

# Nourishing Earth, Nourishing Ourselves Part 3: Locally Adapted Communities as Medicine for an Ailing Planet

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## Abstract

Once a species reliant on nature for food, medicine, clothing, and shelter, *Homo sapiens* is in the process of being consumed by the fossil fuel-based agricultural and technological economies that enabled warming climates, natural disasters, and the sixth mass extinction. These economies, based in competition rather than cooperation around natural resources, cause man-made shortages of clean water, fertile soil, biodiversity, wholesome foods, and unpolluted air. The resources that enabled unprecedented biophysical transformations are now diminishing in availability and increasing in costs. These changes are a defining moment that may lead to mankind's demise or may catalyze the rebirth of a vastly different ecological economy. The challenge is to create economies where communities benefit from locally sourced plants and animal products, produced in ways that nurture relationships among soil, water, plants, animals, and people to sustain a collective wellbeing. To do so, humans will need to relearn what it means to be a part of nature's communities and transform from a technological to an eco-logical relationship with landscapes. If up to that challenge, *Homo sapiens* will remember what it means to be locally co-evolving with one another and the environment. Ultimately, the trials faced in addressing these critical issues have little to do

with the issues per se, and everything to do with healing divides that polarize and isolate people.

## Introduction

The first paper in this series (Nourishing Earth, Nourishing Ourselves Part 1: Linking Plant Diversity with the Health of Livestock and Humans, Volume 71) highlighted how the "taste of a place," or terroir, enables animals to nourish and self-medicate. This is accomplished by learning to eat nutritious combinations of foods early in life, selecting phytochemically and biochemically rich foods from diverse foodscapes, and adapting food preferences as needs change via metabolically mediated flavor-feedback associations that link cells and organ systems with palates. The second paper (Nourishing Earth, Nourishing Ourselves Part 2: Chefs, Diets, Ecological Doctors, Fossil Fuels, and Changing Climates, Volume 73) explored controversies over which diets (herbivorous, omnivorous, or carnivorous) are best for human and environmental health, the relationships between diets and fossil fuels, and the roles shepherds and livestock play in enhancing plant diversity. This final paper explores ways to minimize fossil fuel usage by locally adapting and relearning to nurture communities and each other. Collectively, these practices can help humans live within

the planetary boundaries that have enabled mankind to survive and thrive for the past 300,000 years (1, 2).

### From Techno- to Eco-logical Economics and Local Adaptation

For the last 300,000 years, humans gathered plants and hunted animals for nourishment. Only in the last 150 years did mankind transform from a species reliant upon nature for food, medicine, clothing, and shelter to one that is disconnected, yet still utterly reliant on nature. Like all creatures, humans strive to maximize intake of energy, but unlike plants and other animals, people are now dependent on fossil fuels for energy. Globally, “a mindless, energy hungry, greenhouse-gas emitting Superorganism” has emerged in the form of 8 billion individuals with a collective daily metabolism of 17 terawatts (3).

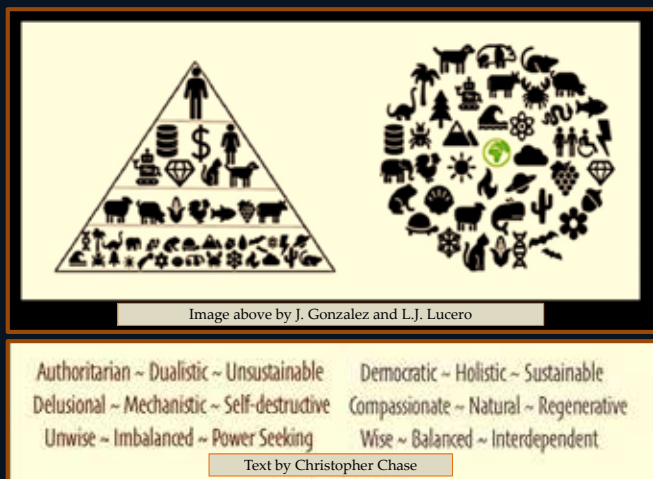
In 2005, James Kunstler predicted that reliance on fossil fuels would decline during the first half of the 21st century due to the increasing costs of extracting and using fossil fuels and their adverse effects on people, environments, and climate. Concerning commerce, Kunstler argues, “The salient fact about life in the decades ahead is that it will become increasingly and intensely local and smaller in scale.” Regarding transportation, he contends, “The 21st century will be much more about staying put than about going other places” (4). In this scenario, goods would be produced, sold, and consumed locally.

