Section 1

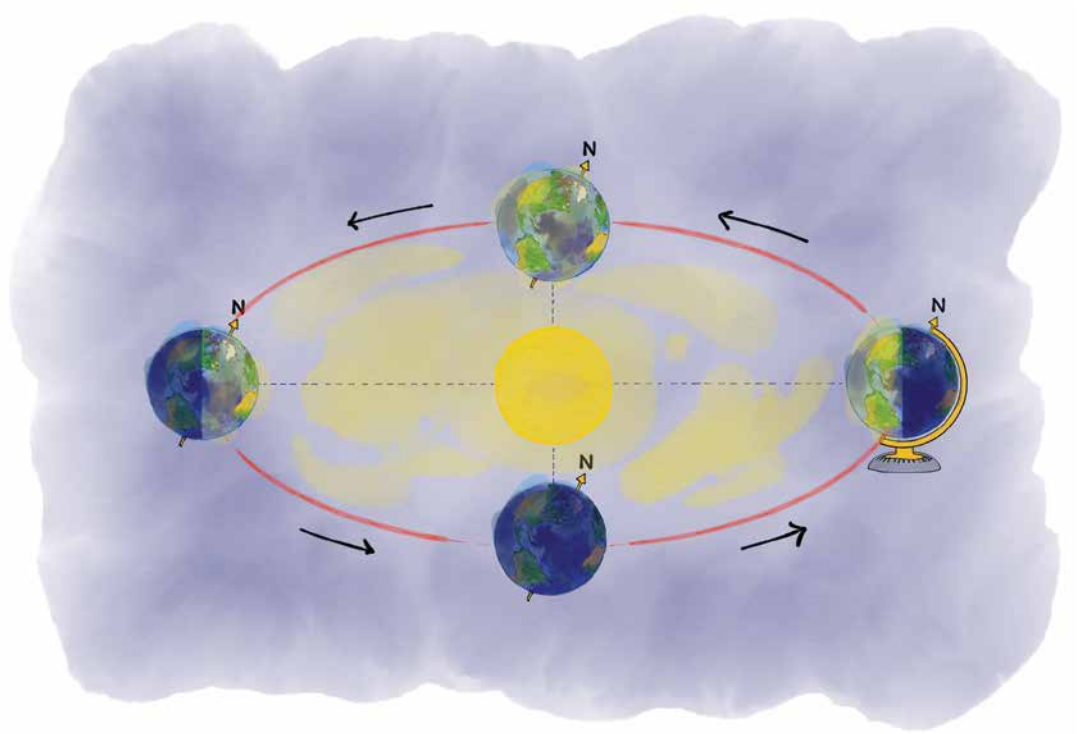
The Ecology of Humanity

OUR EARTH IS A UNIQUE PLACE IN SPACE not just because it possesses a cosmic blend of elements that make it inhabitable, but because it is our home. Of all the planets in the universe, we live here! Earth is precious! Surrounded by the immense unknown of the universe, still mostly incomprehensible to human minds, our Earth is a habitable, enjoyable, incredible place in space. The Earth is over 4.3 billion years old. Our species, *Homo sapiens*, have evolved for the last 200,000 years, and our genus *Homo* emerged on this planet over 2 million years ago. We have primarily inhabited areas of diverse useful and edible abundance—edible ecosystems were our habitat, and they are a cornerstone of societal success and human well-being. This first chapter is a gradual introduction to knowledge about our natural systems and our place within ecosystems.

Precious Place in Space

Let's take a look at our little Earth—
a unique environmental blend that supports life.

A Rare Opportunity



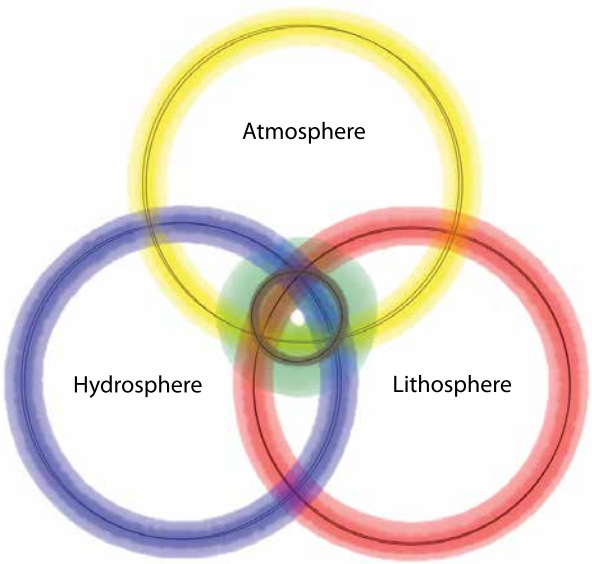
The tilt of Earth's axis and its orbits around the sun provide our seasons.

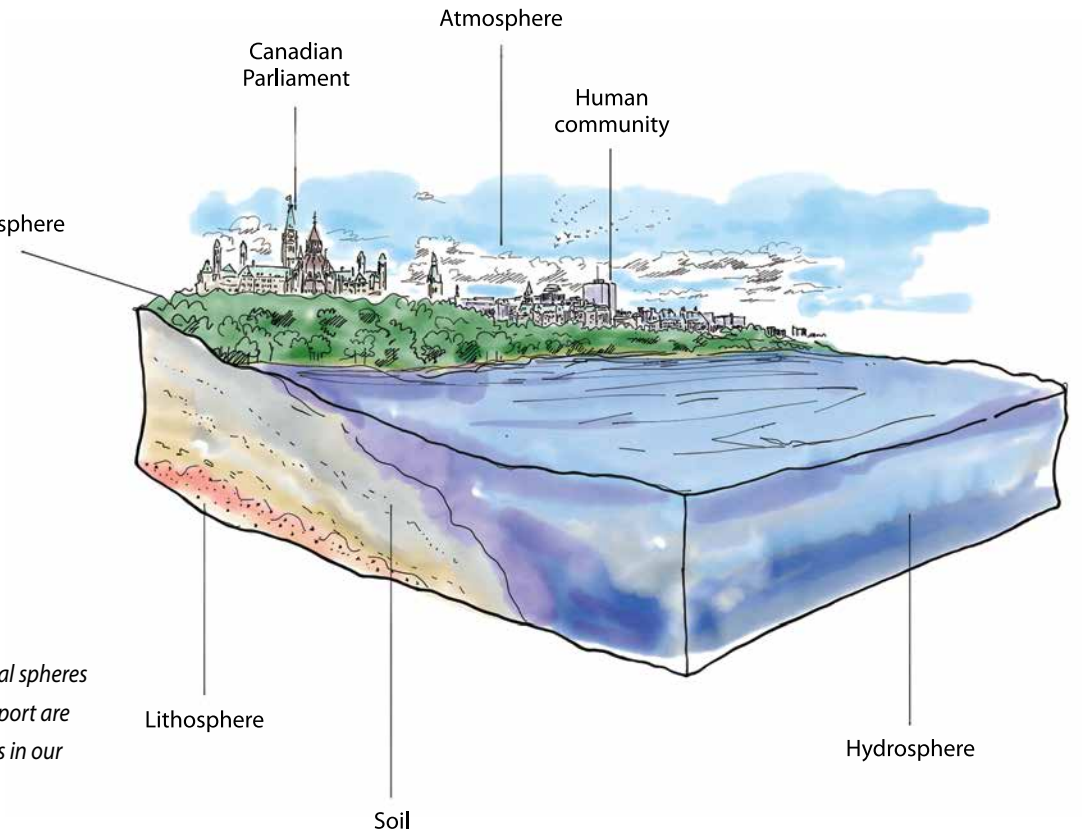
What a precious place…this Earth of ours. It is a rare opportunity to have a planet as livable as ours. Mars is too cold and arid, and Venus is too hot. From the tilt of our axis to the proximity to the sun and the magnetic field around us, our Earth is unique in our solar system and universally rare. It is a life-giving environment.

Environmental Spheres

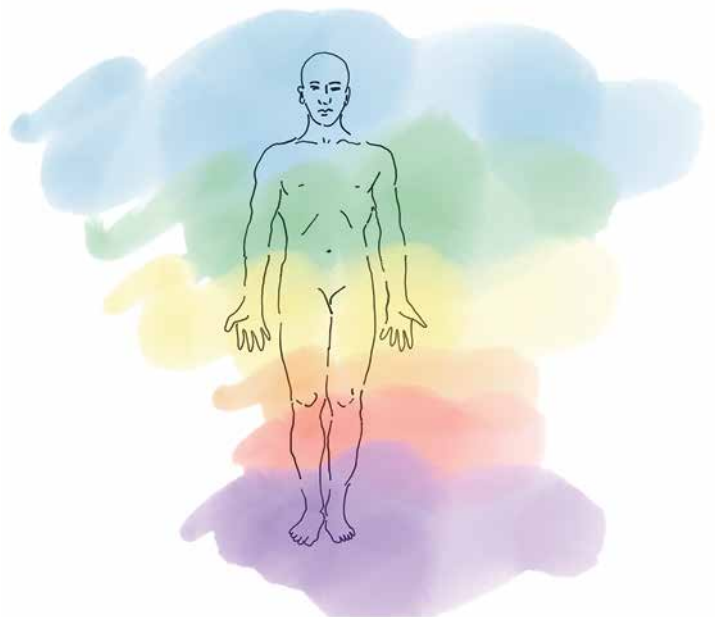
Our planet is composed of **three environmental (or physical) spheres**: atmosphere (air and gases), lithosphere (minerals and rocks), and hydrosphere (water).

These environmental conditions react with the sun's energy, which radiates through space and into our atmosphere. The sun's heat is absorbed by oceans and land, warming our planet and creating the spark of life. These spheres are part of **Earth's life-support system**. Without solar energy, gravity, and the cycling of nutrients, there would be no life on Earth. Biological diversity has flourished over Earth's surface, in its oceans, and its air. What an amazing thing, this spark of life and the diversity that has evolved!





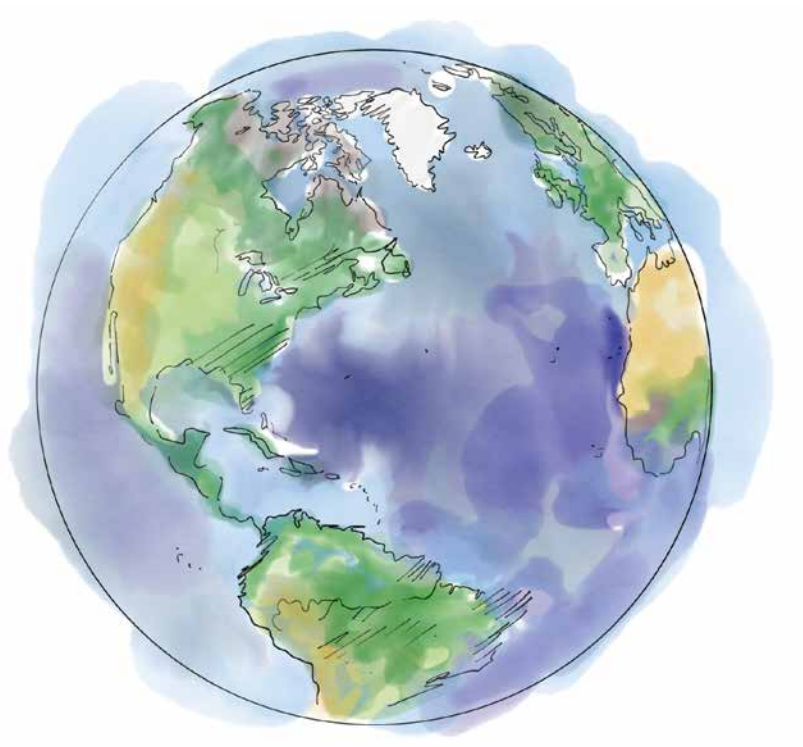
Earth's environmental spheres and the life they support are evident all around us in our modern world.



