ROT COLLECTIVE

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Introduction

What this is

This e-book is a digitized version of the @rot_collective infographic series normally published to instagram. Rot Collective publishes content around ecology, human interaction with the environment, and how to build a more just and resilient world within their intersection.

The intention of this book is to provide an accessible format for those who prefer longer form and text-based reading with less graphics, along with providing image descriptions for those using TTS applications.

Some of these articles have been updated to be more clear concise and readable, or to correct information and messaging from the original articles. Sometimes we have merged multiple posts together in order to improve flow.

This is intended to be a living document which is added to over time. The current version and update information can be found in the version history.

Who we are

We are a collective of individuals who do on the ground ecological restoration work, with a focus on the New Jersey area. We are self taught and do not have any formal ecological qualifications.

We wanted to share what we learned and how we learned it, to enable others to join us in caring for the landscape. All readers are encouraged to cross-reference and check our work, because our lack of formal training has left us with knowledge gaps of unknown size.

Take our publications with enormous grains of salt.

Sharing & publishing

We released this document under Creative Commons Attribution-ShareAlike 4.0 International License so that people can distribute this as a zine if they wish, including selling copies to raise money. Although we have no method to enforce this, we ask that sellers also provide free copies or a link to this digital file for those who cannot afford a purchase, and that any money raised be redirected towards projects making a more just world - especially but not limited to those which have a focus on the ecological landscape.

Please also do not interpret this document being distributed as a sign of authority or infallibility. As we stated before we are not formally trained in ecology, and an unknown portion of this document is likely inaccurate.

Please use this text as a jumping off point for your own learning instead of seeing it as dogma or fact.

What we believe and what we don't

We think ecology belongs to all humans by birth. That relationship and the core information necessary to conduct that relationship effectively cannot be ethically paywalled or rendered inaccessible.

We believe the land rightfully falls under the direction of the indigenous peoples who lived there prior to colonization, and that they by right deserve the autonomy to make decisions on land management. Basic ethical reasoning and all scientific data has pointed towards indigenous held land (including landback efforts) being the best choice for our future.

We do not speak for Indigenous people until or unless an Indigenous person who wishes to speak joins our collective. Please look to Indigenous speakers for their knowledge and leadership. As part of that, we may on occasion cite or reference a public-facing statement from Indigenous people. We will always do our best to direct readers towards those individuals when we cite their words - please correct us if we ever fail to do so.

We also think that non-indigenous land-based cultures can provide key insights into sustainable land usage within their cultural range. Many of these cultures and traditions - such as those coming from rural areas of Appalachia - are often unjustly stigmatized. We wish to lift up the wisdom and joys of these cultural pathways and honor their skilled practices.

We do not provide medical commentary, information, or advice, including the potential uses of plants some label as medicinal. We will only deviate from this if and when a medical provider in our collective and wishes to speak on a topic they're trained in. This is because medical knowledge is hard won and best offered by medical providers using science-based methodology. We believe that sharing potentially inaccurate or ineffective treatment modalities carries tremendous risk of harm and should be considered a grave responsibility. We do however believe in the bodily autonomy of individuals to make choices for themselves when given the fullness of accurate information.

We also know that many Indigenous cultures have ancestral practices which include plants and healing traditions, which is best transmitted between the people involved. We validate the inherent rights and necessity of Indigenous peoples to maintain autonomy, including in the continuance of cultural traditions. As outsiders we believe we play no role in this process, as we are not a member of any culture which maintains these intergenerational practices.

How to use this text

We have arranged this book into sections composed of articles, each article corresponding to an infographic post.

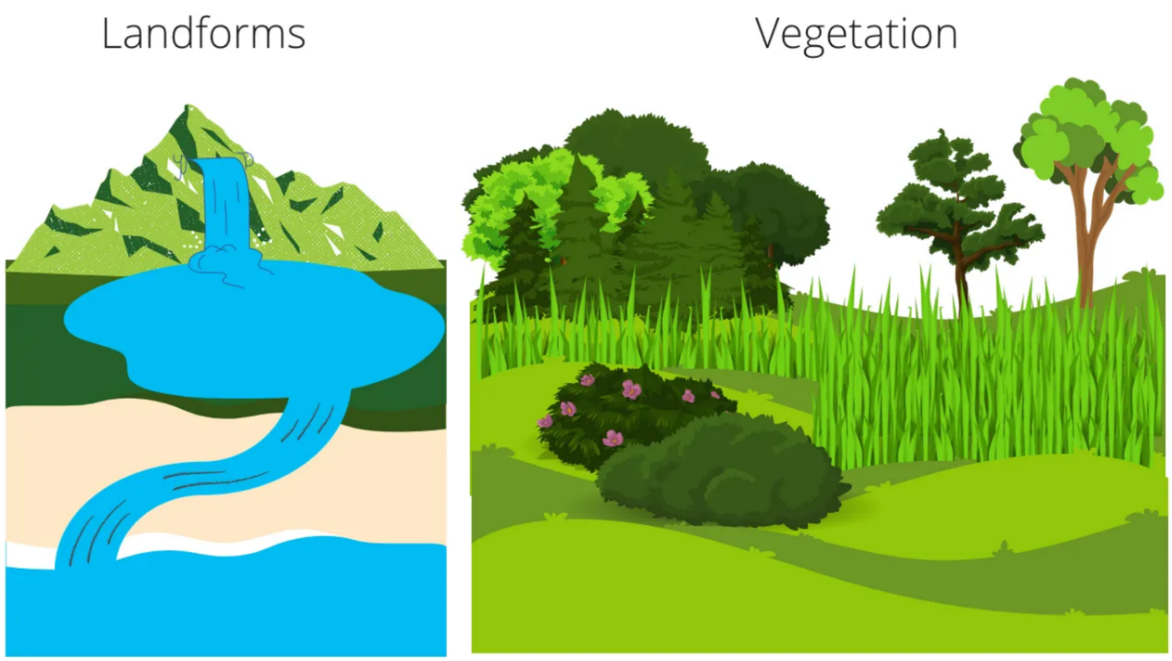
Although in our original posts we included bolding of words to indicate key concepts, and arranged images to flow with the text, neither of these are easily accessible to screen readers. Therefore the formatting may appear clunky or simplified to those visually reading the document. Please know this is an intentional choice. None of us use screen readers as a primary way of consuming information. Please give us feedback if any portion of this document is inaccessible or could be improved in readability.

Assume we are speaking about the New Jersey area or the eastern woodlands more broadly any time a physical location is not listed. Ecology is always place-based. Some of this information may be applicable to other areas, but that is for local people to decide in review of their landscape and the content in question.

Ecological Processes

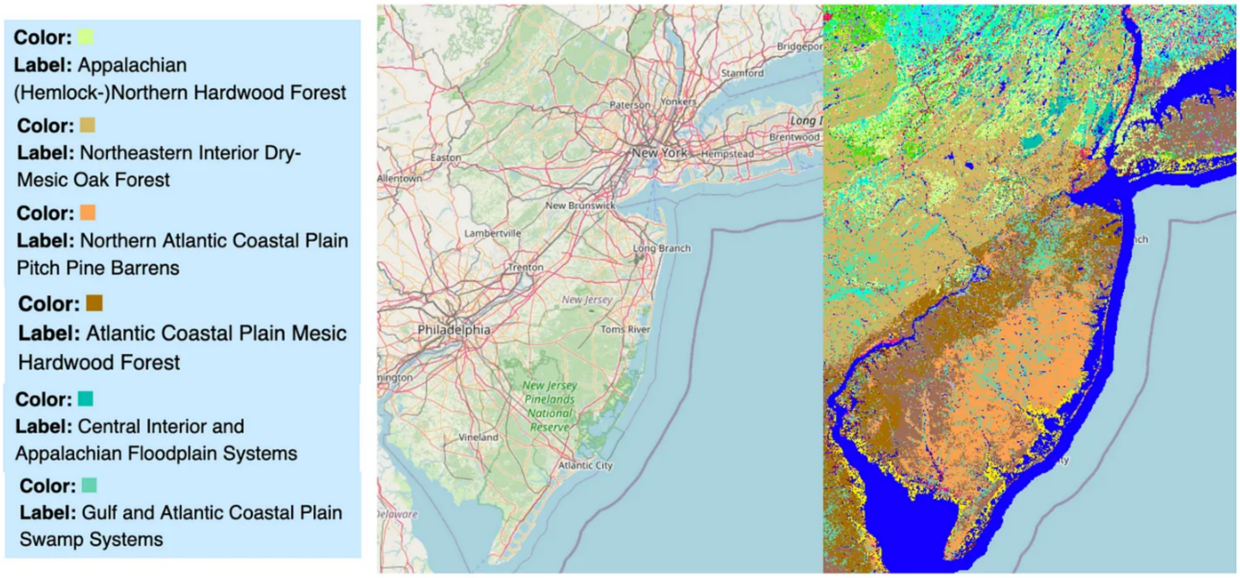
Biophysical Setting

We can break down our ecosystems into combinations of landforms and vegetation



- Landforms are the ways land, water, and climate manifest, and the multitude of ways they interact with each other.
- Vegetation describes the different formations and spacing of plant communities, including the dominance or absence of certain species.

By applying the same vegetation to different landforms, we get ecosystems like wooded swamps or boreal forests. When we further combine landforms, vegetation, and disturbance patterns, we compose biophysical settings. These are tremendously useful categories.