Fossil-fuel based capitalistic economies are grounded in competition for manufactured scarcity, rather than cooperation around natural resource abundance. This rivalry has led to man-made shortages of clean water, fertile soil, biodiversity, wholesome foods, and unpolluted air. The challenge is to create cooperative economies that support communities through local, conscientious production and procurement (5-7). By nurturing the relationships between soil, water, plants, animals, and people, agriculture would hold an important place in communities.

This decreases the need for fossil fuels to power machinery, chemicals to support crop and livestock production, and nutritional supplements and pharmaceuticals to sustain the health of livestock and humans. To achieve this aim, humans must transform their relationships with nature from techno-logical to eco-logical (**Figure 1**).

In this process, humans will have to relearn what it means to be locally co-evolving within landscapes and foodscapes. Plants will regain importance as nutrition centers and pharmacies, with their vast array of primary (nutrient) and secondary (pharmaceutical) compounds once again

**Figure 1**



Western culture teaches linear, hierarchical, competitive, monetized thinking about complex creative systems (techno-logical, as illustrated on the left). Eastern and Native American cultures, traditionally based on harmonious interdependence where fitting in is valued and expected, result in an interdependent view of life, and one that exemplifies what it means for humans to be a part of nature’s communities (eco-logical, as illustrated on the right).

being recognized for their roles in nutrition and health for livestock and people. As demonstrated in times before reliance on fossil fuels, there will be a need to match animal requirements with forage resources by selecting locally adapted livestock that can reproduce with minimal assistance. This implies that livestock production needs should be aligned with seasonal forage availability, for instance by calving and lambing in springtime, when native plants provide nourishment. It also means grazing livestock in ways that enhance the health and wellbeing of soils, plants, herbivores, and people. That makes sense ecologically, economically, and behaviorally; behavior links ecology and economy by creating a match between what is needed and what is available (5, 6).

An example is seen in the southwestern U.S. where ranchers traditionally raised Angus cattle that originated in cooler, more mesic environments in Scotland. Researchers evaluated desert-adapted beef cattle of Hispanic heritage (Criollo) and their crossbreds (Criollo × Angus). In a study of these breeds and 3 ways of finishing cattle (forage Southwest, forage Northern Plains, grain-finished), forage-finished cattle used less water and fossil fuels and had lower nitrogen footprints and production costs than grain-finished cattle. Grain-finished cattle surpassed forage-finished cattle only in lower methane emissions due to less time to slaughter. Forage finishing in the Northern Plains may be better than forage finishing in the Southwest, due to less risk associated with increasingly warmer and drier climate. Regardless of the finishing system, Criollo × Angus

crossbred cattle overall had the most desirable environmental and production parameters, followed by Criollo and then Angus cattle (8).

Nature's varying character requires genes to converse with biophysical environments. For mammals, the field of epigenetics reveals that conversation begins in utero and early in life. Epigenetic responses, acting through developmental plasticity, modify animals morphologically, physiologically, and behaviorally to match the environment where they are conceived, born, reared, and expected to inhabit later in life (6). This occurs if the mother's behavior is appropriate for the postweaning environment and if that environment does not change drastically during the life of her offspring. As discussed in Part 1 of this series, the mother is a transgenerational link that familiarizes her offspring with locally available foods and habitats. Progeny become creative forces as they explore other foods and habitats not used by their mother. Together, they create a balance between constancy (mother) and creative exploration (offspring) that enables ongoing adaptation as environments change.

