of carbon in the soil prior to the arrival of European colonists.

Jeff Creque directs McEvoy's Compost Program

To accomplish this ambitious goal, Jeff and his co-workers embarked on a soil-building strategy that included (1) applying lots of compost generated from the on-ranch olive mill waste, livestock manure, and landscaping debris; (2) employing no-till cultivation, made possible by the maintenance of a permanent cover crop beneath the olive trees; (3) seasonal rotational grazing of

sheep through the orchard; and (4) riparian area restoration to address downcutting gullies on the property. During my visit, Jeff told me that only 15-20% of an olive is actually oil, the remainder is water and solids. In the Mediterranean region in the old days, this organic material would either accumulate at the milling site or be dumped into a nearby river or the sea. This practice was banned in Europe during the 1970s and today the disposal of olive mill waste remains a challenge for olive oil producers. Jeff's idea for the McEvoy operation was simple: compost all of the green waste and apply it to the soil of the orchards, increasing their fertility. And just like that, a problem became a benefit.

"This way, the olive oil agroecosystem takes in more carbon from the atmosphere than it emits," he told me. "Done well, olive oil production can be a regenerative form of agriculture."

Dozens of soil samples are taken every year from all over the ranch and sent to a laboratory for analysis. While results have shown year-to-year fluctuations in the organic matter content of the soil, mostly due to weather variables, the trend over time has been clear: upward. After ten years the carbon content in all samples began hovering around 4%. This means that the olive ranch is sequestering more CO_2 than it did back in 1997. It's also more productive and its soils are holding more water. Jeff didn't want to stop there, however. As the overall productivity of the ranch has increased, the volume of carbon sequestered in the soils also increased, raising a question: why stop at 4%?

"There are no downsides to trying and lots of upsides," Jeff said, "especially for agricultural productivity, sustainability and climate change mitigation. If we can manage our soils to store more carbon, we'll also enable them to store more water, while reducing the volume of CO_2 in the atmosphere. That's a big upside."

Jeff noted that millions of tons of organic waste, including food, grass clippings, tree branches, and manure, go into landfills every year across the nation where they produce a lot of methane. Why not compost them instead and then spread the compost across farms and rangelands where it could provide multiple benefits to the landowner and the public? Of course, there's a financial cost to hauling this material around the region, but it could be offset by increased ecological productivity, not to mention benefits to the Earth's climate system.

In 2009, in an effort to reduce its carbon footprint McEvoy Ranch installed a 225 kilowatt wind turbine on a hill overlooking the orchards. It is estimated that the turbine reduces the ranch's

greenhouse gas emissions by 110 tons of CO_2 each year while meeting about half of its electrical energy needs (solar panels provide much of the rest of the ranch's energy needs). At the time, it was the largest wind project in Marin County. However, the process of getting it permitted became a gauntlet for the ranch and its staff. The original height of the turbine had to be scaled down from 248 feet to 98 feet by orders of the County Commission after neighbors complained about its visual impact. Others opposed the renewable energy project in general, calling it a slippery slope that would affect their (very high) property values if additional landowners began to build their own turbines. The debate grew testy. In the end, the County approved the McEvoy turbine but imposed restrictions on all future wind projects.

Wind Turbine on the McEvoy Ranch

"Increasing soil carbon is relatively easy," Jeff told me with a wry smile. "Overcoming the bureaucratic challenges to installing sustainable energy systems was much more difficult."

It's easy to imagine this will be our predicament in a nutshell as we begin to cross the 400 ppm threshold. We have all the tools we need to increase carbon levels in soils, and we've had them for centuries: microbes, nutrients, water, plants, animals, photosynthesis, carbon dioxide and lots of renewable solar energy in the form of the sun. Best of all, these solutions to climate change are literally shovel-ready. Other solutions will be harder, as Jeff discovered. Hopefully, as the magnitude of the climate crisis begins to bear down on all of us we'll be able to find ways to be more proactive about implementing necessary changes. It won't be an engineering problem, I'm certain. Humans have been extraordinarily clever engineers since the Stone Age. It's what we do. Changing minds, however, especially ones in positions of power hardened by politics or greed will be the main challenge. Climate change requires action, not inaction. Doing nothing is the worst-case scenario. We need to step up.

Tomorrowland depends on it.

■

On the morning of my last day at Midland School, I had a dream about my children. Sterling and Olivia were seven or eight years old, and we sat with Gen at a table in a restaurant

playing a memory game that we loved. To play, three of us would close our eyes while the fourth person carefully rearranged an item on the tabletop, such as a fork, spoon, napkin, or glass of water. At a signal, we would open our eyes and the first person to spot the change was the winner. We knew what to expect. Sterling's rearrangements were imaginative and often complex; Olivia's were discreet; Gen's were gentle and funny; and I tended to subtract things (the first time we played I hid a napkin in my lap). It was a lovely way to pass time, especially if the restaurant's service was slow, the game involving, as it did, a puzzle, friendly competition, companionship, and laughter.

It was the laughter that woke me up. I lay in the dark for a while trying to hold onto the memory. Which restaurant were we at? The one in Colorado after our visit to the San Juan Ranch? On one of our trips to Texas? Yellowstone? The one down the road from our house in Santa Fe? The sound of laughter faded. I sat up, my throat suddenly pinched by an unseen hand. We haven't played that game in years. When we go out to eat now we talk – about politics, school, music, dogs, Roman history, karate, food, archaeology, whatever pops into our heads. They are wonderful, old-fashioned conversations, rich and satisfying. We don't need to play the memory game anymore, though I'm certain the kids would be willing if I asked.