Elemental Human

These same elements that make our planet habitable can be found within the human body. Our bodies are made of minerals: our bones and teeth are mostly calcium, and iron is in our blood; there is air in our lungs, water in our tissues and organs, and electricity in our nervous system. We are made of the stuff of the Earth. Humans are a part of the environment, and conservation of Earth's systems is protection of our well-being.

Biodiversity



Come in closer, let's see this planet of ours! *We occupy a unique zone on planet Earth, shared with an abundance of biodiversity on which we depend.*

Biosphere

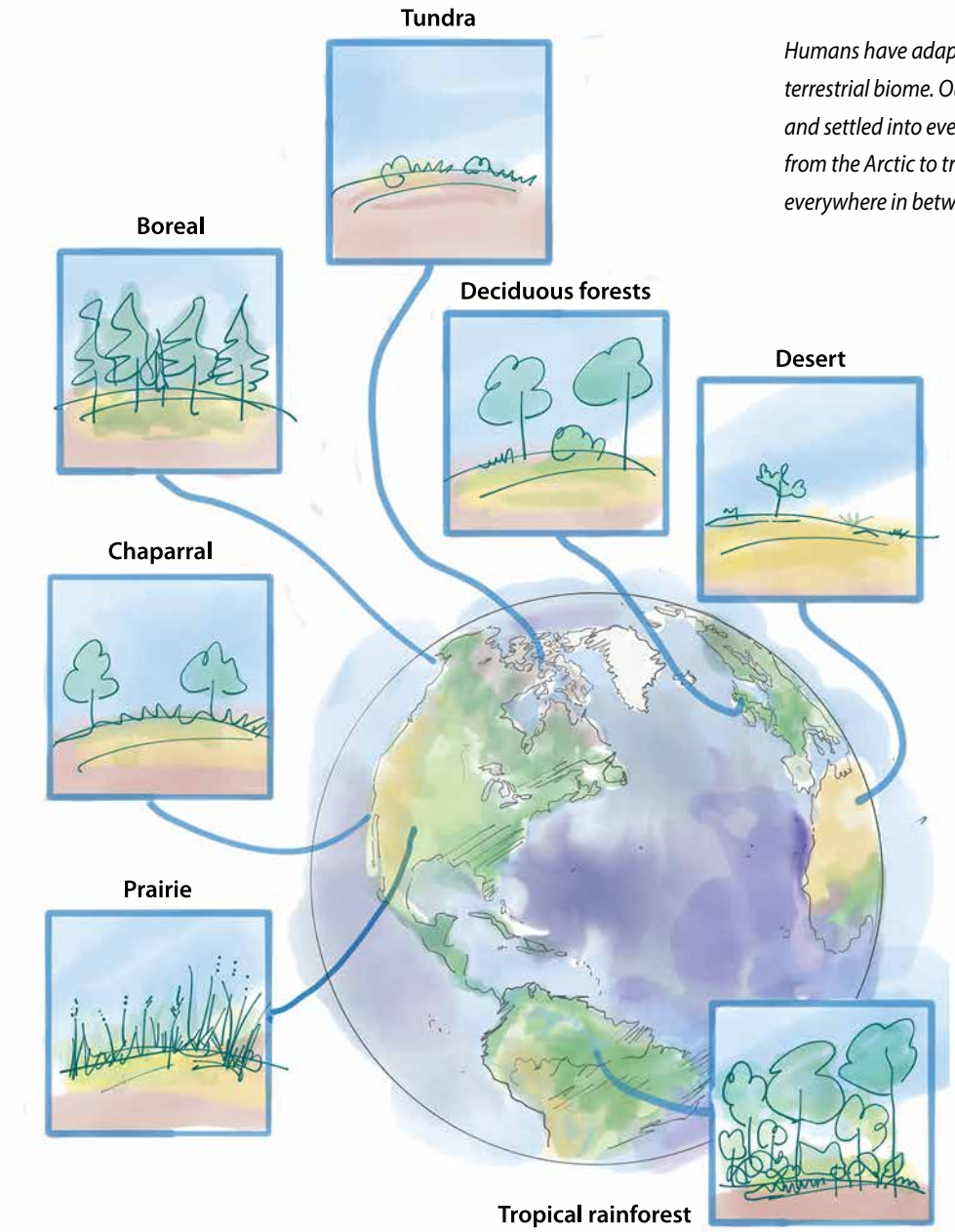
The **biosphere** is the sum total of life on Earth: every creature, every microorganism, and every tree, bee and butterfly. The biosphere is the fourth sphere in which life can exist, and it only occurs within a narrow band along the Earth's surface.

Life Zone

Life only exists within a band called the **life zone**. If the Earth were a basketball, this life zone would only be as thick as the skin of the ball. We need to protect and regenerate the life systems that exist within this narrow zone. With thousands of miles of uninhabited rock beneath our feet and an unlivable atmosphere above us, this is the space that is *just right*. Here, the three bears, Goldilocks, and all the rest of the Earth's estimated 2 billion species[1] find space to live. The life zone contains habitat for humans, lichen, beasts and birds, fish and fowl, plants and trees, microbes, and fungi.

Biomes

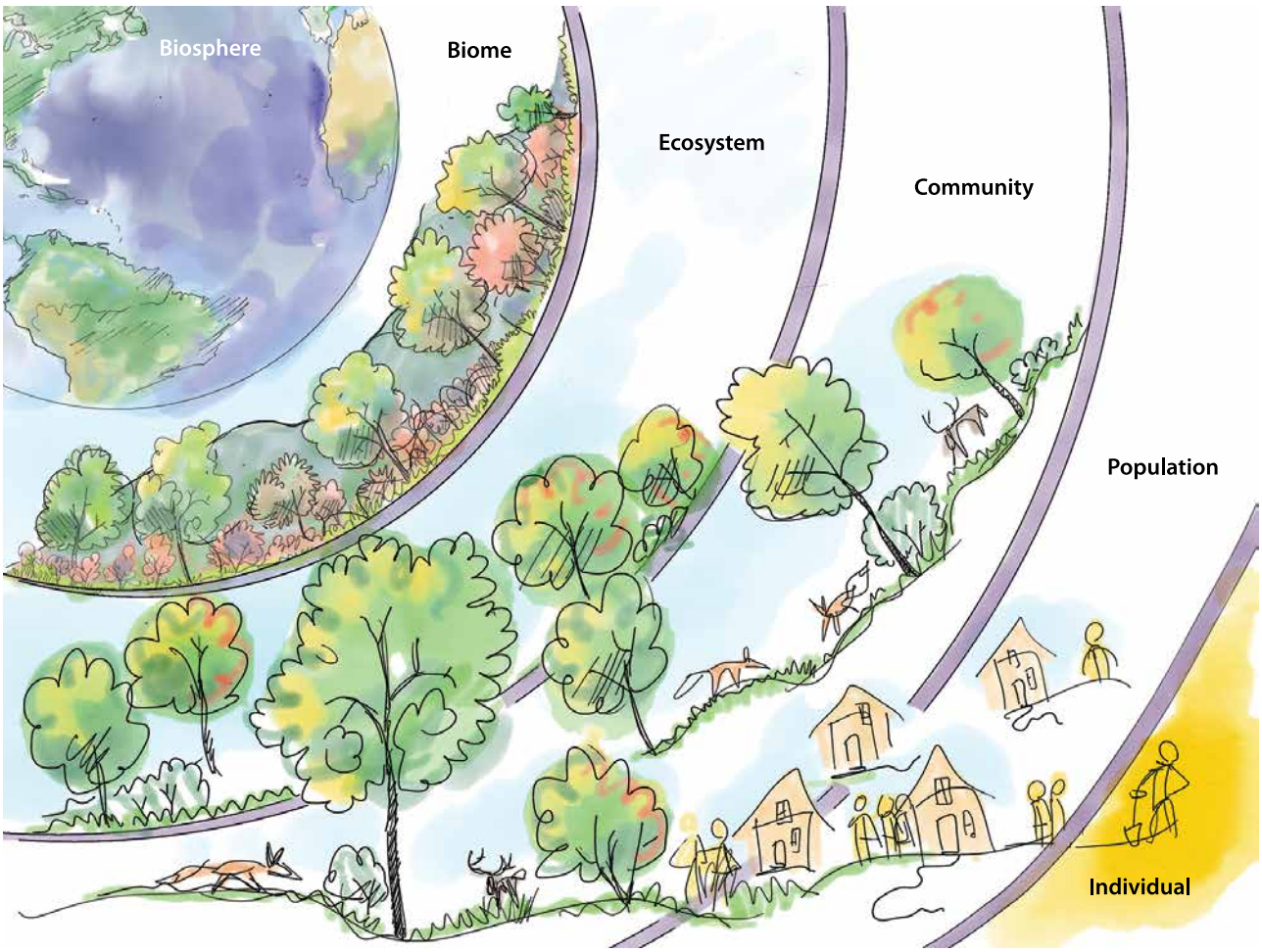
This amazingly habitable planet has **ten major ecological systems (*biomes*)** that occur within the Earth's biosphere. Biomes are vast areas with distinctly similar plants, animals, and other life forms that have adapted to unique environments. Earth's variability in climate, terrain, and water produces unique conditions for the evolution of life adapted to these regional differences. For this reason, you will see succulent plants in all desert areas, though some are endemic to the Gobi and others to the Kalahari.



Humans have adapted to live in every terrestrial biome. Our ancestors migrated and settled into every corner of the Earth, from the Arctic to tropical rainforests and everywhere in between.