In *The Last Ranch*, Sam Bingham discusses local adaptation with George Whitten, a rancher in the San Luis Valley of Colorado in the early 20th century (9). In 1935, George selected ewes that produced 75-pound lambs at weaning, and they culled ewes with twins. Fifty years later, due to increased emphasis on production versus profitability, his sons selected ewes producing 90-pound lambs and a 150% lamb crop. While George's ewes were produced on minimal inputs and had access to year-round native forage, his son's ewes relied on expensive hay and supplements. George described his historical use of the old sheep cycle and emphasized the value of local knowledge, which is hard to regain once lost. In the latter part of the 20th century, ranchers, enamored with stories of the old sheep cycle, hoped to recreate it. But as George pointed out, "They were crazy. Once the knowledge is gone, you can't get it back just like that. They didn't even have a dog that knew anything" (9). This lack of adaptation by dogs, sheep, and humans ensured they were unable to move sheep from the bottom of the San Luis Valley into the mountains, let alone recreate the cycle. As he remarked, "Our ewes were strong and as well muscled as deer, and yours wouldn't last a day where ours went" (9). Everyone involved lacked the knowledge and abilities to accomplish the task.

## Managing to Survive in a World of Change

How does one understand and manage relationships among complex, ever-changing ecological, social, and economic

systems despite an unknown and unpredictable future? The public typically believe that the solution lies in advanced science and management, but this is not necessarily true. Rather, in this arena of constant transformation, anything is possible if people engage each other and environments in ways that nurture creativity. Creativity comes from transcending man-made boundaries. Suspending assumptions—speaking and listening from the heart—liberates scientists and managers from the arbitrary boundaries of prevailing theories and best management practices. Individuals with different knowledge and values can work together to manage landscapes, enhance soil health, create diversity among plant and animal life, and improve human health and the climate.

Nearly 50 years ago, Alvin Weinberg observed that society would increasingly attempt to use science to understand complex issues. He noted that many issues "hang on the answers to questions that can be asked of science and yet which cannot be answered by science" (10). While it is possible to understand the rules of nature's game, this flexible process enables life to evolve as myriad agents respond to ever changing biophysical conditions. Due to the dynamism and complexity of these relationships, any change produces outcomes that cannot be anticipated or predicted in advance. Accordingly, people must continually transform with the shifting biophysical environments that all life is actively co-creating.

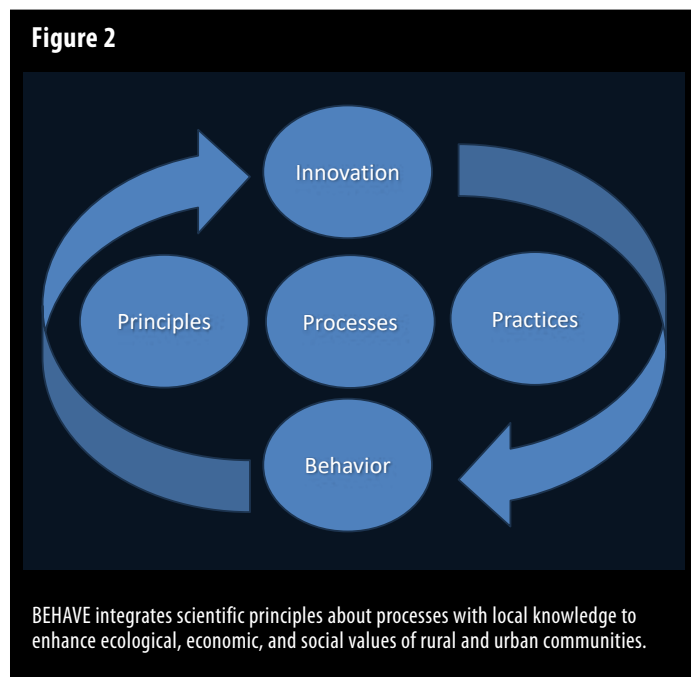
As Margaret Wheatley summarizes in *Leadership and the New Science*, "The new physics cogently explains there is no objective reality out there waiting to reveal its secrets. There are no recipes or formulae, no checklists or advice that describes 'reality.' There is only what we create through our engagement with others and with events. Nothing really transfers; everything is always new and different and unique to each of us. In this realm, there is a new kind of freedom, where it is more rewarding to explore than to reach conclusions, more satisfying to wonder than to know, and more exciting to search than to stay put" (11). Humans are thus coming to view science not as a predictive oracle, but rather as a means to understand nature's creative processes and monitor and assess policies implemented through consensus (6). Playing nature's game is about flexibility in the face of fluid environments, and flexibility is about taking small steps and keeping one's eyes open. Consensus helps guide where to walk, while science helps to focus the view. The challenge is to understand principles, processes, and interrelationships, and the opportunity is to meld science with local knowledge.