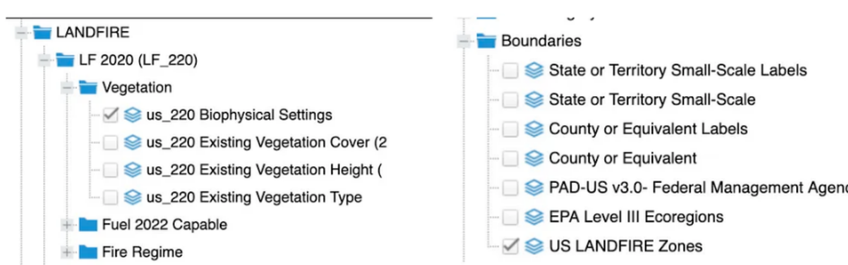
Jersey is mostly composed of 6 Biophysical Settings.

Accessing

(Note - we don't think the government website is accessible to screen readers. We are happy to retrieve the data on your behalf if you cannot access the website).

To view your local biophysical data, do the following:

note - click on the i to access the identify tool



1) Visit landfire.gov, then click the 'get data' button and enter the map viewer.

2) Get your biophysical setting + map zone.

3) Go to landfirereview.org, click on 'Locate BpS', plug in your biophysical setting, and download the data for your map zone.

Understanding

Biophysical settings can extend across political boundaries and plant hardiness zones. This can be confusing to gardeners and land stewards.

Major differences from the current landscape and the biophysical setting often indicate that a stewardship action (such as fire) is missing, or improper disturbance is occurring (like invasive species). Sometimes our biophysical settings really look nothing like our landscape.
This is because the biophysical settings describe the landscape prior to European colonization. Colonization has changed minds just as much as its changed landscapes. We may see an abandoned grassland, and think it's a beautiful forest. A shopping mall may be built on ancient marshes, in areas we think are prairies.

These changes have resulted in decreased biodiversity and stability

Applying

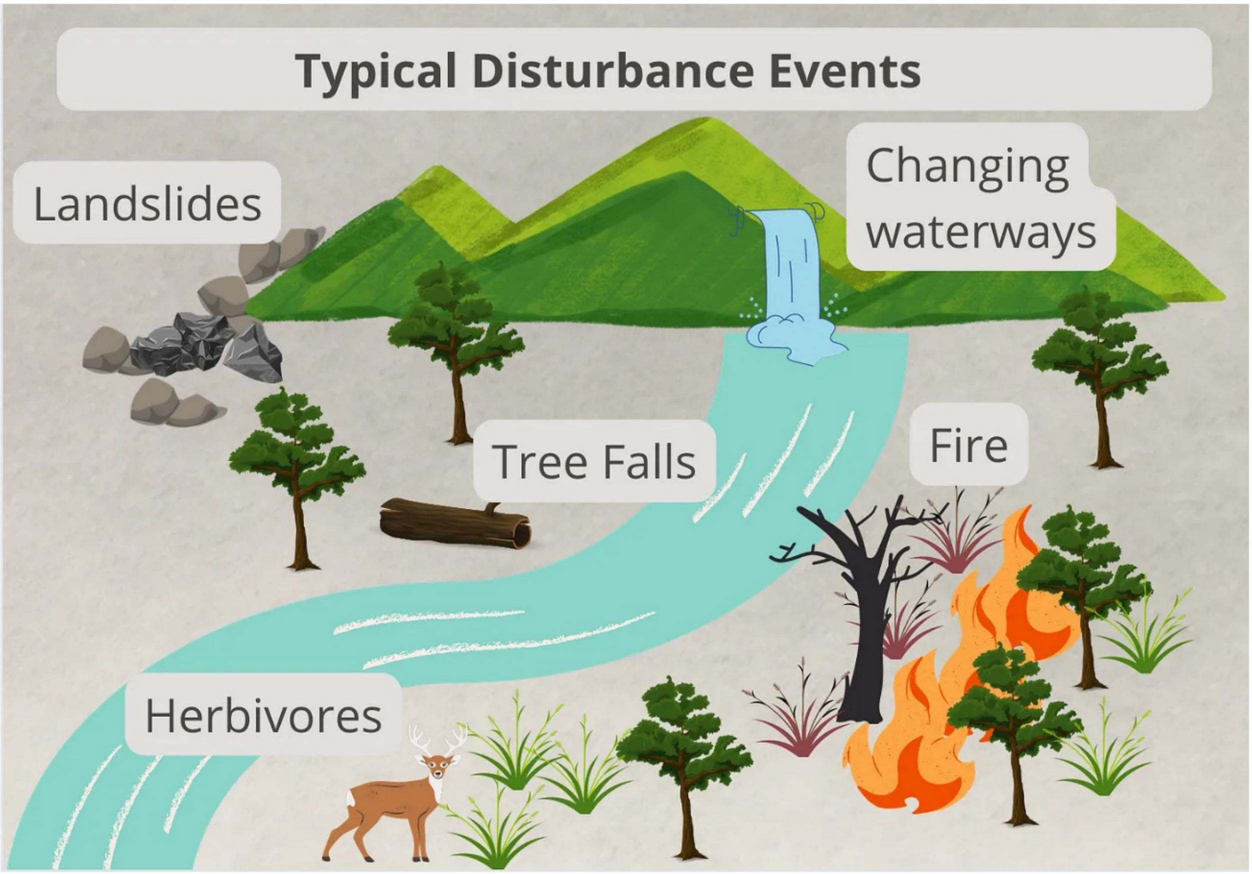
By learning our biophysical setting, we can apply appropriate stewardship actions to improve habitats. This can include sometimes controversial steps such as cutting down sections of healthy forest to restore canopy openings. By responding to our settings rather than our knee-jerk reactions, we can begin to re-connect ourselves to the landscape.

It can feel overwhelming to steward highly developed or degraded areas. We often feel that all is lost, or humans are forces of destruction. Instead we could consider how much creativity we can apply to degraded areas. They can become one of many potential habitats in the biophysical setting.

Ecological Succession

Disturbance in the Landscape

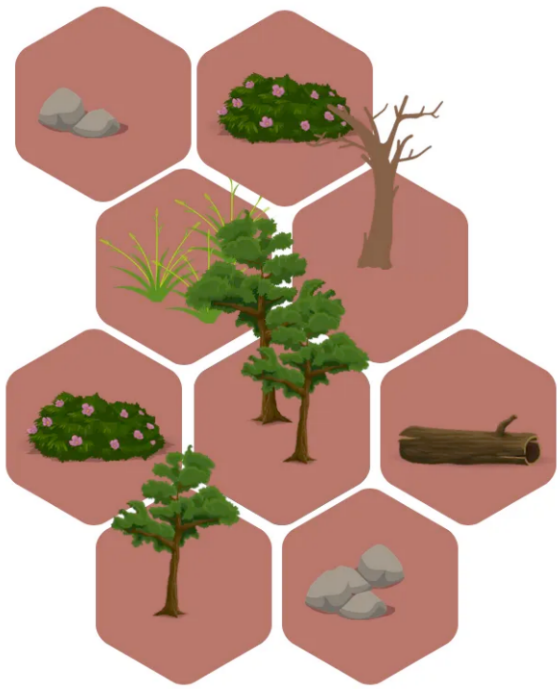
An ecological system is composed of growth and disturbance. These naturally form the rhythms that define landscape populations. Succession is a term used to describe how these systems move through different stages of growth and change



When looking at a landscape we may see some older mature growth, adjacent to some recently disturbed ground. This forms a mosaic of ecological states across the landscape.

The term succession was originally used to describe a linear growth from disturbance to 'old growth'. But ecologists now adopt a more holistic view on succession which includes areas of disturbance in the patchwork of the landscape.

Old growth is not inherently better than another system. What matters is having a full and rich mosaic across our ecosystems.



For example, consider these relationships:

- Beech and Oak trees grow in similar conditions and ranges..
- Beech trees grow faster than oaks.
- Beech cannot tolerate fire.
- Baby oaks can grow in the shade of beeches, but eventually need sun.
- Oaks can tolerate fire.

This means depending on the length of time between fires, beech trees may eventually outcompete oaks, but only until the next fire event when oaks have the opportunity to seize the moment and re-establish their population.

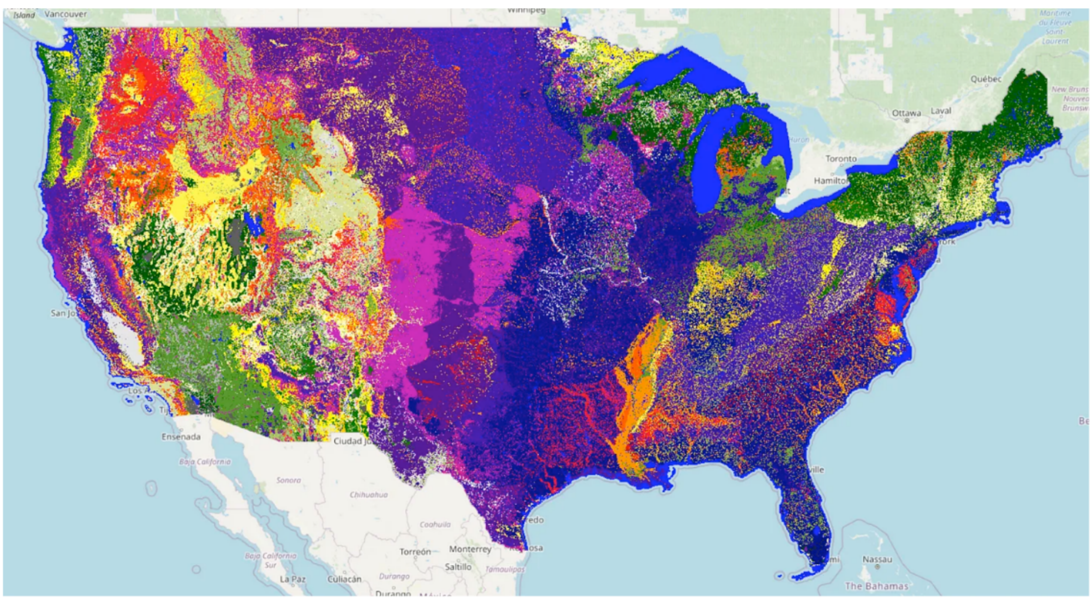
The frequency of fires in the landscape will dictate whether or not beech or oak are dominant in a woodland. Neither tree community is better or worse, they simply reflect the disturbance regimes applied to the land.

