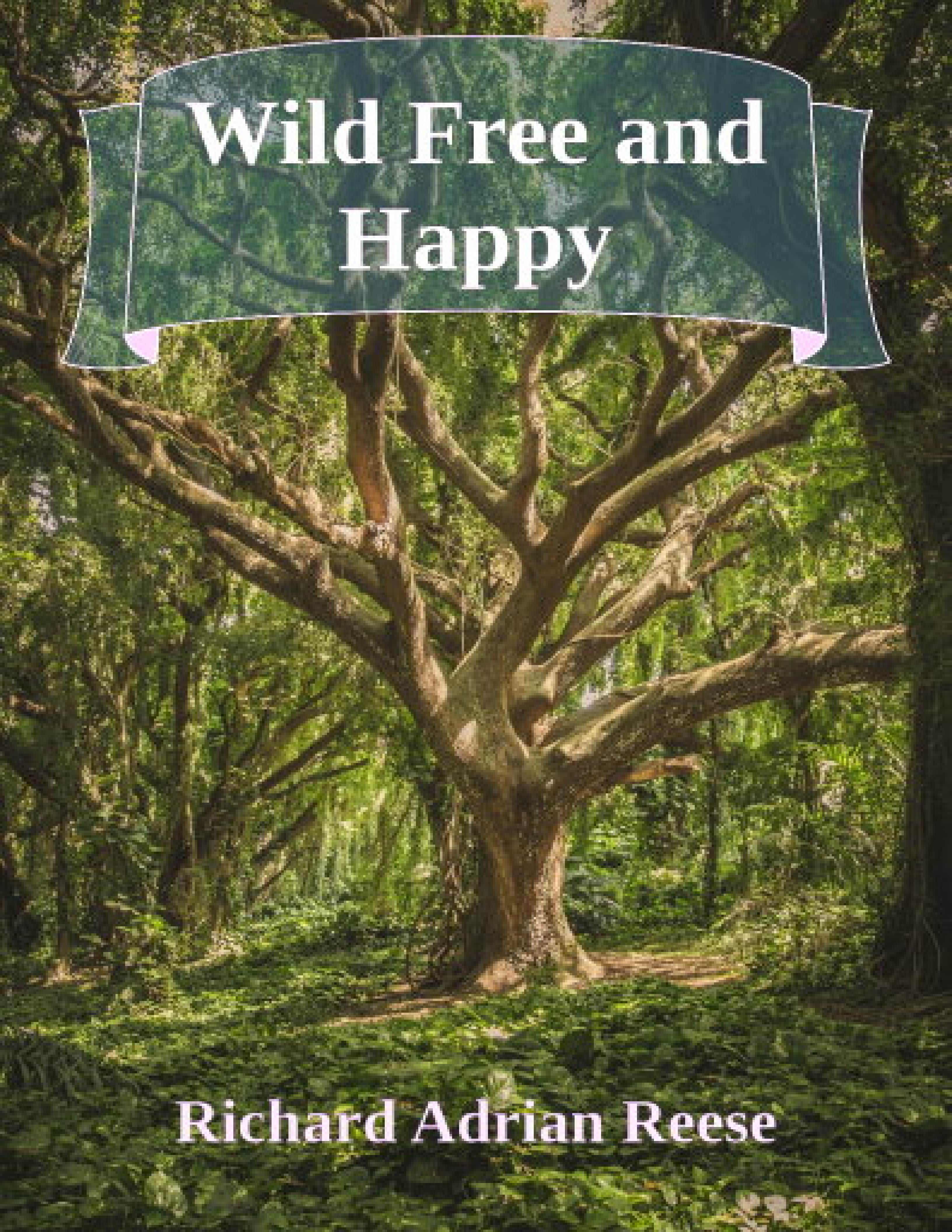
# Wild Free and Happy



Richard Adrian Reese

# Wild Free and Happy

Richard Adrian Reese

Also by Richard Adrian Reese:

What Is Sustainable

Sustainable or Bust

Understanding Sustainability



http://wildancestors.blogspot.com

# Table of Contents


Greetings!

In The Beginning

Two Legs

Fire: Big Juju

The Dance of Evolution

Megafauna Extinctions

Mother Grassland

Stumbling into Domestication

Animal Domestication

Plant Domestication

Disease

Predators

Forests

Soil

Water

Who Are We?

Energy

Limits

Human Webs

Climate Catastrophe

Climate “Solutions”

Helter Skelter

Bibliography

# Greetings!

## Introduction

I've been waking up with the crows lately, around 5:30 AM. They celebrate each new day with enthusiasm, jabbering joyfully in the treetops. Then they take wing and spread out across the land, to spend the day exploring, foraging, hanging out with their buddies, and celebrating the perfection of creation. Near the end of the day, as the sun is setting, they return home from their travels, perch high in the trees, and chatter about the day's events. They've been living like this for maybe a million years, and they have left no permanent wounds on the ecosystem. Experts say that crows are among the world's smartest animals.

After the birds have departed in the morning, the neighborhood begins rumbling. The ground dwelling tropical primates are getting up, taking a crap, eating corn flakes, drinking coffee, and then jumping into powerful 3,000 pound (1,360 kg) motorized wheelchairs, with luxurious seats, air conditioning, entertainment systems. They join hordes of speeding wheelchairs, fanning out across a once-thriving wild ecosystem now mutilated by countless permanent wounds. It's time for another excellent day at the cubicle farm. Joy! As you can see, the two ways of living are radically different.

The venerable historian William Cronon was the son of a history professor. One day, his father gave him the magic key for understanding reality. He told his son to carry one question on his journey through life: "How did things get to be this way?" Two points: (1) the answer is never obvious, (2) the way things are now is not the way they have always been.

Sometime, when you're feeling a bit bored, eager for thrills and excitement, get a library card and spend the next 30 years reading. Search for answers to Cronon's question. Read 500+ books on environmental history, ecology, anthropology, night after night, year after year, and type thousands of pages of notes. I did that.

In the imperial sagas of our culture, we are told that humans are superior to all of our other relatives in the family of life. We are living miracles that excel in the juju of science and technology. Life has never been better, and the best is yet to come. Progress rocks! We are the greatest! Everything is under control.

Greetings readers! Welcome to *Wild, Free, & Happy*! Please take a seat by my campfire. I have stories to tell. I want to explore the saga of our ancestors' journey, the long and exciting voyage from tree dwelling primates to planet thrashing thunder beings.

Every newborn that squirts out of the womb is a wild animal that evolution has fine-tuned for foraging, scavenging, hunting, and thriving on healthy tropical savannahs. Their genes are fine-tuned for a wild, free, and happy life — like newborn chimps, bonobos, raccoons, chipmunks, and everything else. Sadly, our newborns glide out into a family and society that is the opposite of wild, free, and happy.

Maybe it's time to remember who we are, turn around, and try to return to the family of life. Maybe it's time to unlearn, question, and change. Maybe it's time to strew tons of banana peels in the path of the monster. Maybe it's time to goose every sacred cow, and delegitimize the toxic beliefs that make our culture crazy.

Please be aware that this book contains zero miraculous silver bullet solutions to our slithering multitude of predicaments. It provides no instructions for conjuring a powerful magic spell that will throw open the gates to an ecological utopia of love, peace, and happiness.

We're about to walk right past the No Trespassing signs, jump over the fence, and take a long strange trip, down an ancient path, into a realm of ideas forbidden by the grownups. Please toss your cell phones into the latrine bucket. Trust nothing I say. Think for yourself. Good luck! Have fun!

**Preface**

This book is designed to be a power tool for folks who have a deep interest in learning about the long term relationship between humankind and the family of life on Earth.

environmental history, big history, the human saga, etc.

I'm giving this book to the world for free, because it's a big honker, and a printed version would be expensive. Many folks don't have Amazon accounts, or credit cards, or surplus money. My desire is to share what I've learned with as many readers as possible. With the click of a mouse, it's very easy to share this book with others who might be interested.

http://wayback.archive.org hacked in sept 2024.

Rather than a zillion footnotes, it has a zillion hyperlinks to additional sources of information, easily accessed with the click of a mouse. Web pages often have limited lifespans on the internet.

I'm not going to formally publish it because I'm old, tired, and don't wish to spend years getting it out to the world via the corporate publisher route. My low impact lifestyle would avoid doing book tours, and I would not be a good person for spoken interviews. The book contains the essentially stuff I want to share — much more stuff than my aging memory can instantly recall.

do book tour roadshows, or interviews.

My hope is that my book will be found and read by as many as possible. It contains lots of important information that I wish I had learned 50 years ago.

# In The Beginning

## Our Tree Critter Ancestors

The dawn of life on Earth began maybe four billion years ago, with the emergence of single-celled beings, the common ancestors of all forms of life, including us. Let's fast forward to around 65 million years ago, when our first primate ancestors came into existence, not long after dinosaurs moved off the stage. These critters were squirrel-sized, and lived high above the ground in the humid tropical rainforests of Mother Africa. They were probably insectivores, furry little hunters that dined on the delicious flesh of bugs and grubs.

Arboreal (tree-dwelling) primates had little need for a powerful sense of smell like most terrestrial (ground-dwelling) animals have. What they needed was excellent stereoscopic vision, via forward oriented eyes that provided accurate depth perception, so they could scamper and leap through the branches without mishap. Being able to perceive colors made it easier to find ripe fruit, which was a primary food source. Even today, bright red objects attract our attention.

Their hands and feet evolved into forms fine-tuned for grasping bark, vines, and branches, with toes and fingers tipped with nails, not claws. Fingers were long and curved, wrists freely rotated, and shoulder joints were flexible. An acute sense of touch and a sharp mind helped them excel at airborne acrobatics. Humans retain a number of these arboreal traits.

Our ancestors were tree-dwellers for most of the 65-million-year saga of primates. Your body retains clear evidence of this heritage. Most primate species today remain partly arboreal. Humans are the only living primates that are fully terrestrial. Large male gorillas do not sleep in the trees, but the other gorillas do.

In the rainforest, food was available year-round, so our ancestors enjoyed an easy life. Living amidst a cornucopia of organic fruit, nuts, insects, and assorted tree critters, they could live happily without tools, fire, cooking, cell phones, or psych meds. The climate was comfortable, so there was no need for clothing. A simple tree nest was all they needed. It was a wonderful way of life, while it lasted. They only used renewable resources, and they left no permanent scars on the forest. Like all other animals at the time, they had a way of life that was genuinely sustainable.

**Shift to the Savannah**

Climate change is a trickster that takes great delight in periodically pulling the rug out from under stable ecosystems, and watching them scramble to survive. It's a roller coaster of hot and cold, wet and dry, calm and stormy. Species that can't adapt to changing conditions go extinct, creating opportunities for other species to fill their ecological niche. The show of life must go on.

Long, long ago, in Mother Africa, the climate was warm and moist, home to the magnificent rainforests in which primates evolved. Later, around five million years ago, as glaciers grew in the Northern Hemisphere, the climate in African rainforests began shifting to cooler and dryer. By two million years ago, lush rainforests were far smaller, largely replaced by expanding savannahs (grasslands with scattered trees). If it wasn't for climate change, you might be sitting naked on a branch today, wild, free, and happy in a lush rainforest paradise, nibbling on fruit with your friends and family, in a clean, healthy, sustainable world.

As the rainforests shrank, our tree-dwelling ancestors were something like tadpoles in a puddle that was drying up. Many species of arboreal critters went extinct, but not all of them. The ancestors of chimps, bonobos, gibbons, and orangutans were able to remain in the forest and avoid extinction, while baboons, gorillas, and our ancestors took a deep breath, moved to the ground, and tried to adapt to a new way of life.

On the savannah, our early ancestors were weird looking, funny smelling undocumented immigrants, attempting to survive in a habitat for which evolution had done little to assist them. Their limited speed, size, and strength were serious drawbacks. They were newcomers in a grassland neighborhood where most of the long-term residents had been coevolving for millions of years. In this balancing act, when prey got a bit better at escape, predators got a bit better at taking them.

The new neighborhood included numerous large carnivores that were strong, fast, and equipped with sharp claws and fangs. They specialized in weeding out the injured, sick, elderly, immature, and inattentive. Many of our ancestors became organic cat food.

To survive, our ancestors used several defensive strategies. They lived in groups, where many eyes were constantly paying attention to the surroundings. When someone noticed a threat, loud calls were made to alert the gang, and the predator lost the advantage of surprise. Sometimes they mobbed hungry predators, aggressively assaulting them. Other times they quickly scattered in every direction. The ancestors were careful to be as invisible as possible. They chose sleeping places that offered the most security. As a result of their cleverness, luck, and risky choices, an enormous number of ground-dwelling primates survive today.

Rainforests have high biodiversity; they provide a pleasant home for huge numbers of species. Savannahs support far less biodiversity but, unlike dense forests, they provide excellent habitat for many large animal species. A square mile of rainforest contains tons of biomass in its trees, far more than a square mile of grassland, but grassland can produce more biomass every year, primarily during the wet season. This nutritious vegetation, which includes high-energy seeds, grows close to the ground, a convenient location for grazing animals.

The biological productivity of grasslands (savannahs, prairies, and steppes) encouraged the emergence of large herds of herbivores and their predators. When our ancestors moved to the ground, evolution had not equipped them for hunting large game, or escaping from speedy carnivores. They had two options, adapt or go extinct.

## Primate Clans

Primates include both apes (no tails) and monkeys (tails). You and I are apes. Over the eons, different primate species evolved in different ecosystems. Each location had a different mix of climate, food resources, advantages, and dangers. These variables encouraged unique evolutionary adaptations. The adaptations that best increased the odds for survival were more likely to be passed on to the following generations. Each ecosystem was also in a process of endless change, sometimes slow and gradual, and other times fast and extreme. Over time, in response to change, primate evolution fine-tuned beneficial adaptations, and scuttled the duds.

Since Neanderthals disappeared from the stage, our closest living relatives are the chimps and bonobos, with whom we share up to 99 percent of our genes. Next closest are gorillas, and in fourth place are orangutans. The ancestors of all four relatives have inhabited tropical forests for millions of years without trashing their ecosystems. Let's take a peek at a few of our primate relatives.

Baboons

When climate change shrank the forest and expanded the savannah, the ancestors of baboons evolved in a way that allowed them to spend much of their time on the ground. Few of them now live in tropical forests, but all baboons have retained the physique for scampering up trees. Baboons intelligently avoid wild predators by sleeping at the top of steep cliffs. Sleeping in trees protects them from lions and hyenas, but not leopards. In daylight hours, when many large carnivores are snoozing, baboons forage in groups, paying constant attention to their surroundings.

Spending time on the ground increased their vulnerability to daytime predators. Male baboons evolved big, strong bodies and large canine teeth. When predators approach, male baboons form a point defense to obstruct a quick, easy, surprise kill. While the males hold off the threat, the females and their offspring have a chance to escape. Baboons did not fabricate weapons and hunt animals larger than they were but, on happy days, they could mob a leopard and disassemble it. Readers who have killed adult leopards, by using just their teeth and bare hands, know that this can be very dangerous.

The ancestors of both baboons and humans moved onto the savannah, where they learned to survive as ground dwelling primates in a rough neighborhood that included lions, hyenas, leopards, cheetahs, and crocodiles. Baboons demonstrate that primates can survive in a dangerous habitat without spears, fire, or complex language — and they can do this without causing irreparable ecosystem degradation. With smaller brains, grunt communication, and sticks and stones, the baboons have brilliantly lived sustainably for millions of years. They continue to enjoy a healthy, pleasant, and traditional life as wild critters. This implies that our human ancestors were not forced to choose between tool addiction and extinction.

Baboons have tails, so they are monkeys. Paul Shepard noted that ground monkeys are "the most aggressively status-conscious creatures on Earth." High-ranking males have primary access to females and food. The rank order in the hierarchy regularly changed. So, to maintain or elevate your rank, it was important to brutally attack your inferiors at every opportunity. Daily life was a state of heightened stress and anxiety. Any minute you might be chased, pummeled, and bitten.

Robert Sapolsky spent 30 years studying a troop of baboons. Over time, he came to like a few of them, but he really disliked the troop, because they were exceptionally mean to each other, hour after hour, day after day. He came to understand that hierarchy and competition can be a destructive force in a community, and this principle also applied to humans, many of whom are painfully tormented by stress filled lives.

## Gorillas

Gorillas evolved a different mode of sustainable living. They never left the tropical forests, and their diet is primarily vegetarian. They would have a hard time surviving outside of the forest. Gorillas spend hours each day stuffing their faces at the salad bar. They have evolved large guts in order to digest this bulky fibrous feast. Insects provide the animal food in their diet. In one study, 25 percent of gorilla poop samples contained bits of termites.

Males can be twice as heavy as females, growing up to 485 pounds (220 kg). The big guys can't climb trees, but smaller gorillas do. Trees are a place to sleep, and to escape from predators. They live in groups of 6 to 30 individuals, dominated by one or two silverback males. Silverbacks are generally shy and relaxed, except when disturbed by uninvited humans or other gorillas. The only predators they fear are humans.

## Gibbons

There are about 20 species of gibbons, apes that inhabit the tropical forests of Southeast Asia. Gibbons are primarily arboreal, and they live in small monogamous groups. They can swing through the tree canopy with astonishing speed — up to 34 miles per hour (55 km/h). Science calls this form of travel *brachiation*. Today, physically fit humans still have a limited ability to brachiate.

Members of most gibbon species range in size from 12 to 17 pounds (5.5 to 7.5 kg). Because they are small, confronting large predators is not an option, so the males and females of most species are about the same size. Smallness is an asset, enabling them to travel rapidly through the forest canopy.

Orangutans

Our orangutan cousins in Sumatra spend about 90 percent of their time in the trees, where they are safe from hungry tigers. Living in low density, often solitary, they enjoy a peaceful life, free from the emotional aggravation of living in an anxious crowd. Of all the apes, they are the least noisy, usually silent. They move through the trees at a leisurely pace, never in a hurry. There is always something to eat in the rainforest. On average, females give birth every eight years, a longer spacing than any other mammal.

Orangutans are very intelligent. Researcher Biruté Mary Galdikas said, "I've had this feeling, ever since I was very young, that the tropical rainforest represents the original Garden of Eden. Our ancestors left the garden, but orangutans never did. They maintained a childlike innocence that humans lost a long, long time ago." Sadly, a mob of palm oil tycoons are furiously replacing the rainforest with palm plantations, mostly in Borneo and Sumatra.

Chimpanzees

Chimpanzees can grow to a standing height of 5.5 feet (1.7 m), weighing up to 130 pounds (60 kg). Males are larger and more robust than females. Chimps spend most of their time in the trees. Because of their size, they are less speedy and graceful at leaping through the tree canopy, compared to smaller primates. So, when they want to visit somewhere not close by, they go to the ground and knuckle walk.

Humans evolved for living on the ground. While chimps are smaller than humans, their arboreal lifestyle has made them far stronger. One experiment found that the arm strength of male chimps is five times that of humans. Big heavily muscled human wrestlers can’t hold a chimp still, not even a young four-year-old.

Frans de Waal warns that “Having a chimp in your home is like having a tiger in your home.” When chimps feel threatened by a human, the human is in danger, and if he attempts to defend himself, the chimp will be even more brutal. Outdoors, when humans appear to be harmlessly passing through, chimps generally ignore them.

Chimp bands are dominated by an alpha male, who is often backed up by one or more alpha wannabes. From time to time, the alpha is challenged by lower status males, one of which will eventually dethrone the cocky king of the harem. When the alpha is defeated, the new alpha often kills the infants of nursing females, so they will become fertile sooner, and produce offspring having his superior genes. An alpha tends to be abrasive to everyone, to intimidate them, and assert his control. When male strangers make an appearance, they are welcomed with teeth, fists, clubs, and stones. In skirmishes to defend territory, chimps are sometimes beaten to death.

## Bonobos

Bonobos and chimps live close to each other, but their rainforest habitats are separated by the Zaire River. The two species have never met in the wild, because neither can swim. They look a lot alike, and until 1929 were thought to be a single species. Chimps far outnumber bonobos, and their territory is much larger. Male bonobos can weigh up to 86 pounds (39 kg), and females up to 68 pounds (31 kg).

The bonobo culture is strikingly unusual for primates. Their groups are matriarchal. Males are second-class. Females determine how food is shared, and they eat while the males wait. Chimps have sex only when a female is fertile. Bonobos have sex almost anytime, several times a day, with anyone interested, young or old, in every imaginable way. Because of this, it's impossible to know who your biological father was. So, no youngsters are deliberately killed.

Bonobos are incredibly lucky. They live in a habitat with abundant food, and no serious competitors in their ecological niche, an ideal situation that does not encourage competition. Chimps live in leaner lands, and compete for food with gorillas and baboons. They feel the squeeze of crowding, and they reduce this pressure by infanticide, and by killing or driving away competitors.

## Hominins

Hominins are ground-dwelling primates that are bipedal (like you and I). They evolved for life in the tropics, where there was no need for warm fur. When they migrated into non-tropical regions, life got dangerously chilly. To survive in snow country, they needed warm clothing and shelters — technological crutches that require work that was completely unnecessary in their natural habitat. They did not gradually move out of warm lands, and let evolution perfectly fine tune them for cooler places. They were already extremely unusual high-tech critters, with their thrusting spears and domesticated fire. They impatiently bypassed evolution. Oh-oh!

## Primate Diets

The first primates evolved from small nocturnal insectivores that gobbled bugs during the dinosaur era. Today, all primates are omnivores, consuming both plant and animal foods. None are vegetarians, but gorillas are primarily leaf eaters (folivores). Most primate species are mainly fruit eaters (frugivores). Tropical forests typically provide a year-round supply of fruit, so most primates live close to them. Fruit is 75 percent of a chimp's diet, and sugar is rapidly converted to energy. It's interesting that human babies have a preference for things that taste sweet, a relic of our tree dwelling days.

Protein is an essential nutrient for primates, and it is mainly acquired by consuming animal foods, and certain types of leaves. The primary source of animal protein is insects. When insects are abundant, they can provide up to

90 percent of a healthy primate's diet. Meat is a high-quality source of protein, far superior to plant sources. It takes less effort for our digestive systems to utilize the protein from meat. Some primates are good at predation, killing small animals. Some are scavengers, dining on the leftovers of carcasses abandoned by carnivores.

While plant foods are most of their diet, bonobos also eat caterpillars, earthworms, shrews, reptiles, bats, flying squirrels, and small forest antelopes (duikers). Chimpanzees also eat insects, birds, eggs, colobus monkeys, duikers, bushbucks, wild pigs, young baboons, human infants, and carrion. Baboons also eat insects, fish, shellfish, rodents, hares, birds, vervet monkeys, duikers, and human infants. The orangutan diet includes more than 400 types of food, but it majors in ripe fruit. They sometimes dine on invertebrates, like caterpillars and worms, and, on rare occasions, meat. Gibbons feed mainly on fruit, but also consume leaves, insects, bird eggs, and sometimes young birds.

Hominins are unusual primates because some species learned how to kill and cook large animals. This was made possible by their experiments in tool making, and the domestication of fire. Unlike other primate lines, hominins are able to digest big servings of highly nutritious animal foods. Shepard Krech noted that the diet of Native Americans could sometimes include six to twelve pounds (2.7 to 5.4 kg) of meat per day. For employees of the Hudson Bay Company, the daily ration was seven to eight pounds of meat. Of course, the diet of wild artic societies consisted almost entirely of animal foods.

## The Bottom Line

Humans are quite proud of our notorious reputation as tool makers, but we are not alone. In Thailand and Myanmar, crab-eating macaques use stone tools to open nuts, sea snails, oysters, and other bivalves. Chimps use twigs to fish for termites, rocks to crack nuts, and sharpened sticks to stab bush babies. Rocks and branches were used to resolve conflicts with other chimps and predators. Some types of progress, like using a rock to crack nuts, do not disrupt the balance of the ecosystem, or threaten the future of the species.

Non-hominin primates did not make complex weapons, spread around the world, enslave other species, invent agriculture, explode in numbers, live in filth, and die by the millions from infectious diseases. They did not wage war against infectious diseases, soar into extreme overshoot, load the atmosphere with crud, and blindside the planet's climate. Instead, they continue to inhabit a niche in their ecosystem, and live as they have for millions of years, without rocking the boat. This is nature's way.

When a cooling climate forced our ancestors onto the savannah, it's possible that they were driven out of prime habitat by forest dwelling competitors — maybe the ancestors of chimps and bonobos. Habitat for fruit and nut trees was shrinking, which likely inspired some lively competition, in which our ancestors were the losers. Chimps and bonobos have mastered ecological sustainability, and we have a hard time comprehending its importance.

Somewhere along the way, hominins began exploring new paths that eventually led them farther and farther from nature's way, into dark and dangerous realms. A growing number of the cool new tricks had uncool consequences, eventually triggering disturbances that not only rocked the boat, but rocked the planet. Edward Abbey said, "Man is literally undoing the work of organic evolution."

I don't believe that our genetic hardware is fatally flawed, but our cultural software is certainly far from flawless, as the state of the world today proves beyond a doubt. In the following chapters, I'll sketch out my interpretation of the human saga, from the perspective of humans as animals — not the Crown of Creation. Happy trails!

# Two Legs

## Savannah Pioneers

When our ancestors moved from the forest to the savannah, they began a journey into an entirely different way of life. Critters that evolution had fine-tuned for arboreal living were poorly prepared for surviving on open grassland. They were not big, strong, or speedy. They didn't have horns, fangs, or claws. They couldn't digest grass. They had to adapt to different sources of food, and different threats to their survival. It took centuries of trial and error to develop new ways of living, and hundreds of thousands of years to evolve new and improved bodies fine-tuned for survival on their new path.

In the early days, our ancestors were not apex (top level) predators, they may have been more like delicious walking meatballs, easy prey for big cats, packs of hyenas, huge crocodiles,

and other hungry carnivores. Chris Stringer mentioned genetic research which indicated that today's Earth-pounding mob of *Homo sapiens* trace back to an ancestral population of about 10,000 breeding individuals. Earlier, a million years ago, in the *Homo erectus* era, there were just 20,000 breeding individuals. For a very long time, our ancestors existed not too far from the brink of extinction. It wasn't easy being a highly vulnerable ground-dwelling primate.

## Scavenging and Primitive Hunting

Our ancestors on the African savannah were hunter-gatherers, and their diet majored in plant foods, with a regular supplement of highly nutritious animal foods. In the early chapters of the great hominin adventure, they were not expert hunters with effective weapons. Meat was acquired via scavenging and primitive hunting. With bare hands, they could grab critters like grubs, grasshoppers, termites, maggots, snails, shellfish, lizards, and frogs. They could kill animals sleeping under bushes, dig up others from their burrows, chase down slow-moving aardvarks and porcupines, and snatch immature youngsters. Large birds could be knocked down by throwing clubs.

It's easy to forget that rocks can be lethal weapons. Wendell Bennett wrote that the Tarahumara people of Mexico threw stones with remarkable accuracy, killing rabbits, birds, and animals up to the size of coyotes. Some of their groups did more hunting with stones than with bows and arrows.

Alfred Crosby wrote that any human more than eight years old, male or female, can throw projectiles farther and more accurately than any other species. This ability gave us the power to effect change from a distance. Well-thrown projectiles could drive away hungry predators or kill a plump bunny for dinner. Researcher Frans de Waal noted that stone throwing chimps also have "impressive long-range aim." (Ouch!)

Crosby noted that a few hundred years ago, Europeans visiting Samoa got a painful lesson in the superb stone-throwing skills of the natives. Of the 61 men sent ashore, 12 were killed by well-thrown rocks. Humans also invented the rock-throwing sling, which was even more deadly, especially when loaded with lumps of lead. Many of the conquistadors visiting Mexico had life-changing experiences while getting stoned by the angry sling-twirling Indians.

Scavenging is getting meat from carcasses that you didn't kill — leftovers from large carnivores, or animals that died from other causes. In later times, as the ancestors became more skilled at hunting, scavenging was not abandoned. Meat is nutrient rich treasure, no matter how it is acquired. Scavenging was often less work and less dangerous than pursuing and killing an animal.

During the day, our ancestors paid careful attention to the skies. When vultures flew in a specific direction, they might be en route to a fresh carcass. Circling vultures were strong evidence of a banquet directly below. Once you got a hot tip, it was best to move quickly, in an effort to beat other scavengers to the banquet.

Hyenas work in gangs, and can quickly strip the scraps off carcasses, leaving few leftovers, if any. Their arrival time was sometimes delayed by their need to stop, pant, and cool off from time to time. Our ancestors were far better at shedding heat, an important advantage. If hyenas or jackals arrived first, it was sometimes possible to mob them and drive them off. On lucky days, it was possible to steal lunch from a lone cheetah.

Lions were another story. To drive them away from a kill, surprise was important. You and your buddies should suddenly charge, waving your arms, shouting, throwing rocks, swinging clubs, or maybe start a grass fire upwind. Smart scavengers never tried this when lions were just beginning their lunch feast, and were still very hungry. It was best to wait until they were full and ready for a nap. Lions rarely consume brains or marrow, and sometimes leave some meat scraps for the intrepid.

It was also important for scavengers to pay attention to trees. When leopards didn't completely consume a kill at one sitting, they stored the leftovers up in the branches. Leopards are night creatures. If you found their unguarded stash in the daytime, there was less chance of getting shredded and devoured by an angry cat.

Right now, your eyes are following a track of squiggly scratches, and your mind is comprehending meaning from them. My thoughts and actions created those tracks, and they contain specific meaning for those who have learned how to interpret them. The farther you are able to follow my tracks, the more you will learn about me.

Similarly, animals leave behind tracks and other signs as they move across the land. Folks who are skilled at reading this information can accumulate pieces of a story. They can perceive a fantastic amount of information by studying *spoor* — footprints, urine, feces, saliva, blood, fur bits, feeding signs, smells, sounds, and so on. Spoor provides clues about the animal's species, gender, size, behavior, direction of travel, time of passage, and so on.

Fresh tracks left by a game animal indicated that it had passed through the area, and the direction it was moving — essential information for hungry hunters. Also, spoor left by large carnivores indicated predators on the move. Following their tracks might eventually lead to a recent kill, and a carcass to scavenge.

## The San

Louis Liebenberg is a South African lad who has spent years on the Kalahari Desert with the San people (other names include Khoisan, Bushmen, !Kung). He was not a nerdy anthropologist, he directly participated in hunts, and eventually became a skilled tracker. He wrote two outstanding books about tracking, scavenging, and persistence hunting.

One time, Liebenberg asked some San trackers if they could actually recognize the spoor of an individual antelope. They burst out laughing at his incredibly stupid question. They couldn't imagine anyone not being able to do this. When they see a human footprint, they immediately know which individual in their band made it. Children can identify the tracks of their parents. Footprints are as unique and recognizable as faces. To see the footprints of an unknown stranger was highly unusual, and would inspire caution. San women were at least as good as men at interpreting spoor.

More anthropology books have been written about the San than any other wild people. Geneticists have found that they have the oldest DNA of any living culture — it is the genetic foundation of nearly all modern humans. Their genes are the closest to the ancient female from whom all living humans descend, known as Mitochondrial Eve. Thus, your family tree likely leads back to ancestors similar to the San. (Pygmies are the second oldest living culture.)

The San have been hunter-gatherers since the dawn of humankind, and they enjoyed a way of life that managed to survive into the 1970s. Eight hundred years ago, the San homeland included all of southern Africa. Since then, Bantu and European herders and farmers have displaced them from lands that were suitable for grazing and agriculture, forcing the San into the Kalahari where, on average, two of every five years are drought years, and severe droughts occur one in every four years.

There are large regions of the Kalahari that are quite flat, an endless landscape having no notable landmarks for a white boy like me, who would quickly become hopelessly lost, and turn into vulture chow. The San, on the other hand, always know exactly where they are, across large regions, because they orient themselves by the layout of plant communities, even small ones, noting their size, shape, position, and unique features. They know every stone, bush, and irregularity of the ground surface. Hundreds of places have been given names. They know the face of their land as well as they know the faces of their family.

Richard Lee wrote about the San. Their primary food was highly nutritious mongongo nuts. These nuts were reliably produced every year. They could be gathered throughout the year because they didn't spoil while lying on dry ground. Meat was their second most desired food. The Kalahari provided them with about 100 edible plant species, which they were careful not to overuse. The San expected periodic times of scarcity, so they reserved some plant species for drought food. Portions of their territory were set aside for lean times.

John Reader wrote about an extreme drought in the Kalahari that lasted three years. The San didn't starve. Neighboring Bantu farmers were hammered by three consecutive crop failures, and 250,000 of their cattle died. United Nations famine relief kept 180,000 farming people on life support. Some farmers who didn't get food relief had to forage for wild food, putting further strain on food resources. Still, the San were able to acquire their food with just 12 to 19 hours a week of effort. They dwelt in a desolate "wasteland" that no civilized people could survive in, and they lived well and joyfully.

**Bipedal Locomotion**

Baboons survive today because their ancestors evolved a successful approach for living on the savannah. They did this by organizing into powerful bad ass gangs. Like all other non-human animals, baboons still survive by living in the manner for which evolution has fine-tuned them, free from addiction to crutches like fire or complex weapons. They stayed in their tropical homeland, and could possibly remain there for another million years, if the current human turbulence in their ecosystem would mercifully wind down as soon as possible.

Unlike baboons, our ancestors took a radically different approach to surviving on tropical savannahs. They quit knuckle walking, evolved an upright posture, and became bipedal — standing, striding, and sprinting on two legs, not four. This transition reduced or eliminated their ability to quickly scamper up trees, where they were less vulnerable to predators. So, a new category of primates was born: *hominins* — bipedal ground-dwelling primates.

The earliest bipedal primate is the subject of controversy. By about 4 million years ago, our ancestors' feet had become less useful for grasping (climbing trees), and more attuned for walking smoothly. For the sake of this book, let's say that hominins have existed for about 4 million years, and the genus *Homo* (a subset of hominins) is maybe 2.8 million years old.

In Tanzania, 3.6 million years ago, two bipedal ancestors left their footprints in wet volcanic ash. In 1978, at the Laetoli site, scientists discovered 70 of their fossilized footprints, in a sequence that was 88 feet long (27 m). These ancestors were probably *Australopithecus afarensis*.

Why the shift to bipedal travel? Over time, as climate change expanded grassland, the distance between clusters of trees increased. Knuckle walking is OK for short trips, but striding is more comfortable and energy efficient for longer journeys. Standing upright provided a better view of the surroundings. It also made them more visible to hungry predators. It freed up their hands for carrying things like food, water, infants, embers, and tools. But their new and improved hands were less capable of powerful grasping, a necessity for life in the trees.

For brief high-speed getaways, hominins were far slower than galloping chimps. Alfred Crosby noted that bipedal striding is like walking on stilts, and it increases the odds for falling down. Four-legged critters (quadrupeds) like canines, cats, or horses move in a manner that is far more graceful, stable, and speedy. Humans can't outrun tiny yappy lapdogs.

On the savannah, evolution typically selected for prey animals that were better high-speed escape artists. Consequently, it also selected for the predators that were more effective at killing them. If prey gradually got larger, predators gradually got larger. If prey got faster, so did the predators. If prey got too good at surviving, they would overgraze the savannah and starve. If predators got too good at hunting, they would eliminate their prey and starve. The ecosystem was an endless bloody evolutionary soap opera, an incredible balancing act.

With regard to our ancestors, evolution advanced an unusual mutation. Instead of size or speed, it selected for heat tolerance and long-distance running. Compared to four-legged critters, standing upright exposed less of their bodies to hot sunbeams, and their bushy hairdos provided extra heat protection. With the head held higher above the hot ground, it could better be cooled by passing breezes. Their nearly furless bodies, equipped with three million juicy sweat glands, allowed them to shed body heat better than other savannah mammals. Standing upright reduced their exposure to hot sunbeams.

Tree-dwelling primates enjoyed a diet majoring in fruit, which grew all around them, all year long. On the savannah, there was less fruit, so foraging required travelling farther, and finding other things to eat. Some believe that our ancestors became bipedal to improve their success at scavenging — beating competitors to fresh carcasses. Bernd Heinrich wrote that at Yellowstone Park, dead animals are reduced to a pile of bones in just seven hours. In Africa, hyenas devour the bones too.

You have a body that is optimized for long distance running. Your toes and heel tendons provide a bounce when your foot hits the ground, improving energy efficiency. Your legs and spine are fine-tuned for jogging, keeping your head and eyes steady. Skilled runners gracefully glide along, lightly skimming across the land.

The shift to bipedal locomotion resulted in some radical changes in our ancestors' skeletons. Notably, the pelvis got narrower, which reduced the size of the birth canal — the passageway through which fetuses pass during birth. This challenge was dealt with in two ways. (1) Birth occurred earlier, when brains were smaller and less mature. This extended the duration of childhood, the spacing between births, and the need for extended parental oversight. (2) Since bipeds no longer slept in the trees, they could grow heavier and bigger. Increased size was an asset for hunting and defense. Longer legs enabled longer strides, which boosted running speed. Larger bodies retained water better, delaying dehydration.

Bipedal locomotion was an unusual evolutionary experiment. Few if any humans still live in the manner for which evolution fine-tuned us, a practice known as persistence hunting.

**Persistence Hunting**

On the savannah, predators made speedy attacks, and their prey attempted quick getaways, but both soon had to find shade and chill out, because bursts of high exertion promptly led to overheating. Consequently, predator attacks were resolved quickly. If a charging lion failed to promptly take down its target, the attack ended, and the prey might live to see another day.

Our ancestors gained the ability to engage in steady long-distance running, hour after hour, in the oven-like midday heat of tropical savannahs. Once a chase began, the prey animals immediately scattered. The hunter quickly selected an animal that was less strong and speedy, and began trotting after it. Even when the prey was miles ahead, the hunter would doggedly follow its trail, reducing its ability to rest and cool off.

Persistence hunting requires no weapons. Hunters must possess a deep understanding of animal behavior, great skill in the art of tracking, an intuitive mind, a healthy body, and sufficient water and nutrients for a long run. Kalahari people had exceptional tracking skills. Women were as good as men, or better, at interpreting spoor. At the end of a successful pursuit, the prey might collapse from exhaustion or heat stroke, or simply stop running. If the hunter found it still alive, he could suffocate it or bonk it on the head.

Louis Liebenberg was maybe the first civilized person to participate in persistence hunting (he nearly died from heat stroke). He observed a six-and-a-half-hour chase that covered 21.7 miles (35 km), on a day when the temperature ranged between 89°F and 107°F (32°C and 42°C).

He noted that tracking encouraged wild people to develop heightened abilities for intuitive thinking, because the tracks of their prey were rarely clear and complete. Knowledge of animal behavior helped to fill in the blanks and suggest the most likely escape route. The mental process was fast, automatic, effortless, and often unconscious. Intuition also enhanced social relationships. Wild people were far more sensitive to each other than folks in the modern world, whom Liebenberg saw as being severely handicapped by shallow or dysfunctional relationships.

Maybe our ancestors learned persistence hunting from hyenas, who hunt in packs, using their super-sensitive noses to follow animals until they are exhausted. Or maybe they first learned by chasing small, slow-moving critters. Somehow, maybe several million years ago, our hominin ancestors learned the clever trick of using overheating and exhaustion as deadly weapons — and the keys to their survival.

Every gardener who has experienced backaches or sore knees, is painfully aware that evolution did not fine tune hominins for spending long hours on their knees or bent over, engaged in tedious repetitive movements — digging, cultivating, planting, weeding, picking, threshing, grinding, and so on. Evolution gave you a body ideal for long distance pursuits across hot African savannahs — a meat-loving hunter and forager.

Bears have never forgotten their identity, consequently they confidently continue to live like bears, which is why they remain perfectly sane, and have no need for psych meds. The same can be said for all the wild animals alive today. The glaring exception is a super large mob of modernized persistence hunters who have become extremely disoriented by memory loss.

Young children, even in the deepest darkest McMansion suburbs, are fascinated by bears, lions, horses, bunnies, piggies, and others. They play with teddy bears, pretend to be horses, and love looking at animals in picture books. The kids are animals, and their hominin ancestors have been fascinated by animals for four million years. Sadly, most will spend their lives in a reality where most of the animals they'll closely experience will be thoroughly domesticated critters purchased for companionship or status display.

Carl Jung, the famous psychiatrist, said that we still retain unconscious memories of our ancient tree dwelling past, when falling out of trees caused big fear. Many of us have suddenly awakened with a gasp when a dream included a sudden plunge. Nightmares commonly involve being chased or attacked by dangerous predators. In crowded movie theaters, when the woman is about to be stabbed by a psycho killer, the hall explodes with loud squeals and screams, like our primate ancestors in a distant rainforest.

Over the last four million years, every species of bipedal primate has gone extinct, except one — and almost all of us have abandoned persistence hunting as a routine component of basic survival. Don't worry, go shopping. Close your eyes and imagine how glorious humans might become if we spent the next 200,000 years sitting on couches, staring at glowing screens, washing down greasy pizza with fizzy sugar water.

**Running Goes Global**

By and by, as hominins spread far beyond the savannahs of tropical Africa, so did persistence hunting. It spread around the world, because it works, and because evolution fine-tuned us for doing it. For almost the entire hominin saga, we lived on our feet. Running was a key factor in our ancestors' survival, until we got wheels, four legged slaves, and other weird and troublesome things.

Tim Flannery reported that the Aborigines of Western Australia would pursue an individual kangaroo until it was overheated and

exhausted. The chase could take several days. Johann Kohl wrote that the Ojibway would often run down elk, especially in the winter, when deep snow soon wore out the animal. Hunters on snowshoes could pursue the animal for hours. Kohl also mentioned a Sioux hunter who chased a bear to exhaustion.

Bernd Heinrich wrote about the Penobscot tribe chasing down moose, and the Navajo and Paiutes wearing out pronghorn antelopes. In Southern Africa, hunters chased steenbok, gemsbok, wildebeest, zebras, and others. Wendell Bennett wrote about the Tarahumara people of Mexico pursuing deer and turkeys until they collapsed.

Peter Nabokov noted that some Tarahumara lads could run 170 miles (273 km) without stopping. Mexicans would hire them to capture wild horses, sometimes chasing them for two or three days, until the horses could run no more — while the men remained fresh. Nabokov quoted a Hopi man: “Long ago when the Hopi had no sheep, no horses, no burros, they had to depend for game-capturing on their legs.”

Nabokov provided numerous accounts of Indian messengers traveling great distances. One ran 50 miles in six hours. A Mojave lad ran 200 miles (322 km) in 24 hours. Seven days a week, a Tarahumara man ran a 70-mile (112 km) route, carrying a heavy mailbag. After running 15 miles (24 km), Zuni runners still had a slow heart rate and no signs of fatigue. Men in their seventies continued to have tremendous endurance, as well as low blood pressure.

For wild people in open country, running was essential for communication, warfare, hunting, ceremonies, and rituals. Apache boys of 8 to 12 years old regularly ran to improve their endurance and pain tolerance. They ran carrying big loads, and they ran up mountains. Apache warriors were much stronger and braver than the U.S. Army lads sent to exterminate them.

Nabokov wrote that four-year-old Navajo boys had to get up before sunrise every day and run four miles before having breakfast. Speed and strength were essential when attacking enemies, or being attacked. No one will help you in this world, you must run to get strong. Your legs are your friends.

## Fire: Big Juju

Before hominins learned how create fire, they very carefully preserved the flames of a naturally caused fire by feeding it fuel. Burning sticks could be taken to other locations and become the source of additional fires. Folks were extremely careful to preserve the live embers because, if they ever went cold, the unlucky brothers and sisters might begin to smell like cat food.

Civilization would have never been possible without the domestication of a superpower we call fire. Long, long ago, someone discovered that vigorous friction could generate heat, smoke, and glowing embers. This knowledge inspired the invention of the fire drill. Its spindle is a straight, pointed, dry wooden stick. The tip of the spindle is inserted into a cone-shaped socket in a wooden fireboard. Rapidly spinning the spindle creates friction as it rubs into the fireboard's socket, and eventually, if all goes well, a glowing ember comes into being. The fireboard is then tilted to drop the ember into a fluffy wad of dry tinder. The ember is gently blown on, forcing its heat into the tinder. Finally, a wee flame emerges in a puff of smoke. Success!

The invention of the fire drill enabled our tropical ancestors to migrate into chilly non-tropical ecosystems, and eventually spread to all continents, even the Arctic.

### Domestication of Fire

Once upon a time, in an African wilderness, someone figured out how to conjure a dancing flame into being. This happened maybe two million years ago — before the emergence of *Homo sapiens*. Likely suspects include *Homo erectus*, or an earlier australopithecine.

In the hominin saga, that first glowing ember catapulted our ancestors into a spooky new realm of power and danger. They began controlling something that no other animal could — and they certainly understood that only they possessed this big magic. We are not like all the rest.

Without domesticated fire, hominins would have probably remained something like chimps and bonobos, who still live simply and sustainably. With fire, we acquired a dangerous superpower, and lost the stability enjoyed by ordinary animals.

James Scott thought that the good old days ended with the domestication of fire. In his mind, the nightmare world we live in is the result of four domestications — fire, animals, plants, and humans. Domesticated fire was as addictive as heroin, a habit impossible to willfully quit. The habit eventually spread around the world. Carleton Coon noted that only a few folks made it into the nineteenth century without becoming fire makers — the Tasmanians, Sentineli (Andaman Islands), and the Pygmies of the Ituri forest.

Charles Darwin wrote, “He has discovered the art of making fire, by which hard and stringy roots can he rendered digestible, and poisonous roots or herbs innocuous. This discovery of fire, probably the greatest ever made by man, excepting language, dates from before the dawn of history.”

Fire kept our ancestors warmer. Humans have three million sweat glands to cool us off in hot weather. In cold weather, the body directs more warm blood to the skin. One thing that struck Europeans about primitive people was that they seemed to be impervious to cold. During his famous voyage, Darwin was surprised to observe natives who wore little or no clothing during bitterly cold weather in Tierra del Fuego.

On the Kalahari, night temperatures in June and July can dip below freezing. Elizabeth Marshall Thomas was with a group of naked San people during a night when their water froze. Their only protection was a kaross — an animal skin wrapped around their shoulders.

Fire enabled folks to survive in regions having extended cold weather. They eventually expanded into much of the Northern Hemisphere, home to woolly mammoths, sabertooth cats, and many other species of megafauna. By making uninhabitable regions habitable, fire increased the global carrying capacity for the hominin hordes — more territory, more food, more hominins.

Fire was used on a large scale to manage landscapes for more productive hunting and foraging. It was used to drive game animals into bogs or streams, off precipices, or into locations where they could be confined and killed. It burned off cover that concealed hidden nests or burrows. Flame was used for optimizing grasslands to attract more game — it consumed dead vegetation and woody brush, encouraging the growth of fresh nutritious green forage. It left behind a banquet of roasted grasshoppers. It discouraged visits from bloodthirsty flies and mosquitoes.

Fire enabled slash-and-burn agriculture (swidden), which replaced forest with cropland. Crops were grown for a year or so, until soil fertility was depleted, at which point another area of forest was slashed down. The depleted fields were left to recover for ten or twenty years, when they were slashed again. After multiple slash-and-burn cycles, the land was rubbished. Daniel Hillel reported that in Indonesia there are more than 39.5 million acres (16 million hectares) of land that is incapable of supporting either agriculture or forest.

Fire has long been used as a weapon of mass destruction during violent conflicts. Cities built of wood often fed the flames of horrific firestorms that claimed many lives. Even in peacetime, structures heated with open flame fireplaces frequently went up in smoke, often igniting the rest of the village. For many centuries, firefighting technology was an ineffective process of hauling buckets of water by hand. Deadly fires were very common, and a great source of fear. The Christian concept of Hell was intensified by the terror of frequent fires in early times.

Fire had a spiritual aspect in every traditional culture. Jacob Grimm mentioned the needfire rituals that were once common in many regions of Western Europe. Every year at the summer solstice, each home in the village let their hearth fire die out. A new fire was kindled into existence, and everyone took home a bit of the needfire to light their hearth for the coming year. Often people and livestock were passed through the glowing embers for purification and protection. Fire was highly sacred business. Many old pantheons had fire gods, goddesses, and myths.

## Cooking

The domestication of fire kicked open the door to a revolutionary change in the hominin saga — a technology called cooking. Cooking softened and pre-digested food. Cooked food required less energy to digest than uncooked food. This freed up energy that could facilitate the development of bigger brains. Infants could be weaned sooner when softened food became an option, so births could be spaced closer together. The toothless elderly benefitted from access to soft food. Chewing was less work, so hominins evolved smaller teeth compared to other primates. Also, digestion took less processing, so our guts got smaller, and tummies flatter.

Cooking could zap disease pathogens and parasites. It transformed some foods that had been toxic or indigestible into edible nourishment. By increasing the variety of plants we could eat, and the amount of nutrients we could extract from them, it became possible for an area of land to feed more ancestors. Thus, cooking boosted an ecosystem's carrying capacity for hominins.

Cooking gave us the keys to industrial civilization. Imagine the astonishment when early hominins watched some heavy rocks in the fire turn red and melt into a liquid form. The first smelter was born. Metallurgy gave us the ability to fill rivers with spilled blood, to reduce cities to ashes, and to ravage ecosystems in countless, devastating, and irreparable ways.

The ancestors also learned about cooking clay. They were baking figurines in primitive kilns 25,000 years ago. This knowledge eventually evolved into baking pottery and bricks. Sand could be cooked into glass, limestone into cement, wood into charcoal, water into steam, crude oil into distillates (gasoline, diesel, kerosene, etc.), and on and on and on.

Alfred Crosby noted that chimps can't cook, so they spend six hours a day chewing their raw food diet. Large teeth are needed to pulverize their food, and a large gut is needed to extract the nutrients from the fibrous glop. Hominins have domesticated fire. We can cook our food, which softens and predigests it. Thus, we spend only an hour per day chewing. In primates, the two biggest energy guzzlers are brains and guts. Chimps have smaller brains, and bigger teeth and guts. We have larger brains, and smaller teeth and guts. Chimp brains consume 8 to 10 percent of their energy supply, and our brains consume 20 to 25 percent.

Peter Ungar chatted about how hunter-gatherers kept themselves nourished. Their preferred source of food was meat. This was supplemented by foraging for plant-based foods. When hunting was poor, their reliable backup food was tuberous roots. This energy dense food source was available year-round. Tubers were tossed on the campfire, where the heat softened the fibrous pulp, and broke down toxins. Cooking was essential.

Chimps never cooked anything. Ungar mentioned Richard Wrangham, who once worked as an assistant to Jane Goodall. He observed what chimps ate, and sampled these foods. They were bitter, fibrous, tough, and dry. Humans would struggle to survive on chimp food. Wrangham later discovered that Mbuti pygmies avoided eating chimp food, even when hungry.

Ungar also described how mammals utilize the energy they consume. For example, every day a 100-pound human needs to consume about the same number of calories as most other 100-pound mammals. Our brains are about 2 percent of our body weight, but require 20 percent of our energy supply. Muscles are 50 percent of our body weight, but only use 15 percent of our energy. Tree-climbing chimps are far stronger than we are, so they have energy guzzling muscles. We have energy-guzzling brains. Other mammals have much smaller brains, and energy-guzzling guts. They don’t cook food, so their digestive systems must work much harder.

# The Dance of Evolution

## A Foggy Path

Experts have endless lively disputes about many aspects of hominin evolution. There were many predecessors to *Homo sapiens*, but an accurate lineage of the hominin family tree does not exist, and probably never will. The physical evidence discovered so far is extremely incomplete. It's like a million-piece jigsaw puzzle where more than 99 percent of the pieces are missing, and most of these have disintegrated over time.

Evolution does not resemble automobile assembly plants, where production of 2024 models completely ends on a fixed date, and the process of building new and improved 2025 models begins. The transition from one species to the next is a blurry process that can take hundreds of thousands of years, and isolated groups of the same species can evolve in significantly different ways.

In addition to arguments over the branches of the family tree, the dates assigned to specific events are also controversial and inconsistent. Technology for dating specimens has advanced over the years, and different technologies often produce very different dates for the same bone or artifact. Also, ongoing field work continues to make new discoveries. So, did *Homo sapiens* emerge 190,000 years ago, or 400,000? Did they arrive in Europe 50,000 years ago, or 42,000, or 36,000? And so on. Numbers are slippery.

If we step back a bit, and disregard numeric dates, there is general agreement on a number of big picture trends. *Homo erectus* is much older than Neanderthal, and both are older than *Homo sapiens*. *Homo sapiens* evolved in Africa, and Neanderthals did not. Erectus and Neanderthals are not clearly associated with megafauna extinctions, but our species certainly is. For the purposes of this book, the trajectory of trends is important — event A preceded event B. All numeric dates presented in this book are controversial.

Although the Earth Crisis has roots much older than *Homo sapiens*, our species has played the starring role. For this reason, the following chapters will primarily focus on humans, and the emergence and expansion of some high impact cultures. But first, a few comments on two notable cousins.

**Erectus and Neanderthal**

*Homo erectus* emerged maybe two million years ago, and eventually spread across some of the warmer regions of Africa, Asia, and Europe. They may have been an early ancestor of modern humans. Erectus hunted, gathered, and used stone tools. They were the first hominins to evolve a larger than average brain, and they were among the early users of domesticated fire. Erectus maybe walked off the stage somewhere between 200,000 and 50,000 years ago. Erectus apparently lived on Earth much longer than Neanderthals did.

Neanderthals probably evolved north of the Mediterranean, not in Africa. Their remains have been found in Siberia, the Middle East, and Europe. The earliest discoveries date to maybe 400,000+ years ago. We share up to 99.9 percent of our DNA with them. Because they lived in non-tropical regions, they evolved thick bodies with large bones that provided greater strength and cold tolerance.

Clive Finlayson noted that recent research has found clear evidence that Neanderthals and non-African humans interbred. East Asians have 2.3 to 2.6 percent Neanderthal DNA, and Western Eurasians have 1.8 to 2.5 percent. Signs of these romances are as old as 100,000 years ago, and as recent as 37,000 years. Today, humans of various ancestries carry different segments of Neanderthal DNA. Thus, up to 20 percent of the Neanderthal genome might still exist, scattered throughout the vast human herd.

Erectus, on average, had 1,000 cc brains. Neanderthals were the brainiest hominins, at 1,600 cc. Sapiens averages a modest 1,350 cc. Could our smaller brains be the result of having access to cutting edge new technology (javelins, harpoons, bows and arrows, etc.)?

Kathleen McAuliffe reported on research finding that human brains have shrunk about 10 percent in the last 20,000 years. The *Homo sapiens* with the biggest brains lived in Europe 20,000 to 30,000 years ago. They were the Cro-Magnons, who had to overcome the many new challenges of surviving in snowy ecosystems, while fending off hungry cave lions, cave hyenas, and saber-tooth cats. The shrinking brain trend has been found in China, Europe, Africa, and even Australia, which remained Stone Age until 1788. Why? Perplexed experts propose some theories, but they don't know for sure.

One study found that human brains get smaller as population density increases. Tim Flannery suggests that modern consumers live like cattle on a feedlot, all our needs conveniently provided with the push of a button. We no longer have the skills or knowledge to survive in the wild. With every species of domesticated animals, their brain volume is 10 to 15 percent smaller than their wild ancestors. Some think that humans domesticated themselves.

Anyway, the trademark Neanderthal weapon was a heavy thrusting lance. Hunters had to slowly, silently, and very skillfully approach the prey undetected, then suddenly charge the animal, firmly gripping the spear with both hands, and ram it deep into its flesh. Readers who have hunted hippos with wooden thrusting spears know that this can be very dangerous. One site in Croatia contained the remains of 75 Neanderthals, and none were older than 35. Many of their bones had healed fractures, suggesting painful accidents or encounters with fierce animals. Dying of old age was unlikely.

The climate of the Neanderthal era was like a roller coaster. In Europe, they were pounded by an extended era of extreme cold that began about 70,000 years ago. From maybe 50,000 to 30,000 years ago, the climate was a spastic freak show. Finlayson noted that the climate often flip-flopped between warm periods and intensely frigid. Radical shifts could arrive suddenly, and last hundreds or thousands of years, all across Eurasia. Youngsters might grow up in a chilly steppe ecosystem that used to be a comfortable forest in the days of their grandparents.

Finlayson believes that bad luck was the cause of Neanderthal extinction. They were woodland animals. Their thrusting spears required close contact, and forest provided concealment. Humans had projectile spears, which were useless in woodlands, and they were moving into Europe at a time when woodland habitat was shrinking and fragmenting. The last Neanderthals died on the sunny shores of the Mediterranean, in Gibraltar, maybe 32,000 to 28,000 years ago. This was definitely after the arrival of humans in Western Europe, and before the spasm of megafauna extinctions on the continent.

Would Neanderthals have become the modern global primate if *Homo sapiens* had blinked out in Africa? I sometimes wonder if real estate was a significant limiting factor. Caves were luxurious addresses during glacial centuries, compared to hide-covered teepees or huts. The primo caves were south (sun) facing, and ideally overlooked the seasonal migration routes of animal herds. But there was a limited number of caves, and many were not vacant. Neanderthals were always welcome dinner guests when they stumbled into caverns inhabited by hungry, jumbo-sized cave lions, cave hyenas, and cave bears.

In warmer and wetter periods, glaciers retreated, and tundra transformed into forest and grassland, habitat for critters like red deer, horses, and moose. In colder and drier periods, glaciers advanced, forest retreated, and tundra returned, as did mammoths, woolly rhinos, and reindeer. Neanderthals listened to their growling tummies, and went where the meat was. They migrated northward in warmer eras, and retreated south when blast freezers returned.

Our human supremacist culture routinely preaches that Neanderthals were pathetic dullards. During their long vacation in Europe, maybe 270,000 years, Neanderthal technology didn't change much. From the supremacist perspective, Neanderthal's maybe 400,000-year era of stable, low impact, ecological sustainability was indisputable proof of low intelligence.

Elizabeth Kolbert absolutely disagreed. Neanderthals lived in Europe for a very long time while affecting their ecosystem no more than any other large mammals. Flannery noted that, for hundreds of thousands of years, Neanderthals coexisted with straight-tusked elephants, mammoths, and woodland rhinos — without driving them extinct. If humans had never wandered in from the Middle East, Europe might still be a wild, free, and happy celebration of Neanderthals, Irish elk, saber-tooth cats, straight tusk elephants, and aurochs. What's wrong with that?

Everything! *Homo sapiens* are blessed with incredible intelligence, brilliant innovation, complex hunting weapons, sophisticated language skills, and artistic creativity. We are the absolute Crown of Creation, and the rest of the family of life was provided for our sustenance.

For 150+ years, many experts have sneered at the inferior Neanderthals. European intellectuals were quite sure that the Garden of Eden had been located rather close to London. They were stunned and bewildered by the growing evidence that the ancestors of all hominins trace back to Mother Africa. All *Homo sapiens* living 50,000 years ago probably had beautiful dark skins. Oh my God! It can't be true! Horror!

**Neanderthal Hunting**

Compared to earlier hominin species, archaeologists have discovered significantly more evidence left behind by Neanderthals. They often resided in luxurious caves, where their debris and artifacts were deeply buried over the ages, safely protected from winds and rain. Neanderthals were around for maybe 400,000 years, including maybe 270,000 years in Europe. During this time, climate fluctuated. In frigid eras, steppe and tundra habitat dominated. In warmer eras, woodlands expanded. The game animals they hunted varied with the climate trends. For example, woolly mammoths and reindeer when chilly, and deer and wood bison when warmer.

Neanderthals hunted on foot, with thrusting spears, probably in teams. They were highly familiar with the landscape in the region. They knew the regular hangouts for game animals. They knew when and where prey made seasonal migrations. They understood how each prey species reacted to attacks. When they drove animals into traps, they killed indiscriminately, because frantic animals made selective killing impossible. When the dust settled, the prime food was butchered and taken, especially the fattest.

Apparently, smart hunters tried to avoid a premature death. They seem to have focused their efforts on less dangerous young animals and their mothers, who travelled in nursery herds. Mature males were huge, very strong, viciously defensive, and got more respect. Some suspect that our human ancestors may have learned some useful survival tricks by observing how Neanderthals lived.

Mark White and associates did a fascinating study on Neanderthal hunting. Let's take a quick peek at what they found.

STEPPE BISON. At the Mauran site in southwestern France, Neanderthals hunted steppe bison. The remains of more than 4,000 animals were found there. Most were younger animals, one to three years old.

A large steppe bison could stand as tall as six and a half feet (2 m) at the shoulders, and weigh up to 2,000 pounds (900 kg). Their horns were far larger and longer than modern bison. A panicked herd fled as a group that was hard to stop or turn once running. They could gallop at speeds up to 37 miles per hour (60 km/h).

At Mauran, animals were driven into a limestone cul-de-sac trap at the end of a gully, and then killed. Small groups of bison were taken at each hunt, over the span of centuries. Eighty percent of the remains were of cows and young animals, which were less dangerous than bulls. Also found at the site were remains of horses, red deer, and bears.

AUROCHS. At the La Borde site in southwestern France, Neanderthals killed aurochs (wild cattle). They were driven into a pit that had been created when a section of the cave below collapsed. In 1971, the site was accidentally discovered, and heavily damaged, by construction work. Researchers found the remains of 40 aurochs, but the remains of far more animals were destroyed by the machinery. It is unknown if the animals were killed at one time, or over the span of centuries.

The hunters focused on nursery herds — cows and immature youths. Adult bulls were big, strong, and ferociously violent. Smart lads left them alone. The decision to use the pit as a trap reflects an understanding of aurochs behavior. The success of the hunt relied far more on brain power than their low-tech spears.

RHINOCEROS. The Taubach site is along the Ilm River in southeast Germany. Here, the remains of brown bears, beaver, bison, and Merck's rhinoceros were found in what had once been a marshy wetland. Researchers focused their attention on rhinos. More than half of the remains were animals 1 to 1.5 years old. They were likely accompanied by their mothers. Adult males were usually solitary.

A rhino's sense of smell was acute, hearing was OK, but eyesight was limited, especially with motionless objects. Hunters likely hid downwind from wallows or salt licks, waiting for dinner to arrive. Rhinos were not herd animals, so the remains were not likely the result of mass kills. Taubach was likely a place that hunters regularly visited over the years, because it was a well-known rhino hotspot.

HORSES. The Zwoleń site is in the valley of the Zwolenka River in Poland, at a location where the valley narrows to a bottleneck that concentrated migrating herds. In flat terrain, horses tend to travel in single file. The site contained the remains of at least 38 horses (as well as mammoths, bison, rhinoceros, and reindeer). Most of the horses were less than 2 years old.

There were large numbers of some types of bones, and far smaller numbers of others — few complete skeletons. Researchers suspect this discrepancy resulted from hunters carrying the prime parts way from the kill site, to be processed elsewhere. This suggested the possibility that several thousand horses were killed at Zwoleń. The ambush killing was indiscriminate, and the butchering was selective. Hunters focused on harem groups, which were less dangerous than bachelor herds.

REINDEER. The Salzgitter Lebenstedt site in Germany is along the Krähenriedbach River. Reindeer were hunted here maybe 54,000 years ago. The remains of at least 86 animals were found, mostly adults aged 8 to 9 years. They may have been tundra reindeer, not woodland. Tundra reindeer make seasonal mass migrations, often moving 15 to 18 miles (25-30 km) per day. Large herds can include hundreds of thousands of animals, and take several days to pass.

Reindeer are curious animals, and don't live in a constant state of high alert for danger. They have a reputation for not being especially bright, and easy to drive into traps. All animals trapped were killed, but not all were butchered. Hunters preferred adult males, because their body weight was up to 20 percent fat (fuel for long winters). Calves are born around the end of May. Newborns were able to walk within an hour, and outrun a human in a day.

**Sustainability Doesn't Suck**

Anyway, Neanderthals demonstrated that bipedal primates with huge brains can live sustainably for several hundred thousand years, in extremely challenging conditions, without agriculture, metal making, animal enslavement, fish mining, deforestation, or writing. In fact, stability is not a problem or flaw. Stability sounds like a fun and healthy alternative to mindless perpetual growth, fanatical eco-destruction, and devastating hurricanes of irrational illusions.

Clive Finlayson reminded us that no animal species can foretell the future. When life is comfortable, and the ecosystem is not being ravaged, the safe and intelligent option is to be conservative, and remain on the well-worn time-proven path. But when the hits the fan, and traditions totally fail, innovation might be a less dangerous option. The path of innovation is risky, often leading to unintended consequences and bloody surprises. In worst case scenarios, innovation can backfire spectacularly, as eight billion people are now painfully discovering. Yikes!

Chris Stringer reminded us that the myth of progress is a new idea. The notion of utopia-bound continuous improvement is a bit over 200 years old. Civilization was imagined to be an upward spiral.

But in earlier civilizations, mobs of ambitious ax murderers were furiously mowing down ancient forests, triggering landslides, flash floods, and harbors choked with silt. Each new generation inherited an ecosystem that was obviously in worse condition. The passage of time was seen as a downward spiral of decay and decline, an inevitable one-way descent into social and ecological Armageddon.

Stringer noted that the wizards of modern society are possessed by an overwhelming and irrational blind faith in progress and perpetual growth. We are far more advanced than Neanderthals, and they were better than Erectus. You and I are lucky to enjoy the amazing pinnacle of billions of years of evolution. Stringer does not see this as proof of divine destiny. He believes that the fact that Neanderthals blinked out, and we didn't, was largely a result of chance. We survivors were assisted by the good fortune of being in the right place at the right time.

For example, about 70,000 to 75,000 years ago, the Mount Toba super volcano erupted on the island of Sumatra, spreading enormous amounts of ash. In some regions of India, up to 19 feet (6 m) of ash accumulated. Much incoming sunlight was blocked, and global temperatures may have dropped by 3° to 5°C for several years. Others imagine an intense thousand-year instant ice age. Still others suspect far less global impact.

One theory, presented by geneticists, asserts that the human population plunged to 5,000 to 10,000 individuals — implying that we nearly went extinct. Others point out that there is no evidence of extinction spasms among mammals at this time. It's not easy being an expert on days long past.

Anyway, Stringer suggests that if a similar eruption had happened closer to Africa, instead of Sumatra, it could have been game over for our species, but maybe not Neanderthals, who resided north of Africa. Or, today might look very different if the rollercoaster of ice ages had occurred in a slightly different pattern over the last 200,000 years. The outcome could have easily been quite different. Chance is powerful juju. Stringer is not a member of the progress cult. He believes that our long-term future is entirely unpredictable. I agree.

## Genetic Evolution

Charles Darwin achieved fame for popularizing the knowledge of genetic evolution, a normal and natural life process. All living things have genes, and no other critter, living or dead, possesses genes exactly like yours. Each of the billions of cells in your body carries a copy of them. Cells exist for a while, then die. New cells are created to replace them. Every hour, your genes are duplicated countless times as your body replaces dead cells with new ones.

The genes in every cell are incredibly complex, and it is normal and natural for booboos to occur in the duplication process. The mutations are purely random, and they are called genetic drift. It is not unusual for mutated genes to be passed from parent to offspring. For some offspring, random mutations might be beneficial in some way. Other offspring can be diminished by mutated genes, leading them to become less able to survive, thrive, and reproduce.

Everything on Earth, and all beings in the family of life, are constantly changing. Food resources can increase or decrease. Drought can be washed away by deluge. Parasites, viruses, volcanoes, fires, floods, invasives… the wheels of change keep spinning. Glaciers become tundra, tundra becomes grassland, grassland becomes forest, and then the parade reverses. Stability is a temporary state, change is the long-term norm. Evolution helps the family of life adapt and survive. Species unable to adapt to change disappear from the stage.

In the animal world, if predators get too good at hunting, they deplete their prey, go to bed hungry, and maybe starve. If prey get too good at escape, the growing herd will decimate the vegetation, and maybe create a desert, so everyone starves. If the predators gradually become one percent faster, the prey gradually become one percent faster, not two. Balance requires predators to be slightly better at killing than their prey is at evading.

Evolution is fascinating. Rabbits and mice have numerous offspring because they are vulnerable to predators. Other species have deflected the predator challenge by evolving to great size, like mammoths, hippos, and rhinos. Big critters have long lifespans and low birth rates. This made them highly vulnerable when *Homo sapiens* moved into the neighborhood.

Evolution proceeds much faster in species with brief lifespans. This is why pathogenic bacteria can quickly develop resistance to antibiotics, and insects to insecticides. Some fungi can develop resistance to a new fungicide in just three years. Big Mama Nature just howls with laughter at our comical efforts to selfishly control the dance of life.

**Cultural Evolution**

Genetic evolution is billions of years old, as old as life on Earth. Cultural evolution is not about genes, it's about the realm of learned information — beliefs, ideas, knowledge, habits, and so on. In hominins, genetic evolution proceeds through millennia at a snail's pace, but cultural evolution can sometimes advance at great speed. We are complicated critters, and so is our cultural world. During our pilgrimage from womb to grave, every human floats in the currents of culture, like fish swim in water.

When someone's leg is amputated, they can be fitted with a prosthetic leg. Warm clothing is prosthetic fur. Heated dwellings can provide a prosthetic tropical climate in Siberia. Carnivores succeed via speed, strength, teeth, and claws. Human hunters have learned that they can kill large animals with prosthetic gizmos like lances, javelins, arrows, bullets, etc.

Chimps have a simpler culture. They snatch insects and lizards with their hands. Chimps can catch, kill, and disassemble animals the size of a 25-pound colobus monkey with their bare hands. Indeed, their million-year track record of traditional simplicity has been genuinely sustainable. Their knowledgebase is modest, limited to local affairs, in the here and now. They learn by observing and imitating their elders — exactly enough information to live sustainably from birth to death. Perfect!

When I was a young lad, I was forced to spend years in classrooms, preparing to be an obedient, punctual, productive cog in the industrial society that's pounding the planet to pieces. Like an assembly line, students had their brains filled with government approved cultural information.

Priests used to boast: "Give me your child for his first seven years, and I will have him for life." The cultural information you are imprinted with in childhood usually solidifies like concrete, beliefs that are held until your final breath. This works perfectly in sustainable wild cultures, where kids learn healthy time-proven knowledge. It sucks in super-toxic cultures, where folks are rewarded for living too hard, and thinking too little.

Over millions of years, evolution provided giant tortoises with large bodies, invincible lion-proof shells, and long lifespans. In the blink of an eye, these advantages were rubbished when hominins moved into the neighborhood, and began killing 200-year-old tortoises with big rocks. This hunting method was not a gift fine-tuned by evolution. It was a sudden innovation that popped into the mind of a hungry hominin — and it worked! Invincible tortoises were immediately transformed into helpless sitting ducks that didn't have a bright future. Evolution was yanked out of the driver's seat. Ancient rules no longer mattered. Cultural evolution (human cleverness) became the new sheriff in town. It conjured fire making into existence, a powerful juju that radically rewrote the future.

Alfred Crosby wrote, "Ten and twenty thousand and more years ago members of the *Homo sapiens* species, furnished with firestick, atlatl, and latterly, many of them, with bow and arrow, were the most dangerous, adaptable, and widespread of all large land animals. They were equipped to be the champion imperialists of their entire phylum, to solve problems abruptly and, if necessary or if simply so inclined, by broadcast violence."

George Basalla wrote, "No technology whatsoever is required to meet animal needs." "There are no fire-using animals nor are there animals that routinely fashion new tools, improve upon old tool designs, use tools to make other tools, or pass on accumulated technical knowledge to offspring."

"Instead of relying on nature directly for sustenance, we have devised the wholly unnecessary techniques of agriculture and cooking. They are unnecessary because plants and animals are able to grow and even thrive without human intervention, and because food need not be processed by fire before it is fit for human consumption."

Paul Ehrlich once spent time among the Inuit of Hudson Bay, Canada. He was surprised to discover that the entire knowledgebase of their cultural information was known by everyone — how to hunt seals, tan pelts, weave a net, sew a coat, and so on. In Ehrlich's own culture, nobody knows even a millionth of our cultural information. Most of us know little or nothing about ecological sustainability.

Genetic information moves in a slow-motion one-way flow, generation by generation, from parents to offspring. Cultural information can instantly flow in all directions, to many people around the world, with the click of a mouse. Genes with serious defects don't stick around. Unfortunately, remarkably stupid ideas can sometimes rapidly infect large numbers of people, and grow deep roots. But it's also true that crappy ideas can be tossed overboard and become extinct. Cleverness is messy stuff.

**Social Structure**

You and I are tropical primates, and our family tree originated in Mother Africa. Africa played a primary role in the evolution of our bodies and minds. Our hominin ancestors were hunter-gatherers for at least four million years. This way of life did not allow them to live in large groups. Too many hunters spoil the ecosystem.

The key to success was to live in small groups of maybe 15 to 30, work as a team, and move elsewhere when food got scarce. The normal daily experience of wild hominins included constant exposure to a wide variety of other species. In the family of life, we were a wee minority group, not the dominant animal. Ancestors spent every day of their lives in a healthy natural habitat, not an ugly noisy stinky industrial gulag of concrete and steel.

Joe Kane spent time in the Amazon rainforest. He was impressed by the fact that Huaorani men and women enjoy equal status. It was always unacceptable to give orders, or to raise a hand against a woman or child. Family harmony was important. He noted that, prior to contact with outsiders, most Huaorani never encountered more than seventy or eighty people during their entire lives, most of whom they knew by name. Imagine that.

Mentally, we are far more comfortable being in small groups where we are known and respected. It's not pleasant being a stranger in a vast mob of strangers, day after day, year after year. You can begin to feel like a zoo animal, serving a life sentence for being born in the wrong place at the wrong time.

Functioning as a wild hunting and foraging team was very different from civilized life. Sharing was essential. Nobody went hungry unless everyone did. Louis Liebenberg mentioned a study of San hunters. Of those aged 15 to 38, just 17 percent of the hunters were responsible for 70 percent of the kills, while half of the hunters killed nothing at all. If meat was not shared, many would starve, and the community would blink out. Cultures had different methods for distributing portions of the meat, but this task was never a job for the day's lucky hunter, and his portion was never the largest.

It was essential to avoid personal conflicts, and to promptly resolve the ones that occurred. Clans typically had time-proven strategies for nurturing good interpersonal relationships. A humble and respectful demeanor encouraged warm drama-free relationships. Self-deprecating discourse (the opposite of boasting) was common among wild people. Peter Freuchen wrote that when an Eskimo hunter brought home a primo feast, he would shamefully apologize to the others for bringing back crappy meat that was unfit for dogs. The people nodded, smiled, and enjoyed the feast.

Bands of nomadic hunter-gatherers had no tolerance for bigheads. Whenever someone displayed the first symptoms of pride, they were mocked, teased, or shunned — whatever was needed to restore the swollen head to normal size. Then came reconciliation and forgiveness. Uppity males who could not be reformed might be deported to other clans. Incurable jerks sometimes had to be euthanized.

Christopher Boehm described how an American anthropologist created an ugly scene while staying with the Utku Eskimos of northern Canada. She behaved in an ordinary American manner, sometimes a bit moody, occasionally displaying a flash of anger when irritated. This was totally uncool in a culture where folks spent long, dark, frigid winters in close company. Folks were expected to smile, laugh, and joke — to display good manners.

Everyone's highest responsibility was to maintain the stability of the group. In the Utku culture, except for childish outbursts, it was rude to show your emotions, because strong thoughts can kill or cause illness. Anger was dangerous juju, highly toxic. Eventually, the natives ran out of patience with the American, and she became a nonperson.

A primary benefit of nomadic life was that you couldn't have more belongings than you could carry in both hands. This avoided all of the bad juju of hoarding, inequality, and hierarchy — the core curse of modern society. In regions having abundant wild food, like the Pacific Northwest, tribes became sedentary, lived in permanent dwellings, and became able to hoard stuff. Those with lots of stuff tended to look down on folks who don't. Inequality was a reliable cause of resentment, conflict, and bloodshed.

Lakota writer Vine Deloria noted that everyone is a descendant of tribal ancestors. In each tribal homeland, unique spiritual traditions emerged, fine-tuned to its landscape, ecology, and climate. Every homeland had sacred places where the community participated in special ceremonies. They had no religious controversies because everyone had deep roots in the homeland, and shared a common historical experience — cultural identity was unified.

In modern society, neighborhoods are constantly changing swarms of occupants having highly diverse incomes, ethnicities, religious beliefs, and political views. People may live side by side for years, yet have nothing in common, and sometimes intense differences. Many do not know the names or faces of most folks in their neighborhood. This is not a coherent community sharing a profound sense of responsibility for the wellbeing of their ecosystem.

Johann Georg Kohl spent six months in 1855 with the Ojibway people living in the Lake Superior region. He was surprised to see that the Ojibway heathens actually practiced what the Christians preached. "There are no rich men among them." An Indian will not hesitate to share his last meal with a hungry stranger. The principle is "that a man must first share with others and then think of himself." No man, not even a cripple, considered another Indian to be his superior.

Colin Turnbull spoke fondly of Father Longo, a Catholic missionary. Pygmies had no word for evil. “In order to convert them, then, he would first have to teach them the concept of evil, and that he was not prepared to do.” He left them unmolested.

John Gunther saw that folks in a wild animist African tribe shared traditional spiritual beliefs. When missionaries taught them Christianity, it was highly disruptive, because it taught the importance of the individual, a foreign idea. Amitav Ghosh noted that Protestantism especially encouraged Man to dream of achieving his own self-deification, by radically isolating himself before an arbitrary God.

Jay Griffiths wrote that missionaries in South America often provided the natives with mirrors, to heighten their sense of individuality. While you might have a salvation experience, your less virtuous friends and family might be destined for a horrific afterlife.

Knud Rasmussen traveled across the Arctic, from Greenland to Siberia, from 1921 to 1924. He enjoyed the Eskimo people. “A notable feature was their lively good humor and careless, high-spirited manner.” The women worked very hard, but “they were always happy and contented, with a ready laugh in return for any jest or kindly word.” Eskimos perceived whites to be uptight and coldly impersonal.

Richard Lee spent time with the !Kung (San) of the Kalahari Desert. He noted that the women were quite independent from their parents and husbands. “The many forms of sexual oppression that women experience in other societies, such as rape, wife battering, purdah, enforced chastity, and sexual double standards are absent in !Kung society.”

### Technological Innovation

When a hungry chimp snatches a small monkey, termite, or bird egg, all she needs to eat it are fingers and teeth. When a hungry baboon discovers a carcass abandoned by lions, he can chew the meat and fat off the bones and hide. It’s very different when a persistence hunter chases a large kudu until it is exhausted, and then suffocates it. What now? Imagine turning a roadkill deer into a feast without a knife. Have a bloody good time!

Chimps use slender sticks to fish for termites. They use clubs and rocks to aggressively attack critters that annoy them. Macaques use stones to smash open shellfish. Vultures use rocks to open ostrich eggs. Ravens use gravity to crack open the nuts they drop. This is not complex technology.

Our ancestors began a transition from found tools to manufactured ones. The oldest ones discovered so far, mostly simple choppers, were found in Africa, and date to about 2.5 million years ago. A major advance emerged around 1.5 million years ago — biface knapping. Some types of rocks, like obsidian or flint, can be carefully knapped to knock off flakes having razor sharp edges. These were useful as scrapers, knives, and choppers. Later, ancestors learned how to knap long sharp blades, and attach them to handles. Still later, they became skilled at chipping flakes into delicately shaped spear points and arrowheads.

In a culture of glowing screens, people look down on the primitive technology of our early Stone Age ancestors. In reality, stone tools were revolutionary inventions that shifted the hominin saga onto a new, unusual, and risky path. For the first time, folks could effectively skin and butcher large animals — an ability that greatly expanded their food resources, and provided high quality nutrients for their jumbo-sized energy-guzzling brains. Imagine a world in which teeth were the only cutting edges for any purpose. Civilization would be impossible. It's unlikely that hominins would have ever evolved.

Kathy Schick and friends once successfully butchered a dead elephant with stone tools. A mature adult's rugged hide is about one inch thick (2.4 cm). Scavengers like hyenas don't even bother trying to chew into the carcass of an elephant that recently died. They let it bake in the sun for a few days, allowing decay to soften it up.

Our ancestors used sharp cutters to remove hides, cut meat off bones, and dismember the carcass into portions easier to haul back to camp. They used stone hammers to smash open bones, to extract the marrow, which was rich with fat. Fat is an essential nutrient, and the meat of wild game has only one-seventh of the fat found in supermarket beef, according to Schick. Ancestors may have scavenged elephant carcasses, but adult pachyderms may not have been prime targets for hunters. Once you strip the meat off of the exposed side, flipping over a dead elephant is a huge challenge. Smaller game takes less effort.

We have no idea when spear technology was first developed. It could have been two or three million years ago. Wooden artifacts are highly prone to decompose over time. Spears were also revolutionary. They made it easier to kill large game, and allowed the ancestors to be less dependent on scavenging. Spears were also useful for discouraging attacks from man-eating predators.

Thrusting spears, or lances, were driven directly into the prey by hungry hunters, at close range. Javelins were thrown spears that could kill from a distance, which was much safer. Carleton Coon mentioned a tribe that could hurl long spears with deadly accuracy from up to 180 feet away (55 m).

The oldest spears found so far were discovered in a coal mine at Schöningen, Germany. Frederick Coolidge and Thomas Wynn wrote that seven spruce spears, a throwing stick, and other tools were found near ten butchered horse carcasses. The spears were 400,000 years old, up to 6.5 feet long (2 m), scraped smooth, and pointed at both ends. They were made by the ancestors of Neanderthals (*Homo heidelbergensis*).

At some point, the killing power of spears was boosted by the invention of the atlatl, a spear-throwing device that enabled the projectile to be hurled faster, and four times farther. Alfred Crosby said that projectiles could be thrown up to 328 feet (100 m), and were highly accurate within 130 to 165 feet (40-50 m). In Peru, an Incan warrior with an atlatl could send a short spear completely through a conquistador wearing metal armor.

The atlatl required the hunter to stand up prior to launching, which often gave the surprised game a chance to flee or attack. The bow and arrow allowed the hunter to shoot from a concealed position, and fire every six seconds with great accuracy. Nobody is sure when the bow and arrow was invented. Like the spear and atlatl, this deadly technology spread around the world, and over time enabled the slaughter of countless millions of animals.

Of course, with state-of-the-art weaponry, well fed clans grew in number, conflicts increased, and hunters increasingly had to also turn their weapons on strangers who encroached into their territory.

A bloodless alternative to conflict was migration into lands uninhabited by hominin competitors. Many frontier regions introduced the ancestors to new species of prey, and clever folks invented specialized technology for killing them. Joe Kane spent time with the Huaorani people of the Amazon rainforest. Their armory included spears and blowguns. Poison darts would kill monkeys in the branches above, requiring the hunter to climb up and retrieve them. Over time, lads who did a lot of tree climbing developed odd-shaped feet. Their big toes bent outward, providing a tighter grip.

Carleton Coon mentioned other tribes using different poisons that relaxed the muscles of monkeys, so they would fall from the trees. No climbing needed. Pygmy poisons were a potion made from snake venom, beetle larvae, and ten different plants. They paralyzed muscles and stopped the heart. In Japan, the Ainu built booby traps, in which deer tripped on a cord, and a bow shot a poison tipped arrow into the animal.

When marine mammals were speared, their corpses often sank into deep waters, never to be retrieved and consumed. The solution was to carve barbed detachable harpoon heads which would not pull out of the animal's flesh. The embedded head was attached to a cord linked to the hunter above. When the dead animal sank, it could then be retrieved and invited to lunch.

Innovation also led to the use of rock-throwing slings, bolas, hunting nets, traps, and on and on. You could fill a book on this subject, and Crosby did, covering the entire spectrum from rocks to nuclear weapons. Humans are remarkably creative when it comes to devising an endless stream of new and improved systems for killing things. It's been a nonstop arms race.

The wheels of innovation spin faster when populations grow, and become able to support more and more nerdy specialists. Also, trade with other regions brings distant groups into contact, where they are exposed to the gizmos and ideas from other cultures, and this can greatly stimulate the imaginations of anxious nerds. The velocity of change in my lifetime has been a hurricane, impossible to keep up with.

Craig Dilworth described what he called the Vicious Circle Principle (VCP), a cycle in which (1) scarcity spurred technological innovation, (2) innovation increased access to more resources, (3) more resources increased consumption, (4) increased consumption fueled population growth, (5) population growth led to resource depletion, and (6) resource depletion led to scarcity once again.

The VCP cycle keeps repeating, each time ratcheting up the impact, until it eventually slams into firm resource limits, or chokes to death on its own pollution. Some hunter-gatherer cultures managed to survive into recent times in a low impact manner — until the vicious circle mob barged into their world via loggers, miners, missionaries, and so on.

Dilworth noted that, from its beginning, technological development has degraded ecological health and balance. Should we be proud of our legendary wizardry? Species that don't manufacture tools, like chimps, never experience this predicament. Our current technological utopia, swarming with billions of hominins, continues to work tirelessly to destroy the ecological basis upon which it depends, a one-way dead-end path. How smart is that?

Evolution is brilliant! When predators are free to perform their natural ecosystem services, their prey do not experience population outbursts. Chimps make no effort to exterminate the big cats that prey on them, consequently there are not eight billion chimps pounding the stuffing out of the planet. The sacred dance of predator and prey works beautifully until it gets blindsided by technological innovation. Technology improved our abilities at offence (killing game) as well as defense (exterminating competing predators). Balance got blown out of the water. Being too clever at survival is a ticking time bomb.

Dilworth mentioned that by 200 B.C. the leopards and lions of Greece, and along the coast of the Near East, were gone. Several centuries later, tigers no longer survived in northern Persia and Mesopotamia. Predator extermination is a standard process in cultures that enslave domesticated animals. Today, few wild high-level predators survive in most of the civilized world.

Environmentalists tend to focus their campaigns primarily on problems related to modern technology, because they think it's especially terrible. Dilworth's VCP sees all technology as dangerous and unnecessary. Across Eurasia and the Americas, megafauna extinctions surged between 10,000 and 30,000 years ago — in the Stone Age, prior to agriculture and civilization, when fewer than ten million humans likely wandered the Earth. It was an ecological beating that our culture has largely swept under the rug. As we pedal to work, we are also careful not to think about the sixth mass extinction that is happening right now. Of the six, this is the one and only mass extinction caused by a single species.

The bottom line for Dilworth is that if technological development was truly wisdom-driven, intelligent, and beneficial, it would not have transformed the planet's healthy genuinely sustainable wild ecosystems into toxic devastated wastelands, depleted countless precious resources, and sabotaged the climate. Why do we continue proudly teaching children about our magnificent big brains and the wonders of progress? The good news is that the VCP cycle is unsustainable, and will eventually blink out. What will be left when it does?

**Modes of Communication**

All forms of life, both plants and animals, seem to communicate in various ways, sending and receiving information with the life around them, via sounds, smells, chemicals, behaviors, gestures, and so on. When I walk through a forest, I often hear warnings of my arrival being announced by noisy birds or squirrels. On dark nights, when I quietly wander past a pond where the spring peepers are roaring in celebration, they all suddenly become silent. In a rainforest, some calls warn of an approaching leopard, while different calls broadcast a snake alert.

Modern humans do not perceive or understand most of the constant communication taking place in the natural world. Jon Young learned nature awareness from his mentor, Tom Brown, and became highly attuned to bird language. One time, he went along on a field trip with ornithology students. He heard a bird call. It was announcing the approach of a Cooper's hawk, warning nearby critters that a predator was getting close. Pay attention!

Jon mentioned this to the others. The professor gazed at the sky, saw nothing. He winced and hissed "that's impossible!" A minute later, the hawk came into view. Wow! Jon's classmates were astonished that the professors, who were card-carrying bird experts, were clueless about bird language.

Clive Finlayson mentioned that hunters in Spain still use traditional technology to attract birds. During breeding season, they blow on rabbit bone whistles that imitate the mating calls of quails. Upon hearing the fake urgent pleas for hot romance, lust-crazed males would speed to the hunters, who could then catch them with their bare hands.

Nonhuman animals communicate about the here and now: "tiger coming." Without words, baboons can communicate irritation, contentment, excitement, and so on. In addition to this basic mode, humans also have the ability to vocalize unusual sequences of grunts, clicks, gasps, and moans. Words enable the possibility of extremely complex communication. We can jabber about the here and now, the future, the past, events in other places, and a million other subjects. We can talk to ourselves, out loud or mentally.

Communication is sometimes mysteriously telepathic. Robert Wolff was astonished by the Sng'oi people of Malaysia. Whenever he made a rare unannounced visit, someone would be waiting for him on the trail, ready to lead him to their current camp. How did they know he was coming? They said that a feeling inspired them to go to the trail, be there, and respond to what happened. Jon Young told a similar story about the Bushmen of the Kalahari. Unannounced visitors always found someone waiting for them.

We are the word critters. Words bounce off our lips and tongues, zoom through the air, and plunge into the ears of others. We learn words, speak words, hear words, think words, dream words. Nobody knows exactly when hominins began using words, but many scholars have imaginative opinions, none of which are supported by compelling archaeological evidence.

The first words babies learn are nouns (mama, dada). Then comes verbs, stuff to do (pee, poop, eat). Later comes feelings (happy, sad, tired, afraid), and abstractions (good, bad, progress, capitalism). At about 18 months, we begin assembling words into sequences. Everything significant to us has a name — other people, species of plants and animals, rivers, hills, stone formations, stars, tools, and countless others.

Paul Shepard wrote about two scientists who raised young chimps in their home, along with their own children of similar age. The chimps were at least as intelligent as children, until the children were three or four, learned language, and left the chimps in the dust. If the kids had been raised by wild chimps, they would have grown up to be intelligent animals, free from the enormous burdens of our cultural baggage, much of it unwholesome and crazy making.

Carleton Coon, who studied the cultures of hunter-gatherers, pointed out an ironic twist of spoken language — it could also make effective communication impossible. When two hunting cultures came into contact, and they weren't happy to see each other, they could not negotiate a peaceful resolution if they spoke completely different languages. Both sides could only exchange meaningless gibberish and frustration. This could lead to using the universal language of violent conflict. He thought that only humans suffered for this. Can wolves from Michigan communicate with wolves from Wisconsin or Minnesota? I suspect they can.

Complex language was certainly an asset for survival in the hunter-gatherer days. It increased our ancestors' ability to conjure clever new tricks and accumulate them. Over time, the power of the word critters intensified. At some point in the long journey, excess cleverness forced them to swerve over the line of ecological balance, and into the helter-skelter lane. Hominins got too big for their britches in the dance of the family of life.

Cleverness never rests. The growing herd developed a growing ecological footprint. Food resources became more and more scarce, encouraging the transition into plant and animal domestication. By and by, this led to a huge escalation in the power of the word critters. They learned how to encode words into visual symbols that could be penned or painted onto papyrus, scratched into clay, chiseled into stone, cast into metal, converted into digital pixels, and so on. Then the word symbols could be arranged into sequences that conveyed important, detailed, informative meanings (similar to the fascinating stories told to hungry San trackers by the spoor of horny warthogs).

Julius Caesar described the French in 51 B.C. There were two groups in Gaul's upper class, Druidic priests and warriors. The priests provided spiritual guidance, resolved conflicts, and oversaw sacrifices. Their training, which took up to 20 years, required them to memorize a large collection of verses. Druids shunned writing, because it weakened memory, a crippling handicap. Consequently, we know almost nothing about them today.

A few pages back, we saw how the rate of technological innovation was accelerated when people lived in dense populations, and were exposed to ideas and gizmos from other cultures, via long distance exploration, trade, and conflict. In the digital age, the flow of exotic information has shifted into warp drive. Technology enables written words, spoken words, and images to be sent to the other side of the planet in a second, with the click of a mouse.

On my bookshelves are rows of manuscripts written by many thinkers, from different cultures, from different eras — a crowd of interesting minds and stories. We have never before been able to store such vast amounts of information. And we have never before lived in such a destructive manner. This is not a coincidence. Almost all of that information is about stuff that is unhealthy, unnecessary, and unsustainable — not passionate celebrations of love for the beauty of the world.

Industrial civilization is already in the early stages of collapse, and this is obvious to folks who are paying close attention to reality. Some worry that collapse will lead to a catastrophic loss of accumulated information. Some day in the coming decades, the grid, the lights, the laptops, and the cell phones will go dark forever. I expect that there are folks alive today who will see the last car die, and the last supermarket close. Without ongoing maintenance, time will eventually compost our wonderful libraries. When the oceans of modern data evaporate and fade from memory, our information will come from fireside stories, the here and now, and the ecosystem we inhabit.

Jon Young has devoted his life to helping people restore three types of damaged connections — connection with others, connection with self, and connection with nature. My generation grew up playing outdoors with the neighbor kids. I was lucky to live close to forests, lakes, and open land. We had no iPods, cell phones, video games, or laptops. Our social networking was face to face, in the here and now, and preferably outdoors.

We were at home in nature. We built forts, climbed trees, went swimming, and caught frogs, turtles, salamanders, night crawlers, and fish. We played until mom called us home. Where I live now, it's common to see tweakers, junkies, and other homeless folks camping amidst trash piles throughout the neighborhood. It's getting unusual to see children playing outdoors.

Most of us spend most of our lives indoors, and our visits outdoors usually take place in manmade surroundings. Few of us spend our entire lives in the place we were born, and develop an intimate and reverent relationship with the wild ecosystem around us (if any). This is a most unusual situation for tropical primates, or any other animals. We can be something like the lads who walked on the moon in their silver spacesuits — lost, disconnected, homeless wanderers.

Folks in a post-collapse world are going to be devoting most of their attention to daily survival. This will require them to actually wander out into their ecosystem, on foot, and attempt to blend into it. When the land provides you with fish, nuts, and berries, you feel gratitude and respect. You develop an intimate relationship with the family of life around you.

## Out of Africa

As hominins gradually wandered out of Africa, they first moved eastward, across the tropical regions of Asia, and eventually to Australia. Adapting to these tropical ecosystems was not a huge challenge for tropical primates. Pioneers found new sources of food, and new sources of danger.

The climate was comfortable, food was available year-round, and the bare-naked look was very trendy. Pioneers probably took fire-making and stone knapping knowledge with them. Later, they began wandering north into snow country — regions of Europe and Asia that had a temperate climate. The transition to frost country was more challenging.

William Rees noted that every species has two traits. (1) They will expand to all locations that are accessible to them, where conditions might allow their survival. On the other hand, negative feedback can discourage new expansion, or encourage retreats. The climate might be hostile. Food or water resources might be scarce. Powerful predators or hostile people might live there. So, might disease agents, like tsetse flies, malarial mosquitoes, or parasitic worms.

For walking critters, the area accessible for expansion has limits. People with domesticated horses or camels have greater potential for long distance expansion. The same is true for folks having watercraft that can travel on rivers, or move across seas and oceans. Also, folks with flying machines, or driving machines. Critters that know how to make fire, sew warm clothing, and have shelter can expand into snow country.

(2) When critters expand into new habitat, they will learn how to utilize all available resources — until they smack into limits, and have to back off. This is no big deal for animals that live as they naturally evolved to live — without complex tools. When a resource becomes scarce, they can switch to a substitute, if any, or they can move elsewhere, or they can turn into cat food.

Technology can expand what resources are available. A mammoth is not a resource that an empty-handed hominin can utilize, but a hominin with a thrusting spear, stone blade, and fire drill can. Fishing with a hand net is one thing, a motorized trawler is another. Hunter-gatherers did not mine and smelt ores, fabricate machines, drill oil wells, or replace wilderness with mega farms growing millions of tons of corn — but industrial civilizations do.

As you can see here, there are limits to expansion. Innovation and technology can push back narrow limits, sometimes to a huge degree. For example, 10,000 years ago, the human population was maybe 10 million. Today, its more than eight billion, thanks our ability to cleverly bypass countless limits to growth, our feeble ability to foresee the unintended consequences, and our reluctance to use critical thinking to question reality when we're enjoying regular meals. This is fantastically unsustainable.

**Hominin Wanderers**

Anyway, hominins emerged in Mother Africa, and eventually expanded around the world. This was not unique. Long before hominins appeared, many "ordinary" animals travelled widely — mammoths, horses, wolves, salmon, bears, bison, migratory birds, and so on. These species did so gradually, allowing evolution to fine tune them for new conditions — with zero dependence on technological crutches.

Much later in the hominin saga, *Homo sapiens* emerged, maybe 300,000 years ago. In Africa, this time period is sort of a black hole in the archaeological record. Minimal evidence has been found. Paul Jordan wrote that the geologic chemistry of African caves was lousy for preserving bones, while the limestone caves of Europe were excellent.

By and by, our human ancestors wandered out of Africa, and entered the Middle East somewhere around 130,000 and 100,000

years ago. Clive Finlayson suggested that this was not an exodus to escape problems, and it was not purposeful — brave pioneers eager to explore the unknown. Folks just gradually moved into new regions over the span of many generations, like roaming herds of bison, going where their stomachs led them. It was a wonderful luxury to have free access to uninhabited lands that were rich with resources.

The early pilgrims were probably small groups, and there were likely multiple expeditions over the centuries. They wandered eastward, across tropical regions of Asia, and arrived in Australia maybe 50,000 years ago. Humans began migrating into Eastern Europe about 36,000 years ago, and arrived in Portugal 2,000 years later. Finally, folks wandered into the Americas maybe 13,000 years ago, maybe earlier.

Moving through the tropical regions of Asia was not a daunting challenge for critters that evolved in tropical Africa. They didn't need clothing or warm shelters. Meat and plant-based foods were available year-round. In Asia, as in Africa, they remained vulnerable to man-eating predators that were big, strong, fast, smart, and armed with sharp teeth and claws. In both continents, our ancestors were at a distinct disadvantage — smaller, weaker, slower, and wimpy in the teeth and claws department. Back then, the notion that we could someday become the dominant animal on Earth seemed hilarious.

Self-defense was a primary challenge. Folks likely kept a fire burning all night, with someone staying awake on guard duty. They used spears, clubs, rocks, and impolite suggestions to discourage unwelcome visits from their hungry carnivorous neighbors. In those days, being a walking meatball 24 hours a day inspired folks to constantly pay acute attention to the sights, sounds, smells, and patterns of the surrounding reality (unlike today's cell phone zombies). Like all other animals, it was not common for humans to die from old age. The other primary challenge was regularly acquiring food.

**Fearless Prey**

OK, now pretend that it is 75,000 years ago, and you are a huge, powerful, ass-whooping aurochs munching on the greenery along a river in tropical India. One fine day, a few strange animals appear in the meadow — brown, hairy, stinky, fairly small, oddly walking on two legs, and carrying long sticks. What the are those? You sense no danger and continue grazing. Healthy mature aurochs fear no other animals. Large carnivores prefer to attack game that is less likely to tear them to bloody shreds. Suddenly, the gang of alien critters charge and ram their sticks into you. Game over.

Thanks to predator control programs run by the U.S. government, wolves ceased living in the Tetons for 50 years. By and by, new generations of elk and moose lost their memory of wolves. Later, some wolves from Yellowstone began drifting back in. They were delightfully surprised to discover herds of delicious animals that had

completely forgotten their natural fear of wolves. William

Stolzenburg wrote that wolves could simply stroll into a herd and snatch away their calves. Eventually, animals realized that wolves were dangerous predators, and promptly rewrote their survival manuals.

Back in Mother Africa, no critters ever forgot that lions, leopards, hyenas, and humans were vicious serial killers. Because predators and prey coevolved over thousands of years, African game animals were better adapted for evading human hunters.

Paul and Anne Ehrlich wrote, “The world is, and has long been, truly a dynamic coevolutionary wonderland.” Coevolution was a safety net that set limits on hunting success. It nurtured balance in the sacred dance of predator and prey, and encouraged long-term ecosystem stability.

When human pioneers wandered away from their original African homelands, they entered lands where they were not restrained by the limits of the coevolution balancing act. A wide variety of animals had no fear of them, because they were not perceived to be predators. They were mysterious space aliens.

Elizabeth Kolbert noted that humans are not notably swift, strong, or fertile, but we’re resourceful. When our ancestors moved into new regions, “none of the usual constraints of habitat or geography seem to check them.” Game was fearless, and hunting weaponry enabled lads to kill animals 20 times bigger than themselves. They could live like gods. Abundant food enabled rapid population growth.

In 1921, Knud Rasmussen’s Arctic expedition made a winter camp on Danish Island. Out on a walk, “we encountered a hare so amazingly tame that we were tempted actually to essay his capture with our bare hands. Soon afterward, we spied a lonely caribou who at once was all curiosity and came running toward us to investigate these strange visitors. Never before had I encountered from animals such a friendly greeting.”

Tim Flannery wrote about the elephant seals that lived on Tasmania’s King Island. Some weighed up to four tons. When hunters found them, the seals calmly watched as the animals around them were killed. It was a surreal experience. The hunters felt like gods. In 1802, when European explorers arrived at Kangaroo Island, off the south coast of Australia, the fearless kangaroos could be calmly approached and shot in the eye, or smacked with a club.

In 1805, when the Lewis and Clark expedition was crossing into Montana, Lewis wrote, “The buffalo, elk, and antelope are so gentle that we pass near them while feeding, without appearing to excite any alarm among them, and when we attract their attention, they frequently approach us more nearly to discover what we are, and in some instances pursue us a considerable distance apparently with that view.”

In 1887, William T. Hornaday wrote about the fearless bison in the U.S. west. “He was provokingly slow in comprehending the existence and nature of the dangers that threatened his life, and, like the stupid brute that he was, would very often stand quietly and see two or three score, or even a hundred, of his relatives and companions shot down before his eyes, with no other feeling than one of stupid wonder and curiosity. Neither the noise nor smoke of the still-hunter’s rifle, the falling, struggling, nor the final death of his companions conveyed to his mind the idea of a danger to be fled from, and so the herd stood still and allowed the still-hunter to slaughter its members at will.”

On numerous islands, the first explorers found that the wildlife was incredibly tame. Birds could be killed with a stick, and many islands were home to enormous bird communities. Thriving colonies of fish knew nothing about hooks or nets. When legions of sea turtles came to nest, they were sitting ducks. For a while, newcomers to islands enjoyed an easy life of feasting — until limits began raining on the party.

## Surplus Killing

Sometimes hungry predators kill more prey than they need, and abandon what they can’t use. Often surplus carcasses are simply abandoned, tasty offerings for the local scavengers. Other times, the killers will return to the site in the following days to continue dining. Surplus killing is common with many species including badgers, wolves, red foxes, leopards, lions, spotted hyenas, bears, coyotes, lynx, feral dogs, house cats, and humans.