This author's experience of ongoing creativity came through a program called BEHAVE (Behavioral Education for Human, Animal, Vegetation, and Ecosystem Management), which integrates behavioral principles and processes with local knowledge to enhance ecological, economic, and social values of communities (Figure 2). BEHAVE laid the foundations and provided a template for behavior-based management that integrates science with local knowledge. It showed how innovative science can be linked with groundbreaking practices to enhance ecological, economic, and social wellbeing of local communities and landscapes.

Examples of BEHAVE initiatives include enabling livestock to eat invasive plants once thought to be unpalatable, while also training sheep to avoid eating grapes in vineyards. By providing supplemental food for black bears in the spring, BEHAVE researchers reduced bear depredation in forest plantations. They created habitat for a 1,000-head elk herd to forage for themselves, rather than be fed hay at great expense during winter. By strategically moving livestock across landscapes and habitats they would otherwise avoid, managers were able to blend ranching and conservation. This further fostered complex mixtures of phytochemically-rich plants to nurture various species of wildlife and produce quality meat and dairy products from livestock. Through these and other practices, BEHAVE inspired researchers and managers in varied fields, including pasture and rangeland management, phytochemical and landscape ecology, wildlife management, animal welfare, rural sociology and development, nutrition and behavior (6, 12).

The managers in BEHAVE were interested in increasing profits by decreasing costly fossil fuel inputs, as seen in practices to reduce the costs of finishing bison. In this study, bison were offered different forages and grain or fed a total-mixed ration. They were maintained in tight or loose confinement or they foraged on rangelands. Those kept in loose confinement performed better than those in tight confinement. Bison that were given a choice of forages and grain had higher average daily gains, lower cost of gain, less stress, and less mortality compared to those fed a total-mixed ration in feedlots. The least stressful and most profitable method of finishing bison was to maintain them on rangelands (13). Additionally, the meat from bison finished on rangelands had higher levels of polyphenols, tocopherols, carotene, and omega-3 fatty acids, which are beneficial for the health of both bison and humans. The phytochemical richness of the range-fed bison diet, combined with higher levels of physical activity, led to more athletic, lean muscle tissue compared to pen-fed "couch potato" bison. Muscle tissue from the latter was characterized

by enhanced mitochondrial, glucose, and fatty acid metabolism. The increased mitochondrial oxidative enzyme levels in the range-fed bison with phytochemically rich diets is analogous to those of fit human athletes (14).



The creative interplay between scientists and managers is also illustrated with sagebrush (*Artemisia tridentata*), an aromatic shrub laden with terpenes. Sagebrush grows in arid and semi-arid conditions, covering over 422,000 square miles from British Columbia to Baja California and into the western Great Plains. Sagebrush is a vital part of these environments, providing habitat for numerous species of fauna. A biodiversity challenge arises when sagebrush dominates landscapes improperly grazed by livestock, which favor palatable grasses and forbs (wildflowers) over the terpene-rich sagebrush during spring and summer. Historically, people used mechanical and chemical methods to rejuvenate these overgrazed sagebrush-steppe landscapes, but these practices are now viewed as harmful and cost prohibitive. A low-cost alternative is to fashion management systems where locally adapted sheep and cattle use sagebrush as late autumn and winter forage, which reduces feeding costs and enhances grasses and forbs growth during spring and summer. BEHAVE researchers evaluated the practicality of autumn sagebrush browsing by sheep and cattle, assessed foraging behavior and body weights of animals with varying levels of browsing experience, and measured the responses of sagebrush, grasses, and forbs to grazing (6, 12). Grazing by sheep and cattle during autumn and winter was biologically and economically effective, and renovated habitat by creating locally adapted

management systems in ways that other landscape manipulations (eg, chemicals, mechanical treatments, prescribed fire) cannot (15).

Rejuvenating the sagebrush-steppe with livestock reduced ranch operation costs. Rather than relying on mechanical or chemical treatments to reduce the abundance of sagebrush, ranchers worked in partnership with cattle and sheep to increase cover, production, and percent composition of grasses and forbs (15). As landscapes became more diverse, the combination of sagebrush, grasses, and forbs provided abundant winter forage and quality nutrition for locally adapted livestock and wildlife. This action increased profitability, as ranchers no longer had to cover the costs of equipment to irrigate pivots or cut, bail, and haul hay to feed in winter.