After significant disturbance, the land shifts to a state known as 'early successional' which often consists of fast-growing plants with numerous seeds. Early successional is not a good or a bad state. In fact, many of our crops were adapted from early successional plants due to their habit of fast growth and abundant seed.

Some food plants which were adapted from early succesionals include corn (after burning) sunflower (after buffalo grazing) and chickpeas (after landslides and tree fall). 'Weeds' are common in annual gardens due to the continual disturbance which favors early succession crop growth, and also other 'weedy' early succession plants.

Disturbance Management

Communities across the globe have always managed landscapes with carefully planned disturbance. In the Eastern Woodlands, fire was a routinely used disturbance to shift the ecological community towards more productive and stable states through the balancing of grasses, forbs, trees, and shrublands. Traditional farm clearing practices in many areas involved killing trees by ringing the bark, followed by a burn to kill the deadwood and open the land for planting. Depending on the region, the landscape burned every year, decade, or century.



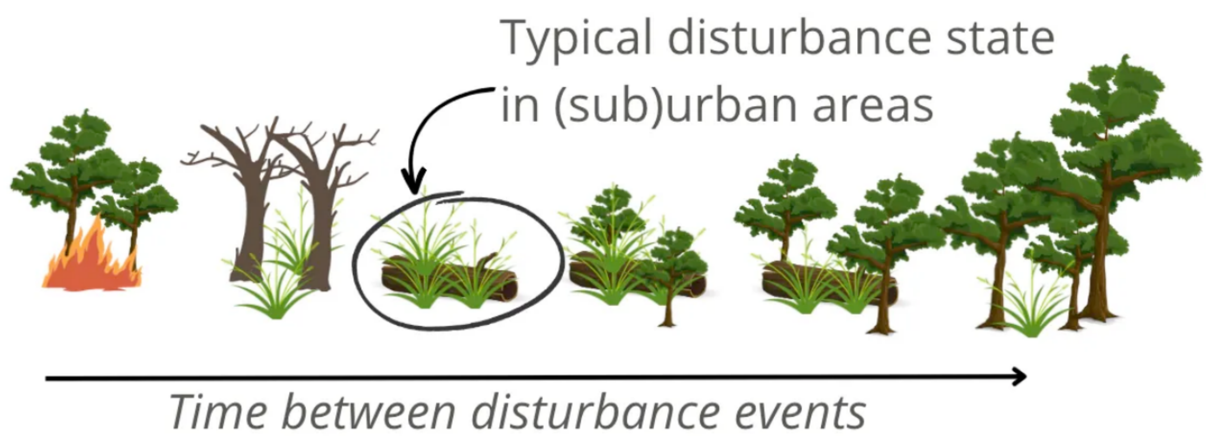
LANDFIRE is a tool provided by the US Forest Service which provides visualization on numerous aspects of the US ecological communities. Here we can see the 'fire return interval' - the average length of time between fires prior to european settlement. The deepest purple colors indicate land burned every 0-5 years, and the deepest green almost never burned (about once a millennia or less). We can see that save for new england and parts of the northern midwest, the east resembled California in the rates of burning.

Milpa Farm Cycle of Disturbance

Milpas are a well-documented meso-american farming tradition that is one of the most productive agricultural systems known. The practice involved burning of woods, followed by selected plantings of food plants until the forest eventually returned, when it was again burned and planted.

For landscape stewards, an overabundance of one ecology and an absence of another indicate a potential to shift disturbances to favor a more rich and balanced landscape system. Part of managing ecology is determining what level of disturbance is desired - ranging from minimal to intense disturbance. This is why landscape-level information and data-driven management is so vital to restoration. You cannot determine an appropriate disturbance regime without knowing what the current landscape state is, and what other ecosystems might be integrated with a shift in disturbance patterns.

Selective disturbance can lead a system to a desired state, and careful plant management can guide it to another. By encouraging plants appropriate to the next stages of succession, a landscape can be gently driven towards a desired ecology.



For example, in a highly disturbed environment like a city, early successional plants are the first community which should appear in a natural setting. If these plants are not already present, they can be introduced to begin reflecting what would be a normal community in this disturbance stage in the ecosystem.

If woodlands are desired as a next stage, disturbance such as fire and mowing can be withheld from grasses to enable woody growth to begin forming. These of course can be selectively planted and invasive plants should continue to be removed despite the withholding of disturbance.

Using these Tools

Guiding questions can help stewards seek clarity and refinement in their landscape practices:

- What ecological communities were common in my area, but are now missing?
- What were the traditional landscape stewardship practices in my area? Who did them, when did they do them, and why?
- What is the ecological state I'm driving towards? What are the successional communities between here and there?
- Is the seedbank of my soil diverse enough to support disturbance? Or do I need to supplement with transplanting or seed casting?

How Soil Works

Soil is a highly complex deposition of organic and inorganic materials, and the living organisms which call it home. The term dirt typically describes dead lifeless ground, or the stuff that gets under your fingernails. Soil scientists have given unique names to the thousands of soil types throughout the world, because soil is just as rich a community as any other biome.

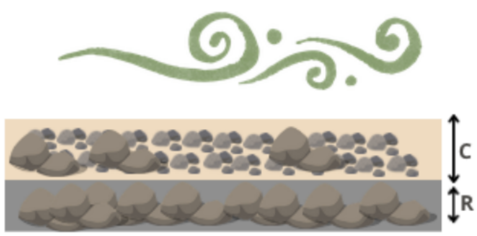
The earth's soils are defined by a simple mix of key components, in differing ratios and densities. The natural variations of these ingredients has led to the incredible diversity of the world's soils.

- **Rocks** (both large and flour-like) from natural geologic processes. These provide the mineral components of the soil.
- **Organic matter**, mostly from dead organisms. These supply important nutrients and influence soil consistency.
- **Voids**, which can be filled by gasses or liquids. These are critical for defining drainage and the ability to hold nutrients.

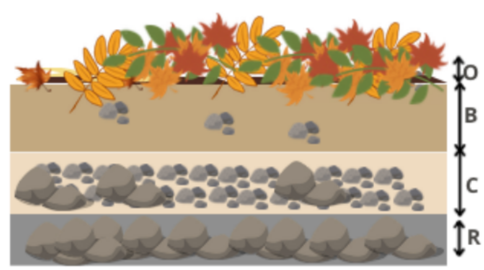
Soil Horizons

Soils have formed through the geological and biological processes of several billion years. As new materials are deposited on top of bedrock, layers form. These are called horizons.

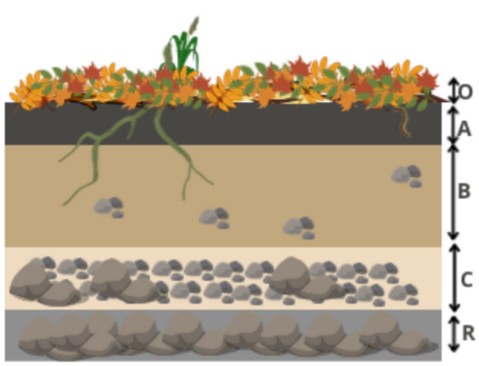
- Living and dead material like fallen leaves make the **organic layer** (O horizon).
- Broken down organic and inorganic materials form **topsoil** (A horizon).
- Dirt with minimal organic matter defines **subsoil** (B horizon).
- Weathered bedrock breaks down into rocky **parent material** (C horizon).
- The bottom layer is the earth's crust, which we call **bedrock** (R horizon).



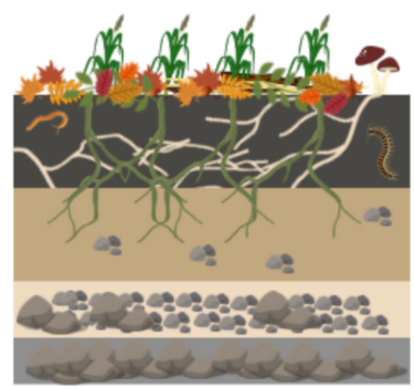
Bedrock is weathered away to parent material