Organization of Life

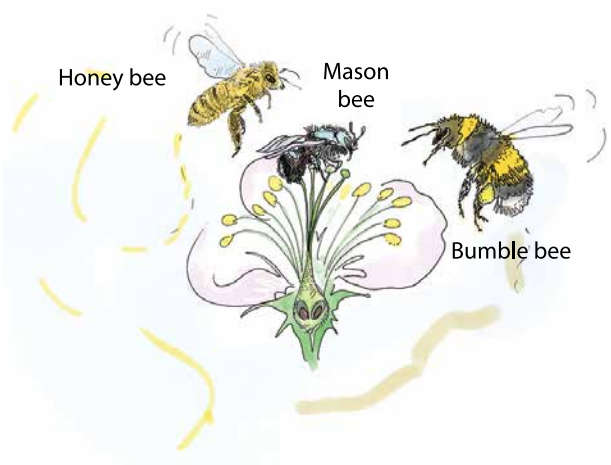
Life on Earth is understood by science as fitting into different categories; this is called the **organization of life**. Biomes are the broadest category of life on Earth after the biosphere itself. You are an **individual** and part of a **population** of humans (*Homo sapiens*). We all live within a **community** of different living organisms, such as foxes, deer, birds and trees, and grass. Each community is part of a particular **ecosystem**, meaning a community of living organisms that interact with each other and their non-living environment. There are many sorts of ecosystems within a biome.

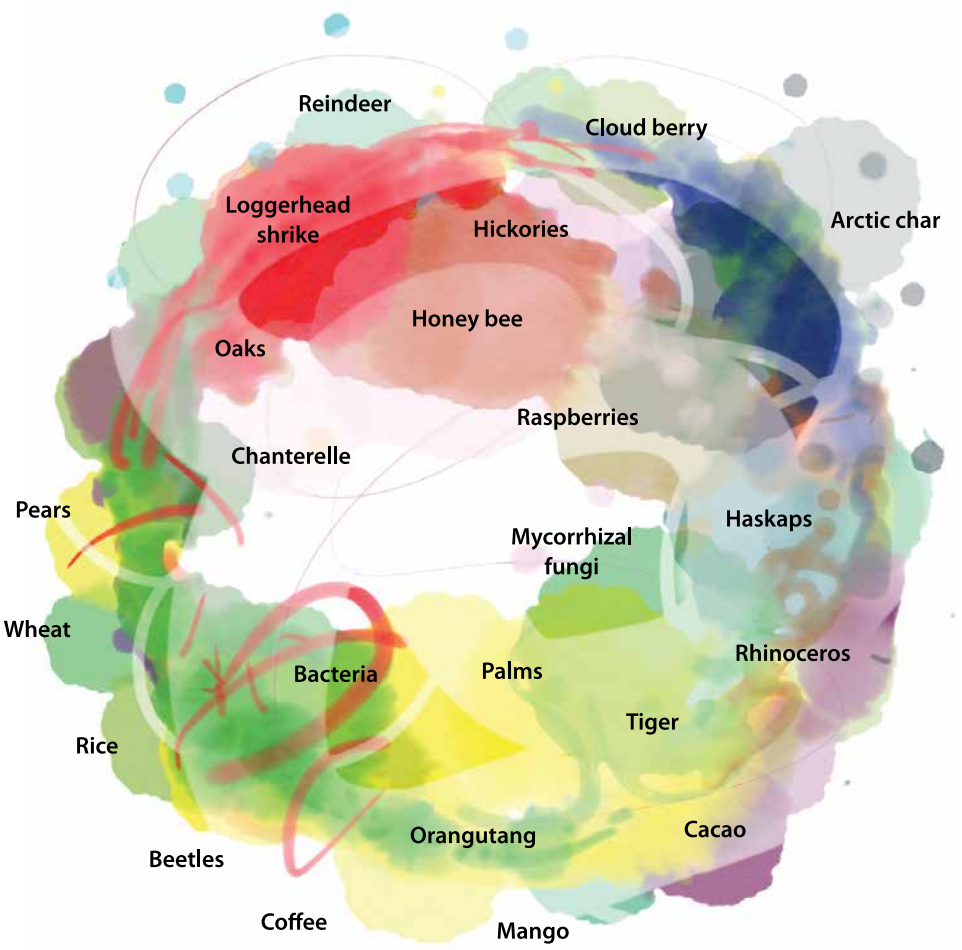


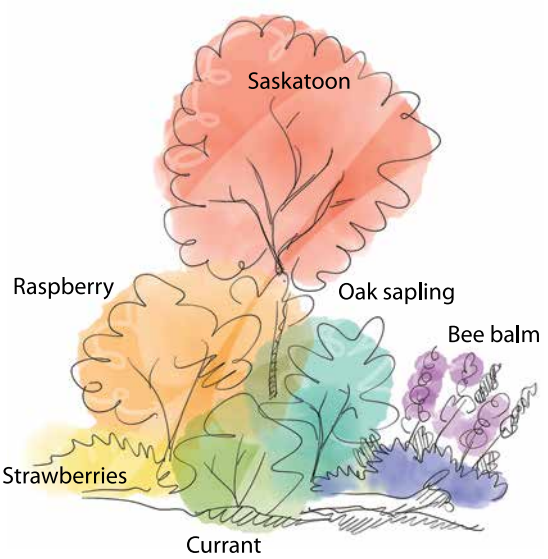
Biodiversity

Biodiversity is the variety and abundance of life.

We can consider biodiversity as being three-fold: **species**, **genes**, and **ecosystems.** In other words, there can be many different **species** of bees (bumble, honey, mason) in a meadow. The population of bumblebees in this meadow is composed of many individuals. Each individual has a unique **genetic variability**. These three different bee populations are part of a community of other organisms (birds, butterflies, frogs) in this meadow ecosystem. Each of these species is adding to the species richness of this ecosystem. This meadow is one of many ecosystems (woodland, wetland, etc.) that occur throughout a deciduous biome.







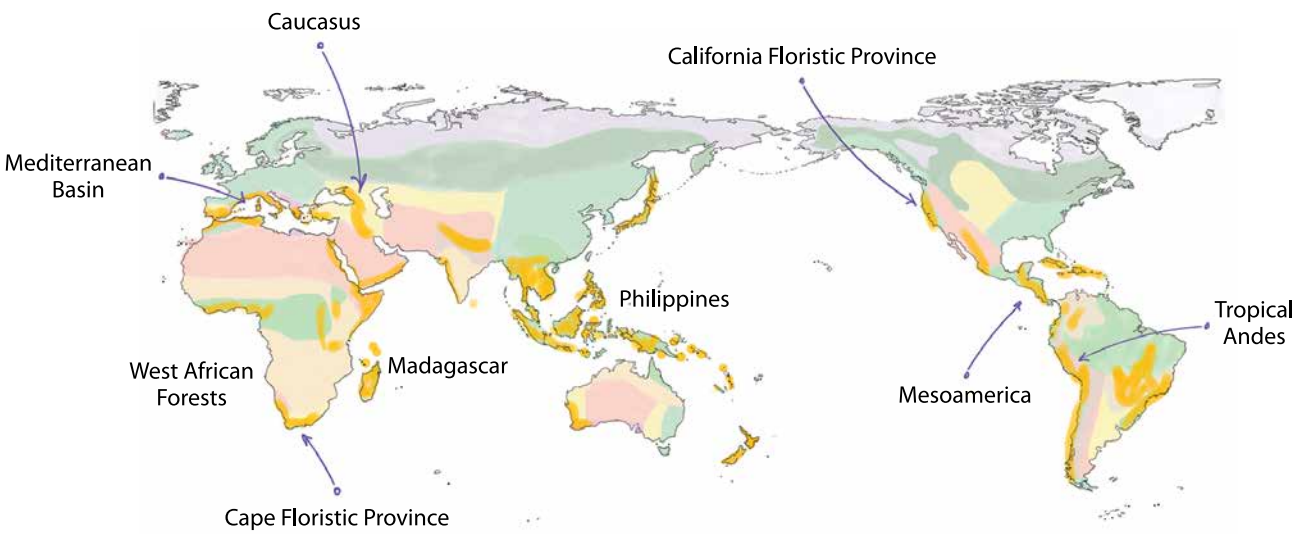
Species Richness Is Productive

Species-rich landscapes are particularly productive. Two landscapes with similar access to sun, soil, and comparable terrain, but a difference in species diversity will have different productivity, with increases in favor of the diversified landscape. This is because diverse organisms partition resources and create companionships. There is more **net primary productivity** (a measure of photosynthesis production in biomass) in **layered ecosystems** (woodland) than there is in a **single-species system** (wheat field or lawn).

Biodiversity Hot Spots

Some areas on Earth have particularly high biodiversity. Other regions have high biodiversity and also high **endemic diversity**, with species that occur nowhere else. And some have especially high *edible and useful diversity* for humans. Within any biome, areas of diversity richness can occur, and these are worth treasuring and marking for conservation and restoration efforts. Biodiversity has been a cornerstone for societal success and is one of the greatest allies we have for a future of wealth and wellness. It is important to note that these diversity-rich areas can occur as micro-ecosystems anywhere! They might be found in your backyard or in an abandoned industrial lot. Because human communities have been built in areas of high diversity, *some of the most important ecological resources are close-to-home*, and they demand our attention before they are lost. These are also proximate to us for maximum services to society when restored.

These are some of the most biodiverse areas on the planet. They are known as biodiversity "hot spots."

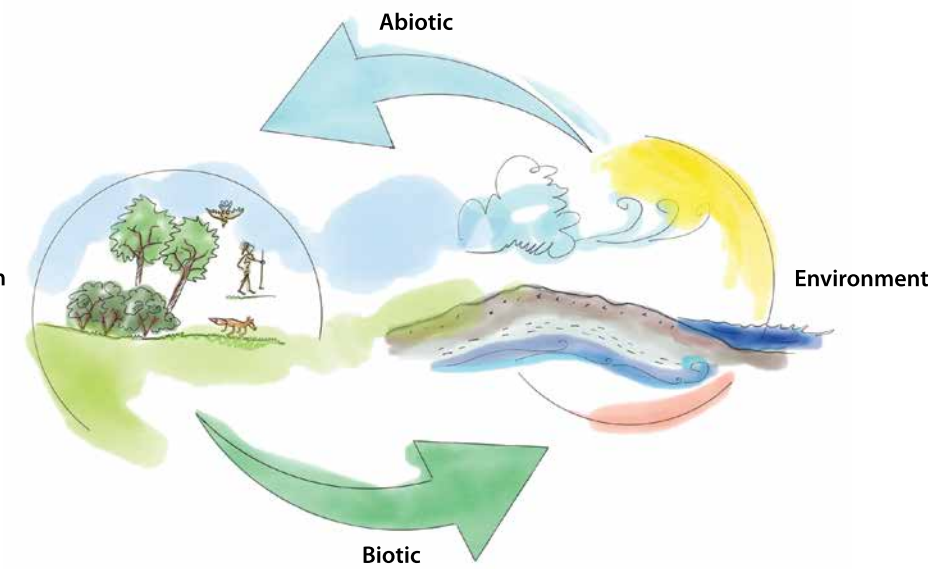


Ecosystems

Let's go closer. *North America, like all other continents, is a blend of ecological landscapes, or ecosystems, that support and are supported by biodiversity. Humans have made their home within all these ecosystems and have been supported by their biodiversity.*

What Is an Ecosystem?