Offspring of cows who forage on sagebrush, dormant grasses, and forbs during pregnancy can better use these forages in winter. Experienced animals (ie, pregnant cows with calves, bred yearling heifers, and first-calf heifer/calf pairs) ate up to 63% more sagebrush during grazing and maintained or gained more weight than naive animals (15). Compared with naive offspring, calves exposed to a high-fiber diet in utero ate more high-fiber forages, digested them better, and had superior growth (16). In a related study, calves were first exposed to a fibrous forage (straw) for 2 months with their mothers. Five years later, they were fed straw as a major part of their diet for 3 subsequent December to May periods. During every year of the 3-year study, the experienced cows ate more straw, gained more weight, maintained better body condition, produced more milk, and conceived sooner than cows not exposed to straw early in life. Genetic analysis shows heritability of dry matter intake and digestibility of straw is only 20%, so experiences in utero and early in life account for 80% of the responses (17).

The goal in rejuvenating sagebrush-steppe was to create mosaics of habitats to meet seasonal needs of domestic and wild species. While some livestock grazing can adversely impact sage grouse, grazing by sheep and cattle can also improve habitat for sage grouse (18, 19). Forbs, an important component of brood-rearing habitat for grouse, respond positively to winter grazing by livestock, and sage grouse prefer winter-grazed to ungrazed areas. Other wild animals also prefer these grazed areas due to the diverse food and habitat provided within the monocultures of sagebrush. Thus, the challenges and opportunities are to graze during fall and winter at scales that provide diverse habitat for large numbers of animals.

In these BEHAVE projects, each member was a student, striving to understand creative systems and to inspire people to use behavior to manage landscapes (12, 20). The interchanges between scientists and managers nurtured innovation. Participants were free to create practices that were inclusive, innovative, and self-transforming. Embracing the inevitability and uncertainty of change altered beliefs and behaviors from rigid, unyielding, and uncreative, to fluid, malleable, and invigorating. In the process, researchers and managers came to view themselves as an integral part of a larger ecological system, cultivating the capacity for self-renewal and transforming philosophies and practices as they co-evolved within complex creative systems (20). As this understanding shifted, animals were no longer seen as machines, nor their genes as destiny. Rather, genes are expressed and behaviors modified to create opportunities in the face of challenges brought about by constant environmental change.

### Local Adaptation: From Farms to Lawns and Gardens

As discussed in Part 2 of this series, mitigating the impacts of mankind in the current Anthropocene age can be accomplished through the production and consumption of foods

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to improve both human and environmental health. Currently, agricultural changes are addressed by farmers and ranchers who foster plant diversity (supporting life below and above ground), thus helping to mitigate the ongoing sixth mass extinction, reduce greenhouse gas emissions, and increase carbon sequestration (21-23). Maintaining plant cover and minimizing soil disturbance are the basic tenets of these practices, as are limiting or eliminating use of herbicides, pesticides, and fertilizers (24). Livestock are integrated into cropping systems in ways that mimic wild herbivores and their relationships with native plant communities. When farmers combine no-till, diverse cover crops, rotations, and livestock grazing into their farming practices, they improve soil health and yield products higher in vitamins, minerals, and other phytochemicals compared with conventional practices (25, 26). This global agrarian network includes farmers, ranchers, and groups (eg, UnderstandingAG, Holistic Management International, and Ranching for Profit) working on millions of acres to provide ecological, economic, and social health to communities.

Most people are not farmers or ranchers, but any landowner can nurture biodiversity by creating homes for plant and animal species on their property. They can plant native grasses, forbs, shrubs and trees to provide food for wild insects, birds, and mammals, thus diversifying life above and below ground. People can also grow vegetable, herbal, and medicinal gardens and raise bees, chickens, and lambs. In so doing, everyone can reduce the need for water—the drastically diminishing lifeblood of this planet—and fossil fuels to grow, fertilize, weed, and mow lawns (27). The use of small livestock (eg, “lamb mowers”) can aid in clipping and fertilizing lawns (28). Growing plants and animals that become food can help people appreciate that all life—plant and animal alike—is a sacred gift from nature’s bounty to be shared.