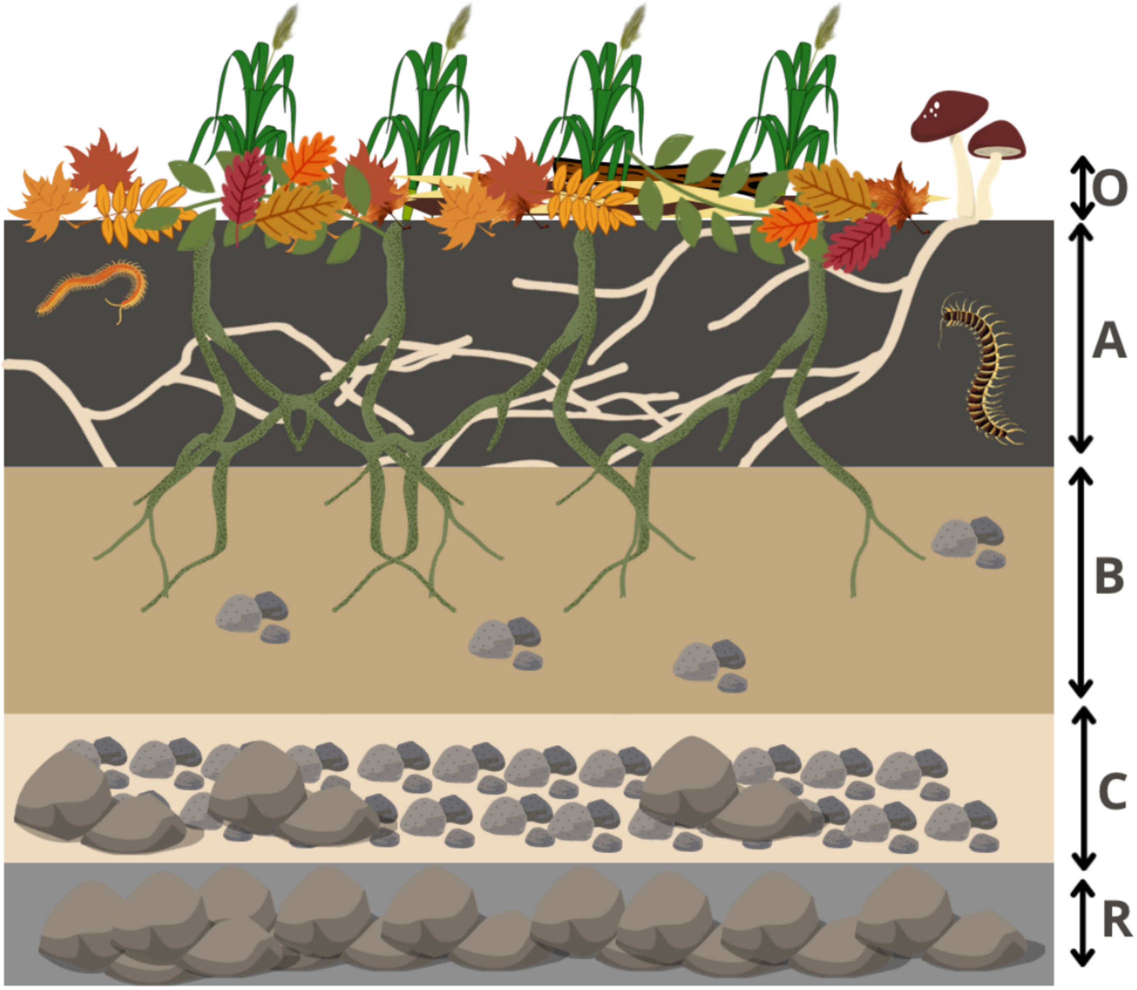
Organic material begins to mix with parent material to form a subsoil layer



topsoil begins to form and life soon follows



Topsoil expands, and fills with rich microbiome



When minimally disturbed, soil naturally forms in these clear horizons. This is considered highly mature soil. When disturbed (such as when digging and tilling), the O, A, and C horizons become mixed. This reduces the maturity of the soil and limits the growth of many late succession organisms such as soil fungi.

Although the lower layers of bedrock and substratum (the parent material or R and C horizon) define much of the mineral constituents of the upper soils soil, living organisms mostly dominate the B horizon (subsoil) and above.

Subsoil forms out of the parent material below. This is the layer where plants and associated microbiome members can access many inorganic resources like minerals and moisture.

The topsoil resting above of the subsoil contains the majority of subterranean life. This is because the majority of organic and living plant material is found at this layer. Conservation of topsoil (and the slowing of desertification) is a major topic of concern within the field of agriculture and ecological restoration. This layer is defined by a mix of organic and inorganic materials which have naturally commingled due to naturally occurring processes. Soil sold at landscaping stores tries to mimic topsoil by mixing organic and inorganic materials together - such as excavated subsoil and compost.

The topmost portion of soil is the organic layer. This contains all of the leaf litter and dead plant material that covers the topsoil. The organic layer protects the topsoil by blocking UV radiation and limiting moisture evaporation. Home gardeners often use chipped wood mulch as a mimic for this. Over time, the o horizon is broken down by fungi, bacteria, and animals. This decomposed material becomes more topsoil increasing the A horizon.

Soil Categorization and Use

Rocks ground to different coarseness can be considered sand, silt, or - at their most fine - clay. Depending on the proportion of these rock powders, a topsoil can be categorized into a soil type such as sandy loam or silty clay.

Loams are typically considered the ideal gardening and agricultural soil type, but each soil classification supports unique plant and animal life. When amending soils to grow traditional food crops, different soil types require different care to approach more loamy conditions. Alternatively, gardeners can seek to grow regionally appropriate plants rather than changing the soil to suit their needs.

Soil Development and Conservation

Many highly-eroded and degraded sites have exposed subsoil. This is so infertile that even weeds can fail to grow. This is why construction sites are so often barren of life. Exposed subsoil can only be improved by mimicking the processes of nature - by piling on topsoil or other organic matter rich materials, and allowing life to inoculate the material to begin forming upper soil horizons.

However, tilling in amendments such as compost can have the benefit of rapidly introducing organic matter deep into the soil, helping to form a larger A horizon more quickly. Like any ecology, soil must be treated as a complex web of life with unique needs. Any interventions to achieve a goal must be considered within site and context.

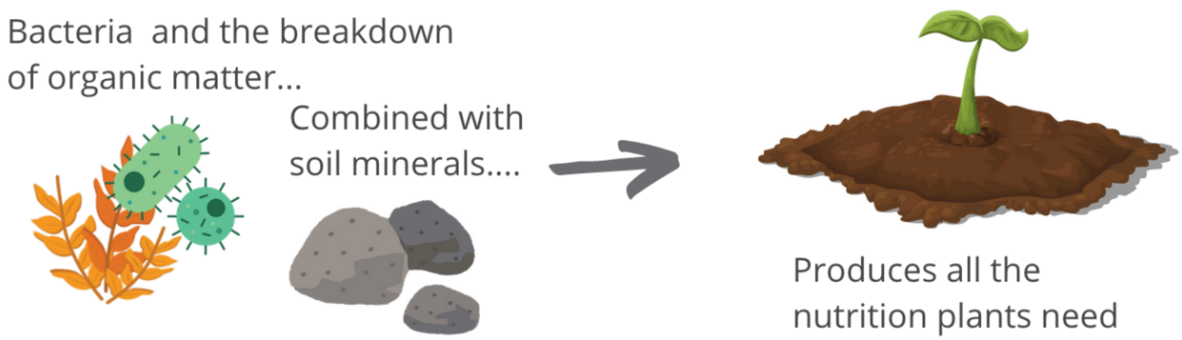
Sources of Organic Matter

For organic matter there are many options available, many of which can be sourced within yards or miles of the soil area, typically for free. However store bought compost is a suitable alternative if you cannot DIY any options.

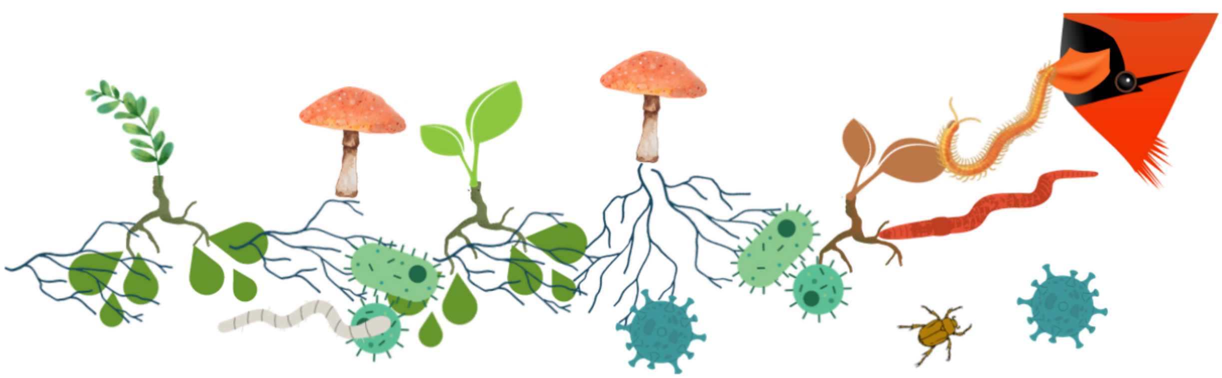
- Manure (Manure should be composted first. Rabbit droppings however can be applied directly as they are 'cold manure' meaning they won't cause fertilizer burns to plants).
- Leaves and other plant materials.
- Wood chips or bark.
- Cover crops.
- Natural farming inputs (such as from KNF or JADAM).
- Compost.
- 'Charged' charcoal (finely ground char mixed with nitrogen source such as urine).

Soil Food Web

In the traditional soil model we tell a very simplified story to help explain the basics of soil health to those working with plants.