An ecosystem is defined by dynamic interactions between **living** (biotic) organisms with each other and with their **non-living** (abiotic) environment. Humans can be part of an ecosystem. We constantly interact with other organisms, such as trees, foxes, and fungi, and certainly with each other. Our interactions with edible and useful plants, animals, and other life forms are of particular importance. Humans have always been connected to **edible and useful biodiversity**.



Ecosystems consist of organisms: animals, people, soil bacteria, etc., interacting with their environment (sun, water, air, minerals) and each other.

Ecosystem variations emerge where environmental differences within a biome's landscape occur. Due to subtle **micro-environmental** changes in a biome (moisture, terrain, soil, etc.), there are variations in plant and animal diversity composition. In a deciduous biome, a dragonfly could fly over three distinct ecosystems: meadow, wetland, and woodland. As we shall see in this book, the site-suitability of ecosystems to their environment is an important consideration in re-envisioning how humans design their landscape to work within **environmental constraints** and provide the benefits of different ecosystems.

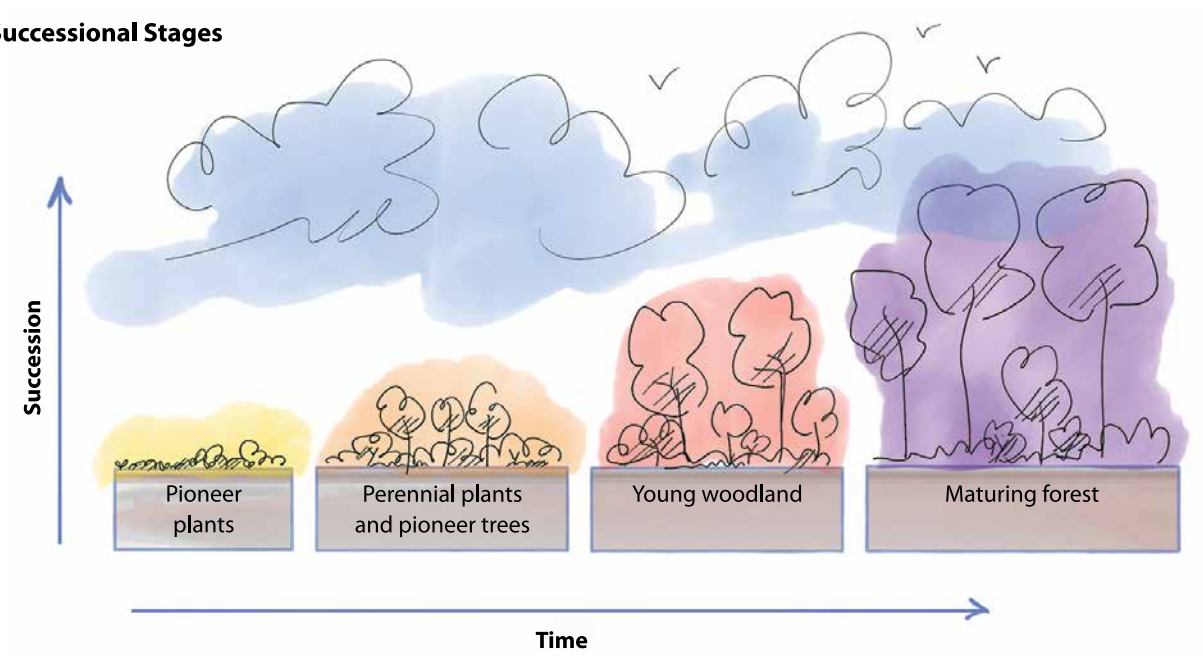
Three ecosystems shown in a cross-section of a deciduous biome.

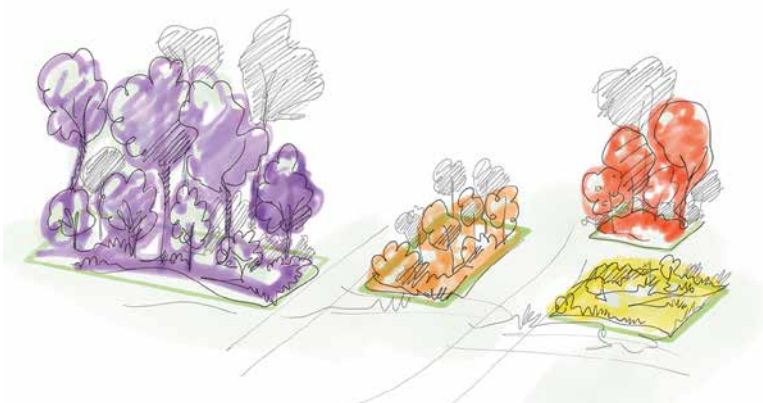
Ecological Succession

To understand ecological **succession,** picture the barren rock and pebble landscape left after the retreat of the glaciers at the end of the last glaciation here in the Northern Hemisphere (18,000 to 10,000 years ago). This rocky ground was slowly colonized by life. First came lichens, mosses, and then perennial herbs and grasses, followed by shrubs and sun-loving trees. Eventually, shade-tolerant tree species germinated and grew up to become part of a mature woodland ecosystem.

Our modern landscape is in a **stagnation of succession**; we spend a lot of money and energy fighting the natural phenomena of ecological succession, which provides us with benefits, as we shall discuss later on. Land planning that includes space for maturing our land use as evolving ecosystems will enjoy various benefits such as carbon capture, genetic resources, and water purification.

Successional Stages





A mosaic landscape of different successional stages maximizes biodiversity and other ecosystem benefits.

Here, we see a woodland, riparian, and prairie ecosystem meeting. This edge environment is very abundant.

The Productivity Between

Ecosystems in the intermediate stage of succession are very productive. The edges between different ecosystems at different stages of ecological succession are even more productive. Remember, **diversity is productivity**. So, a resilient and productive landscape is one with multiple types of ecosystems, with high species richness, at different stages of succession, and adjacent to each other. This is one of **nature's key lessons** that we can apply to land-use planning. If we redesign our cities, suburbs, and farms to include more diversity of ecosystems, and if we stagger their successional stages and improve the species richness of these landscapes, we create strong foundations for societal resilience in the face of disasters.

Ecosystem Form

Ecosystems have organisms with different forms (size and shape). For instance, in a woodland ecosystem, the plants have a variety of growth habits. Some grow tall, some creep along the ground, some climb, and some trees grow so high as to almost touch the sky. The form of a woodland ecosystem is easy to identify: it is well layered, and, in its mature state, the trees are large.

The same layering of different shapes also appears in a prairie ecosystem. Here, some grasses (such as big bluestem) can reach six feet tall; some are only a few inches high. The layering in the prairie is even more evident *within the soil* because some plant roots can grow 30 feet down.

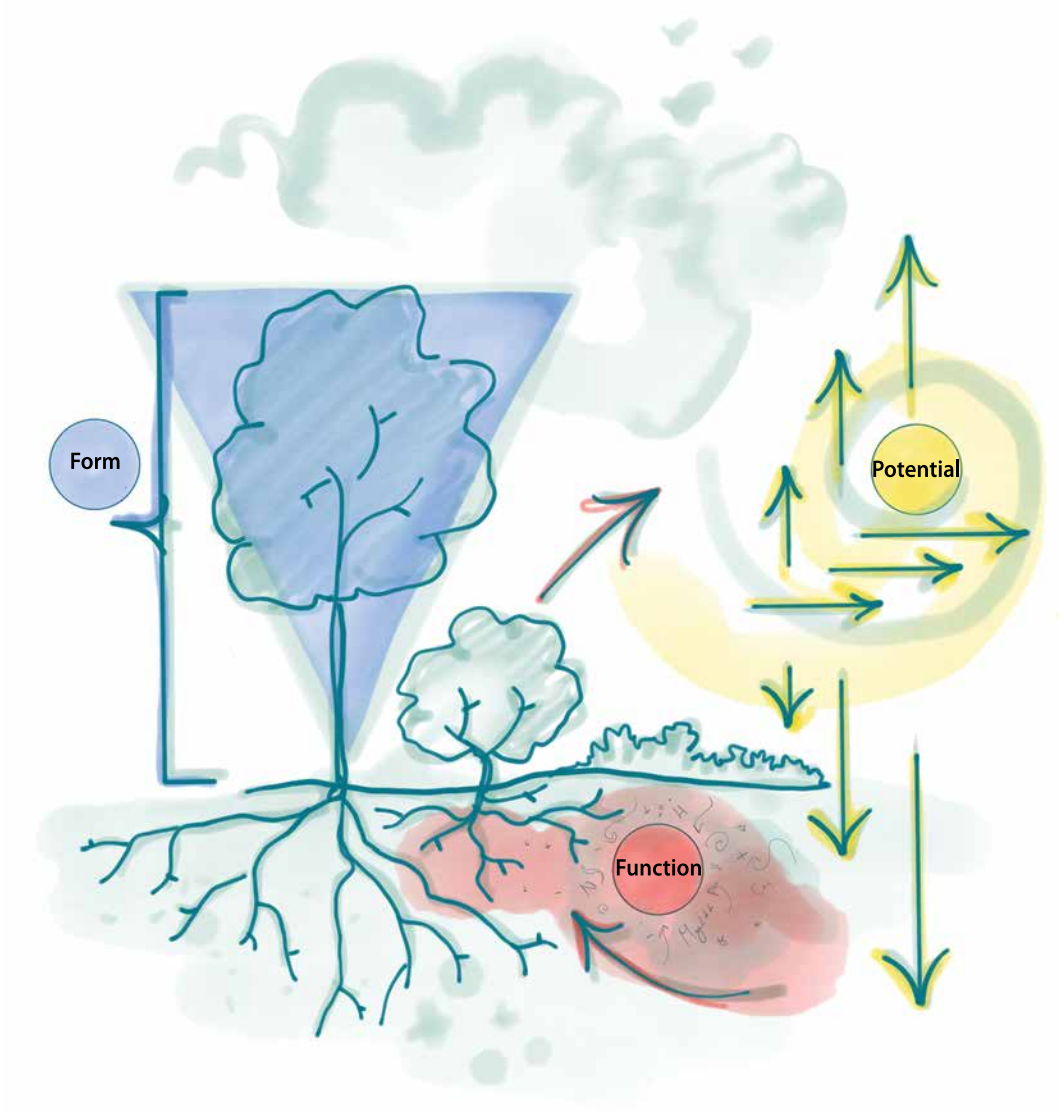
Understanding the form of an ecosystem is important for maximizing land use in modern society. As we have already seen, a well-layered ecosystem is more productive. Integrating diverse layers in our farms and communities has benefits for humans that include increased carbon sequestration* to mitigate climate change and higher yields of desirable products like fruit or wood.

* Carbon sequestration is the removal of carbon from our atmosphere through the photosynthesis of living plants and its storage in their trunks, branches, roots, and the soil.

