

# PERMACULTURE

Produced through The Northern Rhode Island Conservation District 's **Providence County Urban Growers Leadership Program**, in partnership with Andy Goldman from Revive the Roots and Nuts and Bolts Nursery.



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# WHAT IS PERMACULTURE?

Permaculture is a system-level design-based approach to agriculture and growing that focuses on the long-term stability of the environment.

Drawing from chaos theory, there are “normal” states that all living and nonliving things tend to. Water naturally flows downhill or squash plants naturally vine and sprawl across the land. The relationships between different elements in the growing space is essential to permaculture.

Consider that all things have their own goals within a system. Permaculture seeks to work with those various goals of all the elements within the system. We can utilize this by slightly nudging elements in certain directions to serve multiple goals.

Example: you have a plot of squash in your garden and you also want to maintain walking paths in between plots. You can build a trellis to allow the squash to climb and sprawl upwards while also keeping the pathway clear for people to walk through, achieving both goals.



*Photo courtesy of USGS*

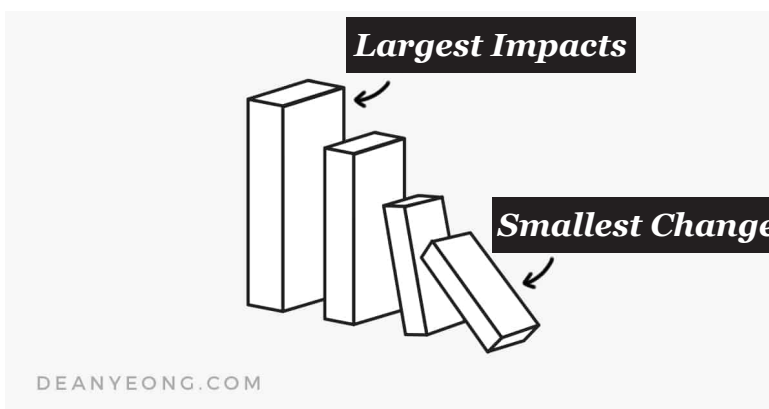
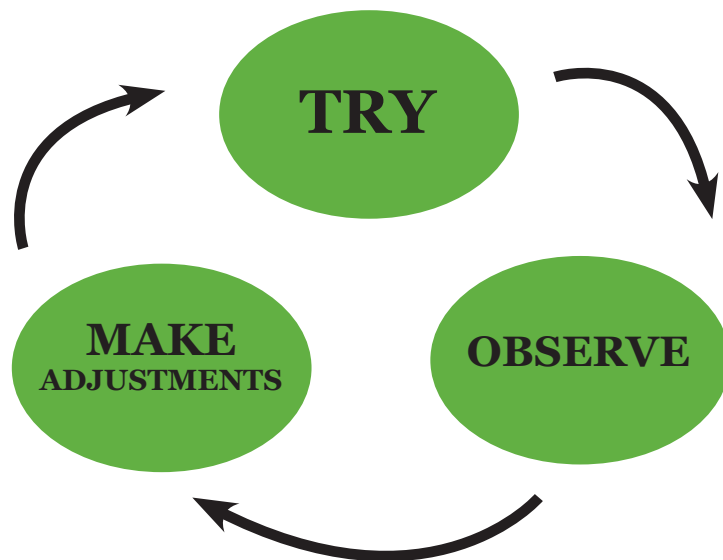


*Image courtesy gardeners.com*

Permaculture is an iterative design process and the information gathered from each trial informs the decision-making of the future.

Observing the results of your changes is a part of listening to the wants and needs of the different things in your garden.

Start where you are at and prioritize the smallest change for the largest impacts.



A strong system is made by a web of multiple connections between the different plants and elements inside of it.

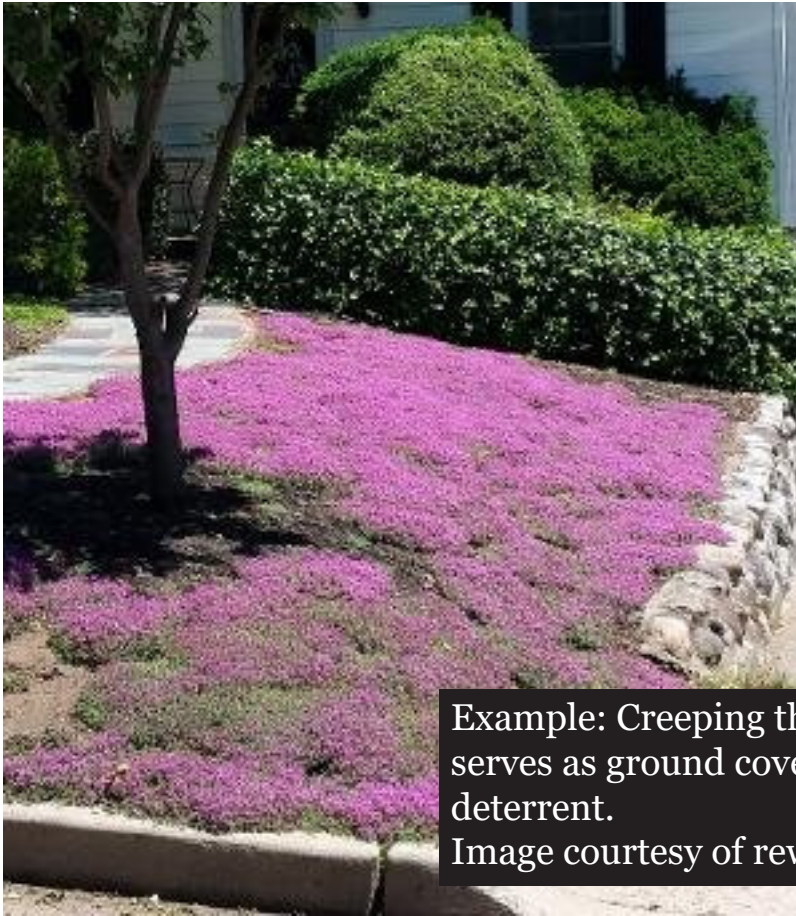
Compare a chain vs. a woven net holding a ball of weight:

If you cut one link in the chain, the ball will fall.