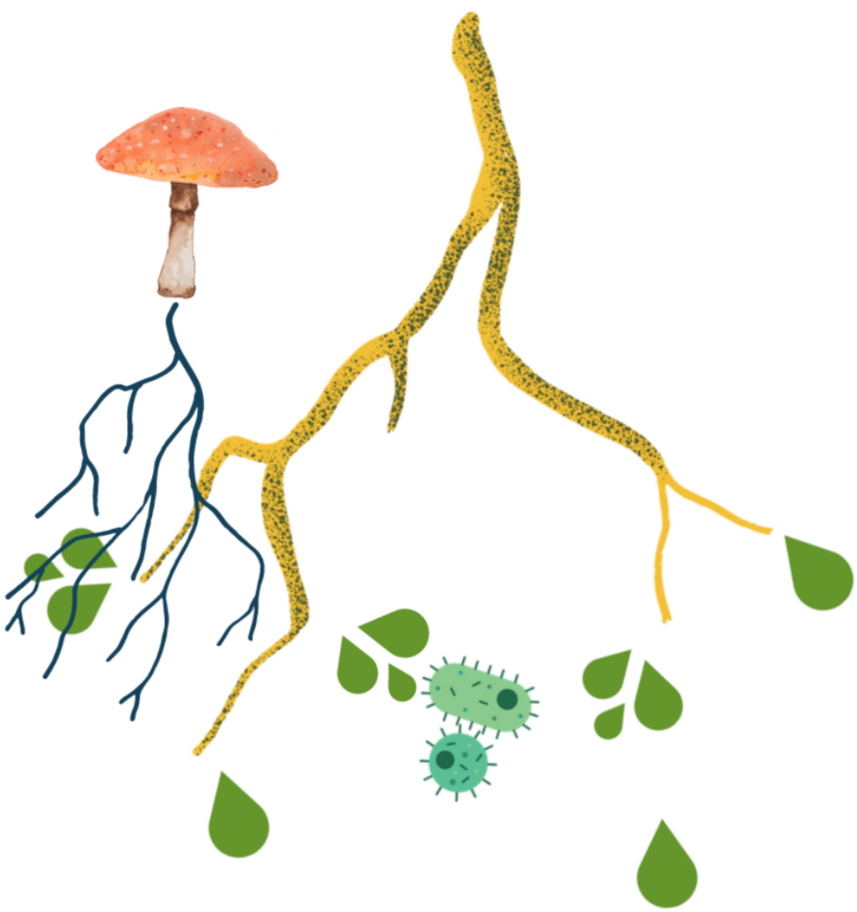
The actual way soil functions is much more complicated and still a novel field of research, which is why it's not often explained to beginners.



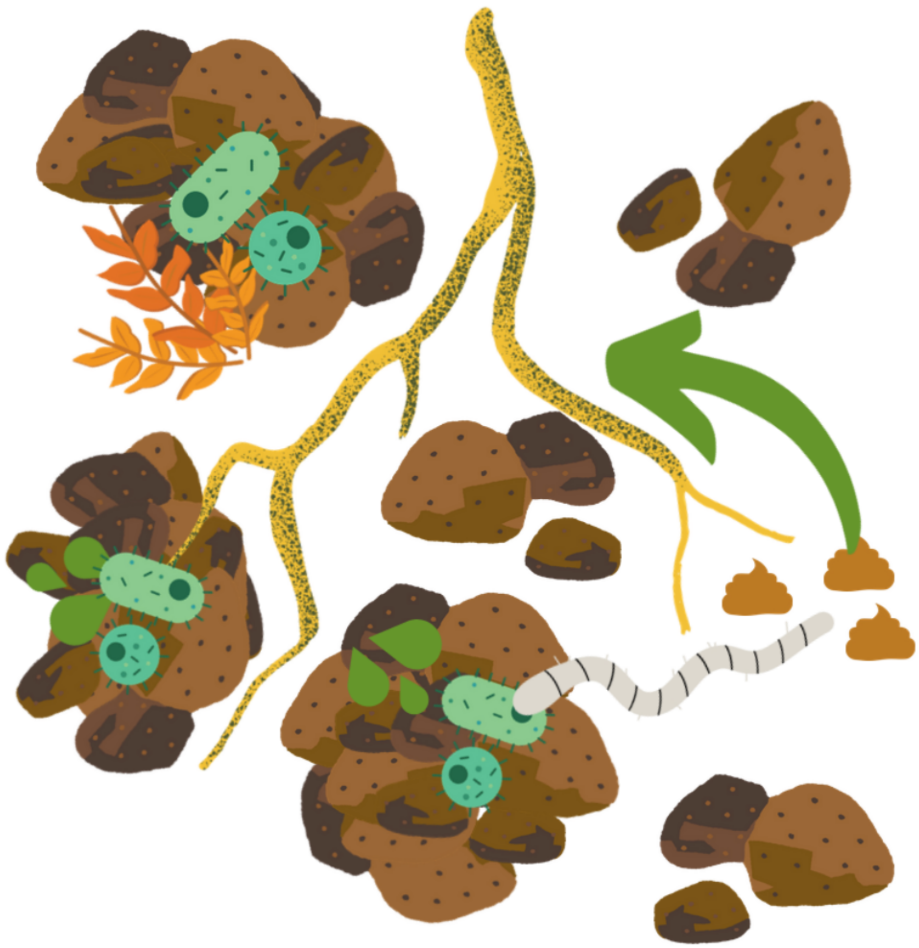
Soil Community

Soil is a living ecosystem, dirt is the medium the ecosystem operates in. Continental bedrock forms what's called the parent material which is crushed up by weathering to form dirt. Pulverized rocks form dirt. Highly pulverized rocks are called clay, less finely crushed is called silt, and the most coarsely ground is called sand. Dirts formed from different kinds of parent material will have different properties and mineral compositions.

As plants grow, they release exudates from their roots. This is a highly nutritious solution of carbohydrates and minerals.The exudates are eaten by bacteria and fungi. Plants can support specific species by shifting their exudate composition. This biologically active area around the roots is known as the rhizosphere.

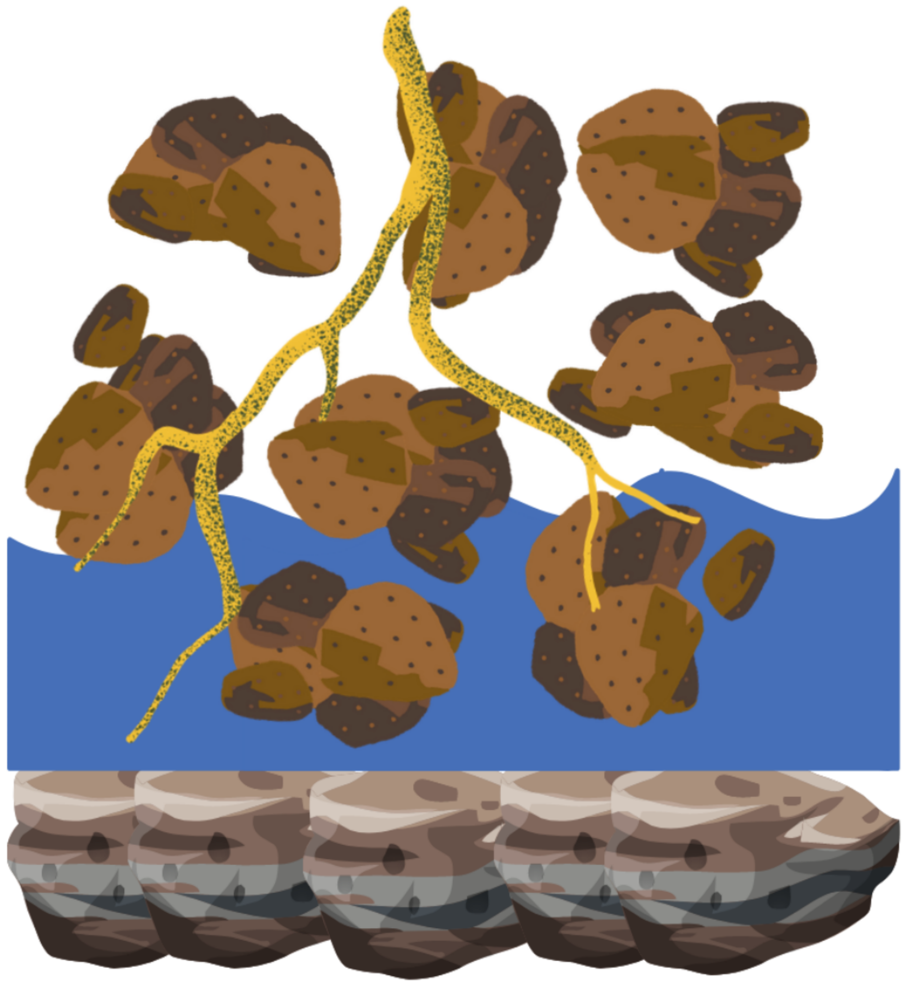


Bacteria live on slime which coats dirt particles as they feed on exudate or dead material, making dirt stick together in clumps called aggregates. Aggregates help maintain aeration, drainage, and reduce potential for erosion. Predators such as nematodes eat the bacteria in the rhizosphere. They then excrete highly nutritious feces full of natural fertilizers, which the plants absorb through their roots.