Tallgrass prairie ecosystems are diverse and layered ecological landscapes. Note: *This sketch is an illustrated copy from an interpretive panel at the Tallgrass Prairie National Preserve, Kansas, and clearly illustrates the depth and shape of diverse prairie plants.*

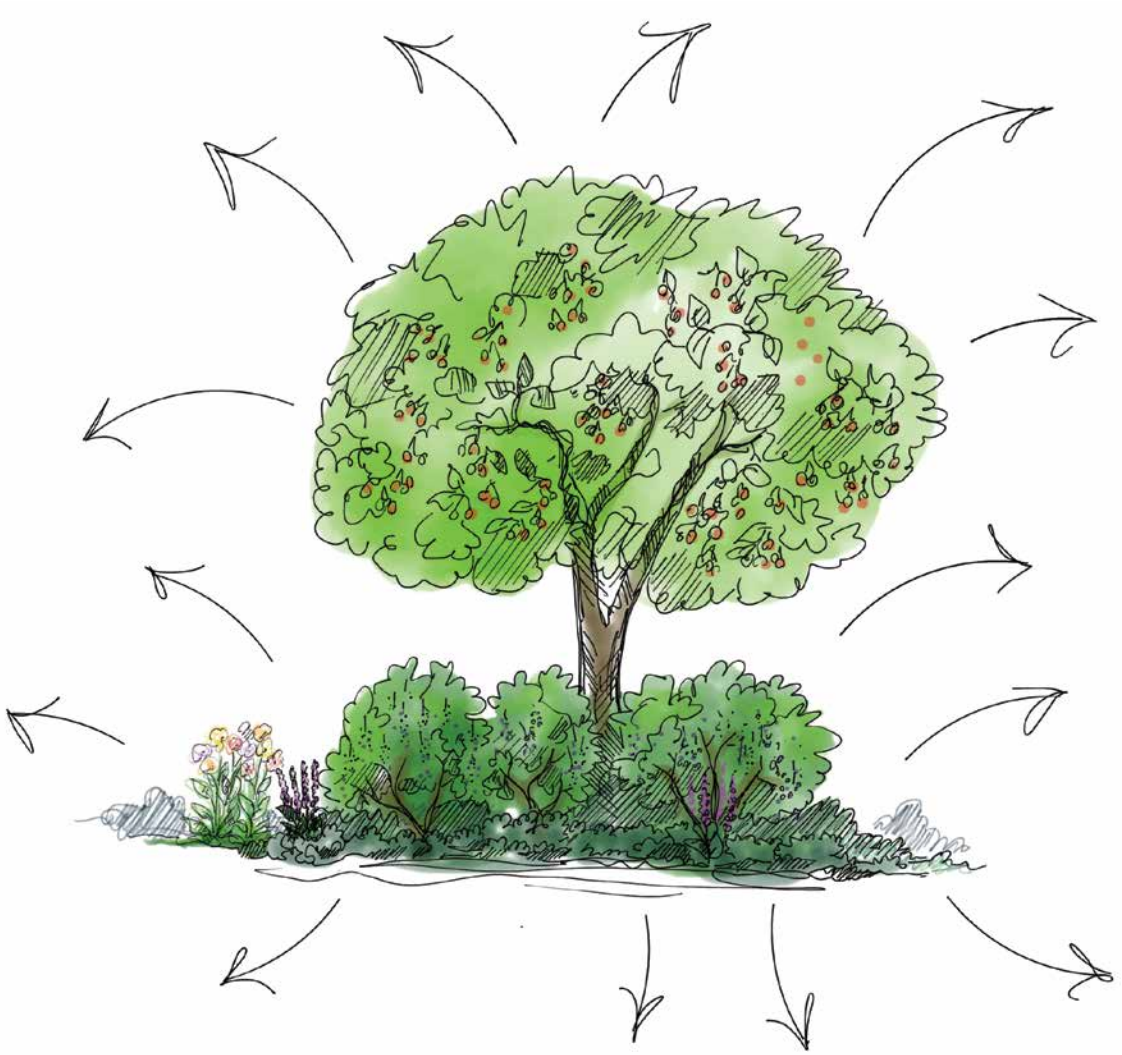
Ecological Function

The plants, animals, and other organisms in an ecosystem have roles to play for their own life cycles and for the system as a whole. For instance, plants with prolific flowers in spring attract pollinators, which are then nearby when fruit trees need pollination in early summer. It is said that form follows function. Certainly, the different shapes of plants in a woodland ecosystem are indicative of function. For instance, plants that creep on the ground help stabilize soils to the benefit of the whole system. The result of a diverse system is more potential benefits for all creatures in a given community.



Ecosystem Services

Ecosystems have a multitude of benefits for humans; these can be thought of as ecosystem *goods* (resources) and *services*, or just the catch-all *ecosystem services*. Goods include products like fresh fruit, air, and kindling. Services include how ecosystems manage Earth's life-support systems, purification of water, soil building, sustaining biodiversity, etc.



Whole-System Potential

As a whole, ecosystems have tremendous potential. As time passes, they literally *build* potential, meaning there is more to go around for individual organisms, including humans, and they store potential that can be transferred to future productivity. Examples of ecosystem potential are the variety of seeds stored in a soil's seed bank, the buildup of organic matter in the soil, and the accumulation of carbon sequestered in the trees.

Consider the potential of a single tree. When an almond seed waits to germinate, it has its whole life ahead of it. As an oak seedling emerges, it is vulnerable; many growing together means some will survive. As a pear tree grows strong, it can offer more and more to the ecosystem as a whole. It has so much to offer humans, too. A maturing ecosystem can initially offer us berries and kindling; then it might provide fruit, nuts, and shade, and finally, it would yield lumber, medicinal and edible mushrooms, and copious seeds for future tree planting. While a young tree can bear only a handful of pears, a mature pear tree might bear 300 pounds of pears. *From one seed comes this pear tree that has the potential to produce 30,000 seeds.* Of those thousands of seedlings, only a few become old-growth trees, which is why we have only a few heritage trees left.

The depth of soil that was built by the prairie ecosystems of North America is another example of whole-system potential. The deep soils had a high capacity to hold water through droughts and provided great nutrient exchange. It was a productive ecosystem and habitat for many useful animal species, such as the bison. This ecosystem was very beneficial to humans for the last 10,000 years.

It is, tragically, almost gone. Because it was so productive, it was quickly turned into farms in the 19th and 20th centuries for **short-term agricultural gain**. However, this is resulting in **long-term pain** for our society because

Soil organic matter is one of the most incredible results of mature ecosystems. It has immense potential to improve crop yields while helping mitigate climate change and other natural disasters.

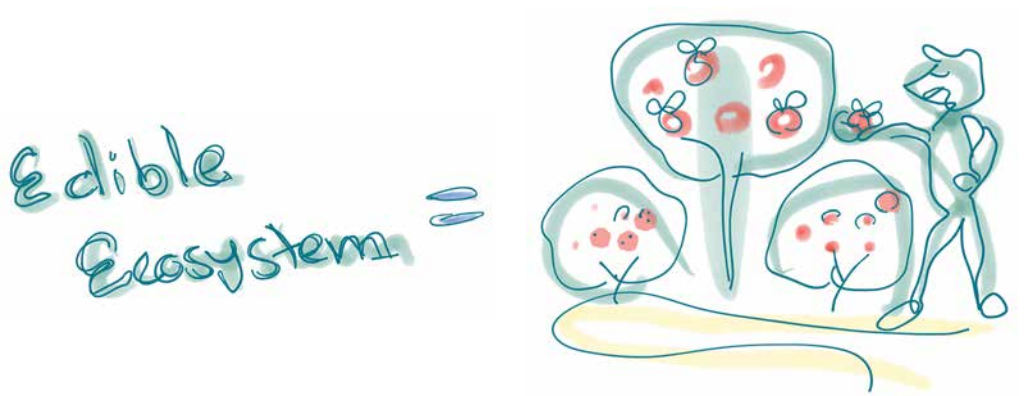
we have literally eroded this amazing resource and are no longer benefiting from prairie ecosystem services. Returning the corn and grain belts of North America to a mix of regenerative farming and ecosystem restoration can help reverse climate change and improve farm productivity by recapturing carbon and putting it back into our soil, and using it to improve yields.

This prairie ecosystem has high species richness. The diverse plants have different forms and functions and provide habitat for many grassland birds, butterflies, and bees. It was also home to one of the most important species for human society to ever roam the Earth: the bison. The ecological potential of the prairies is their deep, rich topsoil, which is now being farmed across Canada and the United States. As such, there is less than 1% of the original tallgrass prairie left. This current land use is not building potential; it is mining, as a finite resource, the product of a once-regenerative system.

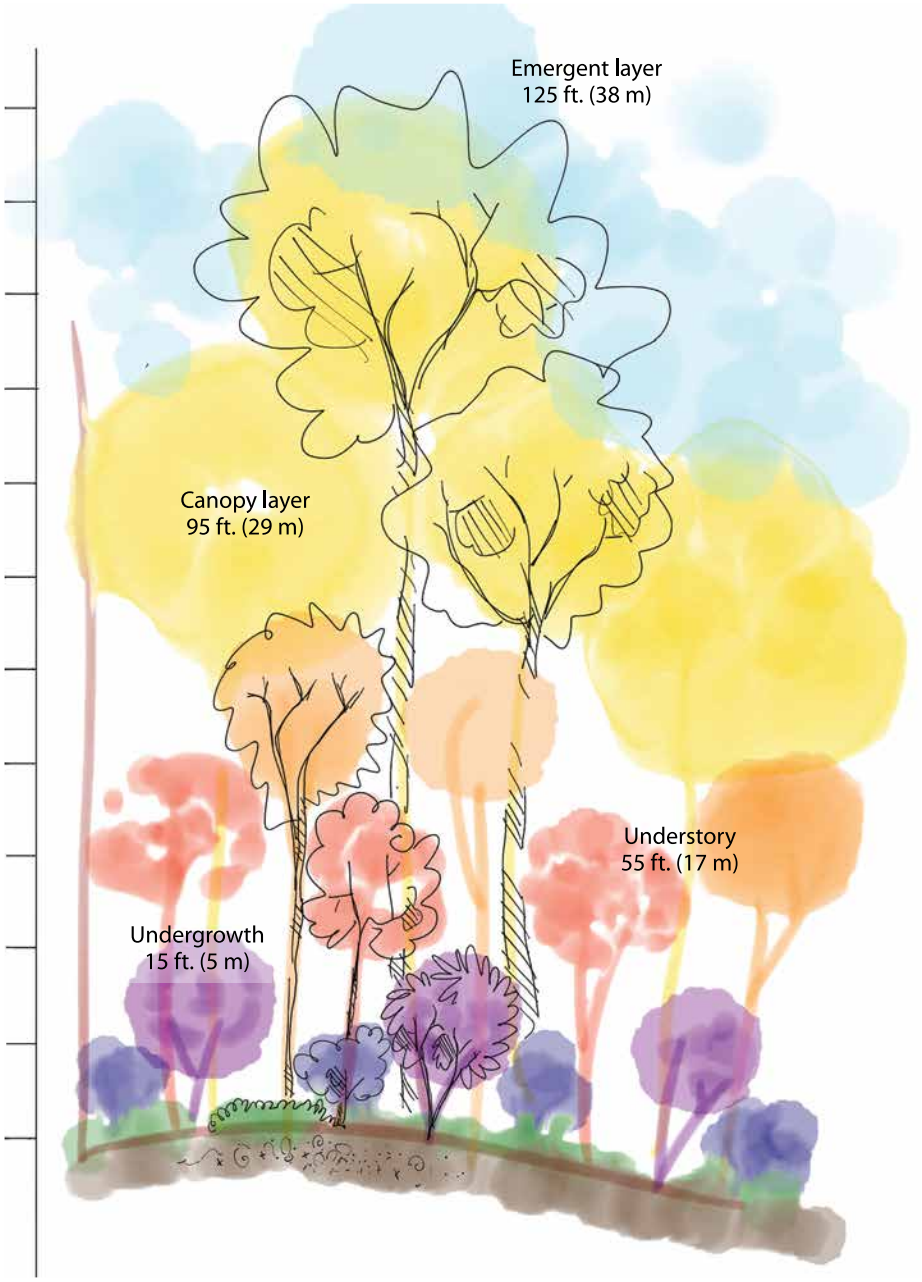
What Is an Edible Ecosystem?