In Tanzania, a pack of 19 spotted hyenas once attacked a herd of Thompson's gazelles, killing 82, and severely injuring 27. Only 16 percent of them were eaten.

During a severe Minnesota winter, when the snow was very deep, the deer had a hard time moving. Wolves killed every one they found, leaving many uneaten.

Sometimes surplus killing is deliberate and purposeful. Weasels kill voles as winter approaches, and leave them in burrows for later dining. In Alaska, a wolf pack killed 17 caribou in early February. Over the next three months, they returned, dug up carcasses, and continued dining on them.

Barry Lopez spent time with native Alaskan hunters, and wrote a book about wolves. When a wolf chases and confronts a caribou or moose, their eyes meet, and their spirits communicate, in what Lopez calls the conversation of death. The prey can choose to resist, which sometimes works, or they can attempt to flee, which sometimes works. A sick or elderly prey might indicate surrender — take me, let my healthy comrades live. Or, the wolves might suddenly end the confrontation and walk away. If there is to be a death, both predator and prey choose this outcome during their spirit-to-spirit ceremony, wrote Lopez.

Wolves and moose have coevolved for a very long time, and both comprehend the sacred power of the life and death encounter. They are fully aware of what is happening. Wolves know that a strong, healthy, mature moose can splatter their skulls with a swift kick. When wolves are desperately hungry, the risk of injury is secondary to the risk of starvation.

Domesticated animals are a different story. Many have had their wild intelligence bred out of them, rendering them passive and infantile. So, when the hungry predator confronts them, and it's time for the conversation of death, the prey's wild spirit is absent — the lights are out, nobody is home, a truly pathetic situation.

In South Africa, one leopard killed 51 sheep in a single attack. There are a number of stories of wolves killing 20 or 30 sheep and just eating 2 or 3. If a herd of prey makes no effort to flee, or are helplessly trapped, predators sometimes keep killing them. In the family of life, predators evolved to be natural born killers. Their sacred mission is to discourage population outbursts in prey species, and the consequent ecosystem impacts. They help maintain balance.

It's daunting to contemplate the ongoing expansion of highly skilled human hunters into new regions outside of Mother Africa, where they certainly encountered fearless prey. Did the human hunters instinctively treat fearless critters the way hungry wolves treat clueless sheep? As humans entered Australasia, Eurasia, and the Americas, large animal extinctions followed. They were the most desired prey, and they had not coevolved with heavily armed tropical primates.

**Smashing Limits**

Fearless prey was a lucky but temporary windfall jackpot for migrating hominins. Another major asset was our ability to digest a highly diverse diet of plant and animal substances. Because we aren't fussy eaters, we can survive changing conditions better than many other species. This advantage was greatly expanded by our unique ability to cook foods. We can nourish ourselves in chilly Greenland, steamy Amazon rainforests, and the scorching Sahara. In recent times, humans have also become the top carnivore in marine ecosystems, despite the fact that we don't even live in the water.

Over the span of millions of years, animal species of all types and sizes evolved time-proven anti-predator strategies for self-defense — flying, fleeing, swimming, climbing trees, diving into burrows, injecting venom, counterattack, camouflage, and so on. These ancient strategies worked fairly well, but not every time. Predators needed sustenance too. Ideally, predators and prey lived in relative balance.

When musk oxen were attacked by wolves, the group backed up together into a circle, butt to butt, with their horns facing outward, and patiently waited for the hungry predators to give up and have a good cry. When raccoons, squirrels, or bear cubs were attacked by predators, they zipped up the nearest tree and giggled at the frustrated killers. These excellent time-proven strategies failed when heavily armed hominins arrived with their deadly projectiles.

For many grassland herbivores, speed was an essential predator defense strategy. Pronghorn antelopes can run for more than 20 miles (32 km). They can flee at speeds up to 70 miles per hour (112 km/h), for up to two miles (3.2 km). Pronghorns originally evolved high speed flight to outrun hungry high-speed cats — species that went extinct maybe 12,000 years ago. Today, wolves and coyotes are way too slow to get them. Sadly, ranchers have installed some fencing on the prairie. While pronghorns can jump over bushes, they are often wary about leaping over fences, and instead struggle to crawl under or through them. So, when hunters pursue them, they pile up at fences, which enables mass kills.

When bison are attacked by natural predators, grazing stops, and running begins — the whole herd following the leader. Slower animals, like calves, the elderly, and the sick or injured become the main course at lunch time. This strategy worked well for millions of years until Neanderthals and humans organized communal hunts, and chose locations where fleeing herds could be guided into traps or off cliffs. In this situation, follow the leader escapes could be disastrous.

For eons, sea birds, sea turtles, and marine mammals found security by living on islands. This advantage was diminished by the invention of canoes, kayaks, harpoons, and so on. Many of these island animals lived in a way that made them highly vulnerable when hungry aliens washed up on shore. Many had a hard time fleeing or hiding.

Critters that found security in camouflage or concealment became far more vulnerable when hominin hunters set fire to the grass. Excellent camouflage lost its advantage when dogs joined the hunt. Their powerful sense of smell enabled them to quickly find prey that were difficult to see. Critters that evolved the ability to make high speed escapes became more vulnerable when hunters began riding horses. When hunters used both horses and dogs, game was far less likely to survive.

Evolving to jumbo size was another very effective anti-predator strategy. Big, strong, healthy, mature elephants, rhinos, and hippos had little reason to fear wild carnivores. Size mattered. Predators preferred to kill their youngsters, because they were less dangerous, and easier to kill. Jumbo size species have far lower rates of reproduction. Wee critters, like mice, bunnies, and insects, are popular items on the menus of many animals, so they must reproduce like champions. Rabbits can get pregnant minutes after giving birth, and can produce a large litter every month.

Hunting large game was energy efficient. Killing a mammoth required far fewer hours and calories than killing a thousand bunnies. Unfortunately, when hominins adapted spear technology, jumbo size became a serious handicap. Elephants were big, slow, easy to find, and had lots of meat. To hungry hunters, they were slow moving giant meatballs.

Stephen Wroe and Judith field summed it all up. Over millions of years, many animals developed anti-predator strategies that were good enough to keep their species in existence. Tragically, the arrival of tropical primates armed with specialized high-tech hunting technology radically altered the rules of predation. Advanced kill power, combined with fearless prey, sparked a revolutionary shift. In the new paradigm, animals had to move beyond traditional anti-predator strategies, and strive to develop new and different anti-predator strategies that were hominin specific. Species unable to make this transition were more likely to blink out.

Technological crutches enabled our ancestors to become direct competitors with wolves, big cats, and other carnivores. Wherever hominins expanded, they had the ability to destabilize long running ecosystem relationships. Crutches also made us less vulnerable to man-eating predators. Spears enabled our ancestors to better repel the predators that could help keep hominin populations stable and healthy. This rubbished the laws of nature. Imagine rabbits inventing tools that allowed them to kill foxes (gasp!).

## Colonizing Snow Country

Obviously, tropical primates evolved to survive in tropical ecosystems, which were warm all year-round. By and by, some hominins migrated out of tropical regions, and into temperate ecosystems, which had four seasons, including snow.

When tropical primates began wandering into regions with frigid winters they were confronted with new and serious challenges to survival. They were presented with a painful warning similar to modern highway signs: Wrong Way! Do Not Enter! But, instead of cautiously turning around, and going back to more comfortable lands, some proceeded deeper into the domain of the frost giants, and discovered many super-cool new ways to die prematurely. The game rules radically changed.

Hunter-gatherers colonizing cold regions eventually developed huge survival toolboxes — weatherproof shelters, warm hearths, fur clothing, specialized weaponry, and food storage. In the far north, hunting clans also required dozens of large sled dogs, and feeding them required killing many additional wild animals, all year long. Staying alive in snow country was far more challenging than life in the tropics.

## Outsmarting Evolution

A bedrock theme in this book is that when wild species move through the millennia guided by normal genetic evolution, they tend not to sharply rock the boat, or leave permanent injuries on the land. It's a very different story when hominins cleverly learned how to hotwire cultural evolution and technological innovation, in order to overcome limits. This provided them with superpowers that gave them the ability to recklessly overturn many ecosystem balances.

Our homeland in Mother Africa had a tropical climate, and genetic evolution had provided our species with better heat tolerance. We remain able to live happily in tropical lands, but still can't survive in snow country without a load of prosthetic technology.

Between the Arctic and the Mediterranean, there were several climate zones — ice, tundra, steppe, and woodland. When the climate plunged into frigid periods, glaciers and ice sheets expanded downward from the north, which compressed the zones to the south. There were times when the ice sheet extended from Scandinavia to northern Germany, and covered most of the British Isles. At times, large areas of France were tundra. The Mediterranean Sea, a large body of warm water, moderated the climate of southern Europe, so the temperature swings were less intense in Gibraltar, and wild foods remained abundant for the remaining Neanderthals.

One indicator of climate shifts is the types of bones found at various time periods in the layers of cave crud. The layers associated with Neanderthals usually indicated warm, moist, woodland or forest. Woodland conditions were identified by the bones of aurochs, red deer, boar, cave bear, leopard, giant deer, and temperate rhinoceros. The ideal weapon for woodland ambush hunting was the thrusting spear, and it remained the perfect tool for maybe 350,000+ years.

It's important to understand that the more recent sites, which are associated with humans, often indicate steppe-tundra conditions, when the land was cold, dry, open, and treeless. Steppe-tundra conditions were identified by the bones of woolly mammoth, woolly rhinoceros, horse, musk ox, ibex, moose, Artic fox, and reindeer. In steppe-tundra habitat, the wide-open landscape had no trees or brush for hunters to hide in. So, their preferred weapon was the javelin, which could kill from a distance.

When humans wandered into the steppe grasslands of Eastern Europe 36,000+ years ago (the "European Serengeti"), their tropical bodies were not fine-tuned for freezing weather, nor had they evolved the clever trick of hibernation. Moving into a winter wonderland was something like colonizing Mars. At this point, their choices were: (1) give up and freeze to death, (2) turn around and return to home sweet home, or (3) innovate like crazy and struggle to survive in a hostile climate where large game was abundant.

## Health Advantages

Aside from stuff like frostbite, winter hunger, and respiratory issues from smoke filled shelters, there may have been significant health benefits to colonizing temperate ecosystems. Our African homeland was tropical, with a climate that ranged from warm to hot year-round. Tropical ecosystems have the highest biodiversity of plant and animal species, including the entire spectrum from elephants to microbes. The colder the ecosystem, the lower the biodiversity, because many species have not evolved the ability to survive months of intense cold.

Pathogenic tropical parasites include malaria, schistosomiasis, and sleeping sickness. Some regions in Africa are uninhabitable due to the high risk of sleeping sickness. Tropical viral diseases include yellow fever, and three hemorrhagic fevers: Ebola, Marburg, and Lassa. A warm climate also has more species of disease transmitting insects, many of which have poor cold tolerance.

The tropics are home to numerous other species of monkeys and apes, with whom humans are more likely to swap diseases. For example, AIDS is caused by the HIV virus, which is probably a mutation of the SIV virus that is carried harmlessly by chimps. Today, chimps, gorillas, and humans are dying from Ebola. It is likely that tropical diseases had far less impact 50,000 years ago, long before deforestation, bushmeat hunting, agriculture, herding, irrigation, high mobility, and explosive population growth. A later chapter will devote more attention to disease.

## Food Storage

In the tropics of Mother Africa, meat spoiled quickly, and yummy carcasses soon attracted mobs of ravenous and dangerous scavengers. When folks fancied a juicy steak, they killed something. Preserving and storing surplus meat was unnecessary, and highly impractical, a stupid idea that never occurred to anyone. There was no reason to hunt heavily for a while, dry lots of meat, haul it around, and constantly protect it.

Snow country was a different story. Winter made travel, hunting, and fishing more difficult. Folks who accumulated and stored surplus food for the winter months were far more likely to survive and inhale the fragrant aromas of blooming springtime flowers. For our human ancestors, fine-tuned for tropical living, long-term food storage was a weird and unnatural idea. But once some pioneers learned how to do it, far more regions became potential locations for future colonization. With storage, we were able to expand into lands having harsher climates.

Clive Finlayson jabbered about a group of humans known as the Gravettian culture, who managed to survive in the steppe-tundra of the Eurasian Plain from 30,000 to 22,000 years ago. Large game was abundant. Here they invented one of the most diabolical Earth-shaking technologies of all time (gasp!), the storage pit! Holes chopped into the frozen permafrost could be used as scavenger-resistant deep freezers, to store surplus food for the lean seasons.

Finlayson believed that food storage was a significant milestone on our long and painful descent to modernity. Surplus made clans more secure, as long as adequate food resources remained available. Acquiring surplus food for winter dining required intensified hunting, which could lead to waste, spoilage, unintentional overhunting, population growth, and the depletion of game.

An additional quirk of snow country was that folks needed to burn lots of calories to stay warm and strong in their physically active outdoor lives. So, a diet rich in fat was essential. The fat content of game animals varied with the seasons. Meat had the most fat in late summer and autumn. Bears were hunted in winter, when the hibernating animals had abundant fat, and were easy to kill. In late winter and spring, many animals were unfit to eat due to insufficient fat. In lean seasons, Native Americans killed bison just to eat their tongues, which were high in fat.

Dixie West noted that animals with minimal fat were junk food. When humans and other carnivores eat lean meat, they can lose weight, because digesting it requires more energy than the meat contains. Folks commonly smashed and boiled the bones that contained the most marrow, to extract the precious marrow fat.

In snow country, as long as large game remained readily available, labor-intensive agriculture made zero sense. As game became scarcer, hunting was gradually displaced by farming. This began about 6,000 years ago. In regions less suitable for farming, hunting persisted longer. The focus shifted from storing meat to storing grain. According to Finlayson, the concept of producing surplus food, and competently managing the surplus, set the stage for the birth of civilization.

The advantages of food storage in snow country encouraged the dawn of the “more is better” mindset, which eventually became a core belief in cultures engaged in agriculture or herding. The Gravettians and other hunters stockpiled frozen or dried meat. Farmers loaded granaries with calorie dense grains. Herders stored their meat on the hoof, gathered milk daily, and slaughtered livestock only when needed. They strove to accumulate as many animals as possible. In different forms, the practice of food storage spread across snow country, eventually crossing from Siberia into the Americas.

Life was simpler for tropical hunter-gatherers, like the San people of the Kalahari. On a really crappy day, if a gang of hyenas snatched an antelope just killed by hunters, what was lost was merely the work of a single day. They were able to maintain their conservative traditional way of life for many, many thousands of years. It was not a high impact way of life.

For the food hoarders of snow country, on the other hand, misfortune could suddenly eliminate months of tedious work, and endanger winter survival. Their food stockpile could be wiped out by fire, flood, scavengers, spoilage, vermin, theft, and so on. The whole community might starve and become wolf chow. Over the long run, "more is better" cultures, with their denser populations, were more likely to swerve into bloody turbulence. Storage is big juju.

## Dress for Success

Hunter-gatherer cultures differed widely in their dependence on technology. The utterly simple Kalahari way of life was practiced by our hominin ancestors for at least two or three million years. In the tropics of Mother Africa, evolution spent several million years fine tuning our bodies for life on the savannah, and the result was an excellent design.

After hominins migrated out of Africa, and colonized tropical Asia and Australia, some folks decided to wander north. It was a cool place to live, and the farther north they wandered, the cooler it got. In snow country, tropical primates were like fish out of water. Brrrr! They wrapped themselves in animal hides, lived in protective shelters, and huddled around warm campfires.

In 1908, Knud Rasmussen told the story of a Greenland Eskimo named Qumangâpik, who had four wives and 15 children. The first wife froze to death, the second was buried by an avalanche, the third died of illness, and the fourth froze to death. Of his 15 children, one starved, four were frozen, and five died of illness. Then, Qumangâpik froze to death, with his wife and two little children. Three of his kids outlived him. In frigid times, ripped or inadequate clothing could be a death sentence.

Over time, early colonists in snow country learned how to cut and sew hides into custom tailored clothing that provided better protection for both humans and their body lice companions. Killing a deer, tanning its hide, and turning it into coats, trousers, hats, or footwear, was a time-consuming process. Deerskin attire was not especially warm, especially when soaking wet or frozen. On the plus side, it could be boiled and eaten when starvation threatened. Fur clothing could be made in two ways. Fur facing inward was good for preserving body heat. Fur facing outward provided better rain resistance.

The first stitching was likely done with sinew, or thin strips of leather. Eventually, some groups learned how to spin plant fibers into thread, which could be used for stitching seams together. In the Republic of Georgia, researchers have found spun and dyed fragments of flax fibers that were 34,000 years old.

Needles were used for sewing clothing and tents, and for making nets. Animal bone needles with eyes, about 25,000 years old, have been found in Central Europe. Needles have not been found at Neanderthal sites yet, but looking for a needle in a haystack is far easier than finding an extremely old needle buried somewhere on the Eurasian land mass.

Over time, folks got better at spinning different types of high-quality thread. It was spun from plant fibers like flax, cotton, or hemp; or animal fibers like wool. Eventually, a clever person invented weaving, a process that wove thread into cloth. Cloth could be used to make a wide variety of useful things.

Kassia St Clair described how gathering and processing plant fibers was time consuming. So was carefully collecting and preparing fibers from sheep, goats, silkworms, and others. So was spinning and weaving. In some regions, folks may have devoted more hours to their wardrobe than to acquiring food. For hardworking people, clothing was precious, and carefully kept mended and patched. Many owned little more than what they were wearing.

During the agricultural era, wool clothing was popular in snow country, until the eighteenth century, when new technology made cotton cloth cheaper to make, and more profitable. Cotton was the primary fabric until the 1970s, when synthetic fibers rose to dominance. It won't be long now until almost all clothing is polyester, which is exceedingly cheap to produce from petrochemicals using state of the art automation, and super cheap sweatshop labor.

Today, many consumers own enormous wardrobes of apparel, much of it rarely worn, if ever. Modern attire is not designed for rugged durability, but to be rapidly mass produced, in order to meet the demand for the latest trendy styles. Trendy styles have deliberately short lifespans. This encourages radicalized consumers to maximize their apparel purchasing. For them, nothing is more embarrassing than to be seen wearing obsolete fashions. Landfills are stuffed with countless tons of formerly trendy attire. Much of it is discarded while still in excellent condition.

## Communal Hunting

Life in snow country was an annual roller coaster ride. The warm season was generous in dispensing food, and the frigid season was stingy. The key to winter survival was adequate fat, because maintaining body heat required more energy. Fat is stored energy. Game carried the most fat at the end of the warm season. For humans, this was the best time to acquire meat for winter storage.

Herd animals were wanderers, following their stomachs to where there was greenery to gobble. In some regions, there were large seasonal migrations of game animals. The warm months were spent in the cooler uplands. When winter approached, they wandered down into the warmer valleys. Herds often followed regular routes on a predictable schedule, and hunters knew this. As winter waned, and stored meat was running low, the spring migrations began. Hurray!

Back in Mother Africa, the annual cycle was far more stable. Because there was no need to store meat for a cold season, there was no need for a period of intensified hunting. In snow country, intensified hunting was an important seasonal tradition. In many regions, this task was best performed by communal hunting. It took a number of forms.

Communal hunting could be very wasteful. The objective was to acquire lots of top-quality meat. In the good old days, game could be abundant, seemingly infinite. At times, the notion that mammoths could ever be wiped out by overhunting was a ridiculous idea. Life was grand! By and by, when the tides changed, and scarcity returned, starvation gave folks important lessons about limits and mindful conservation.

## Předmostí

Předmostí is near the city of Přerov, in the Czech Republic. It is located at the southern end of the Moravian Gate, a narrow corridor that passes between the Carpathian Mountains to the east, and the Sudeten range in the west, linking southern Poland and Moravia. It has long been a strategic trade and communications route. Naturally, it was also a route for the seasonal migrations of game animals in the Pleistocene, including mammoths.

Předmostí has the largest mammoth bone accumulations in central Europe. The skeletons of more than a thousand have been uncovered so far. Mammoth bones were used in the construction of their huts. Excavations have found hearths, a cemetery, stone and bone tools, and carvings made from mammoth ivory. One carving has been named the Venus of Předmostí.

Folks inhabited Předmostí between 27,000 and 25,000 years ago, and again later, about 20,000 years ago. During this time period, at many locations in central Europe, numerous Venus figurines have been found. The figurines inspired archaeologist Marija Gimbutas to imagine a paradise of goddess worshipping people that preceded the dark arrival of patriarchy and bloody warfare, a popular and controversial theory.

## Dolní Věstonice

Dolní Věstonice and Pavlov are small neighboring villages north of Mikulov, in the Czech Republic. In the twentieth century, when a villager decided to dig a cellar, he discovered the remains of a large dwelling built with mammoth bones and tusks. Multiple excavation sites in these villages have revealed fascinating details about Pleistocene hunters, who lived there from 29,000 to 24,500 years ago. They lived on terraces overlooking the river, where they had an excellent view of the vast treeless steppe below. These mammoth bone huts were common in central Europe.

At one camp, four huts were located close together, and the small settlement was surrounded by a low wall made of mammoth bones and rocks, covered with brush and turf. The huts were something like teepees, covered with animal skins. They had a circular foundation made of rocks and heavy bones. Between the huts was a large outdoor fire pit. Up the hill was a small hut containing a kiln for baking clay. This is the earliest evidence of making ceramics (they did not make pottery). They created a variety of figurines, including the heads of bears, foxes, and lions, and Venus figurines with prominent breasts and buttocks.

At a nearby location, the largest lodge was 50 feet long (15 m) by 20 feet wide (6 m), and had five hearths. At one hearth, two long mammoth bones were stuck in the ground, to support a roasting spit. Southeast of the lodge were piles of bones, including about 100 mammoths, mostly young. There were also bones of horses, reindeer, hares, wolves, and foxes. At one dig, they found the remains of a child wearing a necklace with 27 fox teeth. The skull was covered with red ochre, and the body was covered with the shoulder blades of mammoths.

Artists have studied the skulls found in the area, and made paintings of what the people would have looked like in life. When exhibited in Prague, the portrait of a prehistoric wild woman embarrassed the public — because she looked too modern, not like a dirty primitive beast — she looked like the proper and dignified ladies in the gallery (gulp!).

## Roche de Solutré

At the Roche de Solutré site, near Mâcon, France, archaeologists have found the remains of up to 100,000 horses. Prior to 1866, when experts realized the bones were prehistoric, local farmers had been hauling them away for many years, using them for fertilizer. In some places, the surface of the ground was paved with ancient horse bones.

The valley was likely a common route for the seasonal migrations of animal herds. In the summer months, herds grazed at higher elevations to avoid heat and insects. They spent the winter months grazing in the warmer floodplain of the Saône River.

The bone beds are located fairly close to the bottom of a steep limestone cliff. For years, folks theorized that the horses had been killed by driving them over the edge. A new and improved theory disputes this, claiming that the bones were not located close enough to where flying horses should have crash-landed. Hunters probably drove the animals into natural rock corrals, or box canyons, where they were trapped. Once cut off from escape, they were killed, butchered, and smoked. Wild horses were extremely dangerous prey. Big strong stallions would aggressively attack hunters, and stomp them to bloody bits.

The bone bed covers 2.5 acres (1 ha), and is up to 29 feet (9 m) thick. The oldest bones are 55,000 years old, horses killed by Neanderthals. These were covered by six feet (1.8 m) of sterile soil. The next layer is a thick one, the remains of animals killed between 37,000 and 10,000 years ago. Experts say that they were killed by Cro-Magnons (*Homo sapiens*). Prior to 22,000 years ago, the majority of bones were horses. After that, reindeer bones became more common. This was an era of rapid climate shifts.

## Bison Drives

On the western plains of North America, a common method of communal hunting was driving herds of bison off cliffs. White folks called these killing sites buffalo jumps, the Blackfeet called them pishkuns. Pishkuns were scattered from Canada to Mexico. There were more than 300 in Montana alone. For thousands of years, prior to horses and guns, this was a primary method for hunting bison. At the bottom of the cliff at First Peoples Buffalo Jump State Park in Montana, is a buried layer of compressed bison remains that is up to 18 feet thick (5.5 m). An estimated 6,000 bison died here over the centuries.

Jack McNeel described the hunts. When scouts observed a herd moving into the vicinity of a pishkun site, hunters moved to appropriate locations, and became noisy and animated. The herd panicked and ran away from them, moving into drive lanes that funneled the herd to the brink of doom. Brave teenage bison runners, camouflaged in bison hides, led the animals toward the cliff. The runners would disappear over the edge, but safely land on a ledge below, whilst the surprised bison flew over them, and plummeted to the rocks below, where butchers waited.

The Head-Smashed-In Buffalo Jump is in southwest Alberta. It utilized one of the longest and most complex drive structures on the plains. Natives constructed drive lanes that reached up to 6 miles (10 km) into the gathering basin. They followed the contours of the land, to help the flow of animals move as smoothly as possible. The bone deposits at the bottom of the cliff are 39 feet (12 m) deep. This pishkun was in use by at least 6,000 years ago.

In the journal of the Lewis and Clark Expedition, Lewis noted that on May 29, 1805, they discovered the rotting carcasses of about 100 bison at the bottom of a cliff, as well as great numbers of well-fed wolves that were "very gentle." For amusement, Clark felt inspired to shoot one of the chubby blissed out wolves.

It was impossible to have precise control over a stampeding herd. When enough animals had died to meet hunters' needs, the herd did not realize it was OK to stop leaping. Lots of meat, especially bulls and animals with little fat, was left for the enjoyment of happy scavengers — everything was recycled. Cows provided better hides and meat. The tongue and hump were the choicest cuts. In summer, meat was dried for winter use. Also, meat was mixed with fat and berries to make highly nutritious pemmican, which was stored.

The use of pishkuns faded out when Plains Indians acquired horses between 1700 and 1800. Until then, bison had a distinct survival advantage in their ability to run at speeds up to 35 miles per hour (56 km/h). When Indians got horses, the bison lost their speed advantage, and became much easier to kill. Later came guns, and the great slaughter.

Reindeer and Caribou Drives

Reindeer live in northern Eurasia, and caribou live in Greenland, Canada, and Alaska. The two creatures are the same species (*Rangifer tarandus*), but there are nine subspecies, like tundra reindeer, woodland reindeer, tundra caribou, woodland caribou, etc. Several are now endangered. The species is unique in that both

sexes grow antlers. Leslie Davis and Brian Reeves described how humans hunted them.

All around the Arctic Circle, reindeer and caribou have been hunted for thousands of years. They provided meat, sinew for sewing, bone for needles and awls, antler for tools, fat for light, heating, and nourishment, and hides for bags, snares, clothes, and tents. They made survival possible in a hostile climate.

Every spring and fall, herds made seasonal migrations along traditional routes. Hunters knew when and where to expect them. These routes often had bottlenecks that concentrated the herds, ideal locations for hunting. Commonly, groups of hunters would drive the herds into killing places. To direct the movement of a herd, drive lanes included barriers — log fences, brush fences, snow drifts, rock cairns. Some locations had corrals of wood or stone to capture the herd. In Siberia, animals were driven into nets.

Herds were sometimes driven into deep snow and then lanced or shot with arrows. In Greenland, caribou were driven off cliffs. Some hunters used snares, open loops suspended from branches, to grab animals by their necks or antlers. Snares were placed along game trails, where animals voluntarily moved, or scattered along drive lanes where hunters or dogs aggressively drove them. Records from 250 years ago report that near Churchill, Manitoba, caribou herds were driven into corrals that were one mile (1.6 km) in diameter, and 350 to 600 people participated in the kill.

The easiest method, where possible, was to drive the herd into streams or lakes, where the struggling animals were lanced by hunters in canoes or kayaks. Two hundred animals could be taken in a few hours. During a two-week summer hunt on Lake Mistinipi, hunters speared 1,200 to 1,500 caribou. One Copper Inuit settlement, inhabited between 1500 and 1700, was located close to a caribou migration route. During two centuries, an estimated 100,000 caribou were driven into the lake and killed.

Lads in canoes did not always stop killing when they had all the meat they needed. In a frenzy, they killed as many caribou as they could, the entire herd, if possible. It was a great pleasure to kill so easily, many months since the last migration. Near Hudson Bay, an observer in the 1890s found hundreds of carcasses left to rot — overkill.

In Scotland, Norway, Sweden, and Finland, many thousands of pit traps were dug in migration routes to catch reindeer. Animals could be driven into the pits during their outbound and inbound migrations. In southern Norway, trapping pits were used as early as 11,000 years ago.

Caribou herds had been following traditional migration routes for 8,000 years or more. Indians and Inuit built permanent settlements along the routes. In the nineteenth century, when hunters began using repeating rifles, animals could be killed from farther away, requiring less stalking skill. The caribou harvest sharply increased. Before long, herds abandoned traditional routes, communities starved, and their settlements went extinct — an unintended consequence of progress.

Compared to the good old days in Mother Africa, it was far more difficult for tropical primates to survive in cool climates. The selection of kill sites, and the construction of drive lanes, corrals, and pit traps, was a major effort. On the days of mass kills, large numbers of people were required for success. Preserving meat and hides took weeks of work.

## Great Leap Forward

An assortment of thinkers believe that a miraculous turning point took place in the human saga. Before this shift, humans were just ordinary animals. And then… *shazaam!* …we triumphantly glided across a magic bridge, from the archaic era into the modern one. Our species began making great progress on the heavenly path to utopia.

Jared Diamond once suggested that this transition maybe began around 100,000 years ago. Then, as the millennia passed, those critters were acting less and less ordinary. By 40,000 years ago, our heroic ancestors were demonstrating revolutionary advances. What happened? Diamond named this miracle the Great Leap Forward.

Of course, Diamond was raised in a crazy self-destructive wonderland of high-technology — extremely clever stuff that enabled humankind to beat the living crap out of the planet's ecosystems. To modern folks, the ability to conjure fire seems ordinary and insignificant. But it was a crucial turning point, and it happened long before the Great Leap.

In addition to fire, those "ordinary" two-legged animals were unique in their ability to knap sharp stone tools, and manufacture assorted gizmos for hunting. Our hominin ancestors had been developing these extraordinary skills for more than two million years.

Also extremely weird was the fact that those fire making critters were at the top of the food chain, yet they had no serious fangs, claws, speed, strength, or size. All the other apex predators had naturally evolved some combination of those traits, gradually, over the course of eons.

With the Great Leap, humans began doing more and more things beyond what ordinary animals did. They baked ceramic figurines in kilns, made flutes, wore ornamental beadwork, sewed clothing, invented new and improved tools, and built trophy homes with mammoth bone walls. These luxurious dwellings have been found in Ukraine, Czech Republic, Poland, Romania, Belarus, and Russia.

Venus figurines have been found in Slovakia, Italy, Austria, Russia, Germany, Czech Republic, Switzerland, France, Romania, and Siberia. They were carved in soapstone, steatite, sandstone, mammoth ivory, horse bone, serpentine, black jet, antler, limestone, and hematite. Venus figurines date from 30,000 to 10,000 years ago.

Folks learned how to process red and yellow ochre, hematite, manganese oxide, and charcoal into pigments useful for cave painting. Wild artists crawled far inside caverns with torches, and painted gorgeous portraits of the sacred animals for which they had the deepest respect and reverence. Images included the horse, lion, auroch, rhinoceros, salmon, bear, mammoth, buffalo, owl, hare, ibex, auk, weasel, reindeer, chamois, and fox. Their world was entirely wild and alive, and they were intimately involved in it, every minute of every day, bloody hands and all. The paintings celebrate their sacred relationship with the animals that fed them, clothed them, and sometimes killed them.

Prehistoric cave art exists in every continent except Antarctica. In France and Spain, it has been found in almost 340 caves. Famous sites include Chauvet in France (30,000 years ago), Altamira in Spain (15,000), and Lascaux in France (18,000). Recently, D. L. Hoffman's team found paintings in three Spanish caves that were more than 64,800 years old — about 30,000 years before the arrival of humans. This was the Neanderthal era.

The Great Leap Forward has also been called the Cultural Revolution or the Cognitive Revolution. Cognition is about thought, understanding, and knowledge. Around twenty years ago, some believed that the leap was the result of miraculous genetic mutations that turbocharged our intelligence, but convincing DNA evidence has yet to be discovered.

A number of experts theorize that the leap was encouraged by powerful advances in complex language and communication, but this is impossible to prove via archaeological evidence. Spoken words are not preserved in fossils. We may have been singers and poets several million years ago. We'll never know. Many primates and other animals can jabber, shout, squeal, and sing.

Note that most or all of the innovations that emerged during the Great Leap happened in snow country, where tropical primate colonists were forced to innovate or die. Those who didn't freeze or starve had to be extremely creative. The only way they could stay, and feast on the delicious wildlife, was to cleverly invent a collection of prosthetic technology that would boost their ability to survive harsh winters. In a later chapter, we'll see that the domestication of plants and animals primarily began in regions of the Northern Hemisphere that had a temperate climate.

While many Great Leap innovations were survival-oriented prosthetics, others were not. Painting, ornamentation, figurines, flutes, and so on were probably motivated by spiritual affairs, or the desire for enjoyment. Obviously, for a while, these were not folks who were desperately struggling to survive. Their new indulgences would seem to indicate that they were living in a bubble of affluence and leisure. They had learned and refined the skills of survival, and their food resources were temporarily abundant. They were rich. Life was good.

They remind me of America's baby boom generation, of which I am a member. We were born at a time when industrial civilization soared to ridiculous excesses, fueled by an orgy of consuming enormous amounts of premium quality nonrenewable resources, as if they were infinite. Some have called this joyride in self-destruction "The Blip" — a brief extreme spike in many trend lines, something like an asteroid strike.

The following chapters take a deeper look into the aftermath of the Great Leap Forward, and its colossal unintended consequences. As you read, from time to time, take off your Crown of Creation halo for a moment. "Forward?" Really? The chimps, bonobos, and other primates have remained ultraconservatives, and their lifestyles remain perfectly sustainable. Is that a problem? Are we obligated to take great pride in rubbishing the planet?

One important final point here. Many tribes of hunter-gatherers lived in a low impact manner for many thousands of years — a way of life far different from ordinary animals. In the early days, all humans everywhere — everyone's ancestors — lived in a way that had far less impact than modern folks. Over time, as the cleverness levels of different groups expanded, a broad spectrum of higher impact cultures emerged and mutated. Hence, today's devastating overshoot, extinctions, climate catastrophe, etc.

## Megafauna Extinctions

This morning, during your invigorating walk to work, school, or wherever, you probably didn't worry about being devoured by a hungry saber-tooth cat. Did you see a single cave bear or woolly mammoth? As the human herd has colonized the planet, the population of wild megafauna has sharply declined, and many species have gone extinct. Megafauna are mammals weighing more than 100 pounds (45 kg). Megafauna critters include herbivores, carnivores, and omnivores — both wild and domesticated. You are a megafauna, and so am I.

Large herbivores have played a starring role in our ancestors' evolutionary journey, because they enabled the survival of our lineage. Look in the mirror. Look at the folks on the sidewalk. Our bodies are far different from our closest relatives, the chimps and bonobos. We have the bodies of persistence hunters, folks who can run for hours in pursuit of a hot lunch, folks skilled at killing large animals. These hunting skills gave us the ability to colonize six continents, and radically disturb their ecosystems.

Before we proceed, please understand that prehistoric dates and extinction counts are estimates. Different sources present different numbers.

### Blitzkrieg Overkill

Paul Martin is essentially the poster boy for megafauna extinction. The arrival of radiocarbon dating technology made it possible for him to accurately date artifacts up to 50,000 years old (within 100 years). He became able to identify when human colonists first arrived in a region, and a date for the last evidence of a specie's existence. The pattern was that the date of human arrival frequently preceded the extinction dates.

In 1956, Martin's research in the Americas included visiting caves in multiple locations and analyzing piles of ground sloth turds and other delicacies. As he dug through the dung, he focused his attention on the pollen and fungal spore contents in each layer. As he dated his findings, he noticed an odd pattern. Sloths in Arizona had disappeared several centuries earlier than in South America. Also, on the islands of the West Indies, they survived an additional 3,000 years longer than in mainland regions (early hunters didn't have boats). Dates of extinctions indicated how hunters had colonized the New World. From Alaska, they migrated southward, to Central America, and then throughout South America.

The pollen data also indicated changes in plant life communities over time. He collected data on the dates when strong shifts in plant communities occurred, and dates when megafauna extinctions happened. If extreme climate shifts were hammering the megafauna, then an era of animal extinctions should correspond to an era of plant extinctions. With just one exception, he did not find this to be the case. Extinction times did not correspond with major climate events. Many megafauna species had survived many previous glaciations.

By 1966, a daunting new hypothesis had hatched in the space between Martin's ears. Megafauna extinctions were not just an American thing, they had happened around the world. In this updated hypothesis, extinctions began more than a million years ago in Mother Africa, the original hominin homeland. Then, like a gradual cascade of falling dominos, they moved on to Australia, Eurasia, North America, and finally South America.

Australia lost 15 out of 16 genera of vertebrate megafauna and giant reptiles. Europe lost 21 of 37 genera of megafauna, Asia lost 24 of 46, North America lost 45 of 61, and South America lost 58 of 71. What's a genera? It's the plural of genus. A genus is a category of closely related species. For example, the *Homo* genus includes *Homo sapiens*, *Homo neanderthalensis*, *Homo erectus*, and so on (12 different species).

Australia and the Americas got hit especially hard because the megafauna had not lived for thousands of years along with humans, Neanderthals, or other hominins. They had not coevolved with humans, and learned that we were dangerous. Martin created a chart showing the correspondence between human colonization and

extinctions. [LOOK]

Fernando Fernandez described the bottom line. "About two thirds of all animal species larger than 50 kg (the so-called megafauna) were extinct from the late Pleistocene onwards, starting in Australia at about fifty thousand years ago and following humans' footsteps in their expansion throughout Eurasia and the Americas." In the era between 50,000 years ago and 500 years ago, at least 97 of 150 genera of the world's large terrestrial mammals blinked out forever. The scope of his paper did not include the earlier extinctions in Africa, which were also severe (more on them later).

Martin sparked intense controversy with his theory that many of the extinctions in North America essentially took place during a thousand-year era of "blitzkrieg overkill," a lightning war of overhunting. Most estimates date the North American extinction spasm somewhere around 16,000 to 10,000 years ago.

For many folks, it's difficult to imagine hunters with spears and arrows, traveling by foot, in a roadless wilderness, wiping out all the horses, mammoths, saber-tooth cats, and so on, across an entire continent. Martin's theory can sound utterly ridiculous — until you evaluate the less compelling alternative theories. It's important to understand that few, if any, extinctions were quickies, many took more than a thousand years.

Native Americans were especially offended by Martin. The overkill hypothesis implied that their ancestors had foolishly hunted

way too hard. Lakota historian Vine Deloria described, with righteous anger, why Martin's overkill hypothesis was racist, hateful, and wrong.

Dan Flores agreed with Martin's findings, but revised the story in a very interesting way. He wrote that in the aftermath of the initial megafauna extinction spasm, Native Americans came to understand ecosystem limits, wisely established taboos to avoid overhunting, and nurtured a culture of profound respect and reverence for the entire family of life. What followed this transition was 10,000 years (100 centuries) of relative stability. This preserved the continent's downsized wildlife community.

Sadly, the 100 centuries of stability zoomed off a cliff 500 years ago, when visitors from the Old World began washing up on the shores of North America. Their civilized minds were overwhelmed by the sight of unbelievably abundant wildlife. Flores called it the American Serengeti.

And then, “like some new contagion spreading inland from the coasts, they proceeded to effect a widespread demolition of almost all that was here.”

Native Americans were also not fond of the notion that their ancient ancestors originally came from the Old World. In their traditions, America has been their home since the dawn of creation. Similarly, the white settlers remain extremely uncomfortable with the notion that the roots of their family tree lie deep in Mother Africa. For many, many thousands of years, most generations of their ancestors had beautiful brown skin and curly hair (gasp!).

Obviously, Native Americans lived far more gently. In the good old days, they had no horses, wheels, or iron. Early white colonists were astonished by the vitality of New World ecosystems, with their expansive forests, clean water, and fantastic abundance of wildlife. But Lewis and Clark, and other pioneers, mentioned events when natives killed more game than they needed, wasting meat and hides.

Flores wrote that the Cree tribe believed that the numbers of bison were essentially infinite, and that the animals they killed in no way diminished their abundance. William Dobak mentioned an Assiniboine legend that the bison will live as long as the people, and there will be no end of them until the end of time. Shepard Krech wrote that the Powhatan tribe hunted throughout the year, and killed animals regardless of their age, sex, or breeding state. The Cherokee believed that every deer they killed was reanimated, each would be replaced.

William Hornaday wrote about the American bison (commonly called buffalo). Genuine buffalo live in sub-Saharan Africa and south Asia. In the good old days, American observers described bison herds 25 miles wide, and 50 miles long (40 by 80 km), that took five days to pass — maybe 480,000 animals. In 1889, when the bison were close to extinction, he wrote, “No wonder that the men of the West of those days, both white and red, thought it would be impossible to exterminate such a mighty multitude. The Indians of some tribes believed that the buffaloes issued from the earth continually, and that the supply was necessarily inexhaustible. And yet, in four short years the southern herd was almost totally annihilated.” He wondered if elk, moose, caribou, mountain sheep, mountain goat, antelope, and black tail deer would still exist in 25 years.

Baz Edmeades noted that the fantastic number of bison on the U.S. prairie in the 1840s was made possible by the fact that bison didn't have to share the grassland with 12 species of large herbivores that had gone extinct earlier. Charles Mann suspected that bison numbers exploded as a result of the sharp decline in the number of Native American hunters. Smallpox travelled westward far faster than the white settlers, arriving on the plains by the 1730s. Indians had no immunity.

For more than 40 years, many disgruntled experts have worked

hard to disembowel Martin's overkill hypothesis. Todd Surovell and team, writing in 2016, were surprised to see that such a radically unusual idea could survive so many years of intense scrutiny. But, for the most part, it has.

It's vital to bear in mind that this isn't a story about a few generations of fanatically insane exterminators. Indeed, a thousand-year process can take a very long time. What were your ancestors doing a thousand years ago? Where did they live? What did they hunt?

By 2005, Martin's views had shifted. He acknowledged that climate change sometimes played a factor, and that humans had done more than hunt too hard. They also grew in number, swept away forests, cleared wild lands for agriculture, and released exotic invasive creatures, intentionally (livestock) or by accident (rats, etc.). So, blame for the extinctions was shifted from "overkill" to the more accurate "human impact."

## Imperceptible Overkill

Brook and Johnson, studying Australia, disliked the notion of "blitzkrieg overkill." They thought that "imperceptible overkill" was a much fairer description. They created a computer model to analyze possible extinction paths for the giant marsupial, *Diprotodon opoptatum*. The extinction process could have been very slow. "We show that remarkably low levels of exploitation of juveniles (the equivalent of one or two kills per 10 people per year) would have been sufficient to drive these large species to extinction within centuries, as a consequence of their ‘slow’ life-histories.”

Martin’s notion of blitzkrieg overkill can only be seen as speedy when it is viewed from the mountaintop perspective of geological timeframes that span many thousands of years, even millions of years. From the perspective of living hunters around a campfire, it’s possible that the megafauna extinctions may have never been noticed by the passing generations. “Imperceptible overkill” is a more open-minded label.

John Alroy , a paleobiologist at the Smithsonian, created a computer model to test the validity of Paul Martin’s theory of megafauna extinctions in North America. It began with 100 folks from Asia arriving 14,000 years ago. Within a thousand years, they could have spread across the Americas, and grown to a population of a million. In the next 600 years, feasting on the incredible abundance, prey could have been reduced by 75 percent. This analysis supported the overhunting theory, rather than climate change. Alroy noted, “Long before the dawn of written history, human impacts were responsible for a fantastically destructive wave of extinctions around the globe.”

J. B. MacKinnon wrote that in the Florida Keys, photos of fishermen in the 1950s show the biggest fish as being as long as wide as the fishers. In those days, this was the baseline of normality. Photos from 2007 show that most fish were about a foot long (30 cm). So, the baseline perception of normality was now much different. “Normal” is a moving target. He called this “shifting baseline syndrome,” or “ecological amnesia.” As years pass, we tend not to notice changes that we aren’t paying direct attention to. As centuries pass, baseline shifts get larger and larger. Modern folks live in ecosystems where most of the original wild diversity no longer exists.

Farley Mowat compared five centuries of old journals that mentioned wildlife. Based on this, biologists concluded “that biomass — the total weight of living things — off North America’s east coast may have declined by 97 percent since written records began.” Five hundred years ago, cod grew to seven feet long (2.1 m), and weighed up to 200 pounds (91 kg). In 1984, the average cod was 6 pounds. The fishery blinked out, and has never recovered. No generation knows the land as their grandparents knew it.

Fernando Fernandez noted that "the extinctions were a long process that took several millennia to occur in most continents. … Killing large animals just slightly above their fertility rate could wipe them out over the passage of centuries." It wasn't so much about the intensity of the hunting as the fragility of the hunted. Prey often had no instinctive fear of humans. Over a thousand years, and many generations of hunters, extinctions may have been essentially invisible.

Elizabeth Kolbert noted that modern elephants do not reach sexual maturity until their late teens, each pregnancy takes 22 months, and there are never twins. Because they reproduce so slowly, mammoths could have been driven to extinction by nothing more than modest levels of hunting. Doug Peacock estimated that taking only 4 or 5 percent of a slow breeding species could put them on a gradual path to extinction. Peter Ward calculated that if hunters had regularly taken just two percent of the mammoths each year, the extinction process would have taken 400 years — too slow for each generation of hunters to notice. Regardless of climate conditions, hunting alone would have wiped them out.

While the front lines of human colonization advanced, the yet to be explored human-free regions remained wild, free, and happy. Small, isolated bands of people were living in a vast wilderness, unaware of the current conditions in every surrounding hill and valley. There was no way they could accurately monitor the populations of game animals. When hunting was bad, they couldn't know exactly why. Was it a temporary dip, or time to move?

As long as the hunting was good, folks could stay where they were, and enjoy the delicious abundance. Later, when the hunting eventually wheezed, the solution was to wander into the unmolested frontier and resume the feasting. This was the engine of colonization. They followed their stomachs. For thousands of years, during the era of our species' dispersal, few could foresee that they would eventually reach the end of wild abundance.

By the twentieth century, the wide-open wild frontier was a distant memory. There were now limits, boundaries, and regulations. To carefully survive, if possible, tribes had to live with acute foresight and mindfulness. Richard Nelson spent time with the Koyukon people of Alaska, and learned that moose, caribou, and salmon numbers varied from year to year. When deer numbers declined, they stopped hunting them for several years, and ate other critters instead. Also, when game was abundant, they would stop hunting in a portion of their domain, creating a refuge where game could get a break from hunting, and recharge their numbers.

**Megaherbivore Decline**

Beware! The science jargon now gets a bit slippery. *Megafauna* weigh 100+ pounds (45+ kg). A subset of megafauna is *megaherbivores*, plant eaters that weigh more than a metric ton: 2,200+ pounds (1,000+ kg). Megaherbivore extinctions have rocked every continent.

Alfred Crosby concluded that the human colonization of the world caused a general disaster among the rest of the family of life. "Nothing this devastating had happened in millions of years." It was especially hard on huge animals. "When the die-off ended, all land mammals of one metric ton or over, of which there had been numbers of species — mammoths, mastodons, ground sloths, woolly rhinos, giant kangaroos, and more — were gone, except in southern Asia and sub-Saharan Africa." These megaherbivores were the most desirable critters to kill because they were slow, easy to find, and provided lots of meat.

In the good old days, the megaherbivores' massive body size and strength had boosted their ability to survive. Then came the humans with projectile weapons. We are the only predators that use atlatls, which allow us to kill from a distance, at far less risk of personal injury and premature death. A modern hobbyist with an atlatl can hurl a dart right through a car door. Darts can break elephant bones. In 1961, Colin Turnbull wrote, "The Pygmies today still kill elephants single-handed, armed only with a short-handled spear." So, because of this advanced technology, jumbo body size lost much of its defensive advantage. It became a disadvantage, often a death sentence, a trap door to extinction.

As the world's megaherbivores blinked out, so did the carnivores that specialized in hunting the giants. For example, several large cat species had long upper canine teeth or fangs. These saber-tooth and scimitar-tooth cats were specialized for killing huge herbivores with very thick hides. As their traditional large prey declined, the cats' long fangs may have become a handicap for hunting smaller varieties of prey. They were doomed by overspecialization, and were escorted off the stage by bad luck.

In Europe, several sites indicate that Neanderthal hunters had focused on nursery herds, consisting of mothers and their offspring. It was much less dangerous to kill a young aurochs or steppe bison than to attack its huge and powerful daddy, who could easily splatter you into a puddle of bloody mush.

The far less dangerous way of bringing home mammoth steaks was to kill their smaller, weaker offspring. Baz Edmeades noted that scimitar-tooth cats had a fondness for dining on youngsters. In the Friesenhahn Cave in Bexar County, Texas, excavations revealed the remains of 33 cats, and 300 to 400 young mammoths, mostly two-year-olds.

He added that the human youngsters 15,000 years ago were similarly vulnerable. Their homeland did not sound like traffic and sirens, it sounded like moaning lions and whooping hyenas. Wandering away from the camp at night was dangerous and dumb. Babies instinctively cry when left alone too long. Even our chimp and baboon cousins have been known to snatch and devour unattended infants.

## Climate Shifts?

Native Americans aren't the only group that is not fond of Martin's

overkill hypothesis. Lisa Naagaoka and team pointed out that lots of archaeologists are also unconvinced. In the bloody jungle world of academia, fame and glory are often gained by making important discoveries that hurl today's brilliant heroes into the latrine. Naturally, Martin soon had a target on his back.

Where is the compelling "smoking gun" crime scene evidence? There isn't much. There aren't even many sites where extinct megafauna and humans were found in the same region at the same time. Martin pointed out that the archaeological record is not thorough and complete. For the most part, it's essentially an impressive collection of holes and gaps.

In academia, specialists often work in closed circles, isolated from ideas buzzing around in the outer world. Archaeologists hang out with archaeologists, and primarily read journals focused on their field. Experts from a wide variety of specialties rarely gather together at the same pub every night, and engage in lively mind-expanding discussions until sunrise. Naagaoka mentioned five theoretical reasons for the extinctions: hunting, climate change, disease, manmade landscape changes, and a combination of factors. Archaeologists mostly vote for a combination, with climate being the primary suspect.

Ice core research in Greenland has provided lots of information on climate trends going back 122,500 years. It indicates that the extinct megafauna, and their human hunters, had managed to survive multiple super-frigid climate periods. There is not a pattern of extinction surges corresponding to the ups and downs of glaciation cycles. When temperatures got colder, cold adapted species expanded, and heat loving species migrated to warmer locations (and vice versa).

There isn't specific overwhelming evidence linking frigid eras, disease, or landscape change with megafauna extinctions. So, the general thinking, outside of the archaeology club, is that hunting played a role in every extinction spasm, and climate change may have sometimes played a secondary role. If climate change had been a primary cause of extinctions, then plants and small animals would have also been affected. Martin noted that there is no evidence of this. The most common victims everywhere were animals that had "low reproductive potential" — not species that bred like bunnies.

Ross MacPhee noted that the one possible exception is the extinctions in Sahul, the landmass of Australia, New Guinea, Tasmania, and neighboring islands when they were joined together by low sea levels. In Sahul, evidence of early human activities is quite scarce. It's possible that climate change may have been a primary factor. Amos Esty added, "Unlike other parts of the world, nothing in Australia's fossil record proves that humans hunted megafauna."

Alfred Crosby wondered why the alleged super-deadly climate shifts did not strike fast and hard, like an asteroid. Why did they selectively zap nearby regions at different times — mainland regions first, and offshore islands much later? Why did extinctions tend to coincide with the advance of colonization: (1) humans arrive, (2) megafauna blink out? Why did harsh climate events display little interest in hammering small critters, while almost exclusively focusing on megafauna?

Crosby wasn't absolutely convinced that overkill was the one and only cause of the extinction spasms, but he was certain that humans are very unusual critters. During every extinction event, humans are present, and play a major role. Humans have become exceedingly clever at radical high-speed change via cultural evolution — a powerful fork in the human saga. Innovation is our middle name (and our painful curse).

Only humans drove herds off cliffs. Only humans use fire to trap herds. On a lucky afternoon, a dozen primitive hunters with atlatls can have a bloody excellent time. Our uniqueness can also be a quirky two-edged sword. Crosby wrote, "*Homo sapiens* is arguably the only species that commits genocide, which, we might note, might easily extend in practice to species suicide."

**Mother Africa**

Mother Africa was the original homeland of the hominin family.

Baz Edmeades noted that Africa's giant tortoises could weigh more than 800 pounds (362 kg). For a very long time, their enormous shells provided an excellent defense against hungry predators. This suddenly changed when they were discovered by clever primates with large rocks, at which point they were reduced to helpless sitting ducks.

Edmeades noted that giant tortoises had the ability to survive for an unusually long time without food or fresh water. In more recent times, records reported that tens of thousands of them were killed by sailors.

Tortoises were taken aboard alive, laid on their backs, and later killed as the crew got hungry.

Lars Werdelin, an expert on ancient carnivores, wrote: “Hominins seem to have become routine hunters between 1.8 and 1.6 million years ago. With rapidly evolving intelligence and teamwork, hominins were able to level the playing field.” And, “between 2 and 1.5 million years ago, the number of large carnivore species began to nosedive. Entire groups of species disappeared. The steep downturn was 1.5 million years ago.”

Peter Ungar noted that in the archaeological record, the quantity of animal remains and artifacts significantly increased around 2 million years ago. At that time, there were at least four different hominin species living in Africa. Hominins were eating antelopes, hippos, horses, giraffes, and elephants. This indicates the promotion of bipedal primates into the elite club of large predators.

The African continent was loaded with megafauna 1.8 million years ago, but many were gone by 1.4 million years ago. Edmeades mentioned that at the Olduvai Gorge site in Tanzania, they have found bones dating back 1.8 million years, including megaherbivores like rhinos, hippos, and elephants. The bones were marked by signs of butchering.

Edmeades noted that in the good old days, Africa had nine species of big cats (three today), up to twelve species of elephants (one today), and at least four types of hippos (one today). There were giant antelopes, giant hyenas, giant pigs, giant monkeys, giant baboons, and many others — all gone. Over the course of many thousands of years, there was a significant change in the mix of players remaining on the savannah.

Saber-tooth cats emerged in Africa around 12 million years ago. Over time, they spread across Eurasia and the Americas. In Africa, they went extinct 1.4 million years ago. So did most megaherbivores (animals more than 2,200 pounds or 1,000 kg). Coincidentally, *Homo erectus* emerged around maybe 2 million years ago. Erectus was the first advanced hominin, having a brain larger than average for its body size. This era corresponds to the oldest known evidence of domesticated fire. Today, only two percent of the original African large carnivore species still survive. Some species that disappeared in Africa continued to survive on other continents.

Edmeades emphasized that during the African wave of extinctions, there were no similar extinction blips in Siberia, Europe, Australia, or the Americas — regions where zero hominins resided. In these other regions, many megafauna species remained fat and happy for maybe another million years or so.

**Australlia**

Humans arrived in Australia between 70,000 and 50,000 years ago. Within several thousand years of their arrival, 85 percent of the megafauna species were extinct, including 1,000-pound (453 kg) kangaroos, 400-pound (181 kg) birds, lizards 25 feet (7.6 m) long, and 500-pound (227 kg) tortoises.

**Eurasia**

The Eurasian extinctions were far more gradual than those in the Americas. This is likely because the megafauna had lived around hominin hunters for a long time. For example, *Homo heidelbergensis* lived in Europe 500,000 years ago, and Neanderthals had appeared by maybe 400,000 years ago.

Bernardo Araujo and team studied climate models for the last 122,500 years. For 19 regions, they compared the dates when humans arrived, with the dates when megafauna species went extinct. They found that humans were entering Europe and Central Russia about 45,000 years ago. In the colonized regions of Eurasia, extinction dates began about 40,000 years ago, and continued until about 10,000 years ago — the longest of the megafauna extinction cycles outside of Africa.

Araujo emphasized that our colonization of Eurasia was a significant turning point in the human colonization of the planet. It was the first time that our fully tropical species was moving into regions that were colder than the conditions for which evolution had fine-tuned us. It was far more challenging for humans to survive in snow country. Cleverness was mandatory.

Fernando Fernandez reported that in Eurasia, megafauna extinctions corresponded with the arrival of human colonists, not climate swings. Most of the extinctions occurred in two spasms — roughly from 45,000 to 20,000 years ago in the warmer Mediterranean south, and from 14,000 to 9,000 years ago in the cooler north.

Four million years ago in Africa, our pre-human hominin ancestors were smaller, and still learning the tricks of big game hunting. So, the extinctions were a long slow process. The hunters who later colonized Eurasia were bigger, stronger, more skillful, and better armed. Let's take a brief peek at a few of the species that blinked out in Europe. Most had been around for a long time, and survived multiple ice ages.

The elephant-like family originated in Africa, and eventually colonized the five continents, diversifying into many forms. Mammoths emerged in South Africa about five million years ago. By 2.6 million years ago, they had spread across Eurasia and North America.

Woolly Mammoths emerged 400,000 years ago in Eurasia, and went extinct in Europe 10,000 years ago. In Asia, several hundred dwarf mammoths survived until about 3,700 years ago, on Wrangel Island, off the north coast of Siberia.

Straight-tusked elephants were in Europe by around 780,000 years ago, and vanished 30,000 years ago.

Irish "elk" were actually a species of large deer (not elk). They could weigh more than 2,500 pounds (1,133 kg), and their enormous antlers weighed more than the animal's skeleton. They could spread up to 13 feet (4 m) across. They survived for several million years, including 400,000 years in Europe. The last ones died 7,700 years ago in the Ural Mountains. They lived throughout Europe, east to Siberia and China, and south to northern Africa.

Cave hyenas were gone by 13,000 years ago, after 3.5 million years on Earth. They dined primarily on horses, steppe wisent, and woolly rhinoceros. Large hyenas could weigh up to 225 pounds (102 kg). They inhabited northern Africa, the Middle East, and much of Europe and Asia.

Cave bears emerged about 1.2 million years ago, and vanished 29,500 years ago. They ranged from Britain and Spain, east across much of Europe, and into Russia and Iran.

European cave lions were quite similar to the lions still alive in Africa. The two lines diverged about 1.9 million years ago, and the European cats went extinct 13,000 years ago. They ranged in a wide belt from Spain and southern England, to Siberia, Alaska, and the Yukon.

European hippopotamus ranged across Europe, from Spain to Britain to Greece. They emerged 1.8 million years ago, and went extinct 24,000 years ago.

Woolly rhinoceroses were living on the Tibetan Plateau 3.6 million years ago. They were common throughout Europe and northern Asia, from Spain to China. They survived until 10,000 years ago.

In London, buried under the city, construction crews have discovered the remains of hippos, elephants, Irish elk, aurochs, and lions.

**The Americas**

Edmeades summed it up nicely: "With its giant bears, giant beavers, giant armadillo-like species, giant tortoises, and its giant ground sloth species, North America was, without exaggeration, a super-Serengeti containing many more big-animal species than present-day Africa."

Megafauna in the Old World had lived around humans for a very long time. They were likely to know that we were terribly dangerous (run!). This was not the case in the New World, where human space aliens had appeared more suddenly. The New World was hit hardest of all. In North America, when humans arrived, there were at least nine species of big cats, and seven species of elephants. The biodiversity was incredible.

Fernando Fernandez reported that the North American extinctions mostly occurred between 13,500 and 11,000 years ago. Experts still disagree when humans first arrived on the continent, suggesting dates usually ranging from 20,000 to 13,000 years ago. By the time humans entered North America, they had already developed effective tools and strategies for succeeding in snow country. These preparations made a faster dispersal possible. South American extinctions mostly took place between 13,000 and 7,800 years ago.

Fernandez presented a list of arguments why climate change was not the primary cause of megafauna extinctions. (1) The pattern of extinction spasms had little association with the preceding pattern of 31 intense glacial cycles. (2) Many species that vanished had been around for a million years or more. (3) Extinctions occurred first on continental mainlands, while species on isolated islands in the same region, with the same climate, survived much longer. (4) When extinctions took place in a region, there is no evidence that plant species were zapped by climate swings at the same time. (5) It was the large animals that blinked out (the preferred game of hunters). Small animals did not vanish in the same era (like they might have during a climate shift).

He did note that glacial cycles could have stressed ecosystems, making some species less resilient, but he concluded that "low reproductive potential was the main determinant of the extinct species." Importantly, "the pieces of the puzzle immediately fit together when we observe the clear correspondence between the dates of humans' arrival and of megafaunal extinction in each landmass."

The reason why human evidence is rarely found close to mammoth remains is that mammoths spent five million years on Earth. Most of them died without ever seeing a human. Big bones are more likely to survive the passage of time.

Richard Manning chatted with Paul Martin. During the North American extinction spasm, some megafauna species survived, and some went extinct. The survivors included the moose, bison, caribou, elk, deer, grizzly bears, black bears, musk ox, and pronghorn antelope. Of these, the only species that originally evolved in America was the pronghorns. They have been here for 25 million years.

The others were immigrants from the Old World that had crossed the land bridge into the New World. These immigrants had survived for thousands of years in regions where humans hunted them. They were absolutely aware that humans were dangerous critters. At first, the indigenous American megafauna had no experience with humans, and no instinctive fear of them. They were sitting ducks.

Evolution had provided the pronghorns with the ability to zoom across the land at 70 miles per hour (112 km/h), so they could avoid being eaten by speedy American cheetahs. Dan Flores noted that the speedy cats had all gone extinct prior to 10,000 years ago. Today, pronghorns are very well adapted to a reality that no longer exists. Unfortunately, they are unable to leap fences, a fact that delights their cowboy neighbors. In 1892, Texas homesteaders found 1,500 pronghorns trapped by a fence and killed them. By 1900, they had declined from at least 15 million to 13,000. Today there are maybe 700,000.

To put the North American extinctions in context, let's take a peek at some of the evidence. Elephant family species immigrated into America from 1 to 15 million years ago. There were at least seven varieties (mammoths, mastodons, etc.). They survived until 13,000 years ago, with one exception. America's last mammoths died 5,600 years ago on St Paul Island in Alaska's Pribilof Islands. This island was once part of mainland Beringia, the land bridge from Siberia to Alaska. Later, as sea levels rose, it became an island.

Horses originated in North America about 4 million years ago, and later spread into South America, Asia, Europe, and Africa. They were extinct in North and South America by 8,000 years ago.

Saber-tooth cats emerged in Africa 12 million years ago. Some types could grow up to 620 pounds (280 kg). They have been found in North America, South America, Eurasia, and Africa. They went extinct in Africa 1.4 million years ago. In North America they vanished 10,000 years ago.

Scimitar-tooth cats emerged in Africa about 4 million years ago. They vanished from Africa 1.5 million years ago, from Eurasia about 28,000 years ago, and from America about 12,000 years ago.

American lions originated in Africa over a million years ago, and migrated into North America, expanding as far south as Peru. They were 25 percent larger than modern lions. They went extinct around 11,300 years ago.

Camels originated in North America maybe 40 million years ago. By more than two million years ago, some had crossed into Asia, and spread into Africa. In North America, they went extinct 10,000 years ago. They still survive in the Old World.

Short-faced bears were abundant in California. They were among the largest land-dwelling mammalian carnivores on Earth, they could weigh over 1,500 pounds (680 kg). The species emerged about 1.8 million years ago, and went extinct about 11,000 years ago.

Giant armadillos were mammals that originated in South America 5.3 million years ago, migrated into North America, and went extinct about 12,000 years ago. They had an armor of bony plates. Some weighed more than 1,000 pounds (454 kg), and were as big as a Volkswagen Beetle.

Giant ground sloths could grow as large as elephants. They could stand erect up to 20 feet (6 m) tall, and weigh 2,204 pounds (1,000 kg). They emerged in North and South America about 4.9 million years ago, and went extinct 11,000 years ago.

Giant beavers were the largest North American rodent. They could grow to 7.6 feet (2.3 m) long, and weigh up to 276 pounds (125 kg) — about the size of a black bear. They emerged about 2.6 million years ago, and went extinct about 11,700 years ago.

Tapirs could grow up to 4.6 feet (1.4 m) long, and weigh up to 496 pounds (225 kg). They emerged 20 to 30 million years ago in North America, and went extinct about 11,000 years ago in America. In China, some survived until 4,000 years ago.

Woodland musk ox could grow to 934 pounds (423 kg). They lived from Alaska to California, and east to New Jersey. They emerged about 2 million years ago, and went extinct about 11,000 years ago.

Dire wolves lived in North and South America from 125,000 to 9,440 years ago. The average wolf weighed about 150 pounds (68 kg). Their prey included camels, bison, mastodons, ground sloths, and horses.

**Perfection of Hunting**

While low-tech persistence hunting had worked for a very long time in our original African homeland, it didn't work well everywhere. Up north, in temperate Eurasia, we couldn't chase large game for hours in deep snow until they collapsed from overheating and exhaustion. Yet these cooler regions were home to abundant large game, our favorite food — an incredibly vast treasure of precious nutrients, an irresistible temptation.

How could we hunt them? "Necessity" (fear, desire, insanity, etc.) is the mother of invention. We got clever. Technology enabled new possibilities. We figured out how to survive in temperate regions, and became experts at killing big critters. This was a major shift away from our traditional mode of tropical living. Cleverness was the master key to countless treasure chests, and countless disasters. Look at us today.

Our new and improved weapons increased the risk of unintentional overhunting, and that's exactly what happened. Alfred Crosby wrote a fascinating and depressing book on the history of projectile technology, spanning from sticks and stones to ballistic missiles. "Humanity equipped with atlatl and firestick was instrumental in the elimination of scores of species of megafauna." As our ancestors expanded into new regions, they kept learning new hunting strategies, and inventing more and deadlier tricks and gadgets.

In Greenland, Peter Freuchen and Knud Rasmussen felt sorry for the primitive Eskimos. The two lads built a trading post so that natives could have access to the wonders of modernity. Guns made it far easier to hunt (and overhunt). Rifles made so much noise that they scared caribou away — they abandoned their normal migration routes, and entire communities starved. Loud gunfire scared seals away. Seals shot with guns often sank, and were lost. By 1908, Rasmussen had profound regrets about the consequences of his good intentions. The Eskimos appeared to be on the path to extinction.

Farley Mowat told stories about the Ihalmiut people who lived in the region around Hudson Bay in northern Canada. When traders moved in, the natives learned that they could trade fox furs for stuff like guns and ammunition. These made it far easier to kill deer, so their traditional mode of low-tech hunting was abandoned. Prior to firearms, it had never occurred to anyone that it was possible to kill too many deer. Until then, the availability of deer was as reliable as the dance of the sun and moon.

Long ago, hunters who resided in luxurious mammoth bone huts temporarily lived very well via overhunting, but eventually starved. Mammoth hunters had no way to undo the unintended

consequences of their shortsighted progress. Ronald Wright concluded that this mode of progress was (and is) dark juju. Shortsighted progress can be very fun and intoxicating, for a while. Wright called this joyride "the perfection of hunting," and he declared it to be humankind's first *progress trap*. Like a ratchet wrench, it's a one-way process that only moves from tight to tighter, burning each bridge it crosses, and never looking back.

Eventually, the growing number of megafauna extinctions inspired us to shift into a new progress trap, plant and animal domestication, which later led to the trap of industrial civilization. Trap after trap has ratcheted us forward into our ghastly consumer wonderland — eight billion tropical primates devouring the broken, bleeding, crying remains of the family of life.

Pleistocene hunters spread around the world, and feasted on organic grass-fed meat for many thousands of years. Over time, our ancestors exploded in number, from a cute and insignificant minority group, into a global horde of Earth-shaking demolition experts (consumers). Naturally, any joyride of snowballing growth will eventually slam into game changing limits. Wright lamented, “We have already caused so many extinctions that our dominion over the Earth will appear in the fossil record like the impact of an asteroid.”

I invite you to imagine what the world looked like four million years ago, when there were a tiny number of hominins, whilst the entire planet was a thriving paradise of immense biodiversity, abundant life everywhere! Imagine that! This was the incubator in which our lineage evolved. This was the environment in which hominins felt at home, and where they lived in balance. Look at us now (the perfection of confusion). Look at our closest relatives, the chimps and bonobos. They have been here for several million years (the perfection of sustainability).

**Colombian Rock Paintings**

In 2020, news stories announced the discovery of tens of thousands of ice age rock paintings in the Amazon rainforest of

Colombia (Article) (Video). They were found on an eight mile (13 km) stretch of cliff face that was sheltered from the rain. Images date from 12,600 to 11,800 years ago, when humans were busy colonizing North and South America.

This was about the time that a megafauna extinction spasm was underway. The rock painters could have never imagined how generations of low intensity overhunting might gradually lead to devastating irreversible impacts (modern highly educated folks are no less shortsighted and clueless). In the years of feasting on fantastic abundance, they expressed jubilant celebration in their art. Life is grand! Yum!

Today, the Amazon rainforest is dense jungle, where it hasn’t been obliterated by loggers, miners, farmers, and ranchers. The region was much different when the painters worked. In those days, a warming climate was transforming the ecosystem. A patchwork of savannahs, trees, and thorny scrub was in the process of shifting into today’s leafy tropical rainforest. Among the cliff portraits were extinct horses, mastodons, camelids, and giant sloths. These were not jungle critters.

## Island Extinctions

The saga of the family of life is several billion years old. It's a story of evolution, from single celled organisms to a fantastically complex and diverse collection of living beings. It's a story of climate change which, for better or worse, never tires of pulling the rug out from under eras of stability. Craig Childs noted that drill cores of lake sediments in northern New Mexico revealed that some droughts could last up to ten centuries. Six thousand years ago, the Sahara Desert was a lush grassland.

The saga is also a story of migration and colonization. All plant and animal species are sometimes nomadic, remaining in comfortable habitats until conditions become challenging. When their current home becomes harsh, the lucky ones are able to migrate to better locations. The horse family originated in North America about 4.5 million years ago. It was a wonderful place to live — until hungry humans from Eurasia arrived. Pita Kelekna noted that the last wild American horse perished in Patagonia 9,000 years ago.

The horse family remains alive and well today because, long ago, some adventurous herds happened to wander across the land bridge into Eurasia. They migrated into new regions, and found lots of delicious places to live. Like the horses, many other groups of megafauna species have colonized large portions of the world, including assorted varieties of bears, cats, canines, camels, elephants, and so on. They migrated from one continent to the next by walking across dry land. Of these globetrotting critters, only one species has a reputation for causing numerous extinctions, and severely disrupting ecosystems.

Paul Martin was an important pioneer in the study of megafauna extinctions. He noted that ground sloths were eventually driven to extinction all the way from Alaska to Patagonia — except on islands. For example, on the islands of Cuba, Haiti, and Puerto Rico, ground sloths survived 6,000 years longer than those on the continental mainland. Why? The mainland and islands had the same climate. The critical variable was human presence. When watercraft technology eventually enabled hunters to visit islands, the lucky sloths were finally doomed.

After reading a pile of books and papers, I perceived that climate change was not the primary cause for many of the extinctions that have happened since humans migrated out of Africa. Martin wrote that the megafauna species that went extinct had typically been around for a very long time, and had survived the periodic rise and fall of glacial cycles.

In his book *Europe*, Tim Flannery discussed the vast mammoth steppe of northern Europe. Oddly, with the rise and fall of temperature trends, warmth loving species were not more likely to vanish during periods of frigidity. Cold loving species were not more likely to vanish when the steppe got hotter. Uncomfortable animals were inspired to migrate to more pleasant locations. Ice age climate swings happened gradually. Living generations would not have been aware of the changes. Today, swings happen 30 times faster.

Earlier, I mentioned that megafauna extinctions could sometimes take a thousand years or more. Numerous generations were unlikely to actually notice the gradual decline of large game species in a wild frontier. As humans colonized new regions, and unintentionally encouraged extinction spasms, the largest mammals were usually the first to blink out. They were easy to find, provided lots of meat, and had low reproduction rates. Thus, human impact. A climate whammy would have hammered critters of all shapes and

sizes indiscriminately. David Burney and Tim Flannery described a 50,000-year pattern of extinctions corresponding with the arrival of humans.

Fernando Fernandez wrote an unusually readable paper that described six significant problems with the climate change theory.

Bernardo Araujo and team agreed. They concluded that if we disregarded all evidence of human impacts, nobody would be talking about megafauna extinctions today.

Over the years, Paul Martin rejected arguments that blamed climate shifts, but by 2005, he acknowledged that the climate could have led to a few extinctions. Big Mama Nature may have sometimes played a direct role, and that's OK. We can't complain. She will always do whatever she wishes, because this is her circus, and we are her clowns.

Most of the world's woolly mammoths were extinct by 10,500 years ago. A few lasted longer. Saint Paul Island is off the coast of

Alaska. Russell Graham and team noted that woolly mammoths survived there until about 5,600 years ago. A warming climate had elevated sea levels, which shrank the land area of the island. The climate got dryer, and sources of fresh water became scarce. The thirsty mammoths vanished. The first evidence of human presence on the island dates to just 230 years ago. Here, climate is clearly a primary suspect.

The last mammoths on Earth perished about 4,000 years ago on Wrangel Island, north of Siberia. DNA analysis suggests that the mammoths were wrecked by a small population and inbreeding. Lately, new research has found evidence of human presence about 3,700 years ago. The island is huge, and has not been thoroughly studied. When more is learned, this story may add a hunting chapter. Stay tuned.

Today, the world is buzzing with countless conspiracy theories that throw truth under the bus. Humans are the only things that matter, a living planet does not. Earth is a disposable stage prop for the heroic stars of the show. From this mindset, the human colonization of Earth is seen as a wondrous achievement that should fill us with glowing pride. We have blind faith that technology will always sweep aside every challenge on our path. Indeed, the best is yet to come!

Was I missing something important? My muse was nervous and perspiring heavily. She persistently insisted that I take a deeper look at island extinctions, and butt heads with my doubts. So, I did. Wow! It has been a mind-blowing experience. I now have no doubt that islands have especially important stories to tell us. So, let's do some island hopping. Enjoy!

## Pangaea the Supercontinent

I sometimes look out my window and see an opossum. One day, I was fascinated to discover the saga of the opossum people. They are marsupial mammals, and humans are placental mammals (see Google). Opossums originated in the vicinity of Australia. Around 335 million years ago, most of Earth's dry land was clumped together into an enormous supercontinent called Pangaea. It began to break apart around 200 million years ago. Over time, chunks of it drifted all over the place, and arranged themselves into the seven continents we know today.

The plants and animals that had evolved on Pangaea continued living on the drifting chunks, in varying assortments of species. The chunks migrated in different directions, sometimes into different climate zones. Their plant and animal communities continued adapting and evolving, creating unique ecosystems. Opossums had lived on chunks that used to be connected, now called Australia, Antarctica, and South America. For a long time, South America was far away from North America, but they eventually wandered close together, and opossums boogied north across the border, and into my future back yard.

Until recently, I believed that humans were the only species associated with mass extinctions, but I was wrong. A wise woman has now informed me that, three million years ago, when North and South America finally kissed at Panama, North American carnivores charged southward, and exterminated numerous marsupial species.

Anyway, the gradual breakup of Pangaea was rough and messy. Offshore from the large land masses were smaller chunks that had broken away from the edges — islands. Many islands were created. For example, Madagascar broke away from India maybe 100 million years ago. East of Madagascar is Mauritius, a different type of island, created by volcanic activity (like Hawaii).

## Channel Islands

Offshore from Santa Barbara, California are the five Channel Islands. Around 20,000 years ago, when sea levels were 300 feet (91 m) lower than today, the five islands were united in one larger island that was just 6 miles (10 km) from the coast. Over time, rising seas altered the coastlines. Today, the islands are 22 miles from the coast. About 80 percent of their former dry land area is now submerged.

Among the former residents were pygmy mammoths. Their ancestors were the huge Columbian mammoths that lived on the mainland, some of whom decided to swim several miles to the islands. Swim? Yes! Even when sea levels were low, there was no land bridge from the mainland to the islands. Asian elephants have been known to swim to islands 23 miles (37 km) away. Their large bodies are buoyant, and their trunks can be used like snorkels. Did you know that hippos in the Old World have also been excellent long-distance swimmers? No joke!

Anyway, over the passage of thousands of years on the Channel Islands, the mammoths evolved into dwarfs, a unique new species. Maybe this was an adaptation to limited resources. Or, maybe it was a lack of predators. Jumbo size improves the odds for survival when bloodthirsty carnivores live nearby. But when predators are not good swimmers, and live far away, there is less need to be huge and powerful.

Radiocarbon dating is accurate up to 50,000 years ago, and mammoths were on the islands for at least that long. Humans arrived on the islands around 13,000 years ago. The mammoths went extinct between 13,000 and 12,900 years ago. Coincidence?

Wikipedia reports that mammoths still lived on the islands when humans arrived. Two mammoth skulls with the brains removed were found near a fire pit. Of the 100 fire pits examined, at least a third contained mammoth bones. Climate pleads innocent.

Mediterranean

Jacques Blondel was interested in habitat destruction on the Mediterranean islands during the last 10,000 years. Population pressure on the mainland encouraged folks to colonize the larger islands. Forests were pushed back to create cropland and pasture. Humans deliberately introduced livestock, and unintentionally released pests, like rats and mice.

Long, long ago, isolation from the mainland led several species of large animals to become dwarfs on multiple Mediterranean islands. There were pygmy hippos and deer, and at least 12 species of pygmy elephants. The smallest elephants were 39 inches (1 m) tall. The scarcity of predators also led to the evolution of giant rodents and flightless owls.

Blondel wasn't sure if the pygmies were primarily eliminated by hunting, or by feral pigs introduced from the mainland. Either way, this was not a climate bummer, it was a human impact bummer. Bottom line: probably all of the wild mammal species that originally inhabited the Mediterranean islands were eventually driven extinct following human colonization.

Marco Masseti was fascinated by the mammals of the Mediterranean islands, and his report is long, exceedingly thorough, and includes cool maps and illustrations. In the Mediterranean basin, several thousand years of civilization have been fantastically successful at rubbishing the ecosystem, taking a heavy toll on biodiversity. Many islands were once vast jungles of oak trees, now reduced to "little more than mineral skeletons." It may be the most heavily destroyed region on Earth.

The old theory was that when sea levels were low, large mammals simply walked across dry land to what are now islands. When sea levels rose, and islands became cut off, the isolated large mammals became dwarfs. Experts now say that the land bridges never existed. Islands were only accessible by swimming, rafting, or flying. Rising sea levels increased the difficulty. Deer are capable swimmers, and hippos and elephants are champions. Birds and bats can go where they wish. Masseti concluded that human impacts were the primary cause of Mediterranean island extinctions. Again, climate pleads innocent.

Caribbean

There have been two recent studies of extinctions on islands of the West Indies, in the Caribbean Sea. The 2017 paper was written

by Siobhán B. Cooke and team. On multiple islands, it compared the dates of human arrival with the extinction dates. It found that humans arrived on the islands in four waves. The first three were Amerindian hunter-gatherers, and the fourth was Europeans. Each wave generated increased eco-impacts. Open access to the full paper is not free.

Luckily, Mindy Weisberger wrote a news release that summarized the study, and is free to one and all. Prior to human colonization, there were 150 species of mammals on the islands, including sloths, giant monkeys, bats, and jumbo rats. Humans colonized the Caribbean basin mainland by 12,000 years ago, but they didn't begin colonizing the islands until 6,000 years ago. By this time, the climate was stable, well into the Holocene warm era. Most of the extinctions on all of the islands happened after human arrival, not before.

Early in the game, hunting was probably the cause of extinctions. Then came forest clearance and agriculture, which eliminated wildlife habitat. Destruction accelerated 500 years ago, when Europeans arrived, bringing invasive exotics like cats, rats, goats, and mongooses. Indigenous rodent species got hammered. This is not a climate story, it's another human impact tragedy.

In 2021, a second paper was published, written by Samuel Turvey and team. It's online and free. This paper tracked the data on 89 species on 118 Caribbean islands, and explored the pattern of extinctions. All of these species were still alive at the start of the Holocene warm era, which began 11,700 years ago, and has not cooled off yet. Conclusion: "Hunting, landscape transformation, and invasive mammal introduction by successive waves of colonists following human arrival approximately 6000 years ago are considered the primary drivers of Caribbean mammal loss."

Larger animals had low rates of reproduction, and small populations. They were at the highest risk of being driven extinct by the growing human population. The smallest animals were hard hit by the introduction of invasive predators, like black rats and mongooses. Their extinction dates correspond to the arrival of these predators. Again, climate pleads innocent.

New Zealand

The islands of New Zealand were the last large landmass colonized by humans. Polynesian settlers began arriving somewhere between A.D. 1280 and 1350. Over time, almost half of New Zealand's original vertebrate species went extinct, including 51 species of birds. Alexandra van der Geer wrote that nine species of huge flightless moas vanished in less than a century, zapped by hunting and habitat destruction.

Moas shared the trait of gigantism with other flightless birds, like the ostriches of Australia, and the elephant birds of Madagascar. In the extremely distant past, the moas lived elsewhere, and still had wings that enabled flight. When they landed in New Zealand, maybe 60 million years ago, they were delighted to discover that there were no large ground dwelling predators eager to eat them. The only mammals on the islands were bats and seals, and they weren't interested in moas.

Until this morning, I believed that the gigantism of flightless island birds was solely due to little or no predator risk. Today I learned that there was another factor. Isolated islands had no large herbivores that feasted on the greenery. So, birds that could digest the greenery lived in a heavenly all-you-can-eat buffet. They were free to grow to jumbo proportions, in a normal and healthy way.

Flying is an energy-guzzling way for an animal to explore the world. If you live in a place where there is plenty to eat, and little or no risk of getting killed by ground-dwelling predators, then you might have little or no need for wings. Over time, evolution completely eliminated the tiny useless wing bones of the moas.

The largest moas stood 12 feet (3.6 m) tall, and weighed 510 pounds (230 kg). Many collections of moa bones have been found, some containing the remains of up to 90,000 birds. Evidence suggests that a third of the meat was tossed away to rot. Obviously, the birds were super-abundant and super-easy to kill. Obviously, the hunters (like modern folks) did not comprehend the vital importance of mindfully respecting limits.

Moas were the primary food source for the Haast's eagle, the largest eagle that ever lived. They weighed up to 33 pounds (15 kg), and their wingspan was over 8 feet (2.6 m). Not long after the moas were hunted to extinction, the eagles lost their meal ticket and vanished forever.

Polynesian settlers also brought with them domesticated food plants, which required cleared land. Originally, 80 percent of New Zealand was forest. Today, forest covers only 23 percent of the land. Along with the trees, many forest dwelling birds also got wiped out. Europeans stumbled upon the islands in 1642, and substantially accelerated the eco-destruction.

Folks who colonized islands sometimes brought with them rats,

mice, dogs, ferrets, pigs, and so on. Baz Edmeades noted that exotic rodents exploded in number, and drove many island birds to extinction. Their chicks and eggs were no longer safe. Rodents wiped out frogs, flightless songbirds, ground-dwelling bats, and large insects. Again, climate pleads innocent.

Madagascar

Alexandra van der Geer described the ecological history of Madagascar, the world's fourth largest island. It's located in the Indian Ocean, 250 miles (400 km) east of the African mainland. Isolated from the outer world for maybe 100 million years, it was home to a unique collection of tropical fauna (see the illustrations in her report).

Several types of exotic mammals mysteriously began arriving on the island around 60 million years ago, maybe rafting in via ocean currents — lemurs, tenrecs, fossas, and Malagasy mice. More recently, just one or two million years ago, hippos arrived, and eventually shrank to one fourth the size of mainland hippos.

Lemurs evolved into 17 varieties, including giant sloth lemurs that could grow to the size of male gorillas. The island was also home to the elephant bird, the heaviest bird in the world. It was flightless, weighed up to a half ton, and stood 10 feet (3 m) tall. Their eggs could weigh 22 pounds (10 kg). When the European colonizers arrived in the 1600s, elephant bird eggshells still littered the beaches of the island's southern coasts. Conclusion: "The combined evidence suggests that all mammalian species heavier than 10 kg (22 lbs) gradually disappeared forever from Madagascar's fauna list."

Baz Edmeades wrote that Indonesian seafarers first visited Madagascar sometime between A.D. 670 and 920. By the end of the fourteenth century, many mammals, birds, and reptiles were

gone. Elizabeth Kolbert wrote that the lemurs, elephant birds, and pygmy hippos survived into the Middle Ages. All of them eventually blinked out. She noted that the extinction spasms in North America, South America, Madagascar, New Zealand, and elsewhere occurred in a series of pulses, each of which corresponded to the arrival of human colonists. None of the pulses seem to correspond with unusual climate events. Again, climate pleads innocent.

Mauritius

Mauritius is a tropical island, east of Madagascar, in the Indian Ocean, about 1,200 miles (2,000 km) from the African coast. It is one of the four Mascarene Islands. They were created by volcanic activity about eight million years ago. Because of its long isolation, Mauritius was inhabited by an amazing assortment of unique species, including many flightless birds and large reptiles.

It was home to the famous flightless dodos. The dodo lineage was more than 23 million years old. So, they were originally from somewhere else, and arrived in Mauritius by flying there, back when they still had functional wings. Having no natural enemies, dodos enjoyed a wonderful life. For this reason, evolution long ago reduced the dodo's wings to tiny useless stubs. Dodos were unable to fly or swim, but they did enjoy being alive. They could grow up to 39 inches (1 m) tall, and weigh up to 37 pounds (17 kg).

When the Portuguese visited in 1507, there were zero ground dwelling mammal species on the island. The only mammals were fruit bats and marine animals. In 1598, Dutch sailors were the first to describe the existence of dodos. The Dutch East India Company used Mauritius as a service station for trade vessels. The last mention of dodos was in 1662.

There used to be at least ten species of flightless birds on the island, all are now extinct. Humans imported dogs, pigs, macaques, cats, and rats. Some think the imports may have killed more dodos than humans did, by raiding their nests. There is also the matter of habitat destruction. When humans arrived, the island was entirely forested. Dodos were forest birds. Today, just two percent of the forest remains. Again, climate pleads innocent.

There is an old saying that rude folks use to insult others, calling them "dumb as a dodo." Humans could simply walk up to a happy dodo and club it to death. Dodos weren't dumb, they were fearless. They had no concept of predators or danger. To them, humans were mysterious funny-looking weird-smelling space aliens. Fearless flightless birds also vanished in Tonga, New Caledonia, Fiji, Hawaii, Easter Island, the Marquesas, and on and on.

# Mother Grassland

The family of life is solar powered. Incoming solar energy is received by green plants, who use it to produce sugar. This process is photosynthesis. It converts *solar energy* into a form of *chemical energy* that plants and animals must have to survive. Animals acquire this energy by eating plant material, or by dining on plant-eating animals.

Photosynthesis splits water molecules ($H_2O$) into hydrogen and oxygen atoms. Then, in a fancy magic act, hydrogen is stirred together with $CO_2$ to make a sugar called glucose ($C_6H_{12}O_6$). Plants use the sugar to fuel their daily life, or they can convert it to starch, and save it for later. Plants can also make fat, protein, and vitamins. They're much smarter than they look.

The act of snatching carbon from the air, and incorporating it into living plant tissues, is called carbon fixation, or carbon sequestration. As more carbon gets sequestered into the plants and surrounding topsoil, then less of it remains in the atmosphere. This is great, because too much carbon in the atmosphere can lead to catastrophic climate juju.

There are four primary terrestrial biomes: grassland, forest, desert, and tundra. Grasslands are communities of different plants — primarily grasses, mixed with a wide variety of sedges and leafy forbs (wildflowers and herbs). These mixed communities maximize the capture of solar energy, make better use of soil resources, and create rich humus. Humus boosts soil fertility, and helps retain moisture. Some plants also convert pure atmospheric nitrogen into a form that is essential for the survival of all living things. Others are good at retrieving essential mineral nutrients.

There are maybe 12,000 species of grass, and they grow in many tropical and temperate regions. Some are able to survive extended droughts, or long winters. Grasslands have two modes, productive and dormant. In warm climates, they are dormant during the dry season, and recover when the rains return. In temperate climates, they are dormant during the frosty months, and green when the soil thaws.

Following an intense disturbance, grasslands can recover in 5 to 10 years — far faster than a wrecked forest. Evolution has done a remarkable job of fine-tuning grasslands for rugged durability. They can recover more easily after wildfires because only a third of grassland biomass is above ground, where it is most vulnerable to flames. Plants send roots far underground, to acquire moisture and nutrients. Some roots grow as deep as 32 feet (10 m). The seeds of many grassland species can remain dormant for an extended period, postponing germination until appropriate conditions return. Some seeds can survive a hot and slippery ride through an herbivore's gut and remain fertile, enabling the colonization of new locations.

**Grass and Herbivores**

Grassland communities run on carb energy that flows from species to species, up and down the food chain, and enables the existence of the family of life. Grassland ecosystems create the richest soils, and produce abundant nutrients. Seeds with high energy content are highly nutritious, enabling the possibility of large bodies and big brains. Many herbivore species can't digest wood or tree leaves.

Large grass eating herbivores were a favorite source of nutrients for our prehistoric ancestors. For the effort invested in hunting, they provided the biggest jackpots of meat. Our strong desire for these animals, and our ongoing dependence on them, eventually resulted in some hominins evolving into *Homo sapiens*, the last surviving species of hominins.

It's important to understand that herds of large herbivores do not usually reside in forests or jungles. Large body size can be an important advantage on grasslands, but a disadvantage in dense woodlands. In terms of vegetation, forests contain much more plant biomass than grasslands, but most of it is elevated out of the reach of hungry herbivores. On the other hand, grasslands annually produce more biomass per acre than forests, and it's conveniently located close to the ground.

To herd critters, grassland looks like a candy store where all the goodies are free and delicious. Grasslands are the best place to dine on high quality greenery, hang out with friends and relatives, enjoy romance, produce cute offspring, and enjoy a wonderful life of fresh air, travel, and adventure.

Consequently, grasslands are home to far more large animals. I would expect that most land-dwelling megafauna species originated in grasslands.

**Grass and Hominins**

The Miocene Epoch spanned from 23 to 5.3 million years ago. It seems that the early Miocene was wet and warm, and many ecosystems were forests. Much of Antarctica was covered with temperate forest 20 million years ago. Later, maybe six to eight million years ago, it got cooler and dryer, and a different type of ecosystem evolved and expanded — grasslands. Compared to forests, grasslands generally need less precipitation to survive. Today, the Earth's forest area is 80 percent smaller than it was in the Miocene's golden age of trees.

This transition had a significant impact on the human saga. As forests shrank, there was less habitat for our tree-dwelling ancestors. A number of forest species tumbled off the stage forever. Some primates moved onto the savannah, and figured out how to survive as ground-dwelling primates, in open country. They included the ancestors of baboons and humans. Humans are hominins, primates that walk on two legs. About four million years ago, hominins originated on the savannah grasslands of tropical Mother Africa.

Our tree-dwelling ancestors were primarily frugivores, fruit eaters. They ate stuff that grew or lived in trees. When they became ground-dwelling critters, they needed a new diet. Large herbivores eventually became a popular choice. Hunting was the path to success, and grassland was the place to be. Consequently, as humans migrated out of Africa, and colonized the world, they preferred to select routes that majored in grasslands. Their journey took them to grasslands in the Middle East, and then Europe.

Barry Cunliffe noted that a vast steppe grassland began in Hungary and ended in Manchuria, providing a grassy highway that was 5,600 miles (9,000 km) long. As an added bonus, the steppe was largely carpeted with vegetation that was drought-resistant and frost-tolerant. Once established in northern Asia, intrepid pioneers were eventually able to wander from Siberia, over the Beringia land bridge, and then explore the incredible Serengetis of the Americas.

In 1872, Kansas senator John James Ingalls celebrated the power of grass. He wrote: "Grass is the forgiveness of nature — her constant benediction. …Streets abandoned by traffic become grass-grown like rural lanes, and are obliterated. Forests decay, harvests perish, flowers vanish, but grass is immortal. …The primary form of food is grass. Grass feeds the ox: the ox nourishes man: man dies and goes to grass again; and so the tide of life with everlasting repetition, in continuous circles, moves endlessly on and upward, and in more senses than one, all flesh is grass."

**Super Grass**

And now, the plot thickens. There are several ways that photosynthesis fixes carbon in plants. The conventional process is called C . It produces a compound that has three carbon atoms. 3

The turbocharged process is C , and it produces a compound that 4 has four carbon atoms. Maybe 85 percent of the plant species on Earth are C . Their method of carbon fixation is simpler and less 3

efficient than C . Both types are very old, but when climate change 4

favored the expansion of grassland, C species got an important 4 boost.

Elizabeth Kellogg studied C plants. In one experiment she 4 found that, under ideal conditions, C plants could theoretically 3 capture and store up to 4.6 percent of the solar energy they received, while C plants could get up to 6 percent (30 percent 4

more). In other words, provided with the same inputs of sunlight and water, C produces more calories than C — carbs that fuel the 4 3 family of life. They also produce more root biomass, which increases their tolerance for drought and fire.

Kellogg calls the C process a turbocharger. While only 3 4

percent of flowering plant species are C , they account for 23 4 percent of all carbon fixation in the world. Of the 12,000 grass species, 46 percent of them are $C_4$, and they include corn (maize), sugar cane, millet, and sorghum. (Mad scientists are now trying to alter DNA to make rice $C_4$ too.)

There are four conditions under which $C_4$ plants have a big advantage — high temperature, high light, low moisture, and low nutrients. Because they need less water, $C_4$ plants better conserve soil moisture, so their growing season is longer in arid regions. Kellogg wrote, “In the last eight million years, $C_4$ grasses have come to dominate much of the earth’s land surface.”

$C_3$ grasses are better adapted to moist forest floors and limited sunlight. They are less able to thrive in arid grasslands. Out on the savannah, $C_4$ grasses enjoy some important advantages. When conditions are right, they are able to manufacture generous amounts of chemical energy (sugar), and this increases their odds for survival.

[Important!] The big picture here is that climate change radically altered the family of life. It encouraged the substantial expansion of grassland, which boosted the expansion of $C_4$ grasses, which propelled the evolution and expansion of large grazers and carnivores, which boosted the global tonnage of living meat, which set the stage for the arrival of our hominin ancestors. Today’s climate catastrophe seems likely to unleash far bigger changes in something more like the blink of an eye.

Grasslands can support more large animals than forests. Grassland megafauna migrated and settled on five continents (not Australasia). Around the world we find varieties of horses, bison, elephants, antelope, deer, hyenas, wolves, bears, and so on. Grasslands support far less biodiversity than rainforests, which are home to fantastic numbers of different species.

Graham Harvey , a grass worshipping wordsmith, noted that growth is actually stimulated by grazing and fire. In a brilliant design, new blades of grass emerge from growing points located close to the ground, where they are less likely to be damaged by hungry teeth or passing flames. The faster that grasses can send up new blades, the more sunlight they can capture, the more sugar they can make, and the happier the whole ecosystem becomes. Joy!

Another benefit of grazing is that herbivores often nip off the rising shoots of woody vegetation. If trees and brush were allowed to grow and spread, they would compete for sunlight with the grasses. Then, the herds of hungry herbivores would have less to eat, and so would the carnivores that adore red meat. Herds religiously offered their deep gratitude to the grass people by lovingly depositing nutrient rich manure and urine all over the place.

Grass eaters are called grazers. Browsers are critters that eat leaves, woody shoots, bark, and saplings. Some species are both. The elephant family loves to dine on young green leaves, and they sometimes knock trees down to get them. Each day, elephants eat 550 pounds (250 kg) of grass and leaves, and then turn it into magnificent fertilizer. Giraffes are top feeders that specialize in leafy vegetation that elephants and rhinos are too short to snatch.

Browsers can limit the expansion of trees and woody brush, but they aren't fanatical mass murdering exterminators. Savannah ecosystems are grasslands dotted here and there with trees and shrubs. Grass provides food for the grazing herds, and woody vegetation nourishes the browsers — and it provides shade and hiding places. Home sweet home!

Harvey concluded that, in many ways, humans are creatures of grass country, like the bison, hyenas, and vultures. We still are. We take immense pride in the brilliant triumph of humankind, but if we turn off the spotlights and loudspeakers, and pull back the curtains, we see that the Green Mother of this grand and goofy misadventure is our intimate and enduring dependence on grassland ecosystems. Grass is Superman's momma.

## Manmade Grasslands

All flesh is grass, but grass is not limitless. In the old days, there were no hunting licenses, rules, bag limits, or game wardens. The hunting fad was able to grow until it eventually smashed into limits. Flesh is not limitless. Folks began missing dinners, and going to bed with growling tummies. Overshoot is never sustainable. Too many hunters spoil the ecosystem.

When food becomes scarce, a common response is migration, pack up and move. This worked for thousands of years, as folks colonized the regions uninhabited by humans. Eventually, the happy hunters learned a painful new lesson: Earth is not limitless. Shit! What now? Cultural taboos that limited reproduction could provide some pressure relief. So could perpetual inter-tribal warfare, bloody the competition whenever possible. Cleverness is the persistent gift and curse of humankind. It conjured another idea; a magic wand called the firestick.

Shortgrass prairie grassland needs between 10 and 30 inches (25 to 76 cm) of annual precipitation. Most of its plants are less than one foot (30 cm) tall. Tallgrass prairie needs more than 30 inches (76 cm) of annual precipitation. In tallgrass, prairie plants can sometimes grow up to 13 feet (4 m) high — tall enough to hide a horse. Tallgrass can produce far more food for grazing animals, which enables larger herds. However, the precipitation needed by tallgrass is also adequate for the survival of forest. While browsing and grazing helps to maintain open grassland, it's not enough to fully prevent the existence and spread of forest.

When Big Mama Nature gets in a stormy mood, she sometimes ignites wildfires with lightning bolts. Fire can be a good tonic for the health of grass. It burns up accumulated dead foliage and debris, allowing more solar energy to empower the grass people. Also, with the dead junk burned away, the exposed ground warms up faster when the snows melt, enabling the growing season to begin earlier. Soon after fires end, tender green shoots emerge from the ashes. Fresh greenery looks heavenly to the grazing critters, and hunters love grazing critters.

Jill Haukos noted that fire happily stimulates the growth of fresh new grass, but it has zero concern for the health and safety of trees and shrubs. Grass productivity is 20 to 40 percent higher on burned land, compared to unburned. When tallgrass prairie is deliberately burned every few years, it will not transition to forest, because the seeds, sprouts, and saplings can't survive the cruel abuse. Natural wildfire doesn't faithfully follow regular burn schedules, but regular manmade fire is able to trump the tree people.

Wild folks clearly understood that maintaining extensive grasslands improved their hunting. By deliberately controlling nature, they could eat better, and feed more bambinos. So, they did. For hunters, fire was a powerful beneficial servant. For the rodents, birds, and insects of the grassland, fire could be a viciously powerful master. Shepard Krech mentioned that when the first humans settled Hawaii and New Zealand, they cleared the land with fire, driving many bird species extinct. Is it OK to rubbish a thriving ecosystem for selfish reasons? Only human desires matter?

Haukos wrote about bison grazing in tallgrass prairie. Hungry herds have little interest in seeking un-grazed locations that are covered with lots of old and skanky low-calorie grass. They much prefer fresh new grass, and they pay close attention to recently burned landscapes. "Bison maintain large grazing lawns. They return again and again to the same 'lawns' to eat the new growth of grass, which is highly nutritious. These areas may look overgrazed but actually have new growth continually, providing the nutritious grass bison need, even if only one inch high (2.5 cm)."

The practice of using periodic burns to maintain and expand superb grazing land is often called firestick farming, because it uses burning to increase the harvest of life-giving meat. It is a powerful,

easy, low-tech way to benefit large game. Alfred Crosby noted that firestick farming had transformed much of six continents long before the first field was planted. Let's look at a few examples.

North America

The chilly Pleistocene ended about 11,700 years ago, with the arrival of the warmer and gentler Holocene era that we currently enjoy. Ice sheets melted and retreated, creating space for tundra. As the climate further warmed, expanding prairies displaced regions of tundra. Prairie ecosystems can support more complex biodiversity, as different communities of species adapt to different mixes of soil types, moisture, and climate. Where changing conditions favored the existence of trees, forest expanded. Forests tend to trump grassland, because they allow less sunlight to reach the ground. Once established, a forest can thrive for thousands of years, if not molested by murderous terrorists.

One way or another, Native Americans learned the benefits of grass burning. They understood that regular burning could inhibit forest regeneration. As centuries passed, tallgrass regions expanded, much to the delight of large herbivores, and hungry hunters.

Stephen Pyne wrote that when white colonists were settling in the eastern U.S., the western portion of the Great Plains was shortgrass prairie, too dry to support forest. But much of the eastern portion was tallgrass prairie. It had rainfall and soils suitable for forest, but over the centuries, Native Americans had gradually pushed back forest territory to greatly expand the prairie. They maintained this highly productive prairie by burning it every few years, to kill young saplings. It provided excellent habitat for bison and other delicacies.

Burning was a common practice in many regions of North America. By A.D. 1000, the expansion of manmade tallgrass prairie had enabled bison to migrate east of the Mississippi River watershed for the first time.

By the 1600s, several million bison lived in a region spanning from Massachusetts to Florida, but this did not last. Paul Weatherwax noted that bison found corn to be irresistibly delicious, which made agriculture impossible. Farmers did not have bison fan clubs.

Shepard Krech wrote that along the east coast, there were oak openings (meadows with scattered trees) as large as 1,000 acres (404 ha). Manmade grasslands in the Shenandoah Valley covered a thousand square miles (2,590 $km^2$). He noted that Indian fires sometimes had unintended consequences, when they exploded into raging infernos that burned for days, sometimes killing entire bison herds, up to a thousand animals.

Lamar Marshall described the relationship between the Cherokee people and the bison. The tribe resided east of the Mississippi River, and lived by farming and hunting. Legends suggested that bison did not live there until sometime around A.D. 1400. By then, the natives had significantly expanded grassland for hunting, and cleared forest for farming. Game was especially attracted to rivercane pastures (canebrakes) that were burned every 7 to 10 years. Marshall provided a map showing how huge North America's bison range was in 1500. [Look]

Michael Williams noted that as the diseases of civilization spread westward, Indians died in great numbers. They had zero immunity to deadly and highly contagious Old World pathogens. Diseases spread westward far faster than the expansion of settlers. Consequently, the traditional burning was sharply reduced, and forests were returning. In 1750, they may have been bigger and denser than they had been in the previous thousand years. When whites eventually arrived to create permanent agricultural communities, the happy regrown forests had to be savagely euthanized.