Growing native species addresses issues of biodiversity and climate change, as documented in 2019 when King’s College Cambridge in England established a wildflower meadow over a portion of its iconic Back Lawn, first planted in 1772. Despite its small size (0.36 hectare), the meadow supported 3 times more plant, insect, and spider species. Bats were recorded 3 times more often over the meadow than the lawn. Terrestrial invertebrate biomass was 25 times higher in the meadow than the lawn, and 14 species with conservation designations were recorded on the meadow, while only 6 were noted on the lawn. Greenhouse gas emissions (1.36 metric tons of carbon dioxide per hectare per year) were 112 times higher from the lawn (65% from mowing, 35% from fertilizing) than the meadow, while

the maintenance regime for the lawn was 132 times costlier than the meadow. Converting lawn to meadow across all colleges of the University of Cambridge’s 43.7 hectares would reduce greenhouse gas emissions by 59.55 metric tons of carbon dioxide each year and cost £51,713 (\$63,291) less annually to maintain. When surveyed, the college population believed meadows also provided greater aesthetic, educational, and mental wellbeing than lawns (29).

A NASA study delineated some effects of lawns in the U.S., as American lawns now cover an area 3 times larger than any irrigated crop: 63,000 square miles, or roughly the size of Texas (6). Each year, Americans spend \$30 billion on lawn care, using 3 million tons of fertilizer, and over 30 thousand tons of synthetic pesticides which cost over \$2 billion. More than 800 million gallons of gas are consumed annually by mowing lawns, and 17 million gallons of gas are spilled each year refilling gasoline lawn mowers. Residential water used outside the home accounts for 30 to 60% of total water use. In the arid West, 7 to 9 billion gallons of water are used daily for suburban irrigation. One means of reducing this consumption is to leave grass clippings on lawns, which increases water holding capacity, recycles nutrients, and builds healthy soil; this act could cut nitrogen fertilizer usage in half. Growing lawns with clover and dandelions can further limit fertilizer and herbicide usage (6).

Functionally diverse mixtures of species—grasses, forbs, legumes, shrubs, and trees—interact in ways that increase soil nutrient and water availability, alter plant chemistry, and enhance the soil microbiome. Twenty-three years after rewilding abandoned agricultural land, plots containing 16 species of perennial plants had approximately 30 to 90% greater increases in soil nitrogen (N), potassium (K), calcium (Ca), and magnesium (Mg) compared with monocultures of the same species. In the same plots, there were approximately 150 to 370% greater levels of N, K, Ca, and Mg in plant tissues, and roughly 30 to 90% more water- and nutrient-holding carbon in the soil, relative to monocultures (30). Different species harbor unique rhizosphere communities, due to nutrients and phytochemicals exuded from plant roots that foster diverse microbial populations (31). Nutrient inputs from living roots are up to 13 times more efficient than dead plant litter at stimulating the formation of fast-cycling particulate organic carbon and slow-cycling mineral associated soil organic carbon (SOC) derived from live and dead microbes (32). Dead microbes can make up over 50% of all SOC, adhering to mineral surfaces and forming soil aggregates (32). Plant diversity thus enhances life below and above ground while fixing carbon in soil.

These findings suggest that growing vegetables in polycultures, as opposed to monocultures, may increase nutrient and phytochemical richness. Intercropped maize, beans, and squash (commonly called the Three Sisters) is a traditional practice of the Haudenosaunee (Iroquois) peoples (33). Interplanting maize, beans, and pumpkin yielded more energy (12.25 x 106 kilocalories per hectare) and protein (349 kilograms per hectare) than any crop monoculture or mixtures of monocultures (33, 34). While phytochemical richness was not measured in these studies, planting configuration influences concentrations of phytochemicals in plant tissues. Growing alkaloid-producing plants (eg, endophyte-infected tall fescue) in mixture with alfalfa increases alkaloid levels in fescue compared with a monoculture. Likewise, growing tannin-containing plants (eg, birdsfoot trefoil) with alfalfa decreases concentrations of phenolics (tannins) in trefoil compared with monoculture (35).