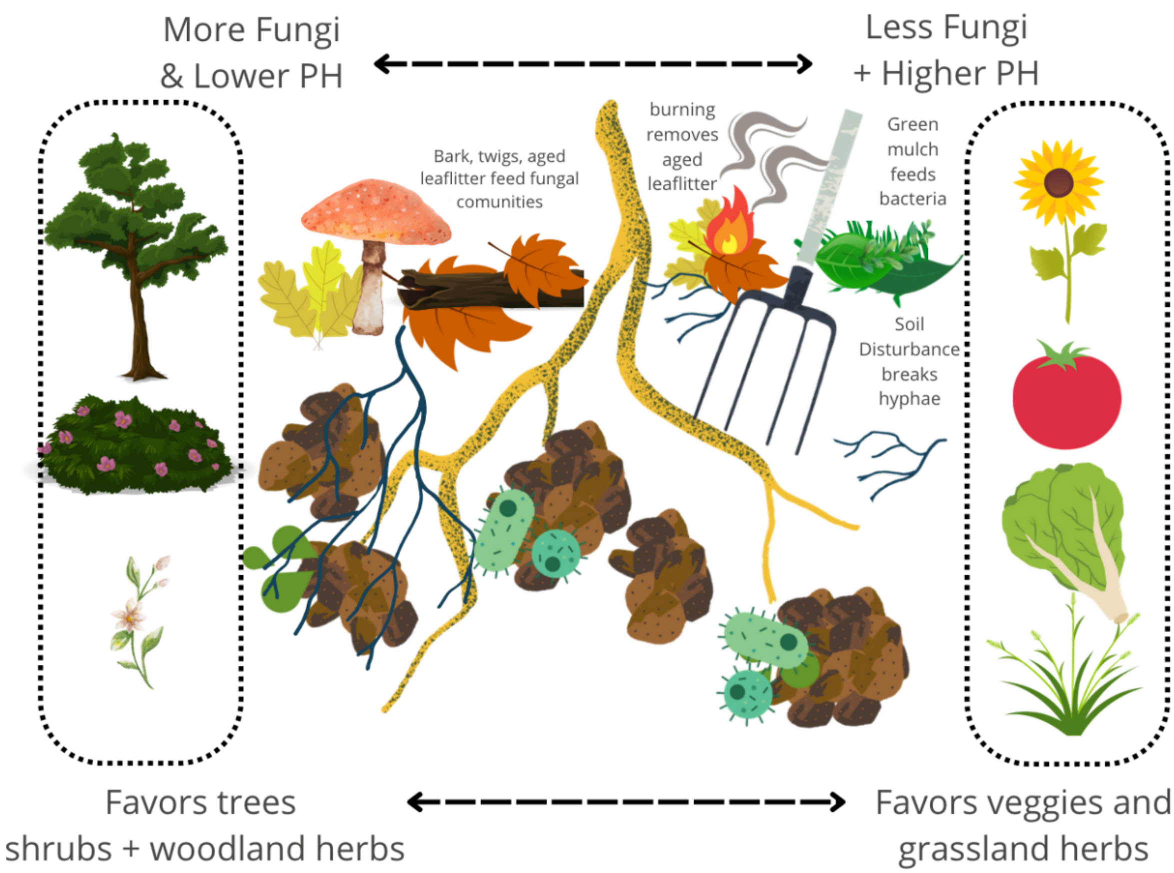
Fungal root-like structures (hyphae) in many species also cause aggregation by producing a sticky substance called glomalin. Some fungi are symbiotic with plant roots. These associate with roots to get nutrients, and in return seek out necessary soil minerals and pass them up to the plant. Predators also eat hyphae just as they do bacteria, excreting nutritious feces.

Water flowing over bedrock or collected after rain is absorbed into aggregated soil like a sponge. The level of absorption also depends on the soil texture and composition. Aggregates are loose enough for plant roots to grow through and be supported. Roots access the water held between these particles.

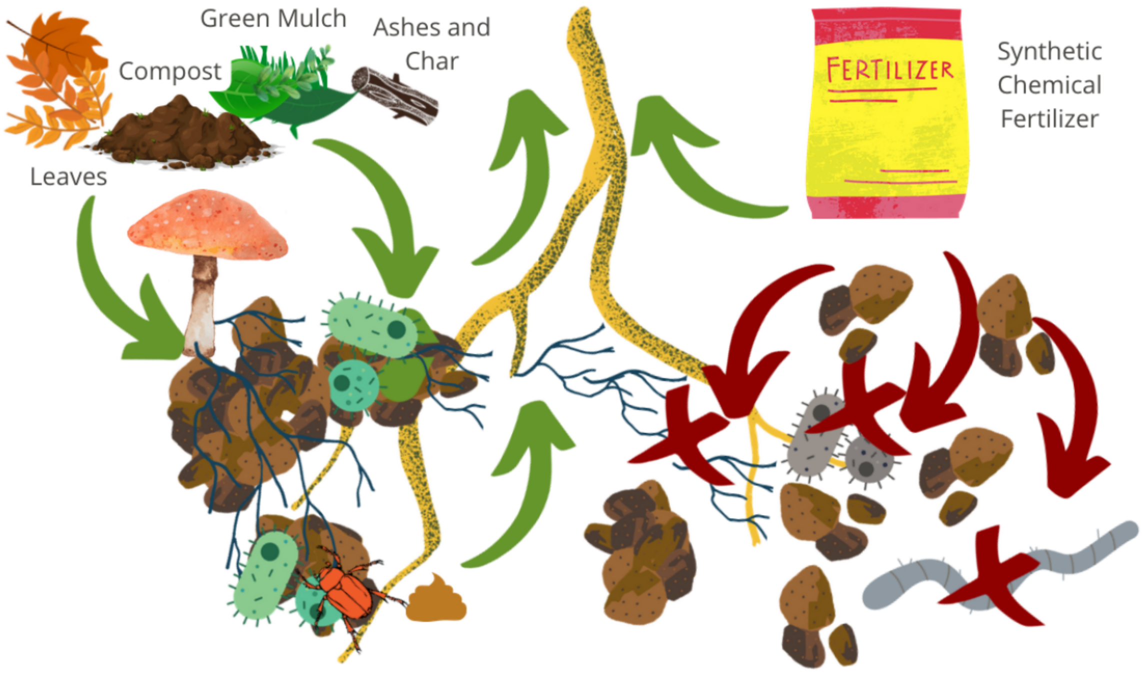


Soil Management

Habitats often disturbed by burning or soil disturbance (such as prairies) contain less fungi than if aged surface leaf litter broke down slowly and fed intact fungal hyphae (such as woodlands).



Although fertilizer contains many of the nutrients plants need, it does not feed the soil community and (in the case of chemical fertilizer) can actually damage them.



Feeding soils similar inputs to what they would naturally receive grows the food web which provides the necessary plant nutrients and builds healthy soil. By mimicking natural systems you can provide your soil community with the most appropriate food. Look to your local ecosystems and their history to see how these food webs are built and maintained.

Nitrogen in Natural Systems

78% of our atmosphere is nitrogen. This element floats in an biologically unavailable state until merged with hydrogen in a process called nitrogen fixing. All life need bio-available nitrogen in order to grow, plants especially to build the structures necessary for photosynthesis (chloroplasts). The only way to fix atmospheric nitrogen is through lightning, bacteria, and a synthetic process called the Haber–Bosch.

Nitrogen Fixation and Human Use

Some plants have developed structures in their roots called nodules which can house nitrogen fixing bacteria to meet their nutrition needs. Most other plants focus on either living in already nitrogen-rich soils, or adapting themselves to tolerate low soil nitrogen. These plab mostly plants in the bean family, including:

- Black Locust.
- Autumn Olive.
- Lupine.
- Soybean.
- Senna.
- Leadplant.
- Hopniss.

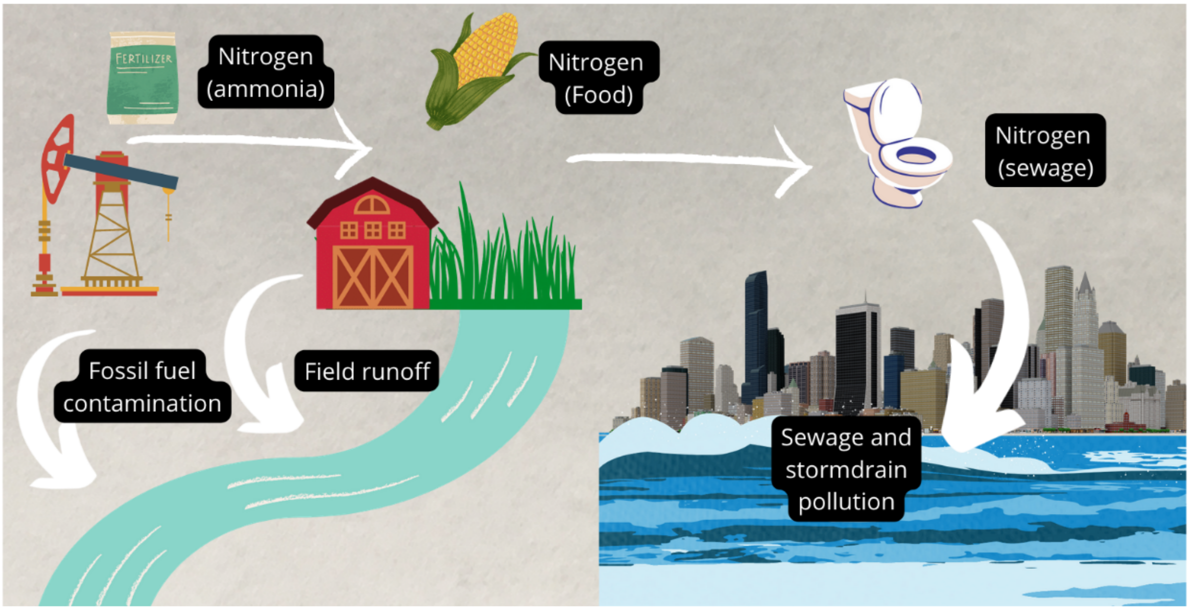
Low-N ecologies are threatened when nitrogen-fixing plants gain a foothold and begin to transform the soil. As nitrogen builds, faster growing plants that heavily feed on fertilizer begin to proliferate. This leads to habitat destruction and ecological homogenization. Loss in biodiversity causes ecological fragility, which harms humans as much as any other life form.

Plants that humans eat tend to have high nitrogen, because animals need protein (which contains nitrogen) as a dietary macro-nutrient. This leads people to believe that low-N soil is 'bad' or 'poor' and high-n soil is 'rich' and ‘good’. To increase soil nitrogen and 'improve' soil, people use fertilizers, composts, and nitrogen fixing plants.

Synthetic fertilizers are produced through the "Haber–Bosch" process. This burns natural gas to produce a fixed nitrogen (ammonia). The process discovered in the early 20th century resulted in the green revolution, averting an anticipated global famine through massive fertilizer-triggered increases in food production. An estimated 50% of your body's nitrogen is the result of the Haber-Bosch process.

Scientists have not yet found a way to synthesize fertilizer without fossil fuels.