Arlie Schorger wrote about the vast manmade tallgrass prairies of southern and western Wisconsin, and the last bison killed there in 1832. Some prairies spanned 50 miles (80 km). Prairie was almost continuous from Lake Winnebago to the Illinois border. Natives had been expanding and maintaining grassland for a very long time. In 1767, white visitors observed "large droves of buffalos" on the fine meadows along the Buffalo River.

By and by, devastating epidemics hammered the indigenous people who had maintained the grassland and hunted the bison. Regular burning sputtered out. The last bison seen crossing the Mississippi River, and entering Wisconsin, was in 1820. By 1854, dense groves of 25-year-old trees were joyfully reclaiming their ancestral homeland. Unfortunately, these recovering forests had a bleak future, because they stood directly in the path of a rapidly approaching mob of merciless pale-faced axe murderers. Shit!

Over the passage of centuries, the tallgrass prairies created topsoil that was deep and remarkably fertile. Then came the settlers, with their plows and ambitions. Plows are magnificent tools for destroying soil, and creating permanent irreparable damage. Today, tallgrass prairie ecosystems are in danger of extinction, maybe one percent of them still survive. Exotic freak show grasses like corn and wheat are far more popular and profitable than the indigenous tallgrass.

Britain

When the glaciers of the last ice age began melting, sea levels were very low, and England was connected by dry land to Ireland, Scandinavia, and continental Europe. Barry Cunliffe wrote that as the ice retreated, and the climate warmed, the newly exposed lands went through a sequence of transitions — from tundra, to steppe, and then forest. Essentially most of Western Europe became a vast forest. Large game thrived on the tundra and steppe, but the expansion of forests reduced grazing land area, and the abundance of large game.

By 9000 B.C., hunter-gatherers apparently made some small clearings in the forest to attract game. By 6000 B.C., England became disconnected from the continent by rising sea levels. By 4500 B.C., when farmers and herders began to trickle in, England was largely a forest, except for the highlands. Hunters dined on red deer, wild boar, and aurochs. By 3000 B.C., there were substantial clearances for cropland and pasture. By A.D. 1100, just 15 percent of Britain was forest. By 1919, it was five percent, Britannia was essentially stripped naked.

Australia

Bill Gammage described the Australia that British colonists observed in 1788, when they first washed up on shore. That landscape was radically different from what it is today. Early white eyewitnesses frequently commented that large regions looked like parks. In those days, all English parks were the private estates of the super-rich. Oddly, the Aborigines who inhabited the beautiful park-like Australian countryside were penniless illiterate bare-naked Stone Age antifascist anarchist heathens. Their treasure chest of wealth was their time-proven knowledge.

In 1788, large areas of Australia had been actively managed by firestick farming, which greatly promoted habitat for the delicious critters that the natives loved to have lunch with. The Aborigines used both hot fires and cool fires to encourage vegetation that was fire intolerant, fire tolerant, fire dependent, or fire promoting. Different fires were used to promote specific herbs, tubers, bulbs, or grasses. When starting a fire, the time and location was carefully calculated to encourage the desired result. According to Gammage, most of Australia was burnt about every one to five years. On any day of the year, a fire was likely burning somewhere.

The natives generally enjoyed an affluent lifestyle. They had learned how to live through hundred-year droughts and giant floods. No region was too harsh for people to inhabit. Their culture had taboos that set limits on reproduction and hunting. During the breeding seasons of important animals, hunting was prohibited near their gathering places. Lots of food resources were left untouched most of the time, a vital safety net. The Dreaming had two rules: obey the Law, and leave the world as you found it.

The white colonists were clueless space aliens. Their glorious vision was to transfer a British way of life to a continent that was highly unsuited for it. Australia's soils were ancient and minimally fertile, and the climate was bipolar — extreme multi-year droughts could be washed away by sudden deluges. But they brought their livestock and plows and gave it a whirl. They believed that hard work was a virtue. The Aborigines were astonished to observe how much time and effort the silly newcomers invested in producing the weird stuff they ate.

The new settlers wanted to live like proper rural Brits — permanent homes, built on fenced private property. They freaked out when the natives set fires to maintain the grassland. Before long, districts began banning these burns. This led to the return of saplings and brush. So, in just 40 years, the site of a tidy dairy farm could be replaced by dense rainforest.

Without burning, insect numbers exploded. Without burning, fuels built up, leading to new catastrophes, called bushfires. The Black Thursday fire hit on February 6, 1851. It burned 12 million acres (5 million ha), killed a million sheep, thousands of cattle, and countless everything else.

Mark Brazil shared a story that was full of crap. In Britain, cow manure was promptly and properly composted by patriotic dung beetles, which returned essential nutrients to the soil. In Australia, none of the native dung beetles could get the least bit interested in cow shit. It was too wet, and too out in the open. Cow pies could patiently sit on the grass unmolested for four years, because nobody loved them. This deeply hurt their feelings. Adding insult to injury, Brook Jarvis noted that fussy cattle refused to graze in the vicinity of neglected pies, so the herd needed access to far more grazing land than normal.

Australian flies, on the other hand, discovered that cow pies made fabulous nurseries for their children. Each pat could feed 3,000 maggots, which turned into flies — dense clouds of billions and billions of flies — which the hard-working Christians did not in any way fancy. Being outdoors was hellish. In the 1960s, folks imported British dung beetles, which loved the taste and aroma of cow pies. Oddly, this is one example where an introduced exotic species apparently didn't create unintended consequences. When they ran out of pies to eat, the beetles simply died.

Anyway, a continent inhabited by Stone Age people was substantially altered by firestick farming and hunting. The Australia of 1788 was radically different from when the first humans arrived. We'll never know if continued firestick farming would have eventually led to severely degraded ecosystems. Some serious imbalances can take a long time to fully develop. Many attempts to deliberately control and exploit ecosystems have spawned huge unintended consequences over time. The ultra-conservative indigenous kangaroos and wallabies were not control freaks, they simply adapted.

Gammage was fond of the Aborigines, because they were highly successful at surviving for a long time in a challenging ecosystem. He was much less fond of the British colonists who, with good intentions, combined with no wisdom, were highly successful at rubbishing it.

Baz Edmeades viewed the entire Australian experience through ecological glasses. Fire reshaped the continent. When humans first arrived, the north coast was home to dry forests that majored in araucaria trees. Before long, they were displaced by fire-promoting forests that majored in eucalypts. The original dry forests went up in smoke. Extremely low-tech Stone Age people substantially altered the ecosystem. We may never have a clear understanding of the early extinctions of the vertebrate megafauna and giant reptiles.

## Stumbling into Domestication

Wild folks let wild animals run free and enjoy their happy lives. Wild critters didn't need to be provided with food, water, protective shelter, and security guards. There was no need to cut, dry, and store hay. When meat was needed, hunters went to work. Similarly, wild food-producing plants were also allowed to grow however they wished. There was no need to engage in tedious backbreaking work to control and exploit them.

In essence, the simple hunter-gatherer way of life was about going out and getting what you needed, when you needed it, and leaving the rest alone. All they needed was enough, and nothing more. They were genuine old-fashioned conservatives — leave the world in no worse shape than the day you were born (and better, if possible). For much of the human saga, this approach could be pursued without obliterating the ecosystem, because there were far fewer humans, and they lived more lightly.

In his lecture, *Four Domestications*, James Scott described four turning points that radically changed the course of the human saga — the domestication of fire, plants, animals, and ourselves. We domesticated ourselves by radically changing the way we lived, in order to protect and nurture the survival and growth of crops and herds. We controlled their lives, and they controlled ours.

We've already looked at the domestication of fire, and how this superpower radically altered the human saga. It enabled tropical humans to survive in chilly non-tropical regions (snow country), colonize the planet, and eventually become participants in monstrous fire-breathing industrial civilizations. Following sections will focus on plant and animal domestication, which mostly began within the last 13,000 years, and fired up the turbochargers for our high-speed one-way rocket ride into the unknown.

### Cradle of Civilization

Jared Diamond seriously wondered why some cultures could remain rich and powerful for centuries, while many others rarely, if ever, had an opportunity to sniff prosperity's butt. He invested a massive number of brain cycles in a quest to find answers. In 1987, he published his boat-rocking essay, "The Worst Mistake in the

History of the Human Race" [Link or Link].

He wrote, "Archaeology is demolishing another sacred belief: that human history over the past million years has been a long tale of progress. In particular, recent discoveries suggest that the adoption of agriculture, supposedly our most decisive step toward a better life, was in many ways a catastrophe from which we have never recovered. With agriculture came the gross social and sexual inequality, the disease and despotism that curse our existence."

Ten years later, in 1997, Diamond published his classic, Guns,

Germs, and Steel, in which he presented a book length discussion of what he had learned. Domestication emerged independently in maybe nine locations around the world, but one region in Eurasia played a starring role in influencing the chain of events that eventually led to the bruised, beaten, and bleeding world outside your window.

It began one day, thousands of years ago, when some intrepid pioneers happened to stumble into a miraculous wonderland known as the Fertile Crescent, the Cradle of Civilization. Gasp! It was as if their wildest dreams had come true! The place was home to a great abundance of wild game and plant foods.

Life was grand for a while, but as the mobs grew in number, they naturally smacked into more and more annoying limits. Cleverness inspired behaviors and illusions that put folks on the treacherous path to farming and herding. This generated a surge of temporary prosperity, while it permanently degraded the ecosystem.

Unfortunately, as centuries passed, the forests, soils, and wildlife got rubbished. Paradise deteriorated into depleted cropland, salt flats, deserts, ancient ruins, and bloody conflicts. The Fertile Crescent (like every other region) was not an ecosystem that could allow agriculture to be successfully practiced forever. Diamond noted that farming is a gradual process of ecological suicide.

In 2002, five years after *Guns, Germs, and Steel*, Diamond published a paper, "Evolution, consequences and future of plant and

animal domestication." [Link] It presented some additional thoughts. The emergence of domestication inspired tremendous changes. It commenced in Eurasia, primarily in the Fertile Crescent and parts of China, where the whims of "biogeographic luck" provided perfect conditions for thrilling joyrides and painful collapses.

Not only were wild foods abundant, but an unusual number of the plant and animal species possessed characteristics that made them suitable for domestication. Despite centuries of trial and error, clever humans have discovered that it's impossible to domesticate the vast majority of plants and animals. To be suitable for domestication, species must have specific collection of vulnerabilities.

For example, Diamond listed six obstacles that made it impossible to domesticate most large animal species. Any one of these could prevent enslavement: (1) a diet not easily supplied by humans, (2) slow growth rate and long birth spacing, (3) nasty disposition, (4) reluctance to breed in captivity, (5) lack of follow-the-leader dominance hierarchies, and (6) a tendency to panic in enclosures or when faced with predators.

Diamond wrote that there are maybe 200,000 wild plant species in the world, of which about 100 have been domesticated. The Fertile Crescent was home several wild grasses that produced large cereal seeds (barley, einkorn, emmer, and spelt), a rich source of carbohydrates. Cereal crops now produce half of the calories consumed by humans. There were also several varieties of pulses (peas, beans, and lentils) that provided protein. In the whole world, purely by random chance, the Fertile Crescent was the biggest treasure chest of future super foods, both plant and animal. It was essentially ground zero for the birth of civilization.

Globally, there are 148 species of large land-dwelling mammalian herbivores and omnivores that weigh more than 100 pounds (45 kg). Sub-

Saharan Africa is home to 51 of these species, but none of them have been domesticated, because all met one or more of the six criteria that prohibited the possibility of enslavement.

Of the 148 species, just 14 have been domesticated. Nine of the 14 only had regional significance, but five species eventually became multinational superstars. The Fertile Crescent was home to four of the top five: the goat, sheep, pig, and cow (horses are the fifth) — an amazing coincidence.

Of the 14 domesticated species, 13 of them originated in Eurasia. Consequently, it's no coincidence that Eurasia played a primary role in the growth and spread of acute, highly infectious, epidemic crowd diseases. Farming and herding created communities of humans that lived in unhealthy proximity to unnatural concentrations of livestock, poultry, rats, fleas, mosquitoes, etc.

This encouraged a number of animal pathogens to adapt to human hosts, including influenza, smallpox, tuberculosis, plague, measles, and cholera. Diamond noted, "Such diseases could not have existed before the origins of agriculture, because they can sustain themselves only in large dense populations that did not exist before agriculture, hence they are often termed crowd diseases."

Nomadic foragers lived in small groups and periodically moved their camps. This was a brilliant strategy for avoiding diseases. On the other hand, humans who lived in crowded villages and cities made tremendous advances in unsanitary living. Crap and garbage were all over the place, all the time. Rivers were the source of drinking water, and the dumping place for sewage and other filth. A later chapter will take a closer look at disease.

Diamond noted four developments that dimmed the future for hunter-gatherers, and encouraged the expansion of farming and herding. (1) Over time, hunting gradually made large game less abundant. (2) We learned new skills for collecting, processing, and storing foods. (3) Societies competed, spurring innovations that improved our ability to survive. (4) Growing populations required large-scale food production.

Folks who inhabited regions suitable for producing plant and animal foods learned tricks for maximizing their production. Population surged, spurring the emergence of cities and civilizations. Civilization encouraged the development of stuff like metallurgy, industry, deforestation, soil destruction, warfare, overcrowding, patriarchy, and slavery.

So, let's rephrase what William Rees earlier said about two traits of species. (1) "Every *civilization* will expand to all locations that are accessible to them, where conditions might allow their survival." As they expand, they will take along their livestock, crop seeds, weaponry, culture, technology, religions, and diseases. (2) "When they *colonize* new habitat, they will *utilize* all available resources, until limits restrain them."

Eurasia spans from Europe to China. The earliest centers of domestication were the Fertile Crescent and parts of China. State of the art food production provided both centers with powerful advantages over their humbler neighbors. The two centers became hubs for territorial expansion. Their languages, genes, tools, and cultural influences have spread around the world.

This is a spooky story. From the two hubs, the realm of farming and herding spread in many directions. In the sixteenth century, European travelers began noticing striking similarities in Indo-Aryan, Iranian, and European languages. They appeared to have a common ancestor. As the years flowed by, scholars noticed that lots of other languages also had similarities. A category was created to name this assortment.

Visit Wikipedia's discussion of Indo-European Languages. See the maps that show how this language family spread across the Old World over time. Around 500 years ago, the age of global colonization exported Indo-European languages to the Americas, Australia, Sub-Saharan Africa, and elsewhere. Today, the native language of about 46 percent of humankind, is an Indo-European tongue.

Drop a pebble in a calm pool of water, and rings of ripples spread in every direction. Diamond wrote that humankind's long and stormy story of food production, population growth, civilization, and global domination, began in the Fertile Crescent. The pebble is called domestication.

The Fertile Crescent has misty borders, and no two maps agree,

but it's blob-shaped. [MAP] One finger poked westward toward Turkey. Another spreads down along the east coast of the Mediterranean and plunges deep into Egypt. Another heads south toward the Persian Gulf. The Fertile Crescent was a primary location for the emergence of plant and animal domestication. Eventually, it became the birthplace of an unsustainable monster known as Western Civilization.

Diamond lamented, "If they had actually foreseen the consequences, they would surely have outlawed the first steps towards domestication, because the archaeological and ethnographic record throughout the world shows that the transition from hunting and gathering to farming eventually resulted in more work, lower adult stature, worse nutritional condition, and heavier disease burdens."

Looking back from the twenty-first century, we can readily see the many unfortunate choices that our ancestors made. At the same time, we can observe the world around us today, and readily see the catastrophes that those wrong turns unleashed. It's heartbreaking. Cleverness without foresight is a deadly combo. It sure is an interesting time to be alive!

**Supply and Demand**

Mother Africa was the homeland where hominins first evolved maybe four million years ago. Experts do not agree on when the human species first emerged. Estimates range from maybe 250,000 to 400,000 years ago. For almost the entire human saga, our ancestors were nomadic foragers — hunters and gatherers. Around 60,000 years ago, some pioneers decided to see the world, and began exploring the tropics of southern Asia, on a path toward Australia.

Around 42,000 years ago, some humans had migrated north into Europe, a region with a temperate climate. It was a major shift, moving outside of the tropical climate for which evolution had fine-tuned us. The curiosity of these explorers helped to accelerate our journey to a stormy future. Long term survival in a non-tropical region required loads of radical innovations.

Humans regularly bumped into limits as they colonized the world, and cleverness often provided ways to bypass the obstacles. As long as wild foods were abundant, there was no need to pursue farming or herding, which required far more time, difficulty, and risk. Large game was our ancestors' preferred food but, over time, hunting a bit too much could gradually deplete the delicious herds. Efforts then had to shift to class B and class C foods — small game, forest animals, waterfowl, fish, shellfish, insects, and so on.

Barry Cunliffe noted that as the last ice age weakened, the climate warmed, and the more comfortable Holocene era began. Prior to this warming, European forests had been located in the south, closer to the Mediterranean Sea. As the climate warmed, forests were able to migrate northward, into tundra regions that were home to herds of megafauna animals. So, tundra habitat shrank, and forest habitat expanded.

Forests were home to more solitary game like aurochs, boars, elk, deer, and small animals. The total biomass of these forest animals was only 20 to 30 percent of the biomass of the tundra herds they replaced. Reduced access to herds of meat critters motivated lifestyle changes. Folks learned that it was easier to survive in locations close to coastlines, lakes, rivers, and wetlands, where a year-round supply of foods might be gathered. This new way of living apparently worked well enough for a while.

Diana Muir wrote an environmental history of New England, from the ice age to today. On the tundra, folks hunted mastodons, horses, bison, and four species of mammoths. There were sabertooth cats, giant bears, giant beavers, and musk oxen. As forests expanded northward, hunters pursued forest game, like deer, bear, beaver, moose, waterfowl, turkeys, and heath hens.

Rivers had huge runs of salmon, shad, and alewives. Stuff like acorns and shellfish were reserved for famine food. As game got scarcer, shellfish became a mainstay. An adult male would need 100 oysters or quahogs each day. Thousands were dug and smoked for winter consumption, a tedious job. In the lower layers of huge shell dumps were oyster shells 10 to 20 inches across (25 to 50 cm) — oysters 40 years old. In higher levels, the shells got smaller and smaller.

Eventually, the seeds of domesticated corn (maize), squash, and beans reached New England. Tribes that pursued the new experiment could produce more food, and feed more people. When fields were first cleared, and the virgin soil was still highly fertile, agricultural land might sometimes produce a hundred times more food than an equal area of wild land used by foragers. Of course, population pressure is a predictable cause of social friction and bloody conflict. Because tribes had no livestock, they had no manure to help conserve soil fertility, which declines over time, shrinking the harvests.

The big picture here is an ongoing struggle for survival, in which limits periodically stomped on the brakes, and cleverness struggled to find alternatives. Cleverness is not an all-powerful miracle-making magic wand. It also has limits, and frequently experiences painful head-on crashes into unintended consequences.

## Control Freaks

Herders and farmers performed backbreaking labor to reduce forests and grasslands to cropland and pasture. The transformation from wild lands to private property typically involved erasing portions of the healthy wild ecosystem, and then regularly keeping the altered land tamed.

Paul Shepard noted that the concept of controlling pests, animals, plants, and predators was relatively new. "If the farmer can destroy his competitors, be they beetles, fungi, birds, or deer, and the pastoralist-rancher can kill lions and wolves, they will be inclined to do so. Wild things become adversaries." Nature is an opponent, something to conquer and subdue. This land is my land. My harvest is stored in my granary. My livestock are grazing on my pasture.

## Status Fever

Over time, status fever spread to epidemic levels in some cultures. Victims became obsessed with an insatiable desire to accumulate wealth and prestige. This fever spurred the emergence of many powerful tribes, empires, and big shots.

Today, ambitious consumers strive to accumulate possessions that proudly display their rank in the social hierarchy — stuff like trophy homes, vehicles, clothing, jumbo TVs, recreational playthings, and so on. It's a never-ending treadmill. The purpose of a successful life of is to fanatically reduce creation to towering mountains of landfill dreck.

Our culture is a thundering nightmare of status fever. We are expected to hoard more than our neighbors, more than our parents and siblings, and to own more cool stuff than we owned last year. If we weren't raised in consumer society, this game would appear to be utterly insane (and it is).

Stan Rowe lamented that consumers are imprisoned in "the solitary confinement of a narcissistic existence." They are trying to fill the vacuum created by their loss of wildness, freedom, and functional community. It's an ineffective attempt to suppress a gnawing hollowness in their lives.

William Cronon compared and contrasted Native American society with the culture of European colonists. Indians enjoyed far greater affluence because they were in an intimate long-term relationship with their ecosystem, and the things they considered to be needs were minimal. When you have few wants, the path to prosperity is short. Even the least industrious wanted nothing.

Colonists, on the other hand, had an insatiable hunger for an infinite number of frivolous needs. Their culture had a demonic technology called money, which made it much easier to exchange commodities, make profits, and accumulate durable wealth.

Back home in Europe, more than 1,500 years of forest clearing had eliminated large regions of ancient woodlands. Wildlife was severely depleted. Rivers formerly loaded with salmon had become sewage canals. Cities were incubators of infectious diseases. America blew their minds. They imagined that the supply of valuable resources was beyond limitless. Most of this astonishing wealth was free for the taking. Whee!

Robin Wall Kimmerer noted that among the Anishinabe, howling winter winds are associated with the Windigo, a legendary monster with a heart of ice. It is the primal survival instinct that rises during the Hunger Moon, and then swerves out of control, from need to greed. It eats until hunger fades, but doesn't stop. Windigo is a selfish spirit that doesn't know when it has taken too much. It is the insatiable hunger of the corporation, the greed freak, and the entranced consumer. It's daunting to see that much of modern society has now become thoroughly entranced by the Windigo spirit.

Jack Forbes, of Powhatan and Delaware heritage, perceived status fever to be an epidemic of insanity. He called it wétiko psychosis, the cannibal disease. It's a spiritual illness that causes people to become predators, and to relentlessly consume the lives of others. Wétiko was the essence of European culture, a spooky nightmare world of bloodthirsty vampires and werewolves. Their "religion" was something isolated from everyday life, practiced indoors, away from the perfection of creation.

Different cultures assigned different status value to different types of stuff. For California Indians, gold was just an ordinary type of

stone. Raymond Dasmann noted that they would happily trade ordinary gold nuggets for pretty glass beads. Pale faced Americans, on the other hand, went absolutely delirious with status fever at the sight of gold. They would do anything to stuff the shiny stones into their pouches. Miners washed away many mountains with hydraulic mining. The Gold Rush brought people from everywhere. "The Indians were deliberately decimated." In 1765, there may have been 130,000 in California. In 1850, maybe 85,000. By 1852 just 31,000 were left.

Sitting Bull was not the slightest bit fond of insane colonizers. "The love of possessions is a disease with them." A century ago,

Peter Fruechen mentioned a comment from a mystified Eskimo, "You white people don't really know how to do without things and still be happy." On another occasion, an Eskimo snarled at Knud Rasmussen. "You are so strange, you white men! You collect things you will never require, and you cannot leave even the graves alone."

Jay Griffiths wrote that consumer culture trains us to develop selfishness and greed. We should strive to be special, like celebrities, famous for being famous, and devote our lives to climbing as high as possible up the social status pyramid.

An old hippy friend of mine, Hitch-hiker John, observed American society with a mix of horror and amazement. "They are never distracted by ideas," he said. "Brainwashed people have no issues — they don't know how to think. The sole focus of their lives is just one all-consuming question: how can I get what I want?"

**Treasure Hunters**

Both farmers and herders invested lots of time and effort accumulating stashes of essential life energy — edible nutrients provided by domesticated plants and animals. Their food stashes were treasure chests, collections of genuinely precious valuables necessary for survival.

The vital importance of treasure chests triggered a diabolical turning point in the human saga. On one dark and stormy night, a demon whispered an idea into the ear of a demented nutjob: "Stealing treasure chests required far less effort than creating them." Oh, my goodness! Why didn't I think of that? Laborious drudgery was for scroungers, peasants, and slaves. Skillful robbery trumps hard work!

Over time, raiding became a popular and successful profession. The raiding game led to centuries of conflict, which spilled rivers of blood. It persists to this day. Paul Henri Mallet wrote one sentence that perfectly summed it up: "The weak had no right to what they could not defend."

The frequent success of raiding inspired the hardworking folks who accumulated and stored precious treasure to invent a new profession: warrior. The purpose of defensive warriors was to make life miserable for raiders, and exterminate them whenever possible.

Sedentary communities were chained to a location. They could not rapidly grab their stored treasure and flee. So, they had to protect their towns and villages with palisades, walls, fortresses, moats. Walled cities protected large amounts of wealth. Raiders kept inventing new and improved ways of overcoming physical barriers and exterminating city defenders. At the same time, cities tirelessly invented new and better ways of protecting themselves and exterminating raiders.

Nomadic pastoralists owned treasure chests that were highly mobile — herds of precious four-legged food lockers. Their nutritious flesh did not spoil whilst they remained alive, it increased — and they produced offspring too. Many raids also acquired slaves, two-legged, muscle-powered busybodies that generously gave birth to adorable baby slaves. Slaves and livestock were valuable commodities that could be sold to agrarian states, in exchange for city made goods.

The raiders' highly mobile way of life gave them a strategic advantage over the immobile city dwellers, whose access to food could be cut off by an extended siege (when dogs became "siege mutton"), while flaming arrows landed on their wooden roofs. Christopher Beckwith wrote that in good times, raiders "were in general much better fed and led easier, longer lives than the inhabitants of the large agricultural states."

James Scott noted that Mongols perceived agrarian communities to be ra'aya (herds) — irresistible get-rich-quick opportunities for merciless, bloodthirsty, mobs of looters. Mounted on speedy horses, hundreds of nomads could suddenly appear out of nowhere, thunder into town without a polite invitation, and enjoy an exciting day of slaughter, rape, pillaging, and demolition.

Status fever is an equal opportunity pathology. Some cities began contemplating other cities in the region, calculating the amount of treasure they controlled, and the weaknesses in their defenses. Naturally, strong cities overwhelmed weaker cities, and empires metastasized. Conquering neighbors was an exciting way to fill treasure chests, and increase their herds of livestock, warriors, serfs, women, and slaves.

Similarly, nomads were not honorable gentlemen having the highest moral principles. It was not beneath their dignity to attack, kill, and rob other pastoralists, if they were believed to possess interesting treasure. There was no reason why strangers should remain the owners of livestock that could become my property with a modest investment of belligerence and terrorism. Social status was very important to testosterone powered egos, and macho lads took every opportunity for elevating it.

Throughout the centuries nomads have enjoyed being parasites on hard working farmers. In A.D. 98, the Roman historian Caius Cornelius Tacitus said this about the tribal Germans: "They will much easier be persuaded to attack and reap wounds from an enemy, than to till the ground and wait the produce. They consider it as an indication of effeminacy and want of courage to gain by the sweat of the brow, what they may acquire at the price of their blood."

Saxo Grammaticus, a Danish historian, was born around A.D. 1150, and had more of a ringside seat at the bloody horror show. "Now the warriors, who were always pillaging the neighborhood, used often to commit great slaughters. Plundering houses, cutting down cattle, sacking everything, making great hauls of booty, rifling houses, then burning them, massacring male and female promiscuously — these, and not honest dealings, were their occupations." War dogs were popular too. "Biorn had also a dog of extraordinary fierceness, a terribly vicious brute, dangerous for people to live with, which had often singly destroyed twelve men."

Saxo also mentioned berserkers (bear shirts), warriors who wore bear skins into battle, and became ferociously violent, completely out of control, and fought in a trance-like wild fury. Ralph Metzner called it a holy rage that they could not turn off. They killed everyone in sight, even friends. In Ireland, Cu Chulainn was so overheated with battle rage that a group of naked women was sent out to calm him. He was put in vats of cold water, which boiled and evaporated.

In that culture, war was their source of honor, riches, and security. Courage was the highest virtue; death was not feared. The honorable way to die was violently, weapon in hand, ideally laughing with their final breath. This was rewarded by a premier afterlife in Valhalla, where they would spend eternity in bloody battle. Every day, they would delight in cutting each other to pieces, and then magically recover, mount their horses, and ride back to the hall of Odin for a night of feasting and oblivion drinking. Yippee!

The shameful way to die was bed death. Folks who died of disease or old age were sent to a low-class afterlife in Niflheim. To avoid this fate, Mallet wrote, warriors would plunge off an ancestral cliff (ättestup) to a violent death, in order to end their lives honorably. Stafva Hall in Sweden had annual festivals, with singing and dancing, after which the wobbly geezers, beyond their expiration dates, leaped into the lake far below. Vilhelm Moberg noted that those too weak to jump could be sent to Valhalla by a caring friend smashing their skull with an ancestral club (ätteklubbor).

With every century that followed, raiding continued spreading into new regions around the world, grabbing as much treasure as possible, often utilizing staggering amounts of destructive force. The twentieth century saw tremendous advances in fossil-powered mechanized warfare, on land, on sea, and in the skies above. Large cities could be reduced to ash trays with the push of a button.

Today, technological innovation has enabled many more options for raiders, few of which require "coming to grips" with their opponent, and getting splattered with their blood, sweat, and spit. Millions of dollars can now be robbed with a mouse click, from a cozy cubicle in nowhere land. We are living in the Golden Age of status fever.

Big Mama Nature is not amused. She will still be standing — scarred and wounded, strong and defiant — when the lights go out, industrial civilization runs out of treasure, and finally slips beneath the waves.

# Animal Domestication

Domestication triggered a shock wave in the human saga. It radically altered the traditional core relationship between humans and the rest of the ecosystem. For maybe four million years, hominins were participants in a family of life that joyfully danced to the ecstatic music of freedom. Domestication was a shift to control and exploitation, a brutally abusive relationship.

Hunting was the pursuit of wild game, which required a combination of skill and random chance. Wild game is intelligent, alert, and driven by a powerful desire to avoid predators. Being alive is precious. Wild game is out of control. They are not passive dimwitted sheep in the pasture, constantly overseen by shepherds and dogs.

Herding was a different game. It's the process of controlling enslaved animals during every minute of their lives. Managing livestock was a constant responsibility. Animals had to be guided to water and fresh grass. They had to be protected from predation. Wild carnivores had to be exterminated at every opportunity. Male animals not needed for breeding services were mellowed out via castration.

### Why Do It?

On the following pages, "domesticated" will refer to animals that have been under human control for many generations, selectively bred to encourage specific traits, and genetically different from their wild ancestors — manmade organisms that had never existed before. It does not mean "tamed." Elephants in India have been tamed, and perform work for humans, but they remain genetically wild.

James Scott wrote that over the passage of generations, selective breeding produces animal slaves that are more passive, less alert, less intelligent, and more dependent on human care. They reach reproductive age sooner, preserve some juvenile aspects, and produce more offspring. The brains of domesticated sheep are one fourth the size of their wild ancestors, and pig brains are a third smaller.

Livestock and poultry are capable of digesting many types of nutrients that humans cannot, like grass. Then, they transform the nutrients into forms that humans can utilize, like meat, milk, and eggs. When animals are milked, they provide herders with far more lifetime calories than could be acquired by simply killing and eating them. In different regions, folks milked cattle, sheep, goats, horses, water buffalos, zebu, yaks, reindeer, camels, and donkeys.

All newborn human infants are able to digest lactose, the sugar in milk. Then, after weaning, the norm was to become lactose intolerant. With the era of animal domestication, this changed. Over time, in cultures that traditionally consume milk products, genetic evolution eliminated lactose intolerance in humans of all ages. This shift was not universal in all cultures. In Northern Europe, less than ten percent are intolerant. In portions of Asia and Africa, the intolerance rate can be up to 95 percent.

Domestication brought other changes. Growing crops depletes soil fertility, and manure rejuvenates it. So, it's good to have adequate grassland, to graze enough livestock, to produce enough manure, to keep the soil happy, to keep the family well fed. Animals also provided hides and wool. Beasts of burden were used to pull plows, carts, and sleds. They hauled loads of cargo. Herders could tap some nutritious blood from living animals from time to time. Folks rode on the backs of horses, donkeys, yaks, reindeer, and camels. Mounted cavalry radically intensified the destructive impacts of warfare and raiding.

Scott summed up the drawbacks of animal domestication. Both a deer and a steer provided meat, bones, hides, and tendons, but the deer required zero human assistance to grow from fawn to adult. The steer could require corrals, winter feed, shelter, herd dogs, salt licks, and a source of water. Nobody owned the deer, but the steer was private property, a potential source of conflict. As long as deer and other game was plentiful, labor intensive herding and farming would have been moronic.

A backhanded perk of being born in captivity is that enslaved critters might have lives that are, in some ways, unnaturally luxurious. Many are provided with protection from the hot sun, and/or frigid weather. Their owners make efforts to protect them from the teeth and claws of wild carnivores. In the end, animal slaves are sent away to visit to the butcher.

## Herds and Property

The concept of personal property expanded to include valuable animal slaves, a source of nourishing life energy. Each critter in my herd became a status symbol, and my social rank was based on the value of the status symbols I possessed. You are what you own. This was a new and radical shift in the human saga. It inspired a sense of power and omnipotence, an amazingly brilliant smarty-pants, Superman. For the first time in the human saga, Superman could have ongoing life and death control over tons of living meat. Whoa!

My ownership of an easily replaced spear or loincloth had trivial importance. On the other hand, my ownership of 40 large herbivores was a matter of tremendous significance. This set me apart from (and above) someone who merely owned two goats. More is better could lead to notions that I am better, and to painful infections of status fever.

## Cattle

From Aurochs to Cattle

Aurochs were the wild ancestors of today's herd of 1.3 billion domesticated cattle. They were huge, strong, and fierce — the opposite today's passive cud-chewing manure makers. In regions having ideal conditions, bulls could grow up to 6 feet (180 cm) tall at the shoulder, and weigh up to 3,300 pounds (1,500 kg). Their horns were much longer than cattle, and pointed forward, aggressively.

Some believe that the species originally emerged in India between 1.5 and 2 million years ago. They survived in a world along with similarly large, strong, and fierce predators. Eventually their range spanned from England to China. Aurochs' preferred habitat was dense ancient forests with lakes, rivers, bogs, and fens. They didn't hang out in frigid tundra regions with reindeers, woolly mammoths, and horses.

In 51 B.C., Caesar wrote that aurochs were animals "a little smaller than elephants, having the appearance, color, and shape of bulls. They are very strong and swift, and attack every man and beast they catch sight of. The natives sedulously trap them in pits and kill them. Young men engage in the sport, hardening their muscles by the exercise; and those who kill the largest head of game exhibit the horns as a trophy, and thereby earn high honor. These animals, even when caught young, cannot be domesticated and tamed."

Charles the Great, also known as Charlemagne (A.D. 747– 814), once had a painful encounter while on a hunting trip. When an aurochs appeared in the forest, his hunting buddies fled in terror. Charlemagne was less intelligent. He rode up to one, drew his sword, and pissed off the monster, who gored his leg. From that day forward, the humbled king walked with a limp.

The famous explorer Marco Polo (1254–1324) also described them. "There are wild cattle in that country as big as elephants, splendid creatures, covered everywhere but on the back with shaggy hair a good four palms long. They are partly black, partly white, and really wonderfully fine creatures."

Anton Schneeberger (1530–1581) was a Swiss botanist and doctor based in Poland. He wrote that aurochs had no fear of humans, and did not flee from their approach. When they were teased or hunted, they got very hot-tempered and dangerous, sometimes hurling fools high into the air.

As agriculture expanded, Europe's ancient forests and wetlands shrank. Grain farmers detested aurochs molesting their crops, and herders resented them dining on prime forage. Aurochs stood in the path of progress.

Cis van Vuure wrote the book on aurochs. He thought that domestication began about 9,000 years ago, in the Middle East and Pakistan. Over time, the mighty aurochs was reduced to countless variations of dimwitted cattle, fine-tuned for specific climates and uses (meat, hides, milk, and muscle power).

It's hard to imagine such notoriously fierce animals being forced into slavery. Alasdair Wilkins wrote about recent DNA research on cattle. The ancestors of every domesticated cow in the world trace back to a tiny herd in the Middle East, a herd as small as 80 animals. The process of domestication may have taken a thousand years, and it was likely done by sedentary people. It would have been impossible for nomadic herders to confine huge powerful animals with a tremendous love of wildness and freedom.

Nobody ever hitched a wagon or plow to an aurochs. Nobody put a saddle on one. Nobody milked them, and made aurochs cheese. They were wild, free, strong, and extremely dangerous. And so, they no longer belonged in the heavily managed manmade societies we were creating. The last aurochs died in 1627, in the Jaktoróv forest of Poland.

Tamed and Enslaved

It was now the cattle age. A quick and easy path to creating mild-mannered bulls was to fetch a sharp knife, relieve them of their testicles, and turn them into mellow, easygoing oxen. In the early days, cattle were used for meat, milk, and hides. Later, they became a source of muscle power — beasts of burden, and draft animals that pulled carts, chariots, plows, logs, and so on.

Folks eventually quit using oxen for muscle power when someone finally invented a contoured collar harness for horses that allowed them to pull serious loads without strangling themselves. Horses required a richer diet, but they worked much faster than oxen. So, farmers could plow larger fields, and fields that were farther from home. Keith Thomas reported that it wasn't until oxen were retired from muscle work that roast beef became the iconic centerpiece of English cuisine. Until then, it wasn't wise to eat your tractor.

Earlier, we looked at the prehistoric deforestation of Europe. Actually, deforestation was a global human enterprise. In early times, we created manmade grasslands to attract large herbivores. With the domestication of livestock, the expansion of agriculture, and the human population outburst, deforestation continued. It's still happening on a massive scale. Paul

Shepard wrote, “If the auroch was the most magnificent animal in the lives of our Pleistocene ancestors, in captivity it became the most destructive creature of all.”

Years ago, I did some hiking in the hills above San Francisco Bay, where cattle were grazing. Generally, the vegetation was kept neatly trimmed, and here and there were 100-year-old oaks. They dropped lots of acorns every fall, but there were few young oak trees, because their seedlings were routinely nipped off or burned. Originally, these hills were thriving oak savannahs, covered with a thick undergrowth of sagebrush and other shrubs, dotted with oaks

of all ages. [LOOK]

Especially in coastal regions, California Indians deliberately burned off the cover of dense sage scrub to create grasslands that attracted game. Later, the Spanish and American colonists created more manmade grasslands for their livestock. Once the brush was burned off, and cattle introduced, the oak savannah was doomed.

To add insult to injury, the exposed grassland became extremely vulnerable to troublesome immigrants, known as exotic invasive European weeds (more on these in a minute).

Western United States

Cattle largely replaced bison in the U.S. west. Bison are also ruminants and, in the good old days, they were wild, free, and happy. Dan Flores mentioned that the bison herds were lovingly managed by family planning brigades called wolf packs. They ate maybe four of every ten bison calves. Wolves did not kill as many bison as possible, just enough to fill their growling tummies. Enough is enough! Life on the prairie worked well. Coevolution can do brilliant things.

When European colonists migrated into the western plains of the U.S., they found millions of bison that had beautifully coevolved with the ecosystem over thousands of years. The alien white lads came from a culture that had a long tradition of owning and exploiting domesticated livestock, which were imagined to be valuable commodities. The more you owned, the cooler you were, and the higher your social status. The settlers soon discovered that bison were not interested in being domesticated.

Rather than doing something sensible, like turning around, sailing back to the old country, where countless generations of their ancestors were buried, and spending the rest of their days in filthy cities roaring with deadly epidemic diseases and bloody religious fanaticism, they decided to stay, and rubbish the indigenous people, wildlife, and ecosystems.

Their brilliant plan was to import domesticated shorthorn cattle from northern Europe — purebred passive dimwits, ideal slaves. They could raise huge herds and become wealthy cattle barons.

Richard Manning wrote an excellent description of the comedy of errors that occurred in this grassland soap opera. The healthy, functional wild ecosystem was a serious problem that needed to be fixed, because it was an obstacle to progress and a growing economy.

Well, there were some annoying challenges. You see, bison could remain fat and happy on a diet that majored in grass. By a lucky coincidence, the western plains produced an abundance of delicious and nutritious grass. For example, the excellent blue bunch wheat grass remained a nutritious food source throughout the winter. Unfortunately, imported cattle gobbled it all up prior to winter, leaving nothing for later. Oops! When this primo grass is overgrazed, it can take ten years to recover.

The digestive tracts of bison had been fine-tuned by evolution to process the native grasses, so they were 18 percent more efficient than cattle. The fussy foreign cattle preferred a diet of leafy forbs (broad leafed flowering plants like alfalfa), which were scarce in their weird new habitat. The frustrated hungry cattle were not impressed, and wanted to go back home on the next boat. Request denied.

Bison were well adapted to the dry climate, and they could comfortably go for several days without needing a drink of water. Their herds roamed across the land at something like a walking pace. It wasn't necessary for them to stick close to water, so they were able to wander and graze over a wide region. They might not return to a location for several years. The result was healthy grassland, healthy riparian areas, healthy herds of bison, and healthy tribes of Indians and wolves.

The prissy imported cattle, on the other hand, had evolved in a much moister climate, where it was far easier to find a drink whenever they got a bit thirsty. Consequently, on the plains, they tended to concentrate their grazing on locations closer water, unload tons of manure, overgraze, and mutilate the banks of the streams (riparian areas). When riparian lands are undamaged, they can produce far more forage. They are top quality places for indigenous herbivores. On the other hand, when the vegetation is damaged, the soil dries out, and floods are more likely to carry it away. Overgrazed land speeds rain runoff, which sometimes leads to spectacular flooding.

The bison were well adapted to surviving in a region where the climate majored in blast freezer winters and scorching summers. The cattle were adapted to living in a dainty moist climate with moderate summers and mild winters — an ecosystem strikingly different from the plains. During the super-cold winters of 1885-86 and 1906-07, maybe 50 to 75 percent of the cattle on the high plains died — while the snow-frosted bison remained warm, well-fed, and secretly amused at the misfortune of the hapless illegal immigrants.

Well, the ambitious colonists had still another brilliant idea. They decided to introduce traditional pasture plants from Europe, so their cash cows could get fatter faster. Unfortunately, most of these exotic plants promptly keeled over and died, because they were equally unsuited for the plains. So, the next brilliant solution was to import pasture plants from arid regions of Asia — a disastrous mistake that has caused irreversible damage.

Manning described some of the bummers. Crested wheatgrass thrived on the plains, and it outcompeted and displaced native plants. In the winter, this wonder grass retained little nutritional value, and so the mule deer, elk, and antelope starved in endless fields of non-native grass.

Spotted knapweed suppresses native grasses, and has now spread to 7 million acres (2.8 million ha) in 48 states. Because of root secretions, most other plants can’t live close to it. Sheep can eat it, but cattle eat bunchgrass instead, which encourages the knapweed to spread.

Leafy spurge is now found in 26 states, where it has spread across 2.5 million acres (1 million ha). It excels at outcompeting most other species, achieving communities that are almost monocultures. The plants have extensive root systems, and can live for 40 years. Spurge has a toxic sap. Cattle will not graze near it, only sheep and goats can eat it. The plant transforms lands into biological deserts, and it is extremely expensive to eradicate.

Cheatgrass can survive in low quality soils, and in regions having minimal precipitation. Only in the early spring does this grass provide significant nutrients to grazing animals. For the rest of the year, it doesn’t, so animals can starve in a thriving grassland. Cheatgrass is especially flammable, and it burns hot enough to roast the seeds of native plants, which it has now displaced across large areas. After a cheatgrass fire, exposed soil is vulnerable to erosion and gullying. Following a rain, the runoff can be rapid, leading to

sudden floods. Dan Flores wrote that in the U.S. west, cheatgrass had turned 100 million acres (40 million ha) into a biological wasteland.

Eliminating invasive exotic vegetation is prohibitively expensive, and often essentially impossible. Invasives are here to stay, and their plan is to spread. Human intelligence remains an unfinished masterpiece.

The punch line here is that both the bison and horses were perfectly adapted to the native vegetation. Both were at home in the native climate. They belonged here. But they really liked being free, and they were less easy to control than cattle. Cattle were square pegs that didn’t fit into round holes.

Australia

Meanwhile, in Australia, the introduction of cattle created other headaches, according to Mark Brazil. In Britain, cow manure was promptly and properly composted by patriotic royal dung beetles, which returned essential nutrients to the soil. In Australia, none of the native dung beetles could get the least bit interested in cow shit. It was too wet, and too out in the open. Cow pies could patiently sit on the grass unmolested for four years, because nobody loved them.

This deeply hurt their feelings. Adding insult to injury, Brooke Jarvis noted that fussy cattle refused to graze in the vicinity of neglected pies, so the herd needed access to far more grazing land than normal.

Australian flies, on the other hand, discovered that cow pies made fabulous nurseries for their children. Each pat could feed 3,000 maggots, which turned into flies — dense clouds of billions and billions of flies — which the hard-working settlers did not in any way fancy. Being outdoors was hellish. In the 1960s, folks imported British dung beetles, which loved the taste and aroma of cow pies. Oddly, this is one example where an introduced exotic species apparently didn't create unintended consequences. When they ran out of pies to eat, the beetles simply died.

**Pigs**

In the last million years or so, the pig family has evolved into a variety of different species, including boars, bearded pigs, peccary, warthogs, and so on. Today, there are a billion pigs on Earth. The ancestors of domesticated pigs were wild boars, which once inhabited regions of Africa and Eurasia, from Ireland and India to Japan and Siberia. Sadly, wild pigs were originally lured into the domestication trap by a treasure chest of garbage, feces, and lush gardens. In North and South America, none of the native pig species have been domesticated. They remain wild and free.

Peter Wohlleben reported that the super intelligent wild boars remain alive and well in portions of Europe, where they have been labelled destructive pests. German hunters kill 650,000 each year. When the shooting starts, boars disappear during daylight hours, and become night critters. Hunters are forbidden to use night vision devices. When hunting season begins in France, the boars swim across the Rhône River to Switzerland, where hunting is banned. As Winston Churchill once said, "Dogs look up to us, cats look down on us, but pigs treat us as equals."

Domestication did not reduce pigs to slobbering dimwits. They are more intelligent than many world leaders. Mud-covered pigs are like rich humans at luxurious health spas. When the mud dries, fleas, ticks, and other parasites are baked into it. Then, pigs rub on trees to discard the cruddy mud, and the annoying pests trapped in it.

Cattle, sheep, goats, and horses are grassland creatures. Pigs are not. They prefer to reside in moist and shady places — temperate and tropical forests, close to water sources. Unlike the other four, nomadic herders don't keep them. Enslaved pigs are usually kept by sedentary communities. They can grow up to 770 pounds (350 kg), and have seven litters per year. Piglets can grow rapidly when food is abundant.

John Reader noted that pigs are remarkably efficient at turning food into flesh. Because their diet is more nutrient rich than mere greenery, they could convert 35 percent of what they ate into meat (sheep 13%, cattle 6.5%). In ten months, the offspring of a pair of pigs can produce 3,200 pounds (1,451 kg) of meat — ten times more than cattle.

While cattle, sheep, goats, and horses are herbivores, pigs are omnivores. They are not fussy eaters. They will chow down on kitchen wastes, slaughterhouse wastes, spoiled spuds, ugly spuds, peelings, excrement, nuts, grains, roots, insects, leaves, fruits, flowers, fish, human corpses, and other carrion. They have been known to bite, and sometimes kill children.

In many settlements, pigs were proud members of the department of sanitation, along with rats and dogs, cleaning up crud discarded by untidy humans and other critters. In regions of India and China, many pigs enjoyed rewarding careers in the sewage treatment profession. Outhouses were often built above pig sties. When steaming turds fell from the sky, pigs would scramble to gobble up the precious gifts from heaven.

For some mysterious reason, folks in the Middle East considered pigs to be unclean. Both Hebrews and Muslims forbade touching or eating pigs. Marvin Harris added that pigs provided no milk or wool, and they were not at all interested in being herded. Pigs ate the same foods that humans did. Consequently, farmers and gardeners were not fond of them. Also, hot sunny, arid lands (like the Middle East) were a poor habitat for pigs. When air temps rise above 98°F (36°C), adult pigs exposed to direct sunlight can drop dead.

Richard Lillard wrote about the early American colonies. Many regions were forested, unsuitable for cattle, but heaven for pigs, who could keep themselves fat and happy via rooting and foraging. For most early settlers, pork seemed like an exotic food, because in the old country, boars were kept in hunting preserves, for the hunting pleasure of wealthy aristocrats. Bacon was for billionaires, high class lords and ladies.

Back country colonists enjoyed a grand life for a while, when the woods of Virginia and Maryland were swarming with pigs. The porkers could run free without supervision, because they were fairly safe. They were not easy prey for wolves or bears, although the alligators of Alabama were connoisseurs of plump, juicy, free range organic ham. As long as you provided a source of salt, and tossed out some corn every day, the pigs would remain in the vicinity. Humans were careful to mark which pigs belonged to them.

Pigs, of course, were delighted to raid gardens and crops, which often pissed off the neighbors. Frantic pleas for compulsory fencing laws were ignored. The majority of back country people loved having pigs, because raising them was much easier than the tedious drudgery of agriculture. Ordinary folks could enjoy a leisurely way of life that provided a decent standard of living.

Simon Fairlie noted that huge numbers of pigs were born and fattened in the frontier forests, and every year their keepers would drive them down hog trails to big cities on the east coast, where they were traded for gold. Pork was America's favorite meat until the 1950s, when beef moved into the top position. The first McDonalds restaurant opened in 1948, and soon became a sprawling empire, serving haute cuisine to America's hungry, burger-loving aristocrats.

Because of their exceptional intelligence, pigs seem to be the domesticated critters most capable of returning to a life of wildness and freedom. An estimated six million feral pigs now roam wild and free in 30 U.S. states, especially Texas. They are descendants of the pigs brought by

Spanish explorers centuries ago. Feral pigs can grow up to 400 pounds (180kg). Humans who grow things that pigs love to eat are shocked and infuriated when pigs happily drop by to enjoy the delicious gifts that were so kindly left for them. The hotheads buy guns and shoot them, but pigs excel at producing piglets, who quickly replace their fallen relatives.

They also have strong razor-sharp tusks. Boars have been known to rip apart tigers. Of course, predator eradication programs have sharply reduced the number of pork-loving carnivores that used to roam the land. I found a news story about a 59-year-old woman who was recently killed by multiple feral pigs as she stepped out of her car at dawn. She bled to death. Attacks like this are extremely rare.

**Sheep**

Mouflon are the wild ancestors of sheep, and they still survive because they are faster than Olympic athletes on steroids. They excel at racing across steep, rocky landscapes. They also have large curled horns, capable of rattling the brains of their bloodthirsty foes. Long ago, folks sometimes discovered mouflon youngsters, brought them back to camp, and raised them. Unlike rowdy aurochs, the young lambs were less challenging to raise in captivity.

Paul Shepard noted that wild animals have a stable genome. Thus, the genes of today's mouflon are likely much the same as their ancestor's 800+ thousand years ago. But during the process of domestication, breeders deliberately selected for characteristics more beneficial for milk production, wool quality, and ease of control. Bye-bye stable time-proven genes.

After dogs, sheep were among the first unfortunate critters to be domesticated, maybe 11,000 years ago. As a result of this process, their brains eventually became 24 percent smaller than wild sheep. They lost a lot of their survival skills. I've seen several reports of wolves killing dozens of sheep, and only eating one or two. When wolves ran into large prey that acted so abnormally helpless, it was surreal and mystifying. The sacred act of killing prey was usually dignified, a triumph, a celebration. Killing sheep was more like drowning puppies.

In the old days, sheep shed their winter wool when springtime brought warmer temperatures. Over the centuries, clever humans have "improved" the sheep they own and exploit. Because of selective breeding, modern sheep are more likely to retain their wool, rather than scatter it all over the countryside. This makes it easier for herders to collect as much of their precious wool as possible.

In Australia, folks discovered one domesticated sheep who had managed to escape six years earlier, and enjoy a life of freedom. Unfortunately, the miserable critter had never been sheared, and was carrying around 93 pounds (42 kg) of filthy wool. This beat the previous record of another sheep found in New Zealand that carried so much wool it could barely walk. It was blind, crippled, and near death. Unshorn sheep are vulnerable to dying from heat stroke in warm weather.

Domesticated sheep are also vulnerable to pests like scab mites, that thrive in the herds. The mites multiply and cause skin lesions, which lead to wool loss and open bleeding wounds. Complications include hypothermia, infections, and death. Mites are spread via the herder's clothing, sheering tools, fence posts, and bits of wool hanging from bushes.

Mouflon manage their own lives, and fully take care of themselves. Enslaved sheep require a lot of human assistance. Shepherds are needed to protect them from bloodthirsty predators — noxious pests that must be aggressively exterminated whenever possible. Smart shepherds are careful to avoid overgrazing. Sometimes sheep also need to be provided with hay, water, salt, and shelter.

Makgabeng Cave

Adrian Boshier (1939-1978) was an English lad who arrived in Africa at the age of 16. He learned how to venture into the bush alone, taking just a knife and a bag of salt, in search of old Africa. He slept in caves and dined on stuff including bats and lizards. He collected the venom of snakes and scorpions to earn some money.

Mother Africa was the land where hominins first evolved four million years ago. The human line emerged maybe 300,000 years ago. Hominins coevolved with the ecosystems they inhabited. Southern Africa was blessed with good luck. Jared Diamond noted that no crop plants were domesticated south of the equator in Africa. In this region, there were also no large herbivores that were suitable for domestication, so hunting and gathering was the primary path to survival. The only animal that was certainly domesticated in Africa was the turkey-like guinea fowl.

Lyall Watson wrote Lightning Bird, a biography of Boshier. Watson wrote, “There are few things in traditional life in Africa than can be identified as distinctively sacred in the sense that they can be separated from the rest of life. For Africans, the whole of life is sacred.” This was the ancient culture of our oldest, wildest, and freest ancestors — the folks whose genes we all still carry.

One day, in the mountains of Makgabeng, Boshier discovered ancient paintings on the walls of a cave. Some of the images were painful, horrifying, heartbreaking — sheep (gasp!). Many centuries earlier, some folks had wandered out of Africa, to see the world. Later, some of them returned to Mother Africa, bringing with them destructive habits, beliefs, and animal slaves. Sheep were ugly freak show critters from outer space. Their portraits indicated the arrival of doom, disharmony, and domestication.

Watson lamented the arrival of herding. “The introduction of a pastoral economy, starting perhaps three or four thousand years ago, seems to have marked the beginning of a relentless destruction, now almost complete, of the earliest way of human life. It was the end of a society that had discovered how to live in harmony with — rather than at the expense of — nature.” The new culture has now almost completely eliminated the earliest human culture — the culture of our oldest, wildest, and freest ancestors — the folks whose genes we all carry.

Viking Sheep

For the first 250,000 years or so, our human ancestors ran around nearly naked in the tropics. With the colonization of snow country, folks were now confronted with the possibility of freezing to death. In the early days, it was fashionable to wear clothing made of animal skins and pelts, ideally cut and sewn into stylish tailor-made active wear. This clothing kept folks fairly warm, until it got wet. Much later, innovation provided colonists with wool clothing, which stayed fairly warm even when wet. The adaptation of clothing was another radical transition in the human saga. It opened up vast regions of uninhabited land for exploration, colonization, exploitation, and eco-destruction.

Kassia St Clair wrote that Vikings used wool to make their clothing, mittens, blankets, and sails. A blanket required the wool of 17 sheep. It took two highly skilled women more than a year to make a typical square sail. To outfit an average Viking cargo ship and crew, production of the clothing, bedding, and sails would require 440 pounds (200 kg) of wool. It required ten person years of labor for producing, shearing, carding, spinning, weaving, and finishing the goods. Some believe that, in the old days, folks in snow country might have spent more hours making cloth than acquiring food. I learned about St Clair's book when I read Claire Eamer's

fascinating essay, No Wool, No Vikings.

Viking long ships were yet another radical transition. Sailing boats were not a new idea. Folks used them in other regions, like the Mediterranean. Coastal regions of Scandinavia were not home to many sheltered, deep-water harbors, so Viking ships were built with a shallow draft, so they could be landed on beaches. This made them great for surprise attacks and fast getaways. The use of sail power was enabled by keels that could be lowered in deep water, and raised when beaching.

These new boats allowed Vikings to raid communities that had

been safe and secure forever. In A.D. 98, Tacitus wrote about the Suiones, who lived along the Swedish coastline. For them, the sea provided an invincible defensive barrier. It was impossible for enemies to attack them by water. But the new boats set the stage for the Viking era — several centuries of raiding, pillaging, bloodshed, and colonizing that rocked much of Europe.

Adam of Bremen, a German writing in 1075, shared a snapshot of the Viking era. He said that the Baltic Sea and the North Sea were thick with pirates. The only thing more dangerous than travelling by water was travelling overland, through the “frightful” dense forests of northern Europe.

Remarkably, the design of Viking longboats also made them capable of travelling on the open ocean. Rugged woolen sails allowed them to cross the Atlantic and build an outpost at L’Anse aux Meadows in Newfoundland, Canada. In those days, most of humankind spent their entire lives fairly close to their place of birth. Imagine gaining the ability to sail to unknown lands more than a thousand miles away. This was a mind-blowing possibility. It rubbished the traditional perception of space, limits, and home.

Long distance sea travel flung open a ghastly Pandora’s Box. Sailing ships enabled aggressive conquerors to colonize vast regions around the world. Environmental history is loaded with horror stories of pathogens delivered by long distance sea travel — potato blight, anthrax, Dutch elm disease, chestnut blight, white-nose fungus, bubonic plague, smallpox, cholera, typhoid, yellow fever, influenza, and countless others. Millions of unlucky indigenous people have been conquered, enslaved, and/or killed by alien invaders from distant lands.

Anyway, wool was big juju. Prior to the nineteenth century, clothing was the product of extremely labor-intensive processes. For hardworking common folks, clothing was precious, carefully mended and patched, and passed on to the next generation. When someone died in a hospital, the clothing of the deceased had to be removed and given to the lawful inheritors. Many folks owned little more than what they were wearing. Like moon explorers, wool space suits enabled tropical primates to survive in frigid life-threatening environments.

## White Gold

St Clair also discussed English wool. The Normans were Vikings who colonized the north coast of France and smelled like sheep. In 1066, they conquered England. By the thirteenth century, England had become famous for its high-quality wool. Regions that produced the softest, richest wool could sell it for very high prices. Most of the cloth makers that bought the wool were not English, many were Flemish or Florentine. Ships that carried the wool to buyers were prime targets for pirates, eager to snatch the precious white gold, and get rich quick.

On the manors of wealthy aristocrats, the peasant tenants were given rights to use specific strips of cropland. Assignments would change from year to year, because some cropland was regularly allowed to lie fallow and recharge. Beside cropland, there were also common pastures, and common forests, which the whole community could use. Tenants raised livestock, hunted, foraged, grew vegetables, and cut firewood and timber. The survival of the peasant community was dependent on always having access to the commons. Even with access, the lives of most were brutally harsh and marginal, compared to modern couch potatoes.

By 1297, half of the total English economy was generated by the wool industry. Before long, ambitious aristocrats realized that they could make far more money from raising sheep, instead of collecting rents from their dirt-poor tenant farmers. This deep hunger for wealth slowly led to a process known as the enclosure movement. Fences and hedgerows were created to prohibit tenants from entering the commons. The peasants were not amused, they were doomed.

Graham Harvey wrote that the enclosures began in England, during the fourteenth century. They gradually spread over the passage of several centuries, and then surged from 1750 to 1860.

Simon Fairlie noted that between 1760 and 1870, about 7 million acres (2.8 million ha), a sixth of England, was changed from common land to enclosed land.

One source estimated that, in Scotland alone, a half million peasants were driven off the land by the enclosures. No food, no home, no future. Across the U.K., the dispossessed were forced into filthy, disease-ridden cities, where there were no social safety nets. Rioting became popular, as did infant mortality.

John Reader noted that the enclosure movement led to the breakdown of a long-standing culture of land-based subsistence living for many. Tenant communities had benefitted from the mutual support of extended families. These communities were replaced by a small number of shepherds. With the tenants gone, there were fewer horses and oxen on the manor, so more grass was available for sheep. Tennant cottages and outbuildings were demolished. Several hundred villages disappeared, except for their churches. Aristocrats enjoyed getting higher income from their manors, and raising sheep was more dependable than agriculture. From year to year, grain harvests were quite vulnerable to the mood swings of weather and luck.

Harvey wrote that in the Black Death era (1340s), Britain was a backwater. Three centuries later, it was Europe's most advanced country. Wool flooded the U.K. with cash, and for 200 years it was the world's richest country. Millions of hungry dirty people in cities were willing to work insane hours, in miserable conditions, for peanuts. This nourished the emergence of a powerful industrial state. By 1832, the medieval peasant community had been completely destroyed. Like I said, wool was big juju. The gentle sheep had eaten many lives and villages.

## My Ancestors

My great-great-grandmother was Sarah Cleaton, who married Edward Rees in 1838. They were born and raised in the village of Cwmbelan, Wales, where a small stream passing through the village powered a waterwheel at the flannel factory. Sheep grazed on the surrounding hillsides (formerly lush forest). Cwmbelan was in the parish of Llangurig. In 1836, the 49,600-acre (20,000 ha) parish had 37,000 acres of commons. By 1875, "large quantities of the common land have been enclosed."

Edward and Sarah had three sons before he died at 23 from "decline." Sarah was a handloom weaver, as was her mother Mary, and her sister Catherine. So were her sister-in-laws, Mary, Elizabeth, Margaret, and Jane Rees. Handloom weaving was a skilled profession. It apparently provided something like a respectable middle-class income for that era.

With the arrival of the Industrial Revolution and its power mills, 500,000 weavers lost their source of income, according to Clive Ponting. Many were forced to move to filthy cities. By 1861, Sarah and her three sons had moved south to Merthyr Tydfil, home to an iron mining district, Dowlais. She was a barkeep at the Green Dragon pub, and her two older sons mined iron.

Merthyr Tydfil had four ironworks, and a slum known as Little Hell, where a super-poor population of "unhappy and lawless" folks were piled together in conditions of squalor that were at least as bad as Liverpool or Nottingham. The district had no toilets. Open sewers encouraged the spread of cholera and typhoid. Millions of friendly lice thrived on folks who rarely if ever bathed.

Unfortunately, for Sarah and sons, by 1861, the ironworks industry in Merthyr Tydfil got blindsided by new technology, the Bessemer process, and local prosperity was fading fast. In 1863 they moved to Pennsylvania. Two years later, they moved to Minersville, Ohio, where her second husband, Edmund Thomas, died in 1868, at 51. Sarah died in 1891, at 73.

In 1919, her son Richard E. Rees, celebrated his fiftieth anniversary in Columbus, Ohio. To commemorate the event, he sent a story to a Welsh newspaper. In it he wrote, "I have worked underground for 65 years; ten in the Old Country, two in Pennsylvania, and 53 in Ohio." He was 75 years old, and lived another ten years.

Australian Sheep

Elinore Melville wrote about the introduction of sheep in Australia, where the firestick farming by Aborigines had maintained expansive regions of grassland. Unfortunately, this excellent grassland was supporting the existence of useless critters called kangaroos. Britain wasn't interested in buying kangaroo meat, but they would pay good money for wool. So, colonists worked hard to exterminate as many kangaroos as possible, as they rapidly expanded the sheep ranching industry. By 1845 there were 9 million sheep, and in 1854 there were 12 million.

The British colonists came from a moist land that had reliable rainfall. Australia was different. When a herd had stripped the vegetation from an area, shepherds moved the animals to a greener pasture. The vegetation they devoured had been storing moisture, which slowed evaporation.

Consequently, the land dried out, and groundwater was not replenished. Drought followed drought. Overgrazing often rubbished grassland regions within 7 to 20 years.

Bill Gammage noted that the native kangaroo grass was excellent ("caviar for grazers"). It was a deep-rooted, drought tolerant perennial that held the soil in place, retained soil moisture, survived fire, and was highly nutritious. It remained green after four months without rain, a great asset for wildlife in drought times. The colonists' sheep grazed it down to bare clay, killing the precious grass.

Colonists drained wetlands to expand pastures. Livestock proceeded to compact the soil, which dried out, and cracked. Springs, ponds, and creeks evaporated, eliminating the critters that lived in them. When rains returned, rapid runoff encouraged erosion, landslides, deep gullies, floods, silt chokes, and the spread of salts. An observer in 1853 commented on the growing soil destruction: "Ruts, seven, eight, and ten feet deep (2 to 3 m), and as wide, are found for miles, where two years ago it was covered with a tussocky grass like a land marsh."

Navajo Sheep

Richard White noted that between the twelfth and sixteenth centuries, the Navajo moved from Alaska and western Canada, down into the U.S. southwest, home of the Hopi, Zuñi, and Pueblo. In the early days, the Navajo lived as hunter-gatherers. In 1598 Spanish colonists arrived, bringing with them domesticated sheep, cattle, horses, and goats. The Navajo became sedentary, and learned sheep herding, weaving, and gardening. They planted fruit orchards. When forage was still abundant, livestock provided more reliable access to food, so famine times were reduced. This new mode of living led to population growth.

The Spanish did not allow the Navajo to own or ride horses, but eventually they acquired them. Horses made it much easier to hunt, and to raid neighbors. Stealing sheep was much easier than raising them. Raiding was about making unannounced visits to neighboring tribes and stealing sheep, horses, women, and children. Sometimes the defenders were killed and scalped. Naturally, other tribes responded by raiding the Navajo.

Raiding was an extremely common practice among pastoral societies around the world.

Peter Iverson noted that by 1846, the Navajo had 500,000 sheep, 30,000 cattle, and 10,000 horses, mules, and asses. As white settlers moved in, they complained about the Indians. So, the government ordered the Navajo to relocate to a reservation, where they could become farmers and get rich quick. The Indians preferred to remain on their land, and continue living in their traditional manner. This was not the proper response.

So, the government sent Lieutenant Colonel Kit Carson to make the whites happy. In 1863 his troops brutally attacked the Navajos and destroyed homes, gardens, orchards, livestock, and people. The 8,000 surviving natives were forced to march 300 miles (480 km) to the less-than-luxurious Fort Summer facility. In 1868, they were allowed to return to a portion of their homeland. Each family was given two sheep, one male and one female.

The railroad arrived in 1881, and trading posts appeared along its route. This encouraged the Navajo to weave rugs and make jewelry to be used as trade goods. They raised large herds of Churro sheep, which produced long, smooth, and less greasy wool that was ideal for hand spinning.

By the time the Depression began in 1929, the Navajo population had swelled. Kendall Bailes wrote that by 1933, two million acres (809,000 ha) of Navajo land was severely overgrazed, some of it reduced to desert. There were huge erosion gullies, and large amounts of silt were moving into Lake Mead, the reservoir at Hoover Dam. Their herding practices, developed 200 years earlier, when grass was abundant, didn't work as well in a dryer climate. There was far less grass. Animals were starving. In the western states, the Dust Bowl had begun.

In 1935, the Bureau of Indian Affairs conducted a survey on grazing land. They found that the Navajo sheep flocks contained more than a million animals, and they were kept on land that could only support 560,000.

The government perceived this to be a very serious problem, for which the obvious solution was a sharp reduction in herd size. The Navajo, on the other hand, believed that this was the opposite of a problem, it was a sacred gift. Their livestock were tokens of wealth, status, and cultural identify. They loved their goats and sheep almost as much as their own children.

The white authorities moved in, without permission, and by the 1940's, the herds were reduced by half. According to Iverson, at first the sheep were shipped urban centers to feed poor people. Eventually, the animals were just taken over the hill, shot, piled up, and left to rot. The government paid the Navajo for every animal eliminated, but the tribal economy was blindsided. Navajo resentment over this action remains fierce. The tribe now has a quota system for herd sizes in grazing ranges.

**Goats**

Cattle and sheep cannot thrive on depleted grazing land, but goats are hardcore survivalists. They can live on barren lands, and

keep them barren. Simon Fairlie wrote that goats are popular in India, because they can survive on the same stuff that cattle consume. While cows are sacred, goats are not, so it's perfectly OK to eat them. While a goat is being raised, it can devour ten acres (4 ha) of vegetation. They do not gently nibble on grass; they can hungrily rip it out by the roots. They kill young trees. Goats create deserts.

Paul Shepard wrote that goats are smarter than cattle or sheep, and they are blessed with interesting personalities. They can learn to follow instructions from their master. They are smaller than cattle, so losses to predators are less costly to the herder. Goats get high grades in sex education classes, and are able to produce numerous offspring. Rustlers love them because they are easier to steal than cattle. Goats are known as the "poor man's cow." A goat can produce more milk than a sheep.

Shepard imagined that in the coming years, when our reckless turbocharged joyride of decadence runs out of gas, and glides into the misty realm of embarrassing memories, our faithful companions amidst the ruins will be goats, the "avatars of poverty." They have given us a 5,000-year lesson in environmental catastrophe. He was no fan of any type of domesticated livestock. He called them "hooved locusts." A primary objective for many pastoralists is maximizing wealth (larger herds) — not preserving a reverent, respectful, ultraconservative relationship with their ecosystems.

The Earth Policy Institute (EPI) reported that ever growing numbers of livestock are working hard every day to diminish the health of world grasslands. The EPI has been tracking livestock population trends, nation by nation. They report that when goat numbers are rising faster than those for cattle or sheep, this is an indicator of deteriorating grassland.

Not fussy eaters, goats are the livestock most associated with overgrazing. As vegetation is gobbled up, less greenery survives to absorb periodic rainfall. Consequently, more rain runs off the land, which can lead to destructive flooding. In addition to depleting the forage, their sharp hooves also pulverize the soil surface, making soil particles more susceptible to erosion via wind or water. Stripped landscapes led to massive floods in Pakistan in 2010.

The EPI noted that between 1970 and 2009, while the global cattle population increased by 28 percent, goat numbers more than doubled. The goat trend line began rising quickly around 1980. The Sahel region, south of the Sahara in Africa, is becoming a dustbowl. Every year, 867,000 acres (350,862 ha) of rangeland and cropland are being lost to desertification. Another dustbowl is rising in central Asia, western Mongolia, and western China. The EPI report was published in 2011, when the human mob was much smaller than today.

John Livingston noted that only two animals create habitats: goats and humans. Goats create deserts. Humans create lots of ecological train wrecks. Sheep and goats don't know any better but, in theory, there are some humans who are capable of making wise choices. History is clear on one thing, we excel at repeating the same mistakes, century after century. As long as they satisfy immediate needs, self-destructive habits are devilishly difficult to shake.

Daniel Hillel didn't resent goats, because goats weren't the problem. The problem was pastoralists who allowed their herds to get too big. When goats were herded on overgrazed rangeland, they were running on empty, so they desperately ate whatever they could find, because they had no other choice. They were far better survivalists than cattle.

Of course, stepping back even further, and using perfect hindsight, it's not hard to see a pattern that associates animal domestication with deforestation, soil destruction, and desertification. Wild and free animals do not have a reputation for being desert makers or forest erasers. Back when all critters were wild, wolves were simply ordinary neighbors, not demonic enemies. Their role in the ecosystem was to dine on herbivores, which helped limit the herd size, which helped keep the land healthy. Great!

Cedars of Lebanon

Lebanon is located on the east shore of the Mediterranean, just north of Israel. It has a narrow coastal plain, and a mountainous interior. Big Mama Nature originally clothed Lebanon with grasslands and forests, and they absorbed precipitation and kept the springs flowing — a healthy ecosystem. The cedars of Lebanon were described in older sources as a legendary forest, a sacred land ("the cedars of god"). Originally, the forests covered almost 2,000 square miles (5,180 $km^2$). That was prior to the arrival of the Phoenicians.

Tom Dale wrote that, in the early days, the Phoenicians were likely nomads who herded goats. This could have been a low impact mode of living, as long as the population of goats and humans had remained modest, via mindful planning. Agriculture required far more hard work than goat herding, so smart folks shunned it whenever possible. As the human population grew, feeding the growing mob became more challenging. Consequently, farming expanded across the coastal plains, and then began spreading up into the hills.

The agriculture practiced in early civilizations, like Egypt and Mesopotamia, was primarily enabled by irrigation. Folks at the east end of the Mediterranean, like the Phoenicians, were the first to attempt large scale rain fed agriculture on steeply sloped land. They received heavy winter rains, followed by fairly dry summers, the pattern we call a Mediterranean climate (like California).

Over time, experiments in self-restraint (if any) eventually failed. By 2500 B.C., a civilization emerged in Phoenicia. It had an impressive merchant fleet, communities of skilled artisans, and good ports at Tyre, Sidon, and Beirut. The biggest threat to their prosperity was insufficient food production (i.e., insufficient family planning). As hillside agriculture intensified, stone terraces had to be built on the slopes to keep the soil from washing away. Constructing and maintaining stepped terraces took lots and lots of hard work. An increasingly pissed off Big Mama Nature sometimes conjured intense cloudbursts to suddenly wash them away.

King Solomon sent 150,000 men to Lebanon to cut and haul lumber back to Palestine, where it would be used for building temples, palaces, and trophy homes for fat cats. Mesopotamia, Anatolia, and Egypt were also growing rapidly, and needed lots of lumber. Wood was traded for food, but the food imports were not enough. So, the Phoenicians created a number of colonies along the Mediterranean coast from which they could extract resources. Their civilization peaked between 1200 and 800 B.C., and blinked out in 332 B.C., when Alexander the Great conquered them, and crucified 2,000 upper class folks in Tyre.

Dale wrote that by then, most of the forests were already history. Over the next few centuries, Greeks and Romans finished off what remained, with a few wee exceptions. Topsoil had largely washed off the hillsides, and silted up the harbors. Clogged river deltas became malarial marshlands. The damage was so severe that the land could not recover and allow another thriving civilization to rise from the ruins.

Anyway, over time, almost all of the cedars of Lebanon got mowed down. Green vegetation emerged amidst the stumps, and herds of goats hungrily chewed it up. Lebanon's cedars don't produce their first cones (seeds) until they are about 40 years old. There were almost no inaccessible rocky crags where goats could not eat new trees. Consequently, the forests were doomed. Deforestation, hungry goats, and winter rains were the prime causes of massive erosion that turned Lebanon into "a well-rained-on desert." It will take many, many thousands of years for nature to replace the lost soil.

Trendy societies destroyed their ecosystems as fast as possible, in order to soar off into a giddy high called decadence. For centuries, a series of Mediterranean civilizations took turns rising and falling, conquering and being conquered. Raiders and pirates worked hard to snatch whatever they could, whenever possible, by any means necessary.

Writing in 1955, Dale wrote that today, Lebanon, Crete, Turkey, Palestine, Tunisia, Algeria, Spain, Italy, Sicily, Yugoslavia, and Greece were far more torn and tattered than in the good old days. All had lived way too hard, something like a binge of oblivion drinking. In the twenty-first century, we (the most "educated" generation ever) continue repeating the same mistakes, all around the world, on a vastly more destructive scale, at a much faster rate. We must grow, at any cost, by any means necessary.

In 1938 and 1939, Walter Lowdermilk toured North Africa and the Middle East to learn about how ancient civilizations destroyed themselves. He discovered that only four small groves of Lebanon cedars still survived. The largest one was home to about 400 trees, of which 43 were old ones. One grove was saved because a monastery was built in it, and it was surrounded by a fence to keep the goats out. Lowdermilk took a photo of the walled grove — a modest group of trees surrounded by a vast barren mountainous moonscape.

Land of Milk and Honey

Palestine was just south of Phoenicia. It was home of the Israelites. Like the Phoenicians, the Israelis were pastoralists. Both were Semitic people, and they likely had common ancestors. "Goat" appears in the Bible 132 times, and "sheep" 188 times. Moses helped his people escape slavery in Egypt. They spent 40 years wandering in the wilderness. Their destination was the Promised Land, located on the far shore of the River Jordan. It was "a land that floweth with milk and honey," a phrase that appears in the Bible 20 times.

Lowdermilk's tour of the Middle East also made a stop in the Jordan Valley. He snapped a photo of a heavily damaged hilly landscape, and wrote: "This is a present-day view of a part of the Promised Land to which Moses led the Israelites about 1200 B.C. A few patches still have enough soil to raise a meager crop of barley. But most of the land has lost practically all of its soil, as observed from the rock outcroppings. The crude rock terrace in the foreground helps hold some of the remaining soil in place."

"We found the soils of red earth washed off the slopes to bedrock over more than half the upland area. These soils had lodged in the valleys where they are still being cultivated and are still being eroded by great gullies that cut through the alluvium with every heavy rain."

"What is the cause of the decadence of this country that was once flowing with milk and honey? As we ponder the tragic history of the Holy Lands, we are reminded of the struggle of Cain and Abel. This struggle has been made realistic through the ages by the conflict that persists, even unto today, between the tent dweller and the house dweller, between the shepherd and the farmer. The desert seems to have produced more people than it could feed."

In the King James translation of the Bible, the word "forest" appears 41 times, and the word "grove" also appears 41 times, but only in the Old Testament. Neither word appears in the New Testament. Hmmm…

In Hebrew traditions, there was The Fall from divine harmony. Genesis was essentially the creation story of western civilization. Eden was paradise, and Adam and Eve were provided with everything they needed. There was just one simple rule to follow, and they promptly disobeyed it. God threw them out.

Mongolian Desertification

Kathleen McLaughlin described how grasslands in Mongolia are currently being degraded by climate change, and by overgrazing the variety of goats that produce cashmere wool. Soft cashmere was formerly used to make expensive clothing. Today, better technology for knitting, combined with the fast fashion trend, has moved cashmere products from the luxury class to the mass market. Because herders make a decent income from raising goats, they are now more than half of Mongolia's grazing livestock. Unfortunately, goats are the most destructive grazers, because they not only eat the roots of plants, but also the flowers that produce seeds for new grasses.

The harsh winter of 2017–2018 killed hundreds of thousands of grazing animals. The Mongolian steppe is twice the size of Texas, and it's slowly turning into a desert. About 70% of the grazing lands are degraded. A number of lakes and rivers have dried up. Overgrazing is a primary factor in grassland deterioration.

In the 1990s, the former communist government set quotas on grazing animal numbers. Quotas are gone now, and grazing livestock have increased from 20 million to 61.5 million. Dead areas are growing, and soil erosion is rising. Native grasses are being displaced by exotic species that are toxic. Grassland degradation is also a growing threat to wildlife species.

**Horse**

The first species of the horse genus (*Equus*) emerged in North America about 4.5 million years ago. Over time, some migrated to South America, and others crossed the land bridge to Eurasia, and spread as far as Western Europe. Maybe 15,000 years ago, hunters from Siberia discovered America, where many native horses still lived. Over the following centuries, a massive surge of megafauna extinctions occurred.

Graham Harvey noted that horses are fine-tuned for grassland living. Sheep and cattle have complicated digestive tracts, so they need to rest after grazing. Horses can eat and run. They can run at a sustained gallop of 43 mph (70 km/h). They can go up to four days without water, so they are able to utilize grasslands farther from water sources.

Dixie West added that horses are able to efficiently digest a high fiber diet, so they can live on a daily intake of just 22 pounds (10 kg) of vegetation. They are better able to survive on low quality forage, and they require less pampering than other livestock. Prior to winter, herders had to gather and store hay for feeding cattle and sheep. Horses were able to feed themselves throughout the cold months. They also grew thick warm coats.

Horses and hominins have had a long relationship. As mentioned earlier, Neanderthals were trapping and killing horses at the Roche de Solutré site in France about 55,000 years ago. Later, around 37,000 years ago, humans killed many horses at the same site. Dixie West noted that, when panicked, horses flee in a single file, rather than rapidly scattering in every direction. This made it easier to drive herds into traps.

Over time, hunters got too good at trapping and killing horses.

Pita Kelekna wrote an excellent book on the history of the horse-human relationship. She noted that by the Neolithic era (8000–4500 B.C.), the once plentiful wild horses had disappeared across most of Europe. Some were able to survive in small pockets of Spain and central Europe.

East of Europe, large numbers of wild horses thrived on the vast wide-open steppes, where there was no brush or trees to conceal hungry hunters. The placement of a horse's eyes gives them a 300° range of vision — they can see in almost every direction. The flat landscape lacked ravines or valleys into which herds could be conveniently driven, trapped, and killed.

Humans have been eating horses for tens of thousands of years. Today, folks in many nations continue enjoying lunch dates with horses. In the top eight horse loving nations, 4.7 million are eaten every year.

Domestication

Long before horses were eventually enslaved, the Middle East had already domesticated sheep, goats, and cattle. Horses remained wild and free until maybe 4000 B.C. They had thrived on the steppes, which were northern shortgrass prairies that spanned a 5,000 mile (8,046 km) range from Hungary to Manchuria. Several scholars have speculated that domestication probably saved horses from extinction, because it transformed them from wild game into private property, and status trinkets — my horsy!

Wild horses were strong, fast, intelligent, and aggressive. They were not easy to domesticate. When cornered, they aggressively stomp, kick, and bite. Swift kicks could be fatal. Zebras, their *Equus* cousins, have never been tamed, despite countless attempts — the older they get, the meaner. The domestication of horses was a revolutionary event in the human saga — like fire making, agriculture, metallurgy, fossil energy, and so on.

Pita Kelekna described, at great length, the huge impacts that domesticated horses had on the course of both human and environmental history. At first, horses were kept for meat, milk, and hides. Eventually folks learned how to effectively utilize horsepower, greatly reducing society's heavy dependence on human muscles. Horses could pull stuff like plows, wagons, logs, and battle chariots. They could carry heavy loads. They could be ridden. A herder with a dog could oversee 150 to 200 sheep, but a mounted herder could manage 500.

Horses enabled humans to quickly travel long distances, a huge boost to our mobility. They made it far easier to hunt large animals, or raid enemies. Trade networks could extend much farther, and larger cargoes of goods could be transported back and forth. Long distance travel could also transfer technologies, religions, ideas, infectious diseases, and invasive exotics. Horse domestication promoted the expansion of farming, herding, logging, and mining.

## Nomadic Pastoralists

Bridle, saddle, and stirrup innovations eventually enabled humans to ride horses, at high speed, while effectively using deadly weapons to kill game or enemies. Military campaigns could travel farther, and strike fast and hard. Horses enabled the emergence of large nomad empires, and the spilling of oceans of blood. Kelekna said that horsepower greatly benefitted the pursuit of "bloodshed, massacres, deportations, enslavement, amputation, beheadings, torture, incineration, rape, castration, famine, pestilence, and destruction."

Nomadic herders produced their own food resources, and enjoyed an independent lifestyle. Seed-bearing grasses were common on the steppe, and nomads simply gathered the wild grain. Herds provided milk, blood, and meat. Nomads were likely better nourished than most of the hungry dirty peasants and slaves in farm country.

Paul Shepard wrote that around 1800 B.C., mounted warriors with iron weapons opened the door to a new and super bloody chapter in the human saga. Sudden surprise attacks from hordes of nomad warriors shattered or destroyed many cities — plump sitting ducks that were irresistibly tempting to plunder. These attacks inspired the construction of a variety of defensive fortifications — wooden palisades, massive stone walls, moats, drawbridges, and so on.

It became unsafe to live in many regions. An old Bedouin proverb declared, "Raids are our agriculture." Describing tribes of horse-worshipping German herders, Tacitus wrote that fighting was better than farming. "They even think it base and spiritless to earn by sweat what they might purchase with blood." Shepard noted that these mounted nomadic raiders developed a culture of "hierarchy, theft, rebellious sons, and competitive use of the earth."

Our wild hunter-gatherer ancestors were often egalitarian, no leaders, all were equal. The secret to their tens of thousands of years of success was sharing, cooperation, and an intimate relationship with the land. Nomads had an entirely different worldview, one that favored patriarchy, raiding, conquering, accumulating personal wealth, and competing for status. Primary components of their worldview continue to be the foundation in modern cultures. Generally, wild society was based on community, and property-oriented societies were based on hierarchy.

## Horses and Wheels

David Anthony wrote that wheeled vehicles first appeared in the Old World around 3300 B.C., and were of enormous benefit to herders. Carts made it much easier to move families, food, tents, and water to greener pastures. He said that horses and carts enabled nomads to intensify their exploitation of the steppes, which had previously been little used by humans.

To better appreciate the impact of horses and wheels in the Old World, it's interesting to look at the Americas. In the New World, the llamas and alpacas of Peru were the only large animals domesticated, and neither was capable of carrying an adult rider. In the Old World, the diabolical invention of the wheel greatly accelerated agriculture, deforestation, population growth, empire building, and on and on. Industrial civilization could not exist in a world without wheels. In the New World, the only wheels were those found on tiny clay toys. Without horses, the pampas and prairies of the Americas had modest populations, and little or no agriculture.

Having no carts or wagons, the Inca civilization in Peru did not need to build smooth roads. They did build bridges, dig tunnels, and cut steps up steep hillsides. Pack trains of llamas could travel up to 12 miles per day (19 km), with each animal carrying up to 101 pounds (46 kg). Speedy long-distance communication was provided by messages relayed from one Inca runner to the next. This was much slower than Genghis Khan's pony express system, which could move messages 248 miles (400 km) per day.

In Mesoamerica, the pack animals were two legged primates. On a good day, a healthy lad might carry 50 pounds (23 kg) for 13 to 17 miles (21 to 28 km). Without carts or pack animals, they could not create vast sprawling empires like Rome. While the Mayans built some roads, hiking in Mexico was via dirt paths, where they existed. Military adventures were restricted in the New World. Each soldier had to carry his own provisions, which limited the load size and distance travelled. Thus, if supplies could not be snatched from villagers along the way, campaigns would have been limited to round trips of eight days or so.

Horse power revolutionized raiding, warfare, and empire building. The Eurasian steppes experienced century after century of the rise and fall of numerous hordes of horse-mounted nomads like the Cimmerians, Scythians, Sarmatians, Alans, Huns, Avars, Bulgars, Magyars, Mongols, and Turks.

Huge Mongol cavalries could zoom across the steppe at 68 miles (110 km) per day. Their empires grew explosively. They peaked between 1279 and 1350, when they inhabited Iraq, Iran, central Asia, most of Russia, and all of China. This was the largest contiguous

empire in human history. The Mongol empire was enormous [MAP]. Beasts of Burden

Paul Shepard was the opposite of a horse lover, because of the many new imbalances that domesticated horses enabled. Compared to hand labor, the introduction of horses to agriculture allowed farm production to double. This, of course, led to population growth, which often increased faster than the Grim Reaper could keep up with. Agriculture's faithful shadow is soil destruction. We're essentially eating soil. The skin is being torn off of Mother Earth. This has no long-term future.

Clive Ponting wrote that prior to 1800, animals provided just 25 percent of the work energy, and humans did most of the rest. Many peasants couldn't afford work animals. Walking was the primary mode of transportation. Folks used very little energy from windmills or waterwheels. Feeding a horse required at least 6 acres (2.5 ha) of grassland, oxen a bit less. In those days, most land suitable for crops was needed to grow food for humans, because agriculture was far less productive than today.

William McNeill noted that another troublesome cargo that domesticated beasts delivered into human society was deadly pathogens. When human communities were brought into constant close contact with animals, it was far easier for diseases and parasites to leap from one species to another. Over time, different diseases emerged in different regions. Eventually, long distance travel for trade or warfare carried diseases from their place of origin to virgin populations that had zero immunity to them. From A.D. 1200 to 1500, regional disease pools eventually combined to form a large pool of civilized diseases.

Horses Return Home

Horses originally evolved in the Americas. The last native horse in the Americas died in Patagonia about 7000 B.C. In 1493, Spaniards brought domesticated horses to the Americas, and by 1550, 10,000 of them were rediscovering their ancestral homeland. Reintroduction eventually had dramatic effects on the western U.S. plains. In 1598, Spanish colonists brought domesticated horses and other livestock to New Mexico. One way or another, plains Indians acquired some of these animals.

Richard White discussed how the acquisition of horses impacted the entire plains ecosystem. They quickly became popular with many tribes.

Horses were trade commodities, the target of raids, and the inspiration for many bloody conflicts. With horses, it became easy for hunters to kill far more bison. With access to more food, population grew, tribal rivalries intensified, and warfare increased. Horse stealing became a common activity among the people of the plains. Living in a remote location was no longer safe and secure, and corn growing villages were especially vulnerable to sudden raids.

John Tanner was born in Kentucky in 1780, and captured by Indians at age 9. He spent the next 30 years living on the wild side. In one of his yarns, he jabbered about his favorite horse. It had been stolen from another tribe by an aggressive war party. The successful raiders had returned with 180 horses. "In this excursion they had been absent seven months. They had fallen upon and destroyed one village, and taken one hundred and fifty scalps, besides prisoners."

Samuel Gwynne noted that prior to horses, the southern plains were lightly populated. The region wasn't well suited for agriculture, and hunting bison, antelope, and elk on foot was far from easy. The prey was much speedier than the hunters. A bison can sprint at 35 miles per hour (56 km/h). The acquisition of horses revolutionized bison hunting. A number of tribes abandoned farming, and became hunters.

As American colonists began moving west from the Atlantic coast, into a wilderness of forests and wetlands, travelling on horseback was difficult or impossible. There were paths, but no roads suitable for wagons or carts. At that time, Indians in the eastern U.S. travelled by footpath and canoe, via predictable routes, where colonists could ambush them. Tribes that raised corn were far more vulnerable than nomadic hunters. When settlers found villages, they often burned them. Stored food was swiped, or burned.

As colonists migrated farther west, they eventually moved beyond forest country and onto the open plains, where they met mounted Indian warriors for the first time. Settlers and soldiers were sitting ducks. Comanches could readily attack any target within 400 miles, and they could shoot 20 arrows in the time it took to reload a musket once.

James Sherow wrote about the challenges that plains Indians had with keeping horses in the Arkansas River Valley. Horses provided them with amazing new powers, and painful new headaches. Horses were personal property, and the more you owned, the higher your social status. In 1855, the Cheyennes owned an average of 5.5 horses per person, and the Comanches, Kiowas, Apaches, and Arapahos owned 6.2.

Climate had a major impact on the grassland. One acre (0.4 ha) might produce 3,000 pounds (1,360 kg) of short grass when annual rainfall rose to 20 inches (51 cm). When it dropped to 10 inches, maybe 450 pounds. During hot spells, rain evaporated in midair. Creeks and springs dried up. In winter, the protein content of grass was half of summer levels. When winters were harsh, large herds shrank. Horses kept in close confinement provided comfortable homes for a variety of parasites.

George Catlin studied western Indian tribes from 1832-1839, when bison herds were still enormous. Natives used bows and arrows to hunt during high-speed pursuits on horseback. Catlin did many drawings and paintings, and wrote extensive notes. While he was fascinated by the many things he learned, he was also sad, because the plains Indians and the bison were on a dead-end path. The arrival of civilized people brought lots of dark juju to the west. Bison were hunted in winter when their fur was thick, and their hides were most valuable for the bison robe market. After skinning the animal, robe hunters usually left the rest of the carcass for the wolves. Traditional native hunters wasted no part of the animals they killed.

Bison were also hunted just for their tongues because they were a high value luxury meat. In May of 1832, a mounted hunting party of 500 to 600 Sioux chased a large herd for several hours, and killed many. At the end of the day, they came to the fort with 1,400 bison tongues, for which they received a few gallons of whiskey, which did not last long among the thirsty lads. The hides and meat of the dead animals was left on the grass.

The white traders were making good money, and it never occurred to them to consider the future of the bison. Among the tribes, there was an ancient and widespread belief that the bison were a gift from the Great Spirit, infinite in number, and whatever they killed would be replaced. But intensive market-oriented hunting rewarded excessive killing. Catlin could see that the bison could be gone in as soon as 8 to 10 years, and was deeply disturbed about the insanity of it all.

Peak Horse

The use of horses for transportation and traction peaked early in

the twentieth century. Clive Ponting noted that the U.S. was home to 20 to 30 million horses in 1900. About a quarter of the nation's cropland was needed to produce their food. Model T Fords did not require six acres of good grassland to fuel them.

My grandparents witnessed the advent of Peak Horse, and my parents saw work horses largely disappear from farms and cities. In

2004, the venerable physicist Albert Bartlett calculated that, with regard to the all-time total volume of oil extracted by humankind, more than half of it will be consumed within the lifespan of the generation born since 1966. We are living during a temporary explosion of staggering waste, and this foolish binge has an expiration date. So, we'll just have to go back to horse power, right? Well, umm, there are some challenges.

Eric Morris wrote a fascinating essay to help us remember life in the Peak Horse era. By 1898, big city streets were jammed with horses, carriages, and wagons, squishing through a deep layer of manure and urine, past rotting horse carcasses, amidst dense clouds of flies and overpowering stench. Cities were rapidly growing, as hordes immigrants moved in to enjoy miserable industrial jobs, while living in crowded, filthy, disease-ridden slums.

Each horse emitted 15 to 30 pounds (7 to 14 kg) of manure daily — 3 to 4 million pounds in New York City every day. In 1800, farmers would pay haulers to bring manure to their fields. By 1900, there was way too much poop, and it piled up on empty lots. Some heaps were 60 feet high (18 m). Clouds of flies picked up pathogenic microbes and brought them to your kitchen, spreading typhoid and other fecal-oral diseases. In 1880, 41 horses died each day on the streets of New York. The average horse weighed 1,300 pounds (590 kg). Carcasses were often left to rot, making it easier to dismember them, so they could be hauled away.

Horses were jammed into filthy, poorly ventilated stables — excellent disease incubators. In 1872, the Great Epizootic Epidemic struck, as huge numbers of horses were infected by the equine influenza virus. Coughing spread it from one animal to the next. Typically, they recovered in two to three weeks, but severe cases could immobilize an animal for six months.

During the epidemic, available horse power was drastically reduced. Folks had to use wheelbarrows and handcarts to transport goods. The postal service was hobbled. Freight piled up. Coal deliveries stopped. Food distribution wheezed. On farms, plows and other equipment fell idle. Boats quit moving on the Erie Canal. Horse-drawn fire engines and street cars did not move. When a big fire roared in downtown Boston, firemen had to pull their heavy equipment from the station by hand.

Almost certainly, there are people alive today who will see the post-peak decline of fossil energy extraction. I wouldn't be surprised if some (or many) will experience the extinction of motor vehicles, and the lights going out on civilization as we know it. Bye-bye railroads, air travel, shipping fleets, elevators, mining, and so on. Sewage treatment plants, municipal water systems, and digital technology will blink out. Vast areas of cropland will cease being plowed, planted, irrigated, sprayed, and harvested. Humans may actually have to walk (eek!!). Imagine that.

**Dogs**

Over the years, I've spent a lot of time close to nature. The deer, bears, skunks, bats, foxes, raccoons, wolves, beavers, coyotes, and weasels tolerated my passing as long as I behaved calmly and respectfully. None of these wild beings had the slightest interest in becoming my friends, or my fur children. None depended on me in any way. None fully trusted me.

All were absolutely free to live as they wished, every minute of every day (unlike me). They all had a perfectly healthy relationship to the land (unlike me). None of them ever sent anything to a landfill, or caused permanent damage to the land, water, or air (unlike me). All of them will celebrate when the lights go out, the last car dies, and the last bullet is shot. Hooray!

Gray Wolves

Gray wolves are the wild ancestors of dogs. Their history is a bit misty. One source wrote that gray wolves emerged in Eurasia maybe a million years ago, and migrated into North America maybe 750,000 years ago. Their range spanned across the northern hemisphere, from Europe and Asia to North America. They didn't fancy living in tropical forests or intensely arid regions. Instead, they adapted to grasslands, temperate forests, and artic regions. Wolves unanimously agree that none of them ever had the slightest desire to be reduced to dogs. All are heartbroken by the degradation of their genetically scrambled cousins.

Barry Lopez wrote that wolves shared their food with others in the pack, and educated their young. They could hear clouds passing, and were able to smell prey from a couple miles away. They were expert trackers, and hunted in a state of heightened concentration, paying relentless attention to details. Wolves generally travelled in packs of 6 to 10 animals, and could sprint as fast as 37 miles per hour (60 km/h). Like many man-eaters, they mostly moved and hunted at night (not the best time to be out alone). One native told Lopez that wolves and Eskimos were equals — prior to the arrival of firearms. Wolves were valuable teachers. While writing his wolf book, Lopez kept two hybrid red wolves at his home, a mistake he deeply regretted. Wolves don't belong with people, so don't raise them.

Wolves and humans likely never met one another until some human pioneers eventually wandered north out of Africa, into wolf country. History is clear that wolves had no dietary taboos against feasting on yummy tropical primates. In the myths of many cultures, big bad wolves enjoyed starring roles, because they had to be taken very seriously in real life.

Joseph Singh and Robert Zingg collected fascinating stories about feral children — kids separated from human society that managed to survive in the wild. Throughout human history, in times of scarcity, food resources were sometimes inadequate to keep everyone fed. Child abandonment was not uncommon, especially females. Sometimes these kids were adopted and raised by wolves, bears, swine, and others. It was not uncommon for wolves to snatch youngsters and carry them away. Many were eaten, some were adopted and nurtured.

Singh wrote about two girls that had been raised by wolves. In 1920, hunters chased them, dug them out of their den, and brought them to his orphanage in Midnapore, India. Like many feral children, they didn't walk upright, but could rapidly scamper on all fours. They didn't learn language. They were naked, indifferent to cold, loved raw meat, and had excellent senses of smell, hearing, and night vision. They lived and behaved like wolves.

He mentioned an 1858 book written by William Sleeman, an officer in the Indian army, who described the powerful taboo against cruelty to wolves. "Nor do they (the Hindoos) with some exceptions dare to destroy a wolf, though he may have eaten their own children, or actually have one of them in his mouth. In all parts of India, Hindoos have a notion that the family of a man who kills a wolf, or even wounds it, goes to utter ruin; and so also the village within the boundaries of which a wolf has been killed or wounded." Consequently, hundreds of children were carried away by wolves. Folks knew where their dens were, but left them alone.

Singh shared a story I'll never forget. One day, along the bank of the Ghagra River, a ranger came upon two wolves, and a 10-year-old boy. He chased and seized the boy, who fiercely resisted. After four months of restraint, the lad calmed down a bit. One night, he was sitting under a tree, when two of his wolf friends came to visit. The three of them happily played. In the next several nights, three or four wolves visited and played with him. Nine months after his capture, the boy ran away. Two months later, his mother was found. She said that her four-year-old son had disappeared five or six years earlier.

## The Dynamic Duo

Everyone agrees that dogs were the first domesticated critters, but exactly when and where remains highly controversial. Wolves and humans maybe began their cautious relationship while scavenging snacks from animal carcasses. Wolves were certainly attracted to the garbage piles at human camps. They can chew up bones that humans can't. Humans were also magical critters who had the fantastic ability to regularly emit indescribably delicious turds that canines cannot resist.

Nobody knows how, but canines and humans gradually became hunting buddies. Eventually, via a long process of selective breeding, wolves were reduced to dogs, critters less likely to rip out your throat, and kill your friends and family. The buddies had complementary skills. Dogs will chase anything that moves. Humans had the advantage of weaponry, and the spooky ability to hurl projectiles (sticks and stones) with remarkable accuracy, often with lethal results. When working together, the dog-human team could find, kill, and eat much more game.

Dogs had superb senses of smell and hearing, excelled at team hunting, and were far speedier than humans. During a high-speed pursuit, they repeatedly bark so the hunter knows where to go (wolves don't constantly bark like dogs do). Once dogs had treed a raccoon, it was easy for the hunter to kill it. Previously, the coon's ability to quickly climb trees had been their primary defense tactic, for maybe a million years or more. It now became less safe to be a coon.

Louis Liebenberg wrote about the San. It was far easier for them to hunt gemsbok with dogs, because there was a point in the chase where the tired prey stopped, faced off the mongrels, and the hunter killed it (deer also eventually stop, face their attackers, and surrender). Dogs were rewarded with the guts and leftovers.

## The Deadly Trio & Quartet

Liebenberg noted that the dynamic duo eventually became a trio, when some folks also added horses to the Kalahari team of hunters and dogs. Consequently, the traditional method of persistence hunting — tirelessly chasing game for hours during the heat of the day until they collapsed — was no longer necessary. Humans are not as fast as many large game animals. Horses excel at high-speed pursuits. They made it far easier for the team to hunt speedy game animals.

As a result of this self-defeating advance, the hunting game got way too easy. Hunters were far less dependent on traditional knowledge. Around this time, outsiders were also prohibiting the San from accessing much of their ancient hunting territory. Now, as the elders die, large portions of a two-million-year-old knowledgebase are going extinct, including much of the original hominin software. The San now live in permanent villages.

Around A.D. 1300, Marco Polo described how Genghis Khan used the deadly trio in an industrial scale process for acquiring wild meat. It included two flanks of mounted hunters, each having 10,000 men and 5,000 great mastiff dogs. The line of hunters would extend to the length of a full day's journey, and no wild animal would escape their dragnet. These hunts were like a bloody vacuum cleaner.

Big Juju Transition

For nearly the entire 4.5-billion-year era of life on Earth, all critters everywhere were perfectly wild and free, as they should be. No species controlled and selectively bred others. Wolves have never forgotten how to be wolves. Bears have never forgotten how to be bears. The same is true for every wild animal species. But all domesticated animals, to some degree, have been severed from their wild ancestors, in mind and body.

Paul Shepard perceived the emergence of domesticated wolves (dogs) as something like a cosmic tear in the universe. A new and turbulent epoch was born. "Before the hound, men hunted with their minds and were on holy ground. With the dog, an equilibrium was lost." He wrote, "The history of ecological catastrophe begins with the hound."

The act of gradually and unintentionally transforming a vicious, wild, man-eating predator into a tolerable shit-eating hunting buddy was super-big juju. We discovered that the spirit of wildness and freedom was something that could be subdued, confined, leashed, and exploited. Enslaved animals could be forcibly bred, castrated, branded, sheared, bobbed, hobbled, milked, slaughtered, butchered, eaten, bought, and sold.

Wolves were not the only species vulnerable to domestication. Over time, human control freaks got very good at enslaving others — aurochs, sheep, goats, pigs, and horses. The domestication of horses created especially explosive changes in the human saga, and the family of life. Shepard wrote that, looking down from the mountaintop of time, horses and hounds can be seen "as destroyers of nature and humankind." The ancient balance of wild freedom is sacred.