Flavors imparted by nutritional and phytochemical richness depend on interactions between the plant variety and the environment (ie, weather, temperature, sunlight, soil moisture, and nutrients) (6). Researchers found different farming systems influenced nutrients and health-promoting phytochemicals in fruits and vegetables, but no management practice (ie, organic, real organic, biodynamic, regenerative, till, no-till) has a monopoly on flavor, nutrient, and phytochemical richness (36, 37). Differences in environments and management practices explain why generalizations about flavor, nutrient, and phytochemical richness are difficult to make (36-38). Each gardener, farmer, or rancher must discover how to enhance nutrient richness and flavor with the varieties of plants they use and conditions under which they grow crops.

To enhance the flavor and richness of foods, people can grow gardens with phytochemically diverse varieties of plants and learn to use local plants for food diversity and agricultural resilience (39). Like ancient grains, wild plants are high in health-promoting phytochemicals (40). Humans cultivate only about 150 of 30,000 edible plant species worldwide, and only 30 species make up most of mankind's daily diet (39). Research and farming practices are directed at improving productivity of a small number of existing crops (ie, the basis of global food economy) rather than increasing crop diversity. This results in a loss of agrobiodiversity that further leads to abiotic and biotic stressors in the food industry. Commercial uses of local wild plants could diversify global food production and better enable insular adaptation to diverse settings.

The value of native plant and animal species is illustrated with the Nunamiut, a semi-nomadic culture in the northern and northwestern interior of Alaska. They contend that meat from wild animals is more nutritious than meat from livestock, and believe eating meat from livestock makes them sick, while wild meat and fish keeps them healthy (41). Their beliefs have scientific validity. First, evidence exists for the elevated phytochemical richness of native plants as well as for the biochemical richness of the meat of herbivores that forage on diverse species of native plants (6, 14, 42). Second, epigenetically expressed morphologies and physiologies enable Nunamiut conceived and reared on local plants and animals to use them effectively. Finally, their beliefs in the health-promoting benefits of wild foods positively influence what they perceive, how they believe, and how they behave (6). Placebo effects, which account for roughly one-third of any medical treatment, are equally, if not more, profound regarding the healing properties of foods and physiological responses to those foods (6). Thus, it is no surprise that Nunamiut doctors and nurses use traditional foods for healing their patients. Alaskan Native hospitals provide phytochemically and biochemically rich local plants and fresh wild game meat and fish to patients who improve when they eat these foods. Moose soup, pickled fiddlehead ferns, and beach asparagus salad are on the menu, along with moose, deer, caribou, seal, smoked salmon, and hooligan. For Nunamiut, comfort food is a bowl of seal soup, smoked salmon on a Pilot Bread cracker, or akutaq, a mix of wild berries and animal fats. As these foods nourish and restore, they also provide layers of cultural connections (43).

### **From Competition to Cooperation, Gratitude, and Belonging**

The fossil fuels that enabled unprecedented social and environmental transformations are now declining in availability and increasing in economic and ecological costs. The challenge is to create economies where communities benefit from locally sourced plants and animals, produced in ways that nurture relationships among soil, water, plants, animals, and people to sustain collective wellbeing (**Figure 1**). Only recently have ecologists and economists begun to appreciate that ecosystems with high biodiversity create mutualisms where all species can thrive better, with fewer resources, than low biodiversity environments (3, 44-48). And they have just begun to value that monetized economic systems based on scarcity do not link plants, animals, and people with gratitude and reciprocity for the bounty of nature (3, 44-48).

In *The Serviceberry*, Robin Wall Kimmerer notes, “Gratitude is the thread that connects us in a deep relationship simultaneously physical and spiritual, as our bodies are fed and spirits nourished by the sense of belonging, which is the most vital of foods. Gratitude creates a sense of abundance, the knowing that you have what you need. In that climate of sufficiency, our hunger for more abates and we take only what we need, in respect for the generosity of the giver.” She continues, “Continued fealty to economies based on competition for manufactured scarcity, rather than cooperation around natural abundance, is now causing us to face the danger of producing real scarcity, evident in growing shortages of food and clean water, breathable air, and fertile soil. Climate change is a product of this extractive economy and is forcing us to confront the inevitable outcome of our consumptive lifestyle, genuine scarcity for which the market has no remedy... Regenerative economies which cherish and reciprocate the gift are the only path forward. To replenish the possibility of mutual flourishing..., we need an economy that shares the gifts of the Earth, following the lead of our oldest teachers, the plants” (43).