I slipped outside quietly. Sunrise was still a ways off, so I threaded my way carefully among Midland's dark houses, through the grove of trees, onto the entrance road. As I walked, I buried my hands in my pants pockets and tried to pick up the thread of the dream again. Instead, my mind drifted back to our first family road trip, which began on a warm summer day in 2002, when the kids were three. We loaded a mountain of stuff into a rented minivan and aimed for the James Ranch, a green slice of heaven along the Animas River, north of Durango, Colorado. It was the first stop on a ten-day journey to explore the *New Ranch* – the term I had coined a few years earlier to describe the progressive ranching movement in the American West. I described a New Ranch in a Quivira newsletter as a place where grasslands are more productive and diverse, where erosion has diminished, where streams and springs, once dry, now flow, where wildlife is more abundant, and where landowners are more profitable as a result. To which I would now add: where increasing amounts of carbon are stored in the soil.

As I walked, memories tumbled into my mind from that inaugural summer trip: pizza in a restaurant that first evening in Colorado where we listened to a group of young river-runners boast about their exploits; a long, lovely stroll together to the fish ponds on the James Ranch under a

crystalline sky; Sterling and Olivia running naked across a lawn on the Allen Ranch and then taking turns sitting adorably in a washtub; drinking coffee with Gen while watching a Wagnerian sunrise over the West Elk Mountains from the Allens' back porch; eating ice cream in Glenwood Springs as the kids played on a short flight of cement steps; listening to festive songs from *Bear in the Big Blue House* on the long drive to Lander; introducing the kids to bunk beds for the first time; smiling at Professor Rick Knight and his wife Heather as they giggled in their backyard while watching Sterling and Olivia sit side-by-side in tiny folding chairs and matching hats looking like an old couple; Olivia accidently scalding her hands on a hot BBQ drum at the Chico Basin Ranch and crying like there was no Tomorrow.

How fresh and new it all was. At the James Ranch, Sterling and Olivia met their first Jersey cows – Dolly and Hannah. They belonged to Danny James, one of five children of Dave and Kay James. Returning home after college, Danny decided to start an organic, 100% grassfed artisanal cheese dairy on the ranch, a business that successfully grew over the subsequent years to include local restaurants, farmers markets, and many satisfied customers. Dolly was Danny's first dairy cow. She was friendly and funny, with bulging eyes and boundless curiosity. Sterling and Olivia laughed with delight when she ambled over that first time, acting like she recognized them. She stretched her graceful neck toward the kids, leading with her wet nose, until human and animal were just inches apart. It ended with a big sniff by Dolly, followed by the stamping of gleeful feet and a lot of giggles.

Dolly Greets Olivia and Sterling on One of Our Trips

Danny described Dolly as kind, patient, and smart. He had never milked a cow before, and she tolerated his fumblings in the milk barn without complaint. He attributed her good nature to being raised in a dynamic farm environment where she lived a proper cow's life, outside on pasture surrounded by other animals. Hannah was a different story. She was as skittish and wary as Dolly was friendly. She didn't allow Sterling and Olivia to approach, preferring to observe them from a distance. The difference was their upbringing. Desiring to expand his operation with a second Jersey cow, Danny found one for sale at a dairy in Utah. When Danny arrived at the dairy, however,

he discovered it was a confinement operation, full of flies, stench, and cement. After loading the cow – tagged as E349 – into a trailer and handing the dairyman a check, Danny was presented with a handful of syringes containing antibiotics. Turns out, the cow had chronic mastitis (a disease of the udder) which is why the dairyman wanted to sell her. Danny felt duped, he but took E349 – rechristened Hannah – home anyway. Upon arrival, he opened the trailer door to a pasture full of clover and other yummy grasses, but Hannah refused to exit. After some gentle coaxing, she stepped into the knee-deep grass and stared blankly at the lushness with her bulging Jersey eyes.

Hannah didn't know how to eat grass. Raised in a dark, dank, cement warehouse without mental stimulation and fed only corn and other industrial products, Hannah had no cow sense at all. Fortunately, Danny knew what to do. He fetched Dolly, who quickly took control. She taught Hannah (by example) how to eat grass, cross a ditch, and not be afraid of running water. Sadly, she couldn't teach Hannah to be curious or friendly – it was too late for that. It wasn't her fault. Hannah had been raised to be a milking machine, not a cow, conditioned for cement, not grass. Hannah's plight symbolized much what had gone wrong with our food system, I realized, as well as a lesson about our dangerous disregard for how nature has been doing things for millennia. Humans are a clever and industrious species, but when we arrogantly mess with time-tested natural systems, such as dumping unprecedented amounts of CO_2 into the atmosphere in only decades, we had better be ready for the consequences. Happily, over the course of return visits to the James Ranch, we witnessed Hannah recover her 'inner bovine' and become a cow again. Meanwhile, Dolly became the foundation of Danny's thriving dairy herd. To this day, Sterling and Olivia fondly recall both Jersey girls in that slice of heaven, long ago.

I stopped walking. Yellow light now crowned the tops of the foothills, scattering clouds. Sunrise was imminent. I turned to face the small valley that I had crossed on the Midland entrance road. All was still, as if the world held its breath. Something important hung in the balance, suspended between Today and Tomorrow. A door waiting to be entered. A threshold crossed. I held my breath too, soaking in the moment. Could carbon actually save us? John Wick believed it could. So did Jeff Creque, who had the numbers. Maria Chen hoped so, as did Miles and Wallace. Me too. For a while, I've hung on the verge of a personal threshold, one foot in Yesterday and the other in the Future, fearful for what may be waiting on the other side. Something good, I hoped, for Maria, Miles, Wallace, and others. For Sterling and Olivia. Suddenly, the iron bell reverberated sonorously across the valley, scattering the quiet, announcing a new day.

I exhaled. Time to go.

Olivia and Sterling at the Monterey Bay Aquarium

~~~~

Photos by Courtney White.
~~~~