## Second Class Critters

Wild hunting people recognized that wolves were beings that possessed immense spiritual power, according to Barry Lopez. The Nunamiut understood that wolves had souls, but their enslaved sled dogs did not. In the Sioux language, the term for wolf was *shunkmanitu tanka*, "the animal that looks like a dog (but) is a powerful spirit." Dogs were banned from ceremonial lodges, except when they arrived in the stew kettle, as they often did.

Jean Liedloff wrote that the Yequana people never imposed their will on others, but with dogs they used strict discipline, hitting them with fists, sticks, and stones. Colin Turnbull described how Pygmies treated dogs: "And the hunting dogs, valuable as they are, get kicked around mercilessly from the day they are born to the day they die."

Dogs inherited coprophilia from their wolf ancestors (an obsession for the exquisite aroma and flavor of excrement). Peter Freuchen wrote that sled dogs were often a nuisance when someone attempted to take a crap. Dogs would sometimes have bloody fights over fresh turds. He also mentioned that it was perfectly acceptable to copulate with a dog when she was in heat, as long as it was done outdoors, in the open. Brighter lads never attempted this with wolves.

Elizabeth Marshall Thomas discussed the dogs that lived with the Bushmen (!Kung). They were typically skeletal and weak from hunger. Dogs were owned and named, but they were only fed excrement. When they tried to snatch human food, they were stoned or whipped. In return for regular hot meals, the grateful dogs drove away leopards, jackals, and hyenas.

John Lame Deer wrote, “There was great power in a wolf, even in a coyote. You have made him into a freak — a toy poodle, a Pekingese, a lap dog…. That’s where you’ve fooled yourselves. You have not only altered, declawed, and malformed your winged and four-legged cousins; you have done it to yourselves.”

Basil Johnston told some dog tales. In the Ojibway creation stories, humans and other animals worked together in harmony. All animals served the family of life in some way — except for the lowly dog, who had nothing to offer. Dogs were dependent on humans for their survival, and the other animals had no sympathy: “He who allows himself to be servile deserves servitude.”

Writing in 1902, Irishman W. G. Wood-Martin had a different opinion: “The dog is the greatest conquest ever made by man, for the taming of the dog is the first element in human progress. Without the dog, man would have been condemned to vegetate eternally in the swaddling clothes of savagery. It was the dog which effected the passage of human society from the savage to the patriarchal state, in making possible the guardianship of the flock. Without the dog there would be no flock and herds; no roast beef, no wool, no blanket, no time to spare; and, consequently, no astronomical observations, no science, no industry. It is to the dog man owes his hours of leisure.”

## Wolfhounds and War Dogs

Many people do not adore wolves, because wolves take great delight in killing and eating their friends, family, and livestock. Consequently, large strong dogs (genetically modified wolves) were bred and trained to kill wolves. By around the third century B.C., Irish wolfhounds were guarding flocks. Much later, the Irish used them as war dogs, to molest the Norman terrorists. Two wolfhounds could knock an armored Norman knight off his horse, down to where he could be ethically euthanized.

War dogs were used by the Egyptians, Greeks, Persians, Alans, Slavs, Britons, and many others. Romans had platoons of war dogs with spiked collars and chain mail armor. Prior to battle, they were deliberately underfed, and then they were released as the first wave of attack. Their Molossus war dogs were unbelievably vicious, but they were wimpy compared to the broad-mouthed war dogs of the Britons, whose mastiffs could grow up to 200 pounds (91 kg).

Columbus brought war dogs to the New World in 1493, to terrorize the natives. Gonzalo Pizarro brought a thousand war dogs to Peru in 1541. Spaniards trained their dogs to disembowel natives (rip out their intestines). In the early U.S., Benjamin Franklin advocated the use of war dogs against the Native Americans who sometimes hid behind every tree, and seriously disliked white folks. Close your eyes and imagine standing in front of five or six charging 200-pound war dogs determined to rip you to bloody shreds.

## Status & Loneliness

Keith Thomas wrote about English social history during the Industrial Revolution (1500–1800). He noted that scruffy commoners kept ordinary mongrels, but the nobility developed something new: high class dogs — hunting hounds for the gentlemen, and small lapdogs (mostly toy spaniels or pugs) for the ladies. Middle class folks striving for upward mobility acquired dogs to demonstrate their elevated social status.

Today, the pet population has skyrocketed. Many critters are considered to be "fur children," members of our family, beloved companion animals. Thomas was a party pooper. "The fact that so many people feel it necessary to maintain a dependent animal for the sake of emotional completeness tells us something about the atomistic society in which we live."

Today, glossy magazines are loaded with photos of glamorous celebrities and their adorable dogs. Super-trendy breeds have become must-have status symbols and fashion accessories for ambitious go-getters eager to present the appearance of fame and success. I once looked in the Seattle paper's want ads to check current prices for yuppie puppies. English bulldog, $3,500.

American Akita, $1,650. Bernedoodle, $2,900. French bulldog, $2,695.

Paul Shepard reminded us that humans evolved in wild ecosystems in which we were always surrounded by a fascinating menagerie of wild and free animals that provided us with a sense of wonderment, respect, and connection to the family of life. For almost the entire 300,000-year human saga, we lived in this sacred relationship. It is the normal, wholesome, and meaningful experience that every newborn infant is fine tuned for, and expects to enjoy.

In The Tender Carnivore, Shepard wrote "Zoos, pets, and domestic animals give us personal satisfaction only because of the ecological poverty of our lives." Animal movies, pets, zoos, and toys are a crude substitute for an inborn need. They are perversions.

Later, in The Others, he noted that "Wild animals… for the first time in history, are almost completely lacking in the child's experience." "The pet cannot restore us to wholeness any more than an artificial limb renews the original." Pets are deficient animals. "Something… is profoundly wrong with the human/animal pet relationship at its most basic level." It fails to provide us with what we most deeply need, a vital connection to sacred otherness.

## Plant Domestication

Plant domestication independently emerged in at least eight regions of the world. Population pressure and resource scarcity must have been primary motivators. Backbreaking farm labor is not something that folks choose to do for fun or kinky pleasure. Domestication was not a brilliant innovation that provided enormous benefits at little or no cost. As it spread from one ecosystem to the next, it accelerated the growth of destructive imbalances.

Forests and wildlife were in the way. Cruel tools ripped open the green skin of the land, and sharply proceeded up the hillsides. Winds and rain carried away soil as the gullies deepened. More food was harvested, and growing populations devoured it. Agriculture is an extremely addictive habit. If you quit, you starve. It was something like a graveyard headstone for the very long era of hominin wildness and freedom. It smashed open the entrance to a turbulent future.

### Why and How

The domestication of crop plants is an enormous subject. It has enabled and accelerated a long sequence of unfortunate and unforeseen consequences over the centuries. Of course, the same could be said for the domestication of animals. If domestication had never occurred, life in the twenty-first century would look nothing like the reality you live in now.

An acre of cropland planted with domesticated wheat produced many more edible calories than an acre of prairie in which wild wheat

grew among other grasses. Jared Diamond estimated that the same amount of land could produce 10 to 100 times more grain. Today's energy guzzling high-tech agriculture produces much larger harvests. And so, our population is zooming down the fast lane toward nine billion, at the same time that a rapidly warming climate is

beginning to disrupt life as we know it. Clive Finlayson reminded us that the end of farming is just one climate change away.

Agriculture was not an amazing invention created by a brilliant mad scientist. For four million years, every hominin who had more than two brain cells clearly understood that plants grew from seeds. Agriculture was not an awesomely cool fad that spread like wildfire around the world. As long as wild foods were adequate, it would have been ridiculous to deliberately shift to tedious difficult work.

Unfortunately, there is strength in numbers, and farmers trumped hunters. In any region suitable for the expansion of agriculture, hunters were vulnerable. A dozen healthy, well-nourished hunters were unlikely to triumph against 100 malnourished corn farmers with bad teeth. The corn powered Iroquois gathered momentum over time, pushing out the tribes of Algonquin hunters. Barry Cunliffe wrote that when agriculture moved close to your home sweet home, you had four options: (1) exterminate them, (2) take up the dirty habit, (3) flee, or (4) be overrun.

When hunters have an unlucky day, they can lose a day's work. When farmers have bad luck, they can lose more than a year's hard work, and have no safety net to catch their fall. Crops can be zapped by drought, deluge, late frost, early frost, fire, storms, plant disease, enemies, wildlife, insects, and so on. Producing more food produces more risks.

Brian Fagan wrote about the Little Ice Age, which arrived in 1315. It rained almost continuously from May to August. Fields became lakes or knee-deep mud. Floods erased entire villages. Wars were cancelled. The survivors eagerly awaited a return to normal weather in 1316, but rains resumed in the spring. The roads were jammed with wandering beggars. Many villages were abandoned. By the spring of 1317, they had eaten their seeds, and had few oxen to plow with. The rains returned. There were seven years of bad harvests, and fulltime employment for gravediggers.

Kat Anderson described how hunter-gatherers in California "tended" the wild landscape to encourage the growth of wild plants that were useful to them. They didn't strip the living green skin off the land, pulverize the exposed soil, and plant seeds. When European explorers arrived in California, they discovered natives who were exceedingly healthy, and enjoyed an abundance of nourishing wild foods.

She mentioned an 1868 report. California was "filled with elk, deer, hares, rabbits, quail, and other animals fit for food; the rivers and lakes swarming with salmon, trout, and other fish, their beds and banks covered with mussels, clams, and other edible mollusca; the rocks on its sea shores crowded with seal and otter; and its forests full of trees and plants, bearing acorns, nuts, seeds, and berries."

At that time, Europe's peasant farmers spent their dreary lives engaged in a labor intense form of agriculture that depleted the soil, and produced minimal yields with erratic inconsistency. Folks were malnourished, unhealthy, and most of them died young. California natives benefitted from a more nutritious diet, and from the stability of a more diverse food supply. Their time proven culture was well adapted to the ecosystem. They were extremely fortunate to live in a place and time where draft animals, plows, carts, and potent super foods like potatoes and corn (maize) were unknown.

Mark Nathan Cohen wrote an important book on prehistoric food crises. He described why agriculture emerged independently in several different regions. It was a jarring transformation for humankind. Hominins had been hunters for maybe four million years, a strategy that had been successful, but not harmless. As hunters spread around the world, a number of megafauna species were driven extinct.

When the original pioneers first arrived in the awesome grasslands of the Fertile Crescent, they were delighted to find abundant herds of game. There was so much wild plant food that some groups had the option of giving up the nomadic life and settling down in delicious locations. Until maybe 10,000 years ago, everything on the menu everywhere was wild foods. By 2,000 years ago, most of humankind depended on food produced on farms.

Plant domestication, to some degree, was unintentional. Wheat plants are annuals, they live one season and die. Every year, new plants must grow from seeds. Ideally, many seeds are produced, and all readily fall to the ground when ripe. This normal ability to release ripe seeds is called shattering. It's essential for the vitality of the plant community, but it's annoying for foragers, who knock lots of seeds to the ground.

Originally, a wee minority of wild wheat plants had a genetic mutation that inhibited shattering. Their seeds were more likely to remain in the head, and end up in the forager's basket. Over time, harvest after harvest, more and more mutant seeds were collected and replanted, because the foraging process was more likely to collect mutants. Eventually, mutants become the majority. They had been domesticated.

**Mesopotamia**

Mesopotamia is one region in the Fertile Crescent. James Scott, a political scientist, studied the dawn of agriculture in southern Mesopotamia, because it was the birthplace of the earliest genuine *states* — hierarchical societies with rulers and tax collectors, sustained by a mix of farming and herding. The primary food of almost every early state was wheat, barley, or rice. Taxes were paid with grain, because it was easier to harvest, transport, and store than foods that were more perishable. An entire field of grain ripened at the same time, which enabled one sweep harvesting.

Today, southern Mesopotamia is largely a treeless desert, and many assume that it has always been so. Actually, it used to be wetlands, a cornucopia of wild foods, a paradise for hunters and gatherers. Edible plants included club rush, cattails, water lily, and bulrush. They also ate tortoises, fish, mollusks, crustaceans, birds, waterfowl, small mammals, and migrating gazelles. The ecosystem was generous, and life was good.

Scott noted that settled communities of hunter-gatherers began appearing by maybe 12,000 B.C. The first evidence of domestication appears around 9000 B.C. Then, it took another four thousand years (160 generations!) before agricultural villages appeared. The first states emerged around 3100 B.C.

Cultivation first emerged in locations ideal for low-tech planting. In the early days, there was no need for irrigation. Stream banks and river deltas were covered with alluvium — a moist and highly fertile deposit of clay, silt, sand, and gravel that was delivered by annual floods. It was a soft and loose soil that was ready for sowing. So, in addition to the wild grains they gathered, it was fairly easy to sow seeds in the recent deposits of alluvium.

Scott mentioned archaeologist Hans Nissen, who studied the ancient Near East. Nissen noted that for quite a while, the climate had been wet and warm. With adequate rains, abundant water moved through the streams and rivers. The Tigris-Euphrates watershed emptied into the Persian Gulf. Nissen measured the accumulated sediments on the floor of the Gulf. Thicker layers of organic matter indicated times when lots of water was moving lots of silt. This study illuminated patterns of climate shifts.

Prior to about 3500 B.C., so much water flowed into the Gulf that its water level was 10 feet (3 m) higher than it is today. The north shore of the Gulf expanded quite a way into southern Mesopotamia. Much of the region was then wetlands, and folks lived on islands. It was a paradise for happy wild people — plenty to eat year-round.

But then, climate trends gradually shifted toward cooler and dryer. Less rain led to lower water tables. The Gulf's shoreline retreated. Wetlands began drying out, and the newly exposed soil was highly fertile. For a while these soils were a sponge that held enough moisture that crops could be grown without irrigation, but this situation did not become permanent.

In the driest regions, agriculture could not survive without irrigation. Over time, an enormous canal system was built in Mesopotamia. The unintended consequence of this brilliant technological masterpiece was total catastrophe. Regular irrigation led to salt buildup in the soil (salinization), which eventually rendered it permanently infertile, killing the golden goose. Walter Youngquist wrote that the Tigris-Euphrates floodplain is now "a glistening desert of salt."

Salt-nuked cropland had to be abandoned, forcing folks to concentrate in more urban settlements. With more people crammed together, conflict levels increased. To avoid social meltdown, conflicts needed to be brought under control. This need encouraged the further intensification of civilization — powerful leaders, laws, enforcers, obedient tax-paying citizens, and hard-working slaves.

Nissen noted that wild grains still grow in Mesopotamia. Today, in remote locations, folks can gather two or more quarts (or liters) of grain in an hour — a decent supply of calories for minimal effort. On the other hand, cultivated grain grown in irrigated fields can produce far higher yields, and sometimes two or three harvests per year.

Annual grain yield was important, but effective storage was equally vital. A primary objective of agriculture was not to produce millions of morbidly obese rats, or impressive heaps of stinky rotten wheat. Grain was best stored in large, closed vessels of fired clay. Mark Nathan Cohen noted that wild wheat had higher protein content than domesticated grain. Nutrient content declines over time in storage.

Gold is dense and shiny, but you can't eat it. It only has value when people with vivid imaginations are possessed by a belief that the shiny yellow metal is incredibly precious. Stored wheat, on the other hand, is something you can eat, food that can sustain your survival. A full granary is truly precious to folks who enjoy being alive, a genuine treasure.

History is clear on one thing — accumulated treasure is fantastically tempting to ambitious hard-nosed folks untroubled by morals, like Vikings, Mongols, or billionaires. Tacitus, writing in A.D. 98, described the wild German tribes. "They actually think it tame and stupid to acquire by the sweat of toil what they might win by their blood."

In southern Mesopotamia, Nissen spent a lot of time digging in Uruk, an ancient site that is now worn-out ruins surrounded by a barren brown wasteland. [Look] In the days of its glory, Uruk was a highly advanced place. Nissen called this era "the beginning of early high civilization." It had writing, large artworks, and monumental architecture. King Gilgamesh built a wall around Uruk that enclosed an area of 1,360 acres (550 ha). The wall included at least 900 semicircular towers.

In some locations, the defensive barriers likely had a second purpose — preventing taxpayers and slaves from escaping to freedom. Many, many centuries have been devoted to a never-ending arms race. Raiders regularly developed new and better ways of smashing defenses, and the home team constantly worked to outsmart them.

## Downward Spiral

As the last ice age gradually rode off into the sunset, the Fertile Crescent ecosystem inhaled a deep breath of fresh springtime breezes, opened its eyes, smiled, and felt the power of new life surging within it. Ancient myths described a Garden of Eden. Large areas were clothed with wild cereals and pulses, fruit and nut trees. It was home to wild goats, sheep, pigs, and cattle. It was cursed with riches, a tantalizing booby trap of treasures. Over time, the abundance led to hallucinations of grandeur that inspired folks to chop down forests, build ghastly cities, and develop impressive world-class wastelands.

The original ecosystem itself was perfectly OK — wild, free, happy, healthy, and beautiful. Its problems didn't begin until human pioneers arrived. They were wandering vagabonds who had strayed far from their ancestral roots in Mother Africa, and they suffered from being a bit too smart for their britches. Peter Ungar wrote that our wild ancestors were *a part* of nature, but domestication drove them *apart* from it.

In a healthy wild ecosystem, all members of the family of life have coevolved over many, many centuries. It's a fantastically complex circle dance that has managed to develop a workable balance over time. It is nothing less than a living miracle. The brightest people on Earth could never invent a process that was so beautiful, and so genuinely sustainable.

Humans habitually fail to foresee all of the unintended consequences of their tireless cleverness — and this often results in

ever growing eco-wreckage. Elizabeth Kolbert thought that innovation was something like a perpetual downward spiral. Fixing problems seems to automatically create new problems that need fixing. Wild nature is a magnificent time proven balancing act nurtured by coevolution. Civilization is a 10,000-year experiment in controlling, exploiting, and degrading nature.

Like all other animals, tropical primates are mostly focused on the here and now. We instantly pay acute attention to immediate risks like lions, tornados, or rattlesnakes. But risks that take decades or generations to arrive at our doorstep are of little or no concern to us. Since few of us have a competent understanding of environmental history, we may not even recognize the presence of powerful trends, directly in front of our eyes, which will eventually hurl our civilization off the cliff.

Since I got up this morning, I have not directly experienced jarring evidence of the growing global climate catastrophe. If I wasn't devoted to paying close attention to the info stream from the outer world, the climate catastrophe would seem less significant, easier to sweep under the rug. Just another hoax. La-de-dah! In the mainstream mindset, ecological sustainability is simply not a matter for concern, or a proper subject for polite conversation (sports, politics, and celebrity gossip are far more important).

If smiling, attractive, well-dressed people on TV repeatedly tell us, with a straight face, that electric cars are eco-friendly, then… …they are! They are made of sparkly rainbow fairy dust by tree hugging druid magicians. We confidently look forward to a utopia of self-driving cars, not self-walking humans.

**Monocultures Risky**

Monocultures in agriculture — fields planted with a single plant species — are delightfully tempting to pests and diseases, like beetles and blight. Similarly, facilities in which thousands of chickens are densely packed, can get wiped out if a mouse sneaks in a wee speck of virus. Big cities are essentially human monocultures. They have always been popular destinations for epidemic diseases. As the human population zooms past eight billion, the entire planet is beginning to assume the appearance of a highly unstable global monoculture.

Wheat was first domesticated in the homeland of the Judeo-Christian culture. The Bible mentions locusts 28 times. "All thy trees and fruit of thy land shall the locust consume." Wheat thrived in the Mediterranean climate, which provided generous winter rains to germinate the thirsty seeds. Both locusts and humans consider wheat to be an excellent food. Humans habitually plant monocultures of wheat, and their golden fields look like paradise to locust swarms.

Jeffrey Lockwood studied Rocky Mountain locusts. Their range spanned from California to Iowa, and Canada to Mexico. He described an astonishing swarm that passed over Plattsmouth, Nebraska in June 1875. Regional telegraph stations relayed messages that documented the advance and size of the swarm. It was about 1,800 miles (2,897 km) long, and at least 110 miles wide (177 km) wide — a swarm about the size of California. This single swarm took five days to pass, blackening the skies. Some estimates of their numbers were in the trillions.

Most of the time, locusts relaxed at home, in the fertile river valleys of the West. From time to time, they exploded in number, and soared away in hungry swarms, searching for nourishment. Outbreaks often occurred several years in a row, generally three to five. When a huge swarm landed, it feasted on the greenery, sometimes devouring maybe 50 tons of vegetation in a day. Wheat fields were a favorite lunch stop. Many farmers lost their entire crops in a few hours. The government had to send food relief to keep thousands of settlers from starving.

Railroads were a curse. They enabled the mass extermination of the bison, which doomed the plains tribes. They enabled the deforestation of the Midwest, which doomed the passenger pigeons. They enabled industrial scale mining and manufacturing. They enabled the settlement of the plains. Swarms of farmers and ranchers fell out of the sky and went berserk on the land. Settlers were especially attracted to the fertile river valleys of Wyoming and Montana — superb locations that were also the ancient ancestral homeland of the locusts.

During outbreak years, all the farmers' desperate efforts to subdue billions of swarming locusts failed. Folks were absolutely helpless. Locusts chewed off their clothes. During ordinary years between outbreaks, it was a different story. Far smaller populations of locusts enjoyed a less chaotic life in their ancestral home sweet home. Sadly, in their homeland refuge they were becoming highly vulnerable. The arrival of cows, plows, and irrigation unintentionally and unknowingly provided the death blow to the locusts. Their nesting grounds got rubbished. In 30 years, locusts plunged from trillions to zero. They vanished forever in 1902.

In the 1990s, Lockwood visited a number of “grasshopper glaciers” in the Rockies. As the warming climate melted the ice, the remains of locusts from centuries past gradually emerged. They had inhabited the region for a very long time, and they had periodically swarmed in large numbers. Outbreaks were perfectly normal and natural, and they didn’t cause permanent irreparable damage. Farmers and ranchers interacted with the land in a way that was the opposite of perfectly normal.

James Scott wrote that both humans and crops are vulnerable to viral, fungal, and bacterial diseases. Crops can be damaged by snails, slugs, insects, birds, rodents, and other mammals. Weeds can diminish their access to sunlight, water, nutrients, and space. The primary vulnerability for civilizations is their overwhelming dependence on a single annual harvest of just one or two cereal staples. Over the centuries, many have been destroyed by droughts, deluges, floods, fires, pests, frosts, storms, crop diseases, and bloody enemies.

Mark Nathan Cohen noted that the diet of the San people included about 75 different plant foods. Having this wide variety reduced the risk of scarcity and starvation. Some plant and animal foods provided their regular diet. Other foods were deliberately reserved for use only in hunger times, a safety net. Some groups set aside portions of their territory that were only used in times of scarcity.

In the 1960s, anthropologists in Botswana were astounded to observe how well the San people lived during the third year of an extreme drought in the Kalahari, one of the harshest ecosystems on Earth. Neighboring Bantu farmers were hammered by three consecutive crop failures, and 250,000 of their cattle died. United Nations famine relief kept 180,000 farming people on life support. Some farmers who didn’t get food relief had to forage for wild food, putting further strain on food resources. Still, the San were able to acquire their food with just 12 to 19 hours a week of effort. They dwelt in a desolate “wasteland” that no civilized people could survive in, and they lived well and joyfully.

Today, the survival of eight billion people is heavily dependent on just three domesticated grass species: wheat, corn, and rice. How will the climate catastrophe affect these staples?

**Corn (Maize)**

Corn is a jumbo-sized tropical grass that can grow up to 10 feet (3 m) tall. In some countries outside the U.S., "corn" means any type of grain, and "maize" is specific to the plant *Zea mays* (mays/maize). Somewhere around 8000 B.C., corn was domesticated in Mesoamerica (the region spanning from central Mexico to Nicaragua). Experts have many different opinions about when, where, and how it happened.

Over centuries, a type of wild grass was somehow transformed into a highly productive super food that generates far more calories per acre than any of the Old World's domesticated grains. Earlier, I mentioned that about 85 percent of plant species are C , and the 3 rest are C . The C species are significantly better at utilizing solar 4 4

energy, and producing more calories. Corn is C . 4

Corn farming began migrating northward into the eastern U.S. around A.D. 200, but the heat loving tropical grass did not enjoy the shorter summers and cooler climate. By 900, it had adapted to the temperate climate, and its use expanded. By 1200, the corn culture had spread from Florida to Ontario. In South America, corn expanded into regions of Peru and Chile.

Alfred Crosby noted that early white settlers in America were amazed by corn. Sowing a bushel of wheat might yield 12 to 20 bushels at harvest time. A bushel of corn might yield 200 bushels or more. Corn was a fairly reliable producer that could be grown using simple tools and unskilled labor. It could do OK in marginal soils, required minimal weeding, and could survive several frosts. It also stored well. When mature, ears could be left on the stalk and harvested later, without risk of spoilage. In hunger years, the stalks were eaten before the grain was ripe.

The thick husks tightly hold the kernels to the cob, so the seeds are not automatically released, which benefits the farmer. Husks also discourage losses to birds and insects. Without the assistance of humans, domesticated corn in an abandoned field would have a hard time perpetuating itself indefinitely. Finally, after the kernels have been removed, the cobs can be used for a procedure that is now commonly performed with toilet paper.

## Corn vs. Health

The skeletons we leave behind preserve a lot of information about our diet and health issues. William Macleish mentioned that the skeletons of hunter-gatherers in California's Central Valley were remarkably healthy people. The opposite was true at the Fort Ancient site in the Ohio River basin. A thousand years ago, those folks were on the "three sisters" diet: corn, beans, and squash. About 20 percent died before weaning, indicating that mothers were not well nourished. Only one in a hundred lived to be 50 years old. Many had rotten teeth and anemia.

Jared Diamond mentioned the research done by George Armelagos, who studied the skeletons of 800 Native Americans found at the Dickson Mounds site in Illinois. The upper level (newer) skeletons were farmers, and those found in lower (older) levels were hunter-gatherers. At birth, a hunter had a life expectancy of 26 years, and a farmer was 19 years. Hunters enjoyed a high-quality diet of wild foods, lots of nutrients, but not calorie dense.

Farmers got adequate calories from starchy foods, but their corn-based diet lacked some amino acids, vitamins, and minerals. Corn eaters had almost 50 percent more tooth enamel defects, four times more iron-deficiency anemia, three times more bone lesions, and more spinal damage, probably from hard physical labor. James Scott mentioned that women who regularly ground corn while squatting on their knees had deformed toes.

Teotihuacán was a corn-powered city located not far from today's Mexico City. It was home to a culture of pyramid builders. At its prime around A.D. 500, it had about 125,000 people, and was the biggest city in the world. Mark Nathan Cohen wrote that it had very high rates of malnutrition, stunted growth, deciduous tooth hypoplasia, and infant and child mortality.

The traditional San hunter-gatherers had a low-carb high-fiber diet. One study of 2,500 found no protein deficiency, and no dental cavities. Dental problems increased with the transition to agriculture, but they have skyrocketed with the modern diet of processed foods loaded with carbs. Cavities are rare in other animals.

Forty years after Diamond's heretical "worst mistake" essay, Peter Ungar published a book that included newer research on changes in bones and teeth over the centuries. A diet rich in carbohydrates (sugar and starch) leaves sticky deposits on the teeth. This encourages bacteria in the dental plaque to produce acid, and acid encourages tooth decay. He noted that in the New World, the average caries rate (tooth decay) for corn eaters was five times higher than for hunter-gatherers. Also, corn eaters had far more caries than folks who ate Old World grains.

Importantly, Ungar did not forget to mention that even corn eating Indians had far better teeth than modern Americans who consume staggering quantities of a devilish health-thrashing substance known as sugar.

Michael Pollan reminded us that you are what you eat. Most of the modern consumer diet consists of processed corn. Thus, you and I might be seen as "corn walking" or "corn chips with legs." Most of the excess calories we consume come from corn. Traditional table sugar (sucrose) is made from sugar cane or sugar beets. In 1970s, the new kid on the block appeared — high fructose corn syrup (HFCS).

Pollan noted that a bushel of corn (35 l) can produce 33 pounds (15 kg) of HFCS. It's extremely cheap, "one dollar can buy 1,200 calories." HFCS is commonly used in making processed foods, breakfast cereals, candy, and fizzy soft drinks. By 1999, the average American was annually devouring 37.5 pounds (17 kg) of HFCS, in addition to table sugar. In 2018, we consumed 62.4 pounds of sugar (both HFCS and table sugar).

Of the world's primary grains, corn has the most nutrient deficiencies. In unprocessed corn kernels, the niacin is not in a free form, so your body can't utilize it. Niacin (vitamin B ) is an essential 3 nutrient. Also, corn has some protein shortcomings — too little tryptophan or lysine (important amino acids). Native Americans eventually figured out how to address these two challenges.

For the niacin issue, the solution is called nixtamalization, which is the process of treating corn with an alkaline solution, like lye (leached from wood ashes), or lime (limestone: calcium carbonate). This unlocked the niacin, making it available to the body. Treated corn is called hominy. Ground hominy is called masa. It is used to make products like tortillas, tamales, and tortilla chips. Folks who didn't know the hominy trick often got pellagra, which killed hundreds of thousands of poor folks. On the downside, hominy eaters experienced far more tooth decay.

To compensate for corn's protein limitations, beans came to the rescue. Beans provide amino acids missing in corn. Eating corn and beans together can provide higher protein content. One source recommended a blend of three parts beans to seven parts corn. Also, squash seeds can contain 30 percent protein. A popular Native American delicacy was succotash, a mixture of corn, beans, dog meat, and bear grease.

On a side note, Lynn White mentioned that, eventually, Europeans also discovered the health boosting magic of legumes (peas, lentils, and beans). Previously, the diet of commoners majored in carbs from cereals, which provided insufficient protein. By the tenth century, the addition of legumes to the crappy traditional diet spurred a surge in the growth of populations and cities. Nutrient deficiency diseases like pellagra, beriberi, scurvy, and kwashiorkor are essentially unknown among hunter-gatherers.

## The Soil Molester Blues

At the dawn of agriculture in Mesoamerica, folks majored in growing corn, beans, and squash. They used techniques that were similar to other regions of the world where plant domestication emerged. Their farm equipment was digging sticks and hoes, so the first places they used were often along shorelines, rivers, wetlands, and flood plains, where the soils were soft and moist. When the planters first rammed their digging tools into fertile virgin soil, the initial harvests could be impressive. But with every passing year, when a field was replanted, the nutrients in the soil were a bit more diminished.

Depending on soil quality, a field could produce decent autumn harvests for several years. When nutrient depletion eventually decreased yields, the field was abandoned, and a new one was cleared. The abandoned field might be given a rest for maybe 10 or 20 years, to recharge its soil a bit. Then, it might be cleared again, and returned to production for a while. This cycle could be repeated a few times, sometimes for several generations, but not forever. Soil fertility in cropland declines over time, and harvests shrink. They did not have herds of livestock that could regularly produce generous amounts of organic fertilizer.

In Mesoamerica, this was called the milpa system, in other regions similar practices were called slash and burn, swidden, or shifting agriculture (milpa means corn field). Milpa is the opposite of wild, free, and biodiverse. Big Mama Nature adores healthy soil, and strives to protect it. Where rainfall is generous, she clothes the land with forest. Where rain is more modest, she covers the soil with grassland. Wild and free has three huge benefits.

(1) Protected soil retains moisture better than bare naked soil that is directly exposed to the sun and wind. Consequently, wetter soil encourages a wetter ecosystem, promoting the existence of springs, streams, ponds, wetlands, and a greater abundance of many forms of life. Magnificent swamps are home to far more biodiversity than deserts. Both forests and wild grasslands send roots deep into the ground, so they can better retrieve nutrients and water, hold the soil in place, and continuously improve soil health and fertility with each passing century.

In the milpa system, the primary crops are *annuals*, plants that live just one season and then die. Trees and many grassland plants are *perennials*, plants that have longer lifespans. Annuals have to be replanted every year, after the farmer first pulverizes the soil surface. This disturbance encourages some of the precious carbon stored in the soil to be released into the atmosphere. It also encourages the moisture in the soil to evaporate, which makes annuals more vulnerable to drought.

(2) Protected soil is held in place by a blanket of vegetation, making it less likely to be blown away, or washed away. Unprotected sloped land is far more vulnerable to water erosion, which can rip

deep gullies into hillsides over time. Paul Shepard described catastrophic erosion in China's Yellow River watershed that created gullies 600 feet deep (183 m). He noted that massive erosion in the Tigris-Euphrates watershed had dumped so much soil into the Persian Gulf that 35,000 square miles (90,650 $km^2$) of salt marsh was created.

Once upon a time, on a lovely Sunday in June, Wes Jackson was driving through Mennonite country in Kansas. He stopped to observe a Mennonite's field, which had recently been planted.

During the previous night, a hard rain had dumped up to five inches (12 cm) in some places, a normal event in that region. Mennonites devote extra effort to being good stewards of the land. Compared to industrial agriculture, their methods have lower impact. Looking at the field, Jackson observed that the rain had washed the seeds away, and the ditches were clogged with rich black mud. It was a wipeout.

Then, Jackson went to inspect a prairie not far away. It was not damaged at all. In fact, it had been invigorated by the refreshing rain, and none of its soil had run away. Prairies can absorb 14 times more moisture than tilled cropland. Forests and prairies can be fairly eternal, but cropland has an expiration date. Sooner or later, the soil is depleted, and the cropland becomes wasteland. This can take many generations, it's not an immediate house-on-fire threat, so it's easy to pretend that all is good. But the damage caused is cumulative and almost always irreparable.

Richard Manning noted that a healthy wild prairie can absorb 5 to 7 inches (13-18 cm) of rain in an hour with no runoff. A field of corn or soybeans can absorb 0.5 to 1.5 inches (1.3-3.8 cm) in an hour, and the excess water runs off almost as fast as from a parking lot. This difference explains the catastrophic 2008 floods in the U.S., following several days of generous rainfall.

(3) Protected soil is often an ongoing miracle of continuous improvement. Several thousand years ago, as the glaciers melted, Iowa's soil was exposed to warm sunbeams for the first time in ages. Vegetation recovered and, with each passing century, the happy prairie created an ever-growing layer of tremendously fertile black topsoil. Before settlers arrived

in the nineteenth century, the soil was remarkably deep in places. Because the sod layer was so healthy, thick, and rugged, native people with corn seeds could not rip it open with digging sticks or hoes.

The Iowa Association of Naturalists became freaked out by soil erosion in Iowa. In 1999, the state was losing 240 million tons of its "black gold" every year. This incredible treasure of soil had been created over thousands of years by a thriving tallgrass prairie. Sadly, half of it has been lost since 1848, as the settlers launched a full-scale war on the soil, armed with the insanely destructive steel moldboard plows manufactured by a madman named John Deere.

In his book *Collapse*, Jared Diamond described a trip to Iowa, where he visited a church in corn country that was more than 100 years old. "On my most recent visit to Iowa, my hosts showed me a churchyard offering a dramatically visible example of those soil losses. A church was built there in the middle of farmland during the 19th century and has been maintained continuously as a church ever since, while the land around it was being farmed. As a result of soil being eroded much more rapidly from fields than from the churchyard, the yard now stands like a little island raised 10 feet (3 m) above the surrounding sea of farmland."

Walter Youngquist noted that half of Iowa's topsoil has been flushed down the Mississippi River, and dumped into the Gulf of Mexico. On some Iowa hills, streaks of the ancient tan and gray marine clays, which had long been buried under the black gold, were beginning to see the light of day once again. In the last 200 years, a third of U.S. topsoil has been lost. He wrote, "The great enemy of soil and, therefore, civilization, is civilization itself as we know it — the human-induced accelerated rate of erosion." From a human timescale, topsoil is a finite nonrenewable resource. Destroying it is foolish.

## Corny Civilizations

In the Americas, as agriculture spread, communities expanded, increasing the odds for friction and sparks. The survival of each settlement required folks to protect their stored food, which was a tempting target for their enemies to swipe or destroy. Dean Snow wrote that corn spread into

Iroquois country around 1350 to 1400. Population grew, longhouses got longer, and many villages were surrounded by double or triple palisades. Nomadic foragers didn't live in dense crowds, haul around lots of food, or construct defensive barriers.

A number of pre-Columbian (before 1492) civilizations in the New World built grandiose monuments — huge pyramids, elevated temple platforms, sculptures, palaces, streets, and plazas. Many resembled the ruins created by the early civilizations in the Fertile Crescent and the Mediterranean basin. Monumental construction projects radiate vibes of power, authority, domination, patriarchy, and self-glorification.

Beginning around 1200 B.C., a series of New World civilizations appeared here and there. They aggressively devoured their resource base, enjoyed a giddy orgasm of prosperity, and then faded. The parade included the Olmecs, Mayans, Aztecs, Toltecs, Oaxacans Incas, Mixtecs, Zapotecs, and so on. This pattern of growth and collapse was also the norm in many regions of the Old World — Uruk, Babylon, Phoenicia, etc. Like fireflies, they blink on for a moment, then off.

Old World civilizations were fueled by propellants like wheat, barley, and rice. New World civilizations were turbocharged by two highly potent propellants: corn and potatoes. Clive Ponting noted that in A.D. 600, wheat powered Rome was home to 50,000. At that time, in the Valley of Mexico, corn-powered Teotihuacán was home to 100,000 (others say 150,000). It is located about 18 miles (30 km) northeast of Mexico City.

The Old World had many powerful components that Mesoamerica did not — livestock, horses, wheels, ships, and advanced metallurgy. Maybe the Romans were handicapped by the persistent barbarian attacks, or by the waves of infectious diseases nurtured by animal domestication, or by their soils depleted by several centuries of wheat farming, or by their lead pipe water distribution system.

In A.D. 600, hungry dirty Europeans were struggling to survive in what we now call the Dark Ages, while Teotihuacán was a state-of-the-art masterpiece of monumental architecture (look at online images). There was the Street of the Dead, the Pyramid of the Sun, and the Pyramid of the Moon. Aztecs ominously referred to Teotihuacán as “the place where men became gods.” The society was destroyed in about 650, and everything flammable was burned. By 900, it was an abandoned ghost town.

Much later, in 1521, when Spaniards arrived, the Aztec civilization of Tenochtitlán (Mexico City) was one of the biggest cities in the world, with a population of about 200,000 (some say 250,000), which was five times larger than London. The invaders were amazed to see a big city in which the streets were not stinky and slippery with deep horse shit. Aztecs are also known as the Mexica.

In an effort to recycle soil nutrients, the Aztecs fertilized their crops with human wastes. Imagine how much poop 200,000 people can plop every day. Imagine continuously moving that poop out to the cornfields — without the benefit of wheeled carts or (nonhuman) beasts of burden. Despite challenges, their population was soaring to new heights — until Old World diseases rumbled into town like a mega-death steamroller.

Several of the Spanish invaders wrote down accounts of what they observed, including the Aztec rituals of human sacrifice. Prisoners were taken to the top of the temple-pyramid, where they were cut open, their beating heart removed and offered to the sun, and their corpse kicked down the steps. Several Spaniards estimated that the number of folks sacrificed was maybe 20,000 per year.

Why were the sacrifices performed? One theory is that ritual sacrifices could nurture a sense of group identity in societies too large for everyone to know everyone else. Michael Harner noted that scholars tended to consider the practice shocking, but sacrifices were not unique to Mesoamerica. Old World cultures had their own tradition of bloody mass murders that were inspired by periodic outbursts of holy hysteria and rabid intolerance.

Harner contemplated the notion that there was more to the rituals than good old-fashioned religion. Long before the rise of the Aztec culture, the deer in central Mexico had been hunted to scarcity. Tenochtitlán was built on a manmade island on the western shore of Lake Texcoco. The lake was too shallow and salty for fish to live in, so the meat department majored in domesticated turkeys and hairless dogs (Chihuahuas).

As mentioned earlier, corn eating societies had more health issues than hunter-gatherers. While it's possible to be fairly well nourished on a diet majoring in corn and beans, it takes some luck. Both have to be consumed during the same meal, in adequate portions, in order to assemble essential proteins. By adding some meat to their diet, folks could improve the odds of satisfying their protein requirements.

Harner proposed the theory that the Aztec sacrifices had two roles, religious and nutritious. Aztecs often raided their neighbors, and brought back prisoners. They did not annex their land, but they left behind survivors to breed replacements that could be captured during future raids. Prisoners who were not eaten on the battlefield were taken back home, where they were kept in sturdy wooden cages, in which they were fattened up for an upcoming sacrifice.

Bernal Díaz was a Spaniard who was an eyewitness to sacrifices. He wrote: "Moreover every day they sacrificed before our eyes three, four, or five Indians, whose hearts were offered to those idols and whose blood was plastered on the walls. The feet, arms, and legs of their victims were cut off and eaten, just as we eat beef from the butchers in our country."

In the sacrifice process, the heads were also removed. In Tenochtitlán, their skulls were displayed on a rack near the temple. Two soldiers were assigned the job of estimating the number of skulls on the rack. They concluded about 136,000 skulls (not including the ones on the towers). Beginning in 2015, excavations behind Mexico City's cathedral began uncovering the legendary

racks of skulls. Sacrifices were also normal events in other Aztec cities.

Cahokia

Glen Hodges wrote about Cahokia, a corn-powered Native American civilization located on the Mississippi River, close to the future site of St.

Louis. The riverside city rapidly developed around A.D. 1050. Some estimates suggest that up to 15,000 lived in the midtown area, and maybe 30,000 more were in the suburbs — a population larger than Paris or London.

By 1400, it was a ghost town. We aren't sure why, but all civilizations collapse. One theory suggests major flooding. Or, did several centuries of agriculture deplete soil fertility? Smallpox had not yet crossed the ocean. Was it America's first energy crisis — not enough firewood for heating and cooking? They had no metal axes, wheeled carts, or beasts of burden.

They must have had hostile neighbors. Sally Chappel noted that the wooden palisade or stockade surrounding the city was 2 miles (3.2 km) long, with guard towers every 70 feet (21 m), indicating a defensive purpose. It was rebuilt four times over the years. Crowding, hierarchy, and agriculture have a long tradition of generating social turbulence, general craziness, and environmental blitzkriegs. Our minds originally evolved for living in small, leaderless, nomadic groups in lightly populated wild ecosystems.

Cahokia left behind about 80 earthen mounds, some of enormous size. Hodges noted, "Making the story even more interesting was the clear evidence of ritual human sacrifice. Archaeologists excavating Mound 72, as they labeled it, found the remains of 53 women and one very high-status man, as well as the decapitated remains of four men who may have been on the wrong side of some sort of authority."

The women were laid out in neat rows, in layers separated by mats. They were sacrificially killed in a way that left no marks on their bones, possibly strangled or poisoned. They were young women of reproductive age (around 21). The mineral content of their teeth indicated that they were from somewhere else, not residents of Cahokia.

Aztec Erosion

M. Lourdes González-Arqueros and team studied soil erosion in the Teotihuacán Valley, northeast of Mexico City. Mexico's soils have taken a beating over the centuries, and the blame is commonly directed at the settlers from the Old World who arrived in the 1500s. They imported many destructive practices, pathogens, and hooved locusts (goats and sheep). Research done by the study concluded that the indigenous people were already damaging soil before the white folks arrived. The team analyzed erosion patterns during three different periods of time:

(1) In the Teotihuacán period (A.D. 1-650), forests still grew on summits, hill slopes, and foot slopes. This restricted some soil erosion. Organic corn was grown by no-tillage methods (picks and spades) on the lower ground.

(2) In the Aztec period (1325-1521), forest area in the valley was drastically reduced as population increased, and agriculture expanded up the hillsides. Much of the landscape was devoted to agriculture. When sloped land is deforested, increased erosion is an expected consequence. In this period, rates of soil loss were much higher, compared to rates in both the earlier Teotihuacán period, and the later modern period.

(3) In the modern period (after 1970), forest area has recovered a bit. A large portion of cropland is now planted with prickly pear, a perennial plant that is fast growing, rapidly rooting, and usually has deep roots. Soil destruction was lower than during the Aztec period, but the study did not give modern practices the Sustainable Agriculture™ seal of approval. Too many people continue living too hard, and soil keeps running away.

The team concluded that land use and soil management were prime factors in the erosion, more so than precipitation and topography. Before Spaniards arrived, the land was gradually being degraded. Then, the colonists launched a full-scale war on forests. Their flocks of imported sheep and goats prevented forest recovery, and their overgrazing accelerated erosion.

## Mixtec Erosion

The Mixtec culture of southern Mexico is ancient. Their homeland is mostly located in the state of Oaxaca which, long ago, was one of the most advanced regions in the Americas. The Mixtec people managed to avoid being absorbed by the Aztec empire, and their writings are much older than those of the Aztecs or Incas. Some believe that the Mixtecs were the ones who originally conjured domesticated corn out of wild teosinte.

In the good old days, prior to agriculture, their homeland was largely forest. Today, portions of the treeless highlands have become a desert that not even thorns can grow in. Oaxaca is Mexico's second poorest state, and a third of its people have moved

away. Photographer Matt Black happened to meet some Mixtecs in California, where they were struggling to survive by doing backbreaking farm labor for $40 a day. They chose this path because their homeland had become a disaster area. Many of them are illiterate, and most speak only their native language, Mixteco.

In 2011, Black got curious about them and decided to visit their homeland, Mixtecapan (the place of the Cloud People), one of the world's oldest farming cultures. Wow! Some places have lost up to 16 feet (5 m) of topsoil. A number of villages are half-deserted, and some of their fields have eroded to bare bedrock. More than a million acres are so severely damaged that the U.N. now calls the region one of the most heavily eroded landscapes in the world.

Most stunning of all, Black described the disintegrating village of Santiago Mitlatongo. One day, a cliff above town fell apart, dumping stones as large as houses on the village below. Whole cornfields disappeared into sinkholes. Homes sank into the ground and vanished. Eventually, the whole village broke away from the surrounding land, like a calving iceberg — homes, fields, churches, stores — an area of about two square miles (5 $km^2$) was in motion. Writing in 2012, Black noted that it was still sliding, a few feet per day, a half mile (804 m) away from its original location.

Corn Blight

H. Arnold Bruns wrote about a serious corn blight that hit the U.S. in 1970-71. The southern corn leaf blight (SCLB) destroyed 15 percent of the corn crop. It was enabled by innovative plant breeding that focused on maximizing yield ($$) by creating highly productive hybrid seeds that had very little genetic diversity. These hybrids reliably generated big money for farmers, who eagerly bought the magic seeds.

On the downside, when certain conditions existed, up to 85 percent of the corn in a field was highly vulnerable to SCLB fungus. The winter and spring of 1970 was wetter than usual, providing ideal conditions for disaster. Some farmers lost 80 to 100 percent of their crop. In the Corn Belt, some clusters of counties had average losses of 35 to 50 percent. Across all of the state of Mississippi, losses were 30 to 40 percent. This inspired big fear. Would the entire U.S. crop be lost? What would we use to feed livestock and poultry? No more whiskey? Gulp!

Before 1930, almost all corn was allowed to pollinate naturally, which resulted in significant genetic diversity that reduced the possibility of catastrophic blights. Then came the hybrids which, in theory, were more vulnerable to crop failure, but they almost always provided far higher yields and profits. Today, in the major corn growing nations, 97 percent of the corn planted is hybrids. The amount of food energy lost because of the SCLB blight was greater than the food lost due to the potato blight of Ireland in the 1840s. The message of both blights is that there is great danger in growing monocultures of extremely uniform crop plants.

Today, Brun worries that the new GMO fad is busy creating ideal conditions for bigger and better disasters — billions of herbicide resistant seeds having dangerous genetic uniformity. What could possibly go wrong? Right now, the banana wilt fungus is working hard to drive a stake into the heart of the banana industry. The entire crop is genetically identical clones.

**Potato**

Two super foods were domesticated in the New World, potatoes and corn. It's possible to grow both without draft animals and plows. Both plants produce more calories per acre than any Old World crop plant, except for rice, an Asian super food. Super foods possess especially powerful juju for enabling the growth of dense unsustainable populations.

Potatoes (affectionately nicknamed "spuds") can be grown in a wide variety of soils and climates, at elevations ranging from sea level up to

14,000 feet (4,267 m). Spuds originated in the Andes region of western South America. They are now grown in at least 149 countries. There are still many varieties of wild potatoes in the Andes, and they come in every size, shape, and color. The tubers of some varieties contain bitter toxins, which encourage hungry critters to eat other stuff. Spuds are smarter than they look.

It's unclear when they were first domesticated, but it was certainly prior to 2000 B.C. There are maybe 400 types of domesticated spuds. Prudent farmers might plant 50 to 60 varieties in their fields, because something that kills one is less likely to kill all. Spuds are awesome. The plants mature rapidly, in just 90 to 120 days. Per day, they produce more food energy per acre than any other crop plant. An acre of potatoes produces up to four times more calories than an acre of grain.

John Reader noted that potatoes are an especially nutritious plant food. Compared to cereal grains, spuds provide a better mix of carbs, protein, vitamins, and minerals. The carbs are primarily starch, which is a healthier source of calories than fats or sugars. Spuds are a good source of B vitamins, and deliver lots of vitamin C. Grains have more protein, but spuds provide protein of higher quality, including essential amino acids in a readymade form.

Reader says that, of all foods, potatoes provide the "best all-round package of nutrition." In Ireland 200 years ago, adult males consumed an average of 10 pounds (4.5 kg) per day. Combined with a glass of milk at every meal, they would get 4,000 calories per day, and receive all the required nutrients. During times of hard labor, lads would sometimes eat up to 20 pounds per day. While Irish peasants were often dirt poor, dressed in rags, and living in mud huts, they had a healthier diet than most Europeans. Unfortunately, being well nourished spurred population growth, which soared almost 500 percent in 154 years (1687 to 1841). Danger!

## Inca Empire

Spuds are associated with the Inca (Inka) civilization, whose capital was Cuzco (Cusco), Peru. The founders were the Quechua people, who were hunter-gatherers long before they became farmers. Hunter-gatherer cultures were living in Andes by 12,000 years ago, and they were the ones who eventually domesticated potatoes.

The Inca Empire was sort of a flash in the pan, existing from about 1438 to 1533. It was snuffed out by Spaniards, and their diseases (smallpox, influenza, typhus, measles). Preceding the Incas, there were a number of civilizations that rose and fell in the Andes region over the span of several thousand years. The Inca Empire had a population of maybe 6 to 14 million, overseen by an elite class of 15 to 40 thousand. The elites were not universally loved, and many folks celebrated the arrival of the tyrannical Spanish, which they saw as a great liberation from unbearable oppression.

The Inca Empire was 2,200 miles long (3,540 km), and 190 miles (306 km) wide. Prior to the arrival of Europeans and their slaves, the Incas were the largest empire that ever existed in North and South America. It was home to 40 percent of the combined population of both continents. The range of the empire was essentially limited to habitat that was suitable for llamas and alpacas, extremely important animals that provided meat, manure, hides, and fiber. The Incas had no wheels, no writing, no iron or steel, no riding animals, and no draft animals to pull carts or plows — but llamas were used to haul loads of stuff.

The Incas grew food on terraced plots, and used irrigation systems. They built stone cities and temples, cut tunnels through mountains, crossed rivers with rope suspension bridges hung from stone towers. They built causeways across wetlands, and cut pathways along the sides of steep slopes. They had about 14,300 miles (23,000 km) of well-maintained roads, long enough to encircle the globe. Teams of relay runners could carry messages 1,491 miles (2400 km) in five days. Great roads also accelerated the spread of diseases, Spaniards, and missionaries.

The original staple food for folks in the high Andes was potatoes, which were often grown in rotation with quinoa and kañihua (cañihua) — two plants that produce high protein cereal-like seeds, but neither are technically cereals, because they aren't card-carrying members of the grass family. The seeds of both can germinate at or near freezing temperature.

Plots of cropland were periodically fallowed, and herds of llamas and alpacas were moved in to drop steaming gifts of precious fertilizer all over the place. In season, folks dined on fresh spuds. Surplus spuds were freeze dried into chuño, a nutritious commodity that the tax collectors came to collect. Chuño could be stored for years. Archaeologists at one site found chuño created 2,200 years ago.

Chuño can be made at elevations above 13,000 feet (4,000 m) during the long dry season, when there are freezing temperatures at night, and bright sunlight in the daytime hours. Chuño country is not far from the equator, but high elevations create an unusual combination of "tropical noon and arctic midnight," which is perfect for freeze drying.

The process for making chuño could take two months. It involved freezing, soaking in cold water, freezing again, rubbing, squeezing, and drying in direct sunlight. The complicated process removed the water, skins, and toxins. The end product was light, firm, highly nutritious, and chalk-white. Incas also freeze dried the flesh of birds, fish, alpacas, and llamas. The word "jerky" came to us from the Andes.

Civilizations cannot exist for long if they don't have effective systems for storing substantial quantities of food (usually grain) to keep folks fed during lean seasons, lean years, and wartime. In the Old World, the emergence of agriculture and pottery-making were closely associated. When dried grain was stored in sealed ceramic containers, it was not lost to rats and mice.

Incas stored chuño, jerky, and corn in thousands of frosty underground warehouses scattered throughout their empire. Stored food provided abundant fuel for the rapid expansion of their empire — road building, urban construction, military adventures, and so on. It also provided a social safety net. Some say that Incas never starved. Fifteen years after defeating the Incas, one Spaniard commented that food stored near Xauxa enabled him to feed 2,000 troops for seven weeks.

At some point prior to the Inca era, corn from Mesoamerica arrived in the Andes. Corn produced high yields, was suitable for long term storage, did not require labor-intense freeze drying, and was easy to transport (but nutritionally inferior to spuds). Corn cannot be grown at elevations above

8,200 feet (2,500 m). Where it could be grown, folks grew corn instead of spuds. Inca leaders actively encouraged the intensified production of corn, and John Reader called this decision a "masterstroke." Folks had to build new terraces and irrigation systems to grow more corn. Potatoes remained the most important crop, but the decision to deliberately maximize the output of super foods lit the fuse for the explosive growth of the Inca Empire.

So, once the Inca leaders were defeated and out of the way, the Spaniards took over the role of cruel, greedy, demonic oppressors. They snatched all the awesome gold and silver treasures in Cuzco, melted them down, and shipped eleven tons of it back home. Then, they learned about the Potosí silver mine, assembled lots of forced labor, and created a boom town. In the year 1592, Potosí produced more than 400 tons of refined silver. By and by, back in Spain, this tsunami of wealth blindsided an already wobbly economy with soaring price inflation. It also funded the creation of the Spanish Empire. The royalty, giddy with enormous wealth, decided this was a good time to go on the warpath.

In addition to gold and silver, lots of other stuff was sent back to the Old World, including turkeys, guinea pigs, cocoa, and tobacco. A planet-rocking time bomb was also shipped back home — two super foods: spuds and corn.

## Super Foods Supercharge Europe

Clive Ponting noted that until about 1800, most of the world's great cities were outside of Europe. In the year A.D. 600, Rome was home to 50,000, while 100,000 lived in Teotihuacán in Mexico. By 1000, Europe was home to 100 towns and cities, half of which were in Italy. In 1086, London had a population of just 10,000. The staple foods in Europe were cereal grains, which produced far fewer calories per acre than spuds, were far less nutritious, and far more laborious to plant. Corn and spuds could be planted with simple hand tools and human muscle power. Wheat, rye, barley, and oats grew best in soil that was pulverized by harnessing a plow to oxen or horses — a far more resource-intensive process.

Spuds arrived in Spain by 1570, and gradually migrated across the continent, arriving in Scandinavia 100 years later. The adaptation of corn also spread slowly. Dirt poor subsistence farmers, who constantly felt the cold breath of starvation on their backs, were exceedingly conservative. They were never eager to impulsively throw all caution to the wind, and bet their survival on weird exotic crops from outer space.

Alfred Crosby noted that skeptical farmers eventually became convinced that the exotics were better in many ways than the crops they traditionally grew. Over time, corn became a staple in southern Europe. Potatoes were widely adopted in northern Europe, where they produced far more nutrients per acre than traditional grain crops. It took 5 acres (2 ha) of grain to feed a family of five, but just 1.5 acres of potatoes. Farmers could raise potatoes on marginal soils, using only a spade. Unlike grains, spuds needed no grinding or milling. Like grains, potatoes were also vulnerable to molds, fungus, and weather that was too wet or cool. Western Europe was best suited for growing healthy forests and wildlife, rather than spuds, cereals, livestock, and tropical primates.

Grain could be stored for years, but not spuds. Europe's climate was unsuitable for making freeze dried chuño. Western Europe had mild winters during which the ground rarely froze. Spuds could be left buried in the field for several months, unharmed by light frost, until springtime warmth returned.

Spuds provided some extra security for farm families. When

grain is ripe, it has to be harvested and stored. William McNeill noted that full granaries were treasure chests of essential nutrients, which made them primary targets for annoying visitors, like tax and rent collectors. Collectors grabbed the grain, but left the spuds alone, because they were too much work to dig up, and they couldn't be stored indefinitely. Landlords and nobles wanted grain.

Passing troops were even more despised than the collectors. In the old days, armies did not haul around caravans of food supplies. Instead, they stopped at farms, confiscated their stored grain, and left the peasants to starve. This was a common practice, and more than a little discourteous. In wartime, while soldiers were dying on the battlefield, peasants were dying in their huts, which seriously disrupted the stability of food producing rural communities. How smart was that?

John Reader noted that during the War of Austrian Succession (1740-48), Fredrick the Great was astonished to discover that far more spud growing peasants survived, compared to those who grew grain, lost it, and starved. Passing troops didn’t have the time or desire to dig up fields of potatoes. It was much faster and easier to empty granaries and march on. Fredrick realized that if folks planted more spuds, wartime would be less devastating to society. It was wise to be nice to peasants. So, he distributed free seed potatoes throughout his kingdom.

McNeill noted that others soon joined the parade. Leaders in Austria, Russia, and France recognized the strategic advantages of joining the spud cult. Over time, the resistance of conservative peasants melted away. More and more came to the conclusion that they preferred boiled potatoes to death by starvation.

This inspired a wave of innovation in agricultural practices. Traditional processes were fine-tuned for maximizing grain output. New and improved processes were needed to accelerate spud production, and clever folks came up with some bright ideas. In the traditional system, every year either a third or half of the cropland was left fallow, to restore soil fertility. In the new system, fallow land became potato fields. Amazingly, the amount of grain harvested was not diminished, and spud harvests provided a mother lode of bonus calories.

Before long, bonus bambinos were squirting out of wombs, at just the right time. See, turning fallow land into potato fields required additional labor, because happy weeds now had to be mercilessly killed, in late spring and early summer, by workers with hoes and spades. By utilizing this extra labor, farmers could now produce two to four times more calories per acre, and feed even more bambinos.

McNeill’s big idea was that potatoes radically changed world history during the era spanning from 1750 to 1950. Spuds had become popular in Ireland and the Scottish Highlands, but were especially important on the vast European plain, which spanned from northern France, Germany, Poland, and eastward into Russia.

While spuds required more farm labor, skyrocketing population growth provided more workers than needed in the fields. Surplus people provided a labor force for the Industrial Revolution, which developed rapidly in northern Europe. Low wages and miserable working conditions were more desirable than starvation. The transition to fossil energy turbocharged the boom years. The era of 1750 to 1950 was also a time when Europe established colonies and built empires. McNeill noted that the entire world was rapidly and radically transformed. Then, around 1947, European empires began disintegrating, and a new era began.

He wrote that without potatoes, Germany would have never grown into a leading military and industrial power in Europe after 1848. Russia would not have become a major threat to Germany after 1891. Millions of Europeans would not have migrated to America and other regions. And so, the humble dirty spud triggered an avalanche of craziness that shook societies all around the world.

Alfred Crosby wrote that, aided by potatoes and corn, both Europe and America were able to harvest far more food. People were better nourished, so child mortality dropped. The population of Europe leaped from 80 million in 1492, to 180 million in 1800, 390 million in 1900, and 556 million in 2019. Europe was bursting with people, and many migrated to colonies — Australia, New Zealand, southern Brazil, Uruguay, Argentina, Canada, and the U.S. Bottom line, world population leaped from 450 million in 1500 to more than eight billion today. Crosby concluded, "Calories can make as much history as cannons — more in the long run."

## Potato Blight

John Reader wrote that spuds first arrived in Ireland between 1586 and 1603. At that time, its population was somewhere between 1 and 1.5 million. By 1845, when the blight began, it had soared to 8.5 million, and about 90 percent of them depended almost entirely on potatoes for their survival. Well-nourished peasants had higher birth rates, and stronger resistance to disease. But when blight nuked the spuds, a million peasants, weakened by hunger and disease, were carried away by the Grim Reaper.

Because Ireland had a wetter climate, it was not an ideal place to grow cereals. Spuds could often tolerate dampness that would rot oats. So, potatoes were less risky, produced lots of calories, and didn't require a draft animal and a plow. Ireland was the first nation in northern Europe to largely switch from cereal crops to spuds.

Before long, the exotic tubers were popular everywhere, from the palace to the pigsty. Brian Fagan noted that the population explosion had been fueled by several varieties of outstanding gourmet spuds, like the Black, Apple, and Cups. But the production of these types could not keep up with the growing numbers of hungry spud addicts. Feeding large families on small plots of land inspired a determined search for varieties of spuds that were even more productive.

By 1835, the Lumper, or horse potato, won the competition and became the dominant spud on the Emerald Isle. It came from England, where it had been developed for use as livestock fodder. The remarkably unexciting Lumper was coarse and watery, less nutritious, and more vulnerable to disease, but it provided indispensable life support for dirt poor peasants who had way too many kids. On the plus side, Reader said that the Lumper was 20 to 30 percent more productive than the fancy upper class spuds it replaced. On the downside, every single Lumper in every single field was an exact genetic clone. What could possibly go wrong?

The Irish famine of 1845-48 was, in some ways, a familiar sort of tragedy. Crop failures, famines, and epidemics occurred from time to time. For example, Clive Ponting wrote that between the tenth and eighteenth centuries, France had 89 famines that were widespread national disasters, of which 26 of them hit in just the eleventh century. England suffered numerous local famines in the sixteenth and seventeenth centuries. Famine rocked all of Europe from 1594 to 1597. Famine struck Belgium and Finland in 1867 and 1868. Rinderpest zoomed into Europe from Russia, and killed 1.5 million cattle from 1709 to 1714. Long before the late blight fungus arrived in 1845, crop failures had killed 400,000 Irish people in 1740 and 1741.

John Reader mentioned a theory that the late blight fungus originally emerged in the highlands of central Mexico. By and by, it migrated to South America. From there, in about 1841 or 1842, it hitched a ride with a shipment of potatoes to the United States. In 1843 the first outbreak of blight appeared in New York and Pennsylvania, and then spread along the east coast. Two years later, in 1845, it had spread west to the Mississippi, and north into Canada.

Meanwhile, in 1843, farmers in Flanders and Belgium were suffering losses from viral diseases and dry rot. To cure the problem, they ordered what they thought were healthy seed potatoes from the U.S. (where the blight was raging). Oh-oh! In the winter of 1843-44, the late blight fungus crossed the Atlantic in a load of spuds. Transatlantic trade in potatoes was made possible by new and amazing high-speed steam ships, and by the use of ice to prevent spoilage. Previously, sailing ships were too slow to deliver a load of spuds in good condition.

Spuds evolved in the Andes, where they adapted very well to a unique high elevation ecosystem, and enjoyed happy and fulfilling lives. Richard Manning noted that when spuds are planted in regions outside their Andes homeland, they can be far more vulnerable to insects, fungi, and viruses. Apparently, the late blight fungus is widely dispersed, and usually dormant. Its wakeup alarm goes off when the weather gets too damp or chilly. Writing in 2000, Manning noted that in upstate New York, a 100-pound sack of ordinary spuds could be bought for $6, but organic spuds would cost $30. The difference is because no other food crop is blasted with so many pesticides, in order to zap insects and fungi.

In Brazil, some regions get sprayed 30 times during the growing season. Also, unlike cereal grains, potato seeds are living tissue that can transfer disease from this year's crop to next year's. So, seeds also get blasted. (Potato seeds are chunks of tubers grown last year. Each chunk must have an "eye" on its skin, a potential embryo for a new plant.)

Sorry! Back to the blight. The summer of 1845 was a cool and wet one. Blight struck Ireland, and parts of Belgium, France, and the Netherlands. Then it spread to Demark, Wales, Scotland, northern Italy, and southern Norway and Sweden. Four months later, 772,204 square miles (2 million km $^2$) of fields were ruined. It was a memorable and heartbreaking experience.

Cecil Woodham-Smith wrote about the Irish famine. The 1841 census revealed that Ireland was probably the most densely populated region in Europe, thanks to spuds. The census noted that half of the people resided in rather unpretentious affordable housing units — small, windowless, single room, mud cabins. In 1845, the fields were looking fine and healthy — until three weeks of wet and cool weather spoiled the party. The crop failure was partial. Fields of cereal crops were not harmed.

In 1846, the blight was severe, and the harvest of both spuds and grain was a poor one. They weren't going to have enough seed potatoes to plant all the fields in the spring of 1847. Across much of Europe, the 1846 harvest was a total or partial failure. Black fields stretched for hundreds of miles, and the stench of rot was overwhelming. By September, not even folks with money could acquire food. They ate cabbage leaves and blackberries.

Across Europe, the winter of 1846-47 was extremely long and severe. The Thames was jammed with floating ice. By January, the Irish folks in county Mayo looked like skeletons. The sheep, cattle, poultry, and dogs were gone. The one remaining pig would not be long for this world. The blight in 1847 was light, but the planted acreage was just 20 percent of normal, for lack of seeds.

In 1848, all the land got planted, and the people were giddy with hope that their troubles were over. Things looked awesome, until the middle of June, when the wet weather would not stop. The blight was severe. In July, some fields would turn black overnight, and millions of ripe spuds rotted in the ground. Even spuds stored away before the blight rotted. Cereal crops were also damaged by heavy rains. There was little to harvest.

In the end maybe a million emigrated, and a million died. Woodham-Smith noted that mortality records were incomplete. She estimated that for every person who died of starvation, ten died from disease. The most popular pathogens were two types of "famine fever" — typhus and relapsing fever, both were spread by lice, and both were quite unpleasant. A bit less popular was dysentery, which was caused by contact with fecal borne pathogens.

Farmers rarely if ever have a plan B when their crops fail, or their granary is swiped. Their overseers may or may not come to their rescue. The Irish didn't get much help. Earlier, we looked at the San people of Botswana who easily survived a three-year drought. They utilized a wide variety of indigenous wild foods, and they were not chained to a specific piece of land. This increased their odds for survival, and provided a healthier, more enjoyable life.

# Disease

## Parasites and Hosts

In 1976, William McNeill wrote a fascinating history of disease. In the family of life, *parasites* are the eaters, and *hosts* provide their nourishment. You and I are host to billions of tiny *microparasites* that live within our bodies from infancy to finish line. Many are the good guys that promote our survival by assisting digestion processes. There are also large bodied *macroparasites*, like lions, tigers, sharks, and humans. They aggressively kill their hosts and eat them.

Not all microparasites are our buddies. Some can trigger infections that result in mild illness. Some can kill you. Some are blocked by a robust counterattack from your immune system. Hosts can serve as carriers of pathogenic parasites (bubonic plague, tuberculosis, cholera, etc.), helping them hitch free rides to uninfected new hosts, and promoting epidemics. Carriers sometimes don't display symptoms, or feel noticeably sick.

Before agriculture, we didn't suffer from devastating population explosions, because our access to nutrients was far more limited. Over time, as crowding intensified, disease-causing microparasites became more popular. They weeded out the weak, elderly, and unlucky.

McNeill concluded that civilization could be seen as a macroparasite that is ravaging the family of life — like "an acute epidemic disease." Mobs of loggers, farmers, herders, miners, industrialists, city builders, and consumers create a devastating super-parasite, a multi-headed, all-devouring monster.

Hominins evolved in Mother Africa. Numerous types of parasites are found in warm and comfortable tropical ecosystems, and many of them love primates. The high biodiversity of tropical rainforests enabled a huge variety of parasites to enjoy a huge variety of hosts. McNeill noted that monkeys and tree-dwelling apes are hosts to 15 to 20 species of malaria (humans just 4). Wild primates are also hosts for legions of mites, fleas, ticks, flies, worms, protozoa, fungi, bacteria, and more than 150 insect-borne viruses. He suspected that this daunting parasite heaven was probably a significant reason why civilization emerged more slowly in Africa.

### Snow Country

Under the guidance of Big Mama Nature, genetic evolution slowly and carefully fine-tuned us for survival in tropical regions. Our ancestors got sun protection from their beautiful brown skin and curly hair, and increased heat tolerance from their sleek furless exterior, combined with a high-performance collection of juicy sweat glands.

According to McNeill, some major turning points in the human saga included our transition from tree dwellers to ground dwellers, the domestication of fire, and the colonization of snow country. While warm moist tropical rainforests were ideal habitat for a staggering number of species, snow country was less complex. Organisms that could not tolerate freezing temperatures were absent from the playground. Temperate ecosystems were home to fewer disease-causing parasites, none of which specialized in infecting primates.

Snow country was also home to vast numbers of large game animals that had never seen humans before, and had no instinctive fear of them. The pioneers became skillful parasites, killing and devouring delicious hosts. Large game was gradually depleted by hunting, over the course of many generations. Eventually, folks collided with inconvenient ecological limits. Options included labor-intense food production (agriculture) or mindful self-restraint (family planning).

### Herd Diseases

As mentioned earlier, the temperate grasslands of Eurasia were home to lots of wild sheep, goats, cattle, and horses — herd animals that were suitable for domestication. They eventually became vital assets for growing empires and civilizations. Over time, herds of enslaved livestock accumulated where green grass was abundant.

McNeill noted that humans caught some diseases via wild animals — bubonic plague (rodents), rabies (bats), yellow fever (monkeys), and so on.

But most of the classic infectious diseases of civilization were acquired from close contact with herd animals, primarily domesticated critters. Over time, some of these pathogens became capable of direct person-to-person transmission. These included tuberculosis, measles, smallpox, chicken pox, whooping cough, mumps, and influenza. By and by, human health in the Old World took a sharp turn for the worse following the domestication of herd animals. In the Bible, "plague" appears 128 times, and "pestilence" 50 times.

James Scott noted that humans share a large number of illnesses with farmyard animals, including poultry (26), rats and mice (32), horses (35), pigs (42), sheep and goats (46), cattle (50), and dogs (65). When different species live crowded together in close proximity to a herd of humans, trouble is sure to follow.

This was not the case in Australia, where zero plants or animals

were domesticated. Bill Gammage wrote about the Aborigines. Over the course of many thousands of years, they developed time-proven strategies for living well in a challenging land. They built no cities, but some groups inhabited simple villages during the months when local food resources were seasonally abundant. Consequently, no serious diseases were native to Australia.

The story was similar in the New World, where only two species of herd animals were domesticated, alpacas and llamas. They did not live in enormous herds in any of the vast American grasslands. Their range was limited to remote regions of the Andes Mountains in western South America. Neither has been associated with the emergence of any epidemic disease.

Why were only two large herbivores domesticated in the New World? McNeill pointed out that around 13,000 years ago, the megafauna species in the Americas were sharply thinned by extinction spasms. Some of the large herbivore species that vanished may have been suitable for domestication, but they blinked out. Modern science has not yet figured out how to domesticate extinct animals.

On the plus side, no powerful epidemic diseases were native to the Americas. On the downside, Native Americans had zero immunity to the nasty microparasites that crossed the Atlantic in the 1500s, and eventually killed maybe 90 percent of them. The spectacularly deadly Old World disease pool crashed head-on into maybe 100 million helpless sitting ducks.

Disease pool? Long ago in the Old World, different diseases emerged in different regions, as local parasites learned how to exploit local hosts. In the beginning, these local diseases remained in limited territories. Over time, expanding trade networks and civilizations linked together more and more communities and regions. So, homegrown diseases had more opportunities to hit the road, and see the world. At the same time, it became easier for exotic diseases from elsewhere to visit your neighborhood, and spur a surge in coffin sales.

Communities along the entire coastline of the Mediterranean Sea were extensively interconnected by regular commerce. Because of these trade webs, the population of the Mediterranean Basin shared the same mob of diseases. McNeill called the parasites of this region a *disease pool*. India's disease pool hosted a different assortment of parasites. China's pool had yet another collection.

He jabbered at great length about how the different Old World disease pools expanded and blended together over the centuries. By 1500, Eurasia was essentially home to one unified disease pool, a powerful hurricane of pathogens. The Old World disease pool then sailed across the Atlantic and absorbed the New World into its pool.

In *Ecological Imperialism*, Alfred Crosby described the diseases present in the Americas prior to colonization. They included "pinta, yaws, venereal syphilis, hepatitis, encephalitis, polio, some varieties of tuberculosis, and intestinal parasites" (syphilis and tuberculosis are controversial). McNeill noted that native stories about precolonial times did not mention epidemics. Aztec history described just three disasters (in maybe 780, 1320, and 1454) that caused many deaths, but they seem to have been the result of crop failure or famine. In the early days of colonization, elderly natives told Spaniards that they had no memory of disease prior to conquest.

Obviously, European diseases overwhelmed the Native Americans. When whites colonized the Americas, the natives had no immunity to their diseases, and they were massively swept away. When whites tried to colonize Africa, many Africans were swept away, but they were not alone. Mother Africa punched back hard, using her deadly arsenal of tropical diseases, which white folks had

little immunity to. Michael Williams said that she pounded white folks with dysentery, yellow fever, typhoid, and especially malaria.

The mortality rate for white folks in Africa was ten times higher than the rate for those who remained back home in Europe. Africa was "the white man's grave." But the whites brought firearms, and before long began carrying away everything of value they could get their hands on (gold, diamonds, ivory, slaves, etc.).

**Epidemic vs. Endemic Diseases**

Alfred Crosby noted that when Siberian hunters first discovered America, they entered a region that was home to zero humans, and none of our close relatives (chimps, gorillas, etc.). So, there was no existing pool of pathogens ready to welcome them, infect them, and compost them. Nathan Wolfe added another point. Humans and Old World monkeys are more closely related genetically, because their ancestors have been hanging out together for 5 million years. New World monkeys are far less closely related to us, because we didn't meet each other until about 15,000 years ago.

Also, when America was discovered about 15,000 years ago, there were no domesticated animals on planet Earth, except for dogs. Because of this, James Scott believes that epidemic diseases probably didn't exist anywhere in the world at that time. Most diseases probably emerged in the last five to ten thousand years, as an unintended consequence of domestication, civilization, urbanization, etc.

*Epidemic* refers to diseases like smallpox, which hopped off a ship in North America, rapidly infected a population that had no immunity to it, and killed millions. It was an unfamiliar pathogen that infected a defenseless population for the first time. Likewise, when measles arrived in America, it also exploded with deadly epidemic force.

Back in Europe, over time, measles had softened into a less ferocious *endemic* disease, because it remained in the population as a chronic infection for many years. What we call "childhood diseases" are endemic — measles, mumps, whooping cough, etc. Endemic diseases can survive in cities and nearby locations, but not in small nomadic groups of wild people. The host population must be large enough to preserve the pathogen, allowing it to pass from one generation to the next.

Prior to modern mobility, endemic measles required a population of 250,000 to 500,000 to survive in a community. The shift to agriculture enabled the existence of dense populations. Before agriculture, endemic measles could not exist anywhere. Today, when millions of folks travel everywhere all the time, it's far easier to get infected by an enormous variety of pathogens that are eager to meet you.

**Crowd vs. Tropical Diseases**

Nathan Wolfe and team analyzed the origin of 25 major infectious diseases that sicken humans. They sorted them into two categories: 10 tropical diseases, and 15 they called temperate. "Temperate" is not a precise description, because temperate diseases are also free to infect folks in the tropics. Infectious diseases are complicated rascals that don't neatly fit into tidy categories. Wolfe summed it up like this: "The sources of tropical diseases tend to be wild primates. The sources of temperate diseases tend to be domestic animals."

Jared Diamond wrote, "In practice, because 13 of our 14 large domestic mammals were Eurasian species, evolution of crowd diseases was concentrated in Eurasia, and these diseases became the most important agents by which Eurasian colonists expanding overseas killed indigenous peoples of the Americas, Australia, Pacific islands, and southern Africa."

Measles likely originated in cattle, but cattle no longer function as a reservoir for the measles virus. So, cowgirls don't catch measles from cows. The virus is now preserved entirely in the human herd, so healthy cowgirls catch measles from infected humans. This direct person-to-person transmission is a common characteristic of the diseases of civilization — crowd diseases. Crowd diseases include diphtheria, influenza, measles, mumps, pertussis, plague, smallpox, typhoid, and typhus. Two crowd diseases also have animal reservoirs, plague (rodents) and influenza (wild birds).

Tropical diseases include Chagas' disease, dengue fever, yellow fever, sleeping sickness, and malaria. These are transmitted by insects. None of them require a significant population of hosts. Even small bands of nomadic hunter-gatherers are vulnerable to them. All of them originated in the Old World, except for Chagas' disease, a New World parasite.

Tropical diseases originated in the tropics, but some were able to migrate into temperate regions. Geoffrey Marks noted that yellow fever arrived in New York by 1686, and it had a good time. It returned in 1702, 1743, 1745, and 1748. During Philadelphia's yellow fever epidemic of 1793, terrified citizens either fled town, or stayed off the streets and shut themselves indoors. They obsessively cleaned their dwellings. When they went outdoors, they held handkerchiefs or sponges soaked with vinegar or camphor near their noses. Burials had no ceremonies; no friends or relatives appeared. People quit shaking hands, and were affronted when a hand was offered. Four thousand died between August and October. **Dirty Diseases**

Like animal domestication, plant domestication also had a devastating impact on human health. Our species evolved for a life of foraging and scavenging in a warm climate, while living in small, widely scattered, nomadic bands. Much later, when some folks got addicted to agriculture, they multiplied in number, established permanent villages and towns, and adapted a sedentary lifestyle. They lived in greater concentrations, and became something like herd animals — highly attractive to parasites.

Steven Johnson wrote about the London cholera epidemic of 1854. At the time, London was the biggest city in the world, and it was suffering from a population explosion. One question tormented the minds of urban bureaucrats: "What the are we going to do with all this shit?" Londoners got their water from shallow wells in their neighborhoods. Sewage and other wastes were stored in cesspools. When your cesspool was full, the night soil men hauled the dreck out to farms, where it was applied to fields.

As the city expanded, the distance to farms increased, as did the cost of removal. So, more and more stinky muck remained in town. Dung heaps grew to the size of large houses. The entire city had a powerfully intoxicating aroma. Parliament had to shut down during a heat wave 1858, when the flowing sewer known as the Thames River emitted the Great Stink.

The center stage of Johnson's book was a well pump at 40 Broad Street, in the Soho district. Near the end of August 1854, the six-month-old daughter of the Lewis family got sick and died. Her soiled diapers went into the cesspool, and caused the biggest cholera outbreak in London history. The cesspool was only accessible to the Lewis family. Other tenants in the building "tossed their waste out the windows into the squalid courtyard at the back of the house." The cesspool was in the cellar, and a brick-lined community well was just 32 inches (81 cm) away. Oh-oh!

All the experts, except one, agreed that the cause of cholera was miasma — stinky air. Since miasma was certainly the cause of the problem, the solution was to move the stink elsewhere. So, in the name of public health, they built sewer systems, and directed the smelly crud into river. Before long, "the Thames had been transformed from a fishing ground teeming with salmon to one of the most polluted waterways in the world." Meanwhile, the epidemics raged.

In this era, private water companies were also growing, in response to the trendy flush toilet fad (flushes filled cesspools even faster). There was no unified city plan. So, it was not uncommon for water company intake pipes to be just a bit downstream from sewer system discharge pipes. Guess what happened.

Another dirty disease was typhus. Hans Zinsser was a scientist who identified the typhus parasite, and then wrote about its history. Typhus has been a very popular disease for centuries — not among small groups of wild nomads, but among civilized people who live in dense concentrations. The bacteria are transferred to humans via lice, and it favors folks whose personal hygiene habits were minimal to none. In the good old days, taking a bath once in a while was not at all trendy. Few if any baths were taken after October.

He wrote that prior to 1890, "Cities and villages stank to heaven. The streets were the receptacles of refuse, human and otherwise. The triangular intervals which one sees between adjacent medieval houses in streets still inhabited are apertures through which waste, pots de chamber, and so forth, could be conveniently disposed of from upper stories…."

Typhus was really fond of soldiers, sailors, and prisoners. At the conclusion of the First World War the victor was clear, "Typhus won the war." Epidemics in Russia killed 2.5 to 3 million people between 1917 and 1921. John Gunther wrote that in the Congo, all Urundi women shaved their heads to avoid typhus (lice).

**Meet Our Diseases**

On the following pages, I'll be jabbering a bit about different categories of diseases, and take a quick peek at some common examples. Please remember that a primary purpose of this book is to compare and contrast wild humans with the less-than-wild mobs that emerged later — from the perspective that wild was our normal and natural state, and modern life is the opposite. There is an enormous difference between the two groups with regard to human health, and with regard to the health of the family of life.

Big Mama Nature lovingly fine-tuned our evolution. Our ecological job description was to live as nomadic hunters, scavengers, and foragers who traveled in small groups. In this manner, our hominin ancestors lived for several million years without radically disturbing fundamental balances in the family of life. This, of course, is the norm for every member of the family.

Along the way, some clever ancestors got lost and confused. By settling down, and crowding together in villages, towns, and cities, they developed a way of life that was at odds with our job description. Over time, the quirky experiment grew and grew, and became ferociously unsustainable. We sort of became herd animals, but not in a healthy wild way.

Herds of wild bison and horses have the inherent intelligence to follow their stomachs and keep moving. They roam over the hill to where the grass is greener, and leave their shit behind to nurture the grass for future visits. Herds of city dwellers generate enormous filth as they cause irreparable damage to the ecosystem. This great "advance" in lifestyle triggers a whopping number of unintended consequences. Let's take a stroll down Pathogen Lane.

**Malnutrition Diseases**

Richard Manning discussed what paleontologists have learned from old bones. The bones of hunter-gatherers are boring to study, because most of them were very healthy. Living in roadless wilderness, amidst man-eating predators, and using wooden spears to kill large strong animals, led to a lot of broken bones and premature deaths. Folks did not spend their lives in climate-controlled compartments, or drive across the land in luxurious motorized wheelchairs. They inhaled a lot of smoke from their fires, which likely led to respiratory problems. In warm regions, they were more vulnerable to intestinal parasites.

The bones of folks from agricultural societies were more interesting. Their diet was far less nutritious than that of hunter-gatherers. Until the last century, agricultural peasants spent their lives performing backbreaking labor, living in filthy conditions, and eating a low-quality diet. Many lived on bread and water alone, or oat porridge. Meat was a rare treat. This diet often led to illnesses from mineral and vitamin deficiencies, like pellagra, anemia, and thyroid problems.

Grain eaters commonly suffered from tooth decay, bone deformities, malnutrition, osteomyelitis, periostitis, intestinal parasites, malaria, yaws, syphilis, leprosy, tuberculosis, anemia, rickets in children, osteomalacia in adults, slow childhood growth, and short stature among adults. Let's take a look at a few diseases of malnutrition.

¶ Rickets is a disease of severely malnourished infants and children. Their bones are soft, are easily fractured, and can grow abnormally. Rickets is common in a number of developing nations. We get vitamin D when we consume foods like butter, eggs, oily fishes, fish liver oils, and fortified milk. Our skin cells use sunlight to convert vitamin D into a usable form, which enables our bodies to properly absorb calcium. When this doesn't happen, dental and skeletal deformities can develop — knock-knees, bowlegs, bulging foreheads, or narrow pelvises that interfere with normal childbirth. In the early days of the Industrial Revolution in London, heavy smog, combined with persistent fog blocked a lot of sunlight. At times, up to 80 percent of children had symptoms of rickets.

¶ Pellagra is caused by chronic niacin deficiency (vitamin $B_3$). Its victims suffer from diarrhea, dermatitis, and dementia. If not treated, death often occurred in 4 to 5 years. Pellagra was common prior to the 1920s, at which point folks discovered that it could be easily cured by a diet that included daily servings of milk, eggs, or meat.

In northern Italy, the poor lived primarily on boiled cornmeal, polenta. In the U.S. south, pellagra was common among poor folks whose diet majored in cornmeal, molasses, and sowbelly (fat salt pork from the belly of a pig). Pellagra was especially common in orphanages, sanitariums, asylums, and prisons, according to Burton Hendrick. Between 1906 and 1940 more than 3 million Americans had pellagra, and more than 100,000 died. Around the world, in the eighteenth and nineteenth centuries, hundreds of thousands died from pellagra.

¶ Scurvy is caused by a deficiency of vitamin C (ascorbic acid) in the diet. This vitamin is found in many fresh fruits and vegetables, especially citrus fruits, like oranges and lemons. Potato eaters also get adequate vitamin C. Before potatoes became a staple in northern regions, scurvy was common in winter months, when fresh foods were unavailable. *Homo sapiens* are tropical primates, and if we had remained in tropical regions, scurvy would never have become an issue.

In the old days, when sailors spent months at sea, living on hard biscuits and salted meats, many got scurvy — until the British discovered the healing power of limes, and their sailors got the nickname Limeys (lemons have more C than limes). After several months of insufficient vitamin C, folks experienced fatigue, and soreness and stiffness of the joints and lower extremities. Then came bleeding gums, loose teeth, bleeding under the skin, and personality changes. When untreated, bleeding or infections led to death.

¶ Beriberi means "extreme weakness." It is caused by a thiamine (vitamin B1) deficiency, and leads to impairment of the heart and nervous system, in both infants and adults. It is common where diets major in polished (white) rice, and little else. The rice husk is removed to greatly extend storage life, but the husk contains thiamine. Beriberi is still common in some locations, like prisons. It's getting less common in Asia, where many are now eating better diets. Untreated, it can cause death. Half of the men in the Japanese navy got beriberi before 1880, when extra meat, fish, and veggies were added to their diet.

**Bacterial Diseases**

Antibiotics are used to treat bacterial diseases. Sometimes they provide cures. Bacterial pathogens often mutate, and mutations can generate resistance to some or all antibiotics. The number of possible mutations is unlimited, but the number of effective

antibiotics is diminishing. Stuart Levy wrote that there are a limited number of substances suitable for use as antibiotics. The low-hanging fruit has already been picked, and inventing new antibiotics is becoming more and more challenging and expensive. Drug companies are losing interest in creating new antibiotics, because

they are not highly profitable — they work too well. The World

Health Organization wrote in 2020 that "we are heading for a post-antibiotic era in which common infections and minor injuries can once again kill."

¶ Cholera originated in tropical regions. It is a fecal-oral disease. Its primary reservoir is marine organisms. Sources of infection include contaminated food, water, and contact with the feces of cholera victims. Symptoms can appear as soon as two hours after exposure, and victims sometimes die the same day. The most common symptom is diarrhea, up to

3 to 5 gallons per day (10 to 20 l). Once the bacteria enter the water supply, the disease rapidly spreads.

Victims primarily die from dehydration. When provided with adequate amounts of water, victims often survive. In severe cases, treatment with antibiotics and hydration can stop the infection. Some strains of the bacteria have developed multiple drug resistance (MDR) — they can survive exposure to two or more types of antibiotics. There are vaccines that can prevent cholera, but they do not provide lifelong immunity.

The first cholera pandemic began in Bengal, India, in 1816, and lasted until 1823. So far, there have been seven global pandemics. The second global pandemic ran from 1829 to 1851. It spread to London and Paris. Cholera was unable to spread to the Americas until 1832, when speedy new steamships enabled the pathogen to survive the voyage. Once in Canada, it rapidly spread, transported by boats and railroads. Riverboats carried it down the Ohio and Mississippi Rivers. The Gold Rush migration carried cholera to California, where it unleashed an exciting rush of firehose diarrhea in 1850. Around the world, in the last 200 years, it has killed many millions. Cholera is still alive and well in the world.

Laurie Garrett revealed a spooky side of cholera. In water or algae, the bacteria can survive encysted, in a dormant state, for months or years. In the harbor of Lima, Peru, a Chinese ship dumped bilge water that contained spores of a virulent form of cholera called El Tor (the bull). People consumed raw shellfish that were contaminated with El Tor, and developed intense diarrhea. Before El Tor arrived, Peru had stopped chlorinating drinking water, because chlorine increases the risk of cancer. So, in 1991, El Tor eventually found its way into the water supply, and came out of faucets. It infected 336,000 people in eleven months, and was carried to the U.S. by infected people who traveled by air.

Cholera is a disease of poor sanitation. Its spread is encouraged by large populations, dirty water, and by high mobility (airplanes, ships, railroads, etc.). It would not have been common among our nomadic wild ancestors.

¶ Typhus has several forms. Epidemic typhus is a bacterial disease spread by lice. It originated in temperate regions. One to three weeks following exposure, flu-like symptoms occur. Then, five to nine days later, a rash appears, and spreads over most of the body. "Typhus" means confused, because many victims became delirious. Without treatment, up to 40 percent die.

Lice transfer the bacteria from infected humans to other humans. Humans are the one and only typhus reservoir. When a typhus-carrying louse bites, it takes some blood, and leaves behind a small gift of poop. The bite itches, the person scratches it, and scratching pushes the bacteria through the bite opening in the skin.

During the Great Famine, many Irish boarded boats to North America. Joining them for the voyage were lice-ridden rats. The boats became known as "coffin ships" because they delivered the typhus epidemic of 1847 to North America. The immigrants were quarantined on their ships, on an island, or held in large "fever sheds." Tens of thousands died at sea, or in quarantine.

Typhus thrives in crowds. It's sometimes called jail fever. It was especially common during wartime. Soldiers had little access to soap, hot water, baths, or clean clothing. They had plenty of company from rats and bugs. Typhus took a big toll during the Russian Revolution (1917–1923), causing 30 million cases with more than 3 million deaths. During World War Two, scientists discovered that lice could be controlled by spraying the soldiers with DDT. This kept them bug free for months.

In the good old days, bathing was considered to be dangerous. Prior to modern water systems, carrying enough water for a bath was a lot of work. The whole family took turns using the same bath water. In the summer, people could bathe in lakes or streams, but the arrival of autumn chilled interest in washing. In the 1800s, even the rich got typhus, because everyone had lice.

Typhus can be controlled by better hygiene, insecticides, and antibiotics. No vaccines are currently available to prevent typhus. It thrives in conditions of crowding, filth, and poverty. It would not have been common among our nomadic wild ancestors.

¶ Typhoid is a bacterial disease that originated in temperate regions. It is caused by consuming food or water contaminated with fecal material. Shellfish living in dirty water can carry the bacteria. So can raw fruit or vegetables fertilized with human shit, or contaminated milk, cheese, or ice cream. On one milk route in Springfield, Massachusetts, 150 consumers caught typhoid, and 25 died. Flies can deliver typhoid to your food.

Symptoms appear six to thirty days after exposure, when victims get a high fever that lasts several days, or sometimes months. The name typhoid means "resembling typhus" because it had similar symptoms. Not until 1837 did science discover that typhoid and typhus were different diseases.

Mary Mallon carried the typhoid pathogen, but it never made her sick. Working as a cook, she infected at least 50 people, of whom 3 died. Earning the nickname Typhoid Mary, she had to be forcibly quarantined for 26 years, which really pissed her off, because she wasn't ill.

Typhoid is a popular disease in regions where dense populations dump their sewage into their drinking water supplies. It is also encouraged by flies and filth. Horses release 15 to 35 pounds of manure daily (7 to 16 kg). In 1900, London streets were home to 50,000 horses. New York had 100,000. Dense clouds of flies feasted on the yummy crap. The invention of the automobile actually had one benefit — by clearing the streets of horses, there was a sharp reduction in typhoid cases.

Typhoid still exists. Worldwide there are 21 million cases annually, with 200,000 deaths. It can be treated with antibiotics, but the bacteria have developed resistance to some of these drugs. Since 1896, there have been typhoid vaccines, but they don't provide lifelong immunity. Good sanitation and chlorinated drinking water can prevent the spread.

Typhoid thrives in conditions of crowding, filth, and poverty. It would not have been common among our nomadic wild ancestors.

¶ Bubonic plague is a bacterial disease that originated in temperate regions. It first entered history with the Plague of Justinian (541–542) which struck the Eastern Roman Empire, and initially killed about 25 million people. Grain ships from Egypt carried infected rats to

Constantinople (Istanbul), where up to 5,000 people per day died. The epidemic returned several times over the following 200 years, and eventually killed about 50 million. In the year 500, the estimated population of the world was between 190 and 206 million.

The second great pandemic was the Black Death, which originated in central Asia, spread through China (1331) and then hammered Europe (1347–1350), possibly killing 50 million, about one third of the people. Periodic plague outbreaks persisted in Europe for the next 350 years. London got hammered in 1666.

The third great pandemic began in Yunnan China in 1855, and spread into India. It killed 12 million people in China and India, and persisted until 1959. In 2015, the Centers for Disease Control reported 15 cases of plague in the United States. Around the world there are several thousand cases each year, and most are cured with antibiotics. Today, many types of ground dwelling rodents are reservoirs of the pathogen.

Fleas acquire the pathogen by biting the rodents, and then pass it to humans with a bite. A pustule forms, and then the lymph nodes in the armpits, groin, and/or neck swell. There is bleeding under the skin, creating purple blotches, or buboes. Eventually the nervous system breaks down, there is intense pain, and then death — usually on the fourth day.

Bubonic plague thrives in conditions of crowding, filth, and poverty. It would not have been common among our nomadic wild ancestors. Sometimes it mutated into pneumonic plague, which could be spread to others with a sneeze, was extremely contagious, and always fatal (so outbreaks were brief).

One of my ancestral homes was in Gran, Hadeland, Norway. The Black Death hammered the population, many farms were abandoned, and forests joyfully reclaimed the fields. My kinfolks told me that one day, many years ago, a lad was hunting in the woods. He shot an arrow, and it struck a bell. He was surprised to discover an old church concealed in the dense forest. Nobody among the living knew anything about the mysterious church, or the community it had served before the plague.

¶ Tuberculosis (TB) is an ancient bacterial disease that we may have acquired from ruminants. The time, place, and way that tuberculosis originated remains the subject of controversy. Maybe a third of humans are infected with tuberculosis, but most have no symptoms, and are not contagious because their immune systems keep it under control. If the bacteria grow, a latent infection can become active. It can then pass directly from person to person via coughing, sneezing, spitting, or speaking. Symptoms include fever, frequent coughing, night sweats, weight loss, and bloody sputum.

In the nineteenth century, as the Industrial Revolution spurred the growth of crowded cities, TB was the main cause of death in Europe and North America. Prime victims were the malnourished who lived in damp conditions. There was no cure. In the twentieth century, it killed an estimated 100 million people. It is quite contagious. A flight attendant with tuberculosis spread it to 23 passengers during several flights.

Tuberculosis can be treated with antibiotics, but drugs are becoming less effective, because a number of tuberculosis strains are developing multiple drug resistance (MDR-TB), a condition that is common in hospitals, prisons, and homeless shelters. The World Health Organization reported that in 2014, there were 9.6 million cases of active tuberculosis, which resulted in 1.5 million deaths.

Of those cases in 2014, 480,000 were MDR-TB, more than half of which occurred in India, China, and Russia. About 9.7 percent of the cases were XDR-TB (extensively drug resistant TB). Recently a new variant is emerging, TDR-TB (totally drug resistant TB), which has been found in India, Iran, and Italy.

For the last 50 years, there has been little interest in developing new first-line drugs for treating tuberculosis. TB is a disease that mainly affects the extremely poor; folks who can’t afford to buy highly profitable wonder drugs.

Tuberculosis thrives in conditions of crowding and poverty. It would not have been common among our nomadic wild ancestors.

¶ Anthrax is an ancient bacterial disease that primarily infects plant-eating mammals, especially animals that live in herds, like horses, cattle, sheep, bison, reindeer, and oxen. Anthrax is spooky because it creates spores that can survive for centuries, even in harsh conditions. Birds that dine on infected carcasses can move the spores to other regions. Moving streams can carry spores downstream. Spores have been found on every continent, including Antarctica.

Humans and other animals can become infected by inhaling spores, or eating contaminated meat. Humans can get it by handling wool or hides. Bacteria can enter via broken skin. Once a dormant spore has entered the body, it can reactivate and spur an infection.

Michaeleen Doucleff reported on an anthrax outbreak in a remote region of Siberia, where thawing permafrost exposed a reindeer that died from anthrax 75 years earlier. Old spores from the dead reindeer then led to the infection of 2,000 reindeer, dozens of people got sick, and one child died. Because livestock are a primary source of food for humans, high mortality in the animals can lead to starvation. When traction animals die, fields can't be plowed.

Prior to 1900, hundreds of thousands of people died from anthrax every year. The disease cannot be transmitted human-to-human, but when someone dies from it, the mass of bacilli in the corpse can become a source for infection. The first effective vaccine was developed in 1881. A second generation is available now, but has severe side effects in one percent of patients. The disease is treatable with antibiotics.

Anthrax is encouraged by the confinement of herd animals, like in livestock operations. Anthrax in humans is encouraged by regularly having close contact with herd animals. It was probably less common among our nomadic wild ancestors. Finding a bunch of dead animals may have encouraged caution.

**Parasitic Diseases**

Humans are tropical primates, and parasites thrive in a tropical climate that is close to our body temperature. In a warm environment, it is easier for them to move among humans and other animals. One in every four humans provides a nice home and warm meals for parasitic worms. Parasitic diseases can cause chronic, long-term, debilitating conditions.

Our wild ancestors in tropical regions certainly had intimate relationships with parasites, but probably on a scale far less than today. The tropics have been substantially disrupted by logging, herding, agriculture, poverty, poor sanitation, and explosive population growth. A warming climate suggests a bright future for the parasites.

Because tropical climates don't have cold winters, they nurture greater biodiversity, which provides prime conditions for parasitic diseases. Parasites include protozoans, roundworms, flatworms, filarial worms, and amoeba. We'll take a closer look at a few parasitic diseases in the following pages.

¶ Malaria. For humans, the deadliest creatures on Earth are not large carnivores, but mosquitoes. Malaria is an ancient tropical disease caused by protozoans that are transmitted to humans via mosquitoes. The disease destroys red blood cells, and an infection can last for years. There are five varieties of malaria, caused by five different parasites. The deadliest variety is caused by *Plasmodium falciparum*, which originated in birds. Humans provide the sole reservoir for malaria parasites, and mosquitoes transfer them from the infected to the non-infected, so dense population encourages the disease.

Following exposure, the incubation period is 7 to 30 days. Early symptoms include fever, chills, headache, sweats, fatigue, nausea, and vomiting. Complications can include brain infection, kidney failure, liver problems, pulmonary edema, coma, and death. Some believe that malaria has killed more people than any other disease.

Mark Nathan Cohen noted that malaria and yellow fever were originally treetop diseases that infected non-human primates. As humans cleared forests for agriculture, they became vulnerable to these diseases. Malaria was rare among nomadic people, but common in farming communities, especially where rice was grown in flooded paddies (mosquito incubators).

Malaria and yellow fever were transferred to the Americas via the

slave trade. In 1864, George Perkins Marsh noted that malaria followed deforestation. In Virginia and the Carolinas, malaria was rare in forested areas, but common in cleared places, especially near the flooded rice paddies in South Carolina and Georgia. He wrote, "The cultivation of rice is so prejudicial to health everywhere that nothing but the necessities of a dense population can justify the sacrifice of life it costs in countries where it is pursued."

John Perlin described how the ancient Greeks cleared forests to create wheat fields. Deforestation led to severe erosion that filled deep harbors with soil, creating malarial marshes. Malaria was so bad that port cities had to be abandoned.

The ancient Romans repeated the same mistake. For centuries, wealthy Romans spent their summers at higher elevations to avoid

malaria. Geoffrey Marks noted that in the eleventh century, the Germans who conquered Rome declared it to be uninhabitable, and abandoned it. For centuries, malaria made Rome almost uninhabitable in the summers, until Mussolini drained the Pontine Marshes in the 1930s.

Today, a billion people live in malaria country. Mosquitoes are developing resistance to insecticides, and the malarial parasites are developing resistance to every antimalarial drug. No vaccines are available. Malaria is untreatable in some regions. The World Health Organization (WHO) estimated that in 2010 there were 219 million cases of malaria (mostly in Africa), resulting in an estimated 660,000 deaths. WHO models indicate that a global temperature rise of 2 to 3°C will put 3 to 5 percent more people at risk of malaria (several hundred million).

Margaret Humphreys noted that three types of malaria were imported to the U.S. by immigrants from Europe, the Mediterranean basin, and African slaves. It spread as far north as Tennessee and North Carolina. Slaves and mosquitoes mingled together in flooded rice fields in South Carolina, and then the mosquitoes infected whites. By the 1680s, whites were getting hit hard, especially the young. Many families fled north during the summer months.

¶ Schistosomiasis (bilharzia) is the second most common parasitic disease, after malaria. It is caused by parasitic worms that live in freshwater snails. The worms emerge from the snails and burrow through the skin of humans standing in the water, often in irrigated fields. These worms can live in your body for 40 years. As their eggs move through your organs, they cause bleeding. Infection sometimes results in bladder cancer, and liver disease. The parasite returns to the water in the feces of victims. It's nearly impossible to eliminate the snails, but medications can eliminate worm infestations in the body. Where schistosomiasis is common, many die young.

¶ Sleeping Sickness (trypanosomiasis) is a tropical disease that originated in Africa. It is caused by a family of protozoa named *Trypanosoma brucei*. Originally, sleeping sickness was transferred from wild antelopes to humans via tsetse flies. The protozoa did not sicken the antelope. Amazingly, the tsetse can drink its own weight in blood in seconds.

For a long while, humans were little affected by sleeping sickness, because they didn't live in close contact with wild animals. But, once upon a time, the herders of domesticated cattle got really tired of living in warm and green ecosystems, because they were hotbeds of malaria. So, to escape from the mosquito hordes, they packed up and moved to a dryer region — tsetse country.

In tsetse country, the native African wild mammals were resistant to the disease, but livestock brought in from elsewhere were not. Cattle and herders were infected with sleeping sickness, and the cattle were hit extremely hard. Slave traders carried the sleeping sickness protozoa to uninfected regions.

The disease messes up the mind and body in many ways, but the most obvious symptom is that victims sleep a lot, and can be very difficult to awaken. Left untreated, all victims fall into a coma and die. There are two forms of sleeping sickness, caused by two different types of protozoa. More than 98 percent of the cases are caused by the weaker one, which can take three years to kill the victim. The stronger form is more virulent, killing the victim within months.