An edible ecosystem is like any ecosystem, except it has more edible and useful plants. Edible ecosystems can be wild, or they can be designed and planted by humans. Sometimes, an edible ecosystem is right under our nose, and we just have to recognize what is already there. And sometimes it requires the purposeful cultivation of a food forest, with plants chosen for their usefulness to humans.

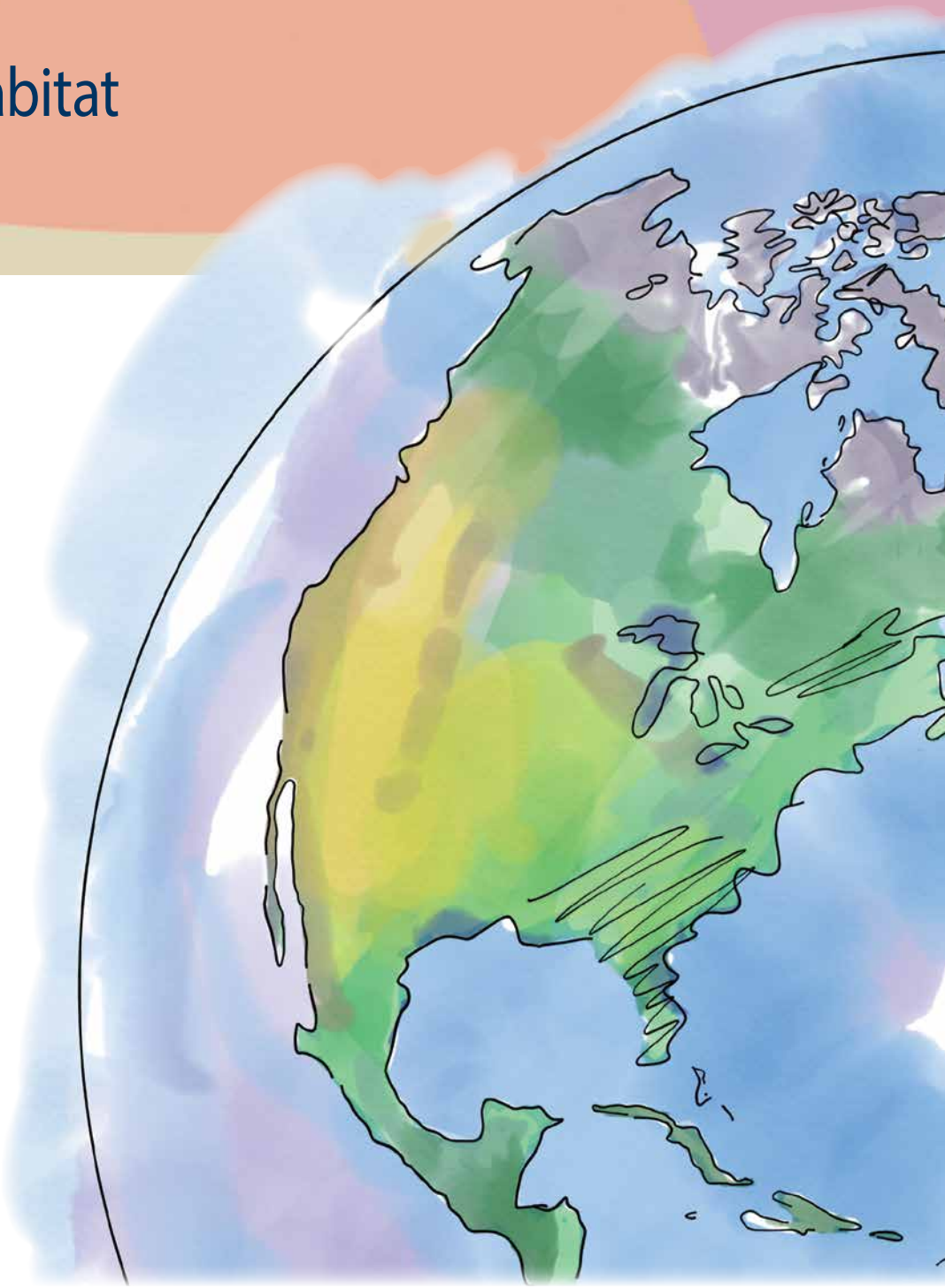
A forest is an ecosystem; a fruit forest is an edible ecosystem.



An edible ecosystem has a diversity of edible and useful plants for humanity. Humans have always been drawn to edible diversity, orientating our internal compass to true food north.



Human Habitat



Zooming into a continental view of North America, *we see a kaleidoscope of ecosystem habitats. The establishment of human habitat has always been driven by accessibility to edible ecosystems. We have traditionally migrated for this abundance and still orient our daily and yearly routines around food and depend on biodiversity for societal success.*

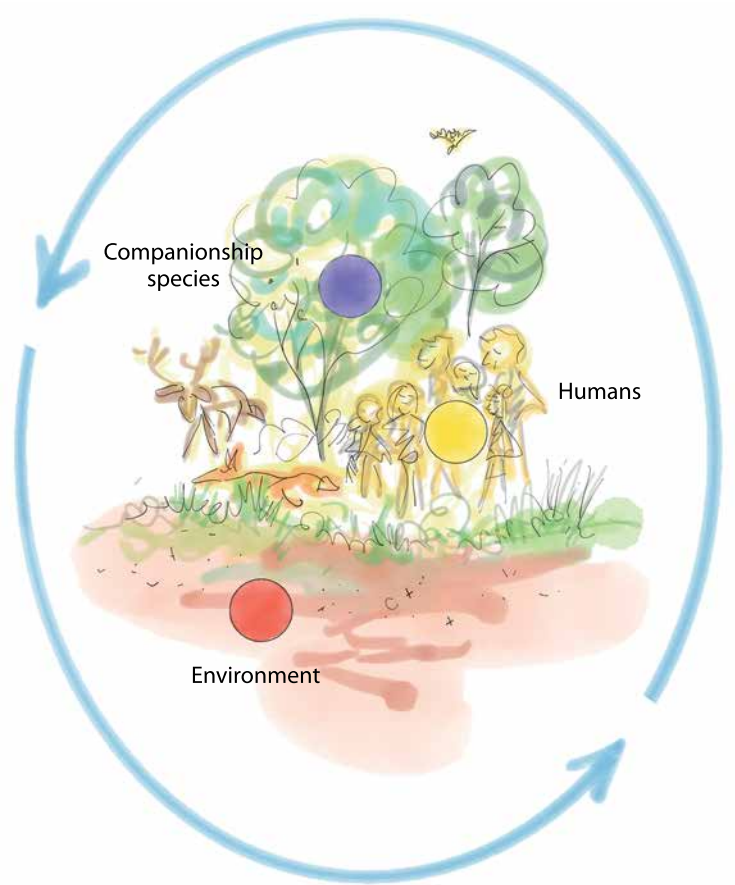
What Is Habitat?

Habitat is the environment where an organism (bee, bear, or butterfly) lives. A habitat can be a hollow log or an entire forest, depending on the how far the organism has to travel to find its necessities. A bear's "bare necessities," as Baloo famously sang, would have consisted of food (honey, berries, insects), water, shelter, and community. The area that provides access to these necessities is what defines a bear's habitat.

Diverse Edible Ecosystem Abundance

Every creature has its home and is adapted to its unique climate and mixture of species. Human adaptation to diverse environments has occurred over millions of years. We now occupy every single terrestrial biome on Earth* and nestle into many of its more challenging ecosystems. But, in particular, we are **drawn to areas with diverse edible and useful abundance.** These are our habitats.

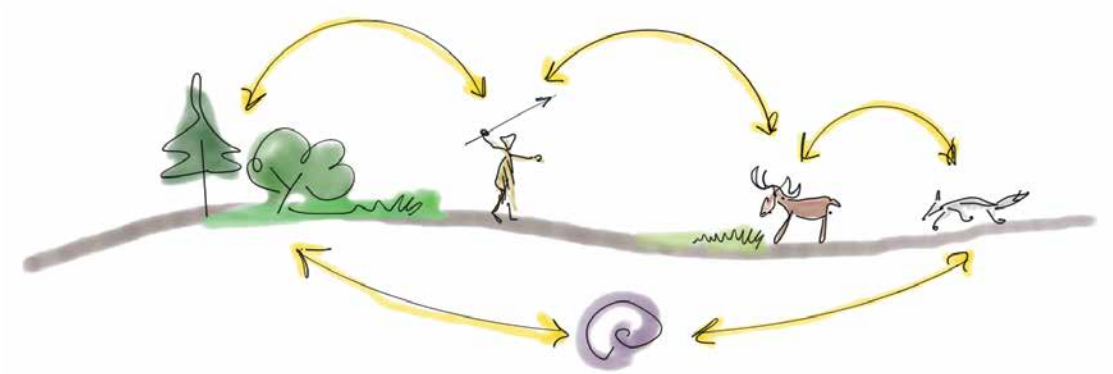
* Humans have only recently set up permanent habitat in Antarctica, but come on, you know what I mean!



We (yellow) are intrinsically linked to the environment (red) and made our habitat in diverse and abundant ecosystems with many companionship species (blue).

Human Habitat

Edible ecosystems, such as fruiting woodlands or berry meadows, make up our **ancestral human habitat**. *Homo sapiens* **evolved** within edible ecosystems, and our cultures and civilizations formed from this diverse ecological abundance. Ecosystems provided life-giving goods and services, generating wealth, technology, and community. Ecosystems also offered challenges such as disease, competition for food, and lack of shelter; still, we prospered and spread around the globe on the foundation of biodiversity.



Living organisms interact with each other as a community. Ancestral communities relied on the interrelationship of the various parts of an ecosystem.

Abundant Edge

All ecosystems have edges where they meet other ecosystems; at *ecotones*,* there is a gradual shift in species complexity across the landscape. This change can also be abrupt.