Nitrogen Cycles and Effects



The flow of nitrogen in living systems is called the nitrogen cycle. Similar to the water cycle, it's important to keep the loop closed. However our nitrogen cycle is not currently closed because nitrogen in food coming from agriculture is not returned to the land, and massive amounts of nitrogen are washed away into our water systems.

When high bioavailable nitrogen and other nutrients are present in water systems it triggers a process called eutrophication. Eutrophying waters have rapidly increasing algae populations from the fertile conditions. This rapidly drops water oxygen, triggering fish die offs, aquatic dead zones, and the release of toxic chemicals which can result in human illness.

Recommendations

These strategies can help manage our use of nitrogen:

- Nitrogen is a resource to be cycled, conserved, and used judiciously to ensure a productive food supply.
- Fertile high nitrogen soils must be protected and developed in sustainable ways for our future.
- Low nitrogen ecologies like pine barrens must be stewarded to maintain biodiversity.
- Non-native nitrogen fixers should be treated with extreme caution, and probably not planted at all.

Ecosystem Management

Restoration 101

Restoration is the process of improving a degraded site. This can include actions like:

- Removing trash.
- Facilitating natural water flow.
- Returning native plants.
- Stabilizing soils.

The process of restoration is incredibly specific to the site - and is dependent on available resources, community uses, and other localized factors.

Goals and Future

Restoration is not one-size-fits all. What is the site being restored to? Are you mimicking a previous state? Why take any action at all? Define your goals, and have reasons for them. 'Restoration' means nothing if not building towards a specific desired outcome.

Doing labor on a site does not always mean you are working towards your goals. Define a set of metrics to figure out if the project is going in the right direction, or has met its goals. Think early and often about how to measure progress and setbacks. Use data to guide you. Follow where your actions trigger positive results.

Many restoration efforts degrade within 5-10 years usually by abandonment. A degraded restoration can be much more unhealthy than a non-restored site. Any effort needs to come with a plan for the future - how will the land be maintained in 2 years? 10 years? Always think ahead and secure a future early.

Strategies

Each biome and ecology is unique. Although you can learn from other efforts, always remember that what works somewhere else may not work in your region. Always seek the most specific information you can find. For example:

- Wetland Restoration in the Chesapeake.
- New Jersey Pine Barrens Forest Management.
- Northern Piedmont Grassland Stewardship.

Restoration experts commonly recommend a counterintuitive strategy of starting from the best areas and moving towards the worst. That means following this order:

1. Protect high quality environments. These are the source of genetic biodiversity and provide havens for migrating species.
2. Improve degraded areas. When a site can be easily restored to a high quality area, it should be. The least impacted sites should be prioritized.
3. Improve highly degraded or destroyed areas last. If a site has been massively impacted, it will take tremendous effort to improve with minimal ecological gain.

Why Native Plants Matter

The ecology is a system of living beings, forming complex interrelationships. Each species relies on another, and another relies on them. All of these relationships formed over millennia. Except for specific deep sea ecosystems, all life on earth is dependent on energy from the sun. Plants convert solar radiation into food for all other life.

Insect Specialization

Insects serve as the next step in the chain - the most ubiquitous terrestrial animal, woven tightly against their local plants. The bodies of these insects are critical food sources for birds, mammals, reptiles, and numerous other forms of life. Without density and diversity of insects in the landscape, ecosystems begin to degrade and fall apart.

Many Insects have evolved highly specific bodies in order to feed on unique plant food sources. Sometimes this adaptations are predatory - eating the plant. Others are mutualist or neutral, such as pollinating insects. These generalizations are sometimes down to plant genus, but they frequently can be species specific. This means a closely related plant will not support the specialized insects.

Because regional plants have lived alongside their local insects for thousands of years, they both had the opportunity to co-evolve. Non-native plants introduced into the landscape have not yet had the opportunity to evolve these tight relationships, and will likely not do so for millennia.

This means every non-native plant risks displacing a native plant, and their corresponding chain of co-evolved species which depend on them.

Native Plants and Biodiversity

To the untrained eye, a non-native plant may appear to support local wildlife, because unpicky generalist species will continue to feed. However - a native will support both the generalist and the specialists leading to highly increased biodiversity and general ecosystem stability.

This increased fitness is often the result of missing specialist insects who would otherwise keep their numbers in check. Worse than non-native are the non-native invasives (NNI). These not only displace native plants, but also out-compete them, spreading into ecosystems indiscriminately and collapsing the local biodiversity.

Many people voice the argument that because invasive plants are already spreading out of control, the "genie is out of the bottle". Or they explain that we need the increased fitness of these 'hearty' invasives (again, this is typically due to a lack of ecosystem participation, not due to health). However, it's important to remember that slowing the movement of species gives opportunities for evolution to work.

Every year we spare a native plant and insect some pressure, they gain another cycle of reproduction, which can carry traits to further improve their ability to include non-natives into the ecosystem.

Value of Prioritizing Natives

Planting native species has immediate and long term impacts for the environment and for people.

- Give time for non-natives to evolve into functional members of the ecology.
- Support biodiversity, protecting rare species and chains of living interrelationships.
- Support ecosystem resilience against disruptive forces like climate change.
- Reduce the amount of labor required to maintain gardens, as they have all evolved to grow well in their exact region.

Helping Native Solitary Bees Survive

This information is adapted from an interview of wildlife biologist Sam Droege from the USGS gave to the Native Plant Podcast on Sept 1, 2021 He leads the Bee Information and Monitoring Lab (usgsbiml) which provides resources including high res public domain images of bees.

Specialist Bees

All bees are specialists, the ones we call generalists are just the least specialized. One of the most generalist bees is the non native honeybee. Honeybees hate feeding on cranberry flowers.

Around 30% of bees are Oligolectic which means they narrowly specialize - often to one plant family or species. Most of our native solitary bees are specialists who spend the majority of their life asleep underground.

They wake up only for around 6 weeks - the time when their plant host is blooming. They then feed, mate, lay eggs in the dirt, and die. This is why both native plants and uncovered dirt are important for native bee survival.

Most solitary bees will forage about 200m or 1/10 of a mile looking for their flowers. If they don't find their plant host, or its not currently blooming, they will starve to death and not lay eggs.

The majority of our native bees are in decline, and many are already endangered or extinct.

Making an Impact

4 blossoms on a native plant is enough food to produce one baby bee. That means a single potted plant can save an entire bee family. Every person can make a difference - put native flowers outdoors anyplace you can. Native bees will follow their plants from skyscrapers to suburbs.

Although every native plant helps, some flowers support more specialist bees. These are the top 6 for New Jersey:

1. Sunflowers - 50 bees.
2. Goldenrod - 42 bees.
3. Asters - 33 bees.
4. Black Eyed Susans - 29 bees.
5. Camphorweeds - 24 bees.
6. Coreopsis - 22 bees.

Chickadee Survival & Non-Native Plants

Thus is a summary of the paper Nonnative plants reduce population growth of an insectivorous bird published in PNAS in 2018.

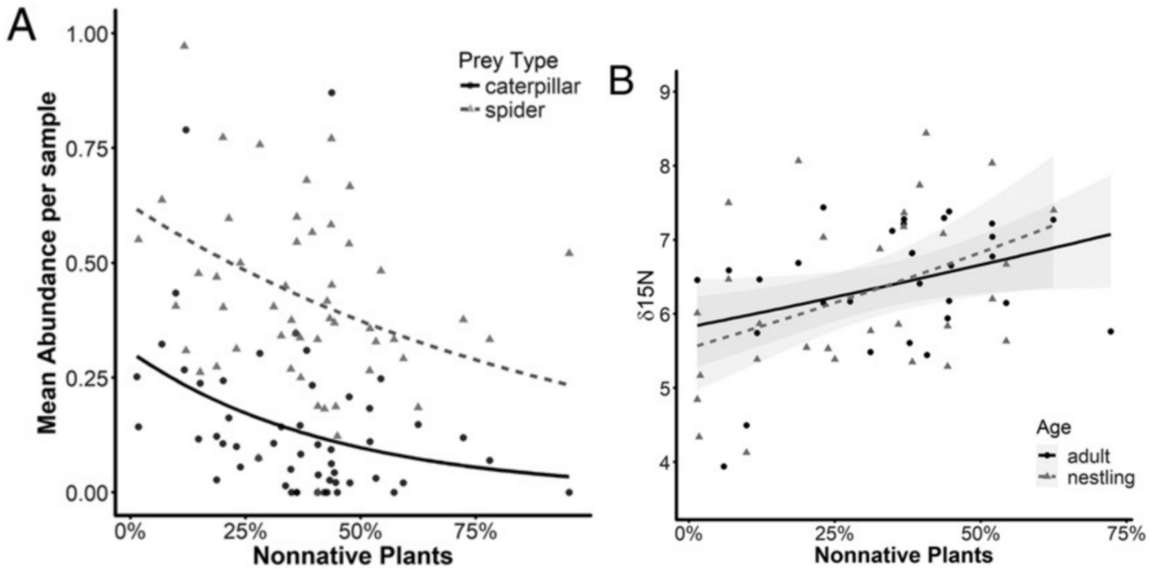
About the Article

The lead author Desirée L. Narango is a postdoctoral fellow at the UMass Amherst department of environmental conservation, Doug Tallamy is an author and professor of wildlife ecology at the University of Delaware, Peter P. Marra is the director of the institute for the environment and sustainability at Georgtown University.

Summary

Researchers looked at 156 bird nesting boxes in suburban backyards in the DC area. They examined the diet and survival of baby and adult carolina chickadees. This was compared against the arthropod populations and percentage non-native plants within a 50 meter diameter (typical chickadee territory size) around the nest box. The goal was to assess the effects of non-native plants on carolina chickadee populations.