In 1859, a sleeping sickness epidemic around Lake Chad was so severe that the town of Digazore, Nigeria was deserted for 50 years. Between 1896 and 1906, sleeping sickness killed 500,000 in the Congo. Between 1898 and 1908, it killed 200,000 of the 300,000 along the northeast shores of Lake Victoria in Uganda. In 1952, Charles Winslow wrote that most of Tanganyika was uninhabitable because of the large tsetse fly belt.

In numerous tsetse hotbeds, trying to graze cattle was not worth the effort, because too many died. People had to get their protein via foods from elsewhere. On the plus side, the flies protected the

indigenous wildlife. William McNeill wrote, "It is mainly because sleeping sickness was and remains so devastating to human populations that the ungulate herds of the African savanna have survived to the present."

Insecticides cannot eliminate the tsetse flies because they inhabit large regions. Eliminating the wildlife that are hosts to the parasites is not an option. Health experts expect that a warming climate is likely to open up new frontiers for tsetse flies. Currently, they are only in Africa. Tsetse flies fall down laughing at the myth of human supremacy.

¶ River Blindness (onchocerciasis) is caused by an infestation of filarial worms that colonize the eyeballs. In some areas of Africa, up to 30 percent of adults are blind. Humans acquire the parasites via bites from black flies, which breed in warm rivers. The flies are hard to exterminate, because some can travel up to 400 miles (640 km) in one day.

¶ Elephantiasis. Lymphatic filariasis is commonly known as elephantiasis. When humans donate blood to mosquitoes and black flies, the insects transmit roundworms to the humans. Infection usually occurs in childhood, and eventually results in damage to the lymphatic system. Untreated, the legs and scrotum of the victims can swell to enormous size. Drug therapy and surgery can treat worm infestations. Intensive insecticide spraying can reduce the flies and mosquitoes.

¶ Chagas' disease is caused by parasite named *Trypanosoma cruzi*. This protozoa is usually spread by kissing bugs, and it has a reservoir in wild and domestic animals. The bugs first bite an infected person, then bite a healthy person, and dump some feces by the bite. Scratching the bite rubs the feces into the wound, and the parasites move into their new home, where they might reside for decades. Some victims experience cardiac or intestinal complications. Chagas' disease is common in Mexico, Central America, and South America. Seven to eight million have the disease, and it causes 12,500 deaths per year.

**Viral Diseases**

Viruses are not living organisms. They are segments of protein-coated genetic material (DNA or RNA) that can infect the living cells of plants, animals, or bacteria. When infected cells reproduce, the offspring carry the virus. There are millions of types of viruses. They can be transmitted by insects, coughing and sneezing, feces, body fluids, person-to-person contact, or via eating or drinking. Some viruses can infect the cells of a few different species, and others can infect many.

¶ Yellow Fever is a tropical disease caused by a mosquito-borne virus. The virus originated in forest primates, who remain the primary hosts. It is a hemorrhagic fever. About 15 percent of victims advance to the second phase of the disease, in which they bleed from the mouth and eyes, and vomit blood. Without treatment, up to 20 percent of victims die. This can increase to 50 percent in severe epidemics.

The *Aedes aegypti* species of mosquitoes carries the yellow fever virus. A tropical village could go decades without a case of yellow fever, because the mosquitoes stayed in the jungle, feeding on marmosets and monkeys. Cutting a stand of trees could spark an epidemic, by bringing mosquitoes closer to the ground, where they could breed in pools of water on the stumps.

*Aedes aegypti* can't survive in a chilly climate. They have migrated out of Africa, and now enjoy life in tropical and subtropical regions around the world. They are thrilled to hear news about global warming, and they urge all humans to increase their carbon-emitting habits, please! Drive like crazy! Fly everywhere! Recently, they have been found as far north as Sacramento and New York City. Yellow fever was far less common in the days before our ancestors became forest molesters, farmers, and city folks.

There is no cure for yellow fever, but a preventive vaccine was developed in 1938. Over time many Africans have developed immunity to it, and can carry the virus without getting sick. Non-Africans have not been so lucky; they die like flies when the virus comes to visit. Anyway, when the good white Christians brought African slaves to the New World, yellow fever came with them. Neither Native Americans nor white colonists had any immunity at all. A virgin land epidemic exploded.

Yellow fever was the reason why the United States got a fabulous bargain on the Louisiana Purchase, which included the territory of fifteen future states. In 1802, Napoleon sent an army to Haiti to put down a rebellion. He enjoyed a smashing victory over the rebels, whilst the Haitian mosquitoes took great pleasure in killing 40,000 of his men with yellow fever. At this point, the mighty emperor lost all interest for further adventures in the frightfully unhealthy continent of North America, and he sold French claims to the USA for a bargain price.

Geoffrey Marks reported that there were epidemics in the U.S. northeast from 1686 to 1832, but it was far more prevalent in the south. For example, epidemics hit Charleston, South Carolina in 1699, 1706, 1711, 1728, 1732, 1790, 1791, 1792, 1795, 1798, and 1799. In 1820, one-third of the people in Savannah, Georgia died. Forest clearing and numerous rice paddies provided abundant habitat for mosquitoes. Today, vaccines keep the disease under control in many regions.

¶ Influenza is a viral disease that originated in temperate regions. It can be highly contagious, and some variants are highly lethal. It often mutates into new variants, and many experts are concerned that a new deadly influenza pandemic is quite likely, at some point in time.

It's odd that many people have heard about the Black Death pandemic of 650 years ago, but far fewer know about the global influenza pandemic of 1918. We prefer to forget it. At a time when world population was about 1.7 billion, the flu infected 500 million, and 50 to 100 million died. It spread around the world in just two months, in an era before commercial air travel. Doctors were helpless to treat it. Some feared the end of civilization.

After a few days of aches and pains, victims would start bleeding from their ears, nose, or eyes. Their lungs filled with blood, and their skin turned purple. Some called it the Purple Death. Folks that appeared healthy at breakfast were dead by evening. Oddly, mortality was highest among healthy adults between the ages of 20 to 40. Some believe that the flu didn't kill them. They died because their healthy immune systems freaked out, flooded their bodies with proteins that caused inflammation. Children and old folks had less robust immune systems, and survived in greater numbers.

Richard Collier wrote an unforgettable play-by-play description of the 1918 pandemic, taken from news accounts of the day. Quarantines didn't work because infected people can appear healthy for a few days. In 1918, ships known to be carrying infected people were allowed to enter ports. The SS Niagara took infected passengers to New Zealand, resulting in 6,680 deaths. The Canadian Pacific railroad carried the flu across the continent, infecting each city where the train stopped.

Some victims went into deep comas, with no pulse or breathing — and then revived in a closed coffin, or at their funeral. This happened to a very unpopular drunkard and wife-beater in Cape Town. He awoke screaming in a wagonload of coffins. One driver said to the other: "I reckon ain't no one going to miss him." He was right.

Michael Greger wrote that wild ducks and influenza viruses peacefully lived together for 100 million years. If humans had never domesticated ducks, influenza might be unknown today. Unfortunately, ducks were domesticated 4,500 years ago in China, moved onto rice paddies, where they were close to chickens, pigs, and humans that were not immune to the viruses. Because China raises 13 billion chickens, 2 billion waterfowl, and 500 million hogs in close contact with humans and other species, it provides perfect conditions for encouraging the mutation of viruses, and their spread to other species.

When a highly lethal, highly contagious mutant emerges, wild migratory birds can carry it to faraway regions, like North America, via Alaska. They poop in the water, and other species acquire the viruses when drinking. It's vital that we change the way we raise animals, but there is little interest. Especially bad are Chinese fish farms where hog, chicken, and human wastes are used as feed.

When the next highly contagious, highly lethal variant appears, existing vaccines may not prevent it. Flu viruses can rapidly mutate, creating a moving target for vaccine makers. Creating a new vaccine can take six to eight months. Then it has to be mass produced and distributed. By then, the pandemic might be over.

Influenza is the result of animal domestication. Its spread is encouraged by dense populations, high mobility, and living with others indoors. It would not have been common among our nomadic wild ancestors. The last words of one 1918 flu victim in Guatemala were, "We die of the blessings of civilization."

¶ Smallpox is a viral disease that originated in temperate regions. It is highly contagious and highly lethal, especially in children under two years old. It does not spare the wealthy. Smallpox is transmitted via face-to-face contact, exposure to infected body fluids, or by touching contaminated items like clothing or bedding. Following exposure, the incubation period was 10 to 14 days, which allowed infected people to travel to distant villages before discovering they were sick.

Symptoms include fever, headache, fatigue, back pain, and vomiting. Red spots then spread over the body, then turn into small blisters, which turn into scabs, and then leave behind deep pitted scars. Most victims over ten years old survive, but some varieties of smallpox are almost always fatal. Once infected, there is no cure, but the symptoms can be treated.

There is evidence that smallpox existed before 1000 B.C. in Egypt, India, and China. It may have appeared much earlier. Many believe that the virus originated in cows, but others suspect camels. Travelers from Eurasia carried the virus to the Americas and Australia, where natives had zero immunity and suffered fatality rates up to 90 percent. In the twentieth century, an estimated 300 to 500 million people died from smallpox.

No other animal provides a reservoir for the smallpox virus. Only humans carry it. Because of this, science was able to eradicate the disease via a successful vaccination program. Smallpox was eradicated in the U.S. in 1972, and the last case occurred in Somalia in 1977.

Smallpox almost certainly was a consequence of the animal domestication. Experts do not agree on the source, but most say camels, and some say cattle. It would not have been common among our nomadic wild ancestors. They may have never experienced it.

¶ Rinderpest is a viral disease that affects ruminants — hoofed animals like cattle, goats, sheep, antelopes, deer, and giraffes. It is the most virulent of all livestock diseases. Because livestock are a primary source of food for humans, high mortality in the animals can lead to starvation in humans. When beasts of burden die, fields can't be plowed, and carts do not move.

Rinderpest is highly contagious and has high mortality rates. When an animal is infected, it takes 3 to 15 days for symptoms to appear. They include high fever, diarrhea, and skin lesions. Death follows in 6 to 12 days. All of a sick animal's fluids are contagious, including tears, urine, saliva, snot, and excrement.

Andrew Rimas noted that the virus apparently originated in East Asia. Mongols carried it west to the Ukraine in 1240, and it eventually spread as far as Scotland. In 1865, a rinderpest epidemic in Europe killed up to 200 million cattle. In 1885, infected cattle were shipped by Italian soldiers to Eritrea, and by 1890, 92 percent of the cattle in East Africa were dead. It took a similar toll on wild ruminants, like buffalo, bison, oryx, elands, and the greater kudu. The Maasai are a tribe of cattle herders, and two-thirds of them perished from starvation. Large feline predators starved. In the absence of large herbivores, trees began to spread into the savannah.

The rinderpest virus likely originated in wild herd animals, and it is likely more than 5,000 years old. It's closely related to the measles virus, and is probably older. Human populations were not dense enough to maintain endemic measles until a thousand years ago. Humans can't get rinderpest, and other animals can't get measles. In 2011, rinderpest went extinct in the wild, because of a successful vaccination program.

Rinderpest thrived in dense populations of confined domesticated livestock. Our nomadic wild ancestors probably did not observe it often among wild ruminants, if ever.

¶ Measles is a highly infectious viral disease that originated in temperate regions. It spreads from person to person via coughs and sneezes. Ten to twelve days after exposure, symptoms appear, including inflamed eyes, fever, cough, and runny nose. Three to five days after the start of symptoms, a red rash spreads over the body, beginning at the face. Complications include pneumonia, brain inflammation, blindness, and diarrhea.

Most of those who survive a measles infection will be immune for the rest of their lives. Therefore, measles needs a continuous supply of victims who are not immune, namely young children. Of those who are not immune, about ninety percent will become infected when exposed to the virus.

Humans are the sole reservoir for measles. It cannot persist in populations of less than 250,000 to 500,000 people; it will die out. Measles was first noted in written records in the tenth century, as European cities grew to densities sufficient to provide a good home for the virus.

Dr. E. Fuller Torrey notes, “It has been estimated that between 1840 and 1990, measles killed about 200 million people worldwide.” A measles vaccine was introduced in 1963. Once upon a time, the World Health Organization hoped to eliminate measles by 2020.

Measles thrives in dense populations and poverty. It would not have been common among our nomadic wild ancestors.

**New Viral Diseases**

New types of viral diseases are now appearing, as humans move deeper into remote areas of the tropics. Loggers are destroying forests, and bush meat hunters are selling a variety of wild primates for food. Because humans are Old World primates, we are more vulnerable to the diseases of other Old World primates, like Ebola, Marburg, and AIDS. We are less closely related to the monkeys of the Americas, so we are not so susceptible to their diseases.

Viruses are notorious for having a tendency to mutate, like the influenza virus. Wild monkeys are susceptible to a highly lethal airborne virus that gives them cancer. The virus has not mutated into a form that humans are vulnerable to — yet. Ebola and Marburg are highly lethal, but the viruses that cause them have not succeeded in permanently established themselves in human populations — yet. Folks who work in labs with monkeys are getting monkey diseases. Some have experimented with transplanting baboon organs into humans.

¶ AIDS. The human immunodeficiency virus (HIV) is contagious. When it is untreated, it can lead to acquired immunodeficiency syndrome (AIDS), a disease that has killed about 40 million. HIV is probably a mutation of the simian immunodeficiency virus (SIV) which is carried harmlessly by chimps. The bushmeat business now operates at an industrial scale, and bushmeat vendors are often exposed to the blood of SIV infected chimps. The first well-documented case of AIDS was in 1959 in the Congo. By the late 1970s, HIV was in the U.S. It spread rapidly among the gay community. HIV researchers at the National Institutes of Health had to keep redefining the meaning of "multiple sex partners." It was 20 partners per year in 1975, 50 in 1976, 100 in 1978, and 500 in 1980. One fun-loving lad claimed 3,000.

¶ Ebola hemorrhagic fever is a viral disease of humans and other primates. It is active in tropical Africa, and outbreaks tend to occur when heavy rains follow a long dry spell. In advanced stages of the infection, victims bleed internally and externally. The virus is transmitted via skin-to-skin contact, and exposure to patient's body fluids and excretions. Usually, mortality is 50 percent, but can run as high as 90 percent. Fruit bats are the likely reservoir of the virus, which does not make them sick. A recent epidemic in West Africa ran from 2013 to 2016, with 28,657 cases and 11,325 deaths.

¶ Marburg hemorrhagic fever is a deadly viral disease that infects humans and non-human primates. It is active in the arid woodlands of equatorial Africa, and fruit bats are the reservoir for the virus. It typically infects people who visit bat-infested caves, or work in mines. It is transmitted via skin-to-skin contact, and exposure to infected body fluids and excretions. Its symptoms are the same as Ebola. Victims die from the failure of multiple organs, not hemorrhage. A severe outbreak in Angola in 2004–2005 had a mortality rate of 90 percent. The U.S. Food and Drug Administration has approved no vaccines for Marburg.

¶ SARS. Severe Acute Respiratory Syndrome is a viral disease first identified in 2003. Symptoms appear two to ten days after contact, with fever and respiratory problems. Severe cases can result in respiratory failure. In 2003, nine percent of all victims died. For those older than 50, almost half died. Scientists believe that it was passed to humans via palm civets, animals sold for human consumption in Guangdong, China. It has also been found in raccoon dogs, ferret badgers, and domestic cats. The natural reservoir for the virus may be bats, which carry it harmlessly. The virus is apparently transferred when different species are in close contact, as they are in Chinese markets — conditions far different from normal life in the wild.

¶ Lassa hemorrhagic fever is a viral disease of humans and non-human primates. It is endemic in western Africa, where it infects 100,000 to 300,000 each year, and kills about 5,000. The reservoir for the virus is a type of rat that commonly colonizes human settlements, and feeds on stored food. Infected rats excrete the virus in their urine and feces. Humans are infected via inhalation, open wounds, or ingestion of contaminated foods. Most infections are mild and not diagnosed, but twenty percent can get serious. The U.S. Food and Drug Administration has approved no vaccines for the Lassa virus.

¶ COVID-19. Coronavirus is a viral disease that triggered a global pandemic in early 2020. It has the potential to become catastrophic. The future has yet to be written.

## Predators

In the good old days of our hunter-gatherer ancestors, the entire family of life was 100% wild, and wild humans were just one of the wild gangs. Back then, if a wolf pack ripped up a young aurochs, nobody grieved. Predation was perfectly normal and healthy. When some cultures transitioned into herding domesticated livestock, the game changed. Those cattle and sheep had become *my* personal property, and the wolves had no right to molest them. But, of course, the wolves ate them anyway. Because of the spooky invention of property and status, wild predators ceased being relatives, and became intolerable enemies, noxious pests that had to be exterminated.

### Kaibab Deer

The Kaibab Plateau lies north of the Grand Canyon in Arizona. Prior to 1905, it was home to about 4,000 deer. President Theodore Roosevelt loved the deer. After a century of intense gun slinging craziness, the plateau was essentially the last surviving remnant of America's once abundant wildlife. In 1906, he created a national game preserve to protect them. Most of the cattle, horses, and sheep were then deported, because their overgrazing had rubbished the vegetation.

By the time the preserve was created, wolves had already been heavily exterminated by ranching interests. Now, deer hunting was banned, and the Forest Service declared war on the remaining wild predators. Between 1907 and 1939, they killed 500 bobcats, 7,388 coyotes, 20 wolves, and 816 mountain lions. As the deer herd grew, the bureaucrats glowed with pride at their success.

By 1924, the deer herd had skyrocketed from 4,000 to 100,000 animals. Vegetation was stripped off the land, and animals began starving. By 1939, the land was seriously damaged, and only 10,000

deer remained. This tragedy fascinated Aldo Leopold, who worked for the Forest Service. He wrote that the deer live in fear of the wolves, but the mountain lives in fear of the deer.

This is a classic example of a trophic cascade, an imbalance that radiates through an ecosystem. With primary predators eliminated, grazing animals exploded in number, stripped the vegetation off the land, and then starved. This was a top-down cascade. There are also bottom-up cascades. For example, if extended drought nukes the forage, the herbivores starve, and so do their predators. If potato blight rots the spuds, peasants experience a die-off, along with their lice and fleas.

The Bible's Old Testament emerged in a Hebrew culture of herders and farmers. In their mindset, the livestock they owned were valuable property, and the wild predators that killed them were mortal enemies. In Hebrew fantasies, wild predators became as harmless as bunnies. "The wolf also shall dwell with the lamb, and the leopard shall lie down with the kid; and the calf and the young lion and the fatling together; and a little child shall lead them. And the cow and the bear shall feed; their young ones shall lie down together: and the lion shall eat straw like the ox." (Isaiah 11:6-7)

**Predator Eradication**

Evolution did not genetically prepare hominins to be apex predators. It was cleverness and technology that enabled our ancestors to become peculiar imitations of genuine, natural born, apex predators (lions, tigers, wolves, etc.). These skills also enabled our ancestors to better defend themselves against attacks from wild carnivores. So, fewer folks got eaten, and more of them could grow up to be hunters, and kill more game and carnivores.

Over the passage of centuries, trends shifted. Folks who raised livestock developed a hatred for wild carnivores, and worked hard to deliberately exterminate them. More livestock survived, allowing more humans to survive. Predator eradication continues to this day. The U.S. has been heavily invested in "predator control" for more than 100 years. Today, we invest $100 million per year in Wildlife Services, a program of the U.S. Department of Agriculture (USDA). In just 2018, Wildlife Services killed 68,186 coyotes, 1,002 bobcats, 375 mountain lions (cougars), 338 bears, 357 wolves, and so on.

Most folks are now more likely to win the lottery than to have a life-threatening meeting with a large carnivore in the wild. Out in the forests and fields, we can enjoy an unnatural sense of safety. The lions, tigers, and bears in our lives are soft fuzzy stuffed animals. We are far from our original role in the living world, and our ancestors' time-proven way of celebrating life.

**Predator Restoration**

William Stolzenburg wrote about the tremendous benefits of wolves. American couch potatoes, ranchers, and hunters really, really, hate Bambi-killing wild predators. In 1925, officials in Yellowstone National Park succeeded in exterminating the last surviving wolf. This launched a trophic cascade. Naturally, elk exploded in number, forcing park officials to scramble. Some were captured and moved, others were exterminated. In 1995, shifting public attitudes inspired the reintroduction of wolves into the park.

Wolves came to the rescue of damaged stream and wetland habitats. During their 70-year absence, red deer had substantially stripped away the vegetation along waterways. With fewer trees protecting the waters, marine life was more vulnerable to predators. With the return of wolves, more and more deer became Happy Meals, and the surviving deer prudently migrated to less accessible locations. Before long, the willow trees returned, shade returned to streams, overheated waters cooled off, and the fish were overjoyed by the great healing provided by the wolves.

Wolves came to the rescue of struggling forests. During their absence, forest regeneration declined, because elk gobbled up too many seedlings and saplings. The youngest cottonwoods were 60 years old. Wolves totally enjoy lunch dates with tree-killing elk, much to the delight of the tree people and other forest dwellers.

Wolves came to the rescue of antelope, who were in decline, because coyotes ate too many young antelopes. Wolves were delighted to dine on their coyote cousins. Within three years, half of the coyotes had become Happy Meals. Consequently, far fewer baby antelope were killed, which led to a recovery of their numbers. A reduction of coyotes was also a gift to other animals, like rabbits, mice, foxes, weasels. Wolves also benefitted scavengers, like bears, ravens, eagles, and others, who were happy to dine on partially consumed carcasses. Predators are essential components of every healthy wild ecosystem.

Stolzenburg noted that American housecats annually kill an estimated one billion wild mammals and hundreds of millions of birds. I live in neighborhood with many lonely humans who keep cats for companionship. Here, birdsong is minimal. A mile away, in a cat free riverside forest, the bird symphonies at sunset are magnificent. Where coyotes have managed to survive, they have become great housecat lovers, much to the delight of the birds. **Delicious Two-Legged Meatballs**

Once upon a time, while exploring the work of Saxo

Grammaticus, I came across the story of Cormac mac Airt (son of Art), a High King of Ireland. His story comes from a misty realm that blurs together legend and history. It's full of bloody feuds, fairies, druids, and wolves. Some say he maybe lived between A.D. 150 and 366. When Cormac was born, the druid Olc Aiche sang five spells over the boy, to protect him from the five primary dangers in life: slaying, drowning, fire, sorcery, and wolves.

It was striking to be reminded that there was a time when, every day of your life, there was a decent chance that you might have an unscheduled lunch date with a hungry predator. If the records in my family tree went back 10,000 years, many thousands of folks in the extended families of my ancestors must have been killed and eaten by large carnivores — a perfectly normal, natural, wholesome event.

Dorothy Cheney noted that our baboon cousins cannot control leopards and hyenas, so the vast majority of baboons die from predation, not old age.

Michael Bright wrote an entire book of stories about man-eating carnivores — whole chapters on wolves, snakes, tigers, lions, crocodiles, and others. In *Grimm's Fairy Tales*, the word "wolf" appears 72 times. Wolf packs in Paris killed 40 in 1450. An English biologist reported 161 human deaths from wolf attacks in Russia in 1875. Other sources noted 624 humans killed by wolves in Banbirpur, India in 1878. In 1996-97, more than 50 children were killed by wolves in Uttar Pradesh, India. And so on.

Tigers also enjoyed us. In 1769, 400 were killed by tigers in the area around Bhiwapur, India. In 1922, tigers in India killed 1,603

people. Sy Montgomery wrote a book about the tigers that live in the mangrove swamps of the Sundarbans region, near the border of India and Bangladesh. She wrote, "Here the tiger is feared but not hated; here it is worshipped but not loved. For the tiger is a sacred creature who rules an enchanted land." During a six-year period in the late nineteenth century, Sundarbans tigers ate 4,218 people. In the 1990s, they were still killing hundreds every year.

Lions love us too. In Tanzania, Bright wrote that during a 15-year period, a pride of 17 lions in a game preserve by Lake Nyasa killed 1,000 to 1,500. John Gunther reported that five hundred Africans were killed by lions near Ubena, Tanganyika in 1946 and 1947. Once upon a time, the original range of modern lions was enormous — most of Africa, the Mediterranean basin, the Near East, the Middle

East, and much of India. [MAP]

Today, most humans spend their entire lives without ever once experiencing a genuine fear of being grabbed, killed, and eaten. A wildcat that innocently trots past a school must die. Naturally, believing that we are the dominant animal has done quite a head job on our perception of reality. It has given birth to the belief in human supremacy, which rubbishes our ancient relationship with the family of life. As long as this deeply rooted attitude persists, the endless war on wildlife will continue.

**Dinofelis**

Long, long ago, our hominin ancestors were humble meatballs.

The work of Baz Edmeades introduced me to an interesting story about large prehistoric cats that apparently loved hominins so much that our ancestors may have been their favorite lunch. In 1924, Raymond Dart discovered the remains of *Australopithecus africanus* in South Africa. It appeared to be the missing link between ape and man. European scholars soiled their britches. Africa? A continent of primitive savages!?? This was profoundly embarrassing and depressing.

White society traditionally assumed that our holy species had originally evolved in a more dignified region, somewhere much closer to London, probably. This was reinforced by Charles Dawson's gratifying discovery of the missing link between ape and man. Its skull was found near Piltdown village in Sussex, England in 1912. It turned out to be a hoax. White folks had a good cry.

Dart had lived through the horrific bloodbath of World War One. While studying the bone collection in the Swartkrans cave of South Africa, Dart observed that many skulls had been damaged by powerful impacts. Based on this evidence, and his wartime memories, he concluded that our early ancestors were insanely violent, and probably cannibals too.

Years later, C. K. ("Bob") Brain studied the same cave. He concluded that the ancestors had not actually been killing each other. Instead, they appeared to have been a favorite source of nourishment for large cats and hyenas. Early hominins were rather small, and probably not masters of self-defense. For large carnivores, *Australopithecus* was a much easier prey than speedy antelopes.

Brain observed that numerous hominin bones were found in the cave, but far fewer antelopes and other critters, which seemed weird. Who killed them? His primary suspect was the large feline carnivore *Dinofelis*, the dirk-toothed cat. Brain strongly suspected that it had specialized in hunting our hominin ancestors. He found some *Paranthropus* skulls with holes punched in them that exactly matched the long upper canine teeth of the big cat.

*Dinofelis* had lived well for several million years, until the emergence of *Homo erectus*, the first hominin having human-like body proportions, and an extra-large brain for its body size. Erectus was a major turning point in our evolutionary saga. Erectus-like critters migrated from Africa into Asia and Europe, and were big game hunters. The type found in Europe is called

*Homo heidelbergensis*. They were killing woodland rhinos in Boxgrove, England 500,000 years ago. Erectus was likely a more challenging prey for *Dinofelis*. The dirk-toothed cats went extinct about 1.4 million years ago. Without this limit to their growth, the hominin mobs continued to expand.

What would the world be like if *Dinofelis* had not blinked out? What if they had prevented the emergence of large-brained Erectus, and kept our hominin ancestors inside Africa? Would the planet today be in perfect health, home to billions of sabertooths, cave bears, woolly mammoths, giant sloths, Irish elk, and on and on? Would your soul be living in a condor today, soaring above the mountains?

**Circle Dance of Nutrients**

Derrick Jensen pointed out that every student in our culture is taught the notion of a pyramid-shaped food chain. Apex predators (like humans) are placed at the pinnacle of the pyramid, and at the bottom are the wee ones that can only be seen with microscopes. It's no surprise that this hierarchy resembles the hierarchy of power in civilizations. Jensen rejected this model. He sees the family of life as a process of cycles within cycles. The wee ones are no less important than the large carnivores. A Cheyenne proverb said it like this: "Let us all be meat, to nourish one another, so that we all may grow."

Paul Shepard wrote about an eternal dance called, "Now you eat me." Life lives on death. Evolution created a number of large carnivore species that are larger, stronger, and faster than humans. Without tools and fire, we were helpless sitting ducks. Without weapons, hominins would have likely gone extinct prior to the emergence of Erectus, Neanderthal, or Sapiens. But we had tools, and we persisted. Many large carnivore species have been driven to extinction. Hominins played some role in this, by directly killing the predators, or by depleting the game animals they depended on.

Val Plumwood was an Australian eco-philosopher. One fine day in 1985, she hopped in a canoe, and paddled around in a lovely national park. She was quite surprised when a large crocodile knocked her into the water, and violently pulled her underwater. It was a mind-blowing experience. This can't be happening! I am a human being! She nearly died.

The crocodile's sharp teeth gave her a sudden and memorable lesson about an important fact of life. All life is food. I am meat. In an ecosystem, "we live the other's death, die the other's life." Our bodies belong to the ecosystem, not to ourselves.

Vegetarians commonly believe that only animals have souls. We should dine on nothing but soul-free food. This builds a concrete wall across the family of life, separating the haves from the have-nots. Plumwood says bullshit! "All our food is souls." (Hazelnuts and grains of wheat are embryos.) "Our bodies flow with the food chain… they do not belong to us; they belong to all."

She chose to be a vegetarian, not because eating meat was wrong, but because factory farmed meat was a spiritual abomination. Domesticated animals are raised in jam-packed concentration camps, isolated from the wild world, and raised solely to be edible commodities — nothing but meat. She believed that this monstrous process de-souled them.

Plumwood detested modern burial customs, which she saw as a weird component of "heavenism," the belief that our brief time on Earth is like a stay in a cheap dirty motel. Our true home is in a heavenly paradise, far from Earth. We bury our dead in coffins, to better preserve their bodies, until angels come to carry them away to their eternal home. The objective is to prohibit the normal and natural recycling of the nutrients within the corpse.

In our culture, we place grandpa's well-dressed corpse in a sturdy coffin, and bury him deep in the ground, well below the upper topsoil where countless tiny living things work tirelessly to transform organic rubbish into nutritious compost. Rich folks sometimes entirely enclose the coffin in a concrete vault. God forbid that a mob of hungry worms should have a magnificent banquet, celebrating grandpa's life, and forwarding his nutrients to the future generations of all species. The body you live in today is made of nutrients recycled countless times, over millions of years, from the dawn of creation.

The civilization we live in is manmade. We consume food mostly made from domesticated plants and animals, mostly from elsewhere, that is processed, transported, and sold by complex energy-guzzling industrial systems. We do not roam across the surrounding land, hunting and foraging, singing and dancing. We live within something like a walled fortress that keeps us isolated from the family of life. In a sense, it's like a strong coffin.

Other cultures do a far better job of composting corpses. In sky burial, corpses are left on the ground for the vultures to eat. This was done by folks like the Tibetans, Western Algonquians, and Zoroastrian communities in India. Similarly, Walter McClintock wrote that the Blackfeet recycled their dead by placing their corpses on scaffolds built in trees, called death lodges. John Gunther wrote that the Bakutu people of the Congo recycled corpses by laying them on termite hills.

Once upon a time, even the prim and proper English recycled the dead. Barry Cunliffe wrote about excavations of prehistoric sites in Wessex. For several thousand years, until about 1000 B.C., corpses were exposed in special locations, where hungry teams of wild scavengers and composters could feast on them. Leftover bones were buried in pits or ditches. The official word for this custom of exposure was "excarnation."

The Maasai are a tribe of African cattle herders who live primarily on meat, milk, and blood. From their perspective, tilling the soil is an enterprise that is totally beneath their dignity. They won't even break the sod to bury their loved ones. Paul Spencer described how they recycled their dead. The corpse was rubbed with animal fat. Then it was taken outdoors, placed beneath a tree away from the village, and left there for the hyenas and other scavengers. Usually, it was gone by the next morning. Joseph Thomson added, "To bury a corpse would, they think, be to poison the soil; it must be thrown to the wild beasts without ceremony." A side benefit was that well-fed hyenas were less likely to molest their livestock.

Knud Rasmussen described the customs of Greenland's Inuit culture. In an ecosystem where the ground was frozen solid, graves could not be dug for the dead. Corpses were buried under a pile of rocks, where they would eventually decompose, and return to the ecosystem. Knud met Merqusaq, an elderly native who told him about a cold dark winter long ago, when their clan ran out of food, and hunger set in. People starved, some died, and were eaten. "I saw them eat my father and my mother. I was too young and could not stop them." When they ran out of corpses, they decided to kill Merqusaq and eat him. He struggled to escape, and lost an eye in the process. Cannibalism was sometimes a necessary practice in this extremely harsh land, where the survival of the group's most essential people was job #1. Boys too young to hunt were expendable.

# Forests

The last Ice Age began winding down around 11,700 years ago.

Barry Cunliffe noted that sea levels were much lower than today, because so much water was held in huge ice sheets and glaciers. Britain was connected by dry land to Ireland, Scandinavia, and continental Europe. As the climate warmed, the ice regions gradually melted and retreated. Sea levels rose. Ireland became an island by 8000 B.C., and Britain by 6500 B.C. By around 9600 B.C., the mild climate of modern Europe was in place. Over time, the warming trend allowed the expansion of tundra, grassland, forest, and wild fauna.

Hunting with spears and arrows in forested places was more challenging and less productive. Large herbivores were our preferred game, and grasslands were their preferred habitat. Clever humans learned that grassland area could be expanded by reducing forest area. This could be done by suppressing seedlings via periodic burning or livestock overgrazing. Trees could be killed via ring-barking (girdling), or by chopping them down. Hunter-gatherers cleared openings to attract game animals. Herders did it to raise more livestock. Farmers did it to expand cropland area.

Cunliffe wrote that, as the climate warmed, wild folks migrated northward from the Mediterranean. At the same time, forests were also migrating northward. Over time, most of Western Europe essentially became a vast forest. By 7000 B.C., it was inhabited by foragers in a number of locations. In challenging regions, they were nomadic, and in places of abundance they put down roots.

By around 4000 B.C., the northward expansion of forests slowed, as it finally reached regions that were too chilly for happy trees. By this time, some folks were raising crops and herding livestock in a number of permanent settlements that used to be forest. Over time, this increasingly abusive relationship between humans and the tree people led to tremendous eco-destruction.

In the good old days, forests originally covered 95 percent of west

and central Europe. Jed Kaplan and team wrote a paper on the prehistoric deforestation of Europe. It included stunning maps that illustrated the shrinkage of forests between 1000 B.C. and A.D.

1850. [Look] Deforestation went into warp drive between 1500 and 1850, as the voracious human swarm plunged deeper and deeper into high impact living.

In the 1970s, Hugh Brody was working on a British documentary about the Inuit people of Canada. He had worked closely with an elder named Anaviapik, who had never travelled outside of his homeland. When the film editing was done, both got on a plane, and flew to London to bless the finished version. One day, Brody took Anaviapik for a drive in the countryside, and he was totally freaked out by what he saw. "It's all built!" The natural face of the land had entirely been torn off, and replaced with manmade scars.

Humankind's war on forests has been intensifying for several thousand years. It's a huge and complex subject. Forests have suffered from many injurious impacts, including agriculture, herding, industry, warfare, construction, consumerism, climate change, and population growth.

In this chapter, I'll share a few snapshots from humankind's tireless war on the tree people.

**Humbaba's Roar**

The Fertile Crescent was the early hotbed of plant and animal domestication. It was in this region that the first civilizations began popping up. It's interesting that the world's oldest written story is the

Epic of Gilgamesh, the saga of Gilgamesh, a lecherous king who ruled over the city of Uruk, located along the Euphrates River in Sumer (now Iraq).

By around 3100 B.C., Uruk was the biggest metropolis in the world. Today, Uruk is a crude pile of brown rubble sitting amidst a desolate barren moonscape. [Look] The ruins have an important message for folks today: "Don't live like we did." But humankind tends to be a herd of sleepwalkers.

The story was originally etched onto clay tablets in cuneiform script. By around 1800 B.C., assorted segments of the story were eventually unified into the version we know today. In the story, King Gilgamesh was a lad who worked hard to expand low-tech, muscle powered, organic agriculture along the Euphrates River (a process now known as Sustainable Development™ ).

Gilgamesh was probably a real king who lived somewhere between 2900 and 2350 B.C. The growth of Uruk led to massive deforestation along the valley, which encouraged immense erosion and flooding. In the story, Humbaba was the sacred defender of the forest. Gilgamesh whacked off his head, and began cutting trees like there was no tomorrow. Rains then washed the soil off the exposed hillsides, down to bedrock. And so, whenever the floods blast down the river, the noise of catastrophic destruction is referred to as "Humbaba's roar." It's the first sound I hear every morning (sirens, train horns, traffic, power tools, etc.).

**Britain and Ireland**

By 9000 B.C., hunter-gatherers had apparently made some small clearings in the forest to attract game. By 4500 B.C., when farmers and herders began to trickle in, Britain was largely a forest, except for the highlands. Hunters dined on red deer, wild boar, aurochs, and so on. By 3000 B.C., substantial clearances for cropland and pasture were increasing. By A.D. 1100, just 15 percent of Britain was forest. By 1919, it was five percent. Britannia was essentially stripped naked, a ghastly painful open wound.

J. B. MacKinnon mentioned a story about Mark Fisher, a British scientist who visited the U.S. From an overlook in the White Mountain National Forest, he could gaze down on 800,000 acres (323,748 ha) of woodland, an amazingly overwhelming experience. He burst into tears and had a long, hard cry. At Yellowstone, he saw wolves in the wild for the first time, and he dropped to his knees. Fisher dreams of rewilding the U.K. — introducing long lost critters like beavers, lynx, wolves, and so on.

The story in Ireland was similar to Britain in many ways, but Ireland got much more rainfall, annually receiving 50 to 200 inches (127-508 cm) of precipitation. The wet climate encouraged the growth of lush temperate rainforests. Frederick Aalen noted that early hunter-gatherers arrived about 8,000 years ago, when the isle was covered with a dense unbroken forest. Folks lived along coastlines, lakes, and streams. In the forest they created some openings to attract game, but these were apparently small in scale.

Then came a paradise-killing transition. Farmers and herders began arriving in Ireland around 3500 B.C., and the war on trees commenced. By the end of the 1600s, the destruction of native forests was nearly complete. When Aalen wrote in 1978, only three percent of the Ireland was occupied by natural forest or tree farms.

Deforestation had many unintended consequences. William MacLeish noted that in the good old days, the rainforest wicked up a lot of moisture from the land, and then released it into the passing breezes, which carried it away. When the trees were cleared to make room for sheep, this dispersal process wheezed. Meanwhile, the Gulf Stream faithfully continued delivering warm rainy weather from the Caribbean. So, the heavy rain continued, and the water remained where it landed. Consequently, water tables rose, bogs spread, and the ground turned acid.

Deforestation blindsided the Irish rainforest ecosystem. The new manmade grassland ecosystem seemed to be a perfect place for raising livestock. Winters were mild, the grass was green year-round, and there was no need to grow, cut, and store hay for winter feed. Barns were not needed to protect livestock from the cold. Milk and meat were available all year-round. Herding worked well, but the very rainy climate made it somewhat risky to grow grain, despite the rich soils.

In A.D. 1185, King Henry II sent Giraldus Cambrensis to visit Ireland and produce a report. He mentioned many beautiful lakes, where some of the fish were larger than any he had ever seen before. Along the coast, saltwater fish were abundant. The woods were home to "stags so fat that they lose their speed." There were numerous boars and wild pigs. Wolves had not yet been fully exterminated. He said it was common to see the remains of extinct Irish elks.

The herding life allowed the Irish people to survive, sing, and dance. They did not have the slightest interest in the dreary backbreaking work of agriculture, a stupid fad. Cambrensis felt great pity for the uncivilized natives. “Their greatest delight was to be exempt from toil, and their richest possession was the enjoyment of liberty.”

**Rhineland**

Julius Caesar roamed around Western Europe and wrote a report in 51 B.C. He was the emperor of Rome, and his mission was to expand the Empire, collect tribute payments, acquire military conscripts, and vigorously spank troublesome subjects. During this campaign, he focused his attention on provinces of Celtic people in what is now France, Belgium, and England.

He had also hoped to conquer the wild Germanic tribes that lived on the east side of the Rhine, but this fantasy was soon abandoned. The Rhine was a large, treacherous, swift moving river. No bridges. It took a lot of effort and luck to get from one side to the other, and once you set foot on the German side, a super violent welcoming party was eager to immediately cut you to bloody bits.

Each tribe preferred to keep their homelands surrounded with a barrier of uninhabited wilderness. The Germans were primarily wandering herders who built no permanent settlements. They had no granaries loaded with valuable food for raiders to swipe, and no roads to make invasions quick and easy. When danger threatened, the people and their herds vanished into the deep forest mists.

For the German herders, nothing would have been dumber than to eliminate the vast ancient forests that provided this security system. The Roman legions were fine-tuned for open battlefield combat, where heavily armored lads attacked in rigid formations. Wild Germanic tribes excelled at hit-and-run guerilla warfare.

On the west side of the Rhine were the Celts of Gaul (France), who were subjects of the Empire. Their forests were mostly gone, roads crisscrossed the land, and folks were forced to engage in the backbreaking misery of muscle powered organic agriculture. Their granaries stored the result of months of hard work.

Stored grain was a treasure that villainous raiders found to be irresistibly tempting. It was impossible for farmers to hide or quickly move their treasure. Raiding was popular because it was much easier than honest work. Consequently, highly vulnerable farm communities required constant military protection, for which they had to pay dearly. In several Western European languages, the words for "road" and "raid" evolved from a common root.

So, the Celts that Caesar described did not reside in the primordial forest that their wild ancestors once enjoyed. They were not wild and free. Peasants were essentially wealth generating livestock controlled by local strong-arm elites. On the east side of the Rhine, the Germanic tribes had not destroyed their forests. They were alive and well, wild and free.

Tacitus was a Roman historian who wrote *Germania* in A.D. 98 (150 years after Caesar). It described several fiercely independent tribes of that era. They preferred the thrills and excitement of raiding to the drudgery of farming. Perhaps they learned this effective and profitable strategy from the Romans.

Tacitus wrote a fascinating description of the vast Hercynian Forest. From the Rhine, it spanned east, across modern Germany, to the Carpathians, and all the way to Dacia (Romania). A quick traveler could cross the forest north to south in nine days, but it was very long, from east to west. Caesar noted, "There is no man in the Germany we know who can say that he has reached the edge of that forest, though he may have gone forward sixty days' journey, or who has learnt in what place it begins."

Pliny also mentioned it: "The vast trees of the Hercynian Forest, untouched for ages, and as old as the world, by their almost immortal destiny exceed common wonders." In those days, there were still a number of primeval forests in the world.

## Scandinavia

In Sweden, forests also provided freedom and security for the

woodland folks. Vilhelm Moberg celebrated the fact that peasant society in Sweden had largely remained stable and functional for 5,000 years. In most regions of Europe, peasants endured many centuries of misery under the heavy fist of feudalism. Many Norse and Swede settlements were lucky to be protected by their vast, dense, rugged, roadless forests. It's simply impossible to kill or rob invisible folks who live in unknown wilderness settlements. Moberg glowed with gratitude for his nation's forests, which allowed the rustic peasants to preserve their freedom until the industrial era metastasized.

Aggressive invaders from elsewhere found no roads, and soon became perfectly lost. Behind every bush might be a man with a crossbow. The local folks knew every hill and rock in the woods. They could pick the ideal time and place to strike. When trouble was advancing, they gathered as many belongings as possible, and vanished into the greenery.

My Norse ancestors told the story of Ragnarök, the twilight of the gods. Some creepy gods had temporarily subdued nature, but in this great battle, the forces of nature rubbished the gods, and cleansed the Earth with a great flood. Peter Andreas Munch described the dawn of a new era: "Out of the sea there rises a new earth, green and fair, whose fields bear their increase without the sowing of seed."

A man and woman survived the flood. From them sprang a new race of people. A few minor deities also survived, including Odin's son Vidar (Viðr means forest). Rasmus Björn Anderson wrote that Vidar was the god of wild primordial forests, where neither the sound of the ax, nor the voice of man, has ever been heard. "Vidar is silent, dwells far away from, and exercises no influence upon, the works of man, except as he inspires a profound awe and reverence." This was a culture that retained a sense of deep respect and reverence for creation, in its wild and unspoiled form. Forests were holy lands.

## Forest Mining

In the transition from hunting and gathering to farming and herding, forests had served as a limit to growth — grain, grass, and herds don't thrive in shady places. Deforestation cleared away the towering giants and let the sun shine in. When metal axes came into common use, it was easier for lumberjacks to reduce vast tracts of primeval forest into rotting stumps, erosion gullies, and pasture. Early villages and cities were built with the carcasses of countless tree people. The rise of civilizations would not have been possible without innovative advances in unsustainable forest mining, soil mining, and water mining.

George Perkins Marsh was a brilliant American hero that few modern folks have heard of. He published *Man and Nature* in 1864. This gentleman from Vermont served as the U.S. Minister to Italy. While overseas, he visited the sites of many once thriving civilizations in the Fertile Crescent. What he observed was terrifying and overwhelming. Each of them had seriously damaged their ecosystems and self-destructed in similar ways.

Massive levels of soil erosion created surreal catastrophes. He saw ancient seaports that were now 30 miles (48 km) from the sea. He saw ancient places where the old streets were buried beneath 30 feet (9 m) of eroded soil. He stood in mainland fields, 15 miles (24 km) from the sea, which were formerly located on offshore islands. He saw the sites of ancient forests, formerly covered with three to six feet (1-2 m) of precious living soil, where nothing but exposed rock remained.

Far worse, Marsh was acutely aware that every day, back home in America, millions were currently working like crazy to repeat the same mistakes, glowing with patriotic pride at the temporary prosperity they were creating on their one-way joyride to oblivion. In a noble effort to cure blissful ignorance, he fetched pen, ink, and paper and wrote a book to enlighten his growing young nation.

Sales were respectable for a few decades, but America did not see the light and rapidly reverse course. Folks thought that the cure was worse than the disease (like today's climate emergency). A radical shift to ecological wisdom would have hindered the success of our orgy of self-destruction. Tom Brown's mentor, Stalking Wolf, lamented that our culture was "killing its grandchildren to feed its children."

Marsh's book has stood the test of time fairly well. It presented a wealth of vital information, none of which I learned about during 16 years of education. Forests keep the soil warmer in winter, and cooler in the summer. Springtime arrives later in deforested regions because the land takes longer to warm up. Forests absorb far more moisture than cleared lands, so after a good rain, runoff is limited, and flash floods are less likely.

Deforestation dries out the land. Lake levels drop, springs dry up, stream flows decline, and wetlands are baked. Back in the fourth century, when there were more forests, the water volume flowing in the Seine River was about the same all year long. When Marsh visited 15 centuries later, water levels could vary up to 30 feet (9 m) between dry spells and cloudbursts. In 1841, not a drop of rain had fallen in three years on the island of Malta, after the forest had been replaced with cotton fields. And on and on. The book is a feast of essential knowledge.

Walter Lowdermilk was deeply inspired by Marsh's work. In the 1920s and 1930s, he visited China, Western Europe, North Africa, and the Middle East. His mission was to study soil erosion, and write a report for the U.S. Department of Agriculture. They created a short booklet that was very readable and filled with stunning photographs. Over a million copies of it were printed. *Conquest of the Land Through Seven Thousand Years* is available as a free

download. [Link]

**Industrial Wood**

Marsh generally discussed the environmental impacts of deforestation that he had observed at the sites of extinct or wheezing civilizations. These catastrophes were usually the unintended consequences of clearing forest to expand fields and pastures, or to produce lumber or firewood. Over the passage of centuries, clever people discovered many new ways that dead trees could be used to generate wealth and power.

John Perlin wrote an outstanding history of deforestation. It's a modern book (1989), and much easier to read than Marsh. It devotes more attention to the political, military, industrial, and commercial motivations for forest mining. It visits locations including Mesopotamia, Crete, Greece, Cyprus, Rome, Venice, England, Brazil, and America.

Dead trees were used to build houses, bridges, temples, and palaces. Wood was made into fences, docks, wagons, furniture, tools, and barrels. It heated homes and fueled industries that produced metal, glass, bricks, cement, pottery, lime, sugar, and salt. Staggering quantities of wood were consumed by industry. Very importantly, wood was used to build cargo, fishing, and war ships. Navies sped the spread of colonies, empires, trade networks, religions, and epidemics.

Cultures that mindfully limited their numbers, and continued living in a low impact manner, had no future. Their thriving unmolested forests looked like mountains of golden treasure in the eyes of civilized sailors cruising by — and civilized people cannot tolerate the sight of unmolested forests; it drives them nuts. In other words, if you didn't destroy your forest, someone else would.

Perlin described the copper industry on Cyprus in around 1300 B.C. Copper was used to make bronze, which was in high demand during the Bronze Age. For each 60-pound (27 kg) copper ingot produced, four acres of pine (120 trees) had to be reduced to six tons of charcoal fuel. Each year, the copper industry on Cyprus consumed four to five square miles (10-13 $km^2$) of forest. At the same time, the general society consumed an equal amount of forest for heating, cooking, pottery, lime kilns, and so on. Can you guess what inevitably happened to the forests, soils, industry, and affluence of Cyprus?

Shortages also affected the use of firewood. In chilly regions, a city of one square mile might depend on 50 square miles of forest to provide the firewood it consumed year after year. In the good old days, this was often possible. Later, as forest area decreased, and population grew, limits spoiled the party.

If Perlin's book sounds interesting, but isn't easy to get, a similar book is available as a free download. In 1955, Tom Dale and Vernon

Gill Carter published Topsoil and Civilization. Readers are taken on a neat journey, during which they discover how a number of ancient

civilizations destroyed themselves. The free PDF is HERE. It is not available in some countries, for copyright reasons, but I once saw a pirate copy on a Google search.

**New World Forests**

Richard Lillard described how early European visitors experienced the ancient forests of North America. When standing on mountaintops, they were overwhelmed by the fact that as far as they could see in any direction there was nothing but a wonderland of trees. The intense experience of perfect super-healthy wildness was surreal, overwhelming, almost terrifying.

Walking beneath the canopy at midday, the forest floor was as dark as a cellar, few sunbeams penetrated through the dense foliage. At certain times, some sections of the forest were absolutely silent, a spooky experience that bewildered the white folks. They were amazed to see vast numbers of chestnut trees that were nearly as big as redwoods.

British visitors to early settlements were stunned to see incredible luxury — wooden houses, sidewalks, fences, and covered bridges! Commoners were free to hunt large game because the forest was not the exclusive private property of fat cats. In the old country, their diet majored in porridge. Now it could major in wild organic meat. Commoners were free to cut as much firewood as they wished, and

keep their cottages warmer than the castles of royalty. Michael

Williams mentioned one winter night when the king of France sat in his great hall. He was shivering as he ate dinner, the wine in his glass was frozen.

William Cronon noted that settlers with steel axes went crazy on the forests, cutting them down as if they were limitless. Lots of excellent wood was simply burned, to clear the way for progress. They built large houses, and heated them with highly inefficient open fireplaces. By 1638, Boston was having firewood shortages.

As clearing proceeded, summers got hotter, and winters colder. As stream flows dropped in summer, water-powered mills had to shut down, sometimes permanently. In winter, upper levels of the soil froze solid on cleared land, and snow piled up on top of it. When springtime came, the frozen land could not absorb the melt, so the runoff water zoomed away, and severe flooding was common.

Stewart Holbrook wrote about the fantastically destructive obliteration of ancient forests in the U.S. On October 8, 1871, the same day as the great Chicago fire, a firestorm obliterated the backwoods community of Peshtigo, Wisconsin, killing five times as many people as in Chicago. On this day, a new word was added to the English vocabulary, "firestorm."

Holbrook interviewed John Cameron, an eyewitness to the Peshtigo fire. Cameron noted that there had been little snow the previous winter, and just one rain between May and September. Streams were shallow, and swamps were drying up. Logging operations left large amounts of slash in the woods (piles of discarded limbs and branches). Slash piles were eliminated by burning, even when it was very hot, dry, windy, and extraordinarily stupid.

The morning of October 8 was hotter than anyone could remember, and the air was deadly still. At noon, the sun disappeared. By nightfall the horizon was red, and smoke was in the air, making their eyes run. At 9 P.M., Cameron heard an unusual roaring sound. The night sky was getting lighter by the minute. A hurricane force wind howled through. Suddenly, swirling slabs of flames were hurtling out of nowhere and hitting the bone-dry sawdust streets. In a flash, Peshtigo was blazing — maybe five minutes.

Cameron saw horses, cattle, men, and women, stagger in the sawdust streets, then tumble down to burn brightly like so many flares of pitch-pine. He winced as he spoke of watching pretty young Helga Rockstad running down a blazing sidewalk, when her long blond hair burst into flame. The next day, he looked for her remains. All he found was two nickel garter buckles and a little mound of white-gray ash.

The river was the safest place that night. People kept their heads underwater as much as possible, so the great sheets of flame wouldn't set their heads on fire. Within an hour, the town was vaporized. Big lumberjacks were reduced to streaks of ash, enough to fill a thimble. In this village of 2,000, at least 1,150 died, and 1,280,000 acres (518,000 ha) went up in smoke.

Also on October 8, 1871, numerous big fires raged across the state of Michigan, where it had not rained in two months. These fires destroyed 2.5 million acres (1 million ha) — three times more timberland than the Peshtigo blaze. This was an era of countless huge fires. For example, in just the state of Wisconsin, tremendous fires destroyed huge areas in 1871, 1880, 1891, 1894, 1897, 1908, 1910, 1923, 1931, 1936.

Paul Shepard wrote, "Sacred groves did not exist when all trees were sacred." In 1990, I chatted on an internet bulletin board with a Shawnee man named Nick Trim. In the mid-1600s, French colonists were teaching the Shawnee how to build cabins. The natives were very nervous about chopping down living trees, because they were often home to "little people," spirit beings that required utmost respect.

Consequently, to avoid spiritual retaliation, a respectful process was essential. They knocked on each tree, described the situation, and explained why they wanted to take its life. This was followed by a ceremony, prayers, and apologies to the trees. Then, they waited a day or so, to give any spirit residents adequate time to find a comfortable new home. This took so long that the French lost their patience, and the project ended.

Peter Wohlleben, a German wood ranger, developed an extremely intimate relationship with the forest he cared for, and wrote a precious celebration of his love for it. Modern folks who spend most of their lives in civilized space stations almost never get to know the tree people. Some do not eat meat because they sense that animals have souls. In an interview, Wohlleben conveyed a deeper understanding. Killing an animal is the same as killing a tree. He once oversaw a plantation of trees lined up in straight rows, evenly spaced. It was a concentration camp for tree people.

# Soil

## Soil Creation

Geologist David Montgomery wrote an outstanding book on the preciousness of soil, and humankind's devastating war on it. Dirt begins as tiny mineral specks that become detached from solid rock. This can happen because of temperature shifts, frost action, abrasion, water, bacteria, fungi, penetrating plant roots, the passage of centuries, and so on.

Newly created dirt is lifeless particles. Over time, it can accumulate organic matter, and create a thriving wonderland of billions of living organisms — worms, insects, burrowing animals, fungi, microbes, and so on.

The living community in the soil is nourished by decaying plant and animal material. The composting team turns organic matter into a treasure called humus. Humus retains moisture, keeps the soil loose, improves fertility, and provides a luxurious home for the legions of wee organisms that are necessary for plant growth. When it is left unmolested, the layer of precious topsoil can build up over thousands of years, and provide a welcome home to a community of vegetation that nourishes soil life, and discourages erosion by wind or water.

On dry land, topsoil is the foundation of the family of life. Paul Shepard called it "the world's placenta." It nurtures and nourishes the beings that are alive, and composts the biomass they leave behind. This complicated process of big magic has worked wonderfully for several billion years — long before the arrival of humans and dinosaurs.

## Soil Destruction

In the good old days, wild ecosystems were complex communities of plants and animals. These wild communities coevolved over time, which kept them fine-tuned for long term survival in ever changing local conditions.

Richard Manning noted that a chunk of native prairie might contain 200 species of plants, and they cooperatively helped one another optimize fertility. Some retain water, some fix nitrogen, some protect neighbors from the wind, and so on. Believe it or not, wild prairies could thrive, century after century, without irrigation systems, synthetic fertilizer, pesticides, fossil powered machinery, human stewards, and so on.

Spencer Wells lamented the transition to food production, when folks shifted from foraging to farming and herding. "Instead of being along for the ride, we climbed into the driver's seat." Richard Manning agreed. He said that in the good old days, "we didn't grow food; food grew." Food production took an increasing toll on the soil. Folks were clueless about the consequences of what they were doing.

With the transition to plant and animal domestication, humans could produce greater quantities of food, and feed more mouths. But the artificial ecosystems they created (cropland and pasture) commonly reduced natural biodiversity, encouraged erosion, and depleted soil fertility.

Walter Youngquist wrote that the average depth of the world's topsoil is less than 12 inches (30 cm). He added that almost all modern folks consider oil to be a vital strategic resource. Oddly, far fewer have a profound appreciation for soil, the most precious mineral treasure of all. For almost the entire human saga, our ancestors left fossil hydrocarbons in the ground, where they belong. Soil is vital for the survival of the entire family of life — yesterday, today, and forever after.

He warned that, from a human timeframe, topsoil is a nonrenewable resource, because new topsoil is created over the passage of centuries, on a geological timeframe. "Overall, one-third of the topsoil on U.S. cropland has been lost over the past 200 years." Humans are destroying it far faster than nature creates it.

Youngquist mentioned the work of Peter Salonius, a soil scientist who performed 44 years of research. Salonius came to the conclusion that all extractive agriculture, from ancient times to the present, is unsustainable. Environmental history clearly supports his conclusion.

Writing in 2000, J. R. McNeill wrote that the U.S. was currently losing 1.7 billion tons of topsoil per year to erosion. At that time, there were 281 million Americans. So, the loss would have been six tons per person. Writing in 2007, David Montgomery noted that

each year, the world was losing 24 billion tons of soil. In 2015, Joel

Bourne reported that every year, a million hectares (2.4 million acres) of world cropland are taken out of production because of erosion, desertification, or development.

Richard Manning wrote, "The domestication of wheat was humankind's greatest mistake." "There is no such thing as sustainable agriculture. It does not exist." David Montgomery agreed. "Continued for generations, till-based agriculture will strip soil right off the land as it did in ancient Europe and the Middle East. With current agricultural technology though, we can do it a lot faster."

Tobacco

Dale and Carter wrote a history of humankind's war on soil. Immigrants who colonized the U.S. behaved much like civilized colonists throughout history. "They caused more waste and ruin in a shorter time than any people before them because they had more land to exploit and better equipment with which to exploit it. Some ruined their land because they knew no better, and others destroyed out of greed for immediate profits, but most of them did it because it seemed the easiest thing to do."

David Montgomery described the farmers of early America. Tobacco was a goldmine, because it reaped six times more income than any other crop, and it could be shipped across the Atlantic and arrive in perfect condition.

Growing tobacco was labor intensive, and slaves provided the muscle power. It was also a heavy feeder on soil nutrients. A farmer could make great money for three or four crops, after which the soil was severely depleted.

At that point, they often abandoned the useless fields, and cleared forest to create new ones, for another round of jackpot moneymaking. It was easier and more profitable. In the early days, frontier land was abundant and cost little or nothing.

Back in Europe, it was foolish to greedily treat topsoil like a rape and run disposable resource. Over time, agriculture had eventually collided with serious limits, when it was no longer easy to expand cropland area by exterminating forests. So, respectful consideration was given to future generations of descendants, who wouldn't enjoy inheriting a (%@&#!) wasteland. Each generation deliberately made efforts to slow soil deterioration by regularly adding manure, compost, leaves, crushed bone, and other fertilizers. Soil was treated like gold.

On the other hand, in early America, ambitious high achievers thought that being conservative stewards of the land was ridiculously stupid. Livestock was needed to produce manure (fertilizer), and livestock required pasture. Tobacco acres earned big money fast, and pasture acres did not. Profit was their god word.

Cotton

Clive Ponting noted that a bit after the tobacco boom, the cotton gin made it more profitable to manufacture cotton fabric, rather than wool. Cotton became a new goldmine for farmers and slave traders. In Africa, slaves were often purchased by trading cotton cloth for them. Like tobacco, cotton was very hard on the soil. Compared to a food crop, it extracted 11 times the nitrogen, and 36 times the phosphorus. Between 1815 and 1860, cotton was 50 percent of U.S. exports.

As with tobacco, depleted cotton fields were abandoned, and farm country migrated westward, as it devoured ancient forests. It was cheaper, easier, and more profitable to move on, so they did.

David Montgomery described how these folks broke every cardinal rule of careful land stewardship. Farmers did continuous planting without crop rotation, used little or no manure, and plowed straight up and down hills (not contour plowing).

Highly explosive ignorance resulted in painful lessons and enduring destruction. Stripping away the forests in hill country deleted what had held the soil in place for thousands of years. Damage was extreme in the Piedmont belt of the southeastern U.S. Further north, the wreckage was a bit lighter, because snow protected the soil during winter months. But in the south, heavy rains were common. Some regions eventually lost most of their soil, exposing portions of bedrock.

Shockingly huge gullies were created in the wake of deforestation. In Alabama, gullies up to 80 feet (24 m) deep soon followed land clearance. One erosion gully near Macon, Georgia was 50 feet deep (15 m), 200 feet across (61 m), and 300 yards long (274 m). Montgomery wrote, “By the early 1900s, more than five million acres (2+ million ha) of formerly cultivated land in the South lay idle because of the detrimental effects of soil erosion.”

## Dust Bowl

As the colonization of the U.S. proceeded, folks continued migrating westward, moving beyond forested regions to the open prairies. They perceived prairies to be wastelands, because they were largely treeless. Many pushed onward toward Oregon, hoping to settle in lands having fertile soil. In the process, they skipped right past the tallgrass prairie, home to the nation’s most fertile soil by far. Eventually, they realized their mistake, and the primo tallgrass belt was settled and mutilated.

Latecomers got the less desirable shortgrass prairie, which had highly fertile soil, but it was lighter in texture, and more vulnerable to erosion. In shortgrass country, strong winds and periodic droughts were normal and common, but evolution had fine-tuned the wild ecosystem to survive these conditions.

The natural vegetation was drought tolerant, retained moisture, and kept the soil from blowing away. Unfortunately, the settlers brought state of the art steel plows, and proceeded to rip the vegetation off the land, and expose the precious soil. Unintentional foolishness led to catastrophe.

David Montgomery mentioned a 1902 report by the U.S. Geological Survey that classified the high plains as being suitable for grazing, but not farming. It was "hopelessly nonagricultural" because it was ridiculously prone to erosion. Gullible farmers were encouraged by sleazy speculators to settle on the land and get rich quick. And many did, for a while.

Walter Lowdermilk wrote that much of the time between 1900 and 1930 was a highly unusual period of above average precipitation. During the wet years, farmers enjoyed big harvests and generous profits. Wheat could do well in the shortgrass climate, and a thriving wheat field protected the fragile soil from erosion. But in drought years, the wheat withered, and there was nothing to hold the soil in place when the winds began howling.

Tractors were the latest cool gizmo. A lad with a tractor could farm 15 times more land than a lad who used draft animals. Cropland area greatly expanded, exposing more and more soil,

which the winds carried away. The stage was set for the Dust Bowl.

Marc Reisner wrote, "The first of the storms blew through South Dakota on November 11, 1933. By nightfall, some farms had lost nearly all of their topsoil. At ten o' clock the next morning, the sky was still pitch black. People were vomiting dirt."

"If not the worst man-made disaster in history, it was, at least, the quickest." From 1934 to 1938, there were numerous huge dust storms, "black blizzards" that could turn day into night. In 1934, congressmen in Washington D.C. went outside to watch the sky darken at noon. The jet stream carried dust across the ocean to Europe.

In many regions, more than 75 percent of the topsoil was blown away by the end of the 1930s. The Department of Agriculture estimated that 50 million acres (20+ million ha) of farmland had been ruined and abandoned during the Dust Bowl.

## Invisible Disaster

Humankind's war on soil continues, and we're winning. In a 2012 article in *Time* magazine, John Crawford, a risk analysis expert, wrote that "A rough calculation of current rates of soil degradation suggests we have about 60 years of topsoil left. Some 40% of soil used for agriculture around the world is classed as either degraded or seriously degraded — the latter means that 70% of the topsoil, the

layer allowing plants to grow, is gone." [LOOK]

In some locations, visible evidence of this loss is obvious — in large clouds of dust, ghastly erosion gullies, or rain shower runoff that looks like chocolate milk. In other places, the loss may not be readily visible during a lifetime. When you gaze at a large field, decade after decade, you might not notice the gradual loss of tons of soil.

Walter Youngquist mentioned a study finding that when one hectare of land lost six metric tons of soil, the surface of the soil dropped just one millimeter. He thought that erosion was similar to cancer, a persistent intensifying destroyer.

Soils with less humus absorb less water, which increases runoff and soil loss. Light soils are more likely to disappear than dense soils. Sloped land is most prone to erosion. Some regions of Europe typically receive gentle rain showers, while some locations in the U.S. often receive heavy cloudbursts. Of course, wild grasslands and forests excel at absorbing moisture, building humus, and retaining soil.

When forest is cleared, or grassland is plowed, the soil is exposed to incoming sunlight. As the soil warms up, microbial activity is stimulated, which accelerates the oxidation of the carbon-rich humus. Precious carbon built up over the passage of years is dispersed into the atmosphere as carbon dioxide. Soil fertility declines, and will not be promptly restored, if ever.

All tilling, to varying degrees, degrades or destroys soil. The healthy green blanket of natural vegetation that protects the precious topsoil is entirely torn off the face of the land. The soil dries out, hardens, and absorbs less precipitation, which accelerates runoff. This increases the chances of sheet erosion, gullying, landslides, and flooding. It can sometimes take centuries for nature to replace the unprotected topsoil lost in a stormy hour.

Long ago, the Mediterranean basin became a hotbed of civilizations as agriculture spread westward out of Mesopotamia. The Mediterranean climate provided generous winter rains, making it a suitable place to grow wheat and barley. Much of the basin was sloped land, which was extensively deforested over time, to meet the growing demand for lumber and firewood.

Flocks of sheep and goats roaming on the clear-cut hillsides overgrazed, encouraged erosion, and prevented forest recovery. By and by, the rains leached out the nutrients, and washed much of the fertile soil off the hillsides. In many locations, bare bedrock now basks in the warm sunshine, where ancient forests once thrived in ancient soils.

Dale and Carter noted that, in the good old days, the Mediterranean used to be among the most prosperous and progressive regions in the world. But when they wrote in 1955, most of the formerly successful civilizations had become backward, or extinct. Many had just a half or a third of their former populations. Most of their citizens had a low standard of living, compared to affluent societies.

Montgomery noted that these ancient civilizations often enjoyed a few centuries of prosperity, as they nuked their ecosystems. Sadly, the soils of the Mediterranean basin were heavily damaged by 2,000 years ago, and they remain wrecked today. They are quite likely to remain wrecked for many, many thousands of years. Much of the region that once fed millions is a desert today.

I never learned any of this in school. Instead, this region was celebrated as the glorious birthplace of civilization, democracy, culture, and science. It had incredible architecture and dazzling artwork. It was home to brilliant writers and philosophers (no mention of slaves). Many of our public buildings today, with their ornate marble columns, pay homage to this era when we first got really good at living way too hard.

Of course, progress never sleeps. In his 2014 book, *The Great Acceleration*, J. R. McNeill narrowed his focus to the catastrophic changes that have occurred since 1945. He noted that in the world, about 430 million hectares (seven times the size of Texas) has been irreversibly destroyed by accelerated erosion. “Between 1945 and 1975, farmland area equivalent to Nebraska or the United Kingdom was paved over.” By 1978, erosion had caused the abandonment of 31 percent of all arable land in China.

**Soil Nutrients**

All life depends, directly or indirectly, on essentials like sunlight, water, oxygen, carbon dioxide, nitrogen, phosphorus, potassium, soil, and so on. Healthy wild ecosystems have, over millennia, evolved biological communities that are better able to survive the kicks and punches delivered by shifting environmental conditions.

Agriculture operates in a far less elegant manner. It’s a powerful, rowdy, perfectly unnatural, manmade monstrosity. Its unpredictable mood swings can range from feast to famine, prosperity to oblivion. In Mary Shelley’s classic horror story, the foolishly clever Dr. Frankenstein got cold shivers when his ghoulish monster turned to him and spoke these words, “You are my creator, but I am your master.” She wrote it in 1816, the “year without a summer,” a time of fantastic storms, caused by the 1815 eruption of the Mount Tambora volcano. Dust hid the sun.

Wild vegetation excels at recycling essential nutrients. On the other hand, field crops excel at extracting and exporting nutrients, a slippery clumsy dance of destruction. For example, phosphorus is transferred from the soil to the corn, from the corn to the hog, from the hog to the human, and finally flushed down the toilet, bye-bye! Little if any is returned to the field to replenish what was removed from the soil.

Poop is precious. Remember that. In 1588, Anzelm Gostomski, a Polish gentleman, once proclaimed an eternal truth: “Manure is worth more than a man with a doctorate.” In the modern world, every shipment of food that moves from the local countryside to faraway consumers is carrying away essential soil nutrients on a one-way ride, never to return.

To keep a farm operation on life support for as long as possible, efforts must be made to replace the deported nutrients. Over the centuries, farmers have kept soil fertility on life support by applying stuff like sewage, manure, ashes, lime, bone meal, seaweed, compost, peat moss, guano, synthetic fertilizer, and so on. In China, human wastes have been used as fertilizers for 5,000 years. Traditionally, manure has been a popular fertilizer. Gathering and spreading manure was far more fun than depleting the soil and starving.

Even modest sized cities could religiously indulge in rituals that

recycled holy shit. In 1909, Franklin Hiram King visited Kyoto, Japan. While traveling down a road one lovely morning, he observed a long caravan of men pulling cartloads of precious night soil from town. They were in the process of returning this sacred life-giving treasure to the fields where their food was grown.

Each cart carried six 10-gallon (38 l) covered containers of delightfully fragrant plant food. King noted that he passed 52 of these carts. Then, on the return trip, he passed another 61 carts. Other caravans moved down other roads. He estimated that 90 tons of sewage was hauled out of town on that morning. I wonder if this was a daily routine.

With the growth of population and urbanization, returning more and more poop to fields that were farther and farther away became impractical. Eventually, imported fertilizers were able to save the day (temporarily). Guano, phosphates, and synthetic ammonia were powerful, but nonrenewable. Unfortunately, they accelerated population growth, forcing the jumbo-sized mob to zoom faster down a one-way road to a less than utopian future.

Writing in 2022, Vaclav Smil estimated that 40 to 50 percent of the eight billion people alive at that time existed only because of the intensive use of synthetic ammonia fertilizer. It had succeeded in shattering the population ceiling (temporarily).

In order to survive in good health, all living plant and animal organisms must acquire the mix of nutrients that are essential for them. Different species prefer different mixes. David Montgomery explained that there are three absolutely must-have macronutrients for all plant and animal life (including you), for which there are *no substitutes* — nitrogen (N), phosphorus (P), and potassium (K). General purpose "NPK" fertilizers contain portions of all three.

Humans acquire these essential nutrients by eating plant and/or animal foods.

Nitrogen (N)

Vaclav Smil noted that all living organisms also require carbon, hydrogen, oxygen, and nitrogen. In the world, there are huge quantities of all four, but nitrogen is the oddball. The air we breathe is about 78 percent nitrogen, but it's not in a form that most living things can actually use.

In the air, it's a gas that consists of tightly bonded pairs of nitrogen atoms ($N_2$) that are too stable to readily intermingle with other atoms. Before it can be utilized by living organisms, it must be transformed via a process called *nitrogen fixation*. In the soil are *nitrogen-fixing* bacteria that can combine nitrogen and hydrogen to produce ammonia ($NH_3$), a compound that can nourish natural processes. Ammonia is 82 percent nitrogen.

These bacteria grow on the roots of *leguminous* plants, like beans, soybeans, peas, chickpeas, peanuts, lentils, carob, alfalfa, and clover. So, when you eat beans, your body is able to absorb the usable nitrogen they contain. After a legume crop is harvested, the leftover plant material decomposes, releasing fixed nitrogen into the soil, fertilizer for future crops. This "green manure" can be plowed back into the field.

When livestock graze, they absorb usable nitrogen from their food, and then produce "brown manure" that generously boosts soil fertility. You and I commonly get our nitrogen when we digest the amino acids in high protein foods, including beans, leafy greens, nuts, seeds, eggs, milk, and lean meat. At the rear end of the process, we expel a potent fertilizer called poop.

Old fashioned low-tech farming could produce modest harvests when assisted by good luck and determined efforts. Unlike modern industrial agriculture, old fashioned farm soil only provided modest amounts of usable nitrogen. Low nitrogen content results in low yields, while high content boosts them. So, nitrogen is a *limiting nutrient*, something like the gas pedal in a car. So is phosphorus.

Ordinary soil generally contains modest amounts of N, P, and K. Applying additional potassium (K) to the soil does little or nothing to boost crop yields. But synthetic fertilizers can boost the content of nitrogen and phosphorus beyond normal levels, and this actually promotes bigger harvests. Of course, bigger harvests can feed larger mobs of hungry humans.

In the short version of nitrogen history, there were two huge leaps in fertilizer technology — guano and synthetic ammonia.

¶ Guano is an organic fertilizer created by dense accumulations of bird shit or bat shit. Seabirds often nest on islands, where they are less vulnerable to pesky predators. For the same reason, bats prefer to shit in the comfort and privacy of caves.

Each day, seabirds gobble up lots of yummy anchovies, return to their nesting ground, and happily unload magic excrement. Century after century, more and more piles of crap grew higher and higher. Mounds of guano could have nitrogen content ranging from 8 to 21 percent by mass! Holy shit!

In arid regions, like the Pacific coast of South America, the nesting islands were deeply covered with nutrient rich guano. Islands off the shore of Peru used to be guano heaven — some deposits were over 200 feet (61 m) deep. In wetter regions, birds also colonize offshore islands, and shit all over them, but rainy weather and humidity leaches out vital nutrients.

According to Wikipedia, "The rulers of the Inca Empire greatly valued guano, restricted access to it, and punished any disturbance of the birds with death." Guano was used for centuries by indigenous folks.

By the 1840s or so, in Europe and North America, a persistent brutally abusive relationship between farmers and their precious dirt was taking a serious toll on soil fertility. Meanwhile the mobs of hungry white folks continued snowballing. How in the are we going to feed them? Trouble ahead!

White folks first learned about magic guano in 1802, via the writings of Alexander von Humboldt, which were translated into several languages. Eventually, some ambitious lads experienced a breathtaking revelation. Holy shit! We could become filthy rich guano tycoons!

As we all know, money is a devilish hallucinogen that can turn kind and decent people into batshit crazy idiots. Consequently, humankind began a dramatic transition from traditional food production that utilized local manure, into a fast lane powered by imported bird shit. In some locations, the guano had an exceptionally high content of nitrogen, phosphate, and potassium. It greatly excited the productivity of field crops.

And so, in the nineteenth century, guano was the world's super fertilizer, and a source of great wealth. A guano gold rush was born. Nations vigorously competed to claim ownership of guano islands. Disputes triggered the War of the Pacific (1879-1884).

Traditions got tossed on the compost pile. Farmers no longer had to devote lots of time to nutrient recycling. They didn't need to plant cover crops of nitrogen fixing legumes, or do crop rotations. They could simply buy magic bird shit, harvest far greater yields, and get rich quick.

Industrial scale guano mining was extremely disruptive to the seabirds that squirted out the valuable shit. On Peru's guano islands, bird populations plummeted from the 53 million in the late 1800s to just 4.2 million in 2011.

Of course, guano was a finite resource created over the passage of countless millennia, and it was being extracted as fast as humanly possible.

Production peaked around 1870. Insatiable greed heads then directed their attention to the saltpeter deposits in the deserts of Chile. Saltpeter is sodium nitrate, a compound that contained usable nitrogen.

J. R. McNeill noted that by 1900, German farmers were highly dependent on imported guano. Without it, they could no longer feed the growing mob of hungry Germans. Gosh! Wouldn't it be wonderful if we could produce fixed nitrogen on an industrial scale? Could it be possible? Yes! Unfortunately, two Germans figured out how.

¶ Synthetic Ammonia. I'd now like to introduce you to Fritz Haber and Carl Bosch. In 1909, chemist Fritz Haber invented a process that could extract nitrogen from the air ($N_2$), mix it with natural gas ($CH_4$), and embed it in ammonia ($NH_3$), via an energy-guzzling process of high heat and pressure. Synthetic ammonia created a sharp turn in human history. (Years later, Haber invented Zyklon B, the poison used in Nazi gas chambers.)

Carl Bosch figured out how to perform this catalytic process on an industrial scale. Haber and Bosch opened the first ammonia plant in Germany in 1911.

Ammonia was also a feedstock for explosives, which were in high demand for countless bloody military adventures. So, many new ammonia plants were built. At the end of World War II, large quantities of ammonia became available for other uses, and the production of synthetic ammonia fertilizer soared.

In the second half of the twentieth century, the production of synthetic NPK fertilizers skyrocketed: 4 million tons in 1940, 40 million tons in 1965, and 150 million tons in 1990. Far more food was produced, and the human population grew at an explosive rate.

Today, the intended benefits of these fertilizers are maxing out — applying more of it to a field no longer increases the size of the harvest. But the potent fertilizer runoff is able to continue increasing the contamination of groundwater, rivers, coastal dead zones, and oceans.

Richard Manning noted that when farmers apply synthetic fertilizer on a field, less than half of it is absorbed by crop plants. Fertilizer can acidify the soil. Some of it dissolves and contaminates the groundwater that folks drink, and lots of it runs off into waterways. Much of the U.S. Corn Belt drains into the Mississippi River, which is an ecological catastrophe.

Fertilizer runoff stimulates the growth of algal blooms. As the blooms die, they consume oxygen and emit $CO_2$. As the oxygen content of the water is depleted (anoxia), this can cause everything to die. The Mississippi flows into the Gulf of Mexico, where it has created a dead zone the size of New Jersey. The Baltic Sea is home to seven of the of the world's ten largest marine dead zones. About half of U.S. lakes have low oxygen content, and the number of dead zones in the world continues growing (415 in 2022).

The National Science Foundation reported that fertilizer runoff is increasing the nitrogen content in rivers and streams, where microbes convert it into nitrous oxide ($N_2O$), "a potent greenhouse gas, with a warming potential of approximately 300 times that of carbon dioxide." Nitrous oxide persists in the atmosphere a long time, and promotes global warming and acid rain (it's also a pain reliever, laughing gas). Cow shit is another source of nitrous oxide emissions, and their belches are a significant source of methane.

In the twentieth century, global population skyrocketed at a rate similar to the rapid increase in fertilizer use. Nitrogen and phosphorus are limiting nutrients, and synthetic fertilizers exceled at sweeping away longstanding limits to crop productivity. Julian Cribb wrote that the wellbeing of most of humankind is now heavily reliant on the use of these potent fertilizers to assure adequate food harvests.

Today, about 80 percent of synthetic ammonia is made using a natural gas feedstock — a finite nonrenewable fossil energy resource. As natural gas prices rise, so will the cost of nitrogen fertilizer, which will increase the cost of food. Political instability in the world is increasing. A few nations have abundant reserves of gas, while all nations are dependent on reliable access to food. This presents many opportunities for heavy handed dog-eat-dog mischief.

## Phosphorus (P)

Like nitrogen, phosphorus is also a limiting nutrient. It is always found in mixed compounds, never in pure form. Much of the P in soil is in a form that plants cannot use. This puts a firm ceiling on crop productivity. In NPK fertilizers, usable P is provided by phosphate ($P_2O_5$), a mineral compound.

When phosphate is applied to a field, crop yields are boosted. When it runs off cropland into bodies of water, it can trigger eutrophication (nutrient overload). Phosphorus enters your body at the mouth, and departs via urine and excrement. It’s possible to recover it from sewage and manure, but not cheap. When mixed 50/50 with water, your urine is an excellent liquid fertilizer that contains both nitrogen and phosphorus — and it’s free. Waste not!

Fred Pearce noted that every living cell needs P, and there is no substitute. It’s as essential to plant life as water is. We are great at misusing it, suck at recycling it, and it’s vital for feeding humans and other critters. Each year, the world mines 170 million tons of phosphate.

The world’s primary source of phosphate rock is an open-cast mine in the Western Sahara, a region currently controlled by Morocco — an unpleasant situation that irritates the native Saharans. Political instability in the region could disrupt the production and distribution of phosphate, and generate a food crisis in many nations.

So, demand is rising, most of the world’s best phosphate reserves are gone, and those that remain are in just a handful of countries. Most of these reserves are in hard rock form, which requires vastly more fossil energy to mine and process. There are also large deposits of phosphates in deep sea locations, but mining them would be deeply expensive.

When will phosphate production peak? That’s a highly contentious question, because accurately estimating the remaining reserves requires lots of guesswork. Today, of the three essential NPK nutrients, P is the most worrisome to experts. ancient seas and lakes. The K added to NPK fertilizer comes from

Just as I was about to send this info to the world, my faithful muse gave me a dope slap and directed me to an important research paper. It's written in super-cryptic science jargon, and ordinary readers (like me) may suffer some permanent brain damage, but it's a fascinating horror story.

Christine Alewell and team put a spotlight on the latest news. If global heating doesn't blindside industrial civilization, phosphorus depletion will. Big Mama Nature brilliantly guided the evolution of wild ecosystems that did a wonderful job of protecting precious topsoil and perpetually recycling essential nutrients. Sadly, cleverness has pulled the rug out from under this delicate balancing act. The tilling of agricultural soils eliminates the protective covering of wild vegetation, and exposes the delicate treasure below.

When P is not locked within solid rock, its water soluble. When rain splatters directly on pulverized farm soil, gravity carries the P runoff elsewhere, like wetlands and streams. Erosion causes about half of the P depletion in farm soil. As P content decreases, so does the productivity of the field. Harvests shrink.

Alewell noted, "The world's soils are currently being depleted in P in spite of high chemical fertilizer input." In poor countries, where folks can't afford potent fertilizer, the rate of P depletion is even higher. In the long run, agriculture is not sustainable. "Soil phosphorus (P) loss from agricultural systems will limit food and feed production in the future."

To continue producing chemical fertilizer requires continued mining of nonrenewable geological deposits of P, an increasingly limited resource. The P moves in a one-way flow from the mines, to the agricultural land, into freshwaters, and finally into oceans.

The "organic management" of P is also unsustainable. A cornfield extracts P from the soil. Then, the harvested grain is sent somewhere else, along with its P content. Added manure and compost won't replace all of the P exported. Similarly, livestock grazing extracts the P from the greenery consumed. Some of it is returned to the land via manure and urine, but some of it is sent away to the meat processor, never to return.

## Potassium (K)

In plants, potassium is important for the synthesis of protein. The potassium component of NPK fertilizer is provided by a variety of minerals rich in potash (K O) that are found in the salt beds of 2

nonrenewable mined sources. David Montgomery noted that “potassium occurs in rocks almost everywhere in forms readily used as natural fertilizer.” We don’t have to worry about near term potassium shortages. Lots of other future crises are closer to the front of the line.

## Bottom Line

Abby Rockefeller wrote a fascinating essay that thoroughly explored the long and exciting history of human pooping and peeing. In modern cities, sewage treatment plants regularly generate sludge, which has to be removed and put somewhere. Somewhere is often cropland.

Besides the holy shit that happily splashes in your toilet, sludge also contains lots of weird stuff produced by industrial civilization. For example, volatiles, organic solids, disease-causing pathogenic organisms, heavy metals, and toxic organic chemicals from industrial wastes, household chemicals, and pesticides. Crops grown in fields treated with toxic sludge produce foods that may be less than wholesome.

Bill McGuire reported that intensive industrial agriculture is depleting the quality of cropland soils. In many parts of the world, including in the U.K., E.U., and the U.S., these soils are becoming “effectively sterile in the absence of regular fixes of artificial fertilizer.” No free lunch. No sustainable agriculture. But eight billion get to pee and poop every day (for a while). Hooray!

# Water

Like soil, water is essential for all life — no water, no life. Access to wetness determines the essence of every ecosystem, from rainforests to deserts. The plant and animal communities that inhabit them are species attuned to surviving in local conditions. Wherever our wild ancestors wandered, they simply ate the healthy wild foods the land provided. Until several thousand years ago, it never occurred to them to play the game of stewardship, and assume the role of owner and master. They had no need to. They were wild, free, and happy. Life was good.

J. R. McNeill wrote that salt water is 97 percent of all $H_2O$. About 69 percent of all fresh water is frozen, mostly in Antarctica. Of the 31 percent that is not frozen, about 98 percent is stored in underground aquifers, many of which are too deep to be molested by folks with boring machines. The water in all lakes and streams is about a quarter of one percent of all freshwater. An essential benefit of incoming sunbeams is desalination. As salt water evaporates, water vapor is released into the atmosphere, where it can travel the world and become dew, rain, frost, or snow.

McNeill wrote that for almost the entire human saga, water was primarily used for little more than drinking and bathing. Today, we use far more, waste far more, and pollute far more. Three major guzzlers are agriculture (70%), industry (20%), and cities and towns (10%). In 1990, we were using 40 times more water than in 1700. In the twentieth century alone, water consumption increased 900 percent.

## Irrigation

Water-guzzling agriculture began in places like southern

Mesopotamia. James Scott wrote a new and improved version of the story about the dawn of plant and animal domestication, and the eventual emergence of civilization. He focused on southern Mesopotamia, where wild foragers originally wandered into a region of thriving wetlands loaded with wild wheat, barley, and many other wonderful things to eat. It was delicious paradise, full of wild game, and nobody owned it, so they decided quit wandering, build luxurious huts, and enjoy a life of prosperity.

By and by, the growing number of bambinos began to strain the party. Their unfortunate solution was to increase food production by transforming desert into productive cropland. In the following pages, we'll examine some of the downsides of irrigation. This was a daunting fork in the path.

Sandra Postel is fascinated by a treacherous addiction called irrigation. Today, about 17 percent of global cropland is irrigated, and it produces 40 percent of our food. Crops can be grown in lands too dry for rain-fed agriculture, and they often produce higher yields. Irrigation enables population growth. Since 1800, irrigated cropland has grown 30 times in area, and global population has soared from one billion to more than eight billion.

In the early days, irrigation was a game of moving surface water into fields via gravity power. Keeping the irrigation channels from silting up was a major and never-ending job that gave legions of slaves and peons satisfying work to enrich their lives. When enemies came to visit, a cruelly enjoyable way of destroying your society was to deliberately rubbish your irrigation system.

After the Second World War, powerful electric and diesel pumps became affordable and popular. So did drilling rigs, which were used to bore tube wells for the extraction of groundwater. In the old days, water was pumped via muscle power or windmills. Cheap and abundant fossil energy allowed far more water to be extracted. This spurred a massive expansion of the area of irrigated land, which tripled between 1950 and 2000.

Today, the mining of underground aquifers makes possible about a tenth of world grain production. Huge fossil aquifers are being drained in the U.S. Great Plains, the North China Plain, and under Saudi Arabia. Ancient water is being extracted far faster than the aquifers can naturally recharge — a foolish one-time joyride.

Walter Youngquist was no fan of aquifer mining, because it created "food bubbles," where crops could be raised in locations where highly productive agriculture was otherwise impossible. In 2011, the World Bank estimated that these temporary bubbles were feeding 175 million in India, and 130 million in China. The bubbles will inevitably burst. Then what?

In the U.S., the huge Ogallala Aquifer lies beneath eight states in the Great Plains. It now provides the water for about 27 percent of the irrigated land in the U.S. The aquifer contains water that may be 25,000 years old. After the Second World War, folks started using automotive engines to pump wells. Rotating motorized center pivot irrigation systems sprayed water over large circular patches of land. Irrigation transformed marginal grassland into a highly productive environment for ranching, and growing soybeans, corn, and wheat.

The Ogallala is mysterious, and humankind has yet to develop X-ray vision. Writing in 2007, Clive Ponting reported that the aquifer could be depleted as early as 2010. More recently, experts predict it could fail as soon as 2028. What is measurable is that in some regions, since the 1940s, the water table has dropped more than 300 feet (90 m). Youngquist noted that "in north Texas, some 15,000 square miles (39,000 $km^2$) of agricultural land has had to be abandoned as the Ogallala aquifer is totally depleted." Luckily, what gets pumped out today will be replenished by nature in a mere 6,000 years, maybe. Others say hundreds of thousands of years.

And so, as topsoil is taking a beating, aquifers and surface water are being overpumped, and population keeps zooming upward (oh-oh!). Joel Bourne noted that agriculture guzzles most of the water used by humans. Irrigated fields have yields that are two to three times higher than rain fed fields. Demand for water is projected to increase 70 to 90 percent by 2050, but water consumption today is already unsustainable. The solution is easy, all we have to do is "double grain, meat, and biofuel production on fewer acres with fewer farmers, less water, higher temperatures, and more frequent droughts, floods, and heat waves" (and rising energy costs). No worries!

## Draining Rivers

Irrigation is also draining major rivers. For example, Erling Hoh described the Yellow River in China, which is 3,400 miles (5,472 km) long. Its waters have been intensively overdrawn for irrigating cropland. In 1972, for the first time in history, the flowing river never made it to its normal outlet in the Yellow Sea. In 1997, lower sections of the river were dry for 227 days, reducing the harvest by an estimated 8.5 million tons. Some sections have been so polluted by cities and industries that the water is unfit for both irrigation and human consumption. Fish no longer survive in some regions.

Sandra Postel noted that a growing number of major rivers are, for months at a time, discharging little or no water into the sea. They include the Colorado, Rio Grande, Yellow, Indus, Ganges, Amu Darya, and Murray. Rivers deliver both life-giving water, and death-bringing pollution. As the volume of flow diminishes, there is less water to dilute the crud.

The Ganges is getting sucked dry. Old fashioned irrigation, which moved river water to fields via canals, worked for centuries, when there were fewer people, and more forests. As demand increased, the water level of the river dropped lower and lower, until the old canal distribution system could no longer work. Luckily, technology came to the rescue. Tube wells were drilled, and motorized pumps began extracting water like crazy, and the crops prospered.

Naturally, with this increased extraction, underground water tables dropped. Consequently, less groundwater naturally flowed back into the river. So, to an increasing degree, the Ganges is

looking less like a mighty river, and more like a big mudflat. [LOOK] Breezes drifting over the mountain from the future have the pungent aroma of food shortages. Progress!

**Subsidence**

Clive Ponting noted that many folks today are still able to snatch as much water as they want, pay nothing for it, and not worry about waste. Irrigating cropland with state of the art, maximum efficiency technology is prohibitively expensive. It’s far easier and affordable to continue using highly wasteful methods. In India and China, two-thirds of irrigation water never reaches the plants, because of losses due to evaporation, or seepage from delivery canals. U.S. farmers merely waste half of their water.

Postel wrote that water tables are dropping beneath large regions of northern China, India, Pakistan, Iran, the Middle East, Mexico, and the western United States. Ground water is being pumped out faster than the aquifers are naturally replenished. When a well begins to wheeze, they keep drilling it deeper and deeper, until it finally goes dry. Up to 10 percent of the global food harvest is made possible by aquifer mining. This path does not have a happy ending.

Subsidence is a common but unintended consequence of aquifer mining. It affects locations where the geology is not sufficiently rigid. Underground, as the water is removed, it leaves behind an empty void that the soil above sinks to fill. Aquifer compaction can be irreversible — nature may never again be able to recharge the aquifer. Game over.

J. R. McNeill reported that in 1990, Mexico City was using 35 times more water than it did in 1900. The land surface subsided.

On the streets, some locations have unevenly sunk up to 23 feet (7 m), which damaged sewer pipes, streets, and buildings. Walter Youngquist wrote that the entire San Joaquin Valley is sinking. In some areas, the water table has dropped up to 500 feet (152 m). Near Mendota, the land surface has sunk more than 28 feet (8.5 m).

[LOOK]

Subsidence is an issue in many places, including Osaka, Tokyo, Bangkok, Beijing, Alexandria, New Orleans, Houston, Las Vegas, and southern Arizona. Jakarta, Indonesia is the fastest sinking major city in the world. It gets 300 days of rain per year, and it sits on a big freshwater aquifer, which its huge population is guzzling faster than it can recharge. Because so much of the city is paved, not enough rain can soak into the ground to keep the aquifer full.

Around the world, farmers, industries, and cities engage in aquifer mining. Subsidence is the shadow of overpumping. The problem will increase as long as irrigation and extreme overpopulation continues. While population continues growing, unsustainable water mining makes it harder for food production to keep up with growing need.

**Salinization**

Great achievements of human cleverness often have daunting unintended consequences. Irrigated agriculture is an excellent example of this. By around 6,000 years ago, irrigation was cleverly transforming the deserts of southern Mesopotamia into a (temporary) utopia of highly productive fields of wheat, barley, peas, and lentils. The long and winding soap opera in this region could fill 100 pages. Let's boil it down to a quickie.

Southern Mesopotamia is a flat, hot, nearly rainless desert covered with fertile soil that has above average salt content. The Tigris and Euphrates rivers flow through the region. To the north, a higher and wetter region, there is an annual rainy season. When the rains arrive, both of the rivers move heavy loads of silt downstream. Something odd happens here.

Over the centuries, as silt dropped out of the water flow, layer upon layer accumulated in the flood plains. Eventually, both rivers were travelling through channels that were elevated above the surrounding land. Clever folks recognized the possibility that life-giving water could be diverted from the rivers into irrigation canals, via a labor-saving magic called gravity. So, they did.

Now, all they had to do was dig miles and miles of irrigation canals to deliver the water across the desert and start growing crops — good healthy exercise for legions of slaves. Unfortunately, year after year, the rivers continued to deliver more and more silt, which took great delight in repeatedly plugging up the tidy canal systems. Keeping the canals clear was a never-ending challenge.

Big Mama Nature thinks this is hilarious. She laughs until the tears flow. Technology and progress have a long history of biting us on the ass. It's so much easier to carefully adapt to elegantly sustainable wild ecosystems, like the rest of the family of life does.

Anyway, irrigation made it possible for folks to produce lots of food, and feed lots of people, which enabled the emergence of the first states, cities, and empires — and the endless bloody clashes between super ambitious, testosterone powered, glory-seeking control freaks. Meanwhile, out in the fields, dissolved salt ions were deeply involved in a project to teach the too-clever critters important lessons about agriculture, irrigation, and unintended consequences.

Several types of mineral salts, at varying levels of concentration, are natural components of soils and water. Even raindrops can contain traces of dissolved salts. All irrigation water contains some salt. Salinization is a process in which the accumulation of salt in the soil can reach levels that affect plant health, or even prohibit plant life. When cropland is not well drained (as in Mesopotamia), irrigation can make the water table rise. When this happens, water containing dissolved salts moves upward, closer to the root zone of the crops above.

When salty moisture migrates close to the ground surface, the water evaporates, and the salt is left behind. When plants are thirsty, their roots take in water, and leave the salt behind. As salt levels intensify near the soil surface, eventually not even weeds can survive. At the end of the road, evaporation of saline water can leave the ground surface covered with a white layer of salt crystals, looking a bit like fresh snow. Coroners would issue these lands a death certificate. They remain useless to this day.

Clive Ponting indicated that salinization can be a slow-motion catastrophe that may remain largely invisible to multiple generations. In Mesopotamia, wheat and barley were grown in equal amounts in 3500 B.C. Barley is more salt-tolerant than wheat. By 2500 B.C., wheat was just 15 percent of the grain grown, indicating salt problems. By 1700 B.C., wheat growing had gone extinct. Around 2000 B.C., there were some reports that "the earth turned white." At its peak, Mesopotamia maybe had a population of 1.5 million. By A.D. 1500, just 150,000 lived there.

Now, let's fast forward to modern times, an era when folks built lots of big dams — a subject that fascinated Marc Reisner. Many were built in the Colorado River basin, for flood control, hydroelectricity generation, recreational fishing and boating, and to store water for irrigation and municipal water systems. Historically, salinization has been a tireless serial killer of civilizations. In the big dam era, human cleverness achieved new levels of brilliant incompetence. Irrigation grew explosively.

As water in the Colorado moves downstream, it is diverted multiple times to irrigate the land it passes through on its long journey from the Rockies to Mexico. The water is dumped on a field, where it keeps crops on life support, dissolves salts in the soil, and eventually finds its way back into the river. The salty water flows down to the next irrigation project, and the next, and the next… picking up salt with each detour.

Along its journey, the water takes rest stops in reservoirs, where about a tenth of it evaporates, concentrating the salt that is left behind. By the time it reaches trendy restaurants in southern California, the water is so salty that it's sometimes served with a lemon slice.

Reisner noted that in the Grand Valley, when Colorado River water is diverted for irrigation, it contains 200 parts per million (ppm) of salt. When it returns to the river, it has 6,500 ppm. On rivers like the Colorado and Platte, the water may be used up to 18 times. Eventually, the Colorado flows across the border into Mexico, where the water has become "liquid death." At the end of its journey, the river used to empty into the Gulf of California. Today, it dries up before it can reach the finish line.

The salt problems could be reduced by installing state of the art drip irrigation systems, in which far more water actually makes contact with plant roots, but this option is insanely expensive. Another option is installing drainage systems in irrigated fields, so dissolved salts can be leached out of the soil. This is also insanely expensive, and it produces very salty dreck that should then be disposed of in a thoughtful mature manner.

Regions of salt damaged soils are found in Africa, Asia, Australia,

and the Americas. Writing in 2015, Pooja Shrivastava summed it up like this: "It has been estimated that worldwide 20% of total cultivated and 33%

of irrigated agricultural lands are afflicted by high salinity. Furthermore, the salinized areas are increasing at a rate of 10% annually for various reasons, including low precipitation, high surface evaporation, weathering of native rocks, irrigation with saline water, and poor cultural practices. It has been estimated that more than 50% of the arable land would be salinized by the year 2050.” Hmmm… Maybe we won’t be having ten billion for dinner after all.

**Siltation**

On the day you took your first breath, you began a fun-filled journey that will inevitably conclude with your final breath. Likewise, the working life of every dam is also finite. Brilliant engineers design them to survive earthquakes, landslides, and intense floods — and they usually do. Most will peacefully die from a natural cause, siltation. Rivers transport both water and silt. When the water flows into reservoirs, it slows down, and the silt is dropped. Year after year, the silt accumulates, displacing space for water storage — the purpose of the dam.

The Advisory Committee on Water Information (ACWI) is an organization within the U.S. Department of Interior. One of their areas of concern is reservoir sedimentation. They created an

excellent report to explain the issue to ordinary folks.

Marc Reisner wrote that, if the dam doesn’t collapse first, every reservoir will eventually be filled with silt, and turn into an extremely expensive concrete waterfall — no more power generation, no more flood control, no more irrigation. Engineers understand this. Typically, dam project plans are calculated to have a sediment design life of 50 or 100 years — planned obsolescence. In China, the reservoir for the Sanmexia Dam was filled to the brim with silt in 1964, just four years after it was built.

So, mommy and daddy get to enjoy the wonderful benefits from their hard-earned tax dollars, and the grandkids inherit a collection of concrete waterfalls that are obscenely expensive to properly dispose of, and increasingly prone to failure as they deteriorate with age.

More than 5,000 large dams in the U.S. are over 50 years old, approaching the end of their designed lifespans. Some are already silt filled waterfalls, enduring monuments to shortsighted pork barrel politics — idiotic projects demanded by slick-talking legislators to delight their donors, and enrich the rich. The folks who get most of the financial benefits are entrepreneurs who adore the golden benefits of socialism, but hate government, and are hysterically allergic to taxes.

Marc Reisner wrote that President Jimmy Carter detested dam projects because the national debt was in the stratosphere, there was double-digit inflation, and dams made little or no economic sense. He was cursed to frequently suffer from painful mental impulses known as principles. "He began to wonder what future generations would think of all the dams we had built. What right did we have, in the span of his lifetime, to dam nearly all of the world's rivers? What would happen when the dams silted up? What if the climate changed?" This didn't win him many friends in the arid west. He didn't get reelected.

Anyway, the ACWI report notes that "proper maintenance" is required to provide dams with eternal life. Proper maintenance involves periodically dredging out many tons of polluted sediment, hauling it somewhere, and disposing it in a thoughtful mature manner. Proper maintenance is massively expensive. This begs a follow-up question: "Is reservoir sediment managed in the USA?" Answer: "With only a few exceptions, the answer is no." It is done at just two reservoirs that fill rapidly. There is no dredging. The dam gates are opened, and the sediment is flushed downstream, which blindsides the riparian ecosystem. This proper maintenance is highly destructive.

An extreme example of "proper maintenance" is the Xiaolangdi Dam on the Yellow River in China. Its reservoir accumulates an estimated 30 million tons of sediment each and every year! So, every year, a team of maintenance professionals open the base drains, and allow 30 million tons of muck to ooze downstream. It's much cheaper than dredging.

In 1950, there were about 5,000 large dams in the world. Today, there are more than 58,700. Big dams are enormously expensive, and the cost of decommissioning a hydropower dam can exceed the cost of building it. Corporations have no interest in building them, because the odds for making meaningful profits are slim at best. So, legislators order them, and taxpayers enjoy getting the huge bills.

Of course, dams can also be very exciting. Reisner shared some thrilling stories. In the summer of 1975, typhoon Nina blasted Asia.

In the vicinity of China's Banqiao Dam, a massive flood resulted from 64 inches (163 cm) of rain, half of which fell in just six hours. The dam collapsed, and the outflow blew out many smaller dams downstream. Floods killed 171,000 people, and 11 million lost their homes. Today, everyone in the Southwest prays several times a day that there will not be a similar chain reaction failure on the Colorado River.

In the 1960s, the Bureau of Reclamation was running out of ideal sites for new dams. For maybe 40 years, Idaho farmers had begged for a dam on the Teton River. Conservatives who detested socialism were eager to have U.S. taxpayers buy them a dam, despite the fact that the costs would far exceed the expected benefits. This was earthquake country, and the proposed site had highly porous bedrock, an unbelievably stupid place to build a dam. It was OK'd in

1973, and built in 1976. The Teton Dam did a spectacular blowout two days after it was filled.

The reckless impulses that conjured the Teton Dam into existence, and non-existence, strongly resemble the impulses that have brought the twenty-first century global economy into existence. It too was built on a dodgy foundation, and is now springing more and more leaks.

# Who Are We?

## Wild Oneness

Over the course of maybe four million years, hominins fine-tuned the dance of small group survival in tropical grasslands. This long and gentle path carefully guided the evolution of our bodies and minds. Each band of hunter-gatherers operated with a conscious identity of "we." They thought like a group, not a sloppy bucketful of anxious, irritated, self-centered individuals.