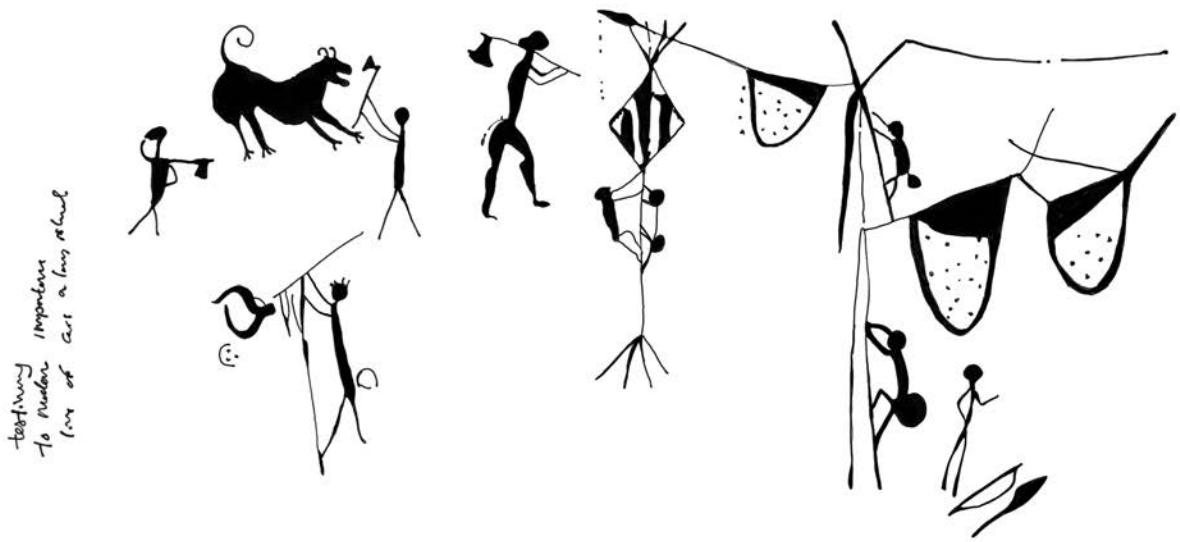
For instance, a cliff can divide an upland grass ecosystem from a seaside ecosystem below, such as we see along the cliffs of Dover, England.

Whether gradual or abrupt, the edges of ecosystems are very diverse. The principle of edge diversity is well documented. For instance, there is a marked abundance in riparian ecosystems (where land and water meet), as well as woodland ecosystems (where open grasslands meet dense forest). A famous example is the edges that occur within a tropical rainforest, where towering trees and multi-layered canopies create distinct vertical ecosystem strata above a single acre of land. Biodiversity flourishes amidst the many **ecological niches** created vertically and horizontally in a mature forest where different environmental conditions (sunlight, moisture, heat) and ecosystem dynamics occur. For instance, different species of birds are found at different canopy layers; in the emergent layer are found many birds of prey where they can spot their game, whereas in the canopy layer there may be more fruit-loving birds.

* A transitional area between two distinct ecosystems (field and forest) on a local scale, or biomes (boreal forest and prairie) on a regional scale.

Proximity to Edible Abundance

Humans have always been drawn to these **ecological edges**, especially those full of edible and useful abundance. We migrated between and settled areas of biodiversity. We were inspired by their bounty and gathered seasonally to enjoy it, to save it for later, and prepare for its return. Our wealth and health were entwined with edible ecological abundance. Edible ecosystems provided for our needs and proximity to them meant survival. For 200,000 years, human evolution was influenced by accessibility to ecosystem abundance. *Humans that could find, harness, and maximize an ecosystem's yields became leaders and progenitors*. It was the "survival of the food-finding fittest," and this means our bodies and minds are tuned to this ecosystem origin. It was—and will be—societies that regenerate this biodiversity that stand the test of time.



Mesolithic petroglyphs in Rajat Prapat, India, depict an abundant cliffside honey harvest from Apis dorsata.[2]

Ecosystem Evolution

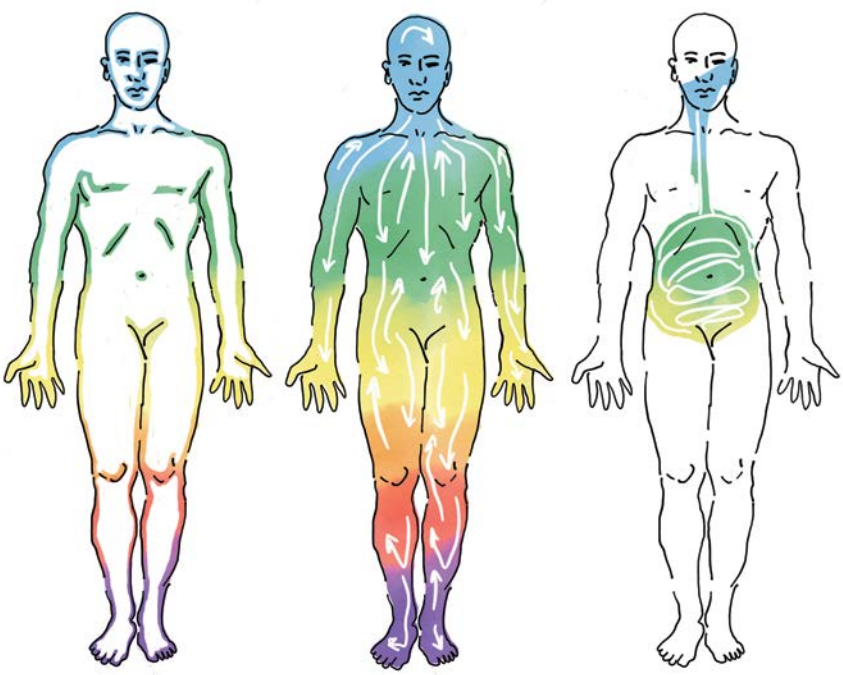
Humans evolved within wild ecosystems. Our physical bodies, minds, and nervous systems adapted to the dynamic and diverse nature around us. We were surrounded by the sights, smells, sounds, and textures of ecosystems. They engaged our bodies, minds, and spirits.

The human body, mind, and nervous system haven't evolved much since we left the wild edible ecosystems. What has changed is our culture. Much of what makes the humans of today different from those of 10,000 years ago is what we are taught from a young age. Our differences are mostly learned and less genetic. If you took a human of 5,000 years ago and plunked them down in the middle of Manhattan, they would probably have a panic attack, but if you brought them up as a child, they could be taught to drive a car or negotiate a grocery store as well as the average person today.

We have the potential to reteach **ecosystem intimacy** and mentor stewardship at a young age. This could create generational change, leading to more ubiquitous ecosystem health and wealth.

"We love nature because we learned to love the things that helped us survive. We feel comfortable in nature because that is where we have lived for most of life on Earth. We are genetically determined to love the natural world. It is in our DNA."

— Dr. Qing Li[3]

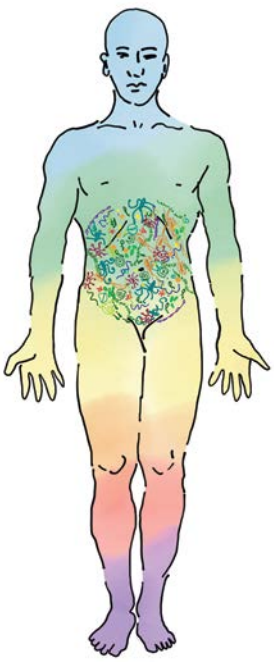


Our minds, bodies, and nervous system are hardwired for the wild, original nature we evolved within.

Ecosystem Within

There is an entire microcosm of life within, on, and around us. The human species evolved within ecosystems, and they evolved within us. Our intestines, stomach, and other organs are teeming with microorganisms that form a micro-ecosystem (**the microbiome**). We are habitat to some 100 trillion microbes.[4] There are significantly more "good bugs" than "bad bugs" in our bodies, and they improve our health in such ways *as aiding in the digestion of our food and improving our immune system*.

When we live in a healthy environment and eat nutritious food, breathe clean air, and drink good water, our microbiome is more likely to be in a state of homeostasis, and we remain healthy and optimally functional.[5] Our microbiome is full of life, and when we are exposed to toxins or neglect necessities, this upsets the balance of a healthy living system within us. Complexity requires complexity to maintain a balance. When our internal biodiversity is lost, we no longer can benefit from their many services.



We are within our ecosystem, and the ecosystem is within us. Diversity provides many benefits, and balance comes from a healthy habitat inside and out.

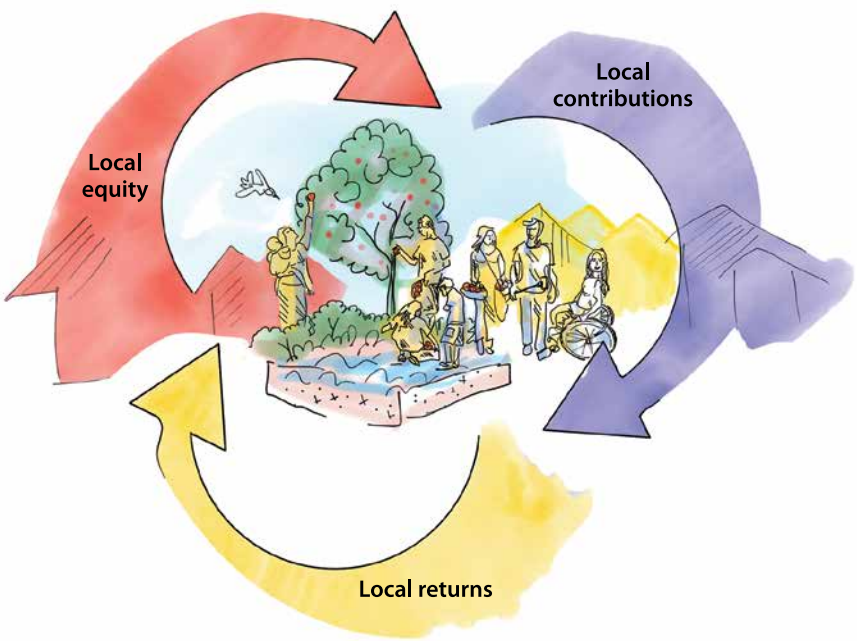
Ecological Niche

Like humans, butterflies are found in almost all terrestrial ecosystems, and they also migrate long distances. Their niche includes eating the leaves of plants when they are caterpillars; then, as butterflies, they dine on the nectar and help the plants cross-pollinate.

An organism's ecological niche is its role within the ecosystem community. Its niche encompasses the resources and services it uses and those it provides. Humans have a broad niche; we are generalists, meaning we can make do in many situations. We have adapted to different climates, and we can eat almost anything—from oysters to arugula. As generalists, we have been able to migrate and settle almost the entire globe and have carried foods from the major centers of plant domestication with us. We are significant dispersers of food plants and seeds. This influence on the propagation of edible ecosystems is part of our ecological niche. *What is your ecological niche?* How do you contribute to your community? Let's reimagine this role as **food plant dispersers** in our modern context: What life forms exist within your community currently or might exist with a change in the landscape? And where do you currently receive ecosystem benefits, such as food, from? Is it possible to have these nearer to home, and could you be a catalyst for this change? The answer is yes, and it is a very human attribute for us all to influence the edible landscape of our communities.