Statistical models are used to help scientists apply observed data to different contexts and population sizes. Researchers collected data from the populations (806 adults, 88 chicks) and mapped it to different statistical models. In this article, scientists attempted to use these 894 individuals to understand how chickadees respond to non-native plants. This also can help us begin to understand how native songbirds in general react to the plants around them.



Using arthropod population assessments, we can see that as native plants decline so do caterpillars. Blood plasma readings show dietary markers for predatory arthropods like spiders increase as non-native plants increase. This suggests the chickadee diet shifts away from caterpillars as their native plant habitat declines.

The authors noticed that adults were only marginally affected by this dietary shift, which they believe was potentially due to nearby bird feeders.

Conclusions

The data shows that Chickadee population could potentially remain stable when their territory contained at least 70% native plants, and only grew when 94% of plants were native. This they argue was likely due to the chicks need for caterpillars in their diet.

Considering how adaptable Chickadees are to urban and suburban environments, the authors believe the effects measured may be even more significant for other bird species. This means that native plants may be even more vital to the survival of our native birds than is depicted in the paper.

The authors believe that gardens with <70% native plants serve as a 'trap' or 'sink' where chickadees will try to roost but babies cannot survive. If we want chickadees to recover their populations, we need <6% non-native plants in our gardens. For other birds, we may need even fewer.

Planting native plants is a matter of survival.

Botany

Dormancy and Stratification

As seasons shifts, life responds. Animals hibernate, breed, build up their strength. So too do plants. Compared to animals, plants must pay even closer attention to the seasons. They cannot move and so must become experts at responding to their environmental conditions. Here in Jersey, our native plants have tightly calibrated inner clocks which respond precisely to our hot summers and cold winters.

Seeds

Seeds have only a single chance to start growing, they need to choose it wisely. Germination is the process where a seed realizes it's time to "wake up" and begins growing. Each seed has its own unique environmental conditions that signal the time is right to germinate These can include moisture, temperature, and light.

Some seeds have complex strategies to protect against germinating at the wrong time. This is a specialized adaptation to areas which have major seasonal shifts in heat and moisture, or an attempt to capitalize on good growing opportunities. Stratification is the process of meeting these unique conditions in order to prepare a seed for germination.

The conditions typically associated with stratification include:

- **Being Eaten**. Many plants wait for teeth or stomach acids to cut into their strong seed coat to begin growing. They awaken in dung - their own pile of fertilizer.
- **Temperature shifts**. Some seeds have chemicals which break down under heat or cold. This triggers them to awaken after the final spring thaw.

We can trigger seed germination by meeting their environmental needs. Look up a seed's "germination code" to learn how. These are some typical methods:

- **Mechanical**. Nicking a seed coat with a nail file can break outer layers, like an animals teeth. This can also be accomplished by a brief bath in acid, or dipping in boiling water.
- **Soaking**. Submerging in water absorbs liquid into seeds, which triggers them to wake up. Soaking is often combined with mechanical methods.
- **Temperature**. Shifting hot and cold mimics seasonal shifts. By putting seeds in the fridge for a period of time, you can convince them winter has come and gone. Some plants require multiple shifts between warmth and cold, with differing degrees of moisture.

For our native seeds, the environment provides all stratification needs. Typically you can just plant outdoors in fall (or whichever season they naturally mature). This is much easier and more reliable than manual stratification.

Seasonality and Dormancy

During our harsh winters many plants go into a quiet state called dormancy. It's not uncommon for plants to lose all their leaves or only live underground during dormancy. Plants may appear dead, or seemingly vanish from the landscape during their dormant periods. In low-moisture ecosystems, dormancy may be triggered during droughts and broken during rains. Dormancy fluctuates between ecosystems and species, and doesn’t even occur for all plants.

Evergreens like pine trees don't undergo a true dormancy - they keep their green leaves and continue to perform photosynthesis. However, evergreens do slow down their metabolism and above-ground growth during winter months.

Our native Prickly Pears (Opuntia humifusa & cespitosa) look dead and shriveled like raisins in winter. This is because they release their water and form a dense viscous interior which is a natural anti-freeze.

Opportunities under Dormancy

Because of winter dormancy, plants have most of their energy deep in their roots, or still locked in their seeds. Sap is also usually not flowing into the above ground parts of woody plants. This gives us unique opportunities to take landscape-level actions without harming the ecology:

- **Pruning** is best done during winter. This is because woody plants do not have running sap, and so energy expenditure and damage is significantly lessened.
- **Controlled burns** are often conducted during dormancy to avoid killing desired vegetation and capitalize on dry conditions, but this varies based on stewardship goals and regional conditions.
- **Planting Seeds** outdoors in late fall or winter allows plants to undergo natural cold stratification, and bloom the following spring or summer.
- **Transplanting** a dormant perennial plant is like moving a person under anesthesia. It will wake up and not even realize what happened while asleep.

Extrafloral Nectaries (EFNs)

Nectaries and Honeydew

Plants and insects have co-evolved in tight relationship. Their anatomical structures reflect and respond to one another - both in mutualistic and antagonistic manners.

The flowering plants have formed a particular bond with animals, where many species depend on the decisions of insects to successfully reproduce. These relationships aren't always clear-cut.

Although these nectaries are often found inside flowers, they occasionally are located elsewhere on the plant. Flowers which produce nectar do so through a gland called a "nectary". Carnivorous plants often have nectaries on their leaves which they use to attract prey.

Aphids are a plant-sap eating insect which attach and feed from the 'veins' (phloem) of plants. The plant liquid they consume is mostly water, and so the aphids continuously excrete a sugary liquid called honeydew from their anuses in order to make more room in their guts to feed. When ants discover an aphid infestation, they protect the swarm from predators, and eat the honeydew in return, this is known as 'aphid farming'.

EFNs

In response to aphid damage, some plants evolved a new nectar producing a nectary structure called an Extrafloral Nectary or EFN. These are feeding troughs which produce a liquid almost identical to honeydew. Meaning the ants can eat for free without farming aphids (and thus avoid harming the plant). Some plants took an additional step, and began to recruit ants as a defensive strategy against would-be plant predators.

Defensive ants patrol the plant while periodically feeding from the EFNs. Plants have developed a strategy to maximize this by reducing the protein content of their nectar when they sense herbivore damage. This deprives ants of necessary nutrition, driving their hunting an aggressive instincts. Ecologists have documented numerous other beneficial predatory insects feeding from EFNs. This means plants bearing EFNs draw in beneficial species which are associated with improved plant survival.

Studies have shown that co-planting with EFN species can be used to reduce pest damage to human food. These species also provide supplementary food to numerous native co-evolved insects which belong in our ecology.

Unfortunately, many plant breeders have selected against EFN production, assuming the plant's caloric energy should be directed towards fruit and leaves.

Native EFN Bearing Plants

The relationships between insects and plants is still mostly unmapped, and the evidence around EFN use is still being gathered. You can be a part of this experiment by planting EFN-producers in your projects and observing the outcomes.

These plants all bear EFN's, and thus are great choices for companion planting and also for ecological support:

- Passionflower / Passiflora incarnata
- Hopniss / Apios americana
- Sennas / Senna sp.
- Sunflowers & Sunchokes / Helianthus sp.
- Plums, Peaches, and Cherries / Prunus sp.
- American Elderberry / Sambucas canadensis

Essays

Ecosystem Health & Chronic Illness

Our unhealthy degraded ecosystems can lead people towards despair. In our grief it can feel like our earth has been corrupted beyond recognition, that it cannot be saved. But our landscapes are independent, living, dynamic systems.

Our role is to care and love, not to save.

It's natural to struggle when we face the difficulties in the ecology. We want the land healed, we want to fix the broken system. But ecosystem stressors existing in perpetuity doesn't make the land a tragedy. The Earth is a living being with a chronic health condition that we can support.

Chronic Illness

Accepting that chronic conditions are a lifelong struggle, we can seek balance. Allow ourselves to enjoy the periods of remission, and not sink into despair during flair ups. Knowing a condition is life-long does not mean that life is over.

People managing chronic conditions cross endless hurdles and roadblocks just to lead a dignified life. Land stewards manage endless ecosystem stressors just to have a modicum of biodiversity. It's natural to feel overwhelmed.

Problems can be overlooked in favor of pointing fingers or dreaming of ideal solutions. For example - plants acting less invasive in a less disturbed ecology doesn't mean the invasive problem isn't real right now. We need to be pragmatic and care for people and systems as they show up.

Pollution and disturbance often degrade ecosystems. These are ecological flare ups due to environmental triggers. Seeing woods along highways, it can look like endless illness without hope of recovery. But we need to remember we can work avoid triggers and treat symptoms.

Health injustice and environmental injustice are interwoven and intersectional. We can manage health complaints without forgetting the underlying injustices. This means holding those who caused harm responsible, and tearing down walls to accessibility and care.

Those who profit from injustice cannot be permitted to continue.

Remission Landscape

Just as we seek to maintain remission in our own chronic health conditions, we can do so in our ecological landscape as well.

Notes & Appendices

Appendix A - Version History

Version 1.0 / May 2023

Created initial version including introduction.

Included Articles:

- Biophysical Setting.
- Ecological Succession.
- How Soil Works & Soil Building Garden Soil.
- Soil Food Web.
- Nitrogen in Natural Systems.
- Restoration 101.
- Why Native Plants Matter.
- Helping Native Solitary Bees Survive.
- Chickadee Survival & Non-Native Plants.
- Dormancy and Stratification.
- Extrafloral Nectaries (EFNs).
- Ecosystem Health and Chronic Illness.

Open issues:

- Need to cite information.
- Need screen reader user to provide feedback.
- Likely have spelling and syntax issues throughout the doc.

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