Similarly, the relationship between bands of hunter-gatherers and the surrounding family of life also consisted of a strong sense of

oneness, of "we." Richard Nelson spent time with the Koyukon people of Alaska, who were the opposite of human supremacists. They had deep respect for wild critters, beings that perfectly understood the art of natural survival. It was impossible for humans to survive in Alaska without manmade technology that compensated for their numerous physiological limitations.

Nelson beautifully described their attitude of profound respect and reverence. "Traditional Koyukon people live in a world that watches, in a forest of eyes. A person moving through nature — however wild, remote, even desolate the place may be — is never truly alone. The surroundings are aware, sensate, personified. They feel. They can be offended. And they must, at every moment, be treated with proper respect. All things in nature have a special kind of life, something unknown to contemporary Euro-Americans, something powerful."

## Nomadic Freedom

In the good old days, bands of nomadic hunter-gathers spent their lives wandering across vast grasslands, and through dense forests. It was a way of life that majored in freedom. No money, soldiers, slaves, taxes, kings, police, wheels, or cell phones. Indeed, hominins evolved as nomads, and remained nomads for almost four million years.

For hunters to stop roaming, and put down roots, would have been very risky. Their best option was to follow their stomachs. Seek food. Survival required cooperation, sharing, and the prompt resolution of conflicts. They were egalitarian, everyone enjoyed equal worth — women, men, young, and old. Nobody gave orders, or obeyed orders.

In 1847, Paul Henri Mallet affectionately celebrated the freedom enjoyed by the nomadic tribes of northern Europe. Listen:

"They were free because they inhabited an uncultivated country, rude forests and mountains; and liberty is the sole treasure of an indigent people; … and he who possesses little defends it easily. They were free because they were ignorant of those pleasures, often so dearly bought, which render the protection of a powerful master necessary. They were free because hunters and shepherds, who wander about in woods through inclination or necessity, are not so easily oppressed as the timorous inhabitants of enclosed towns … and because a wandering people, if deprived of their liberty in one place, easily find it in another, as well as their sustenance. Lastly, they were free because, knowing not the use of money, there could not be employed against them that instrument of slavery and corruption, which enables the ambitious to collect and distribute at will the signs of riches."

Cultures that enjoyed the greatest freedom were wild, uncivilized, and egalitarian. Everyone was equal. Unequal status was corrosive to group cohesion. Folks who became big headed were a serious problem that had to be promptly resolved. Free people were not assigned to specific ranks in a top-down pyramid-shaped hierarchy of power. There was no hierarchy.

Christopher Boehm pointed out the interesting idea that in free cultures, the conflict resolution process actually had a hierarchy, but the pyramid was upside down. When an annoying big head began rocking the boat, everyone united to confront the bozo, and restore order.

### Life in the Wild Lane

Over a long span of time, our minds, bodies, emotions, and instincts were given form on tropical savannahs. Like our savannah ancestors, you and I are social animals, and we do best in small groups, where we can maintain ongoing personal relationships with all the others. Many wild folks likely spent their entire lives without seeing a stranger. For them, exposure to dense crowds of odd-looking, odd-smelling, odd-sounding strangers would have been terrifying.

On the day of your birth, you did not squirt out of momma's womb with credit cards, car keys, and a cell phone. You were a wild animal that evolution had fine-tuned for a wholesome life of hunting, scavenging, and gathering in a tropical wilderness. You were fully expecting to be welcomed into a kind and caring tribe — an egalitarian culture of anarchist singers, dancers, and nature lovers. You were not expecting to squirt into the frightening bright lights of a totally insane planet-thrashing civilization, condemned to a life sentence without parole.

Naturally, you were expecting to spend your entire life out of doors, in a thriving ecosystem where humans were a wee minority group in the family of critters. Living in a healthy wild neighborhood, daily life included seeing, hearing, and smelling your wild non-human neighbors throughout every day. Many of these neighbors were good to eat, and some of them would eagerly leap at any opportunity to tear you to bloody shreds and ravenously feast on your yummy flesh. Survival required paying acute attention to reality at all times. Sudden noises in the forest made everyone snap to attention.

Paul Shepard wrote that for four million years, our wild hominin ancestors were "few in number, sensitive to the seasons and other life, humble in attitude toward the Earth, and comfortable as one species among many."

He was far less fond of civilized humans. "No wonder Western consciousness is an overheated drama of God's vengeance and catastrophe, preoccupation with sacrifice, portents and omens of punishment by a heavy-handed Jehovah. Like the dinosaurs, which are known mainly for their vanishing, the ancestors we know best, and from whom we take our style, are those who seem to have lived mainly to call down calamity upon themselves."

**It Takes a Village**

Soon after birth, many animal species are capable of skills like walking, running, swimming, climbing, and feeding themselves. This is not true for humans, because we are an experiment to see what might happen if tropical primates were allowed to evolve unusually swollen brains. This project required some tweaks.

The birth canal from mom's uterus to her vagina passes through an opening in the pelvis, and this opening is too small to allow the passage of a fetus with a more fully developed brain. Consequently, humans are born long before we are capable of functioning unassisted. Because we are helpless for an extended period, we require a lot of attention from mommy, daddy, and the surrounding tribe. Many observers have reported that wild people did an above average job of raising children.

Jean Liedloff spent two and a half years living with wild people in a Venezuelan jungle, while occasionally zipping back and forth to big city America — two cultures that could not possibly be more different. The wild folks were generally a kind and cheerful bunch. But every time she stepped off a plane in America, she would immediately be jolted by how strikingly unhappy people appeared. Why? This question eventually inspired her to become a therapist, and the author of an awesome book.

Our months in the womb were very safe and comfortable, the most peaceful period in our journey. Liedloff described how tribal folks made the transition to life in the outer world as pleasant as possible. From the moment of their birth, newborns were held and nursed and loved — and this warm, secure, continuous contact lasted until the infant indicated that it was ready to begin the creeping and crawling phase. Raised in this manner, wild kids lived with a sense of wellbeing that might last throughout their entire lives. They were well-adjusted and happy. Life was good.

On the other hand, in modern consumer society, the bright and noisy world outside the womb could be a rather unpleasant place, sometimes hellish. Newborns were hustled away to a nursery, where they could cry by themselves until they ran out of tears. The sense of wellbeing disintegrated, and some of the infants never again recovered it.

Civilized folks, who spend their lives isolated in climate-controlled cubicles, with state-of-the-art entertainment systems, often have to buy books to learn how to raise a kid. Liedloff detested these horrid books. She wrote that if parents followed the printed instructions, they would "produce children they cannot love, who grow up like themselves, anti-self, antisocial, incapable of giving, destined forever to go hungry."

**Salt of the Earth**

I remember seeing paintings of peasants in art history books, harvesting the wheat, or dancing in the streets. They were images of healthy, happy, hardworking, virtuous people — our ancestors. These paintings hung on the walls of plush homes in elegant neighborhoods.

In his incredible environmental history book, Clive Ponting provided a more reality-based description of how humble folks lived in earlier times. Common folks often lived in small huts with dirt floors, no windows or toilet. Bedding was a heap of straw, and water was brought in by bucket. Heat was provided by fire on an open hearth, chimneys were uncommon luxuries.

Prior to burial, usable clothing was always removed from the loved one's corpse, because it was too valuable to waste. Among the humble of birth, there was not a universal belief that children would have a better life than their parents. My grandmother never tossed out apple cores because the entire apple was food, seeds and all.

Ponting wrote, "Since the rise of settled societies some ten thousand years ago the overwhelming majority of the world's population have lived in conditions of grinding poverty. They have had few possessions, suffered from appalling living conditions, and have been forced to spend most of their very limited resources on finding enough food to stay alive." "Until about the last two centuries in every part of the world nearly everyone lived on the edge of starvation."

He concluded, "All but about five percent of the people in the world were peasants, directly dependent on the land and living a life characterized by high infant mortality, low life expectancy and chronic undernourishment, and with the ever-present threat of famine and the outbreak of virulent epidemics."

In the 1960s, Ronald Blythe interviewed old-timers in England who remembered farm life prior to tractors. "The men were beaten because the farms took every ounce of their physical strength and, as they had no great mental strength because of a lack of education, they were left with nothing. It was the farm versus their bodies, and the farm always won."

Brian Fagan talked about excavations in medieval graveyards. Many folks spent their lives working way too hard. Almost all had signs of arthritis, and many had spinal deformations from scything, plowing, and carrying heavy loads. Malnutrition was common. Most fishermen had serious osteoarthritis of the spine.

**Phases of Development**

During our life journey, we pass through four developmental phases. In any society, a child's physical and emotional needs are different from those of an adolescent, adult, or elder. In any region of the world, everyone's body *physically* changes through these four phases. No matter what culture we live in, our bodies will automatically proceed from one phase to the next as we meander through the years of our lives.

On the other hand, it's very important to understand that our *emotional* development is *never* guaranteed to automatically proceed from one phase to the next. You cannot smoothly advance into adolescence emotionally until you successfully acquire the emotional skills of childhood. This is true for every transition through the four phases. Each must be completed before moving up to the next — but this doesn't always happen.

Emotional development can get permanently stuck in one phase, even as the years and decades keep passing. Thus, you can have infantile adults, gray haired adolescents, and other victims of arrested development. Many may never develop a mature sense of social responsibility or emotional stability. This is especially common in complex societies, which have a long reputation for being incubators of mental deformities. Evolution didn't prepare us for living in crowded, sprawling, synthetic habitats.

It takes about 20 years for a newborn to fully develop the body and brain of an adult. We were not born with a comprehensive understanding of how to effortlessly glide through our joyride to the finish line. Luckily, we are social animals, and if we had been lucky enough to be born into a more functional society, the community would have provided us with timely and competent mentoring. Folks raised in dysfunctional societies, like ours, are often not so lucky.

Especially critical are the transitions from one phase to the next. For example, a child does not instinctively know how to gracefully move through the whirlwinds of puberty and adolescence. Rites of initiation are ceremonies that explore the wisdom of cultural stories, and provide important instructions for social behavior, conflict avoidance, and other core issues.

When a safety net of support is provided, transitions can be much easier. These communities are more likely to nurture the blossoming of sane, competent, well-adjusted people. Modern communities do a far sloppier job of providing guidance and support, if any.

We are now about to take a quick peek at the phases of development. Among my all-time favorite books is The Human Cycle, by Colin Turnbull, a gentle soul and careful writer. This book focused on how different cultures guided their people through the transitions of life's journey. Turnbull was raised in a pathetically dysfunctional family and peer group (upper class Britain). Later in life he deeply enjoyed spending lots of time with the Mbuti Pygmies, who celebrated life in the Ituri rainforest of Zaire. For many thousands of years, they were a happy and sustainable society — until paradise turned into a war zone and logging camp. Turnbull shared fascinating descriptions of both wonderful and wonky cultures. He gave us a delicious glimpse of how our ancestors may have lived in the good old days.

The following comments are a generic overview. They do not describe universal practices that are exactly the same in all societies. Humans have created countless unique cultures over many thousands of years. Each attempted to guide folks through their life journey, in a wide variety of ways, with mixed results.

## Childhood

Turnbull noted that childhood games teach cooperation, not competition — playing with each other, not against. "Laughter, jokes, and ridicule are vital elements in Mbuti life," he wrote. "It is difficult to be dangerous or violent if you are laughing so hard you cannot stand." They are generous in sharing when food is scarce. Even when tensions are high, they are non-violent. Without peer pressure, they naturally live in a moral manner. The social good always trumps the individual good.

Childhood is the thrilling and confusing era of intense change that spans between birthday and puberty. For their first three years, all Mbuti infants remained in constant contact with their mothers, which provided a heavenly bonding experience. This prepared the infant for becoming a confident and competent social being during the rest of its life.

On the other hand, in Turnbull's upper-class Britain (and throughout much of the civilized world), the mother-infant relationship was far less intimate and comforting. Turnbull was raised by a long series of nannies. Because of the terribly dangerous "health risks" of breastfeeding, his mother did not nurse him. His brother had different nannies, and lived in the same house, but the two never met until Colin was 6, and they shared a hotel room. With great excitement, they eagerly conversed, until mom discovered the mistake. Rich people can sometimes be oddballs. Colin begged gypsies to kidnap him, but they refused.

Carleton Coon wrote that the Andaman islanders nursed their young until the age of 3 or 4. The hungry little milk lovers were passed around, and suckled by all lactating women. Paul Shepard noted that when the infant's bond with mother was properly formed, it encouraged the potential for intellectual and emotional growth. But if this bonding was dodgy, the damage done could sometimes have lifelong impact.

As the infant eventually learned to speak, crawl, and explore, it became less dependent on mother. This began at around age three. For the next nine years or so, until the onset of puberty at around twelve, it was an amazing time of discovery. In wild cultures, these nine years were a time window for the absolutely vital process of forming healthy bonds with nature, in all its diversity. During this experience, kids absorbed the richness of the natural order — animals, insects, plants, storms, stars, aromas, colors, sounds — the sacred wonderland of creation, home sweet home!

Imagine a catfish that paid little attention to the other living things in the lake — a fish that was raised in a radicalized catfish supremacy cult, who believed that the creator of the universe was a catfish, and the only thing that mattered was the prosperity of catfish. How weird would that be? Unfortunately, many modern folks, eyes riveted to glowing screens, or confined in speeding vehicles, never experience a full immersion baptism in wild nature. They are something like a catfish without a lake. For them, nature is merely static scenery along the highway. Boring and meaningless.

Wild kids spent lots of time watching the “others” (non-human animals), learned their names, categorized them, imitated them, and studied their anatomy when butchered. Kids knew the daily and seasonal patterns of the others, and watched them move through their life cycle, from youngsters to oldsters. Kids developed a strong feeling of kinship with them.

Hunting was a core component of our wild ancestors’ lives. Folks accumulated enormous amounts of knowledge about tracking and animal behavior. Our brains evolved, over hundreds of thousands of years, in wild Stone Age cultures. What you and I are today is a direct result of this very long, beautiful, and deeply intimate wild relationship, despite the fact that it is largely absent in the culture that currently suffocates us.

John Livingston shed more light on the process of bonding with nature. A newborn human is an incredibly flexible animal, capable of fully adapting to the worldviews, religions, lifestyles, and languages of a vast spectrum of cultures, from anywhere in the world.

Thus, a primary component of childhood is open-mindedness, a mindset in which they are free and eager to explore all possibilities. So, for youngsters who have access to wild nature, and who have a tingling curiosity to explore big magic, it's perfectly normal, healthy, and life enhancing to form emotional and spiritual bonds with the family of life. If the bond with nature doesn't form by age 12 or so, it's likely that it never will, but not impossible.

In the ghoulish world of deepest, darkest couch potato suburbia, nature has been reduced to something that folks passively watch on gigantic flat screen TVs, while gobbling cheese doodles and guzzling fizzy sugar water. The normal around-the-clock stimulation of wildness, that every animal needs, is absent. Children are denied the vital education provided by the daily affairs of the family of life.

They are hobbled by what Richard Louv would diagnose as Nature Deficit Disorder (NDD).

Stan Rowe called it EDD (Earth Deficiency Disease), a devastating disconnection from the meaning of life. EDD children tend to form bonds with nifty gizmos, not nature. He estimated that consumers spend 95 percent of their lives indoors. Children are often kept under house arrest, because parents fear that going outdoors is too dangerous. The poor kids share some similarities with the homeless wild animals imprisoned in zoos. Rowe wrote, "Our two best doctors are our legs." He hated cities. "The city is an unhealthy place for those who want to come home at least once before they die."

In modern cultures, a major shift follows the open-minded curiosity of childhood. It is the dawn of a long era of tedious work, responsibilities, challenges, and annoyances. For this reason, Colin Turnbull noted that we romanticize our childhood, a golden age of innocence and joy. The Mbuti did not idolize childhood, "because, for them, the world has remained a place of wonder, and the older they get the greater the wonder."

They bonded beautifully with nature, their forest home was sacred, and the source of all goodness. When they moved through the forest, they sang to it. They referred to it as mother, father, or both. Life was good. By the arrival of puberty, wild children were well rooted in place, feeling at-one with the flora and fauna that surrounded them. They had developed a profoundly important spiritual connection to life.

Puberty & Adolescence

Oh-oh! Somewhere around 12 or so, the path begins to get slippery, anxious, and exciting. Welcome to puberty, girls and boys! Puberty is the kickoff for adolescence, which is the bridge between childhood and maturity. For females, adolescence is generally the years between 12 and 20; and for males, 14 to 25. Puberty is time to say goodbye to the sweet and easy innocence of childhood, and undergo a transformation into sexual beings.

In Mbuti country, the adult community guided young folks through puberty via traditional rituals and ceremonies that are among the most important events in life, according to Turnbull. These are the

rites of initiation. Shepard noted that in various cultures, initiations often provided "ceremonies that include separation from family, instruction by elders, tests of endurance and pain, trials of solitude, visions, dreams, and rituals of rebirth."

For Mbuti girls, the puberty alarm clock rings with a dramatic event, the passing of their first blood. It was time for initiation. Often the community waited until more than one girl was ready. The girls were then moved to the special elima house, where they changed their attire, announcing that they were no longer children. Boys were allowed to visit, and there was sexual play, if the girl permitted it, but it never led to pregnancy. Girls and boys learned new songs and sang them together.

At puberty, boys were not awakened by a bloody alarm. Every two or three years, adults selected a group of boys between ages 9 and 11 for initiation. For Mbuti kids, who sleep in small huts near mom and dad, the mechanics of sex were no mystery at all. Initiation was the time to learn lots of important stuff, including the social responsibilities of adulthood. The strategy here was that the boys would learn — in advance — the possible consequences of what mom and dad did in the dark. For the Mbuti, initiation led to the emergence of "a fully integrated self."

For me and my classmates, the rites of initiation lasted maybe an hour, via an embarrassing lecture in a school auditorium. We passed through puberty in a fairly dis-integrated manner. We were more or less hurled off the end of the dock into deep water (note the high teen pregnancy rates). For many adolescents, the process of emotional development got damaged (note the numerous struggling adults in our society who are the opposite of well-adjusted and fully integrated).

If there was just one idea that Turnbull could send you away with, it would be this: no culture handles puberty and adolescence as poorly as ours. "The consequences of our folly are to be seen all around us in the violence, neuroses, and loneliness of our youth, our adults, and aged." Some never come close to having a full or rich life.

Shepard noted that when the initiation process is inadequate or omitted, the youth remain trapped in adolescence, immature and alienated, whirling in infantile anxieties, chronically narcissistic, enraged at humankind and nature for failing to help him become a complete human. "Everyone who fails will be intellectually, emotionally, and socially retarded for the rest of his life." The natural identity-forming process is incomplete, and they assume a synthetic identity appropriate for the industrial culture.

With the transition into adolescence, the time window for the free-flowing open-mindedness of childhood tends to draw closed. It becomes time to put on cultural blinders, and become fully immersed in our tribal identity. This is something like the process of how wet pourable concrete inevitably becomes rigid, strong, and permanent. The worldview, beliefs, and values of your culture become deeply imprinted infallible truths, a mindset you carry to the end of your days (usually).

If you were a wild, free, and happy Mbuti, this transition was perfectly normal, healthy, and beneficial — an essential step on the path to maturity. Throughout adolescence, the bonds with nature continued expanding and deepening. The Mbuti never outgrew their sacred relationship with the family of life.

If you are a citizen of industrial civilization, its ersatz initiation process leads to a far different outcome. Compulsory education extends from childhood into the years of adolescence. In my youth, busloads of kids my age were separated from society for seven or eight hours a day, so we could be rigorously trained in the myths of our culture, and the skills essential for full time employment.

Turnbull received his public education at Westminster, a prestigious school, where students had their brains filled with knowledge, in an efficient assembly line process. Intellectual skills, like competency in critical thinking, were not part of the curriculum. He had nothing nice to say about the abominable experience, only this: “It would have been good training for a life in prison.”

In Mbuti culture, following their initiation, the new adults did an excellent job of reintegrating with the community — almost all spent the rest of their days living among their friends and kinfolk. They didn’t banish themselves to faraway places, never to return. Notably, their community was stable, closely bonded, and highly supportive.

Rites of initiation are traditionally a three-step process: (1) separation from the community, (2) preparation for adulthood, and (3) reincorporation into society as an adult. Industrial culture commonly omits the last step. Many of our successful graduates are blasted out of a cannon into the outer world, to attend university, pursue a career, enlist in the military, or whatever. Turnbull complained that many of our adolescents actually “expect and *want* a permanent separation” from the community they grew up in, because they seek “freedom.” They scatter to the winds like tumbleweeds, and many are never seen again.

Like Turnbull, Shepard also loathed our culture’s assembly line for manufacturing adults, most of whom never form healthy bonds with nature. Most imprint that humans are the only beings that are truly alive. They internalize chaos, and when it’s time to master social relations, they are not prepared. Shepard wrote, “The only society more fearful than one run by children might be one run by childish adults.”

Adulthood

The point where adolescence ends, and adulthood begins is sort

of blurry. Colin Turnbull noted that in Mbuti society, adulthood begins with marriage. It was a phase during which disputes and conflicts were more common, so adults were involved less in decision making, and more in the routines of daily life. Turnbull thought that adulthood was a time for *doing*, and elderhood was a time for *being*.

Wild cultures and modern cultures take different approaches to adulthood. In our culture, *doing* implies working — activities that bring money into your life, so you can afford, at least, the basic necessities of survival. For many, "work" does not rhyme with "fun" or "joy."

Most consumers have peculiar illusions about the difference between needs (essentials) and wants (desires). Their conception of needs is far more expansive than other cultures — stuff like televisions, cell phones, computers, and trophy homes with four car garages. For several billion less affluent non-consumers, needs focus on today's sustenance.

When I contemplate the amount of all the stuff I've thrown out in my life, it staggers me — many, many tons. Every week, garbage trucks rumble down the alley, and it's stunning to imagine how much crap this neighborhood discards, or this city. It must end up in a landfill as high as the Alps, constantly growing taller. Wild animals leave the world in no worse condition than they found it. This is exactly what sustainability means.

Turnbull noted that in simpler cultures, "work" means no more than what you happen to be doing in your life (assuming that it's socially acceptable). So, a child's play is work, and so is the adolescent's exploration of sexuality. Work is reading a book, or gazing at the stars, or making love, or singing and dancing. The Mbuti have no need for money, because the forest provides all their needs. For them, singing a honey song is seen as essential for survival.

In essence, unlike child's play, Mbuti adulthood is about playing a "constructive role in the furtherance of the social order," and it is "done with a *conscious* sense of social responsibility." This is about cooperation, and consideration for others. Importantly, the focus is on *we*, not *me*. In their culture, being independent and self-centered is out of balance.

In our culture, individualism and competition are promoted "with a curious fanaticism," and this results in a fiercely exploitive crazy-making planet-thrashing nightmare world. In our culture, *me* trumps *we*. To us, absolute individual freedom is the Holy Grail — no responsibilities, no bosses, no rules, no cops, no consequences. I can do whatever I want. Stay out of my way. Shut up! To our distant wild ancestors, this is absolute insanity.

In our culture, adulthood takes different forms. Turnbull wrote, "We have all met many adults in our lives who, without seeming to try, have shown us what a rich thing adulthood can be. We have also met many who have shown us what an empty thing it can be, sometimes by trying too hard to be other than what they are. We have also met all too many who neither try nor succeed, those who are frankly and openly concerned only with their own immediate welfare."

Old Age

In Mbuti society, elders are honored in their golden years. This phase of life is about *being*. Elders shift toward other important roles in society — guarding the camp, playing with children, mediating conflicts, and passing wisdom on to younger generations. They enjoy tremendous respect. While body and mind may have been stronger in years past, they are more experienced than ever, and their heart and soul continue getting stronger. They still have important things to do.

Elders are relieved of adult responsibilities, withdrawing from involvement in a future that is not theirs. These obligations are left to folks for whom the future belongs. So, their social horizons narrow, while their authority expands, as they approach their return "to the source of Spirit." Elderhood encourages three paths: saints, witches, and wise ones. It's common for elders to engage in more than one role.

Saints are rare elders who are radiant with spirit energy, aglow with a warm presence. They don't need to preach, "they just have to be." Their goodness can be especially beneficial to adolescents who travel on a more slippery path.

"Witch" refers to the African sense of the word, not to the unfortunate victims of the Christian Inquisition ("demonic" monsters who must be tortured and burned alive). Mbuti witches (male and female) have acquired excessive power, which is not under control, and can be used for good or ill, deliberately or not. Elderly recluses can provide an important service. They know all the shady things happening in the village, and they enjoy the freedom to piss off whoever they wish, and say exactly what they think. While this makes the offenders uncomfortable, it encourages increased integrity in the community.

Wise elders are living treasure chests of important knowledge and experience. They are the greatest babysitters, because children trust them. They can communicate in a special way, since kids are close to the beginning of life, and elders are close to the end. Elders are outside of the parent-child relationship, and its frictions, so things can be relaxed and open.

Of course, elders in modern cultures are a very different story. Elderhood is often associated with uselessness, decline, poor health, poverty, senility, death. Treating them as diminished beings results in a serious loss to the community. We send elders away to institutions for old folks, "a pre-death limbo" where they are isolated from family and younger generations, and denied the joys of old age. They become an annoying obligation for their children, who cherish their freedom and independence. For many, retirement can be painful and traumatic, because folks no longer feel valued. It can be a sad time of loneliness.

**Coherent Societies**

So, we've taken a peek at how wild and modern cultures attempt to guide their people through the phases of the life cycle, and the different outcomes they produce. Colin Turnbull noted that the Mbuti people enjoyed a society that was harmonized by a common set of beliefs, values, lifestyles, and ethnicity. A beauty! Wild cultures were far more likely to enjoy functional, coherent societies, because everyone was on the same channel.

Our modern society is a boisterous mob of different cultures, ethnicities, classes, crime gangs, hate groups, religious beliefs, and so on. When jolted, it can explode into a swarm of furious hornets. Indeed, Turnbull would not even call it a society. “In larger-scale societies we are accustomed to diversity of belief, we even applaud ourselves for our tolerance, not recognizing that a society not bound together by a single powerful belief is not a society at all, but a political association of individuals held together only by the presence of law and force — the existence of which is a violence.”

Turnbull wrote, “Hunters frequently display those characteristics that we find so admirable in man: kindness, generosity, consideration, affection, honesty, hospitality, compassion, charity, and others.” These traits not rare and noble virtues, they are fundamental to the survival of hunting cultures.

It’s important to pay attention to the core differences between wild and modern cultures. Hunting people lived in small groups, where everyone was family or friends, and all were on the same channel. They had an extremely intimate relationship with the lands they lived in, and they fully understood the patterns of food availability. They followed their stomachs, as they roamed across the land. For hunter-gatherers, the wild menu was highly diverse. They had many more dining options than the hungry dirty farmer with a cow and a wheat field.

Turnbull emphasized that the bottom line here is that a farmer can lose a year’s work in one unfortunate day. All of his eggs are stored in one basket. A Mbuti hunter can only lose a day’s work when his luck takes a nap. He has no need to hoard food, and constantly defend the stash. If one food source becomes scarce, he eats something else. They periodically move from place to place, as guided by their traditional wisdom, and shifting conditions.

Turnbull wrote, “The hunter and gatherer gives little thought for the morrow, getting his feed fresh, from day to day, with the ready assurance of someone who has come to terms with the world around him. He knows the world he lives in as few others do, and he lives in sympathy with it, rather than trying to dominate it. He is the best of conservationists, knowing exactly how much he can take from where at any given time."

The farmer, on the other hand, is betting everything on a narrow mix of food resources, which exist in a fixed location (his field and pasture), and are entirely vulnerable to a wide variety of potential threats. A ripe field could suddenly be reduced to ashes. A swarm of locusts might discover his delicious wheat crop. Passing soldiers, friends or foes, could confiscate his livestock and stored grain. A fungus could turn his bumper crop of spuds into a field of stinky black slime overnight. His livestock could all drop dead when an epidemic of rinderpest or anthrax paid a visit to his region. Drought, deluge, flood, heat wave, early autumn frost, late springtime frost — farming was a risky business, not a pleasant stroll down Easy Street.

Modern consumers are vulnerable to all of these risks, plus they are dependent on an extremely complex system of industrial agriculture, food processing, distribution, retailing, and a functional economic system. If the money in their wallets becomes worthless during an economic meltdown, what's for dinner? Will they get evicted? Will the bank foreclose on their mortgage?

The food system depends on the fossil fuel industry to keep stuff moving on the farms, highways, railways, and airlines. Refrigeration requires energy to keep food from spoiling. Stoves and ovens need power to cook meals. Industrial civilization must remain on life support to keep all the gears of the machine moving. An enormous house of cards. What could possibly go wrong?

### Connection to Place

Coherent societies are most likely to survive in coherent places — healthy wild ecosystems. Wild critters are a constant presence in the surrounding countryside, outnumbering the humans. Wild ones inspire contemplation and deep respect. They provide food for lucky hunters, and they feast on dead hunters whose luck has expired.

Throughout every day, wild people devote careful attention to the ongoing drama of sounds, movements, smells, turds, tracks, spirits, and other matters of utmost importance. Being wild and free is a rich and fully engaging experience. It requires constant mindfulness.

In 1997, I was living in the remains of a once prosperous copper mining district near Lake Superior. I was able to spend a bit of time with the Anishinabe activist Walter Bresette, a man who had a profound spiritual connection to life. To the Anishinabe, all of creation is alive, sacred, and related — everything in creation is a being with spiritual power.

I learned that copper rocks are especially sacred to the Anishinabe, and they affectionately and respectfully refer to these ancient and powerful red metal spirit beings as the "copper people." I kept hundreds of them in my home. One day, after lunch, I showed him a beautiful piece of copper that had been smoothed by passing glaciers.

Walter took the heavy green stone in his hands, and gasped with amazement and delight. The two of them went off, into the next room, and sat down by the wood stove. Walter bowed his head, and he and the copper spirits spent a long time in deep and sacred communication. It was an awesome and moving experience to observe. I will never forget it. He spent a night in my house, to experience the strong presence of so many copper spirits.

Paul Shepard wrote about how our lives can be shaped by animals and places. For hundreds of thousands of years, wild kids enjoyed childhoods in healthy lands where everything around them, the entire landscape, was fully alive with their plant and animal relatives. Animals were especially fascinating. Three-year-olds take great delight in learning the names of different animals, because they are so amazing. Children's lives were warmly embraced by their mothers, families and neighbors, and by the land that fed them and fascinated them.

Shepard said that a child's early homeland imprinted on its psyche, and remained a special and sacred place for the rest of its life. Kids soak in all that surrounds them. At puberty, rites of initiation further strengthened the spiritual bonds to place, via tests of endurance, vision quests, and so on.

The person and the land were one. All beings on the land belonged there. None were pests or weeds that had to be eliminated.

In the good old days, before the plague of glowing screens, and the fear of perverts hiding behind every bush, children were allowed to run free, unsupervised, explore their home range, and get their hands dirty. I was one of these, and I was lucky to live close to forests, lakes, and wetlands. My imprint of this homeland remains vivid. I still remember that place in great detail, 60+ years later. It played an important role in shaping my identity. Most of it has now been obliterated by sprawl. I have no interest in returning, it's too painful to see.

Jay Griffiths and her brothers also spent much of their youth playing outdoors. Like me, they rarely watched television. She fears that her 1960s generation may be the last to experience the remaining vestiges of a normal childhood.

John Livingston lamented how being raised in a manmade reality deforms us. Like livestock, we become passive and obedient servants. We learn to endure the stress of living in dense populations of strangers, and spending most of our time in enclosed climate-controlled cubicles with artificial lighting. Our cubicles are located inside vast concentration camps called cities. We are likely to develop a high tolerance for crowding, stress, abuse, filth, squalor, noise, and intense pollution.

Richard Louv told a touching story about a Girl Scout field trip. Girls with AIDS from Los Angeles were taken to a camp in the mountains. One night, a nine-year-old girl woke up, and had to go to the bathroom. Stepping outside, she looked up and gasped. Growing up in a sprawling megalopolis, she had never seen stars before. "That night, I saw the power of nature on a child. She was a changed person. From that moment on, she saw everything. She used her senses. She was awake."

Natalie Diaz, a Mojave poet, noted that in her language, the same word is used to say both "body" and "land." The Mojave had no supermarkets, malls, cities, or online shopping. So, throughout their lives, their air, water, and food came from the surrounding land, their home. They were at one with the land, like a fetus in the womb.

There is a profound difference between purchasing food-like substances at a shopping center, and gathering nourishment from the land. When the land feeds you, an intimate and reverent relationship is born. I fished a lot in my boyhood years. Later in life, I took great pleasure in foraging in wild places, and on the recovering remains of abandoned farms and mining settlements. Over the years, I've gathered apples, pears, cherries, plums, blueberries, thimbleberries, blackberries, strawberries, elderberries, grapes, figs, walnuts, hazelnuts, almonds, acorns, mushrooms, asparagus, and so on. Joy!

Tom Brown was eight years old when he met an elderly Indian in the woods. Stalking Wolf was a tracker raised in a wild, free Apache community. He possessed vast knowledge about the natural world, and how to survive in it. He spent nine years teaching Tom and his buddy Rick. Tom grew up to establish a school for trackers, and write 17 books.

I was lucky to spend much of my childhood playing in the woods and swamps. I felt at home in nature. Years later, a friend pointed me to Tom's books, and it was a mind-blowing experience — a white American adult who had profound reverence and respect for the family of life. I finally found something that made sense, holiness was all around me. I could see it, hear it, touch it, smell it, respect it.

Jon Young happened to meet Tom Brown in 1971, when Tom was 18, and Jon was 10. Tom spent eight years teaching his young friend. When Jon later arrived at Rutgers University, he had extensive knowledge of wild ecosystems, which made him a total freak among his classmates, who seemed to be more than a little disconnected from life — suburban zoo animals.

Young clearly understood that connection to nature was precious, necessary, and vital. Not forming that connection was a crippling injury, one suffered by most folks in modern society. They have no hearts, because they are "dis-placed," said Okanagan elder Jeanette

Armstrong. In Chief Seattle's famous speech, he allegedly said, "To us the ashes of our ancestors are sacred and their resting place is hallowed ground.

You wander far from the graves of your ancestors and seemingly without regret."

Jon Young visited a number of wild cultures, seeking to find those that remain most intimately connected to nature. He discovered that the San people ("Bushmen") of the Kalahari were incredibly well connected.

Why are some cultures deeply connected, and others not? There are three components here: connection to self, connection to others, and connection to nature. In Western societies, disconnection from self, others, and nature (separation sickness) is at pandemic levels.

Young noted that you always feel safe when being with the San. They are super intelligent and great problem solvers. You never feel competition. People are in love with every aspect of the ecosystem around them, celebrating it with childlike wonder through all stages of their life. Every person in that community is committed to the flowering of every other person. They are incredibly aware of their surroundings at all times, because a brief lapse of attention can kill you in lion country.

When San children grow up with nature in this way, they're well-adjusted, healthier, happier, smarter, spiritually grounded, and more creative. By the time they are 12 to 15 years old, they have master tracker skills. They are illiterate, but they fully understand the language of the Kalahari.

The San are remarkably skilled at living like human beings. They are wary of entering buildings, because folks who do this too often become damaged, no longer human. They go crazy. Today, DNA mapping suggests that the San may be the common ancestors of all humankind. For several million years, our hominin ancestors lived like the San. We have their genes and instincts, but our culture lost its connection long, long ago.

Lame Deer was a Lakota medicine man. His parents were the last generation to be born wild and free. His generation suffered from the relentless efforts of white people to destroy the Lakota people, and he fiercely resented this. Whites had lost their connection to the family of life, and were desperately in need of a big healing. Like their cattle, sheep, and lapdogs, their wild power had been bred out of them. Lame Deer shared a powerful story, in the hope of helping white folks outgrow their bad trip, so their world-killing rampage would come to an end.

He told us that we needed to experience nature in a good way, and become part of it. Let's sit down and listen to the air. Let's talk to the butterflies, owls, rivers, and lakes. They are our relatives. Let's become like stones, plants, and trees. Let us be animals, and think and feel like animals. Even rocks are holy. Every man needs a stone to guide him. His story was painful and beautiful, but it failed to inspire a miraculous healing among the palefaces.

Aldous Huxley wrote, "A man must do more than indulge in introspection. If I would know myself, I must know my environment." Prince Charles said it a bit differently: "In so many ways we are what we are surrounded by, in the same way as we are what we eat." Carson McCullers said, "To know who you are, you have to have a place to come from." Paul Shepard put it like this, "Knowing who you are is impossible without knowing where you are."

Every five years, the average American moves to a different address in the same city, or another county, state, or nation. We typically spend 95 percent of our lives indoors. Someone once realized that prisoners in maximum security prisons typically spend more time outdoors than suburban kids do. We have become space aliens, residents of no place, something like zoo animals.

**Connected People**

Peter Freuchen spent a lot of time with the Eskimos, and married into their culture. In Book of the Eskimos, he wrote that "they always enjoy life with an enviable intensity, and they believe themselves to be the happiest people on earth living in the most beautiful country there is." Inuit women had "perpetual smiles," and "they seem to have more natural grace, more zest for life than their white sisters."

Colin Turnbull spent years with the Mbuti Pygmies, and described them in The Forest People. He was amazed by their joyful way of living. He said that they laugh until they can no longer stand, then they sit down and laugh.

In Original Wisdom, Robert Wolff described the Sng'oi people of Malaysia. They knew each other's unspoken thoughts, seeming to communicate telepathically. "They had an immense inner dignity, were happy, and content, and did not want anything." They loved to laugh and joke. They were often singing and smiling. Angry voices were never heard.

In The People of the Polar North, Knud Rasmussen noted how the Eskimos pitied (and giggled at) the Danes, because they suffered from hurricane minds — they never stopped thinking. Knud once observed an Eskimo who appeared to be deep in thought, and asked him what he was thinking about. The man laughed. "Oh! It is only you white men who go in so much for thinking; up here we only think of our flesh-pits and of whether we have enough or not for the long Dark of the winter. If we have meat enough, then there is no need to think." Eskimos rarely made plans for tomorrow. "An irresponsible happiness at merely being alive finds expression in their actions and conversation."

Jean Liedloff described the natives she met in South America. The Tauripan people of Venezuela were the happiest people she had ever met. All of their children were relaxed, joyful, cooperative, and rarely cried — they were never bored, lonely, or argumentative. The Yequana people seemed unreal to Liedloff, because of their lack of unhappiness. As an expedition was moving up a challenging jungle stream, she noticed that the Italians would get completely enraged at the slightest mishap, while the Yequana just laughed the struggles away. Their daily life had a party mood to it.

In his book, *In Search of the Primitive*, Lewis Cotlow visited Eskimos in arctic Canada. One night, he spent several hours talking to local officers of the Royal Canadian Mounted Police. They kept repeating one idea in different ways: "The Eskimos are the happiest people in the world."

Jon Young spent time with the San people of the Kalahari, folks who had a deep spiritual connection to their land. He said that they had perfect posture, and that their mental health factors are all positive. They were super-happy, super-vital, and totally connected from birth to death.

Dominique Godreche wrote that when psychologists visited the Pirahã people of the Amazon, one of them was amazed by their joy. They "look the most happy of all the people we ever saw; they laugh the most of all the populations we have seen."

In 1832, the artist George Catlin visited Indian tribes in the Upper Missouri River region. He wrote, "They live in a country well stocked with bison and wild horses, which furnish them an excellent and easy living; their atmosphere is pure, which produces good health and long life, and they are the most independent and happiest race of Indians I have met with: they are all entirely in a state of primitive rudeness and wildness, and consequently are picturesque and handsome, almost beyond description. … In my travels I have more than realized my former predictions that those Indians, who could be found almost entirely in a state of nature, with the least knowledge of civilized society, would be found the most cleanly in their persons, elegant in their dress and manners, and enjoying life to the greatest perfection."

**Disconnected People**

Colin Turnbull, in his most daunting book, compared the lovely wild society of Mbuti pygmies to the Ik tribe of Uganda, who were in a heartbreaking death spiral. They had been banished from their ancient hunting grounds by the creation of a national park, and were expected to become farmers during a long and devastating drought. Their traditional society was rapidly disintegrating, as many perished from starvation, and empathy went extinct. The Ik reminded him of Western society, where growing de-socialization was also underway. The Ik seemed like a spooky preview of where we are headed.

Like the Mbuti culture, Pirahã society was also held together by strong social bonds. Their way of life depended on the complete cooperation of everyone, male and female, young and old. This was possible because they lived in small intimate groups, where all were kin or friends, and everyone shared the same beliefs and values. Their way of life echoed the original human blueprint. They had no need for laws and cops.

For the Ik, family relationships had rotted, and society degenerated into a mob of self-centered individuals. Western cultures can also be madhouses of rabid dog-eat-dog individualism. We strive to achieve personal goals via competition for personal advancement. Our morals, values, lifestyles, ethnicities, and religious beliefs are all over the place, and often generate intolerance, resentment, exploitation, and hostility. Our communities are too crowded and diverse to be kept in order by family connections. So, we try to control the herd via laws, cops, and prisons.

A primary difference between wild cultures and civilized cultures is that wild folks spend every day of their lives in an intimate relationship with the ecosystem they inhabit. They are animals of the land, and their long-term survival is promoted by mindfully avoiding choices that could disturb the balance. Foresight and wisdom are essential.

## Family Planning

### Wild Family Planning

Colin Turnbull wrote about tribal life in Africa. Hunting people paid careful attention to the large game animals in their ecosystem, noting their migratory trends, and comparing these to historic patterns. There were periods of abundant game, and times of scarcity. While some species were rising, others declined. Through long experience, they roughly understood how many humans their territory could conservatively support — it's carrying capacity. They clearly understood the difficult consequences of having too many mouths to feed when meat was scarce. It was important to avoid this.

The value of human life did not trump the value of maintaining a healthy relationship with their ecosystem. Newborns were not automatically accepted into the band. They might not be perceived as being fully born before they opened their eyes for the first time, or while their umbilical cord was still wet. When folks agreed that a child had "come to stay," it was given a name, and only then became a proper person. If it died before naming, it was as if it had never been born. Deformed newborns were always promptly buried or smothered.

Elizabeth Marshall Thomas spent a lot of time with the San. She wrote her first book on them in 1958, and her third in 2006. With regard to their methods of family planning, most of the women had one to four offspring. In lean times, intercourse was avoided. When a child could not be kept, the woman gave birth alone, away from the camp, and buried the newborn before it drew breath. In their culture, a newborn did not immediately become alive, so disposing it was OK.

Because of low body fat and hard work, San women began menstruating later. Some did not have regular monthly periods. Nursing further drained their bodies. Children were usually nursed for about four years, which reduced mom's fertility. In a drought year, underfed women lost their milk, and some babies died. Infant mortality was not uncommon. Wild carnivores also took their share. Nomads moved frequently, and belongings and infants often had to be hauled long distances. A woman could only carry one infant, so just one twin was kept.

Peter Freuchen wrote about the Inuit people of the Arctic. During long months of winter darkness, stashes of frozen meat got smaller with every passing week, like a fuel gauge getting closer to empty. Infanticide was common and normal. When hunting was bad, children were killed to spare the group from the misery of starvation. One woman survived a spell of bad hunting by eating her husband and three children.

Folks who could no longer keep up with the hunting party were abandoned. In lean times, those who were too old to contribute to the wellbeing of the community committed suicide (a one-way walk into the frozen darkness), or asked their children to hang them or stab them — and these requests were honored without hysteria or drama, often during a party when everyone was in high spirits.

Infanticide and Abandonment

Like today, early civilizations were also hierarchical. The lucky few on top controlled and exploited the less than lucky masses. This game could work as long as the masses were not too numerous, and not too pissed at the elites. Working folks got pissed when they were unable to adequately feed their families. Unfortunately, the elites were often folks who did not enjoy a reputation for being generous and benevolent. The lower rungs of society were disposable.

The other problem here was that folks did not have easy access to effective contraceptives, or to clinically safe methods for ending unwelcome pregnancies. When families were struggling to feed the kids, they already had, adding more would only worsen their crisis. So, many took a path that had an ancient tradition.

William Lecky wrote that the Greeks were devoted to the greatest happiness principle. "Regarding the community as a whole, they clearly saw that it is in the highest degree for the interests of society that the increase of population should be very jealously restricted." Infanticide was considered to be perfectly normal in most ancient Greek civilizations. Keeping more than one daughter was rare.

Infanticide was also common in Rome, during its Empire phase. Lecky wrote that an ancient law required "the father to bring up all his male children, and at least his eldest female child, forbidding him to destroy any well-formed child till it had completed its third year, when the affections of the parent might be supposed to be developed, but permitting the exposition of deformed or maimed children with the consent of their five nearest relations."

"Infanticide" means actively killing a child less than one year old, via burying, drowning, suffocating, refusal to nurse, etc. Killing older offspring was child murder. "Exposition" (abandonment) means setting the infant down somewhere, and then walking away. In Rome, exposition "was certainly not punished by law; it was practiced on a gigantic scale and with absolute impunity, noticed by writers with the most frigid indifference, and at least, in the case of destitute parents, considered a very venial offence." Lecky added that the abandoned infants were often taken in by speculators "who educated them as slaves, or very frequently as prostitutes."

William Langer made one statement that I will never forget. He said, “In the seventeenth century, Jesuit missionaries to China were horrified to find that in Peking alone several thousand babes (almost exclusively female) were thrown on the streets like refuse, to be collected each morning by carriers who dumped them into a huge pit outside the city.” This practice remained common into the 1830s.

Langer also noted that in 1860s Britain, dead babies were frequently found under bridges, in parks, in culverts and ditches, and even in cesspools. He quoted Dr. Lankester, the coroner of Middlesex, England: “The police seemed to think no more of finding a dead child than of finding a dead dog or cat.”

Barbara Kellum pointed out that unbaptized children were beings of immense dark juju. They were evil, a “captive in the devil’s power.” A mother who died in childbirth had to have the unbaptized child removed from her corpse before she could be buried. Dead unbaptized children could not be buried in the churchyard. They were buried in a secret place, which was thereafter avoided. Sometimes a stake was driven through their heart when buried, to prevent spooky mischief.

Lecky added that killing an infant was terrible, but even worse was the fact that it died unbaptized, because its immortal soul was forever damned, and would suffer for all eternity in the burning flames of hell. Married mothers were often given penance for infanticide. Sometimes, unwed girls got off by pleading insanity. Others got a death sentence, “in the most diabolical imaginable manner” (especially for violent murder). They were buried alive, drowned, or decapitated. Hanging was rare.

He also mentioned a strange law passed in 1803 that declared infanticide to be murder — but only if the baby had passed entirely out of the mother. Thus, if the feet were still in the womb, and you smashed the baby’s head, or cut its throat, no crime occurred. Juries would not convict mothers, because there was no compelling proof of wrongdoing without the testimony of eyewitnesses. This enabled private family matters to remain private.

Foundling Hospitals

With the emergence of Christianity, the deliberate elimination of unwanted babies was strongly denounced, but abandonment remained a common practice among all social classes, especially the poor. In response to this preventable loss of life, some churches were inspired to engage in social charity. They often found babies laying on their front steps. Caring for foundlings was a painful, tedious, and never-ending challenge.

In the thirteenth century, the first foundling hospitals appeared. Their objective was to anonymously receive unwanted infants, care for them, discourage murder, and encourage the community to adopt them. Unfortunately, many mothers worried about being recognized at the hospitals, so they chose more discrete modes of disposal. Gradually, over the following centuries, more cities built hospitals, including London, Paris, and St. Petersburg. On the downside, according to Lecky, under their care 30 to 40 percent of the infants died in the first six weeks. Many were already sickly or half dead. Caretakers were often overwhelmed by large caseloads and emotional strain.

London built Christ's Hospital in 1552, to help foundlings and legitimate orphans, but in 1676 they stopped caring for illegitimate children. In 1741, the London Foundling Hospital was opened. By 1760, it was buried in abandoned babies, far more than they could properly care for. Langer wrote that the hospitals were terrible at saving lives, but they were so popular that they became too expensive to operate, forcing many to shut down. New York City opened their hospital in 1869, and 123 infants arrived on the first day.

Lecky mentioned that in 1811, Napoleon created foundling hospitals in every department of France. These had "tours," a rotating table that allowed mothers outside the building to put the baby on the table, ring the bell, disappear into the night, and remain anonymous. Nurses then spun the baby indoors, where its chances of survival were dubious. This reduced child murders, but the hospitals were quickly swamped. In 1883, 164,319 babies were left at the French hospitals. Tours were a mistake. They made it too easy to discard the unwanted, and were therefore accused of encouraging immorality.

Foundling hospitals were not located in every big city. In some places, they operated for many years, in other places they didn't last

long. The journal Pediatrics noted that foundling hospitals did not solve the problem of abandoned infants. "A majority of the children died within a few years of admission in most areas of Europe …in some times and places the mortality rate exceeded ninety percent."

So, far fewer babies died illegally, but the mortality rates in foundling hospitals were extremely high. Some have called this "legalized infanticide," because the hospitals were provided by religious organizations. Most infants perished from neglect, and many were mercifully put out of their misery by wet nurses.

Baby Farms

Dorothy Haller noted that the English traditionally sneered at young bastards (illegitimate children). Baby farming, a cottage industry that provided illegal infanticide services, received a major boost when the Poor Law of Britain was reformed in 1834. It revised earlier legislation that required the fathers of bastards to be responsible for them. The new regulation shifted all responsibility to the mothers, whose low moral standards were at the root of the problem. They had to support themselves, and their kids, until they reached age 16. Good luck!

Infanticide, abandonment, and abortion were illegal. Communities did not provide effective social safety nets. Churches typically declared pregnancy out of wedlock to be a mortal sin, and said that the women were "fallen." The offender was often ostracized by her neighbors and family, and forced to leave in disgrace. She had to relocate to a place where she was not known, where alone and friendless, she gave birth to an unwanted child. Mom and her infant might not be welcome back home.

She might find work in the new place, but would promptly be fired

as soon as her condition became visible. Joni Johnson noted that it was often impossible for an unskilled unmarried woman to both have a job and take care of her child. A number of orphanages refused to accept illegitimate children, because they were the disgusting offspring of immoral people. The mother of a bastard was not at all appealing to gentlemen looking for a wholesome wife. For many, a baby farmer offered the possibility of a second chance. It was easy to find them, because they printed ads in newspapers. A journalist ran an ad in a paper seeking a nurse for an unwanted child. He promptly received 333 responses.

Baby farmers were women who offered to care for, or adopt, illegitimate children — for a price. Sometimes the mother made regular payments so the caretaker would serve as a foster parent. Other times, the mother paid a fee, allowing the caretaker to adopt the child, or find a family willing to adopt it. The mother would never see the child alive again. Mothers asked few questions, baby farmers kept no records, and doctors didn't get nosey when infants died because their high mortality rate was the norm.

When a mother paid a fixed sum for the caretaker to adopt her child, the sooner the child died, the more profitable it was. Long-term care could not be expected when the fee paid was modest. Some infants died from opiate overdoses. For some reason, baby farmers had two nicknames, "killer nurses" and "angel makers."

Haller mentioned Mrs. Winsor who, for a weekly fee, agreed to take in the four-month-old son of Mary Jane Harris. When Mary couldn't keep up the payments, she watched Winsor smother her son, and wrap his body in a newspaper. He was dumped on the side of a road. Winsor enjoyed a steady business.

Mrs. Martin boasted that, in a ten-month period, she discarded 555 fetuses and infants. In Tottenham, Mrs. Jagger had taken in 40 to 60 infants over three years. Most perished from starvation. The "baby butcher" Amelia Dyer was suspected of murdering at least 400 infants over 20 years. Her career ended at the gallows.

It wasn't until the 1860s that doctors began investigating baby farmers, and demanding reforms. Laws were eventually passed to regulate or prohibit baby farming (decades after animal protection laws were passed). The capital of baby farming was Britain, but it also occurred in Australia, New Zealand, the U.S., Scandinavia, and elsewhere.

## Reproductive Rights

For the first 69 years of the United States, there were no laws against surgical abortion. Massachusetts passed the first regulation in 1845. By 1900, just about every state banned most forms of abortion. As their options diminished, many women felt compelled to choose the risky option of do-it-yourself abortion. Many attempts succeeded, but more than a few died from the unintended consequences, back in the days before antibiotics and reproductive freedom.

Dayna Troisi wrote that the methods women attempted included swallowing gunpowder, drinking turpentine, spending a night in the snow, throwing themselves down the stairs, harshly punching their stomach, pennyroyal, opium, or using a scraping instrument, like the notorious metal coat hanger. In many locations, illegal abortions were provided by underground enterprises, sometimes by real doctors, sometimes by folks having varying levels of experience.

In 1973, the U.S. Supreme Court ruled on the Roe v. Wade case, and in a 7 to 2 decision decided that a woman could have an abortion without excessive government restriction. This struck down many state and federal laws. Since then, a number of states have worked to reduce or eliminate the freedom of female Americans to make important life changing decisions about their own bodies.

Oddly, a number of religious folks assert that abortion is murder, but the Bible says that life begins when the first breath is drawn. “And the Lord God formed man of the dust of the ground, and breathed into his nostrils the breath of life, and man became a living soul.” (Genesis 2:7).

As I write in 2023, there are more than eight billion humans on Earth, and growing. We’ve managed to temporarily send the planet’s carrying capacity into the stratosphere by becoming extremely innovative in food production and health care, a rocket ride enabled by a one-time-only binge on fantastic quantities of nonrenewable fossil hydrocarbons.

We live in ridiculous decadence, directly at the expense of our children, grandchildren, and the entire family of life. This seems rather daffy.

Coming generations are not going to inherit cool stuff like healthy soils, forests, fisheries, wildlife, clean water, and a stable climate. They missed the riotous home wrecking party, and will inherit the toxic smoldering ruins.

In a subway system, you must never, ever step on the third rail, to avoid instant death by electrocution. In modern society, the notion of setting guidelines on reproduction is a third rail subject, and a 100% effective method of political suicide (except in totalitarian states). In the good old days, hungry carnivores, wars, famines, and pestilence helped to reduce the possibility of population outbursts, sparing folks from having to contemplate touchy issues.

Garrett Hardin was often criticized for ranting about overpopulation without also revealing some brilliant solutions. He confessed that he had been intimidated by the ostrich factor — never touch 800-volt issues that are surrounded by large piles of scorched skeletons. You can't win, so bury your head in the sand, and have a nice day! The world was not interested in contemplating the foolishness of perpetual growth. Mass stupidity got the green light.

He lamented that the U.N. decreed two rights simultaneously. (1) Every man, woman, and child has the inalienable right to be free from hunger and malnutrition. (2) Every woman has the right — perhaps with the agreement of her mate(s) — to determine how many children she shall produce. He countered that, in a finite world, unrestricted freedom is intolerable, a loose cannon having great destructive potential. We cherish sacred rights, but have zero interest in sacred responsibilities.

John Livingston lamented that human fetuses have a right to life, but nature does not. Rights are one half of a dynamic duo, and they are typically amputated from their sacred partner, wise responsibilities. Rights are the children of law, human inventions. Limits are not, they are absolutely real. In theory, a woman may have the right to bear a thousand children, but limits trump rights. Limits matter, rights are often dreams induced by hopium. In our culture, limits are demonic bastards.

William Langer, writing in 1974, celebrated the fact that, since the end of World War Two, the wonders of progress have provided humankind with the contraceptive pill, intrauterine device, and legalized abortion. At long last, in theory, there was no longer any excuse for unwanted pregnancy, infanticide, abandonment, or baby farmers. Oddly, now in the twenty-first century, there are still folks who oppose all forms of family planning except the heavenly pleasures of celibacy.

I shall now reveal both good news and an effective solution. The good news is that ecological sustainability is, by definition, inevitable. Unsustainable foolishness can only be a temporary deviation (industrial civilization for example). Whether or not bipedal primates will survive to see the restoration of sustainability is another matter. Time will tell.

I cannot imagine that civilized humans will ever mindfully summon their wisdom and foresight, and then proceed to intelligently resolve the issue of extreme overpopulation.

The one and only guaranteed solution to the problem of overpopulation is time. As the planet's carrying capacity for our species declines, our population must also decline.

# Energy

### Sunbeams

Alfred Crosby wrote a fascinating history of energy use. There are two primary sources of energy, nuclear fusion from the core of the sun, and heat that rises up from the molten magma within the Earth. Almost all of the energy used by the family of life traces back to the solar source. Every day, the sun reliably provides clean energy for our planet, and it never sends us a bill. Solar energy will likely continue long after humankind joins the dinosaurs.

Incoming sunbeam energy is captured by the living solar panels built into green plants. The solar panels contain chlorophyll, which uses sun power to assemble simple carbohydrates by combining molecules of carbon dioxide ($CO_2$) and water ($H_2O$). This magic act is called photosynthesis, and it enables the existence of the entire family of life. The carbs it produces include sugars, lignin, and cellulose. Carbs are used for the plant’s basic survival, growth, and reproduction. Some plants store carbs for later use. The byproduct emitted by photosynthesis is a gas called oxygen.

By a remarkable coincidence, living organisms called animals require both carbohydrates and oxygen in order to survive. Animals burn (oxidize) carbs and release a byproduct called carbon dioxide, the gas that plants need to perform photosynthesis. Animals consume food from plant and/or animal sources and use it for growth, reproduction, daily activities, and so on. The portion of their food intake that’s not utilized is emitted in wastes called pee and poop, which are highly nutritious substances that plants adore.

Finally, all living plants and animals, sooner or later, become dead plants and animals, and dead stuff is a highly nutritious source of food for the recycling crew of wee beings. They convert dead stuff into humus. This organic matter sequesters essential nutrients and improves the fertility of topsoil, much to the delight of the entire family of life. Under ideal conditions, the fertility and depth of topsoil can improve continuously for thousands of years.

Earth is an unusual planet, because it can accumulate carbon-rich organic matter brought into existence by plants. When living things die and decompose, they leave behind the carbon compounds. For example, coal is carbon that was stored millions of years ago.

Stephen Pyne explained that fire requires oxygen, heat, and fuel (carbon). Plants produce both oxygen and carbon compounds. Earth is the only known planet where fire is possible. When conditions are right, flames can burst into existence and devour forests and grasslands. Fire has played a fundamental role in the evolution of the family of life. It's also the primary power source for industrial civilization.

## Carboniferous Period

Plants and trees are children of the sun. Everything that swims, flies, crawls, or walks is a sunbeam critter, including you and me. Fossil energy is hydrocarbon compounds originally created by the dance of sunbeams and photosynthesis.

Coal is fossilized sunshine created during the Carboniferous Period, which was long before the age of dinosaurs. This fossil biomass accumulated over the course of millions of years, largely in the vast swampy rainforests of Europe, Asia, and North America. The rainforests absorbed sunshine and carbon, and used it to create carbon-rich biomass.

Today, tree trunks are roughly 1 part bark to 4 parts of wood. During the Carboniferous, the tree trunks were more like 8 parts bark to 1 part of wood (up to 20 to 1). Back then, there were no microorganisms capable of decomposing the lignin in the bark of dead trees, so nothing rotted for millions of years. The biomass in the rainforest swamps eventually became carbon-rich peat. Over time, pressure and heat transformed the peat deposits into coal. In some locations, coal beds are up to 39 feet thick (12 m).

Because so much carbon was buried, there was far less of it in the atmosphere. Consequently, the oxygen content in the air soared to 35 percent (today it's 21 percent). So, for the animals living in that oxygen-rich air, many things grew to giant proportions. Dragonflies had wingspans of 29 inches (75 cm), and millipede-like bugs grew up to 9 feet long (2.7 m). Some amphibians were almost 20 feet long (6 m).

Finally, the Carboniferous Period was brought to an end by climate change. Wet and warm shifted to cool and dry. Glaciers grew, sea levels dropped, and many rainforest species went extinct, including most of the forests. In the new climate, many reptiles adapted well, because the eggs they laid on land had shells that prevented the embryo from drying out. Eventually, this enabled the emergence of the dinosaur era, which included the ancestors of today's birds.

**Jurassic Period**

Petroleum and natural gas are sequestered sunshine that originated in bodies of water during the Jurassic Period, the age of dinosaurs. In those days, the climate was very warm, creating perfect conditions for teeny-tiny plants called phytoplankton that float around in oceans, seas, and lakes. They absorbed Jurassic sunshine, and used it to create carbohydrates, their food.

Today, phytoplankton are the most numerous organisms in oceans. It is estimated that they comprise one percent of global biomass, yet most of them are too small to see with the naked eye. They are the foundation of the oceanic food chain, and all sea life depends on them for survival. Of all the photosynthesis performed

on Earth, they do half of it. Dahr Jamail noted that "phytoplankton photosynthesis produces half the total oxygen supply for the planet."

During the Jurassic, countless gazillions of these floating organisms lived happily. When they died, they sank to the seafloor. In some locations, large deposits accumulated faster than the material could decompose. After they were buried under layers of sediment, heat and pressure stimulated chemical reactions. Oil and gas were created when the deposits were cooked for millions of years at temperatures ranging from 180° to 280°F (82° to 137°C). In many locations, large concentrations of these hydrocarbons have survived to modern times.

It took 250 million years for the biomass to accumulate at the bottom of the sea, and additional millions to finish pressure cooking it into oil and gas. During this extremely slow process, 90 tons of ancient biomass was transformed into oil from which one U.S. gallon of gasoline (3.8 l) could be refined.

**The Great Bonfire**

During the maybe four million years that hominins have wandered on Earth, the daily inflow of sunbeams has continued, millennia after millennia, sustaining the family of life. Around 25,000 years ago, the woolly mammoth hunters at the Dolní Věstonice site in the Czech Republic lived in a chilly tundra where trees, if any, were not abundant. They heated their mammoth bone huts by burning the solar energy embedded in two fuels: fat-rich mammoth bones, and chunks of black coal they found on the ground.

The hunters were unaware that, in many locations, enormous deposits of fossilized solar energy were buried underground. Folks paid little attention to this hidden treasure until the last few centuries, when industrial societies began a binge of fanatical pyromania.

The great bonfire accelerated around 400 years ago, as growing civilizations depleted their traditional biofuel resource, wood, during a tireless rampage of deforestation. Then, in the last few centuries, fossil energy was added to the bonfire, creating a catastrophic impact similar to an asteroid strike. It has blindsided the climate, enabled skyrocketing population growth, rubbished many ecosystems, and spurred a mass extinction. How smart was that?

Like spoiled children, clever folks got swept away by a never-ending parade of titillating toys, fads, amusements, and status

symbols — silly thrills. Nate Hagens reminded us that cleverness is very different from wisdom. He said that cleverness has a tendency to reduce us to idiot-savants (French for "learned idiot"). We are incredibly skilled at doing stuff that is totally unnecessary and highly destructive.

For many thousands of years, nomads wandered across the Arabian Peninsula, unaware of the invisible oceans of oil below their feet. They had what they needed, lived in their time-honored way, enjoyed their simple lives, and breathed clean fresh air. This was not a problem. The first oil well in Saudi Arabia was drilled in 1938. For Arabians, the petroleum decades have been a turbulent era of explosive growth in wealth, population, urbanization, mass consumption, and environmental destruction.

Prior to the fossil energy fad, most mills and factories were located beside streams, which propelled their waterwheels. Water flows were not constant, they varied by season, and by weather patterns. Many water-powered mills could not work reliably in the summer, when flows were low.

Other enterprises were driven by windmills, but winds could be howling one day, and then calm for weeks. Neither water wheels nor windmills were major power sources. Until the expansion of steam technology, the primary source of power remained the muscles of two-legged and four-legged animals.

Unlike wind or water, coal-fueled steam engines could reliably provide steady power output every day of the year. By and by there were steam powered textile mills, locomotives, steamships, and so on. Later came internal combustion engines, which were used to power a huge variety of machines. Gasoline couldn't run a sewing machine 100 miles away, but electricity could. We invented generators, built power grids, hydroelectric dams, and nuclear power plants. We invented telegraphs, telephones, light bulbs, radio, television, cell phones, the internet, and so on.

Coal

By the thirteenth century, some regions in Europe began fooling around with coal. As Britain was exterminating its forests, firewood became scarce and expensive. By around 1550, wood shortages had become a serious threat to the status quo. Britain was home to significant deposits of coal, a dirty fuel that everyone considered to be inferior to wood.

Britain also had significant deposits of iron ore. Early in the seventeenth century, clever folks discovered that coal could be roasted into coke, which burned hotter, enabling the production of higher quality metal. Before long, Britain was home to a growing iron industry. This unlocked the gate to the Industrial Revolution, and enabled the birth of the British Empire.

One of their colonies was the future United States. America had huge coal and iron ore resources, and many of the deposits were of higher quality than those in Britain. This, along with abundant oil, enabled the U.S. to grow rapidly and become a planet thrashing industrial superpower. History often dances to the beat of geology.

In 1952, during a spell of extreme cold, from December 5 to 9, the region surrounding London was suffocated by the Great Smog. Four thousand died from the choking dense coal smoke. Being outdoors turned your clothes and skin black. At times, it was literally not possible to see your hand in front of your face. A few people stumbled into the Thames and drowned. That winter, undertakers ran out of caskets.

Albert Marrin noted that lignite, or brown coal, is 73 percent carbon. It is soft, and very dirty to burn. Bituminous coal is 85 percent carbon. Black coal, anthracite, is over 90 percent carbon. It is the oldest, hardest, hottest burning, and most deeply buried.

Writing in 2012, Jeff Rubin said that the total energy content of all types of coal mined in the U.S. peaked in 1998. Since then, we've been extracting larger amounts of lower quality coal. Anthracite production in the U.S. peaked in 1950, and then fell 75 percent by 2010. Bituminous production peaked in 1990, and has been declining since.

Most coal production originates in just seven countries, and they only export 15 percent of their output to other nations. It's expensive to ship. Lignite is the most abundant type of coal, but because of its low energy content, it cannot be shipped long distances at a profit. Petroleum, on the other hand, can be widely exported, because it has dense energy content, and is a far more valuable cargo.

Clive Ponting noted that world coal production was 10 million tons in 1800, 760 million tons in 1900, and 5 billion tons in 2000. The International

Energy Agency (IEA) reported that global coal production will soar beyond 8 billion metric tons in 2022, a new all-time high.

Oil

The industrial scale production of oil began in 1859, in Pennsylvania. Initially, the primary product was kerosene for lighting, which replaced whale oil lamps, and candles made of beeswax or tallow. Later, oil provided the fuel source for internal combustion engines, and all hell broke loose. New reserves of oil were discovered at an increasing rate, and society consumed more and more of the black gold. Because oil is a finite nonrenewable resource, neither trend could continue indefinitely, no matter how hard we wished otherwise.

The discovery of new oil reservoirs in the world peaked in 1965, by which time we had discovered most of the easy to find supergiant oil provinces. Since then, discoveries have been fewer and smaller. They require drilling more wells, which drives up the cost of producing each barrel. Meanwhile, the consumption of oil has continued growing. We're consuming it faster than we're discovering

it. [LOOK] This trend has an expiration date.

My friend, Walter Youngquist was among the generation of petroleum geologists who first saw the writing on the wall, with regard to the limited future of world oil production. The trends were disturbing. It was getting harder to discover new deposits.

In the 1990s, several highly experienced gray-haired petroleum geologists began jumping up and down and shouting, attempting to warn humankind that terribly serious problems were approaching in the not-too-distant future. They were predicting that global oil production would peak before 2010, and this was a serious threat to life as we know it. The Peak Oil movement generated lots of information, and got significant attention for a while.

Writing in 2012, Youngquist noted that the first 200 billion barrels of oil were consumed between 1859 and 1968. The second 200 billion barrels was consumed in the next ten years. By 2012, 200 billion barrels was consumed in just six and a half years. Of all the oil ever consumed, 50 percent was used since 1984, and 90 percent has been used since 1958.

As I write in 2022, global oil production is hitting new peaks, and so is its price. In recent years, with a big sigh of relief, many folks have dismissed the Peak Oil predictions as the hysterical delusions of doom perverts. The story is more complicated. Those Peak Oil folks were focused on *conventional* oil, the stuff that's the easiest to extract (its most of the oil produced since 1859). With regard to conventional oil, the geologist's predictions of peak production were essentially correct.

The geologists were well aware that there was still lots of other oil in the ground, but it was found in numerous and much smaller deposits that could not be profitably extracted by the traditional technology. These resources are called *unconventional* oil. They include tar sands, heavy oil, offshore deep-water wells, and tight oil (also called shale oil).

Eventually, new technology, notably fracking and horizontal drilling, enabled a sharp increase in the production of unconventional oil. This oil was far more difficult and expensive to extract, but we now had the tools to effectively produce lots of it (for a while). Consequently, global oil production could continue growing, enabling world population to soar to even greater extremes. This allowed humankind's war on the future to become more destructive than ever.

Tight oil is extracted by a process known as fracking, which can retrieve oil (or gas) from small deposits. Richard Heinberg mentioned a 2014 report. It found that in the North Dakota oil fields, just to maintain current production, 1,400 new wells had to be drilled every year. The lifespan of each well was brief, just a few years. Fracking was not cheap.

Nate Hagens wrote an important paper on current energy trends. Don't miss the graphs at the top of page 6. [LOOK] The right graph shows U.S. oil production from 1900 to 2018, and it indicates the volumes produced by the four primary types of oil sources. The red spike is labeled tight oil, which is the unconventional oil extracted from shale beds by fracking. The sharp spike in tight oil is what has (temporarily) made the U.S. the world's top oil producer. The three non-shale sources had peaked by around 1980, and have since been in steep decline.

Hagens does note an important concern. With the transition to fracking shale deposits, the cost of extraction has been rising faster than the market price for oil, which means that profits are getting squeezed, and rich investors are sobbing uncontrollably. On the other hand, if the market price rises too high, the global economy begins coughing up blood, and mobs of bankrupt fat cats begin leaping out of top floor windows.

Meanwhile, billions of barrels of tight oil remain buried in a number of nations. This oil is "technically recoverable," meaning that it could be extracted if profits didn't matter. The subset of this oil that is "economically recoverable" (makes some profit) depends on the current market price for oil. When prices trend upward, drilling increases.

A crazy gold rush economy must have cheap and abundant energy. Economic growth cannot occur without growing energy inputs. When the inputs decrease, the economy shrinks. When the market price of energy rises sharply, the economy dives sharply. Our economic system is designed to function in just one mode — perpetual growth, by any means necessary, the future. How smart is that?

If growth stops, so does our silly march to an imaginary utopia. As you can see, our economic system is extremely dependent on the accelerating extraction of nonrenewable resources. It will eventually self-destruct, but for a while it allows a portion of humankind to live like spoiled children that love making messes. Ancient Egypt built pyramids; we build monumental landfills.

In the good old days of giant and supergiant fields of conventional oil, high volume production was easy. I remember a time when I bought gasoline that cost 22¢ per gallon. The baby boomer generation experienced a tsunami of robust economic growth and ridiculous material excess. On a chart of population growth and global oil production, both curves follow a similar skyrocket trajectory. The descendants of the boomers are in for a far different experience.

And now, the plot thickens, and the drama takes another unpleasant twist.

## EROEI

It takes energy to develop sources of energy needed to power industrial civilization. For example, with regard to oil, a geologist first has to find a promising location. Then, a road, pipelines, storage tanks, and utility infrastructure must be built. A drilling rig bores a well, and if the project is lucky, some oil is found — maybe a lot, maybe not. Nerds can then calculate how much total energy it took to extract the oil, and compare it to the energy contained in the oil that the well actually produced. The calculation results in a measurement known as the EROEI (Energy Returned on Energy Invested), or sometimes just EROI.

A hundred years ago, it was much easier to locate large high-quality deposits (it's easy to find elephants). Some wells didn't even need to be pumped; you could just open the valve. So, in the good old days, it was not uncommon for a project to invest one unit of energy to extract 100 units from an oil well. In this case, the EROEI was 100:1. The investors that funded the project made a generous profit.

Writing in 2014, Walter Youngquist mentioned that in 1930, U.S. oil production had an EROEI of about 100:1. By 2014 it had fallen to almost 5:1 in the U.S., because of the growing dependence on unconventional tight oil. At that time, the entire global oil industry was operating at about 18:1, because it included production from the conventional oil reserves remaining in the Middle East and elsewhere. Youngquist suspected that the EROEI red line for maintaining life as we know it (high impact consumer society) was about 7:1 (others say 5:1). The ethanol "biofuel" produced from U.S. corn is 1:1 or less. This industry is stupidly kept on life support by government subsidies that delight Big Agriculture.

Please note that calculating an EROEI statistic is far more complicated than weighing a hunk of copper. Experts use different formulas, so the numbers produced by various studies are not consistent. What is absolutely consistent across all studies is that the trend lines for U.S. and global EROEI values have been falling sharply in the last century.

Writing in 2013, Tim Morgan estimated that the global industry in 1990 was running at about 40:1. It dropped to 17:1 by 2010, and was expected to drop to 11:1 by 2020. Few of the new discoveries in 2013 were likely to produce more than 10:1. He expected that by about 15:1, the soaring costs of world production become a serious threat to profitability.

Morgan noted that there are still large deposits of oil and gas in shale beds, but extracting them via fracking at 5:1 generates little profit for the global economy. He wrote that tar sands are slightly higher than 3:1 — but only for the deposits that can be surface mined, which are 20 percent of total tar sands. The other 80 percent of tar sand energy will be left in the ground forever, because its projected EROEI is very low or negative.

There are vast tar sand deposits in Alberta, Canada. Youngquist noted that they contain 1.7 trillion barrels of bitumen, but only 19 percent of it will ever be produced, because it takes two tons of tar sands, and lots of water and natural gas (heat), to produce one barrel of oil.

As EROEI declines, the cost of oil rises, taking a bigger bite out of the U.S. economy. In the 1990s, oil had been around $10 a barrel. In 2004, it was around $30. In 2008, it shot up to $147, economic growth slammed into a wall, and a terrifying mushroom cloud rose over Wall Street. Youngquist said that OPEC (oil producing) nations were delighted by the sudden surge in profits. But in the following weeks, it dropped to $60, and briefly to $40. OPEC freaked out, because falling prices slashed profits.

Alfred Crosby pointed out that the trend of diminishing EROEI means that lots of oil will be left in the ground forever, regardless of how high the price eventually rises. So will a lot of low-quality coal. Imagine having a job that paid $100 per day, but the bridge toll to get there was $101. When it takes a barrel of oil to produce a barrel of oil, there is no net energy gain. Game over. At some point, declining EROEI will make it impossible for industrial civilization as we know it to exist.

Study the fascinating chart of the net energy cliff. [HERE] The green area shows the energy available for consumption, and the red area shows the energy used to extract it. Note that old fields required very little energy for extraction, while tar sands and oil shale require an enormous amount of energy and money to extract. Once EROEI dips below 10:1, the trend sharply changes.

After the Bonfire

Walter Youngquist, a geology professor, lived almost 97 years, and accumulated more than a little wisdom along the way. He said that we're living during an explosive blip of *nonrenewable prosperity*, a blip that can never again be repeated. Fossil energy accumulated over the course of more than 500 million years, and we're going to extract it and burn it in less than 500 years. Then what?

He wrote, "The twentieth century witnessed the rise of the nonrenewable resource-based industrial economy. In some respects, the twenty-first century will be like the twentieth century in reverse." The blip will be a turning point in the human saga. "Most people living now will witness the peak and irreversible decline of world oil production," he warned. We can't exactly predict the date of the turning point, but we'll know it after we've passed it.

Oddly, this is good news, sort of. Luckily, the fossil energy resources that remain cannot keep the blip on life support indefinitely. What a horror it would be to have another century of constantly accelerating, maximum intensity, planet thrashing pandemonium. What would be left? On the other hand, the destructive imbalances we've already unleashed have put us on a path to a destination that will not be mistaken for utopia.

Tim Marshall mentioned a ghastly possibility. Climate change has put us on the path toward a year-round ice-free Arctic. Buried under the ice are significant (huge?) deposits of oil and gas. As the ice melts away, extraction might someday be possible — but not easy or cheap. Hopefully, it will remain where it is forever.

Here's an uncomfortable footnote. Tim Marshall wrote that in a 2009 report, the U.S. Geological Survey estimated possible fossil energy resources located in the frozen Arctic. There could be 1,669 trillion cubic feet of natural gas, 44 billion barrels of natural gas liquids, and 90 billion barrels of oil. As the Arctic ice melts away, these deposits become accessible.

One more footnote. The preceding words in this section were written at least four years earlier. Now it's 2024, and I've found that the latest all-time peak of global oil production was in 2023. This was enabled by advances in oil extraction technology.

John Michael Greer, a venerable druid, provided his fans with wise counsel. We need to compost the notion that the future is going to be better than today. Our lifetime of decadence and excess was a totally insane abnormal fluke. It's time to come to grips with the notion that, with regard to life as we know it, "there is no bright future ahead."

## Limits

"Limit" is a power word, a gateway that can open or close, enable or disable, green light or red light. When members of a species migrate into an ecosystem and adapt to it, they make use of available resources, and expand until their growth is halted by limits — food, water, climate, disease, predators, etc. Herbivores are limited by the availability of digestible vegetation. Predators are limited by the availability of prey. The whims of nature can suddenly tighten limits, or relax them.

The dance of life is full of surprises. Humans are unusual in that we can sometimes drastically push back traditional limits via the wildcard of technological innovation, a risky trick that often generates painful unintended consequences over time. Big Mama Nature is not amused. She spits and hisses: "So, y'all don't believe in limits, eh? Well, limits don't care what you believe."

### Malthus

In 1798, an English clergyman named Thomas Malthus wrote a famous book asserting that endless growth was impossible — a perfectly sane and rational idea. Today, it's common for folks around the world, especially the affluent and well-educated, to become entranced by a toxic conspiracy theory. They suffer from hallucinations of limitlessness. There can never be too many people, or too much wealth. They think like two-year olds, and make many big messes. "Limit" is the most obscene, and disgusting word of all!

When Malthus wrote, Britain's Industrial Revolution was in the process of eliminating the traditional cottage-based craft workers who spun yarn, knitted garments, and wove fabric. As discussed earlier, this shift displaced lots of people. They were forced to migrate to filthy crowded cities that were hellholes of filth, poverty, disease, and vice.

Reverend Malthus was concerned about this painful social decay. When he wrote in 1798, England was home to about 8.8 million. By 1861, the number had soared to 20.1 million, turbocharged by the growing reliance on potatoes, a nutrient dense super food imported from South America. Malthus could see that when subsistence (food) increased, so did population. Eventually, the growing mob would collide with the limits of subsistence, forcing more and more to go to bed hungry.

While the humble of birth suffered, respectable folks like Marx, Engels, and Malthus's father were giddy with optimism, and soaring away on beautiful utopian dreams. Humans are incredibly amazing. Limitless improvement was possible, and we were on the path to a perfect future.

Malthus was a realist who believed that human society was not in the fast lane to perfection. Ongoing instability was insured by the wobbly relationship between subsistence and population. This friction often led to painful surprises.

For 200+ years, legions of critics have been denouncing Malthus, because he predicted that rapid population growth would soon lead to catastrophe. Actually, he never made that prediction, although he was right to be wary of growth. It seems apparent that many of his critics never actually read his book.

Over the years, Malthus penned six editions of it. Garrett Hardin sat down and read them all, comparing the additions and deletions. He reframed Malthus' message as: "Disaster is a natural outcome of perpetual population growth, but disaster can be forestalled if society can find the will to put an end to population growth."

In Living Within Limits, Hardin concluded that 95 percent of his ideas were correct. Not bad! The primary booboo of Malthus had to do with math. He was right that population was capable of growing exponentially (2, 4, 8…), but wrong in assuming that subsistence could only increase arithmetically (2, 3, 4…). In the last 100 years, both food production and population have skyrocketed — and this surge will not have a happy ending.

**Overshoot**

William Catton wrote Overshoot, a masterpiece on *carrying capacity* — "the maximum success, of any species, that an ecosystem can support indefinitely." Around 300,000 years ago, the planet's carrying capacity for early humans was limited by the resources available within their original homeland in east Africa, and by their limited ability to utilize those resources.

For any species, the carrying capacity limits for a region, or the planet, can be altered in two ways. (1) *Takeover* is expansion into new habitat, which provides access to additional resources. This is not inherently naughty. For example, long ago horses and camels migrated from North America to the Old World. Mammoths and saber-tooth cats migrated in the opposite direction. So, takeover can enlarge carrying capacity for a species.

(2) *Drawdown* enables carrying capacity limits to be temporarily overridden by depleting exhaustible resources. For example, synthetic fertilizer generously boosts harvests, and more food spurs population growth. But a primary input for making fertilizer is natural gas, a finite nonrenewable resource.

Drawdown does not actually elevate carrying capacity, because it is unsustainable — it depletes limited resources, so its benefits can only be temporary. So, what drawdown creates is "phantom carrying capacity." Today, the existence of more than eight billion humans is almost entirely dependent on phantom carrying capacity — destroying topsoil, overdrawing water resources, depleting fossil energy, exterminating forests, and so on. Our way of life has an expiration date.

Catton called this predicament *overshoot* — "growth beyond a region's carrying capacity, an imbalance that eventually leads to *crash* — a pressure reducing die-off." He noted that the global expansion of overshoot has been intensifying for several centuries. He referred to our ridiculously abnormal era as the Age of Exuberance.

Catton put his finger on Malthus's core misunderstanding. Back in 1798, Malthus simply could not imagine that it was possible for humankind to ever exceed Earth's carrying capacity. It *is* possible to survive in overshoot

— *temporarily* — like humankind is currently doing, as it devastates the planet with reckless fury.

During an interview with Derrick Jensen, Catton noted that the energy needs of hunter-gatherers were about 2,500 to 3,000 calories per day. The energy needs of modern consumer lifestyles (including their technology) requires about 200,000 calories per day.

**Energy and Growth**

During this long and lumpy comedy of errors, the transition to fossil energy shifted the monster into warp drive. Today's globalized industrial civilization is living like there's no tomorrow, and behaving as if we were the last generation. This story will have a crappy ending. Consumer society has zoomed far beyond the border, deep into the bowels of Crazyland, where folks soar away in beautiful hallucinations of limitlessness — a magical realm of progress, abundance, perpetual growth, maniacal shopping, and 500 channels of nonstop entertainment with no commercials.

J. R. McNeill and Peter Engelke wrote about the planet shaking explosion of eco-destruction that has occurred since 1945. They noted that energy is the guiding force, the trail blazer, of humankind's long meandering saga. We can't photosynthesize sunlight, so we survive by eating plants and animals. In the days before hominins learned how to kindle fire, their sole source of life energy was a raw food diet. Fire led to cooking, which enabled the ancestors to transform indigestible stuff into an additional sources of life energy. Increased access to edible energy enabled the survival of more food eaters.

Tragically, with the emergence of plant and animal domestication, traditional limits to growth could be radically exceeded, temporarily, by rubbishing wild ecosystems, and replacing them with manmade ecosystems capable of producing far more edible energy, when conditions were favorable. Cereal grains are energy dense, and suitable for long term storage. Today, our food is produced by mechanized, irrigated, chemical drenched, industrial agriculture, which further accelerates overpopulation.

Similarly, the domestication of livestock and poultry generated even more food energy, especially when wild predators (competitors) were systematically exterminated. Enslaved horses could convert the solar energy stored by vegetation into mechanical energy useful for carrying riders and cargo, or for pulling plows, carts, and carriages. Prior to this time, for almost 300,000 years, the primary source of mechanical energy used by our ancestors was human muscle power.

Catton wrote that agriculture provided phantom carrying capacity. Another phantom was the exploitation of "ghost acreage." The hungry mobs in places like Britain could be fed by importing lots of food produced on faraway acres in other lands. Many nations are now dependent on imported food. Another phantom was industrial fish mining, depleting wild fisheries to feed hungry urban populations. All wild animals have limits too. The global food system can seem like a shaky house of cards.

The planet-eating monster is primarily powered by nonrenewable fossil energy, a form of stored sunshine that accumulated over the course of 500 million years, most of which we'll burn in a mere 500 years. Every day we move closer to the post-fossil era, the funeral wake for today's global food industry, and the overshoot it conjured into existence.

In 2019, ecological economist William E. Rees wrote a stunning sentence: "It is a quirk of exponential growth that half the fossil energy ever used (and half the fossil CO ever produced), has been 2 burned (emitted) in just the past 35 years!" Rees has concluded that humans are not "primarily a rational species." It's hard to disagree.

He added, "In short, we are currently 'financing' economic growth by liquidating the biophysical systems upon which humanity ultimately depends. There are too many people competing for the same diminishing quantity of essential resources."

Like fossil energy, a keg of beer is a precious but finite nonrenewable resource. Alfred Crosby reminded us that after a binge of oblivion drinking, a hangover should be expected to follow. When the keg has no more beer, the party's over. We will not miraculously be rescued by the renewable beer fairy.

### Growth Soars Away

Eventually, our food production surpluses rose to the point where a portion of the mob was no longer needed in the fields and pastures. It became possible to feed people who could indulge in specialized activities, like metallurgy, woodworking, ceramics, construction, warfare, religion, government, and on and on. We swerved into the fast lane, and commenced our joyride of turbocharged cleverness with no brakes, no roads, and no foresight — full speed ahead into the powerful nightmare world of unintended consequences. Yippee!

Growing numbers of folks accumulated in villages, towns, and cities. Poor sanitation, malnutrition, and high density living laid out

the welcome mat to a wide variety of infectious diseases. William

McNeill noted that for 8,000 years, cities were demographic black holes, because of their high death rates. Their ongoing existence depended on the constant inflow of surplus people from the countryside, commonly bachelors, spinsters, orphans, and refugees who were not among the lucky winners in the land inheritance lottery.

William Stanton pointed out that around 1750, population trends shifted into a new mode, accelerating growth. Food production was booming. Colonies in Africa, Australia, and the Americas greatly expanded the area of land used for growing crops and raising livestock. It became possible to import abundant amounts of food. New World crop plants were sent back to the Old World, including two extremely productive super foods — potatoes and corn (maize). Old World livestock were sent to the colonies, where they could explode into the millions.

Our skills at soil mining improved. The area of land that could support ten people in 1700, could support 50 by 1900. New types of potent fertilizers became available, further boosting productivity. Norman Borlaug's crop breeding research launched the Green Revolution, which enabled a dramatic increase in productivity, via energy intensive and unsustainable processes.

Writing in 2003, Stanton wrote that when agriculture became dependent on oil, the need for human labor was reduced by a factor of 40 to 1. Using the latest mega-technology, the factor might be close to 100 to 1. New farm machinery promoted higher crop yields. New dams enabled deserts to become lush croplands. New irrigation pumps enabled water miners to drain ancient aquifers. New petrochemicals reduced crop losses by insects, diseases, and weeds.

Birth control is intended to prevent unwelcome pregnancies. Stanton talked a lot about its opposite, death control, which was intended to delay unwelcome deaths. Prior to 1750, high mortality rates provided a reliable restraint on growth. Then, from 1750 to now, stunning advances in death control kicked open the gateway to a horrific population explosion. He decreed that this was an era of weak restraints on growth (WROG). Naturally, when death rates drop below birth rates, population rises. Growth happens.

In prehistoric times, there were periods of WROG that began when wild humans first set foot on uninhabited continents and islands, and discovered an abundance of delicious resources. Five centuries ago, civilized folks from the Old World washed ashore in the New World. The infectious diseases they carried with them rapidly spread, killing a huge portion of the inhabitants on two continents. The massive die-off then cleared the stage for a 500-year WROG rocket ride.

In the current WROG surge, while birth rates chug along, death rates have been dramatically driven down by technological innovations. Food production is booming. Mortality from infectious diseases has been reduced by new vaccines, antibiotics, wonder drugs, antiseptic surgery, and other health care advances. Public health has been improved by energy-guzzling systems for garbage disposal, safe drinking water, and sewage treatment. What this one-time binge on fossil energy is doing to the climate will hasten the end of the WROG era.

## Growth Nears Retirement

As the old proverb says, what goes up, must come down. During the current WROG nightmare, technological cleverness has made it possible to maximize drawdown, and foolishly override carrying capacity limits. We're rocketing forward, at maximum velocity, into the turbulence of overshoot. This is what is known as progress, sustainable growth, a high standard of living, and so on.

Albert Bartlett tirelessly preached that growth in population and resource consumption is undesirable, unwise, and unsustainable. Therefore, the super-trendy buzzword "sustainable growth" is an oxymoron. It's like the neon sign in the tavern window, "Free Beer Tomorrow." Bartlett was amused by the popular fantasy that if you called something "sustainable" enough times, then it was!

When you spend every minute of your life pounded by a howling hurricane of deceptive information, it can become difficult to see and think clearly. Most folks unconsciously assume that the decadent lifestyles of the WROG era (including our entire lifetime) are perfectly normal, and will happily continue into the distant future. Wrong!

We've gotten way too clever at exceeding limits — by sneaking around them, leaping over them, tunneling under them, or exterminating them. Consumer society has soared away into a state of full-blown debauchery. This way of life has an expiration date, and there are folks alive today who will experience its arrival.

In the absence of wisdom, foresight, radical birth control, and enthusiastic worldwide cooperation, food will become increasingly expensive and/or scarce. No matter how hard we wish, it is not possible to conjure megatons of food out of thin air via hope, prayers, voting, or positive thinking. Overshoot will eventually slam into the stone wall of carrying capacity.

Sooner or later, the most vulnerable regions will eventually reach what Stanton calls the violent cutback level (VCL). When this happens, violence becomes inevitable. He noted that a number of regions began approaching VCL levels in the late 1970s, Rwanda for example. The number of hotspots continues growing. Stanton noted that folks having low social status, or high bad luck, will be among those affected first. Political correctness will go extinct, as will sympathy for the poor and hungry.

Societies that are ethnically and culturally homogenous, like Iceland, have not shattered into aggressively competing factions. For them, reaching their VCL may not be an imminent danger. On the other hand, in dysfunctional, oppressive, intolerant, multi-cultural societies, the VCL is always just one spark away.

**Tikopia**

Tikopia has excelled at mindfully avoiding full scale VCL. It is a tiny volcanic island in the Pacific, just 1.8 square miles (4.6 $km^2$) in size, much of it was steep rugged hillside. People have lived there for about 3,000 years. Luckily, the island has no valuable resources that would excite the greed of sickos from industrial civilization. Luckily, the islanders have no way of acquiring money and shapeshifting into trendy consumer robots.

Tikopia is 85 miles (137 km) away from its nearest neighbor, Anuta, an even tinier island, and both are extremely isolated from the outer world. Folks travel by paddling across treacherous open waters in dugout canoes. The survival of Tikopian society is entirely dependent on a self-sufficient way of life.

Each household is assigned to specific orchards and garden spaces which the family uses to produce their food. In traditional Tikopian culture, based on existing conditions, the household head set limits on producing new offspring. When the limit was reached, subsequent newborns were suffocated, so the rest would have adequate food. In the old days, everyone practiced coitus interruptus to avoid unwanted pregnancies. Junior members in a family had less reproductive freedom.

This system worked very well for many centuries. Unluckily, the Tikopians were discovered by missionaries, who spent more than a century teaching them that their remarkable time-proven culture of mindful sustainable living was evil.

Living mindfully was far more enjoyable than hunger and conflict. Today, this simple brilliant obvious idea never inspires the minds of the vast majority of humankind. Giant societies are breeding like bunnies, zooming down a dangerous path with no safety nets. A growing number of regions are now experiencing painful collisions with bedrock limits, and this trend is certain to continue.

## Human Webs

The modern world is fantastically irrational, burning every bridge it crosses, and then charging forward to rubbish what lies on the path ahead. Efforts to comprehend reality often result in throbbing headaches. In the early pages of this book, I mentioned a

fundamental question that William Cronon's father gave him, to help his son navigate the path of life with greater wisdom, "How did things get to be this way?" Dad's question has guided my process of writing this book.

William and John McNeill were another father and son team of historians, and their vision was to write a book that actually answered the question. William's 1963 experiment was written in a conventional history textbook style, and was a hefty 829 pages. John thought a slimmer and slicker book was possible. He envisioned an unconventional approach, and with a few years of effort the two of them got the job done in 350 pages, *The Human Web*.

Webs are relationships that link together groups of people who have come into contact with each other, and exchanged information. In ancient times, hunter-gatherers were few in number, and widely dispersed. Bow and arrow technology somehow spread around the wild and roadless planet, to every continent except Australia. The McNeills called this the first worldwide web. Learning the skills used by others could increase the odds for survival.

Later came agriculture. As farming and herding grew in importance, the human herd also grew. More and more cities and civilizations mutilated once-healthy ecosystems, filling the land with more and more people. Strangers from different webs bumped into each other, more and more often. These random meetings exposed folks to more and more foreign technologies, crops, ideas, goods, and so on. Over time, regional webs formed, and these often merged with others, forming larger webs. Webs enabled a wide variety of information to travel to distant lands, where it accumulated, mutated, intermingled, and jumped on the next boat or caravan to elsewhere.

Eventually, via this process of mergers and acquisitions, the most powerful web of all began forming around A.D. 200, the Old World Web. In its early phase, it spanned across North Africa and most of Eurasia. By 1450, about 75 percent of humans lived within it. After 1890 it grew explosively. Today, it has essentially become a single worldwide web that includes most of humankind, from beggars to billionaires. Our gizmos include motor vehicles, glowing screens, writing tools, chainsaws, guns, and so on.

As professors, the McNeills had a sacred occupational obligation to gush with pride about the wonders of science, technology, progress, and human brilliance. It's mandatory that innocent young students be filled with an intoxicating blind faith that we're zooming up the path to a better tomorrow.

At the same time, the McNeills felt a moral obligation to make an embarrassing confession, regarding the dark shadow of brilliance — civilization's chronic addiction to self-destructive habits. The amazing consumer wonderland that we live in is only kept on life support by ever-growing complexity made possible by ever-increasing flows of rapidly diminishing non-renewable resources — a steep and slippery downhill path to a mangled tomorrow.

More and more, the inflow of strategic resources is getting squeezed. We are moving at a brisk velocity toward rock solid limits. Consequently, John regretfully sighed, "the chances of cataclysmic violence seem depressingly good." They were writing in 2003, back in the happy days when far less was known about methane plumes, thawing permafrost, abrupt climate change, and the limits of modern technology to conjure miraculous solutions.

**Old World & New World**

In 1492, Native Americans did not discover Spain, it was the other way around. Because Europe had horses, they had long distance trade networks which linked a variety of cultures and civilizations. Networks enabled the spread of devious ideas, mystifying religions, domesticated plants and animals, dangerous technological innovations, and deadly epidemics.

Pita Kelekna noted that both people and ideas moved slowly in a horseless world, if they moved at all. The brilliant mathematical achievement of the Mayans was the invention of the *zero* — 500 years before the Hindus. In the Old World, the extremely useful idea of zero spread fast and far, while the Mayan zero never left home. The voyage of Columbus depended on the existence of countless tools, resources, and skills, none of which were invented in Spain. Some came from as far away as China, like gunpowder, forged steel, paper, and printing. Imagine what today would look like if the concept of gunpowder had never left China, and was still only used for glittering fireworks.

Ronald Wright pointed out that in 1492, after at least 15,000 years of separation, the cultures of the Old World and New World directly met each other. In Mexico, the European invaders found "roads, canals, cities, palaces, schools, law courts, markets, irrigation works, kings, priests, temples, peasants, artisans, armies, astronomers, merchants, sports, theater, art, music, and books."

Wright also talked about "progress traps," seemingly beneficial innovations that were also severely addictive, like horse domestication, agriculture, metallurgy, autos, or computers. Once you got hooked on a powerful habit, good luck quitting. Over time, the impacts of their unintended consequences kept ratcheting up. The dodgy solution for problematic progress was to introduce more and bigger progress — snowballing lunacy. Progress traps had no safe and easy Undo button.

Large predators used to provide an important check on our numbers, but many went extinct. We got too good at killing them. We got too good at killing large game. We got too good at confining herds of livestock. We got too good at producing and storing huge harvests of calorie dense grain. We got too good at coercing dense populations of humans to obey orders and perform tedious, difficult, dangerous, soul killing work. We got too good at perfecting insanely unsustainable technology. Now what? [UNDO] [UNDO] [UNDO] Shit!

## Wild Webs

In prehistoric times, webs were small and simple exchanges between neighboring tribes. Like all other wild critters, our ancestors were absolutely integrated into the ecosystem around them, to a degree that we can barely imagine today — like your hand is connected to your arm. The full attention of all their senses was tuned into the sights, sounds, and smells of the surrounding land. Their world was sacred, alive, fascinating, worthy of full respect.

Louis Liebenberg spent lots of time among the hunter-gatherers of the Kalahari Desert, folks who lived like your ancestors once did. Hunting on the hot, dry Kalahari was challenging. Some hunters were more skilled than others. In one group, up to half of the adult men did not kill even one large animal in a year. Some barely killed any large game during their entire lives. Reciprocity was the bedrock norm. Meat was always shared with everyone. Hunters were expected to be humble and gentle. When a lad had a long lucky streak, he might take some time off — sometimes for weeks or months — to avoid inspiring envy and resentment.

Each band lived within a territory that they considered their hunting grounds. The boundary lines were not marked, but the neighboring hunting bands knew where they were, and respected them. Boundaries reduced the likelihood of friction and conflict. In drought years, when a hunting ground dried up, the band could shift to the hunting ground of an allied band. This provided life insurance in a land where precipitation varied from place to place, and year to year.

It's hard to imagine our ancestors' extremely intimate connection to place. Each person was entirely a living embodiment of the nearby water, air, soil, plants, and animals. People were buried in the land of their birth, the land of their ancient ancestors, the place they belonged, home sweet home. Over time, nature recycled their corpses, for the benefit of new generations of living beings, an endless circle dance.

You carry yourself much differently when you deeply experience your sacred connection to all that is, and are fully present in a healthy wild ecosystem. This sense of oneness with life, experienced by our *Homo* ancestors for more than two million years, has had a substantial influence on the development of what we are as a species. The mind and body of the amazing critter you see in the mirror was fine-tuned via a very, very long era of successfully living as happy, healthy, brown skinned, curly haired, bare naked, illiterate wild heathens in the tropics.

Infants continue to be born with the genes of a Pleistocene tropical primate. Today's newborns still expect to first open their eyes in a healthy wild world that is filled with abundant life. They are ready to spend their life's journey wandering, living in small bands of family and friends, singing under the stars, dining on a generous variety of wild foods. For us, still today, it is comfortable and enjoyable to be among small groups of people that we love, respect, and trust. Cooperation and sharing are what wild humans naturally do.

In modern society, most of us do not spend every day surrounded by an intimate circle of equals. It can be very unpleasant being around folks who are self-centered individuals. Their core ambition is to climb as high as possible up the pyramid of social status.

John Trudell, a Santee Sioux activist, bitterly detested the colonization of the Americas. Traditionally, tribal people were raised in a culture of spiritual reality, which emphasized a profound respect and reverence for the family of life. Their guiding star was responsibility.

Lakota writer Vine Deloria said that a tribal person "does not live in a tribe, the tribe lives in him." Very importantly, their sense of identity and being was rooted in "we," not "me." Self-centeredness was a spiritual abnormality. Everyone had powerful bonds to the land, the clan, and their family.

For us, still today, it can be comfortable and enjoyable to wander through a forest, gathering mushrooms, berries, and nuts. It's healing to watch moonlight rippling on the surface of a lake or stream. It's inspiring to feast on the beauty of northern lights in a winter wonderland.

In modern society, eight lane highways filled with speeding motorized wheelchairs seem like horrific glimpses into the roaring screaming bowels of hell. Nothing could be more unnatural and traumatizing than living amidst large numbers of strangers, day after

day. We are like zoo inmates surrounded by walls and fences. John

Livingston wrote that lions raised in zoos, under absolute human control, and isolated from wild habitat, go insane. They are "overfed, graceless, apathetic, almost catatonic." No animal was meant to live like this.

Today, our lives are connected to the global economy, industrial civilization, numerous news and entertainment feeds, and necessities produced by perfect strangers in faraway places. Many of us don't feel at home in nature. We live in climate-controlled space stations, staring at glowing screens, lonely in a world of billions, clinging to our companion animals, our fur children. Alexis de Tocqueville once wrote, "What can one expect from a man who has spent the last 20 years of his life putting heads on pins?"

**Big Fork**

John Gowdy put his spotlight on a massive shift in the human saga. Humans emerged maybe 300,000 years ago, near the end of the Pleistocene epoch. The Pleistocene was a 2.5-million-year era of countless whipsaw climate swings. Trends could sometimes shift back and forth between warm and frigid in just two centuries. The pattern changed around 9,700 B.C., with the arrival of the Holocene epoch, a highly unusual and long-lasting era of climate stability and warmer temperatures.

In several regions of the world, this warming trend encouraged a surge in the abundance of wild foods. It became possible for agriculture to be practiced over the span of several thousand years without blast freezer interruptions. Conditions became suitable for civilization. Today, as temperature trends swerve toward hothouse, this moderate stable climate is beginning to experience sharp chest pains. Shadows are deepening on the future of industrial agriculture, and the billions who depend on it.

James Scott focused his research on southern Mesopotamia because it was the birthplace of the earliest genuine states. What are states? They are hierarchical class-based societies, with rulers and tax collectors, built on a foundation of farming and herding. Taxes were usually paid with grain, which was easier to transport and store than more perishable stuff. States often had armies, defensive walls, palaces, ritual centers, and slaves.

In Mesopotamia (now Iraq and Kuwait), the transition from wild tribes to states took several thousand years. By around 12,000 B.C., there is scattered evidence of hunter-gatherers who quit being nomads and settled down in regions having abundant wild foods. The menu included wild grains and pulses, large herbivores, and wetland wildlife. Plant and animal domestication began around 9,000 B.C. Then, it took at least four thousand years (160 generations) before agricultural villages appeared, and then another two thousand years before the first states emerged, around 3,100 B.C.

States were typically located close to the floodplains of large rivers, places having abundant fertile soil. They could produce enough grain to feed a pool of laborers. States had no interest in expanding into less productive lands that couldn't generate enough wealth to pay the cost of governing them. Scott noted that as late as A.D. 1600, most humans in the world were still not governed or taxed by any state.

Wild humans were typically mindful to avoid the overuse of resources. They lived and thought like a coherent group, not a motley crew of competitive self-centered individuals. This very long tradition of mutual support strongly influenced the evolution of who we are today.