As emphasized in all three papers in this series, plants are the givers of life. They transform dirt into soil, and diverse communities of plants turn soil into homes, grocery stores, and pharmacies for all life. Behavior links diverse ecologies with economies for plants and animals by creating a match between what they need and what is available. By integrating behavioral principles and processes with local knowledge, the scientists and managers of BEHAVE conceived and used innovative science to create ground-breaking practices that linked the ecological, economic, and social wellbeing of local communities and landscapes. They did so by encouraging locally adapted plant and animal communities in ways that minimized dependence on fossil fuels, thus greatly decreasing costs and increasing profits.

It is time for people to rethink values instilled in societies by fossil-fuel based capitalistic cultures grounded in competition for manufactured scarcity, rather than cooperation around natural abundance. Cultures differ in their emphasis on competition versus cooperation. Western cultures emphasize individual choice, individual rights, and individual fulfillment (**Figure 1**, left). Eastern and Indigenous cultures traditionally were based on harmonious interdependence among peoples and the landscapes they inhabited (**Figure 1**, right).

European conquerors (Western views) despised Indigenous peoples (Eastern views) for their poverty and simplicity, but as Charles Alexander Eastman points out in *The Soul*

*of the Indian: An Interpretation*, “They forget, perhaps, that his religion forbade the accumulation of wealth and the enjoyment of luxury” (47). To them, the love of possessions was a snare, and the burden of a complex society a source of needless peril and temptation. Indeed, they shared the fruits of their skills and success with their less fortunate brothers, and kept their spirits free from greed, envy, and pride (47). Their ways fit with recent psychological and neurological studies that make the case for complementarity in economic relations and show that competition should be rejected for cooperation as the means to individual health and social improvement in society (46).

What kind of culture can best enable humans to survive on planet Earth? That is the issue raised by the Wellbeing Economy Alliance: “What is the economy? Simply put, it’s the way that we produce and provide for one another. We often think of the economy as something given, fixed and unchangeable—but it is not. The rules, social norms and stories that underpin our current system were designed by people, and that means they can also be changed by people (48).”

Nearly 75 years ago in *A Sand County Almanac*, Aldo Leopold warned of the dangers of breaking cooperative linkages with the plant and animal communities that nurture and sustain humans when he wrote, “There are two spiritual dangers in not owning a farm. One is the danger of supposing that breakfast comes from the grocery, and the other that heat comes from the furnace. To avoid the first danger, one should plant a garden, preferably where there is no grocer to confuse the issue. To avoid the second, he should lay a split of good oak on the andirons, preferable where there is no furnace, and let it warm his shins while a February blizzard tosses the trees outside” (49). Despite Leopold’s insights and eloquent pleas, societies have forgotten that breakfast does not come from the grocer nor does heat come from the furnace.

People have made an art form of dining but tabled the larger issues. Individuals frequent the grocer in impersonal acts where money is exchanged for sanitized items precisely arranged on grocery store shelves. Humans have forgotten that nurturing the plants and animals that nourish and sustain man creates a relationship that is both physical and spiritual through acts of growing and harvesting. The final act, consuming, is participating in endless transformation, as plants and animals give their lives to sustain our lives. As “I” eat, the energy and matter in *someone* is transformed into this entity called “me” which will, in the flicker of a cosmic eye, return to Earth as plants



and animals. In pondering this mystery, we may come to realize that all life is sacred.

Around the globe, changing climates and polluted air, dramatic declines in groundwater, infertile soils, massive declines in populations of wild plant and animal species as humans participate in the sixth mass extinction, economic and social inequities, and political upheaval are all signs that people have broken their linkages with Mother Earth (21-23, 27, 44, 46-48). They are reminders that human beings are a part of nature's communities. What we do to them we do to ourselves. Only by nourishing Mother Earth can we nourish ourselves.

What will become of Homo sapiens? No one knows the answer to that question. At this moment the issue is not if life will continue on Earth, but whether Homo sapiens will continue to live on Earth. In the end, the challenges mankind faces in addressing these critical issues have less to do with the issues than with healing the divides that polarize and isolate people from one another and the settings where they live. The irony is that working together to transcend manmade boundaries is addressing the big issue, and people can do that by declaring love—not war—on one another and the environments we share with all life on Earth.

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