Thrive or Survive

Are you thriving or surviving? If you give contributions to your community and receive resources and services in return, you exist within a balanced niche. Humans want to thrive and not just survive, but when we thrive within a global system, we need to provide global support for the regeneration of the ecosystems that support us. When an individual's contributions and returns are local and direct, a community is more sustainable and resilient. As Theodore Roosevelt said, "The nation behaves well if it treats its natural resources as assets which it must turn over to the next generation increased, and not impaired, in value."[6]

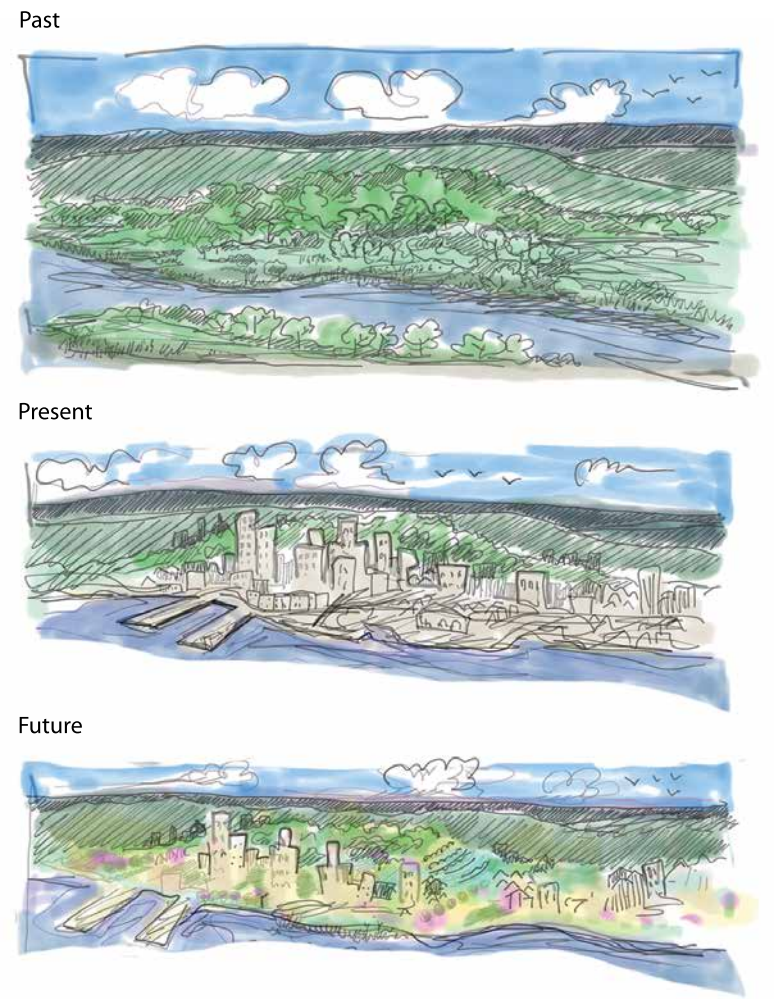


The Acceleration of Land Use

The human desire to thrive rather than just survive is what drove humans to change how we interacted with the land. We began to domesticate and cultivate diversity to secure our sources of wealth and well-being nearer to home and to manage seasonal productivity. This tendency to desire a better life is not a bad thing, but it did drive us down a road of intensive ecological intervention, and what seemed like a good idea—agriculture and technological development—is now on a crash course.

Humans' abilities to organize our ecosystems accelerated generation to generation, society to society. With the advent of modern technology and urbanization, the power of humans' ability to shape natural systems outstripped the pace at which natural systems could regenerate themselves. We are exceeding the biocapacity of our planet. This has consequences for human health and societal wealth if we run out of what we need to thrive and survive.

Montreal was built on an island of diverse abundance and could be returned to this biodiversity as part of a new cultural landscape.



Short-Term Gains and Long-Term Pains

There are three pitfalls to the seemingly incredible achievements of humankind and our development model:

1. **Our Societal Success Is Non-regenerative:** Despite our capacity to "conquer nature," ecosystems remain the source of our **societal wealth**, and unsustainable and non-regenerative practices will ultimately be our demise. The significance of ecosystem goods and services for human society can be seen across all of our cultural practices. Most human needs are met directly from our environment and biosphere.
2. **Our Health and Wellness Is Not a Priority:** Arguably our best preventative measure and remedy against disease is to live a healthy lifestyle in a clean environment. Human cognitive development moves faster than our physical evolution. Our bodies are accustomed to the qualities of a biodiverse world, and the monoculture model of land-use planning is undermining our primary health.
3. **Globalization Means Global Consequences:** We are no longer simply locally or regionally effecting change. Our non-regenerative socio-economic model is affecting the global life-support systems. In a way, we are *too* adept at survival for the *now*, rather than for long-term success. History shows that societies will *cut the last tree*, as they did on Easter Island. Communities with access to diversity thrived; those who didn't manage it sustainably expanded, warred, and collapsed.[7]

   Our pattern of using up resources, overpopulating an area, and then expanding our catchment area is getting old. Today, the catchment area is already global. It cannot be further expanded without seriously jeopardizing the cornerstone of our wealth and wellness: biodiversity and life-supporting ecosystems. Caring for your backyard is responsible sustainability. If you are accessing wealth from a global resource pool, then your responsibility grows. Frankly, humans are not capable of tracking responsible purchases on such a global scale, and political and corporate "fair trade" and "green" actions are rarely regenerative and equitable. It is better for communities to maximize the production of needed foods, and other ecosystem goods and services near-to-home and then import and export responsibly with other communities.

If there were ever a time to move on to the next stage in human land management, it is now. Edible ecosystem land planning provides for essential needs through community models, such as local farmers markets, community gardens, backyard orchards, pick-your-own hedgerows, and edible bike lanes.

Human innovation has and will continue to forge new ways forward using our cognitive might. Mightier still would be reimagining our place within natural systems and focusing our ingenuity on ecosystem solutions that will meet current and future needs.

Biocapacity and Ecological Footprint

An **ecological footprint** is a measure of our impact on Earth's life-support systems (demand and supply of Earth's ecological assets). These goods and services include the production of food, timber, and water, as well as the filtration and absorption of our regular and toxic waste. **Biocapacity** for any community, city, or region is a measure of ecological productivity, including the hectares needed for grazing, forest, and cropland, as well as fisheries and spaces for housing and infrastructure.

We would need five Earths to support society if everyone today had the same ecological footprint of the average North American.[8] Vancouver is considered an eco-conscious city, but even there, the ecological footprint is huge. Vancouver's total ecological footprint in 2006 was 10,071,670 gha (global hectares)*; this is about 36 times larger than the metro area itself.[9] Food production has the most significant impact on Vancouver's ecological footprint (which includes accounting for the land needed to produce food and the carbon sequestration required to offset the production and transport emissions).[10]

Another study found that the average UK resident had a carbon footprint** of 12.12 tonnes of CO_2. (This is the amount of emissions resulting from one person's use of ecosystem goods and services, direct and indirect).[11] As human populations continue to grow, and in consideration of a growing middle class globally, we will find our ecological footprint is reaching the Earth's biocapacity—its ability to sustain us with resources and services such as air, water, and food.

* The global hectare abbreviated as (gha) is the measurement unit for ecological footprint and biocapacity accounting. According to the Global Footprint Network, it is "a globally comparable and standardized hectare with world average productivity."

** Carbon footprint is the measure of total emissions caused by an individual, company, or nation. It is a factor in our ecological footprint and is currently a major cause of anthropogenic climate change.

Most modern communities have built up an ecological deficit because the population's ecological footprint exceeds their regional biocapacity. Community use of resources and need for ecosystem services is far beyond the local ecosystem's capacity to renew them. Thus, our demand for goods and services is being met by far-off ecological reserves in areas where biocapacity is higher, and the local footprint is lower. But, globally, this is reaching a critical threshold of global footprint surpassing global biocapacity.[12]

Natural Capital Loss

We are losing our natural capital—the wealth that is responsible for all of human success and is still our primary source of societal wealth and well-being. Topsoil, old-growth forest, clean air, and water—all our ecosystems are being consumed, polluted, and degraded. Top on the list of concerns is the loss of biodiversity. We are in the midst of the **sixth major extinction Earth** has experienced during its 4.3 billion years of formation and evolution. The importance of this loss of wealth is incalculable. The preservation of biodiversity could yield pharmaceutical discoveries, new foods, and remediation of toxins in our soil and water. The simple economic value of our natural wealth is immense, and there is so much biodiversity we haven't begun to benefit from in our current development model. We need to evaluate diverse wild ecosystems before we replace them with low-diversity land use, while also redesigning our typical development to be more diversified. An approach to land use planning that focuses on diversity will regenerate our natural capital and strengthen our societal resilience.

On traditional grazing land in Mongolia, a gully is opening up as a result of compaction from motorbike and truck traffic that ranges across the grasslands. My guide told me these areas were flat just ten years earlier, but little changes in the land from tire ruts led to the flooding and erosion that has now produced extensive gullies. Our ecological footprint can be improved through good design and care for landscapes.

Learning about pollinator species, from bees to butterflies, their benefits, and habitats is a great outdoor activity. Humans have been enjoying city parks and the great outdoors for centuries, and now we can build upon this with an enthusiasm for the ecosystem services the spaces provide, creating new pollinator gardens, and reducing harmful toxins.

Stewards

Now, for the first time in history, an individual's ecological niche is global. We cannot really manage being a responsible consumer and meaningful contributor on this scale. Clearly, humans have a high capacity to alter ecosystems—primarily for short-term gain. For humans to truly thrive on planet Earth, we need to embrace our ecological niche as *stewards of the ecosystem, not exploiters*. Some of the principles about how to do this can be found in humanity's past, though we will need to reinvent and reinterpret them in light of humanity's present.

Stewardship

Stewardship is the responsible planning and management of our resources. It can be applied to various professions, a property, or the environment as a whole. Our society's stewardship of Earth's natural capital might include both a community's stewardship of single forest or an individual's stewardship of their yard. Stewardship is a critical part of societal success—through stewardship, we protect ecosystems so they can function for our benefit. It is also something that needs to be incorporated into every business, taught to our children at a young age, and recognized as one of the most important new "green" job opportunities of the future.

There is only one Earth, and we are all in this together. Stewardship is the way forward.

We can go somewhere we have never been before. Our true niche lies within **accessible biodiversity**, which, by definition, mandates the regeneration and growth of our habitats. We should all participate in this and enjoy the results. With the right design framework for landscape transition and generational changes bringing new ethics and aesthetics, localizing many ecosystem goods and services can become the norm for our global society.

Stewardship is a powerful means of making change through exemplifying, mentoring, and sponsoring change in our communities (this will be discussed further in Section 5).