The important point here is that wild people were free, nobody gave or obeyed orders. But with the transition to farming and herding, freedom got put on a short leash. We began living under the control of a hierarchy of masters. Small groups can readily and happily cooperate, but large groups are more likely to generate snarls and sparks. Crowding overwhelms our Pleistocene minds, stimulating anxiety, resentment, depression, and so on. Naturally, this undermines social tranquility.

Masters fear disorder because angry mobs can rip them to pieces. To prevent this, crowds must be overseen by enforcers. Rules must be strictly obeyed, and violators punished. Growing up in civilization, folks have to obey numerous rules decreed by families, schools, religions, businesses, bureaucracies, and so on. The god words for this way of life include *compete*, *control*, and *obey*.

Most of humankind is now compelled to spend much of their time wandering among mobs of strangers, folks who are not friends or kin. Some crowded communities are ruled by aggressive thugs, ideological fanatics, or the chaotic whims of fate. Others have law and order, tolerable rules, and sufficient enforcement — the preferred option for those who must live in Strangerland.

John Livingston wrote that many endure the numbing conformity of Strangerland by choosing the safe and easy path of docility. Rules are good tools for controlling people, but beliefs are sometimes even better. When properly programmed by an ideology, our behavior can be largely manipulated by an autopilot of beliefs, like a self-driving robo-car. Believers passively accept control from their superiors, and leap to their feet and when der Führer calls.

Because we excel at herd-like followership and self-deception, it's easy to be swept away by trendy fads or bloody gangsters. Leni

Riefenstahl filmed Triumph of the Will, a haunting documentary on the 1934 Nuremberg Rally, which starred 700,000 Nazi supporters. Scene after scene shows streets jammed with folks in crisp new uniforms, marching in orderly rows. Today, with the benefit of highly advanced communication systems, charismatic hucksters, sorcerers, and lunatics can entrance large mobs of naive believers in many locations at the same time.

Carl Jung was a world-famous Swiss psychiatrist (1875-1961). He enjoyed a wholesome childhood in a small rural village little changed since the Middle Ages. "Nature seemed to me full of wonders, and I wanted to steep myself in them. Every stone, every plant, every single thing seemed alive and indescribably marvelous."

In his adult years, the civilized world fell into ever-growing chaos and catastrophe — rapid industrialization, urbanization, population explosion, two world wars, mustard gas, atomic bombs, holocaust, the rise and fall of

Hitler and Stalin. “We have plunged down a cataract of progress which sweeps us on into the future with even wilder violence the farther it takes us from our roots.”

This was an ideal time to become a psychotherapist. Mobs bring

out the worst in us, creating ideal conditions for devastating psychic

epidemics “which are infinitely more devastating than the work of natural catastrophes.” “The most dangerous things in the world are immense accumulations of human beings who are manipulated by only a few heads.” Folks become vulnerable to “complete atomization into nothingness, or into meaninglessness. Man cannot stand a meaningless life.”

## Metaphysical Whirlwinds

### Linear Time

Control freak societies can get obsessive-compulsive about time, measuring it in seconds, minutes, hours, days, weeks, months, years, centuries, millennia. I am writing at 4:08 PM PST on Sunday, January 17, A.D. 2021. This moment is unique in the life of the universe, like a fingerprint, or a DNA sequence. Many were just born, many just died, and Big Mama Nature received more kicks.

Wild folks had a softer and gentler perception of time. Time was the daily passage of the sun across the sky, and the monthly phases of the moon. Time was the perpetual cycle of winter, spring, summer, and fall. It was the zig and zag of wet seasons and dry seasons, of cold ones and hot ones, of serenity and stormy weather. For these people, time was circular, a wheel that never stops turning, and it is real and alive and good.

As early civilizations metastasized, like those in Mesopotamia, something extremely weird happens — the notion of linear time emerges. It is not circular. Linear time is like a drag strip for tire-burning hot rods, a one-way sprint from the starting line (creation) to the finish line (apocalypse), from paradise to wasteland, from womb to worms. It is a cosmic (comic?) soap opera in which the spotlights remain focused on the rise and fall of an odd and amusing species of primates — as if we are the one and only thing in the universe that matters. Nothing came before us, and nothing shall follow us. Really?

Paul Shepard wrote that folks living in unsustainable societies couldn't help but notice that their way of life was wobbly and corrosive. He wrote, "Living amidst collapsing ecosystems, agrarians accept a religion of arbitrary gods, catastrophic punishments by flood, pestilence, famine, and drought in an apocalyptic theology." Folks could see that the surrounding region was dotted with the ruins of past glory, remnants of the eternal two-step of overshoot, and its faithful companion, collapse.

Populations sometimes grew faster than Big Mama Nature could limit the swarms. When the flood plains reached full occupancy, settlement expanded into forests, and up hillsides. Hungry herds of hooved locusts chewed away the vegetation, exposing the naked soil, which blew away and washed away. Rainfall and snowmelt rapidly ran off of stripped slopes. Consequently, catastrophic floods were common, as were landslides. Irrigation systems eventually made the fields so salty that nothing can grow in them. A satellite

flying over Mesopotamia now sees THIS.

The McNeills commented on the expanding shoreline along the Persian Gulf, into which the Tigris and Euphrates rivers emptied. Sumerian cities that were once located on the coast, or close to it, are today up to 100 miles (161 km) inland from the shore. Former islands are now mainland, far from the coast. Massive erosion was a perfectly normal consequence of upstream deforestation, overgrazing, and agriculture.

The ancient Greeks saw history as a long and tragic saga of human decline. Hesiod lived around 2,700 years ago. He wrote of the Golden Age: "They lived like gods, free from worry and fatigue; old age did not afflict them; they rejoiced in continual festivity." This was followed by the Silver Age, a matriarchal era of agriculture, when men obeyed their mothers. This was followed by the Bronze Age, a patriarchal era of war. "Their pitiless hearts were as hard as steel; their might was untamable, their arms invincible." This was followed by the Iron Age, a time "when men respect neither their vows, nor justice, nor virtue."

Today, we live in the Overshoot Age, when billions of people spend their lives in the crazy lane, and nothing seems to really matter. Do redwoods matter, or whales, or polar bears, or ravens, or children? Is anything sacred? Hello? Is anybody home?

Holy Lands

Wild cultures naturally felt a sense of oneness with their homelands that provided their needs and enabled their survival. It was a relationship of profound reverence and respect. Something like paradise was their birthplace and permanent address, the home of their ancestors, and the generations yet to be born. A Karuk man, Leaf Hillman, once took me to a bluff, and pointed down to a bend in the Klamath River where the Karuk people were first brought into existence, long, long ago.

Modern Americans are two-legged tumbleweeds that have blown in from countless distant places. We frequently move every few years. Many tumbleweeds have little or no knowledge of their ancestral homelands. Many never develop a spiritual connection to any place. For them, nature is typically nothing more than a meaningless static backdrop along the highway, stuff they zoom past during their daily travels.

Paul Shepard noted that this was a big shift away from older cultures, in which folks felt a profound spiritual connection to the land

where they lived. His wife Florence Shepard said it like this, "At the heart of our identity is a fundamentally wild being, one who finds in the whole of wild nature all that is true and beautiful in this world." By the time wild children reach puberty, they have developed a healthy connection to place. They have a profound sense of belonging that most modern tumbleweeds cannot begin to imagine, and will never experience.

In 1945, a farmer named Mohammed Ali found an ancient jar near Nag Hammadi in Egypt. Among the contents of this jar was a book containing the Gospel of Thomas. This gospel of Jesus' life had never been edited, corrected, clarified, or blessed by the official Holy Roman Church. In chapter 113 of the Gospel of Thomas, Jesus is talking about the nature of heaven — God's kingdom. He said that it was not an event that would occur in the future. Here is what he said: "The kingdom of God is spread out upon the earth, and people do not see it." Heaven is where your feet are standing. Wherever you stand is sacred ground.

Magical Thinking

Imagine living in an era when bubonic plague epidemics were

common and horrific. Geoffrey Marks noted that the Black Death arrived in England in 1348, and was followed by epidemics in 1349, 1361, 1363, 1365, 1369, 1371, 1373, 1375, 1378-1382, 1390, 1399-1400 …and on and on… until the Great Plague of London in 1665-1666. Over the course of several months, the Great Plague killed about 100,000, almost a quarter of London's population.

In 1772, Daniel Defoe (author of *Robinson Crusoe*) published *A Journal of the Plague Year*. He was a young boy during the Great Plague, and had a front row seat on the horror show. As an adult, he interviewed a number of survivors. His uncle kept diaries during the nightmare.

The city was a fantastically filthy nightmare. Sewage was dumped in ditches along the streets. Horseshit and garbage everywhere. Everyone had lice, bathing was rare, and great mobs of rats enjoyed a wonderful life.

When folks heard news of an approaching contagion, anyone who had options (nobility, clergy, physicians, officers, etc.) fled London in a great stampede. Poor folks were left behind to experience what the fates would deliver.

Efforts were made to slow the spread of disease. When someone was known to be infected (or so suspected), a red cross was painted on the door, and the dwelling was guarded day and night by a watchman, to prevent escapes, and to provide necessities. Thus, the entire family was condemned to die. Folks were infuriated, and there were riots.

Bell ringers moved through the streets, shouting “bring out your dead.” They were followed by buriers or bearers who loaded the dead carts. Large pits were dug in which to dump the corpses. Defoe wrote, “It is impossible to describe the most horrible cries and noise that the poor people would make at their bringing the dead bodies of their children and friends out of the cart.”

Doctors had no cures, and prayers got no response. Johannes Nohl reported that during plague years, a number of communities in Europe engaged in ceremonial dances, hoping to drive away the evil spirits. Hundreds danced until they collapsed from exhaustion. Folks were overwhelmed with despair. People rolled in filth, begging others to beat them. “Otherwise modest maidens and matrons lost all sense of shame, sighed, howled, made indecent gestures, and uncovered obscene parts of their bodies.”

It was obvious to everyone that the plague was killing the clergy at especially high rates (it was their job to visit the dying). Why did God have no interest in protecting his own special agents? Many priests lived with concubines, an abominable sin. Did this mean that the baptisms they performed were worthless? Many lost their faith. While large crowds danced, the churches sat empty. A furious mob of Germans went to Liège, determined to massacre all clergy.

One tradition noted that in 1424, a lad named Maccaber arrived in Paris, and took residence in an ancient tower next to a cemetery. Folks believed he had supernatural powers. He initiated an ecclesiastic procession. Every day, for months, crowds of men and women danced in the cemetery. Folks wore scary masks to drive away the evil spirits.

Over time, in many places, during many plagues, folks experimented with a wide variety of rituals. Despite good intentions, their efforts failed. The rats and fleas remained alive and well, and the grim reaper worked overtime. Blind faith in rituals is called magical thinking. Unfortunately, beautiful wishes don’t always come true.

Today, of course, global telecommunication systems and the internet allow magical beliefs and assorted conspiracy theories to spread through large populations at astonishing speeds. Societies become fiercely polarized, echo chambers roar, intolerance punches, courtesy vaporizes, bullets fly, and daily life becomes a surreal tragicomedy. Elections no longer have losers — every candidate claims victory!

Humanism

Many humans imagine that our species enjoys a superior status in the family of life. Indeed, many hiss and snarl at the notion that humans are animals (!!). We are obviously smarter, stronger, and greater in every way! A number of religious traditions assert that humans are something like the glorious crown of creation, the managers of the world. Earth is our playground.

James Scott noted that at Yale University, belief in this humanist ideology was the norm, and compulsory for professors who hoped to get tenure. He called it "positivism."

These beliefs typically emerged in cultures that became addicted to the exploitation of domesticated plants and/or animals — turbulent societies that cleared forests, planted fields, raised birds and herds, and radically altered (and damaged) the ecosystems they inhabited.

Our wild ancestors were far humbler. They were hunters and foragers, not planet smashing thunder beings. Peter Ungar wrote that when an anthropologist in Tanzania asked some Hazda hunters how humans were different from other animals, they were completely baffled. There is no difference. What a stupid question! We all eat, drink, breathe, excrete, wander, and reproduce. Many carnivores think we're absolutely delicious, and they eagerly enjoy every opportunity for having us for lunch.

Richard Nelson spent time (1976-77) with the Koyukon people of Alaska. Their often-quoted proverb is: "Every animal knows way more than you do." They believe that animals can understand everything we say, regardless of distance. The Koyukon were not a culture of motor vehicles and glowing screens. They were a hunting culture that had an amazingly deep understanding of nature, and absolute respect for it. Modern folks have lost this intimate wild connection to home. Nelson wrote, “We live alone in an uncaring world of our own creation.”

Knud Rasmussen spent time with Greenland natives in the 1920s. Igjugarjuk was a holy man, a wizard. He said a memorable line: “All true wisdom is only to be learned far from the dwellings of men, out in the great solitudes.” Indeed!

David Ehrenfeld wrote *The Arrogance of Humanism*. It was an aggressive critique of the widespread belief in human supremacy. He wrote that humanism was “the dominant religion of our time.” It’s essentially the air we breathe. Humans are absolute geniuses, the successful conclusion of evolution! There is no problem we cannot solve. We have no limits. As resources become depleted, we’ll readily develop excellent alternatives. Our children will enjoy even better lives than our own, and the best is yet to come. Yippee!

Ehrenfeld wrote back in 1978, when pollution controls, if any, were weak, and the air and waters were heavily contaminated with noxious substances. The entire city of Gary Indiana was hidden in a stinky orange fog of steel mill filth. The Cuyahoga River in Ohio caught on fire.

In the ’70s, numerous eco-disasters were occurring around the world, but the general mob paid little attention to stuff happening elsewhere — out of sight, out of mind. Network television avoided the yucky stuff, and mesmerized folks with generous servings of sports, entertainment, and happy news. School systems tirelessly preached the holy gospel of humanism, and celebrated the age of miracles that students were so lucky to enjoy.

While the thundering human juggernaut was beating the living shit out of the planet, the mob barely noticed. They were busy polishing their new cars. Most remained zombie-like cheerleaders of the wonders of modernity, and the beautiful future that laid ahead.

This baffled Ehrenfeld. Nobody cares! The poor lad apparently suffered from a devastating incurable mental disorder known as critical thinking. He was a sick pariah. Humanist culture has zero respect for hopeless nutjobs, defeatists, misanthropes, oddballs, and doom perverts.

Ehrenfeld shrugged. "Evidence is growing that the religion of humanity is self-destructive and foolish. But the more it fails, the greater our faith in it. We imagine that what we want to happen is actually happening."

He was not a misanthrope. He didn't hate, distrust, and avoid humans. Actually, he was an "anti-humanist." He detested the ridiculous mass hallucinations — the enthusiastic celebrations of human genius, and the wondrous technological utopia that we have brilliantly created. We are so lucky to be alive in the spectacular gushing orgasm of the entire human experience!

Ehrenfeld noted that pure anti-humanists were rare. Most folks who know how to read have spent their entire lives in hard core humanist cultures. We've been constantly absorbing humanist ideas for years. They have deep roots in our minds, and a strong influence on how we think. It's sort of pleasant to imagine that we're on the path to a better tomorrow. Progress will wash away the pain.

On the other hand, having read a pile of anthropology books, it's clear that wild folks who lived undisturbed in their traditional way, in their ancestral land, tended to be enthusiastic and shameless anti-humanists. They seemed to be nearly unanimous in perceiving civilized folks as being absolutely batshit crazy! How could people be so stupid? How can they have no respect and reverence for the natural world? Why are they so aggressive and selfish?

Ehrenfeld wrote that a general rejection of humanism is now long overdue. It won't be easy. Blind faith in humanist hopes and dreams remains strong, and the furious war on the family of life rages on, and on, and on.

Patriarchy

Abdullah Öcalan, a Kurdish political scientist, wrote about the history of Mesopotamia, his ancestral homeland. Sometime before 3,000 B.C., the first state-based civilization emerged in Sumer, located in southern Mesopotamia, where the Tigris and Euphrates rivers approach the Persian Gulf, and empty into it.

Sumerian civilization established or advanced many unusual experiments, including agriculture, herding, patriarchy, slavery, irrigation, deforestation, metallurgy, etc. The ability to produce surplus food enabled some folks to indulge in specialized pursuits — merchants, potters, smiths, miners, leather workers, fishers, bricklayers, weavers, scribes, and so on.

Sumer's inventions include the calendar, writing, mathematics, astrology, and prostitution. Women were assigned to an inferior status in the gender hierarchy. The traditional animism of wild folks was displaced by new forms of religion, first pantheism (multiple gods and goddesses), and later monotheism (one male god). Öcalan wrote that today's mosques, churches, synagogues, and universities have their roots in Mesopotamian ziggurats (temples).

In his pro-feminist writing, Öcalan wrote, "The 5,000-year history of civilization is essentially the history of the enslavement of women." Prior to 2000 B.C., the woman-mother culture strongly influenced Sumerian civilization, and the two sexes were fairly equal (no shaming of women). Over time, the warrior class encouraged a strongman cult that came to dominate religion. The creator of heaven and Earth was male (Marduk). "So radical was this sexual rupture, that it resulted in the most significant change in social life that history has ever seen."

This led to the "housewifization" of women, a sharp demotion. Their new role was to sit at home, and faithfully obey their husbands. Chastity became mandatory, in order to guarantee the genuine paternity of daddy's children, so that only his true sons would rightfully inherit his wealth. It was vital that young women remain virgins prior to marrying their master.

### Wild Free Isolation

We live in interesting times. Bunnies aren't acidifying the oceans. Salmon aren't blindsiding the climate. Geese aren't nuking rainforests. Even our closest relatives, the chimps and bonobos, remain absolute champions at sustainable living. The human mob, on the other hand, has been making quite a mess.

During my years of studying and writing, I have enjoyed learning about wild cultures that preserved elegant low impact simplicity. They hold up a mirror so we can fully appreciate the incoherence of modernity. Let's take a quick peek at a few of those cultures.

Sentineli

Outsiders can sometimes view them from offshore boats, or from helicopters, but the natives want nothing to do with outsiders. Intruders who get too close are showered with arrows, rocks, and rude comments. Some have been killed. India has outlawed all visitors. Today the Sentineli enjoy a complete separation from the modern world.

Their island is 14,700 acres (5,949 ha), a bit smaller than Manhattan. The interior is forest, surrounded by sandy beaches, surrounded by reefs. Treacherous currents make landing on the island impossible for ten months of the year, and extremely dangerous for the other two. The island has nothing that is attractive to greedy parasites from elsewhere. For these reasons, the Sentineli remain wild and free in the twenty-first century.

Flyovers have noted the existence of several villages with clusters of small huts. No evidence of agriculture has been observed. There may be 50 Sentineli, or 500, nobody knows. They survive by foraging, fishing, and gathering shellfish. They may also hunt for turtles, birds, and invertebrates. Their small canoes are used in the lagoons, but not for open-sea travel. They fish with spears and nets.

Long ago, two expeditions were able to land on North Sentinel. They brought along folks from a nearby island to serve as translators. In the brief and hostile meetings, the Sentineli spoke a language that the translators did not understand. Obviously, they have been living in isolation for a long time. They may be descendants of the folks who first settled in the Andaman Islands 60,000 years ago.

Imagine what it would be like to live in a society that was not at war with the planet and the future — a genuinely sustainable way of life, a tropical culture with a year-round supply of food, where your wardrobe consisted of a g-string, headband, and a couple leaves. Imagine a life without money, clocks, calendars, automobiles, airplanes, sirens, internet, locks, fences, bosses, salesman, presidents, police, classrooms, guns, dogs, nuclear weapons, taxes, racism, billionaires, and religions. Imagine a paradise where the diseases of civilization were unknown.

Contemplate the enormous load of information stored in your brain, accumulated during a lifetime of existing in a highly complex society, and your constant struggle to keep pace with competitors in the endless quest for status, wealth, and power. Now, imagine being blissfully unaware of absolutely everything happening in the outside world — and the entire outside world knowing almost nothing about your society. Imagine having a healthy, simple, sane life.

Imagine living on an island where there were no strangers, where the soundtrack was waves, birds, breezes, and the voices of your friends and family. We weren't meant to live like consumers. There are better paths.

## New Guinea Highlands

New Guinea is a land base much larger than Oregon and California combined. Around 1930, white folks from elsewhere began wandering into the highlands, in search of mineral treasure. At that time, the highlands were home to a million uncivilized folks unknown to the outer world.

Bob Connolly and Robin Anderson wrote that native groups spoke maybe 800 languages, of which several hundred were unique, having absolutely nothing in common with any other language in the world. Communication between tribes was limited or impossible. It wasn't easy for innovative ideas to spread from group to group. This helped tribes preserve traditional cultures.

Long distance travel (10+ miles) was also difficult or impossible because of the rugged mountain landscape, warlike enemies, and deadly fevers.

There were no roads, wheels, or beasts of burden. One group might be completely unaware that other groups resided just a few miles away.

So, many groups may have existed in complete isolation, living as they had always lived, in their ancient time proven manner.

Nobody in the highlands knew that they lived on an island, or that the Pacific Ocean existed. There may still be uncontacted groups that remain wild, free, and unknown to the outer world.

As mentioned earlier, when interaction between groups creates regional webs, and more and more webs share more and more ideas with a widening circle of other webs, shit happens. Over the passage of centuries, accumulations of cleverness can trigger explosive snowballing chain reactions, creating situations like the world outside your window. How clever was that?

Pirahã

I was especially fascinated to learn about the Pirahã (pee-da-ha) people of the Amazon rainforest. They are hunter-gatherers who live in a few jungle villages along the Maici River in northwestern Brazil. Estimates of their population range up to 800. They hunt, fish, and forage. Fish provide about 70 percent of their diet.

Over the years, I've read about many wild cultures. The Pirahã are among the simplest and lowest impact of all. We know a lot

about their culture, largely because of Daniel Everett, a missionary sent to save them. Over time, it became painfully clear to him that they didn't need to be saved. He was the one who was lost. He concluded, "I would go so far as to suggest that the Pirahãs are happier, fitter, and better adjusted to their environment than any Christian or other religious person I have ever known."

The Pirahã knew the usefulness and location of all important plants in their area. They understood the behavior of local animals, and how to take them, or avoid them. They could walk into the jungle naked, with no tools or weapons, and walk out three days later with baskets of fruit, nuts, and small game. By the age of nine, all of them were capable of surviving in the jungle on their own, feeding themselves and making shelter.

The Pirahã were able to effectively communicate via speaking, singing, humming, and whistling. When hunting, whistles were less likely to spook monkeys and other game. Whistled words allowed conversations between folks who were not close together. Their language has nothing in common with any other language in the world.

The Pirahã had no leaders or social hierarchy, all were equal. It was taboo to tell someone to do something. They were amazingly content, tolerant, and patient. Children were never spanked or given orders. They were free to play with sharp knives. Adults spoke to them as equals, no baby talk.

In the tribe, memories of ancestors or historic events were not preserved, they evaporated. Their realm of reality was limited to stuff that they could personally see or hear, or things seen or heard by their living parents, grandparents, friends, and kinfolk. History was strictly limited to living memory. If a missionary had not actually met Jesus, then jabber about Jesus was meaningless.

The Pirahã people were remarkably easygoing and infectiously happy. They wore bright smiles, and laughed about everything. Folks didn't worry about what happened yesterday, or what might happen tomorrow. They had no word for worry. They lived entirely in the here and now. They had no cultural folklore, legends, fables, or worship. He wonders if they might be the only group in the world that has no numbers, and no creation myth.

Everett wrote, "Committed to an existence in which only observable experience is real, the Pirahã do not think, or speak, in abstractions." ("Abstract" is the opposite of concrete. Abstractions only exist as ideas or thoughts.) They have no concept of heaven, hell, sin, god, creation, apocalypse, devils, angels, guilt, punishment, salvation, damnation, sustainable, rich, poor, overshoot, democracy, capitalism, and on and on.

Modern folks spend their entire lives with their heads constantly buzzing with swarms of abstractions. The Pirahã spend every day of their lives being highly attuned to the incredible living paradise that they are so lucky to inhabit. They enjoy living in a stable, low impact, time-proven culture where everyone shares the same belief system.

Everett was amazed by them. "This is a culture that's invisible to the naked eye, but that is incredibly powerful, the most powerful culture of the Amazon. Nobody has resisted change like this in the history of the Amazon, and maybe of the world."

They were lucky to have enjoyed centuries of isolation in a vast tropical rainforest. They had very little contact with clever outsiders who had bad habits, odd tools, dark impulses, and heads slithering with brainworms. Unfortunately, the outer world has found them, and wants to "help" them enjoy the wonders of modern living.

Every morning, I listen to news reports describing a world that is out of its mind. I think about the Pirahã, who are also getting up, smiling and laughing, down by the river, welcoming the beginning of a new day. Same species, same morning, same planet. They have not forgotten who they are, or how to live.

If you are curious about the Pirahã, and have two hours to invest,

I recommend that you listen to the 52 minute The Humanist Hour

#183 podcast (2015), and watch the 2012 documentary, The

Grammar of Happiness.

# Climate Catastrophe

Climate change has influenced the hominin saga since cooler and dryer conditions reduced forest area, and encouraged our tree dwelling ancestors to move onto the savannah. Today's crisis is climate change on steroids. It's doing things that humans have never experienced before — countless huge, accelerating, scary, uncontrollable changes that we don't fully comprehend. The climate catastrophe will eventually be affecting everyone everywhere, to a breathtaking degree.

The climate catastrophe is an enormous fast-moving subject that is generating a staggering number of articles, reports, books, and videos. The future has yet to be written, but a number of current trends have a clear trajectory — warming climate, melting ice, thawing permafrost, rising seas, extreme weather events, etc. Numerous critical climate-oriented trends are obviously on a treacherous path.

## Climate Impacts

The information on the following pages is a very rough sketch, like a cop's body camera video of a chaotic crime scene. My plan here is to present a sampler of core ideas, and toss in links to interesting sources. Readers who want to further explore the issue can follow the links, and feed their hungry brains.

Albedo

When incoming sunbeams hit white regions of ice and snow, some of the heat is reflected away from the planet, back into outer space. This ability to reflect is called albedo. Fresh snow, which is very white, reflects 80 to 90 percent of incoming heat. So, it has an albedo of 0.8 to 0.9. Ice that has been bare for a while accumulates soot and dust, which makes it darker, less reflective. It has an albedo of 0.4 to 0.7. Sea water and dry land are darker, absorb more incoming heat, and then radiate it. Open water has an albedo of 0.1.

When albedo reflectivity is diminished, more heat can enter the atmosphere and accumulate. Ice gets thinner, breaks up, and retreats. Then, more solar heat can hit more open water or bare ground. More of the thick ice that used to exist year-round now melts away during the warmer months. The duration of ice-free summer periods is lengthening. This pattern is called a positive feedback loop — more warmth, more melting, more warmth… etc. It's the engine of runaway warming, the arctic death spiral.

Arctic Ice

In 1968, the Apollo-8 mission orbited the moon, and took the first photo of the Earth rising above the moon's horizon. In that photo, Earth was white around both the north and south poles. Today, when it's summer in the Northern Hemisphere, the view from outer space shows a white Antarctic, and a blue Arctic. As it melts, the ancient northern ice sheet is gradually becoming an open ocean. Human impacts and runaway warming are changing the planet, and the future.

Peter Wadhams has been studying Arctic ice for 50 years. He has a way-above-average understanding of the danger we're in. He's been working hard to alert us, but few are grasping the importance of his message. Arctic ice is extremely precious because it's essential for maintaining vital climate balances. The cool temperatures, and highly reflective whiteness, have enabled the existence of life as we know it. This beneficial balancing act is being destabilized.

Over the last 70,000 years, climate trends have typically been a zigzag pattern of frequent erratic swings, hot-cold-hot-cold…. Today, we are living in the rear end of an 11,700-year era of unusually stabile warm temperatures — a weird deviation that enabled the emergence of fairly reliable agriculture, and has (temporarily) allowed more than eight billion people to survive at the same time. The long-term trends imply that we're long overdue for a new ice age. Fat chance! Instead, we're in the fast land to a hotter tomorrow.

The planet is sliding down the path to a largely ice-free Arctic. A few decades ago, the North Pole as covered with ice 10 to 12 feet thick. No more. “With the steady disappearance of polar ice cover, we are losing a vast air conditioning system that stabilized the climate for thousands of years.” We have been living in “the Goldilocks climate” — not too hot, not too cold, just right! That pattern has been disrupted by rapidly overloading the atmosphere with ancient carbon.

Wadhams lamented, “We are fast approaching the stage when climate change will be playing the tune for us while we stand by and watch helplessly, with our reductions in $CO_2$ emissions having no effect.” He has zero expectations that the climate catastrophe can be stopped and forgotten. In 2016, he wrote a short and easy to understand summary of his findings, with excellent illustrations. I strongly recommend checking it out [HERE]. YouTube also has many Wadhams videos.

Morgan McFall-Johnsen described the rapid melting of Greenland’s ice in 2019. That year, in just five days, 55 billion tons of melt water rushed out of Greenland’s ice sheet, “enough to cover the state of Florida in almost 5 inches of water.” In their most pessimistic scenario, scientists had predicted that this level of melting would not be reached until 2070. We did it 50 years ahead of schedule! “The Arctic is warming almost twice as quickly as the global average.” The times are changing. Trouble ahead.

David Wallace-Wells noted a similar scenario at the South Pole. “In 2018, a major study found things accelerating faster still, with the melt rate of the Antarctic ice sheet tripling just in the past decade. From 1992 to 1997, the sheet lost, on average, 49 billion tons of ice each year; and from 2012 to 2017, it was 219 billion.”

## Greenhouse Gases

Under normal natural conditions, $CO_2$ is precious. If there was no $CO_2$, there would be no plants or animals. During photosynthesis, plants take in $CO_2$ and emit oxygen. At the same time, animals breathe in oxygen and exhale $CO_2$. It’s a harmonious circle dance, normally. But the balance gets blasted when we extract millions of years of ancient carbon from deep underground, burn it, and totally overload the atmosphere.

The atmosphere is also precious. It allows incoming solar heat to pass through, and warm the planet below, which enables the survival of the family of life. It also allows some heat to escape back into outer space, but not as much as it lets in. So, the atmosphere acts like a comfortable greenhouse. Wadhams noted that if Earth had no atmosphere, it would be a lifeless frozen planet. The moon is a frigid place because it has no atmosphere, and its average temperature is -4°F (-18°C). Earth's lovely atmosphere enables an average temperature of 59°F (15°C).

There are several compounds that help the greenhouse maintain a happy climate. In normal times, the greenhouse is wonderful magic act. In crazy times, greenhouse gas overloads allow too much heat to be retained. The four main greenhouse gases are carbon dioxide ($CO_2$) methane ($CH_4$), nitrous oxide ($N_2O$), and water vapor ($H_2O$). $CO_2$ is responsible for maybe 55 percent of the current imbalance. In preindustrial times, $CO_2$ levels in the atmosphere were 280 ppm (parts per million). In 2024 they reached 422 ppm — estimated to be the highest concentration in several million years (3, 4, or 15 million, depending on who you ask).

Methane levels are also soaring, from preindustrial 700 ppb (parts per billion) to around 2,000 ppb in 2019. Methane remains in the atmosphere for 7 to 10 years, during which its impact can be 100 to 200 times worse than $CO_2$. Then, it breaks down into $CO_2$, which can remain in the atmosphere much longer. When methane's brief existence is calculated within a hundred-year timeframe, its impact is 23 times worse than the hundred-year impact of $CO_2$.

Nitrous oxide is a minor offender, found at about 300 ppb in the atmosphere, where it can remain for 120 years. Its source is primarily synthetic nitrogen fertilizers.

Water vapor can act like an insulating blanket. As the Arctic warms, its air can hold more moisture, and a layer of water vapor (clouds) helps to retain warm air.

The bottom line here is that manmade carbon emissions have been working hard to turn the delightful greenhouse into an overheated hothouse. Too much heat is being retained in the atmosphere, frigid regions are melting, and a hideous crisis has popped out of the womb screaming.

The good news here is that we're beginning to learn a very important lesson. Mistakes can be fabulous teachers. The bad news is that we are learning this at a time when a growing number of experts believe that the crisis is already past the point of no return, off the leash, sprinting away, disregarding our frantic commands. Far too late, the wizards have discovered that the unusually warm and stable climate that we used to enjoy was possible because of a priceless treasure of snow and ice, which is now riding off into the sunset.

Clouds

Fred Pearce described how clouds also play a role in the greenhouse magic act. When the sun is shining, bright clouds can reflect away 30 to 60 percent of incoming solar heat. Over the seas, stratus and stratocumulus clouds shade the ocean, so less heat is absorbed by the water. During the day, low clouds provide cooling shade, but after sunset they become a heat retaining blanket.

Whether clouds make shade or trap heat "depends on how reflective they are, how high they are, and whether it is day or night." Until recently, experts believed that the conflicting effects of clouds were about equal, so they balanced out. That belief is going extinct.

Satellite data from NASA indicates that since 2013, cloud cover over the oceans has declined, at the same time that global average temperatures have risen sharply. Other studies indicate that in warmer years, there are fewer low-level clouds in the tropics. This indicates that in a warming climate, clouds are expected to get thinner, completely burn off, or not form at all. This would lead to even higher temperatures, and faster global warming — a positive feedback loop of more heat, less clouds, more heat….

Pearce wrote, “Recent climate models project that a doubling of atmospheric $CO_2$ above pre-industrial levels could cause temperatures to soar far above previous estimates.” In pre-industrial times, $CO_2$ levels in the atmosphere were 280 ppm. Double that would be 560 ppm. In 2021 they reached 420 ppm. The higher they go, the hotter it gets, the fewer the clouds.…

## Carbon Emissions Skyrocket

As described in earlier chapters, our ancestors began acting like odd animals long, long ago. Our quirky path picked up momentum with fire making, hunting tools, clothing, huts and tents, plant and animal domestication, and the emergence of civilization. The turbo thrusters ignited with the arrival of the Industrial Revolution, when we plunged headlong into the brave new world of fossil energy. With this shift, more and more carbon was emitted by human activity, and then absorbed by the oceans, atmosphere, and greenery.

The twentieth century was radically different from all previous time. We’re well into the process of burning up a colossal 500-million-year treasure chest of highly potent energy, in less than 500 years. Unencumbered by foresight, dangerously clever humans looted the ancient hydrocarbon cemeteries, hauled much of the buried treasure into the daylight world, and used it to enjoy a brief, fantastically ridiculous, explosion of childish decadence.

In 2000, environmental historian J. R. McNeill wrote an eco-obituary for the twentieth century, Something New Under the Sun. This book revealed the nightmares that exploded during that century from hell. Later, as the years clicked past, McNeill realized that his book did not say enough. The years following World War II were so spectacularly insane that they made the first 45 years of the century look somewhat wholesome.

So, in 2014, McNeill and Peter Engelke published *The Great Acceleration*, which focused on the era after 1945, when the poop slammed hard into the fan. This era was the freak show in which I have spent my life's journey, the freak show when the human population more than tripled, the freak show that the living generation perceives to be the normal way of life.

They wrote that in 1750, when the Industrial Revolution was still in diapers, 3 million tons of carbon were released into the atmosphere each year. By 1850, it was 50 million tons. In 2015, it was 9,500 million tons. Here is an IMPORTANT sentence: "Some proportion, perhaps as much as a quarter, of the roughly 300 *billion* tons of carbon released to the atmosphere between 1945 and 2015 will remain aloft for *a few hundred thousand years*."

In other words, emissions do not promptly dissipate, so ongoing emissions continuously ratchet up the concentration in the atmosphere. Reducing emissions only slows the increase. The gearshift has no reverse. We've started something we cannot stop.

Terrestrial Permafrost

Peter Wadhams noted that permafrost exists under dry land across the Arctic, spread across an area of 7.3 million square miles (19 million $km^2$), something like the combined land area of Russia and Argentina. As Arctic temperatures soar, the permafrost is rapidly thawing (it does not "melt"). Soils in this permafrost contain lots of organic carbon, plant material that lived in ages past, but froze before fully decomposing. Unlike offshore (sea bottom) permafrost, terrestrial permafrost does not contain frozen methane. But when it thaws and decays, microbial life can then create and emit $CO_2$, methane, and nitrous oxide.

Susan Natali, an Arctic ecologist, studies permafrost, climate change, and greenhouse gases. In the Northern Hemisphere, about 25 percent of the land area sits above permafrost, a layer of frozen soil, rocks, water, and organic material. Some of it has been frozen for up to 40,000 years. Permafrost contains about 1,500 billion tons of carbon — twice as much as the carbon already in the atmosphere, and three times as much as the carbon stored in the world's forest biomass.

Temperatures in the Arctic are rising twice as fast as they are in the rest of the world, a trend likely to continue indefinitely. This warming is thawing the upper layers of permafrost. “Not all of the carbon that’s in permafrost will be released. Our current expectation is about 10 to 15 percent of that carbon will be released into the atmosphere. That said, if all of the carbon of permafrost was released, at that point, this is not going to be a habitable planet for humans.”

Craig Welch also commented on the daunting speed at which Arctic permafrost is thawing. Until recently, scientists expected the rate of thawing to be gradual. Reality disagrees. When forest soils thaw and soften, trees get wobbly as root systems destabilize. These “drunken trees” will eventually fall down. When frozen slopes thaw, landslides happen, exposing the bones of mammoths and other ancient critters.

Abrupt thaw increases the number of massive ground slumps. These depressions collect melt water and rain, creating new ponds and lakes. Bubbles of methane and CO rise up out of the mud 2 beneath the water. As the climate warms, and Arctic lakes grow in size and number, greenhouse gas emissions from permafrost could triple.

Ed Struzik notes that permafrost consists of up to 80 percent frozen water. When permafrost thaws, the land can turn to mud. Craters up to the size of football stadiums are forming in the tundra, as the land sinks. The Batagaika Crater in the Yana River Basin of Siberia is 0.6 miles (1 km) long, and 109 yards (100 m) deep. These thaw slumps or landslides are increasing. Stream flows are changing, and seashores are collapsing. In the Northwest Territories, when a rapidly thawing cliff bordering the shores of a tundra lake collapsed, the 800,000-gallon lake drained in two hours. In the Mackenzie River Delta, up to 15,000 of the 45,000 lakes are expected to dry up in this century.

With warming, willows and shrubs are now displacing tundra vegetation, which includes cranberries, blueberries, cloudberries, shrubs, sedges, and lichen. This is affecting wildlife. In 2006, there were 3,000 caribou on the Tuktoyaktuk Peninsula, now there are half as many. They have less lichen to eat. Musk oxen in Canada and reindeer in Siberia seem to be dying from ancient pathogens that are coming back to life.

The U.S. Geological Survey wrote an excellent 68-page report on thermokarst. This is a fairly new landform in the Northern Hemisphere that has come into existence since the 1980s. Thermokarst is created as permafrost thaws, and the land surface changes in 23 different ways. Common characteristics include lakes, sinkholes, pits, landslides, collapsed pingos, etc. (See

Wikipedia's thermokarst page for breathtaking photos of massive permafrost melting.)

Katey Walter Anthony and team noted that thawing is creating millions of thermokarst lakes in Arctic marshlands. Freeze/thaw cycles generate expanding frost heaves that lead to the rising of mounds, which eventually collapse, leaving depressions that collect water. Open water absorbs more solar heat, which speeds the thawing of permafrost beneath the surface. Over time, small melt ponds can expand into lakes, where streams of methane bubbles rise to the surface.

Louise Farquharson and team studied thermokarst development in the Canadian High Arctic. They studied land that had been frozen for thousands of years. Until recently, the buried permafrost had been in equilibrium with the climate. They were surprised to find that, thanks to rising temperatures, permafrost thawing was reaching depths that were not predicted for another 70 years. "Our data show that very cold permafrost (<10°C) at high latitudes is highly vulnerable to rapid near-surface permafrost degradation due to climate change."

Dahr Jamail is a nomadic journalist who writes powerful stories from the front lines of the climate blitzkrieg. He visited the Inupiat village of Utqiagvik, Alaska. The original village is collapsing into the sea, because the solid permafrost it was built on thawed and turned to pudding. The new village is also destined to tumble into the sea. Polar bears are gone.

A gravedigger said that in the past, solid permafrost was close to the surface. It used to take three days of chopping to dig a grave. Now it takes five hours. "Roads, railroads, oil and gas infrastructure, airports, seaports, all these things were built across the Arctic on the assumption that the permafrost would stay frozen." Ooops!

Offshore Permafrost

In addition to terrestrial permafrost, there is also offshore permafrost, which lies beneath seabed sediments. It originally formed under dry land thousands of years ago, when sea levels

were much lower. Offshore is what gives Peter Wadhams screaming nightmares. It contains substantial amounts of methane hydrates (also called methane clathrates), and it is especially vulnerable to thawing as sea ice retreats, and water temperatures rise.

Methane hydrates are frozen crystals of methane that will melt and burn when close to a flame. They look like ice. An estimated 10,400 gigatons of methane are stored in hydrate deposits. When hydrate crystals melt, the methane is released. In the entire Arctic Ocean, the hydrate deposits are estimated to contain 13 times the amount of carbon currently present in the atmosphere.

Wadhams is especially focused on the East Siberian Arctic Shelf. In the East Siberian Sea, this shelf consists of 810,000 square miles (2.1 million $km^2$) of shallow water, of which 75 percent is less than 130 feet (40 m) deep. In the good old days, the entire sea used to be covered year-round with surface ice, which kept the water frigid or frozen. This changed in 2005, when summer sea ice began disappearing, exposing seawater to the atmosphere. Sunlight could now penetrate directly into the water and warm it. Shallow waters warm faster than deeper areas.

For the first time in tens of thousands of years, warmer water could reach shallow regions of the seabed, causing permafrost to thaw. As permafrost thawed, the frozen methane hydrates began melting, releasing plumes of methane bubbles. In waters deeper than 330 feet (100 m), the methane oxidizes while rising, and the plume disappears before reaching the surface. In shallower waters, bubble plumes make it to the surface, and methane is released into the atmosphere.

In a 2016 article, Wadhams described the possibility of a sudden catastrophic methane release from the East Siberian Sea. Researchers "fear that a pulse of up to 50 gigatons of methane — some 8 percent of the estimated stock in the Arctic sediments — could be released within a very few years, starting soon.” This would generate a surge of warming. Russian scientists on site calculate that the probability of this is at least 50 percent.

Super Seeps

Valeria Sukhova and Olga Gertcyk wrote an update on sea floor methane seeps. Scientists have been doing research in the Laptev and East Siberian seas, where there are large deposits of offshore permafrost and methane hydrates. Numerous seeps are releasing methane into the atmosphere. In the air above the water’s surface, methane levels are 16 to 32 ppm (parts per million). This is 15 times higher than the average methane content for the world atmosphere.

More than a thousand large seep fields (super seeps) have been found so far. “They probably are not having a large impact on atmospheric $CO_2$ or methane yet.” Meanwhile, the Arctic climate is rapidly warming, the ice continues melting, the water continues warming, and there are large deposits of seabed hydrates that have not yet thawed.

Methane Craters

Methane craters are massive holes in the tundra that are caused by methane explosions. As the climate warms, thawing permafrost leads to methane releases that can accumulate in underground pockets. The holes are also called gas emission craters, blowout craters, funnels, and hydrolaccoliths. Methane craters are not the same as thaw slumps caused by subsidence, when the land surface softens and sinks due to thawing permafrost. Slumps sometimes fill with water, creating lakes or ponds.

Anna Liesowska reported that methane craters are a recent surprise, appearing on the Yamal and Taymyr (Gyden) peninsulas of northern Siberia. The first one was discovered in 2014, by a plane passing over tundra in the middle of nowhere on the Yamal peninsula. Until this sighting, these craters were unknown. She mentioned this 2014 discovery in a July 2020 article that announced the discovery of the seventeenth methane crater. It was about 164 feet (50 m) deep.

Her article included a number of stunning photographs. They included two photos of pingos, large mounds created by rising

pressure. The Pingo article in Wikipedia will further illuminate your understanding. Pingos are only found in permafrost regions. There may be 11,000 of them on Earth. One region in Canada has permafrost that's more than 50,000 years old.

Richard Gray created an excellent article for the BBC. It is recent (November 2020), provides a deeper discussion of methane craters, and includes a number of dramatic photographs. Satellite images, taken over multiple years, indicate that the site of the seventeenth crater (2020) had previously been a pingo that first appeared in the autumn of 2013. In northwest Siberia, the exploding pingos are apparently created by concentrated pockets of methane, and they develop in a few years. They are located in regions located above deep deposits of gas and oil.

The explosions can be very exciting. "Local reindeer herders reported seeing flames and smoke after one crater explosion in June 2017 along the banks of the Myudriyakha River. Villagers in nearby Seyakha — a settlement about 20.5 miles (33 km) south of the crater — claimed the gas kept burning for about 90 minutes and the flames reached 13 to 16 feet (4 to 5 m) high."

In this region of northern Siberia, satellite images taken from 1984 to 2007 indicate a five percent change in the landscape, as the climate warms, and more permafrost thaws. The Arctic is warming twice as fast as the global average, so permafrost will continue thawing in summer months, and more methane will be released. How many more craters will explode in the coming years? How much more methane will be released into the atmosphere? Also worrisome is that craters are exploding in a region of gas and oil extraction. There are many pipelines running across the land, and some are close to pingos. There is potential here for eco-catastrophes.

Portia Kentish reported on impacts caused by the 2020 heat wave in Siberia, "where thawing permafrost means the ground is no longer able to support structures built on it. For many, this raises particular concerns over the oil and gas industry, which is the primary economic sector in the Arctic

Circle. Pipelines, processing plants and storage tanks on unstable and thawing ground become a serious threat to the natural environment."

In 2019, the Intergovernmental Panel on Climate Change (IPCC) released a report. It found that "45 per cent of oil and natural gas production fields in the Russian Arctic are located in the most hazardous and at-risk region. Moreover, areas of discontinuous permafrost could see a 50-75 per cent drop in load bearing capacity over the period from 2015-25 in comparison to 1975-85." Stuff like roads, bridges, power grids, and towns are vulnerable.

## Undersea Craters

Nancy Bazilchuk reported on research in the Barents Sea, which is a region of the Arctic Ocean located between Norwegian and Russian territorial waters. In the 1990s, scientists discovered craters that blew out of the seafloor 12,000 to 15,000 years ago. Recent research has discovered hundreds more ancient craters. Some are 300 to 1,000 meters (328 to 1093 yards) in diameter, and blasted out of solid bedrock.

Karin Andreassen and team have been doing this undersea research, and they published a very detailed paper. Over the eons, there have been numerous glaciations (ice ages). When regions freeze, methane is trapped beneath ice sheets, and solidifies into methane hydrates. When warm periods return, some of the frozen methane can thaw and be released. Releases can be gradual, in streams of bubbles, or they can be abrupt, with crater-making explosions.

The incredible genius of humankind now allows us to cleverly disrupt the climate in a remarkable number of ways. Andreassen assures us that there are still enormous amounts of methane stored in seabeds and terrestrial permafrost. "It is apparent that extensive sub-glacial hydrate accumulations exist beneath the Antarctic and Greenland ice sheets today." She expects that more methane craters will explode.

Life as we know it is moving into the rear-view mirror. Nobody knows how hot it will get, how long it will last, and what it will remain when it's over.

## Ocean Heating

Cheryl Katz discussed how oceans have been cushioning climate impacts by soaking up excess heat that has been trapped in the atmosphere by greenhouse gases. By keeping the atmosphere a bit cooler for a while, this has delayed our inevitable head-on collision with reality. Currently, up to half of our $CO_2$ emissions are absorbed into seawater, mostly in the Southern Hemisphere. Also, heating up the oceans has accelerated acidification and deoxygenation (more on these below).

Experts are learning that the surface waters are now warming faster and deeper than ever. The situation was worse than they thought. Heat gain had been underestimated by as much as half — too little attention had been devoted to the Southern Hemisphere, where 60 percent of ocean water resides. Most of the heat gain was happening well south of the equator. At the same time, the Arctic Ocean is heating especially fast, as its ice cover melts and shrinks.

When water gets warmer, it expands. So, warmer oceans contribute to higher sea levels, as does the huge volume of water flowing out of melting glaciers and icepacks. The art of accurately predicting upcoming sea level changes has yet to be perfected. The world is far more complex and capricious than the programmers of computer models can imagine. There are limits to how much heat oceans can store. As their ability to absorb heat maxes out, they may stop absorbing heat, and begin releasing stored heat into the atmosphere.

Paul Ehrlich and John Harte noted that in a warming climate, higher ocean temperatures can power more intense storm events, and the warmer atmosphere has the capacity to store more water, so rainstorms are more intense.

Tierney Smith notes that oceans absorb between 35 and 42 percent of $CO_2$ emissions. They also absorb around 90 percent of

the excess heat energy that results from the warming climate. This elevates surface temperatures, and a warmer surface will absorb less of our $CO_2$ emissions. So, more carbon will continue to accumulate in the atmosphere, further warming the planet.

Timothy Lenton wrote, "Ocean heatwaves have led to mass coral bleaching and to the loss of half of the shallow-water corals on Australia's Great Barrier Reef. A staggering 99% of tropical corals are projected to be lost if global average temperature rises by 2°C, owing to interactions between warming, ocean acidification, and pollution. This would represent a profound loss of marine biodiversity and human livelihoods."

Todd Woody discussed the findings of a 2019 IPCC report. It noted that the rate of ocean warming has doubled since 1993. Extreme flooding of coastal areas will likely occur at least yearly by 2050. Fish populations face collapse thanks to a combination of ocean acidification, loss of oxygen, and warming of the ocean's surface, which blocks the flow of nutrients to and from the deep sea. Ocean Deoxygenation

Karin Limburg and team reported that oxygen levels in the oceans have been declining for about 70 years. This is gradually suffocating saltwater ecosystems ("oceans are losing their breath"). Low oxygen conditions can exist in coastal sites, semi-enclosed seas, and the open ocean. At the extreme, in regions of the Baltic Sea, the water contains zero measurable oxygen (anoxic).

More than 700 coastal sites in the world are experiencing low oxygen conditions (hypoxic). They are overloaded with nutrients, like nitrogen and phosphorus, runoff from fertilizer and sewage. We call them dead zones, but they aren't completely dead. They are home to large mobs of algae (phytoplankton), tiny aquatic plants that thrive in nutrient rich water.

Algae feast on the nutrients, explode in number, and create algal blooms. In the process, they emit lots of oxygen. When the nutrients run low, the algae die and decompose. Then, blooms are often followed by a surge of wee aquatic animals (zooplankton) that feast on the rich stew of dead algae, absorb the abundant oxygen, and emit $CO_2$. This depletes the oxygen content of the water. In this example, deoxygenation is encouraged by eutrophication (nutrient overload).

Deoxygenation is also encouraged by climate change, in two different ways. (1) Cold water can hold more oxygen. When the atmosphere is warmer, the water surface is warmer. The layer of warm water reduces the migration of atmospheric oxygen into the cooler waters below. This harms marine life.

(2) A warmer atmosphere accelerates the melting of ice, which feeds more fresh water into the salty sea. Freshwater is less dense than salt water, so it stratifies above salt water. This restricts the migration of oxygen below the surface.

So, compared to earlier times, less oxygen is now available in deeper waters. Some sea animals are able to survive in zones of minimal oxygen, others are forced to move. Animals having a high metabolism, like tuna or sharks, move to shallower depths, where they are more likely to be caught. Migration introduces some chaos into traditional food webs, as more species become crowded together.

Ocean Acidification

Cody Sullivan and Rebecca Lindsey of the National Oceanic and Atmospheric Association (NOAA) wrote about how oceans are being affected by human-produced $CO_2$. Oceans are the only long-term sink for manmade $CO_2$ emissions. So, less $CO_2$ accumulates in the atmosphere, which is good. But more is absorbed into the ocean, which is the opposite of good.

Colder waters tend to absorb $CO_2$, while warmer waters tend to release it back into the atmosphere. Since 2000, the overall net increase in $CO_2$ absorption has been trending upward at a robust

rate. Unfortunately, the higher uptake of carbon also encourages ocean acidification.

Cheryl Katz studies ocean acidification (“global warming’s evil twin”). In the Arctic, and in the Southern Ocean surrounding Antarctica, lots of ice is busy melting away, exposing the water below. In cold polar waters, $CO_2$ is more soluble, so more of it can be absorbed. Some of it reacts with the water to form carbonic acid. Consequently, the frigid waters near both poles are becoming highly acidified. Conditions in the polar regions are getting close to a tipping point toward extreme acidification.

The area of increasingly corrosive water is expected to expand into the North Atlantic and North Pacific, impact the ocean food web, and threaten important fisheries. Already, oysters are dying off in the U.S. Pacific Northwest. Shell-building organisms need carbonate minerals. In the past, carbonate ions in the water provided a buffer against the acids. As these ions are depleted, acidity is able to rise. Creatures with shells are having a harder time building and maintaining shells, because they corrode.

Increasing ocean acidification is a severe threat to the planet. It is expected to have a big impact on fisheries in Alaska and throughout the Arctic. As waters warm, species like Atlantic cod are migrating toward the cooler Arctic, where acidification is high. Fish populations are likely to decline, impacting the global food supply for humans.

Stephanie Dutkiewicz and team studied the impact of acidification on phytoplankton (algae), the tiny plants that are the foundation of the marine food web. They absorb CO and emit the life-giving 2 oxygen that's necessary for the existence of animal life. Oceans absorb about 30 percent of manmade carbon emissions, and this intensifies acidification. Their analysis concluded, "At the level of ecological function of the phytoplankton community, acidification had a greater impact than warming or reduced nutrient supply."

## Thermohaline Circulation

Ocean current circulation is a very big deal. It has a major impact on regional climates because it moves heat. In plain English, it's called the global conveyor belt. In science speak, it's called the thermohaline circulation (THC). The THC moves heat around the world via a long and winding pathway. Wikipedia provides a nice

plain English description of the THC [HERE].

The flow of the current is driven by seawater density, which is determined by variations of surface temperature and salt content (salinity). Warm water is less dense than cold, so it rises to the top. Freshwater is lighter, less dense, so it stays close to the surface. Salt water is denser and heavier.

Today, melting ice sheets, glaciers, and sea ice are pouring huge amounts of cold freshwater into the ocean, which throws a monkey wrench into the traditional operation of the current. Global warming will increasingly have an impact on ocean circulation. These changes are expected to eventually alter the traditional patterns of the THC as we know it. Some experts are contemplating the possibility of a slowdown or shutdown of the THC. Wikipedia

discusses the possibilities [HERE].

Atlantic Meridional Overturning Circulation (AMOC)

One segment of the global thermohaline circulation is the Atlantic Meridional Overturning Circulation (AMOC). As the name implies, this involves the currents moving north and then south in the Atlantic Ocean. The AMOC is fed by warm and salty water flowing past the cape of Africa, heading northwest to the Caribbean, then up the coast of North America, then northeast to Iceland and Scandinavia. In the far north, the current loses much heat, and sends cool water back down toward the South Pole.

The segment of the AMOC that moves warm water from the Gulf

of Mexico toward the Arctic is called the Gulf Stream. It keeps the climate of the eastern U.S. and northern Europe warmer than is typical at such a high latitude. This allows modern agriculture in these regions. Some worry that the melting Arctic will increase the frigid freshwater flowing into the AMOC, and this could lead to a slowdown or shutdown of the current, and possibly a chillier future for the eastern U.S. and western Europe.

Some have presented evidence that the AMOC is slowing down. Others don't find this evidence to be compelling, and they don't expect a slowdown in the near-term future. Much is not known about ocean currents, and controversies abound. Scientists are far from full agreement on what is happening, and what might happen in the future.

Nicola Jones wrote an easy-to-understand description of current AMOC research and debates. Undersea instruments that measure the current's flow are indicating a significant slowdown. Experts aren't sure if this is worrisome evidence of climate change, or simply reflects normal variations.

"Should the AMOC shut down, models show that changes in rainfall patterns would dry up Europe's rivers, and North America's entire Eastern Seaboard could see an additional 30 inches (76 cm) of sea level rise as the backed-up currents pile water up on East Coast shores." This hasn't happened yet. For now, data collection continues, and the debates rumble on.

Overheating

In 2017, David Wallace-Wells wrote that the five warmest summers in Europe since 1500 have all occurred since 2002. Rising heat will have the most dramatic impacts in the Persian Gulf and Middle East, where record temperatures have soared to frightening heights. In 2015, temps as high as 163°F (73°C) were recorded in the Middle East.

Matthew Lewis described how rising numbers of people are dying because extreme heat events are becoming more common. "Deadly heat is cooking us alive." When our bodies get too warm, we sweat, which helps us shed excess heat as it evaporates. If you're lucky, this keeps your body temperature in the normal range.

We evolved our ability to sweat on African savannahs, where the humidity is typically low ("dry heat"). So, we can survive for a few hours of 120°F (49°C) in Death Valley, California. It's a different story in super-humid Florida, where "a single day of 120-degree temperatures in Palm Beach would be a mass casualty event. Dead bodies would pile up in the morgues, victims of hyperthermia (heatstroke) — cooked, alive, in their own bodies." Alas, the cooling powers of sweating have limits.

Tara Santora explored the maximum amount of heat that the human body can endure. “Air temperature” is the scale of heat that a thermometer displays. “Wet bulb temperature” is produced by a thermometer covered in a water-soaked cloth. It takes into account both air temperature and the humidity level. She reported that the limit we humans can endure is a wet bulb temperature of 95°F (35°C). You probably wouldn’t last three hours.

When the air temperature is 115°F (46.1°C) and humidity is 30%, the wet bulb temperature is 87°F (30.5°C). When the air temperature is 102°F (38.9°C) and humidity is 77%, the wet bulb temperature is 95°F (35°C). When the wet bulb temperature is close to your normal body temperature, you still sweat, but this doesn’t cool you. Shade doesn’t help, nor does drinking water. You can also overheat at lower temperatures if you are exercising and/or exposed to direct sunlight. As the climate warms, the risks of overheating increase.

Janet Larsen noted that a warming climate is expected to increase the number and intensity of heat waves in the coming years. In 2003, a blast furnace heat wave caused the deaths of more than 52,000 people across Europe. It was the hottest weather in at least 500 years. Temperatures were over 104°F (40°C) for up to two weeks. Fatalities rose to 2,000 per day in France. The higher the humidity, the higher the death rate. City folks were most at risk,

because urban areas are heat islands. Jean-Marie Robine and team did additional research and estimated that the actual mortality in 2003 was more than 70,000.

John Gowdy added, “During the record heat in Europe in Summer 2003, maize production fell by 30% in France and 36% in Italy. A 2008 study found that southern Africa could lose 30% of its maize crop by 2030 due to the negative effects of climate change. Losses of maize and rice crops in South Asia could also be significant.”

Extreme heat dries out the land, making it more flammable.

Wikipedia noted that the 2003 European heat wave corresponded with a series of fires in Portugal that destroyed 1,160 square miles (3010 km$^2$ $^2$ ) of forest, and 170 square miles (440 km) of agricultural land. In southern Portugal, the temperatures reached as high as 117°F (47°C).

Deepa Shivaram reported on a heat wave that hit British Columbia in July 2021. Along the coastline of Vancouver, on one beach alone, the rocky shore was covered with hundreds of thousands of dead mussels. It also killed barnacles, clams, crabs, sea stars, and intertidal anemones. Overall, an estimated one billion sea creatures died from the heat. Other animals that depend on sea life for food were also affected. During the same heat wave, 180 wildfires ignited in the region.

Water and Climate

In *The Great Acceleration*, McNeill and Engelke described how a warming climate is disturbing the relationship between water and the family of life. The precipitation patterns of the past are changing, creating new challenges for ecosystems, human societies, and life as we know it.

Extreme weather events are expected to occur more frequently. When ocean surface temperatures get warmer, cyclones are more likely to be spawned. Warmer air can hold more moisture. In regions having a moist climate, clouds bloated with water are more likely to form. More and more often, storms are dumping huge loads of rain, sudden deluges that cause destructive floods and landslides ("atmospheric rivers"). In regions having a dryer climate, warmer air will create fewer clouds, produce less rain, crank up the air temperature, intensify drought conditions, and encourage wildfires.

With a warming climate, the glaciers of the world are melting and retreating more rapidly. Winter precipitation is delivering more rain, less snow. Winter rain tends to run off promptly. Snowpack retains the moisture longer. It melts later, closer to the growing season, when the water can be used to irrigate thirsty cropland.

The melt water flowing out of the Himalayas feeds the Indus, Yangzi, Mekong, Ganges, Yellow, Brahmaputra, and Irrawaddy rivers. Two billion people depend on this water arriving in adequate amounts, at the appropriate time. In the coming years, more water shortages and major changes are expected.

Paul Ehrlich and John Harte wrote that a third of global crop production depends on irrigation. Melting snow has been an essential source of irrigation water. “The winter snowpack in mountainous regions such as the Himalayas, the Rockies, the Sierra, and the Andes is a most efficient reservoir, storing water through the cold months and releasing it gradually as snowmelt in warm months when farmers need it.”

“In response to severe and prolonged drought in many regions of the world, including China, India, Thailand, Italy, and California, loss of surface irrigation water has resulted in excessive pumping of groundwater, which in turn has led to land subsidence, groundwater depletion, and irreversible loss of aquifer volume.” Food production is also challenged by droughts, deluges, super storms, heat waves, aggressive wildfires, declining insect pollinators, soil salinization, soil depletion, erosion, and so on.

Sahana Ghosh reported that the once mighty Ganges River is wheezing. Over the years, river volume has been declining, because farmers have been diverting too much water via their irrigation canals. The river got shallower. Then, they switched to tube wells with motorized pumps. Naturally, overpumping the groundwater has serious consequences. In the dry months, the river now looks more like a mudflat. Reduced flow also concentrates the load of pollutants. Researcher Abhijit Mukherjee said, “Our prediction shows that about 115 million people can be impacted due to insufficient food availability in the next few decades.”

Jim Robbins wrote about the Colorado River blues. The 1,450-mile (2,333 km) watershed starts in the Rocky Mountains and ends at the Pacific. It used to empty into the Gulf of California, but not a single drop of water enters the Gulf today. In 2018, river volume was just two-thirds of normal, tied for the record low.

The Colorado is one of the most heavily engineered waterways in the world — designed for the benefit of humans, not nature. It is the source of much contention. It serves 40 million people, and the number of users keeps growing. A drought since 2000 has reduced its flow. It is the most severe drought in 1,250 years. The Lake Mead reservoir at Hoover Dam, and the Lake Powell reservoir at Glen Canyon Dam, are both at all-time lows.

Some suspect that climate change is drying out the West. This is not just a temporary drought; the West may actually be getting permanently dryer. "Worst case, if the reservoirs ever hit 'dead pool' — when levels drop too low for water to be piped out — many people in the region could become climate refugees."

Agriculture uses 80 percent of the Colorado's water; cities use 10 percent. As demand exceeds supply, some users will be cut off. Dewatering agriculture would snuff out many farms and nearby towns. Wildlife does not have a top priority.

Frederick Pleitgen and team described an emerging water shortage crisis in the Middle East, caused by persistent drought and extreme heat. Temperatures sometimes soar to life threatening levels. Rainfall mostly evaporates. Rivers, lakes, and wetlands are drying up. As Iran's once large and beautiful Lake Urmia shrinks, its water is getting too salty, so farmers are pumping groundwater for irrigation. Aquifers are being overpumped, depleting the limited reserves. If current trends continue, some regions will become uninhabitable.

Homes in Jordan receive some water once or twice a week. Numerous upstream dams limit the amount of water that eventually arrives at the end of the watershed. Israel has a huge water desalinization program that requires large amounts of fossil energy to operate, adding still more carbon into the atmosphere.

## Agriculture and Climate

Most of humankind depends heavily on agricultural products. Every variety of plant and animal has different environmental requirements for basic survival and optimal productivity. With regard to crop plants, important variables include temperature, sunlight hours, pH, available moisture, soil fertility, and so on. A changing climate will generate new challenges. Evolution cannot quickly respond to shifting conditions. Experts are getting more and more nervous.

Brian Halweil emphasized how important a stable climate is to agriculture. In 2003, for the first time, the potato blight fungus came to visit the town of Chacllabamba, Peru. It almost totally destroyed their crop. Located at an altitude of 13,000 feet (4,000 m), a cool climate had protected the potato fields for thousands of years. No more. Spuds had been their staple food.

Jerry Hatfield and John Prueger investigated how rising temperatures affected a variety of crop plants. Extreme heat events may last a few days, and have a big impact. When temperatures are outside of the ideal range, plant growth, pollination, and reproductive processes can be affected. Pollination is especially sensitive to rising temperatures. High temperatures during the reproductive phase of the life cycle can reduce corn yields by as much as 80 to 90 percent.

When wheat is maturing, a frost can cause the grains to be sterile. Too much heat can reduce the number of grains that form. Rice is especially vulnerable to high heat during the pollination process. For the major crops, yields are expected to decrease as global temperatures rise.

Kimberly Cartier noted that growing conditions are getting less predictable than in the past. Rainy seasons may be more intense than usual, or less. Their arrival may be earlier than the ideal time, or later. The El Niño-Southern Oscillation (ENSO) pattern is associated with precipitation patterns, and it is a well-known troublemaker. In 1983, an unusual ENSO coincided with the largest global failure of corn (maize) crops in modern records. ENSO can also alter wheat and soybean production on a global scale.

Mike Davis wrote about a horrific era of ENSO related droughts and famines. In the years 1876-79 and 1896-1902 between 12.2 and 29.3 million died of famine in India. In the Madras Deccan, "the only well-fed part of the local population were the pariah dogs, 'fat as sheep,' that feasted on the bodies of dead children." In the same period, between 19.5 and 30 million died of famine in China, and 2 million in Brazil. Famine hit these three nations the hardest, but many other nations were also affected. In the U.S., churches organized to send relief to hungry farmers in the Dakotas and western Kansas.

Samuel Markings wrote about the relationship between photosynthesis and temperature. In plants, photosynthesis is the process that uses sunlight to transform water and CO into food 2 (glucose) and oxygen. Optimum temperatures range between 50 to 68°F (10 to 20°C). Above this range, higher temperatures slow photosynthesis. The process declines sharply when temps rise above 104°F (40°C). When temps persist in this range, plant survival is endangered.

Abdul Wahid and team wrote an extensive report on heat tolerance in plants. Each crop species has a threshold temperature. If this temperature is exceeded too long, the result is heat stress — irreversible damage to plant growth and development. Harm varies based on intensity (temperature in degrees), duration, and the rate at which the temperate rose.

Qunying Luo extensively described threshold temperatures for a number of major crop species. At different stages of a plant's life, they can be damaged by excess heat — leaf initiation, shoot growth, root growth, sowing to emergence, grain filling, etc. For example, "Several studies found that temperatures of above 35°C (95°F) are lethal to maize pollen viability"

Tnau Agritech Portal published a report on the effects of high temperature on plant growth in India. Each plant species has a thermal death point. For many annual crops, 122°F (50°C) is fatal. Excess heat can reduce yields, and inhibit the absorption and assimilation of nutrients. It can cause pollen abortion, which reduces the grain set. Even short exposure can affect the growth of shoots and roots.

Evelyn Lamb wrote that rice provides 16 to 20 percent of the calories consumed by humankind. Corn and wheat are similarly popular. Thus, more than half of the calories consumed by humans are provided by rice, corn, and wheat. Growing rice in flooded paddies produces more greenhouse gas emissions per calorie than corn or wheat — twice the emissions from wheat.

Santosh Koirala reported that most rice crops begin by transplanting young plants in flooded paddies ("puddling"). "When rice is grown under puddled transplanted conditions, paddy soil becomes anoxic — depleted of dissolved oxygen — and then, in the absence of oxygen, microbes that break down plant matter produce methane." Puddling "is becoming less profitable because of the costs of labour, shortage of water, and high energy costs." It results in depletion of soil quality, and higher methane emissions.

"Methane is the second major greenhouse gas, after carbon dioxide, and agriculture accounts for 40% of these greenhouse emissions. Although farm animals are a major source, flooded rice paddies emit as much as 500 million tons, which is around 20% of total manmade emissions of this gas."

Kritee Kritee and team noted that rice is a staple food for almost half of humankind, so it's especially important to pay attention to its climate impacts. Globally, one third of water used for irrigation goes to rice farming. Rice receives one seventh of all fertilizer used. "Methane from global rice cultivation currently accounts for one-half of all crop-related greenhouse gas emissions."

Experts recommended that these methane emissions could be reduced by shifting from continuously flooded rice fields to intermittent flooding. Unfortunately, the team was surprised to discover that this brilliant solution had an unintended consequence. The emissions of nitrous oxide (N O) tripled — a greenhouse gas 2 that persists in the atmosphere much longer than methane. It is an unintended consequence of using nitrogen rich fertilizer.

Janet Ranganathan and team wrote a hefty and thorough report filled with recommendations for reducing the environmental harm caused by high impact diets and overpopulation. Consumption of animal-based foods is growing, and these foods (especially beef), result in higher emissions of greenhouse gases.

Meat and dairy foods are not necessary for adequate nutrition, so less is better. "Plant-based foods can be readily combined to provide the full set of essential amino acids, as with rice and beans or peanut butter and bread." The only essential not provided by a vegetarian diet is vitamin B12, which supplements can provide.

Obesity is a growing trend, even among low-income people. "Globally, there are now two-and-a-half times more overweight than undernourished people. More than one in three adults are overweight.” Folks around the world are overdoing the consumption of calories and protein.

The Second State of the Carbon Cycle Report is a spellbinding 878-page report on the carbon cycle in North America. I learned a very important fact of life: “Globally, soils contain more than three times as much carbon as the atmosphere, and four and a half times more carbon than the world’s biota [living things]; therefore, even small changes in soil carbon stocks could lead to large changes in the atmospheric concentration of carbon dioxide ($CO_2$).”

Carbon compounds are central to the existence of the entire family of life. The $CO_2$ that plants extract from the atmosphere allows them to live and grow. Plants exhale oxygen that animals need, and animals exhale $CO_2$ that plants need. Soil is home to an amazing community of fantastic microbes. Dead organic material contains carbon. When stuff drops to the ground, soil microbes eagerly decompose it, and do so in a way that stabilizes the carbon, so it is more likely to be retained in the soil, rather than wander away. Soil microbes that encourage carbon retention are hindered by unusual shifts in moisture or temperature. They don’t enjoy deforestation, tilling, or being sprayed with farm chemicals.

Livestock production is a significant source of greenhouse gases — $CO_2$, methane, and nitrous oxide. Ruminants include cattle, sheep, goats, elk, deer, bison, etc. The digestive system in ruminants includes a process called enteric fermentation, which produces methane emissions (3% farts, 97% belches). Poultry, hogs, and horses emit greenhouse gases in smaller volumes via different processes. Manure stored in large quantities generates large emissions of methane. Pools of deep shit contain little or no oxygen, so they provide ideal conditions for producing methane.

“Soils in North America have lost, on average, 20% to 75% of their original topsoil carbon with historical conversion to agriculture.” Most of this conversion took place in the last 200 years or so. To add insult to injury, “On a per-person basis, food loss and waste in North America is 375 to 500 kilograms per year.” (826 to 1,102 pounds). How smart is that?

## Arctic Fires

Zombie fires were the subject of a BBC story. They are also called overwintering fires or peat fires. They occur in Russia, Canada, and Alaska. In recent years, temperatures in the Arctic have been soaring, and permafrost has been thawing. When tundra and forest lands dry out, they become prone to wildfires. These fires can ignite ancient peat deposits beneath the surface. Burning peat can smolder all winter, beneath the snow cover. When spring arrives, the snow melts, oxygen reaches the embers, and the fire can reignite. They “come back from the dead,” hence the zombie tag.

Alexandra Witze reported that in the summer of 2020, there were many Siberian tundra fires, and they emitted 244 megatons of $CO_2$, a 35 percent increase over the intense 2019 fire season. About half of the fires were burning on peat lands, the most carbon-dense ecosystems. When shallow layers near the surface dry out, they are more susceptible to burning. Warmer winters and springs mean the fire season starts sooner. In the Arctic, the fire zone is moving northward, into lands that have traditionally been fire-resistant.

Portia Kentish reported that the climate catastrophe is well underway in Arctic regions, causing huge and spooky impacts — a powerful warning to the rest of the world, which is not leaping to action. During a May 2020 heat wave, locations in Siberia that are normally close to freezing had temperatures hotter than Athens or Rome. Some Arctic permafrost is up to 80,000 years old. When permafrost thaws, methane emissions begin. Heat waves encourage wildfires. They are burning peat deposits that have been building up for 15,000 years. About half of Russia’s Arctic fires are consuming peat soil.

## Forest Impacts

We could sequester lots of $CO_2$ by planting enormous numbers of trees. That sounds wholesome. Sadly, the current fad is the opposite, deforestation

— cutting enormous numbers of trees to grow soybeans, create livestock pastures, make charcoal, produce wood products, and clear the way for urban sprawl.

As the planet gets warmer, forests will become more vulnerable to pests and pathogens. Droughts will become hotter, longer, and dryer. This encourages wildfires. Wikipedia is posting pages that, year by year, document wildfire activity in the world. The report for

the record-breaking year of 2021 is [HERE]. As of August 19, fires had been reported in Algeria, South Africa, Cyprus, India, Israel, Russia, Turkey, France, Greece, Italy (10 regions), Canada, and United States (9 states), Argentina, and Australia.

Rodrigo Pérez Ortega reported that climate change is encouraging trees to grow fast and die young. Research suggests that this may be universal, affecting almost all tree species and climates. Based on tree ring analysis, this trend corresponds with the exponential growth of human caused $CO_2$ emissions, as well as rising temperatures — a combo that stimulates rapid growth. This reduces their potential for maximum long term $CO_2$ absorption.

Nate McDowell and team studied changing forests. "Shifts in forest dynamics are already occurring, and the emerging pattern is that global forests are tending toward younger stands with faster turnover as old-growth forest with stable dynamics are dwindling." These shifts are occurring because of "anthropogenic-driven exacerbation of chronic drivers, such as rising temperature and $CO_2$, and increasing transient disturbances, including wildfire, drought, windthrow, biotic attack, and land-use change." Their findings indicate that it is "highly likely that tree mortality rates will continue to increase."

Robert Hunziker reported on new information linking rising temperatures with the increase in tree deaths. In the U.S., giant sequoias are dying from the top down. In the Southwest, drought has killed hundreds of millions of trees. In Africa, 2,000-year-old baobab trees are wheezing and dying. In Germany, dead trees are everywhere. Dead and dying trees are more vulnerable to insects and disease. They provide abundant fuel for forest fires. Siberia is burning up. "New studies show drought and heat waves will cause massive die-offs, killing most trees alive today."

In 2017, Dahr Jamail visited Glacier National Park, home to a formerly thriving boreal forest. The warming climate has delighted millions of hungry pine bark beetles, some of whom can now have two life cycles per year. In the last 20 years, beetles have killed 40 million acres (16 million ha) of trees. They kill fewer pines now, because fewer pines remain alive. The latest serial killer is white pine blister rust, which has infected almost 85 percent of the trees in the park.

Songlin Fei and team studied how insects and diseases are hammering U.S. forests, which are now home to more than 450 nonnative tree-feeding insects and tree pathogens. The study focused on the 15 most destructive nonnative forest pests. It found that "41.1% of the total live forest biomass in the conterminous United States is at risk of future loss from these 15 pests. These results indicate that forest pest invasions, driven primarily by globalization, represent a huge risk to U.S. forests and have significant impacts on carbon dynamics."

Peter Wohlleben shared his intimate knowledge of the trees in his beloved German forest. Trees can't walk, but forests are always slowly wandering. Since the end of the last ice age, a warming climate has enabled the trees of central Europe to gradually migrate northward. Animals and winds move seeds away from their source. Today, the climate is warming way too fast, which presents a mortal threat to temperature sensitive species. Human tree huggers are working to relocate and transplant as many types of trees as

possible. Assisted migration is a heroic effort to "help forests walk."

Climate and Disease

The climate catastrophe is not expected to promote miraculous advances in the health of humankind. The huge herd is moving into an era of food insecurity, power shortages, water scarcity, poor sanitation, infectious diseases, deteriorating medical care systems, political instability, and so on. A hotter climate and extreme weather events will add to these challenges.

The Lancet's 2020 report presented a competent 42-page discussion on the climate change impacts on health. Warming trends are increasing the frequency and intensity of floods, drought, storms, wildfire, temperature anomalies, and food scarcity. These changes are killing more folks in the 65+ age range. In 2018, heat waves killed about 296,000 people.

"The climate suitability for infectious disease transmission has been growing rapidly since the 1950s." The dengue virus is spreading across South America. "From 1950 to 2018, the global climate suitability for the transmission of dengue increased by 8.9% for *Aedes aegypti* and 15% for *Aedes albopictus*. In 2015 to 2019, suitability for malaria transmission in highland areas was 38.7% higher in the African region and 149.7% higher in the Western Pacific region compared with a 1950s baseline."

David Wallace-Wells added that malaria also thrives in hotter regions because "for every degree increase in temperature, the parasite reproduces ten times faster." Consequently, by 2050, up to 5.2 billion people may be infected, according to World Bank estimates. As tropical climates move northward, so will tropical pathogens.

# Climate "Solutions"

Hydropower

It's easy for most folks to imagine that hydropower is clean, green, and renewable. We build huge dams, collect water in huge reservoirs, send it through generators, electricity happens, we feed it into the power grid, and spend our lives enjoying goofy high impact lifestyles. The source of this water is melting snowpack. During drought periods, less winter snowpack accumulates in the mountains upstream. So, less meltwater flows into streams, less water accumulates in reservoirs, less water pressure spins the turbines, and less power is generated.

In normal years, hydropower provides about 15 percent of California's electricity. In 2022, water levels in California reservoirs were at historic lows. Justine Calma reported that extreme drought was expected to reduce the state's summer hydropower generation by about half. At the same time, above average air temperatures inspired folks to crank up their air conditioners. When hydropower generation declines, power companies typically replace the shortfall by burning more natural gas, which generates more CO emissions. 2

As mentioned earlier, all dams accumulate silt over time, and this reduces reservoir capacity. Removing huge amounts of silt is extremely expensive. Each dam devastates the ecosystem of the river it enslaves. Walter Youngquist reminded us that hydropower is not renewable energy. All dams have limited working lifespans. Each one is made of millions of tons of concrete. Making concrete requires intense heat that only fossil energy technology can generate.

Nuclear Energy

Humankind is beginning to comprehend that our fossil energy joyride, which enabled some interesting possibilities, had costs that far exceeded the benefits, and caused massive irreparable damage. Whoops! Some folks imagine that replacing fossil energy with nuclear power would be a great idea! We could sharply reduce carbon emissions and drive around in high-tech electric vehicles.

William and Rosemarie Alley wrote the book on nuclear waste storage in the U.S. William worked for the U.S. Geological Survey, and it was his job to find a secure place to safely store this stuff forever. He spent years on the Yucca Mountain project in Nevada, America's preferred site for the "safe" permanent storage of nuclear waste.

At first, folks thought the nuke waste would become harmless in 600 years or so. Eventually, they realized that some of the waste would be dangerous for hundreds of thousands of years. It needed to be stored in a geologic repository, in strong deep bedrock that would not collapse if a future ice age put a mile thick ice sheet above it. It had to be dry, seismically stable, accessible to transport, and inaccessible to terrorists.

By 2012, the U.S. had generated lots of high-level radioactive wastes — 70,000 tons of spent nuclear fuel, and 20,000 giant canisters of military material. Waste was stored at 121 sites in 39 states. In 2013, Alley noted that "there are some 440 nuclear power plants in 31 countries. More are on the way. Yet, no country on Earth has an operating high-level waste disposal facility." Nuclear waste remains extremely toxic for hundreds of thousands of years or more.

In 2022, there is far more high-level waste sitting around. The U.S. has 60 nuclear power plants, and there are 449 in the world. Guess how many nations are using geologic repositories. Zero. A small one in Finland might open in 2023.

The U.S. government invested $10 billion on 25 years of research on Yucca Mountain. The objective was to prove that the site would be safe for a million years. No place on Earth would be a perfect site. Dr. Alley believed that Yucca Mountain was close enough to ideal, and should be approved. It wasn't.

Barack Obama was elected president in 2008. At that time, Yucca Mountain was the widely supported location for our nuke waste repository.

One crappy day, the Alleys were blindsided by an unpleasant surprise. In March 2009, Obama's new Secretary of Energy, Steven Chu, told a Senate hearing that "Yucca Mountain was not an option." In July 2009, the license application was withdrawn, and all funding for the project was cut. Game over.

Chu cited no issues, and offered no alternatives. The Alleys wrote, "Virtually all observers attributed the decision to pull the plug on Yucca Mountain as political payoff to Harry Reid, the Senate Majority Leader from Nevada (D-NV). Nevada was a swing state in the election, and Obama had pledged to kill Yucca Mountain, if elected." He needed Reid in order to push his health care plans through. Republican Senators blasted Chu with sharp questions about his hasty dumb decision.

In 2016, Donald Trump was elected president. Wikipedia described his Yucca Mountain policies. "On March 15, 2017, the Trump Administration announced it would request Congressional approval for $120 million to restart licensing activity at the Yucca Mountain Repository, with funding also to be used to create an interim storage program. The project would consolidate nuclear waste across the United States in Yucca Mountain, which had been stockpiled in local locations since 2010."

Then, he changed his mind, according to Wikipedia. "Although his administration had allocated money to the project, in October 2018, President Donald Trump stated he opposed the use of Yucca Mountain for dumping, saying he agreed with the people of Nevada."

"On May 20, 2020, Under Secretary of Energy Mark W. Menezes testified in front of the Senate Energy and Natural Resources Committee that Trump strongly opposes proceeding with Yucca Mountain Repository."

In November 2020, voters chose Joe Biden to be the next president. Biden did not overturn Trump's policy. The Wikipedia article continues. "In May 2021, Energy Secretary Jennifer Granholm said that Yucca Mountain would not be part of the Biden administration's plans for nuclear-waste disposal. She anticipated announcing the department's next steps in the coming months."

A year later, in May 2022, Jennifer McDermott reported that Granholm had not changed her mind. “The Energy Department is working to develop a process to ask communities if they are interested in storing spent nuclear fuel on an interim basis, both to make nuclear power a more sustainable option and figure out what to do with the waste. Granholm said it’s the best way to finally solve the issue. A plan to build a national storage facility northwest of Las Vegas at Yucca Mountain has been mothballed because of staunch opposition from most Nevada residents and officials.” So, Obama, Trump, and Biden rubbished the Yucca solution, and offered no Plan B. Sorry kids! Sorry Earth!

Because Yucca Mountain was repeatedly cancelled, America’s spent fuel rods continue building up, many of them temporarily stored in cooling ponds. If the circulating pumps for the cooling ponds stop, the water boils, the pool evaporates, and the rods are exposed to air, melt, and release radioactive gasses. The meltdowns at Three Mile Island, Chernobyl, and Fukushima were triggered by overheated fuel rods.

Paul Dorfman pointed out that climate change is leading to rising sea levels. The Greenland ice sheet is approaching a tipping point that will make accelerated melting inevitable. If supernatural miracles don’t rescue us, we’re going to see more coastal and inland flooding. “With 41 percent of all nuclear plants world-wide operating on the coast, nuclear may prove an important risk.” May? At least 100 of these plants are just a few meters above sea level.

“The near-term effect of rising mean sea-levels at coastal nuclear installations will be felt most profoundly during extreme storm conditions when strong winds and low atmospheric pressure bring about a localized increase in sea-level known as a ‘storm surge.’” Inland plants also face warming-related risks — wildfires, river floods, low river levels. If river temperatures get too warm, their ability to properly cool reactors is diminished. Worldwide, more than a half billion people live within 50 miles (80 km) of a nuke plant.

Edwin Lyman wrote a 148-page report on the new generation of “advanced” reactors that may be put into commercial use at some point in the future. He works for the Union of Concerned Scientists, an organization dedicated to objective analysis. It is financially and politically independent of the nuclear power industry's interests. The industry makes a number of impressive claims about the technological advances of the new reactors. Lyman has reservations. Different is not the same as better. He labels ten claims, including improved safety and security, to be "misleading." The report is a free download. Enjoy!

In 2021, Megan Seibert and William Rees wrote that only two prototypes of "intrinsically safe" Generation IV reactors are in development, one in China, the other in Russia. Both are probably 20 to 30 years from final completion, and claims made about their safety are "misleading."

My grandparents and mother were born in homes without electricity. Satellite photos of the Earth at night reveal tremendous amounts of wasted energy. [LOOK] Energy wasted on lighting is just the tip of the iceberg. Every power switch has an OFF position. Bioenergy with Carbon Capture and Sequestration (BECCS)

BECCSs was another big idea. Instead of burning filthy coal, we could grow, gather, and burn lots of "replaceable" biomass fuel — grasses, trees, crop residues, etc. These fuels would absorb CO as 2 they grew, and then we could burn this renewable resource to make happy green electricity. The chimney smoke from the burning would be processed to remove the CO , which could then be safely stored 2 underground forever in some way. The technology for capturing the CO is expensive, guzzles lots of energy, and is far from ready for 2 full scale deployment.

## Net Zero

James Dyke, Robert Watson, and Wolfgang Knorr are three venerable climate science elders who have been watching the clan of eco-wizards contemplate possible solutions to the climate catastrophe for many years. They wrote, "It has been estimated that BECCS would demand between 0.4 and 1.2 billion hectares of land. That's 25% to 80% of all the land currently under cultivation." (Land now used to produce food.)

The three lads wrote a fascinating and heartbreaking essay on

the elusive goal of net zero emissions. [HERE] The climate catastrophe is a consequence of having way too much $CO_2$ in the atmosphere, and adding more and more every day. So, the apparent solution involved extracting the excess $CO_2$ from the air, while also sharply reducing the rate of current emissions. The Holy Grail was "net zero" — extracting as much carbon as we emit, creating a healthy balance. In maybe 30 years of net zero, bye-bye climate catastrophe, hello happy days!

Until 2021, the three professors kept their opinions to themselves. The technosphere is a sacred realm of miracles. Expressing doubts is heresy. Heresy can rubbish your reputation, and jeopardize future research grants. They understood that the notion of net zero was daffy — "burn now, pay later."

If we plant a bunch of trees, they'll sequester carbon as they grow, and we can continue living recklessly. This encourages blind faith in future techno-miracles, and it discourages everyone from making big changes in the here and now. Consequently, carbon in the atmosphere keeps increasing. The professors finally came out of the closet, and shared their pain. Hooray!

Bonnie Waring laments humankind's belief that, with a bit of encouragement, the world's forests can absorb enough carbon to end the climate catastrophe. "But the fact is that there aren't enough trees in the world to offset society's carbon emissions — and there never will be." We're simply kicking the can down the road.

### Solar Radiation Management (SRM)

The goal of SRM is to increase albedo, and reduce atmospheric temperatures, by bouncing away a larger portion of incoming solar radiation. The plan involves regularly dispersing tons of reflective

substances high in the sky, year after year, forever. McKenzie Funk wrote about Microsoft billionaire Nathan Myhrvold, who was working on a planet saving miracle. His StratoShield project would spray 2 to 5 million metric tons of sulfur dioxide into the stratosphere every year. This would make the sunlight one percent dimmer and, in theory, keep high impact lifestyles on life support for a bit longer (maybe).

While this might deflect some incoming heat, ongoing $CO_2$ emissions would continue building up in the atmosphere and oceans. Will vegetation be OK with reduced sunlight? Will precipitation patterns change? Apparently, the fantasy is that by reducing incoming heat, the Artic would quit melting, and humankind could live happily ever after. Another variant is cirrus cloud thinning — modifying high-altitude clouds to make them thinner, less of an insulating blanket. This would allow the planet to release more heat from the atmosphere.

Direct Air Capture (DAC)

Direct air capture (DAC) is an experimental technology that removes $CO_2$ (but not methane) from the atmosphere. The captured carbon can be permanently stored in the ground, at significant expense, or sold for commercial uses. For example, it could be pumped into active oil wells to enhance oil recovery, or converted into a synthetic fuel, or used to carbonate bubbly beverages, etc.

Alister Doyle reported on a radical DAC experiment. Climeworks, a Swiss business, is developing a DAC facility in Iceland. Big fans suck in air, the $CO_2$ is removed, mixed with water to form a mild acid, and then pumped into basaltic rock that is 2,600 to 6,500 feet (800 to 2,000 meters) below ground. Two years later, 95 percent of what was $CO_2$ is petrified, turned to stone, where it will safely remain for millions of years. The basaltic formations suitable for these operations are only found under about 5 percent of the world's dry land, but more are available underwater.

This is an energy-intensive process, and Iceland was chosen because it produces cheap and abundant zero carbon geothermal energy. In 2020, there were 15 DAC plants in operation around the world, capturing more than 9,000 tons of $CO_2$ per year, which was "the equivalent of the annual emissions of just 600 Americans, each producing about 15 tonnes of climate-changing pollution."

Robert Hunziker wrote about a DAC plant in the southwest U.S. that will begin operation in 2024. Powered by natural gas, it will capture one million tons of $CO_2$ per year. Meanwhile, worldwide human activities are emitting 4.2 million tons every hour. In this plant, air is sucked in, $CO_2$ is extracted by a chemical solution (like potassium hydroxide), more chemicals then transform it into pellets of 50 percent $CO_2$, the pellets are heated to 900°C, producing a gas that can be stored underground forever.

By building a global system of 100 million of these processing units (as soon as possible), enough $CO_2$ could be extracted from the air to keep up with global emissions (but not the carbon already in the atmosphere). Extraction could be done at the bargain price of $330 to $800 per ton.

Vaclav Smil was not a fan: "The enormous scale and cost of material and energy demands make it impossible to resort to direct air capture as a decisive component of rapid global decarbonization."

DAC is not used for high concentration point source emissions, like those from the worlds many cement factories, or biomass power plants. These operations can use Carbon Capture and Storage (CCS) systems.

## Carbon Capture and Storage (CCS)

Jorgen Randers believed that the excess carbon in the atmosphere could be successfully extracted by building 33,000 large Carbon Capture and Storage (CCS) plants, and keeping them running forever. Permanently storing huge amounts of a gaseous compound is far more challenging than storing gold or diamonds. Also challenging is finding enormous amounts of money to build 33,000 plants.

CCS was a super-delicious fantasy. We could keep burning nonrenewable fossil energy, remove the carbon from the smoke, and avoid the dreadful need to sharply cut other forms of carbon emissions. Not one coal plant got a CCS system. It was too expensive, and it was not mandatory.

Carbon Dioxide Removal (CDR).

CDR is also intended to remove $CO_2$ from the atmosphere. It uses different methods than DAC. Plant more trees. Encourage agriculture to sequester more carbon in the soil. Restore wetlands. Spread nutrients on the ocean surface to stimulate blooms of phytoplankton (tiny plants) to increase their intake of $CO_2$. One study found that oceanic phytoplankton declined about 40 percent between 1950 and 2008. The prime suspect is rising surface temperatures.

Geoengineering (Climate Engineering)

Geoengineering is a word used to describe large scale interventions like SRM and CDR. If one or both turn out to be miraculously successful, humans could, in their wildest dreams, continue burning fossil energy, and living like there's no tomorrow. In reality, neither is a proven success, nor cheap, easy, or sustainable. Both ideas make lots of people nervous, for a wide variety of intelligent reasons, including expense. Unintended consequences are guaranteed.

## Climate Confusion

Climate change is an idea that makes many people sweat and squirm. Poorly informed folks say it's a hoax spread by lunatics. Religious folks might have faith that climate change is God's will. Other folks, who pay close attention to the news, perceive that climate trends have obviously swerved into spooky new patterns that potentially endanger the status quo for everyone everywhere.

Folks who believe that climate change is real and important tend to be divided into two groups. (1) Techno-optimists feel confident that the threat of climate change can and will be resolved via human brilliance. (2) Techno-skeptics perceive that the danger is powerful, intensifying, overwhelming, and destined to destabilize life as we know it.

On the center stage of mainstream discussion, the spotlights are usually kept shining on the optimists. They celebrate the miracles of new technology that will eliminate climate change, and steer us into the fast lane to utopia. Everything is under control. Our prosperous way of life is safe and sound.

Samuel Alexander added that the "techno-fix" approach is politically and socially palatable. "It provides governments, businesses, and individuals with a means of responding to environmental problems (or appearing to) without actually confronting the underlying issues."

The rich and powerful want to keep it on life support. Indeed, the climate catastrophe could be monstrously profitable — many trillions of dollars' worth of electric vehicles, solar panels, wind turbines, lithium mines, power grid infrastructure, and on and on.

Wackernagel & Rees neatly summed up the clumsy predicament: "The politically acceptable is ecologically disastrous while the ecologically necessary is politically impossible."

Big Mama Nature is not amused. She doesn't care what we believe. This is her circus, we are her monkeys, and Mama is pissed! We're monkeying around with extremely destructive games, while screeching and chattering. Life is but a dream!

## Secret Weapons

Joseph Goebbels, the Nazi Propaganda Minister, brilliantly convinced war weary Germans that they'd soon be saved by an amazing technological miracle. The human mind has a spooky ability to develop a powerful blind faith in almost any idea, no matter how goofy. Literally, nothing is unbelievable.

Albert Speer was in Hitler's inner circle. In March 1945, German defeat was inevitable. In the final weeks, Hitler revealed his brilliant plan to the German people. What seemed to be a rapidly approaching brutal defeat was actually a cunning trap! He was luring the enemy armies into an ambush where they would soon be obliterated by a new and terribly powerful secret weapon!

Just days before the fall of Berlin, Speer made a visit to the western front. While German cities were smoldering heaps of rubble, rural folks enjoyed a hopeful blind faith in the secret weapon nonsense, and were eagerly awaiting a glorious victory. Speer was surprised that many top-level Nazis also believed this.

Ghost Dance

By 1889, the once vast herds of bison on the U.S. plains had nearly been driven to extinction. To the native people, this

monstrous tragedy felt like the end of the world. Lame Deer, a Lakota medicine man, described the Ghost Dance movement, a desperate effort to conjure a powerful act of spiritual healing.

Dancing would roll up the all the crud of the white man's world, like a dirty carpet. This would uncover once again "the flowering prairie, unspoiled, with its herds of buffalo and antelope, its clouds of birds, belonging to everyone, enjoyed by all."

The Ghost Dance movement spread from tribe to tribe. Dancers were not allowed to have things from the white world: liquor, guns, knives, kettles, or metal ornaments. They would dance for four days. Whites feared an armed uprising, so they attacked the dancers. During the Wounded Knee massacre, 153 Lakota people were exterminated.

Electric Car Dance

Today, drivers concerned about climate change are being persuaded to abandon their old-fashioned petroleum powered machines, and acquire one of the new and luxurious electric powered wheelchairs. Marketing wizards assure us that the batteries in these wheelchairs will someday be charged with "clean green" electricity produced by solar panels, wind turbines, and other cool gizmos. Currently, the primary source of energy used to generate electricity for charging stations is fossil fuel, often natural

gas.

The motorized wheelchair fad began a few years before my father was born in 1913. Ford was an early leader. In the previous 300,000 years, humans primarily got around on foot — a cheap, healthy, practical, and climate friendly mode of transportation.

Newborn infants squirt out of the womb with two astonishing miracles at the ends of their legs. These happy feet allow us to wander through forests, prairies, deserts, wetlands, and mountains. They propel us while swimming and dancing, and they're quite useful for kicking and stomping troublesome annoyances.

Happy Thoughts

In the Peter Pan story, Tinker Bell is the fluttering fairy of magical thinking: "Just think a happy thought and you can fly!" We're so lucky to live in a golden age of happy news! Scroll your phone. Read the paper. Turn on the radio or TV. It's not hard to find somewhat optimistic climate change news.

The core message assures us that we have a plan, and we're making significant advances on important goals. Some issues are more challenging, and will take additional time. Climate change is a complicated rascal, but we know what we're doing. Everything is under control. It's not too late. Relax!

For example, Wikipedia's 100% Renewable Energy page reported: "Recent studies show that a global transition to 100% renewable energy across all sectors — power, heat, transport, and desalination well before 2050 is feasible… worldwide at low cost."

Elsewhere, eco-warrior Bill McKibben wrote that "we have the technology necessary to rapidly ditch fossil fuels."

On the other hand, many educators deliberately limit what they tell their students, to avoid souring their precious innocence (don't scare the children!). News organizations often limit coverage of unpleasant stories that could disturb their audience and/or advertisers. Politicians who promise quick and easy solutions win more votes.

Rupert Read wrote, "Environmentalists are often accused of being doom-mongers… I think that almost all environmentalists incline in fact to a Polyanna-ish stance of undue optimism."

Kevin Anderson noted that this undue optimism was the product of something like a conspiracy theory. "Half of global emissions come from just ten percent of the population. The top one percent are responsible for twice the amount of carbon as the bottom half of the world's population. The inequality in who is causing emissions is obscene." "We're heading for collapse of modern society, and the collapse of most of our emblematic ecosystems."

At the same time, this elite one percent is primarily responsible for framing the global discussion on climate change. They are especially interested in perpetual economic growth, boosting their personal wealth, and keeping business as usual in the fast lane for as long as possible, by any means necessary.

The status quo is catastrophically unsustainable, and it's essentially out of control. We're not going to quit driving, flying, mining, and buying stuff from faraway places. Sharply reducing emissions would sharply disrupt business as usual. So would doing nothing, disregarding climate impacts, partying like there's no tomorrow, and letting nature clean up the bloody mess.

Feeling lucky? Flip a coin. Heads, you lose. Tails, you lose. If we see climate change as a fake creepy hoax, or a remote possibility, or a fixable booboo, it's easier to put it in the closet, and kick the can down the road. It's uncomfortable to frequently hear news that arouses concern that life as we know it is experiencing chest pains.

Green New Deal

The Green New Deal offers us a complicated wonderland of hopium, sweet dreams, fake news, and shameless marketing balderdash. Climate change gives us the heebie-jeebies, because it's obviously dangerous, there is no quick and easy cure, and there is powerful opposition to tossing consumer society into the compost bin. It's far less stressful to simply hope for miracles and see what happens.

Anyway, climate change sucks. It's largely caused by a mob of eight billion critters generating way too many carbon emissions. A primary source of carbon-rich pollution is the combustion of staggering amounts of fossil fuel.

S*hazaam!* The quick and easy solution is perfectly obvious! We just abandon our naughty addiction to dirty energy, and replace it with clean green renewable energy. Hooray! State of the art technology will allow us to painlessly glide into a beautiful green utopia that requires no significant lifestyle sacrifices.

In this great healing, solar panels, wind turbines, batteries, and electric motors play starring roles. The climate-saving magic word here is *decarbonize*. In a number of nations, this crusade has gradually been growing since 2018 or so. The main U.S. version of this movement is called the Green New Deal (GND).

The GND vision is to make radical, gargantuan, and super expensive changes around the entire world over the next 20 to 30 years. Ideally, every nation would eagerly cooperate, and this would allow humankind to gradually reduce the brutality of the beatings that Big Mama Nature receives every day. Then, miracles happen, and future generations maybe enjoy a smoother journey into the future. What could possibly go wrong?

Well, as noted earlier, ongoing $CO_2$ emissions are increasing, and they are accumulating in the atmosphere, where they will persist for thousands of years. John Gowdy concluded, "The effects of fossil fuel burning are irreversible on a time scale relevant to humans." We've started something we cannot stop.

In 2021, Seibert & Rees released a free report that provided a vigorous critique of the GND's shortcomings and fantasies. It's a competent intro, and it's fairly easy to read — "GND proponents are appallingly tolerant of the inexplicable."

Vaclav Smil is an energy theorist, the author of *How the World Really Works*, and 40 other books. He's a sharp critic of the GND's pipe dream of a full-scale transition from fossil energy to clean green renewable energy. He calls it science fiction. "Heavy doses of wishful thinking are commingled with a few solid facts."

Smil smirked at the GND's juicy promises. "Who could be against solutions that are both cheap and nearly instantly effective, that will create countless well-paying jobs, and ensure care-free futures for coming generations?" Many others agree with Smil's skepticism.

We talk about two categories of energy: nonrenewable (fossil), and renewable (wind, solar, etc.). Nate Hagens clarified this subject. Geese and oak trees are "renewable." Solar collectors and wind turbines are "rebuildable." They have a working lifespan of up to 20-30 years, at which point they must be periodically replaced, until the time when civilization rusts in peace. Their components are not designed to be recycled in an affordable and eco-friendly way. Many go to landfills. Some are considered to be toxic waste.

William Rees explained how our dreams of "solving" global warming have deep roots in magical thinking. Proposed "solutions" are compatible with perpetual economic growth and business as usual. All that's needed is a worldwide transition to "clean green renewable energy." We can pretend to save the world while mindlessly enjoying our cool toys until the lights go out. Yippee!

During its evolution, the GND mindset has been an intoxicating cornucopia of heartwarming utopian fantasies. We'd have 100% renewable energy by 2030. Decent jobs for everyone. Free college education. Single-payer healthcare. Adequate housing. Healthy affordable food. Public transportation and high-speed rail. Perpetual economic growth. And so on. (See Wikipedia's *Green New Deal* section.)

Great Acceleration

Readers with gray hair are acutely aware that they have spent their entire lives in a hurricane of explosive change. I was born in Michigan, and spent my first 18 years in West Bloomfield Township, a suburb of Detroit. In 1950, it was home to 8,720 people. In 2020, there were 65,888!

When my grandparents were born in the late 1800s, there were 1.3 billion people on Earth. When I was born in 1952, there were 2.6 billion humans. Today, just during my lifetime, the mob has more than tripled, zooming past eight billion. We continue growing like a voracious planet eating swarm.

In 2000, J. R. McNeill published *Something New Under the Sun*, a fascinating (and shocking) book on the environmental history of the twentieth century, when cultures blind drunk on gushers of cheap oil spurred a population explosion. In his 2014 book, *The Great Acceleration*, McNeill narrowed his focus to the catastrophic changes that have occurred since 1945.

This explosion was propelled by a fossil fuel bonfire that enabled industrial civilization to sharply increase food production. Look at

this mind-blowing graph [Here]. The curve of energy consumption closely corresponds with the curve of population growth.

William E. Rees, writing in 2023, noted a daunting factoid: "Half the fossil fuels ever consumed have been burned in just the past 30-35 years." (As much as 90% of it has been burned since the early 1940s).

Fossil energy is not renewable, and the remaining reserves are shrinking every day. Currently, this bonfire has propelled a turbulent joyride of titillating decadence. Humankind has far exceeded the planet's carrying capacity in countless ways.

Bill McGuire is a professor emeritus of Geophysical & Climate Hazards at University College London. He wrote *Hothouse Earth*, and was a contributor to the 2012 IPCC report. McGuire warned that "there is now no chance of dodging a grim future of perilous, all-pervasive, climate breakdown." In today's snowy regions, winters will be brief or go extinct, and summers will get toasty. We're gliding toward a world "that would be utterly alien to our grandparents."

The other night was a full moon. It stirred some powerful feelings. Once upon a time, that same moon shined down on the woolly mammoths. It made Neanderthals smile. It glowed upon our ancient tree-dwelling ancestors, and on the age of dinosaurs. It lit the night when there was no life on Earth. The moon remembers so much.

Global Energy

It's vital to comprehend the major limitations of renewable energy. The International Energy Agency (IEA) is an organization that

focuses on global energy consumption. Their 524-page World

Energy Outlook 2022 report revealed some daunting statistics.

First, a vocabulary lesson. "*Primary* energy consumption" measures total energy demand. "*Final* energy consumption" is a subset of primary — it's just the amount of energy consumed by end users, such as households, industry, and agriculture. It is the energy which reaches the final consumer's door and excludes that which is used by the energy sector itself.

With regard to global *final* energy consumption, 80% of it is provided by fossil energy, and 20% is provided by electricity — and about 95% of this electricity is currently generated with nonrenewable fossil energy. In addition to this, the GND plan also requires that the global fleet of cars, trucks, trains, etc., must be switched to "clean, green, carbon-free power." It can't.

Vaclav Smil warned us. "We are a fossil-fueled civilization whose technical and scientific advances, quality of life, and prosperity rest on the combustion of huge quantities of fossil carbon, and we cannot simply walk away from this critical determinant of our fortunes in a few decades, never mind years."

It’s absolutely impossible to radically decarbonize our current way of life because electricity can’t provide the power needed for many processes that are fundamental to life as we know it. The concrete, steel, and other essential components of solar panels, wind turbines, hydro dams, and electric vehicles cannot be made with electricity.

Alice Friedemann discussed critical shortcomings of the renewable energy fantasy. “All contraptions that produce electricity need high heat in their construction. They all need cement made at 2600°F (1426°C).” There is no known way to make cement with electricity.

Making steel for wind turbines requires 3100°F (1700°C). “Solar panels require 2700° to 3600°F (1500° to 2000°C) of heat to transform silicon dioxide into metallurgical grade silicon.” Nuke plants still on the drawing board, in theory, might be able to generate 1562°F (850°C), but this is not hot enough for making cement, steel, glass, and lots of other stuff.

Vaclav Smil agreed. Sharply cutting back, or ending, the use of fossil energy, would blindside our party. For example, he mentioned cement, steel, plastic, and ammonia. He calls them “the four material pillars of modern civilization.” The GND does not explain how the four could be produced solely with renewable electricity. They also don’t explain how trucking, shipping, rail transport, and flying could largely be carbon-free in a decade or so, if ever.

Smil reminded us that the large-scale production of highly potent synthetic ammonia fertilizer led to a dramatic increase in agricultural yields. More food could feed more mouths. Of the eight billion people alive in 2022, he estimated that the existence of 40 to 50 percent of them was only made possible by the bigger harvests enabled by ammonia fertilizer, a product made from natural gas (fossil energy).

The steel industry is dependent on coking coal and natural gas, and its emissions contribute substantial amounts of greenhouse gases. Smil wrote, “But steel is not the only major material responsible for a significant share of CO emissions: cement is much 2 less energy-intensive, but because its global output is nearly three times that of steel, its production is responsible for a very similar share of emitted carbon.”

Cement is made of limestone and clay. Concrete is made of cement, water, sand, and rock. Andrew Logan wrote, “After water, concrete is the most consumed material on Earth.” Making high-performance concrete requires heating calcium carbonate, a process that releases $CO_2$. Additional $CO_2$ is released by the kiln, which burns fossil fuel to generate a temperature of 2,700°F (1,482°C). This intense heat cannot be generated by using electricity.

Jonathan Watts noted that the four biggest causes of $CO_2$ emissions are coal, oil, gas, and concrete. He called concrete “the most destructive material on Earth.” Its global production has increased 25-fold since 1950.

Smil’s bottom line: “With current technologies, and for the foreseeable future, you simply cannot make cement, steel, plastic, or ammonia absent fossil fuels.” Fossil energy is essential for making potent fertilizer, manufacturing farm equipment, and operating the machines. It enables the processing, packaging, refrigeration, and distribution of the nutrients that keep countless folks on life support.

## Nonrenewable Mining

Fossil energy is essential for manufacturing wind turbines, solar panels, batteries, electric vehicles, pavement, power transmission grids, and on and on. All of them are made of materials extracted from the Earth. The mining, crushing, hauling, and smelting of mineral resources are extremely dependent on fossil powered technology.

Walter Youngquist mentioned an old geologist saying, “If it can’t be grown, it must be mined.” The GND dream seems to assume that the planet’s reserves of strategic minerals are essentially limitless — a cookie jar that never empties, no matter how fast we eat them, century after century.

The dream involves an extensive redesign, replacement, and expansion of most of the global infrastructure used for power generation, distribution, and consumption. The dream envisions that every nation on Earth, from the richest to poorest, will eagerly cooperate to complete the transition within

20 or 30 years. Seriously? What happens if poor countries can't afford new power infrastructure, and continue burning fossil energy?

Frik Els was thrilled by the GND optimism. He is the editor of Mining.com, a news source for the mining industry. He praised the efforts of frontline GND proponents Alexandria Ocasio-Cortez and Greta Thunberg, calling them "mining's unlikely heroines." Why? Because the GND would be a multi-trillion-dollar godsend for mining and manufacturing corporations, and their lucky stockholders.

Vaclav Smil provided an illuminating example. A typical lithium car battery weighs about 990 pounds (450 kg), and contains lithium, cobalt, nickel, copper, graphite, steel, aluminum, and plastics. To make just one battery, extracting those ingredients would require crushing and refining 40 tons of specific ores. To access and fetch those 40 tons of ore-bearing rock, 225 tons of worthless rock would first have to be moved out of the way. Folks, that's one battery for one car!

In 2021, Simon Michaux wrote a 1,000-page report for the Geological Survey of Finland, a government bureaucracy. It documented the results of a study done to determine if it was possible to replace fossil energy with electricity generated by renewable methods, on a global scale.

In 2019, the global transport fleet included about 1.41 billion cars, trucks, buses, and motorcycles, of which 1.39 billion used Internal Combustion Engine (ICE) technology. To shift the fleet to Electric Vehicle (EV) technology would require 1.39 billion batteries to store their electricity. Also, the world's gas stations would need to be replaced with charging stations that can deliver renewable energy.

As mentioned, making batteries requires enormous amounts of mineral resources. The Geological Survey of Finland wondered if there were adequate mineral resources on Earth to make 1.39 billion batteries for vehicles (282.6 million tons of batteries). Their study concluded: "No, not even close."

Batteries typically have a working lifespan of only 5 to 15 years. Michaux warns that current mining production, and existing mineral reserves, are insufficient to manufacture *even the first generation* of renewable technology. “What are the theoretical options for running industrial systems on renewable energy? The geologists can’t think of any.”

Christopher Ketchum noted that a full-scale U.S. transition to renewable energy technology would require a massive surge in the production of critical metals. Estimates predict that this could increase demand for them by 700% to 4,000%.

Alice Friedemann noted the heavy impacts associated with renewable energy. “Mining consumes 10% of world energy. Wind, solar, and all other electrical generating machines rely on fossil-fueled mining, manufacturing, and transportation every step of their life cycle.”

Jon Hurdle wrote about recycling solar panels. “Today, roughly 90 percent of panels in the U.S. that have lost their efficiency due to age, or that are defective, end up in landfills because that option costs a fraction of recycling them.”

Seibert & Rees noted that renewable energy devices have limited lifespans. Solar panels and wind turbines last an average of 15 to 30 years, DC inverters last 5 to 8 years, batteries last 5 to 15 years. Unfortunately, the materials used to create the highly complex physical infrastructure for the entire system are not made of magic fairy dust. Nor are the bodies, motors, and batteries of electric vehicles. They have their roots in strip mines, smelters, chemical plants, toxic waste dumps, oil refineries, and on and on.

Many tons of steel and concrete are needed to manufacture and install each wind turbine. To make a solar panel, you need stuff like cobalt, gallium, germanium, indium, manganese, tellu rium, titanium, and zinc. To create the computer hardware needed to operate the grids, you need to fetch stuff like platinum, rhenium, selenium, gold, strontium, tantalum, gallium, germanium, beryllium, yttrium, and pure silicon.

Another essential component of modern living in a world of eight

billion is extensive networks of well-maintained roads. Walter

Youngquist noted that in the U.S., there are more than 2 million miles of paved roads and highways. About 94% of these miles are asphalt — a material that is 90% crushed rock, and 10% bitumen (a sticky black byproduct of petroleum refining). "Asphalt is easy to put in place, and far less expensive in terms of energy expended and cost of materials than concrete."

In 2007, the American Concrete Pavement Association reported that about 500 million tons of asphalt are placed in the U.S. each year. Doing this consumed 1.45 billion gallons of diesel fuel (5.488 billion liters). Asphalt typically needs resurfacing every 8 to 10 years.

Concrete can last 30 to 40 years before resurfacing, and it's strong enough to better carry the weight of heavy loads. About 60% of U.S. interstate highway system pavement is concrete. Fossil energy is absolutely required for the production of asphalt and concrete. This energy is nonrenewable, and so is our way of life.

## Electric Supply & Demand

There are two flavors of electricity. Power plants generate alternating current (AC) electricity and feed it into the grid. AC is impossible to store — use it or lose it. But if AC is converted to direct current (DC) electricity, it can be stored in battery systems. Then, when demand increases, the stored DC power can be converted to AC, and fed back into the grid.

In a conventional power system, centralized plants generate the electricity and feed it into the grid for distribution — a hub and spoke design. Throughout every day, demand for power rises and falls. When demand rises, more power must quickly be fed to the grid. To do this, secondary generators are kept running on standby, providing a "spinning reserve."

Renewable energy systems are quite different. There is no central production plant with a spinning reserve backup. Generation is provided by a scattered network of solar panels and/or wind turbines. They are installed at sites likely to generate the most power, and these are often not located close to existing grids and energy consumers.

In addition to the normal daily ups and downs of end-user demand, power generation cannot be carefully managed. The challenge here is *intermittency*. Solar panels do nothing at night, or when heavy clouds move in, or when their collectors are covered with snow, dust, bird droppings, etc. Wind turbines take a nap when the breeze fades away, or when their blades are coated with ice. The strength of sunbeams and breezes is variable, uncontrollable, and often unpredictable.

Mitch Rolling noted, "In Minnesota, wind farms produced electricity only 34.67 percent of the time in 2016." Vaclav Smil wrote, "The best offshore wind turbines produce electricity 45% of the time, and photovoltaic panels 25% in ideal locations — while Germany's solar panels produce electricity only 12% of the time."

Wind and solar systems don't have a spinning reserve generator for backup. So, to reliably respond to surges in demand, surplus generation can be stored in batteries. When demand increases, stored power can be released to the grid.

Imagine living on the 60th floor of a skyscraper when the region's renewable energy production has been hobbled by intermittency for days or weeks, and the batteries are drained. No power, water, lights, elevators, etc. This challenge will increase as the grid transitions from fossil energy to renewable.

Vaclav Smil noted that existing energy storage systems have far less capacity than needed to maintain reliable power delivery. "It is still impossible to store electricity affordably in quantities sufficient to meet the demand of a medium-sized city (500,000) for only a week or two, or to supply a megacity (more than 10 million people) for just half a day."

Opposition

As mentioned earlier, many fundamental components of industrial civilization can only be produced with the high temperatures made possible by fossil energy (steel, concrete, solar panels, wind turbines etc.). Thus, current technology does not allow us to actually decarbonize the global economy, or even come close.

A number of U.S. counties and localities are creating rules to prohibit the construction of wind and/or solar installations. In 2023, 411 U.S. counties had established some restrictions on renewable energy installations. Rural folks don't want their countrysides blemished with unsightly power towers and access roads. Leave us alone!

Many folks who make money via the production and distribution of coal, oil, or natural gas products are not the slightest bit interested in decarbonizing the economy. Neither are those who make or sell gas stoves, furnaces, or water heaters.

In 2024, USA Today reported, "Local governments are banning new utility-scale wind and solar power faster than they're building it." New wind turbine projects have been banned in 23 counties of North Carolina, in all 120 counties of Kentucky, in all 8 counties of Connecticut, in all 14 counties of Vermont, and in 91 of Tennessee's 95 counties.

In 2024, a UN Report described a growing massive fake news industry. Fossil fuel companies are running "a massive mis- and disinformation campaign" so that countries will slow down the adoption of renewable energy and the speed with which they "transition away" from a carbon-intensive economy.

In 2024, The Guardian reported that "Climate change deniers make up nearly a quarter of US Congress." They include 100 members of the House of Representatives, and 23 senators. These Republicans deny the existence of human-caused climate change.

Poor nations can't afford to make costly investments in renewable energy, and wealthy nations are not eager to generously provide them with enormous financial assistance. At the same time, folks in wealthy nations aren't interested in radically simplifying their high impact lives.

There are 193 nations in the world. At international meetings, they proudly announce their optimistic goals for transitioning to renewable energy within several decades. Given that extended timeframe, it's tempting to assume that technological miracles, yet to be invented, will somehow save the day. Optimistic goals are easy to announce. Fulfilling them is another story.

Vaclav Smil noted that China and India are still expanding coal extraction and coal-fired power generation plants. In other regions, there is strong opposition to new rules that restrict the expansion of natural gas infrastructure. Coal mining communities don't want to shut down the mines. The petroleum industry remains hard at work.

In Iowa, the term "climate change" can sound like an obscene

demonic hoax. Chris Gloninger, a TV weather forecaster, foolishly spoke those two words during a live broadcast. Viewers exploded with rage. He got death threats, quit his job, and moved out of the state.

Overshoot

And now, dear reader, the plot of this word dance makes a sudden swerve into a dangerous lane. The soundtrack gets speedy screechy loud and scary. A vicious monster steps out of the shadows and into the spotlight. The audience screams. Alas, the actual planet smashing boogeyman is far more horrifying and powerful than climate change. Its name is *overshoot*, and it cannot be easily swept away with clever gizmos, optimistic hallucinations, or clueless indifference.

In an earlier chapter, I mentioned William Catton, the author of

Overshoot. He defined *carrying capacity* as "the maximum population of a given species which a particular habitat can support indefinitely." *Overshoot* is "the condition of having exceeded for the time being the permanent carrying capacity of the habitat." Today, humankind's tremendous impacts on the entire planet far exceed the limits. Way too many critters are living way too hard, we don't understand what we're doing, and we have no interest in stopping.

In his book *Collapse*, Jared Diamond wrote about the Viking colonization of Iceland, which is now "the most heavily damaged country in Europe." Since settlement in A.D. 870, most of the original trees and vegetation have been destroyed. Half of its soil has been moved into the ocean. Large areas that were green when the Vikings first landed are now "a lifeless brown desert without buildings, roads, or any current signs of people." The Vikings were low-tech amateurs, and climate was not a primary factor in this disaster.

Today, the rapidly growing mob of 8+ billion hungry horny primates is mindlessly beating the living crap out of the planet in countless ways. It's very important to understand that climate change is merely one component of overshoot, the huge whoop-ass monster we have conjured into existence.

William Rees explained that the impacts of overshoot include climate change, ocean acidification, freshwater depletion, mass extinctions, deforestation, plunging biodiversity, soil/land degradation, falling sperm counts, pollution of everything, etc. "Climate change is the best-known symptom of overshoot, but mainstream 'solutions' will actually accelerate climate disruption and worsen overshoot. The global economy will inevitably contract, and humanity will suffer a major population 'correction' in this century."

Seibert & Rees wrote, "Overshoot is a genuine existential threat. Climate change alone is capable of making large patches of Earth irreversibly uninhabitable for humans in this century and ultimately jeopardizing global civilization."

The safe and effective cure for overshoot is obvious, but the medicine is bitter. "We argue that the only viable response to overshoot is a managed contraction of the human enterprise until we arrive within the safely stable territory defined by ecological limits. This will entail many fewer people consuming far less energy and material resources than at present." Good luck with that! We're going to be served what we have unintentionally ordered.

At the same time, pronatalism is on the rise in some nations, where policies generate financial and social incentives that reward having and supporting children. Abortion and contraception are shameful. Declining birthrates are bad for the economy, and more dangerous than climate change.

Meanwhile, many talking heads are telling us exactly what we want to hear. We can relax and comfortably continue working and shopping. We just need to buy an electric car, become vegans, have one child or none, and enjoy a wonderful life. The magic verb that speeds our pilgrimage to eco-utopia is “decarbonize.” Clean green renewable energy will save the Earth.

William Rees disagrees. The last thing we need to do is shift the mining industry into high gear, and produce 1.39 billion batteries for the world’s transport fleet. We’ll also need a huge number of storage batteries to provide backup power for the world’s electric grids. Producing huge numbers of solar panels and wind turbines will require even more mining, smelting, manufacturing, and transport.

What this means is that the Green New Deal will actually intensify overshoot, as it radically modernizes power generation and distribution around the world. This upgrade will mainly be enjoyed by affluent folks, who are also the primary contributors to overshoot. Poor folks have lower impact lives, but they will suffer just as much or more from intensified overshoot.

The delusional fantasy is that almost everyone everywhere will enthusiastically cooperate in radical lifestyle simplification. Brilliant leaders will guide this transition in a way that allows the global economy to remain strong and growing. Well, I hereby officially predict that overshoot will not deliberately be escorted off the stage by an exciting mass awakening of human wisdom and compassion — or by incredibly brilliant technological miracles.

We live in a predicament, not a problem. Problems have solutions, predicaments have outcomes. Overshoot is a predicament, and it’s outcome is some sort of crash, according to Catton.

## Welcome to the Anthropocene

Scientists enjoy categorizing, ranking, and naming. In the realm of Earth history, they have broken the process down into a series of epochs — like the Pliocene, Pleistocene, Holocene, etc. In the mid-1970s, some folks began feeling a need to create a new epoch, the Anthropocene, an era when human activities generated substantial eco-impacts.

Science has not yet agreed on an official definition. Some say it started with the explosive impacts of the Great Acceleration, which began in 1945. Others say the Industrial Revolution (~1780). Others say the Neolithic Revolution, the dawn of agriculture and civilization, which began about 12,000 years ago.

Dan Flores believes that it began much earlier, during the late Pleistocene, as humans migrated out of Africa. When they arrived in new regions for the first time, megafauna species were hit hard, resulting in a series of extinctions. He wrote, "The Pleistocene extinctions, in other words, look very much like the first act of the

Anthropocene, the beginnings of what we now call the Sixth

Extinction."

These early ancestors were successful predators because they benefitted from technological advantages including spears, slings, blades, warm clothing, and fire. High-tech teams were able to kill powerful prey. Their high-tech advantages enabled humans to successfully colonize much of snow country — despite the fact that their lean and nearly hairless bodies were finetuned by evolution for tropical climates.

Close your eyes and imagine what northern Eurasia and the Americas would look like today if they had never been colonized by hominins — a vast, astonishing, Serengeti-like wild paradise of abundant life! Wow! Wild, free, happy… and perfectly healthy and sustainable! Imagine that!

When our ancestors first wandered in, snow country was home to a variety of huge animals that had enjoyed living there for a very, very long time — grazers, browsers, predators, and so on. A number of these species were originally from tropical regions of Africa and Asia, like the elephant, rhino, and sabertooth families. Over time, these tropical megafauna species gradually evolved traits that improved their ability to survive in the cooler climate, like warm coats of thick fur.

Snow monkeys (Japanese macaques) are interesting primates. Like our hominin ancestors, they originated in tropical Africa several million years ago. Over time, their ancestors wandered off into the outer world, and eventually migrated from Korea to Japan more than 300,000 years ago. Some now live in Japan's chilly regions, where snow might cover the ground for four months, in depths up to 10 feet (3 m), and temperatures can plunge to -4°F (-20°C).

Snow monkeys adapted to snow country via a long slow process of evolution. So now, when winter approaches, their thin summer fur automatically grows and thickens into luxurious warm coats. During the summer, they build up body fat by feasting at the warm season buffet. In winter months, they survive on stored body fat, and rough foods like leaves and bark. They huddle together to keep warm. They don't use fire. They've lived 300,000 years in Japan, and they're still alive today because humans have allowed them to continue existing.

Also around 300,000 years ago, *Homo sapiens* emerged in Africa. From there, we migrated out of the tropics, and eventually colonized most of the world, including regions having temperate or arctic climates. Instead of gradually evolving beneficial adaptations like the snow monkeys did, our clever technology boosted our ability to keep warm and survive in chilly places.

In modern cultures, a belief in human supremacy is the norm. Our limitless brilliance is the mother of infinite miracles. We'll easily fix climate change, save the world, colonize Mars, and enjoy endless love, peace, and happiness! The notion of Anthropocene has an aroma of human vanity. We are the most powerful and important critters on Earth!

Welcome to the Pyrocene

The four primordial elements are earth, water, air, and fire. Fire has existed on the planet for more than 400 million years, long before the dinosaurs. It will continue burning long after the human circus moves off the stage, as long as there is fuel, oxygen, and spark.

One mind-altering day, my brain crashed into the work of Stephen

Pyne, the author of more than 30 books about fire, and one of the world's foremost experts on fire history. He described an extremely crucial turning point in Big History: the domestication of fire. The earliest evidence of this has been found in South Africa, inside Swartkrans Cave. It dates to about two million years ago, long before the emergence of *Homo sapiens*. The two primary suspects are *Homo erectus*, or an earlier australopithecine hominin. Did we drive these predecessors off the stage?

Much later, *Homo sapiens* inherited the knowledge of fire making, and this ability eventually enabled us to become the dominant species on Earth, and the planet thrashing demolition team of today.

Greek mythology includes the story of Prometheus, a sassy man who stole fire from the god Zeus and gave it to humans. Stories say that he was the inventor of the fire drill, the tool for kindling flame. He boldly violated forbidden limits, and the gods severely punished him. His theft initiated the dawn of human misery.

As discussed earlier (see Mother Africa), the domestication of fire began in the same general timeframe as a wave of megafauna extinctions in Africa. Was this a coincidence? Peter Ungar noted, "…the sudden appearance of large concentrations of artifacts and animal remains around two million years ago surely signals a change in the role of hominins in their world.

Our ancestors had grabbed a place at the dinner table with the large carnivores. Hominins were eating antelopes, hippos, horses, giraffes, and elephants. Stone tools gave hominins better access to meat and marrow.

Pyne thinks that the Anthropocene idea is too limited. It is rooted in the emergence of agriculture and civilization. But the primary event that made these changes possible was the domestication of fire. So, instead of the narrower time window of the Anthropocene, he recommends the creation of a broader epoch called the *Pyrocene* (pyro means fire). It would include the events of the Anthropocene. The Pyrocene would close the curtains on the ancient Ice Age, and conjure into existence a new and turbulent Fire Age.

Pyne described three categories of fire.

First fire is natural, sparked into flame by lightning, volcanoes, etc. Its fuel is wood and vegetation. This fire has existed for 400 million years.

Second fire is anthropogenic, ignited by hominins. It enabled agriculture, civilization, early industry, soil destruction, deforestation, and the massive expansion of human inhabited regions. Its fuel is wood and vegetation. Third fire ripped open the trap door to hell. Growth of the industrial era eventually required far more fuel than firewood could provide. The heartbreaking mistake was to introduce the fire breathing monster to fossil hydrocarbons (coal, oil, gas). Suddenly, humankind had access to a million times more energy dense combustible fuels. Shit! Trouble ahead!

Carbon Cycle

NOAA calls carbon "the chemical backbone of life on Earth. Carbon compounds influence the Earth's temperature, make up the food that sustains us, and provide energy that fuels the global economy."

Carbon is an element that exists in the atmosphere, oceans, living organisms, rocks, soils, sediments, fossil fuel reservoirs, etc. This is called the *carbon pool*. The pool is a magic act that allows the flow of carbon throughout the ecosystem, which is vital to the survival of the family of life. The pool includes both *carbon sources* and *carbon sinks*.

A carbon source emits more carbon than it absorbs. Major sources include the burning of coal, oil, and gas, and the emissions from making concrete.

A carbon sink absorbs more carbon than it releases. For example, a forest is a carbon sink, and it absorbs and stores carbon as it lives and grows. The two primary sinks in the global carbon cycle are the land and the water.

The atmosphere is neither a source nor sink. It constantly absorbs carbon emissions, and it's constantly a source of carbon for plant life to absorb. In the atmosphere, carbon is allowed to pass back and forth between sources and sinks — something like a train station, an ongoing flow of in and out.

Prior to the industrial era, the carbon load in the atmosphere was a relatively stable closed loop — the volume of incoming carbon from sources was similar to the volume of outgoing carbon absorbed by sinks.

Today, that stable closed loop is long gone. When fossil energy is burned, CO is released into the atmosphere. From there, the 2

water sink absorbs some of it, and so does the land sink. Unfortunately, these two sinks cannot absorb CO as quickly as it's 2 now being emitted, so the growing surplus accumulates in the

atmosphere. Here is a chart that displays the explosive growth of global CO emissions from 1900 to 2020. Note that what the land 2

and ocean sinks can't absorb builds up in the atmosphere.

With the fantastically tragic mistake of industrialization, humankind unleashed a planet roasting monster that is raging against the vitality of life on Earth — a furious roaring bonfire of fossil carbon. This monster had been safely and harmlessly sleeping underground for millions of years. Unfortunately, some goofy smarty pants could not leave it alone, and all hell broke loose. Big Mama Nature screamed!

The normal and natural balancing act of atmospheric carbon got slammed. In 1850, the atmosphere contained 280 ppm of $CO_2$ (parts per million). In 2024 it's up to 426 ppm and growing. Consequently, the CO content of the atmosphere is now higher than 2

at any time in the last 3.6 million years, and its volume is skyrocketing now. The planet's climate is going batshit crazy, and the worst is yet to come. Ooops!

Global CO2 Emissions is a chart showing carbon emissions from 1800 to 2006. The four nations that emit the most carbon are highlighted. Note the enormous surge of carbon emissions since 1930!

As we burn fossil energy day after day, year after year, faster and faster, enormous amounts of ancient carbon are released into the atmosphere, where it constantly accumulates, clobbers climate stability, and generates heat waves, droughts, catastrophic floods, monstrous storms, and huge wildfires. Earth is getting hotter and hotter. Thawing permafrost is releasing huge amounts of methane. Glaciers are shrinking, sea levels are rising, the family of life is getting brutally bludgeoned. Circle what is wrong in this picture.

If humankind suddenly went extinct next week, the permafrost would continue thawing, releasing additional methane, trapping more heat, and further boosting the temperature of the atmosphere and oceans. And every day we keep burning like crazy. The pyromania genie cannot be put back into the bottle. Sorry kids!

## Helter Skelter

Stephen Pyne has spent a lifetime thinking about fire. Without the ability to use fire as a powerful tool, humans could have never migrated out of tropical Africa, and colonized the outer world.

When human pioneers eventually reached the Fertile Crescent in the Middle East, they discovered plant and animal species that were especially ideal for domestication. This region became known as the Cradle of Civilization. Its development enabled us to accelerate our long and painful march to the staggering eco-horrors of today.

Pyne is especially concerned about industrial fire. Its combustion of fossil fuel results in carbon emission levels that are turbocharging an angry swarm of catastrophes. "Our ecological effects have had the impact of a slow collision with an asteroid… together we have so reworked the planet that we now have remade biotas, begun melting most of the relic ice, turned the atmosphere into a crock pot, and the oceans into acid vats."

Fire made us the unusual creatures we have become. Our colonization of the world was like a spreading human wildfire that expanded across unspoiled wildernesses in search of fuel. We enjoyed feasting on megafauna until they became scarce, at which point we advanced into new regions. Over time, hungry humans ran out of unoccupied territory to expand into. Oh-oh!

Groups had to revise their menus to include different food sources. Aggressive groups could attempt to smash their way into territories inhabited by other groups. As the millennia passed, and populations grew, friction between groups increased and spilled blood became more common.

Weaker groups were more likely to be swept aside. For example, of all the surviving wild cultures, the San people have the oldest DNA. Their time-proven way of life was incredibly sustainable. Their original homeland territory was vast, but over time, farmers and herders eventually snatched most of it away, forcing the San to retreat to the harsh Kalahari Desert. By the 1970s, their traditional way of life had taken a serious beating.

Alfred Crosby summed up a bedrock lesson of history: "Winning streaks are rarely permanent." Like the traditional San people, most of the countless wild cultures that once existed sooner or later got blindsided by stuff like disease, colonization, capitalism, genocide, urbanization, and so on. The wild cultures that still survive are not safe and secure. Uninvited intruders from the outer world rarely enjoy a warm and fuzzy reputation for being kind and caring ladies and gentlemen.

Meanwhile, in the fast lane, the human wildfire learned how to paddle down rivers, sail across oceans, roll on railways, drive across continents, fly through the clouds, zoom to the moon, vaporize cities, produce enough food to feed billions, blindside a stable climate, exterminate vast forests, and turn Earth into a loony bin for hordes of lost and confused primates.

Big History is a million-page catalog of countless bloody dog-eat-dog conflicts between tribes, nations, religions, and empires. The strongest usually triumphed over the weakest, because the weak had no right to what they could not defend. But those who remained in the fast lane were still vulnerable to getting blindsided by brutal surprises.

Sadly, glowing screens and motor vehicles are more precious than wooly mammoths or healthy planets. The wizards of progress are guiding us toward a future of unimaginable prosperity, decarbonized energy, and tremendous achievements in family planning. Everyone will eagerly cooperate. Really? Well, if you believe it, it's true!

Animal in the Mirror

Pyne noted, "Without fire humanity sinks to a status of near helplessness, a plump chimp with a scraping stone and digging stick, hiding from the night's terrors, crowding into minor biotic niches." In other words, an ordinary wild animal.

Since Neanderthals disappeared from the stage, our closest living relatives are now the chimps and bonobos, with whom we share up to 99 percent of our genes. They have lived in the same forests, in the same way, for several million years, without degrading their ecosystem, starting a fire, or fooling around with tools fancier than sticks or stones. They luckily benefit from their isolation, and the fact that their traditional habitat does not contain valuable resources that are tempting to greed monsters from outer space.

In his book *Grandfather*, Tom Brown shared a beautiful story he heard from his mentor Stalking Wolf, a traditional Apache from desert country, who traveled widely over the years, from the Amazon to Alaska, living off the land, and learning from it. One time, while in Alaska as winter approached, he frantically had to stock up on food and firewood for the coming months.

A bit later, when the snows arrived, he became fascinated by the ptarmigans, birds that survived in the frigid climate by their wits alone, sleeping in cozy snowdrifts. They belonged in this arctic land, like the lizards belonged in Death Valley. Lizards could not survive in Alaska, and ptarmigans could not survive on the desert.

With the use of specialized tools, our species could survive almost anywhere. But Grandfather felt uncomfortable because humans without fire and tools can only survive in special ecosystems. He deeply wanted to genuinely belong somewhere, like the ptarmigans and lizards. Over the passage of time, their way of life had become fine-tuned for surviving in the ecosystems they inhabited.

Dear reader, this is a tremendously important point. Animals that are wild, free, and happy are perfectly at home in the wild ecosystems they inhabit. Like squirrels in an oak forest, they live where they belong, and remain intimately attuned to their habitat.

Our hominin ancestors fanned out across the planet, and eventually generated assorted impacts, including numerous extinctions. Today, most of the mob of eight billion no longer lives and thinks like healthy wild animals. A number of cultures have developed worldviews and lifestyles that are self destructively unclever, and ferociously brutal to the family of life.

Jay Griffiths wrote that humans evolved as highly alert nomadic hunters and foragers. “We were made to walk through our lives wildly awake.”

Modern lifestyles are often mind-numbing routines — the opposite of the freedom we so deeply need. When healthy wildness deteriorates into passive obedience, we become vulnerable to the burning pain of cage rage. Very often, the daily news seems to be a barrage of batshit crazy cage rage stories from a wheezing world.

Timothy Scott Bennett concluded that we modern consumers were born and raised in captivity, something like zoo animals, the opposite of free, wildly awake, and at one with the land.

Robin Wall Kimmerer is a Potawatomi biologist. One of the spirits in their tribal traditions is Windigo, a monstrous demon cursed with a voracious appetite. The more it eats, the hungrier it becomes. In the old days, Windigo was notorious for hunting too hard, and not sharing with others, leading to hunger times.

Later, uninvited pale faced invaders from outer space smashed into tribal lands. Native folks were stunned by their pathological foolishness. Around the world, colonists have now created countless Windigo whirlwinds of mining, deforestation, industrial agriculture, overhunting, and insatiable shopping.

Today, the hurricane of daily news from around the world shouts that the Windigo spirit has become a horrific global superpower. Billions of folks everywhere eagerly dream of having more, more, more. Even the superrich are maniacally grabbing and hoarding as much status glitter as possible. This is not the path to a balanced and healthy future.

The Future?

In the preceding pages, I have explored my core question: how did things get to be this way? Now what? Humankind is deep in overshoot, and zooming down the path to a treacherously exciting future without brakes or safety nets. My computer has a wonderful Undo function that can easily vaporize a sequence of mistakes. Nature does not. If you broke it, you bought it.

For folks who have more than a dozen working brain cells, the growing number of climate change reports and news stories are overwhelming. It's not a fake news hoax (unless you pretend it is). Indeed, folks who yank off their blinders can discover a nonstop firehose of heartbreaking stories about floods, furious storms, heat waves, droughts, crop failures, melting glaciers, massive wildfires, and on and on — week after week after week.

Our foolishly unclever culture, hobbled by limited understanding and foresight, has successfully conjured into existence a colossal whirlwind of bad juju. Eight billion consumers, with their famously big brains, are stampeding down the fast lane to a turbulent blind date with the rough justice of overshoot. How embarrassing!

## Fare Thee Well!

Dearest reader, congratulations! One way or another, you've arrived at the skanky rear end of this word dance. Pressure is visibly rising around the world, rivets are popping on the Titanic, and the global circus has become a freakshow of wildfires, climate catastrophes, conspiracy theories, religious fanaticism, cocky neofascism, merciless dog-eat-dog greed, berserk cage rage, pathological status seeking, fire-breathing patriarchy, and all-purpose bad craziness. Something seems to be out of balance. Like the old Chinese proverb warns, we are living in interesting times.

OK! I've said what I needed to say. I hope you've had some kind of meaningful experience with my literary monsterpiece. Now it's your move. Good luck! Do your best!

## An Innocent Booboo?

Finally, a weird idea. Kindling the first domestic fire by spinning a fire drill stick was not, in any way, an obvious thing for a wild African primate to do. The uncomfortable possibility is that maybe just one individual ancestor (a kid?) discovered it purely by accident, and it consequently unleashed two million years of change and catastrophe, and created the global horror show outside your window. Whoops! Undo! Undo! Undo! Shit!

# Bibliography

Aalen, Frederick H. A., *Man and the Landscape in Ireland*, Academic Press, London, 1978.

Adam of Bremen, *History of the Archbishops of Hamburg-Bremen*, 1075, Reprint, Columbia University Press, New York, 1959.

Alewell, Christine, et al., "Global phosphorus shortage will be aggravated by soil erosion," *Nature Communications*, 2020. [Link]

Alley, William M. and Rosemarie Alley, *Too Hot to Touch*, Cambridge University Press, New York, 2013. [Review]

Alroy, John. "A Multispecies Overkill Simulation of the End-Pleistocene Megafaunal Mass Extinction." *Science 292* (June 2001): 1893–96. [Link]

Anderson, Kevin, "The current state of the climate crisis," YouTube 2023. [Link]

Anderson, M. Kat, *Tending the Wild*, University of California Press, Berkeley, 2005. [Review]

Anderson, Rasmus Björn, *Norse Mythology*, 1875, Reprint, S. C. Griggs and Company, Chicago, 1884.

Andreassen, Karin, "Massive blow-out craters formed by hydrate-controlled methane expulsion from the Arctic seafloor," *Science*, June 2017. [Link]

Anonymous, "Mortality Of Abandoned Infants Before And After The Appearance Of Foundling Homes In The Thirteenth Century," *Pediatrics*, September 1990, 86 (3) A66; [Link]

Anthony, David W., *The Horse the Wheel and Language*, Princeton University Press, Princeton, 2007.

Anthony, Katey Walter, et al., "21st century modeled permafrost...," *Nature Communications*, August 15, 2018. [Link]

Araujo, Bernardo, et al., "Bigger kill than chill… (megafauna extinctions)," *Quaternary International*, November 2015. [Link] Ashworth, William, *The Late Great Lakes*, Wayne State University Press, Detroit, 1986.

Axtell, James, *The European and the Indian*, Oxford University Press, New York, 1981. [Review]

Bailes, Kendall E., *Environmental History*, University Press of America, New York, 1985.

Bailey, James A., *American Plains Bison*, Farcountry Press, Helena, Montana, 2014. [Link]

Bain, Marc, "If your clothes aren't already made out of plastic, they will be," *Quartz* (qz.com), 5 June 2015.

Barnes, Julia, *Bright Green Lies*, Oceanic Productions, 2021. [Link]

Bartlett, Albert, *The Essential Exponential!*, Center for Science, Mathematics & Computer Education, University of Nebraska, Lincoln, 2004. Also: [Link] [Review]

Basalla, George, *The Evolution of Technology*, Cambridge University Press, New York, 1988. [Review]

Basso, Keith H., *Wisdom Sits in Places*, University of New Mexico Press, Albuquerque, 1996. [Review]

Bazilchuk, Nancy, "Giant gas craters discovered at the bottom of the Barents Sea," sciencenorway.no, October 5, 2018. [Link]

BBC Newsround, "What are 'zombie fires' and why is the Arctic Circle on fire?" May 20, 2021. [Link]

BBC, *Bonobo: Missing in Action*, 2006 (Rebroadcast by NOVA as "The Last Great Ape" in 2007).

BBC, *Conquest of the Parasites*, Films Media Group, New York, 1984.

Beckwith, Christopher, *Empires of the Silk Road*, Princeton University Press, Princeton, 2009.

Bendell, Jem, *Breaking Together*, Good Works, Bristol U.K., 2023.

Bennett, Timothy Scott, *What a Way to Go* (video), 2007. [Link]

Bennett, Wendell C., and Robert M. Zingg, *The Tarahumara: An Indian Tribe of Northern Mexico*, 1935, Reprint, The Rio Grand Press, Glorieta, New Mexico, 1976.

Bernays, Edward, *Propaganda*, Horace Liveright, New York, 1928.

Blumenthal, Max, "'Green' billionaires behind professional activist network that led suppression of 'Planet of the Humans' documentary," *The Gray Zone*, September 7, 2020. [Link]

Blythe, Ronald, *Akenfield: Portrait of an English Village*, 1969, Reprint, Akadine Press, Pleasantville, New York, 2000.

Boehm, Christopher, *Hierarchy in the Forest*, Harvard University Press, Cambridge, 1999. [Review]

Bolster, W. Jeffrey, The *Mortal Sea*, Belknap Press, Cambridge, Massachusetts, 2012. [Review]

Bourne, Joel K., *The End of Plenty: The Race to Feed A Crowded World*, W. W. Norton & Company, New York, 2015. [Review]

Brain, Charles Kimberlin, *Hunters or the Hunted?*, University of Chicago Press, Chicago, 1981.

Brazil, Mark, "How Dung Beetles Came to Save Australia," *The Japan Times*, May 3, 2001.

Bright, Michael, *Man-Eaters*, St. Martin's Paperbacks, New York,

2002.

Broadbent, Noel, *Lapps and Labyrinths*, Smithsonian Press, Washington, D.C., 2010. [Review]

Brody, Hugh, *The Other Side of Eden*, North Point Press, New York, 2001. [Review]

Brook, Barry W., and Christopher N. Johnson, “Selective hunting of juveniles as a cause of the imperceptible overkill…,” *Alcheringa*, Volume 30, 2006. [Link]

Brown, Lester R., *State of the World 1990,* W. W. Norton & Company, New York, 1990.

Brown, Tom, Jr., *Grandfather*, Berkley Books, New York, 1993.

Brown, Tom, Jr., *The Tracker*, Berkley Publishing Group, New York, 1979. [Review]

Brown, Tom, Jr., *The Vision*, Berkley Books, New York, 1988. Brown, Tom, Jr., *Tom Brown’s Field Guide to Wilderness Survival*, Berkley Books, New York, 1983.

Bruns, H. Arnold, “Southern Corn Leaf Blight,” *Agronomy Journal*, Vol. 109, Issue 4, 2017.

Burney, David A. and Tim Flannery, “Fifty millennia of catastrophic extinctions after human contact,” *Trends in Ecology and Evolution*, Vol. 20, No. 7, July 2005. [Link]

Caesar, Julius, *The Gallic Wars*, London MacMillan, London, 1908. Translated by Thomas Rice Holmes. [Review] [Link]

Calma, Justine, "Extreme drought could cost California half its hydroelectric power this summer," *The Verge*, June 1, 2022. [Link]

Cambrensis, Giraldus, *Topography of Ireland*, George Bell & Sons, London, 1905. [Review] [Link]

Carbon Cycle, National Oceanic and Atmospheric Administration, 2019 [Link]

Carrington, Damian, "Plummeting Insect Numbers Threaten Collapse of Nature," *The Guardian*, February 10, 2019.

Cartier, Kimberly M. S., "Climate Change Uproots Global Agriculture," *Eos*, January 25, 2021. [Link]

Catlin, George, *Letters and notes…*, 2 vols, Dover Publications, New York, 1973.

Catton, William R., *Bottleneck*, Xlibris Corporation, USA, 2009.

Catton, William R., "Malthus: More Relevant Than Ever," *NPG Forum*, August 1998. [Link]

Catton, William R., *Overshoot*, University of Illinois Press, Urbana, 1980. [Review]

Chagnon, Napoleon A., *Yanomamö*, Holt, Rinehart, and Winston, New York, 1968.

Chappell, Sally A. Kitt, *Cahokia: Mirror of the Cosmos*, University of Chicago Press, Chicago, 2002.

Chatwin, Bruce, *The Songlines*, Penguin Books, New York, 1987. Cheney, Dorothy L., and Robert M. Seyfarth, *Baboon Metaphysics*, University of Chicago Press, Chicago, 2007. [Review]

Childs, Craig, *Apocalyptic Planet*, Pantheon Books, New York, 2012. [Review]

Clugston, Christopher O., *Scarcity: Humanity's Final Chapter?*, Booklocker.com, Port Charlotte, Florida, 2012. [Review]

Cohen, Mark Nathan, *Health & the Rise of Civilization*, Yale University Press, New Haven, 1989. [Review]

Cohen, Mark Nathan, *The Food Crisis in Prehistory*, Yale University Press, New Haven, 1977. [Review]

Colapinto, John, "The Interpreter," (Dan Everett), *The New Yorker*, April 16, 2007. [Link]

Collier, Richard, *The Plague of the Spanish Lady*, Atheneum, New York, 1974. [Review]

Connolly, Bob and Robin Anderson, *First Contact: New Guinea's Highlanders Encounter the Outside World*, Penguin Books, New York, 1987.

Coolidge, Frederick L., and Thomas Wynn, *The Rise of Homo Sapiens*, Wiley-Blackwell, Chichester, U.K., 2009. [Review]

Coon, Carleton S., *The Hunting Peoples*, Little, Brown and Company, Boston, 1971.

Cotlow, Lewis, *In Search of the Primitive*, Little, Brown, and Company, Boston, 1966.

Crawford, John, "What If the World's Soil Runs Out?," *Time*, 14 December, 2012. [Link]

Cribb, Julian, *Surviving the 21st Century*, Springer, Switzerland, 2017. [Link]

Cribb, Julian, *The Coming Famine*, University of California Press, Berkeley, 2010. [Review]

Cronon, William, *Changes in the Land*, Hill and Wang, New York, 1983. [Review]

Crosby, Alfred W., *Children of the Sun*, W. W. Norton & Company, New York, 2006. [Review]

Crosby, Alfred W., *Ecological Imperialism*, Cambridge University Press, Cambridge, U.K., 1986.

Crosby, Alfred W., *Germs, Seeds, and Animals*, M. E. Sharpe, Armonk, New York, 1994. [Review]

Crosby, Alfred W., *Throwing Fire*, Cambridge University Press, New York, 2010. [Review]

Cunliffe, Barry, *By Steppe, Desert, and Ocean*, Oxford University Press, New York, 2015.

Cunliffe, Barry, *Europe Between the Oceans*, Yale University Press, New Haven, 2008. [Review]

Cunliffe, Barry, *Wessex to A.D. 1000*, Longman, London, 1993.

Dale, Tom, and Vernon Gill Carter, *Topsoil and Civilization*, University of Oklahoma Press, Norman, 1955. [Review] [Link]

Darwin, Charles, *The Descent of Man*, Vol. 1, D. Appleton and Company, New York, 1871.

Dasmann, Raymond, *The Destruction of California*, MacMillan Company, New York, 1965. [Review]

Davis, Leslie B., and Brian O. K. Reeves, editors, *Hunters of the Recent Past*, Unwin Hyman, London, 1990. [Review]

Davis, Mike, *Late Victorian Holocausts*, Verso, New York, 2001. [Review]

Davis, Wade, "On Ecological Amnesia," *The Tyee*, November 8, 2018. [Link]

Defoe, Daniel, *A Journal of the Plague Year*, 1772, Reprint, J. M.

Dent & Sons, London, 1975.

Deloria, Vine, Jr., *Red Earth, White Lies*, Scribner, New York, 1995. [Review]

deMenocal, Peter B., "Climate and Human Evolution," *Science*, Vol 331, February 4, 2011, pp. 540-542.

Deur, Douglas & Nancy Turner, ed., *Keeping it Living*, University of Washington Press, 2005.

Devall, Bill, editor, *Clearcut*, Sierra Club Books, San Francisco, 1993.

Di Liberto, Tom, "Changes in ENSO impacts in a warming world," NOAA, Climate.gov, September 27, 2018. [Link]

Diamond, Jared, "Evolution, consequences and future of plant and animal domestication," *Nature*, 418, 700-707 (8 August 2002). [Link]

Diamond, Jared, "The Worst Mistake In The History Of The Human Race," *Discover*, May 1987, [Link] or [Link]

Diamond, Jared, *Collapse*, Viking, New York, 2005.

Diamond, Jared, *Guns, Germs, and Steel*, W. W. Norton & Company, New York, 1997. [Review]

Diamond, Jared, *The Third Chimpanzee*, Harper Collins, New York,

1992.

Diamond, Jared, *The World Until Yesterday*, Viking, New York, 2012.

Diaz, Natalie, "Manhattan is a Lenape Word," *NPR Weekend Edition*, March 1, 2020. [Link]

Dilworth, Craig, *Too Smart For Our Own Good*, Cambridge University Press, New York, 2010. [Review]

Dobak, William A., "Killing the Canadian Buffalo: 1821-1881," *Western Historical Quarterly*, Vol. 27, No. 1 (Spring, 1996), pp. 33-52.

Dorfman, Paul, "When climate breakdown goes nuclear," *Ecologist*, July 14, 2021. [Link]

Dotterweich, Markus, "The History of Human-Induced Soil Erosion," *Geomorphology*, 2013. [Link]

Doucleff, Michaeleen, "Anthrax Outbreak in Russia," *NPR Morning Edition*, August 3, 2016. [Link]

Dowd, Michael, "God: Personification ≠ Person," *Huffpost*, June 9, 2013. [Link]

Doyle, Alister, "Iceland is sucking carbon dioxide from the air and turning it into rock," *Thompson Reuters Foundation*, February 4, 2021. [Link]

Driver, Harold E., *Indians of North America*, University of Chicago Press, Chicago, 1961.

Dudman, Clare, "Interview With Daniel Everett," November 2008. [Link]

Duffy, Katharyn, et al, "How close are we to the temperature tipping point of the terrestrial biosphere?" *ScienceAdvances*, January 13, 2021. [Link]

Dutkiewicz, Stephanie, et al., "Impact of ocean acidification on the structure of future phytoplankton communities," *Nature Climate Change*, July 20, 2015. [Link]

Dyke, James, et al., "Climate scientists: concept of net zero is a dangerous trap," *The Conversation*, April 22, 2021. [Link]

Eamer, Claire, "No Wool, No Vikings," *Hakai Magazine*, February 23, 2016. [Link]

Earth Policy Institute, "Growing Goat Herds Signal Global Grassland Decline," *Grist*, June 21, 2011.

Edmeades, Baz, *Megafauna: First Victims of the Human-Caused Extinction*, Houndstooth Press, 2021. [Review]

Ehrenfeld, David, *The Arrogance of Humanism*, Oxford University Press, New York, 1978.

Ehrenreich, Barbara, *Bright-Sided*, Metropolitan Books, New York, 2009.

Ehrlich, Anne, and Paul Ehrlich, *Earth*, Franklin Watts, New York, 1987.

Ehrlich, Paul and Anne Ehrlich, "Returning to 'Normal'? Evolutionary Roots of the Human Prospect," *BioScience*, June 16, 2022. [Link]

Ehrlich, Paul, and Anne Ehrlich, *The Dominant Animal*, Island Press, Washington, 2008. [Review]

Ehrlich, Paul, and Anne Ehrlich, *The Population Explosion*, Simon and Schuster, New York, 1990. [Review]

Ehrlich, Paul, and John Harte, "Pessimism on the Food Front," *Sustainability*, MDPI, 9 April 2018. [Link]

Els, Frik, "Mining's unlikely heroines: Greta Thunberg and AOC," Mining[dot]Com, October 30, 2019. [Link]

*Epic of Gilgamesh* [Link]

Esty, Amos, "Investigating a Mega-Mystery," *American Scientist*, Sept-Oct 2005. [Link]

Everett, Daniel, "Seek Out Strangers," *The Chronicle for Higher Education*, April 30, 2017. [Link]

Everett, Daniel, "Wisdom from Strangers," TEDxPenn, June 15,

2017. [Link]

Everett, Daniel, *Don't Sleep: There are Snakes*, Pantheon Books, New York, 2008. [Review]

Fagan, Brian, *Cro-Magnon*, Bloomsbury Press, New York, 2010. [Review]

Fagan, Brian, *The Great Warming*, Bloomsbury Press, New York, 2008. [Review]

Fagan, Brian, *The Little Ice Age*, Basic Books, New York, 2000. [Review]

Fairlie, Simon, "A Short History of Enclosure in Britain," *The Land*, Summer 2009. [Link]

Fairlie, Simon, *Meat: A Benign Extravagance*, Chelsea Green, White River Junction, Vermont, 2010. [Review]

Farb, Peter, *Man's Rise to Civilization*, E. P. Dutton & Company, New York, 1968.

Farquharson, Louise, et al., "Climate Change Drives Widespread and Rapid Thermokarst Development in Very Cold Permafrost in the Canadian High Arctic," *Geophysical Research Letters*, June 10, 2019. [Link]

Fernandez, Fernando, "Human Dispersal and Late Quaternary

Megafaunal Extinctions…," *ResearchGate*, July 2016. [Link] (Readable & detailed)

Finlayson, Clive, *The Humans Who Went Extinct*, Oxford University Press, New York, 2009. [Review]

Finlayson, Clive, *The Smart Neanderthal*, Oxford University Press, Oxford, 2019. [Review]

Flannery, Tim, *Europe: A Natural History*, Atlantic Monthly Press, New York, 2019.

Flannery, Tim, "Megafauna Extinction," *The Science Show*, ABC Radio National, Sydney, September 8, 2001. [Link]

Flannery, Tim, *Here on Earth*, Atlantic Monthly Press, New York, 2010.

Flannery, Tim, *The Eternal Frontier*, Atlantic Monthly Press, New York, 2001.

Flannery, Tim, *The Future Eaters*, George Braziller, New York, 1995. [Review]

Flis, Andrej, "An unusual Ocean anomaly is being detected in the Gulf Stream…," *Severe Weather Europe*, February 14, 2021. [Link]

Flores, Dan, *American Serengeti*, University Press of Kansas, Lawrence, 2016. [Review]

Flores, Dan, *The Natural West*, University of Oklahoma Press, Norman, 2001. [Review]

Flores, Dan, *Wild New World*, W. W. Norton, New York, 2022. [Review]

Forbes, Jack D., *Columbus and Other Cannibals*, Seven Stories Press, New York, 2008. [Review]

Fox-Skelly, Jasmin, "What is the hottest temperature life can survive?" *BBC Earth*, February 10, 2016. [Link]

Frankel, Jeremy, "Crisis on the High Plains: The Loss of America's Largest Aquifer: the Ogallala," *University of Denver Water Law Review*, May 17, 2018. [Link]

Fraser, Evan D. G., and Andrew Rimas, *Empires of Food*, Free Press, New York, 2010.

Freuchen, Peter, *Arctic Adventure*, 1935, Reprint, Lyons Press, Guilford, Connecticut, 2002.

Freuchen, Peter, *Book of the Eskimos*, World Publishing Company, Cleveland, 1961. [Review]

Friedemann, Alice, *Life After Fossil Fuels*, Springer, Cham, Switzerland, 2021. [Review]

Funk, McKenzie, *Windfall: The Booming Business of Global Warming*, Penguin Press, New York, 2014. [Link]

Galdikas, Biruté Mary, *Born to Be Wild*, Warner Brothers Pictures, Burbank, California, 2011.

Gammage, Bill, *The Biggest Estate on Earth*, Allen & Unwin, Sydney, 2011. [Review]

Garrett, Laurie, *The Coming Plague*, Farrar, Straus and Giroux, New York, 1994.

Gesner, Conrad, *Historiae Animalium*, Christoffel Froschower, Zurich, 1602.

Ghosh, Amitav, *The Great Derangement*, University of Chicago Press, Chicago, 2016.

Ghosh, Sahana, "A drying Ganga could stall food security and prevent achieving SDGs," *Mongabay-India*, September 13, 2018. [Link]

Gibbs, Jeff, *Planet of the Humans*, Huron Mountain Films, 2019. [Link]

Giger, Peter, "Climate change will be sudden and cataclysmic. We need to act fast," *World Economic Forum*, January 19, 2021. [Link]

Global Monitoring Laboratory, "Basics of the Carbon Cycle and the Greenhouse Effect," [Link]

Godreche, Dominique, "The Amazon's Pirahã People's Secret to Happiness," *Indian Country Today*, June 25, 2012. [Link]

González-Arqueros, M. Lourdes, et al., "Human Impact on Natural Systems…," *Catena*, July 2018. [Link]

Gordon Anita, and David Suzuki, *It's a Matter of Survival*, Harvard University Press, Cambridge, 1991.

Gore, Albert, *The Future*, Random House, New York, 2013.

Gowdy, John, "Our hunter-gatherer future: Climate change, agriculture and uncivilization," *Science Direct*, Futures 115 (2020) 102488. [Link]

Graham, Russell, et al., "Timing and causes of mammoth extinction on St. Paul Island," *PNAS*, 16 August, 2016, vol. 113, no. 33. [Link]

Grammaticus, Saxo, *The First Nine Books of Danish History*, 1514, Reprint, David Nutt, London, 1894. [Link]

Gray, John, *Straw Dogs*, Granta Books, London, 2003. [Review]

Gray, Peter, "Play as a Foundation for Hunter-Gatherer Social Existence," *American Journal of Play*, Spring 2009, pp. 476-522.

[Link]

Gray, Richard, "The mystery of Siberia's exploding craters," *BBC*, November 30, 2020. [Link]

Greer, John Michael, "Waiting for the Millennium," *Archdruid Report Mirror*, June 2017. [Part 1] [Part 2]

Greer, John Michael, *The Long Descent*, New Society Publishers, Gabriola Island, BC, Canada, 2008.

Greger, Michael, M.D., *Bird Flu*, Lantern Books, New York, 2006. [Review]

Griffiths, Jay, *A Country Called Childhood (Kith)*, Counterpoint, Berkeley, 2014. [Review]

Griffiths, Jay, *Wild (Savage Grace)*, Jeremy P. Tarcher, New York, 2006. [Review]

Grimm, Jacob, *Teutonic Mythology*, 4 vols, 1883, reprint, Peter Smith, Gloucester, Massachusetts, 1976.

Guerber, Hélène Adeline, *Myths of Northern Lands*, American Book Company, New York, 1895.

Gundry, Steven R., *Dr. Gundry's Diet Evolution*, Crown Publishers, New York, 2008.

Gunther, John, *Inside Africa*, Harper & Brothers, New York, 1953.

Gunther, John, *Inside Europe*, Harper & Brothers, New York, 1938.

Gwynne, Samuel C., *Empire of the Summer Moon*, Scribner, New York, 2010.

Hagens, Nate, "Economics for the Future," *Ecological Economics*, 169 (2020) 106520. [Link]

Hagens, Nate, "No Matter Who Wins," 2 November, 2020. [Link]

Hagens, Nate, "Where are We Going?" *Resilience.org*, 8 May 2018. [Link]

Haller, Dorothy L., "Bastardy and Baby Farming in Victorian England," 1990. [Link]

Halweil, Brian, "The Irony of Climate," *World Watch*, March/April 2005. [Link]

Harari, Yuval Noah, *Sapiens*, Harper, New York, 2015. [Review]

Hardin, Garrett, *Living Within Limits*, Oxford University Press, New York, 1993. [Review]

Hardin, Garrett, *The Ostrich Factor*, Oxford University Press, New York, 1998. [Review]

Harner, Michael, "The Ecological Basis for Aztec Sacrifice," *American Ethnologist*, May 1976. [Link]

Harris, Marvin, *Cows, Pigs, Wars, and Witches*, 1974, Reprint, Vintage Books, New York, 1989.

Harrison, Robert Pogue, *Forests: The Shadow of Civilization*, University of Chicago Press, Chicago, 1992.

Hart, Donna, and Robert W. Sussman, *Man the Hunted*, Westview Press, New York, 2005. [Review]

Harvey, Graham, *The Forgiveness of Nature*, Random House, London, 2001. [Review]

Hatfield, Jerry L., and John H. Prueger, "Temperature Extremes: Effect on Plant Growth and Development," *Weather and Climate Extremes*, 10 (2015) 4-10. [Link]

Haukos, Jill, "The Tallgrass Prairie," Konza Environmental Education Program, Kansas State University, 2021. [Link]

Heinberg, Richard, *Afterburn*, New Society, Gabriola Island, B.C., 2015. [Review]

Heinberg, Richard, *Snake Oil*, Post Carbon Institute, Santa Rosa, California, 2013. [Review]

Heinberg, Richard, *The End of Growth*, New Society, Gabriola Island, B.C., 2011. [Review]

Heinberg, Richard, *The Food and Farming Transition*, Post Carbon Institute, Sebastopol, California, 2009. [Link]

Heinrich, Bernd, *Why We Run*, Harper Collins, New York, 2002.

Hendrick, Burton J. "The Mastery of Pellagra," *The World's Work: A History of Our Time*, XXXI: 633–639, April 1916.

Hillel, Daniel, *Out of the Earth*, University of California Press, Berkeley, 1991.

Hillman, James, and Michael Ventura, *We've Had a Hundred Years of Psychotherapy: And the World's Getting Worse*, Harper Collins, New York, 1992. [Review]

Hodges, Glenn, "America's Forgotten City," *National Geographic*, January 2010.

Hoebel, E. Adamson, *The Cheyennes: Indians of the Great Plains*, Holt Rinehart and Winston, New York, 2d ed., 1978.

Hoffman, D. L., et al., "U-Th dating of carbonate crusts reveals Neanderthal origin of Iberian cave art," *Science* 359: 912–15, February 23, 2018. [Link]

Hoh, Erling, "Red alert for Yellow River," *SF Gate*, 4 March 2002. [Link]

Holbrook, Stewart H., *Burning an Empire*, Macmillan Company, New York, 1945. [Review]

Hornaday, William Temple, *The Extermination of the American Bison*, Government Printing Office, Washington D.C., 1889. [Link]

Hornaday, William, *Our Vanishing Wildlife*, Charles Scribner's Sons, New York, 1913. [Link]

Hornaday, William, *The Extermination of the American Bison*, Government Printing Office, Washington, 1889.

Humphreys, Margaret, "Malaria in America," Snowden, Frank and Richard Bucala, eds., *The Global Challenge of Malaria*, World Scientific Publishing, Hackensack, New Jersey, 2014.

Hunziker, Robert, "Boundless Dying Trees," *Counterpunch*, September 29, 2020. [Link]

Hunziker, Robert, "Direct Air Capture and Big Oil," *Counterpunch*, March 12, 2021. [Link]

Hunziker, Robert, "Menacing Methane: An Analysis," *Counterpunch*, December 12, 2020. [Link]

Hurdle, Jon, "As Millions of Solar Panels Age Out, Recyclers Hope to Cash In," *Yale Environment 360,* February 28, 2023. [Link]

Ingerman, Sandra, *Soul Retrieval*, Harper, San Francisco, 1991.

International Energy Agency (IEA), "Key World Energy Statistics 2020." [Link]

International Energy Agency (IEA), "World Energy Outlook 2022: Key

Findings." [Link]

Iowa Association of Naturalists, *Iowa Soils*, Guthrie Center, Iowa, 1999.

Iverson, Peter, *The Navajos*, Chelsea House, New York, 1990.

Jackson, Wes, *New Roots for Agriculture*, 1980, Reprint, University of Nebraska Press, Lincoln, 1985. [Review]

Jamail, Dahr, *The End of Ice*, The New Press, New York, 2019. [Review]

Jarvis, Brooke, "The Insect Apocalypse is Here," *New York Times Magazine*, November 27, 2018. [Link]

Jensen, Derrick, Lierre Keith, and Max Wilbert, *Bright Green Lies*, Monkfish Publishing, Rhinebeck, New York, 2021. [Review]

Jensen, Derrick, *Listening to the Land*, Sierra Club Books, San Francisco, 1995.

Jensen, Derrick, *The Myth of Human Supremacy*, Seven Stories, New York, 2016. [Review]

Johnson, Doug, "Ecological impacts of solar geoengineering are highly uncertain," *Ars Technica*, April 11, 2021. [Link]

Johnson, Joni E., "Life on the Baby Farm: Killing kids for cash," *Psychology Today*, May 2013. [Link]

Johnson, Steven, *The Ghost Map*, Riverhead Books, New York, 2006. [Review]

Johnston, Basil, *Ojibway Heritage*, 1976, Reprint, University of Nebraska Press, Lincoln, 1990. [Review]

Jones, Nicola, "How Climate Change Could Jam the World's Ocean Circulation," *Yale Environment 360*, September 6, 2016. [Link]

Jordan, Paul, *Neanderthal*, Sutton Publishing, Stroud, Gloustershire, U.K., 1999.

Josephy, Alvin M., *500 Nations*, Alfred A. Knopf, New York, 1994.

Jung, Carl Gustav, *Memories, Dreams, Reflections*, Vintage Books, New York, 1965.

Jung, Carl Gustav, *The Earth Has a Soul*, edited by Meredith Sabini, North Atlantic Books, Berkeley, 2008. [Review]

Junger, Sebastian, *Tribe: On Homecoming and Belonging*, Twelve Books, New York, 2016. [Review]

Kane, Joe, *Savages*, Vintage Books, New York, 1996. [Review]

Kaplan, Jed O., et al, "The prehistoric and preindustrial deforestation of Europe," *Quaternary Science Reviews*, 28 (2009) 3016–3034. [Link] and [Map]

Katz, Cheryl, "How Long Can Oceans Continue To Absorb Earth's

Excess Heat?" *Yale Environment 360*, March 30, 2015. [Link]

Keith, Lierre, *The Vegetarian Myth*, Flashpoint Press, Crescent City, California, 2009. [Review]

Kelekna, Pita, *The Horse in Human History*, Cambridge University Press, New York, 2009. [Review]

Kellogg, Elizabeth A., "C4 Photosynthesis," *Current Biology*, Vol 23. No 14, R594. [Link]

Kellum, Barbara A., "History of Infanticide in the Later Middle Ages," *History of Childhood Quarterly*, vol 1, pp. 367-388, 1974.

Kentish, Portia, "Melting permafrost is a threat not just to the Arctic, but to the entire planet," *Emerging Europe*, August 26, 2020. [Link]

Ketchum, Christopher, "The Green Growth Delusion," *Truthdig.com*, April 4, 2023. [Link]

Kimmerer, Robin Wall, *Braiding Sweetgrass*, Milkweed Editions, Minneapolis, 2013. [Review]

Kimmerer, Robin Wall, *Gathering Moss*, Oregon State University Press, Corvallis, 2003.

Kingsnorth, Paul, "Dark Ecology," *Orion Magazine*, Jan/Feb 2013. [Link]

Knapp, Alan K., et al., "The Keystone Role of Bison in North American Tallgrass Prairie," *BioScience* Vol. 49 No. 1, January 1999. [Link]

Kohl, Johann Georg, *Kitchi-Gami: Life Among the Lake Superior Ojibway*, 1860, Reprint, Minnesota Historical Society Press, St. Paul, 1985.

Koirala, Santosh, "Rice paddies raise methane threat," *Climate News Network*, September 10, 2016. [Link]

Kolbert, Elizabeth, *The Sixth Extinction*, Henry Holt and Company, New York, 2014. [Review]

Kolbert, Elizabeth, *Under a White Sky*, Crown, New York, 2021. [Review]

Krech, Shepard, *The Ecological Indian*, W. W. Norton & Company, New York, 1999.

Kritee, Kritee, et al., "High nitrous oxide fluxes from rice indicate the need to manage water for both long- and short-term climate impacts," *PNAS*, September 25, 2018. [Link]

Kurtén, Björn, *Pleistocene Mammals of Europe*, Aldine Publishing Company, Chicago, 1968.

Kurtén, Björn, *The Cave Bear Story*, Columbia University Press, New York, 1976.

Lamb, Evelyn, “Should We Eat Less Rice?” *Scientific American*, August 21, 2019. [Link]

Lame Deer, John, and Richard Erdoes, *Lame Deer: Seeker of Visions*, 1972, Reprint, Washington Square Press, New York, 1994. [Review]

Lancet, “The 2020 report of the Lancet Countdown on health and climate change: responding to converging crises,” Institute for Global Health, January 9, 2021. [Link]

Langer, William L., “Infanticide: A Historical Survey,” *History of Childhood Quarterly*, vol 1, pp. 353-365, 1974.

Larsen, Janet, “Setting the Record Straight: More than 52,000 Europeans Died from Heat in Summer 2003,” *Plan B Updates*, Earth Policy Institute, July 28, 2006. [Link]

Lecky, William Edward Hartpole, *A History of European Morals from Augustus to Charlemagne*, Longmans, Green, and Company, London, 1869, vol II.

Lee, Richard B., and Richard Daly, eds., *The Cambridge Encyclopedia of Hunters and Gatherers*, Cambridge University Press, New York, 1999.

Lee, Richard B., *The Dobe !Kung*, Holt, Rinehart and Winston, New York, 1979.

Lemish, Michael G., *War Dogs*, Brassey's, Washington, D.C., 1996. Lenton, Timothy, et al., "Climate tipping points: too risky to bet against," *Nature*, November 28, 2019, Vol 575. [Link]

Lenton, Timothy, et al., "Tipping elements in the Earth's climate system," *PNAS*, February 12, 2008. [Link]

Leopold, Aldo, *A Sand County Almanac*, 1949, Reprint, Oxford University Press, New York, 1989. [Review]

Levy, Stuart B., M.D., *The Antibiotic Paradox*, 2d ed., Perseus Publishing, Cambridge, Massachusetts, 2002. [Review]

Lewis, Matthew, "When Will It Get Too Hot for the Body to Survive?" *Slate*, July 26, 2021. [Link]

Liebenberg, Louis, "Persistence Hunting by Modern Hunter-Gatherers," *Current Anthropology*, Volume 47, Number 6, December 2006.

Liebenberg, Louis, *The Art of Tracking*, David Philip Publishers, Claremont, South Africa, 1990. [Link] [Review]

Liebenberg, Louis, *The Origin of Science*, CyberTracker, Cape Town, South Africa, 2013. [Link] [Review]

Liedloff, Jean, *The Continuum Concept In Search of Happiness Lost*, Addison-Wesley, New York, 1977. [Review]

Liesowska, Anna, “First glimpse inside the Siberian cave that holds the key to man’s origins,” *The Siberian Times*, 28 July 2015. [Link]

Liesowska, Anna, “Giant new 50-metre deep 'crater' opens up in Arctic tundra,” *Siberian Times*, August 29, 2020. [Link]

Lillard, Richard G., *The Great Forest*, Knopf, New York, 1947.

Limburg, Karin, et al., “Ocean Deoxygenation: A Primer,” *One Earth*, January 24, 2020. [Link]

Little, Charles E., *The Dying of the Trees*, Viking, New York, 1995. [Review]

Livingston, John A., *Rogue Primate*, Roberts Rinehart Publishers, Boulder, Colorado, 1994. [Review]

Livingston, John A., *The John A. Livingston Reader*, McClelland & Stewart, Toronto, 2007.

Lockwood, Jeffrey A., *Locust*, Basic Books, New York, 2004. [Review]

Lockwood, Jeffery, “Voices from the Past,” *American Entomologist*, Volume 47, Number 4, Winter 2001. [Link]

Logan, Andrew, *Explained: Cement vs. Concrete*, MIT News, April 3, 2020. [Link]

Loh, Jules, *Lords of the Earth: A History of the Navajo Indians*, Macmillan, New York, 1971.

Lopez, Barry, *Of Wolves and Men*, 1978, Reprint, Scribner Classics, New York, 2004. [Review]

Lowdermilk, Walter Clay, *Conquest of the Land Through Seven Thousand Years*, 1948, Reprint, U.S. Department of Agriculture, Washington D.C., 1999. [Review] [Link]

Luo, Qunying, "Temperature thresholds and crop production: A review," *Climate Change*, December 2011. [Link]

Lyman, Edwin, "Advanced Isn't Always Better," *Union of Concerned Scientists*, March 2021. [Link]

MacKinnon, J. B., *The Once and Future World*, Houghton Mifflin Harcourt, New York, 2013. [Review]

Macleish, William H., *The Day Before America*, Houghton Mifflin, New York, 1994.

MacPhee, Ross, *End of the Megafauna*, W. W. Norton Company, New York, 2019. [Review]

Mallet, Paul Henri, *Northern Antiquities*, 1770, Reprint, AMS Press, New York, 1968. [Review]

Malthus, Thomas, *Essay on the Principle of Population*, 1798, Reprint, Oxford University Press, Oxford, 2008.

Mann, Charles C., *The Wizard and the Prophet*, Alfred A. Knopf, New York, 2018.

Mann, Charles, *1491: New Revelations of the Americas Before Columbus*, Alfred A. Knopf, New York, 2005.

Mann, Michael, *The New Climate War*, Public Affairs, New York, 2021.

Manning, Richard, *Against the Grain: How Agriculture has Hijacked Civilization*, North Point Press, New York, 2004. [Review]

Manning, Richard, *Food's Frontier: The Next Green Revolution*, North Point Press, New York, 2000.

Manning, Richard, *Grassland*, Viking, New York, 1995. [Review]

Manning, Richard, "Graze Anatomy," www.onearth.org (extinct), August 26, 2010. [Link]

Manning, Richard, "The Oil We Eat," *Harpers*, February 2004. [Link]

Markings, Samuel, "The Effect of Temperature on the Rate of Photosynthesis," sciencing.com, March 9, 2018. [Link]

Marks, Geoffrey, and William K. Beatty, *Epidemics*. Charles Scribner's Sons, New York, 1976. [Review]

Marsh, George Perkins. *Man and Nature*, Charles Scribner, New

York, 1864. [Review] [Link]

Marshall, Lamar, "The Cherokee Landscape and Buffalo Economy," *Wild South*, March 4, 2016. [Link]

Marshall, Tim, *Prisoners of Geography*, Simon & Schuster, New York, 2016.

Martin, Paul S., "Africa and Pleistocene Overkill," *Nature*, October 22, 1966. [Link]

Martin, Paul S., *Twilight of the Mammoths*, University of California Press, Berkeley, 2005.

McAuliffe, Kathleen, "If Modern Humans Are So Smart, Why Are Our Brains Shrinking?" *Discover Magazine*, September 2010. [Link]

McDermott, Jennifer, "Energy secretary: We must find a solution for nuclear waste," AP News, May 20, 2022 [Link]

McClintock, Walter, *The Old North Trail*, MacMillan and Co., 1910. [Review]

McDowell, Nate, et al., "Pervasive shifts in forest dynamics in a changing world," *Science*, 29 May 2020. [Link] McFall-Johnsen, Morgan, "Greenland's ice is melting at the rate scientists thought would be our worst-case scenario in 2070," *Business Insider*, August 14, 2019. [Link]

McGuire, Bill, *Hothouse Earth*, Icon Books, London, 2022.

McGuire, William and Hull, R. F. C., eds., *C. G. Jung Speaking*, Princeton University Press, Princeton, 1977.

McKibben, Bill, *Falter*, Henry Holt and Company, New York, 2019.

McKibben, Bill, "In a World on Fire, Stop Burning Things," *New Yorker*, March 18, 2022. [Link]

McKibben, Bill, *The End of Nature*, Random House, New York, 1989. [Review]

McLaughlin, Kathleen, "Exploding demand for cashmere wool is ruining Mongolia's grasslands," *Science*, 30 January, 2019. doi:10.1126/science.aaw8397 [Link]

McLynn, Frank, *Carl Gustav Jung*, St. Martin's Press, New York, 1997.

McMichael, A. J., et al. editors, *Climate Change and Human Health: Risks and Responses*, World Health Organization, Geneva, Switzerland, 2003.

McNeel, Jack, "The Bravery of the Buffalo Runners: Providing for the Tribe," *Indian Country Today*, July 8, 2014. [Link]

McNeill, J. R., *Something New Under the Sun*, W. W. Norton & Company, New York, 2000. [Review]

McNeill, J. R., "The First Hundred Thousand Years," Uekotter, Frank, ed., *The Turning Points of Environmental History*, University of Pittsburgh Press, Pittsburgh, 2010.

McNeill, J. R., and Peter Engelke, *The Great Acceleration*, Belknap Press, Cambridge, Massachusetts, 2014.

McNeill, J. R., and William H. McNeill, *The Human Web*, W. W. Norton & Company, New York, 2003. [Review]

McNeill, William H., "How the Potato Changed the World's History," *Social Research*, Vol 66, No 1, Spring 1999, pp 67-83. [Link] McNeill, William H., *Plagues and Peoples*, 1976, Reprint, Anchor Books, New York, 1998. [Review]

Melville, Elinor, *A Plague of Sheep*, Cambridge University Press, New York, 1994. [Review]

Metzner, Ralph, *The Well of Remembrance*, Shambhala Publications, Boston, 1994.

Michaux, Simon P., "Assessment of the Extra Capacity Required of Alternative Energy…," Geological Survey of Finland, August 20, 2021. [Link] [Review]

Mintz, Sidney W., *Sweetness and Power: The Place of Sugar in Modern History*, Penguin Books, New York, 1985.

Moberg, Vilhelm, *A History of the Swedish People: From Prehistory to the Renaissance*, Pantheon Books, New York, 1970. [Review]

Monbiot, George, "Mass starvation is humanity's fate if we keep flogging the land to death," *The Guardian*, December 11, 2017. [Link]

Monbiot, George, *Feral: Searching for Enchantment on the Frontiers of Rewilding*, Allen Lane, London, 2013. [Review]

Montgomery, David R., *Dirt: The Erosion of Civilizations*, University of California Press, Berkeley, 2007. [Review]

Montgomery, Sy, *Spell of the Tiger*, Houghton Mifflin, Boston, 1995. [Review]

Moor, Edward, *Hindu Infanticide*, J. Johnson and Company, London, 1811.

Morgan, Tim, "Perfect Storm: Energy, Finance, and the End of Growth, Strategy Insights," Issue Nine, *Tullett Prebon*, January 2013. [Link]

Morris, Eric, "Horse Power to Horsepower," *Access*, Number 30, Spring 2007. [Link] [Review]

Mowat, Farley, *Sea of Slaughter*, Atlantic Monthly Press, Washington D.C., 1984. [Review]

Mowat, Farley, *The Desperate People*, Bantam Doubleday Dell, New York, 1981.

Muir, Diana, *Reflections in Bullough's Pond: Economy and Ecosystem in New England*, University Press of New England, Hanover, New Hampshire, 2000.

Munch, Peter Andreas, *Norse Mythology*, 1840, Reprint, AMS Press, New York, 1970.

Naagaoka, Lisa, et al., "The overkill model and its impact on environmental research," *Ecology and Evolution*, John Wiley & Sons, 2018. [Link]

Nabokov, Peter, *Indian Running*, Ancient City Press, Santa Fe, New Mexico, 1981. [Review]

Natali, Susan, "Losing Frozen Earth Could Cook the Planet," *Living on Earth*, June 12, 2015. [Link]

National Oceanic and Atmospheric Administration, "Carbon Cycle," 2019. [Link]

National Science Foundation (NSF), "Agricultural Runoff Contributes to Climate Change," *Research News*, 8 Nov, 2021. [Link]

Nelson, Richard K., "Searching for the Lost Arrow." In *The Biophilia Hypothesis*, edited by S. R. Kellert and E. O. Wilson, Island Press, Washington, 1993.

Nelson, Richard K., *Make Prayers to the Raven*, University of

Chicago Press, Chicago, 1983. [Review]

Nissen, Hans J., *The Early History of the Ancient Near East 9000–2000 B.C.*, University of Chicago Press, Chicago, 1988.

Nohl, Johannes, *The Black Death*, 1926, Reprint, Unwin Books, London, 1971.

Öcalan, Abdullah, *Liberating Life: Woman's Revolution*, 2d ed., Mesopotamian Publishers, Neuss, Germany, 2017. [Link]

Öcalan, Abdullah, *Prison Writings: The Roots of Civilization*, Pluto Press, London, 2007.

Olsen, Sandra L., "Pleistocene Horse-hunting at Solutre," Johnson, E., ed., *Ancient Peoples and Landscapes*, Museum of Texas Tech University, Lubbock, 1995, pp. 65-75.

Olson, Miles, *Unlearn, Rewild*, New Society Publishers, Gabriola Island, British Columbia, Canada, 2012. [Review]

Ortega, Rodrigo Pérez, "Trees Are Growing Fast and Dying Young Due to Climate Change." *Smithsonian*, September 16, 2020. [Link]

Owen, James, "Extinct Giant Deer Survived Ice Age, Study Says," *National Geographic News*, October 6, 2004.

Paddison, Laura, "Wind energy has a massive waste problem," *CNN*, May 28, 2023. [Link]

Peacock, Doug, *In the Shadow of the Sabertooth*, Counterpunch, Petrolia, California, 2014. [Review]

Pearce, Fred, "As Climate Change Worsens, A Cascade of Tipping Points Looms," *Yale Environment 360*, December 5, 2019. [Link]

Pearce, Fred, "Phosphate: A Critical Resource Misused and Running Low, *Yale Environment 360*, July 7, 2011. [Link]

Pearce, Fred, "Why Clouds Are the Key to New Troubling Projections on Warming," *Yale Environment 360*, February 5, 2020. [Link]

Perlin, John, *A Forest Journey*, Harvard University Press, Cambridge, MA, 1989. [Review]

Pleitgen, Frederick, et al., "The Middle East is running out of water…" CNN, August 22, 2021. [Link]

Plumwood, Val, "Prey to a Crocodile." *Aisling*, Issue 30, Beltane 2002. [Link]

Plumwood, Val, *The Eye of the Crocodile*, edited by Lorraine Shannon, Australian National University Press, Canberra, 2012. [Link] [Review]

Pollan, Michael, *The Omnivores Dilemma*, Penguin Press, New York, 2006. [Review]

Polo, Marco, and Rustichello of Pisa, *The Travels of Marco Polo*, ca. 1300, Reprint, Project Gutenberg, 2004. [Link]

Ponting, Clive, *A New Green History of the World*, Penguin Books, New York, 2007. [Review]

Ponting, Clive, *The Twentieth Century: A World History*, Henry Holt and Company, New York, 1999.

Postel, Sandra, "Water: Adapting to a New Normal," Heinberg, Richard and Daniel Lerch, eds, *The Post Carbon Reader*, Watershed Media, Healdsburg, California, 2010. [Link]

Postel, Sandra, *Pillar of Sand*, W. W. Norton & Company, New York, 1999. [Review]

Powell, Nick Clarke (director), *Decoding Neanderthals*, Nova/PBS, Arrow International Media, London, 2013.

Price, Weston, *Nutrition and Physical Degeneration*, 1939, Reprint, Price-Pottenger Nutrition Foundation, La Mesa, California, 2008. [Link]

Pyne, Stephen J., *Fire in America*, 1982, Reprint, University of Washington Press, Seattle, 1997.

Pyne, Stephen J., *Fire: A Brief History*, University of Washington Press, Seattle, 2d ed., 2019. [Review]

Pyne, Stephen J., *How Humans Made Fire*, Aeon Essays, 5/5/2015. [Link]

Pyne, Stephen J., *The Planet is Burning*, Aeon Essays, 11/20/2019. [Link]

Pyne, Stephen J., *Welcome to the Pyrocene*, Bloomberg, 9/20/2020 [Link]

Pyne, Stephen J., *Vestal Fire*, University of Washington Press, Seattle, 1997.

Quinn, Daniel, *Ishmael*, Bantam Books, New York, 1992. [Review]

Randers, Jorgen and Ulrich Goluke, "An earth system model shows self-sustained melting of permafrost even if all man-made GHG emissions stop in 2020," *Scientific Reports*, (2020) 10:18456 [Link]

Ranganathan, Janet, et al., "Shifting Diets for a Sustainable Food Future," *World Resources Institute*, Washington D.C., 2016. [Link]

Rasmussen, Knud, *Across Arctic America*, G. P. Putnam's Sons, New York, 1927. [Review]

Rasmussen, Knud, *The People of the Polar North*, Kegan Paul, Trench, Trübner & Co., London, 1908. [Download]

Ratey, John J. M.D., and Richard Manning, *Go Wild*, Little, Brown and Company, New York, 2014. [Review]

Read, Rupert, and Samuel Alexander, *This Civilization is Finished*, Simplicity Institute, Melbourne, 2019.

Reader, John, *Man on Earth*, Perennial Library, New York, 1990.

Reader, John, *Potato*, Yale University Press, New Haven, 2009. [Review]

Rees, William E., "Ecological economics for humanity's plague phase," *Ecological Economics*, 169 (2020) 106519. [Link]

Rees, William E., *Is Humanity Fatally Successful?*, Vancouver Institute, British Columbia, 2003. [Link]

Rees, William E., "Overshoot: Cognitive obsolescence and the population conundrum," *Population and Sustainability*, Vol 7, No 1, 2023. [Link]

Rees, William E., "The Human Nature of Unsustainability," Heinberg, Richard and Daniel Lerch, eds., *The Post Carbon Reader*, Watershed Media, Healdsburg, California, 2010. [Link]

Rees, William E., "The Human Ecology of Overshoot: Why a Major 'Population Correction' is Inevitable," *World 2023*. [Link]

Rees, William E., "The human eco-predicament: Overshoot and the population conundrum," *Vienna Yearbook of Population Research*

*2023*, (Vol. 21), pp. 1-19. [Link]

Reese, Richard A., List of Rants and Reviews. [Link]

Reese, Richard A., Old Fashioned Family Planning, 2012. [Link] Reese, Richard A., *Sustainable or Bust*, CreateSpace, Charleston, 2013.

Reese, Richard A., *Understanding Sustainability*, CreateSpace, Charleston, 2016.

Reese, Richard A., *What Is Sustainable*, CreateSpace, Charleston, 2011.

Reisner, Marc, *Cadillac Desert*, Penguin Books, New York, 1986. [Review]

Rimas, Andrew, and Evan D. G. Fraser, *Beef: The Untold Story of How Milk, Meat, and Muscle Shaped the World*, Harper, New York, 2008.

Robbins, Jim, "The West's Great River Hits Its Limits: Will the Colorado Run Dry?" *Yale Environment 360*, January 14, 2019. [Link]

Roberts, Alice, *Evolution: The Human Story*, Dorling Kindersley, New York, 2011.

Robine, Jean-Marie, et al., "Death toll exceeded 70,000 in Europe during the summer of 2003," *Comptes Rendus Biologies*, February 2008. [Link]

Rockefeller, Abby A., “Civilization & Sludge: Notes on the History of the Management of Human Excreta” [Link]

Rolling, Mitchel, “Limited Lifespans of Wind Turbines…” *Energy Environment*, June 26, 2018. [Link]

Rowe, Stan, *Earth Alive: Essays on Ecology*, NeWest Press, Edmonton, Alberta, 2006. [Review]

Rowe, Stan, *Home Place: Essays on Ecology*, NeWest, Edmonton, Alberta, 1990.

Rubin, Jeff, *The Big Flatline: Oil and the No-growth Economy*, Palgrave Macmillan, New York, 2012. [Review]

Ryan, William Burke, *Infanticide: Its Law, Prevalence, Prevention, and History*, J. Churchill, London, 1862. [Link]

Sale, Kirkpatrick, *Rebels Against the Future*, Perseus Publishing, Cambridge, Mass, 1996.

Sánchez-Bayo, Francisco, and Kris A.G. Wyckhuys, “Worldwide decline of the entomofauna,” *Biological Conservation*, 232 (2019) 8–27.

Santora, Tara, “What's the hottest temperature the human body can endure?” *Live Science*, July 31, 2021. [Link]

Schick, Kathy D., and Nicholas Toth, *Making Silent Stones Speak*, Simon & Schuster, New York, 1994.

Schmookler, Andrew Bard, *The Parable of the Tribes*, 2d ed., SUNY Press, Albany, New York, 1995. [Review]

Schorger, Arlie William, *The Passenger Pigeon*, 1955, Reprint, University of Oklahoma Press, Norman, 1973. [Review]

Schorger, Arlie William, "The Range of the Bison in Wisconsin," Durand, Loyal, Jr., ed., *Transactions of the Wisconsin Academy of Sciences*, Arts and Letters, vol. XXX, 1937. [Link]

Scott, James C., *Against the Grain: A Deep History of the Earliest States*, Yale University Press, New Haven, 2017. [Link] [Review]

Scott, James C., "Four Domestications: Fire, Plants, Animals, and … Us," *Tanner Lecture Library*, University of Utah, 2011. [Link]

Scott, James C., *Intellectual Diary of an Iconoclast*, Annual Review of Political Science, 2024. [Link]

Scott, James C., *Seeing Like A State: How Certain Schemes to Improve the Human Condition Have Failed*, Yale University Press, New Haven, 1998. [Link] [Review]

Scott, James C., *The Art of Not Being Governed*, Yale University Press, New Haven, 2009. [Review]

*Second State of the Carbon Cycle Report*, U.S. Global Change Research Program, Washington, D.C., 2018. [Link]

Seibert, Megan and William E. Rees, "Through the Eye of a Needle: An Eco-Heterodox Perspective on the Renewable Energy Transition," *Energies*, MDPI, July 26, 2021. [Link] Setumu, Tlou, "Communal Identity Creation Among The Makgabeng Rural People In Limpopo Province," Ph.D. diss, Department of History, University of Limpopo, 2009. [Link]

Shakespeare, Nicolas, *Bruce Chatwin*, Nan A. Talese, New York, 1999.

Shepard, Paul, "On Animal Friends," Kellert, Stephen R., and Edward O. Wilson, eds., *The Biophilia Hypothesis*, Island Press, Washington, 1993.

Shepard, Paul, edited by Florence Shepard, *Coming Home to the Pleistocene*, Island Press, Washington, 1998. [Review]

Shepard, Paul, edited by Florence Shepard, *Encounters With Nature*, Island Press, Washington, D. C., 1999. [Review]

Shepard, Paul, *Nature and Madness*, University of Georgia Press, Athens, Georgia, 1998. [Review]

Shepard, Paul, *The Only World We've Got*, Sierra Club Books, San Francisco, 1996.

Shepard, Paul, *The Others: How Animals Made Us Human*, Island Press, Washington, 1996. [Review]

Shepard, Paul, *The Tender Carnivore*, 1973, Reprint, University of Georgia Press, Athens, Georgia, 1998. [Review]

Shepard, Paul, *Where We Belong: Beyond Abstraction in Perceiving Nature*, University of Georgia Press, Atlanta, 2003. [Review]

Shepard, Paul, and Barry Sanders, *The Sacred Paw: The Bear in Nature, Myth, and Literature*, Viking Penguin, New York, 1985.

Sherow, James E., "Workings of the Geodialectic: High Plains Indians and Their Horses in the Region of the Arkansas River Valley, 1800-1870," *Environmental History Review*, Vol. 16, No. 2 (Summer 1992), pp. 61-84. [Link]

Shivaram, Deepa, "Heat Wave Killed An Estimated 1 Billion Sea Creatures," NPR, July 9, 2021. [Link]

Shrivastava, Pooja, and Rajesh Kumar, "Soil Salinity," *Saudi Journal of Biological Sciences* (2015) 22. 123-131. [Link] Siberian Times, "'Big bang' and 'pillar of fire' as latest of two new craters forms this week in the Arctic," *Siberian Times*, July 2, 2017. [Link]

Simmons, I. G., *An Environmental History of Great Britain*, Edinburgh University Press, Edinburgh, 2001.

Simpson, Howard N., "The Impact of Disease on American History," *New England Journal of Medicine*, 04/22/1954, Vol. 250(16), pp.679-687.

Singh, J. A. L., and Robert M. Zingg, *Wolf-Children and Feral Man*, 1939, Reprint, Archon Books, 1966. [Review] [Download]

Smil, Vaclav, "Beyond Magical Thinking," *Yale Environment 360*, May 19, 2022. [Link]

Smil, Vaclav, *Enriching the Earth: Fritz Haber, Carl Bosch, and the Transformation of World Food Production*, MIT Press, Cambridge, Massachusetts, 2001.

Smil, Vaclav, "Global Population and the Nitrogen Cycle," *Scientific American*, July 1997.

Smil, Vaclav, *How the World Really Works*, Viking, New York, 2022.

Smith, Joseph Russell, *Tree Crops: A Permanent Agriculture*, 1929, Reprint, Island Press, Covelo, California, 1987. [Link] [Review]

Smith, Melissa Diane, *Going Against the Grain*, Contemporary Books, Chicago, 2002.

Smith, Tierney, "Warming oceans face CO tipping point," *Climate* 2 *Change News*, January 24, 2012. [Link]

Snow, Dean R., *The Iroquois*, Blackwell, Cambridge, Massachusetts,

1994.

Speer, Albert, *Inside the Third Reich*, Macmillan, New York, 1970.

Spellberg, Brad, *Rising Plague*, Prometheus Books, Amherst, New York, 2009.

Spencer, Paul, *The Maasai of Matapato*, Indiana University Press, Indianapolis, 1988, p. 240.

St. Clair, Kassia, *The Golden Thread*, John Murray, London, 2018. [Review]

Staller, John E., et al., eds., *Histories of Maize,* Left Coast Press, Walnut Creek, California, 2009.

Stanton, William, "Demographic Significance of the 40 Factor," *Optimum Population Trust Journal*, October 2007, p. 26.

Stanton, William, *The Rapid Growth of Human Populations 1750-2000*, Multi-Science Publishing, Brentwood, U. K., 2003. [Review]

Steffen, Will, et al., "Trajectories of the Earth System in the Anthropocene," *PNAS*, August 14, 2018. [Link]

Stolzenburg, William, *Where the Wild Things Were*, Bloomsbury, New York, 2008. [Review]

Stone, Daniel, *The Food Explorer*, Dutton, New York, 2018. [Review]

Strayer, Joseph R. and Dana C. Munro, *The Middle Ages 395-1500*, 5th ed., Appleton-Century-Crofts, New York, 1970.

Stringer, Chris, *Lone Survivors: How We Came to Be the Only Humans on Earth*, Times Books, New York, 2012. [Review]

Stringer, Chris, and Peter Andrews, *The Complete World of Human Evolution*, Thames & Hudson, New York, 2005.

Struzik, Ed, "How Thawing Permafrost Is Beginning to Transform the Arctic," *Yale Environment 360*, January 21, 2020. [Link]

Sukhova, Valeria, and Olga Gertcyk, "Bubbling methane craters and super seeps: is this the worrying new face of the undersea Arctic?" *Siberian Times*, November 19, 2020. [Link]

Sullivan, Cody and Rebecca Lindsey, "2017 State of the climate: Ocean uptake of human-produced carbon," *NOAA Climate.gov*, August 1, 2018. [Link]

Surovell, Todd A., et al., "Tests of Martin's overkill hypothesis…," *PNAS*, January 26, 2016. [Link]

Svoboda, Jiri, and Vojen Lozek, *Hunters Between East and West: The Paleolithic of Moravia*, Springer Science, New York, 1996. Tacitus, Caius Cornelius, edited by Moses Hadas, *Complete Works of Tacitus*, The Modern Library, New York, 1942. [Review] [Link]

Tanner, John, *The Falcon*, 1830, Reprint, Penguin Books, New York, 1994. [Review]

Thomas, Elizabeth Marshall, *The Harmless People*, 2d ed., Vintage Books, New York, 1989. [Review]

Thomas, Elizabeth Marshall, *The Old Way: A Story of the First People*, Farrar Straus Giroux, New York, 2006.

Thomas, Keith, *Man and the Natural World*, Pantheon Books, New York, 1983. [Review]

Thomson, Joseph, *Through Masai Land*, Sampson Low, Marston, Searle, & Rivington, London, 1887.

Tnau Agritech Portal, "Agrometeorology: Temperature and Plant Growth," 2016. [Link]

Torrey, E. Fuller, M.D., and Robert H. Yolken, "Their Bugs Are Worse Than Their Bite," *Washington Post*, April 3, 2005 p. B01.

Trainer, Ted, "Can Renewable Energy Sustain Consumer Societies? A Negative Case," Simplicity Institute, 2012. [Link]

Trainer, Ted, *Renewable Energy Cannot Sustain a Consumer Society*, Springer, Dordrecht, The Netherlands, 2007. [Review]

Trainer, Ted, *The Simpler Way*. [Link]

Troisi, Dayna, "How We Got Abortions Before Abortion Was Legal," *Allure*, April 11, 2019. [Link]

Trudell, John, Introduction to *Of Earth and Elders*, by Serle L.

Chapman, Mountain Press, Missoula, Montana, 2002. [Many Trudell interviews on web.]

Turnbull, Colin M., *The Forest People*, Simon and Schuster, New York, 1961. [Review]

Turnbull, Colin M., *The Human Cycle*, Simon and Schuster, New York, 1983. [Review]

Turnbull, Colin M., *The Mbuti Pygmies*, Holt, Rinehart and Winston, Fort Worth, 1983.

Turnbull, Colin M., *The Mountain People*, Touchstone, New York, 1972. [Review]

Turnbull, Colin M., *Tradition and Change in African Tribal Life*, World Publishing Co., New York, 1966.

Turner, Jack, *The Abstract Wild*, University of Arizona Press, Tucson, 1996. [Review]

U.S. Geological Survey, *Thermokarst and Thaw-Related Landscape Dynamics*, Reston, Virginia, 2013. [Link]

Ungar, Peter S., *Evolution's Bite*, Princeton University Press, Princeton, 2017.

Vale, Robert, and Brenda Vale, *Time to Eat the Dog*, Thames & Hudson Ltd, London, 2009.

Van Vuure, Cis, *History, Morphology and Ecology of the Aurochs*. [Link]

Van Vuure, Cis, *Retracing the Aurochs*, Coronet Books, 2005.

Villa, Paola, and Wil Roebroeks (2014), "Neanderthal Demise: An Archaeological Analysis of the Modern Human Superiority Complex," PLoS ONE 9(4): e96424, doi:10. 1371/journal.pone.0096424.

Waage, Malin, et al., "Geological controls of giant crater development on the Arctic seafloor," *Scientific Reports*, May 21, 2020. [Link]

Waal, Frans de, *Are We Smart Enough to Know How Smart Animals Are?*, W. W. Norton & Company, New York, 2016. [Review]

Waal, Frans de, *Bonobo*, University of California Press, Berkeley, 1997. [Review]

Waal, Frans de, *Our Inner Ape*, Riverhead Books, New York, 2005.

Wackernagel, Mathis, and William E. Rees, *Our Ecological Footprint*, New Society Publishers, Vancouver, Canada,1996. [Preview]

Wadhams, Peter, "The Global Impacts of Rapidly Disappearing Arctic Sea Ice," *Yale Environment 360*, September 26, 2016. [Link] Wadhams, Peter, *A Farewell to Ice*, Oxford University Press, New York, 2017. [Review].

Wagner, David, et al., "Insect decline in the Anthropocene: Death by a thousand cuts," *PNAS*, January 12, 2021. [Link]

Wahid, Abdul, et al., "Heat Tolerance in Plants: An Overview," *Environmental and Experimental Botany* 61 (2007) p. 199-223. [Link]

Wallace, Ronald L., *Those Who Have Vanished*, Dorsey Press, Homewood, Illinois, 1983.

Wallace-Wells, David, *The Uninhabitable Earth*, Tim Duggan Books, New York 2019. The shorter 2017 version is [HERE]

Ward, Peter D., *The Call of Distant Mammoths*, Copernicus, New York, 1997. [Review]

Waring, Bonnie, "There aren't enough trees in the world to offset society's carbon emissions — and there never will be," *The Conversation*, April 23, 2021. [Link]

Watson, Lyall, *Lightning Bird: The Story of One Man's Journey into Africa's Past*, E. P. Dutton, New York, 1982. [Review]

Watts, Jonathan, "Concrete: the most destructive material on Earth," *The Guardian*, Feb. 25, 2019. [Link]

Weatherwax, Paul, *Indian Corn in Old America*, The Macmillan Company, New York, 1954.

Weisman, Alan, *The World Without Us*, St. Martin's Press, New York, 2007.

Welch, Craig, "Artic permafrost is thawing fast. That affects us all," *National Geographic*, September 2019. [Link]

Wells, Spencer, *Pandora's Seed: The Unforeseen Cost of Civilization*, Random House, New York, 2010. [Review]

Werdelin, Lars, "Hominids, Carnivores, and the Origin of the Anthropocene," Swedish Museum of Natural History, 50 min. video. [Link]

Werdelin, Lars, "King of Beasts," *Scientific American*, November 2013, pp. 34-39.

West, Dixie, *Hunting Strategies in Central Europe During the Last Glacial Maximum*, British Archaeological Reports, Oxford, 1997. [Review]

White, Lynn Jr., *Medieval Technology & Social Change*, Oxford University Press, New York, 1962.

White, Mark, Paul Pettitt, and Danielle Schreve, "Shoot First, Ask Questions Later: Interpretive Narratives of Neanderthal Hunting," *Quaternary Science Reviews*, Volume 140, 15 May 2016, Pages 1-20. [Link]

White, Richard, *The Roots of Dependency*, University of Nebraska Press, Lincoln, 1983. [Review]

Whitehouse, Harvey, et al., "Big Gods Came After the Rise of Civilizations…," *The Conversation*, 20 March 2019. [Link]

Wilkins, Alasdair, "DNA Reveals That Cows Were Almost Impossible to Domesticate," *Gizmodo*, March 29, 2012. [Link]

Williams, Michael, *Deforesting the Earth*, 2d ed., University of Chicago Press, Chicago, 2006. [Review]

Wilson, Robert Anton, *Prometheus Rising*, New Falcon, Tempe, Arizona, 1983.

Winslow, Charles Edward Amory, *Man and Epidemics*, Princeton University Press, Princeton, 1952. [Review]

Witze, Alexandra, "The Arctic is burning like never before," nature.com, September 10, 2020. [Link]

Wohlleben, Peter, *The Hidden Life of Trees*, Greystone Books, Berkeley, 2016. [Review]

Wohlleben, Peter, *The Inner Life of Animals*, Greystone Books, Berkeley, 2017. [Review]

Wolfe, Nathan D., Claire Panosian Dunavan, Jared Diamond, "Origins of Major Human Infectious Diseases," *Improving Food*

*Safety Through a One Health Approach*, National Academies Press, Washington D.C., 2012. [Link]

Wolff, Robert, *Original Wisdom,* Inner Traditions, Rochester, Vermont, 2001. [Review]

Woodham-Smith, Cecil, *The Great Hunger*, 1962, Reprint, Penguin Books, London, 1991.

Wood-Martin, W. G., *Traces of the Elder Faiths of Ireland*, 2 vols, 1902, Reprint, Kennikat Press, Port Washington, New York, 1970. [Review]

Woody, Todd, "To save our oceans, we have to change what we do on land," *Grist*, September 25, 2019. [Link]

*World Malaria Report 2012*, World Health Organization, Geneva, Switzerland, 2012.

Wrangham, Richard, "Out of the Pan, Into the Fire: How Our Ancestors' Evolution Depended on What They Ate," *Tree of Origin*, Harvard University Press, Cambridge, 2001.

Wrangham, Richard, and Dale Peterson, *Demonic Males: Apes and the Origins of Human Violence*, Houghton Mifflin Company, New York, 1996.

Wright, Ronald, *A Short History of Progress*, Carroll & Graf, New

York, 2005. [Review]

Wroe, Stephen, and Judith Field, "A review of the evidence for a human role in the extinction of Australian megafauna and an alternative interpretation," *Quaternary Science Reviews*, 25 (2006) 2692–2703. [Link]

Yong, Ed, "In a Few Centuries, Cows Could Be the Largest Land Animals Left," *The Atlantic*, April 19, 2018. [Link]

Young, Jon, *What the Robin Knows: How Birds Reveal the Secrets of the Natural World*, Houghton Mifflin Harcourt, Boston, 2012.

Youngquist, Walter, "Framework of the Future," *Negative Population Growth*, December 2016. [Link]

Youngquist, Walter, "Our Plundered Planet and a Future of Less," *Negative Population Growth*, Alexandria, Virginia, July 2014. [Link]

Youngquist, Walter, *GeoDestinies*, National Book Company, Portland, Oregon, 1997.

Youngquist, Walter, *GeoDestinies 2022 Edition*. [Review] [Free Download]

Youngquist, Walter, *Mineral Resources and the Destinies of Nations*, National Book Company, Portland, OR, 1990.

Zinsser, Hans, *Rats, Lice, and History*, Blue Ribbon Books, New

York, 1935.