If you cut one section of the net, the ball will still be held. You have to cut multiple parts of the web in order to get it to fail.



***Permaculture seeks to make a web of connections, as opposed to a chain of connections.***



In a permaculture system, **every element should perform multiple functions** and **every function should be performed by multiple elements.**

Example: Creeping thyme grown in a garden bed serves as ground cover, a source of food, and pest deterrent.  
Image courtesy of [rewildlongisland.org](http://rewildlongisland.org)

Example: A garden has multiple types of ground cover/mulch: wood chips, creeping thyme, and strawberries.

Images courtesy of [rick\\_\\_wilson](#) on flickr, USGS, and [shunya.net](#)

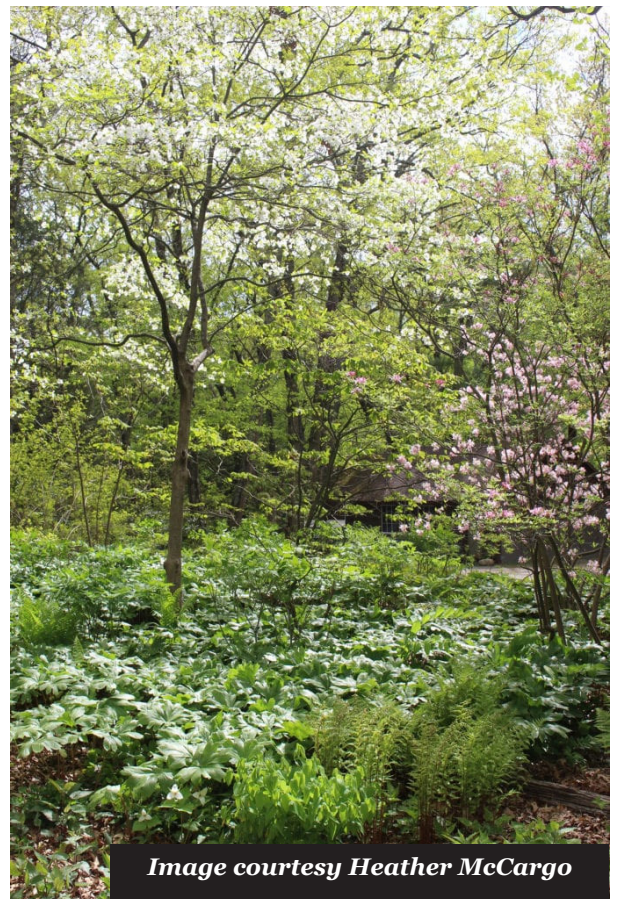


A garden or farm growing one type of plant or a singular crop is susceptible to pests and disease that can wipe out all their plants. A farm with a diverse rotation of plants with many different roles and interactions with each other are more resilient in the face of pest/disease pressure.



*Images courtesy of USDA*

Growing with permaculture design thinking leads to **growing at multiple canopy levels**, that is, tall trees, medium shrubs, and short annuals and flowers and herbs. This builds habitat for a range of other organisms to also interact with the environment. Each of these relationships serves their own role in the circular ecosystem that strengthens the resilience of the environment.



*Image courtesy Heather McCargo*

# SOIL HEALTH AND FUNGI

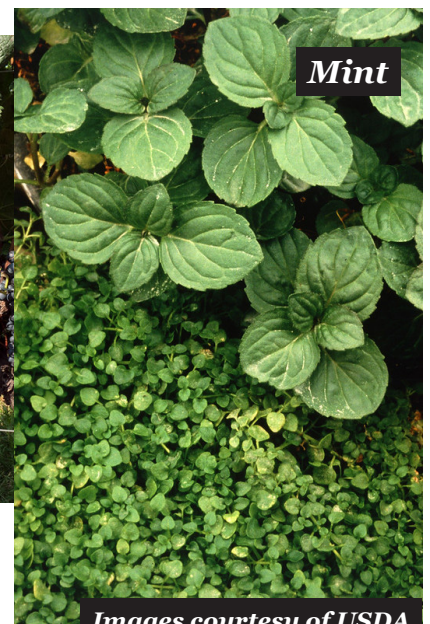
*“If the soil is right the plants will be right.”*

**Annuals** are plants that complete their full growing cycle in one growing season. Some examples of annuals in our growing region (Zone 6a or 6b generally):



**Perennials** are plants that persist and return with new growth every spring when the weather warms. Their foliage dies back in the autumn and winter, but their root structure survives and allows them to regrow in the spring.

They are sometimes distinguished between **woody perennials** (like trees and shrubs) and **herbaceous perennials** (herbs). Some examples of perennials are:



Images courtesy of USDA

Annuals prefer a bacterially-dominated soil whereas perennials prefer a fungally-dominated soil. **If you want to grow trees, plant it in soil made from woody material. If you want to grow vegetables, plant it in soil made from vegetable scraps.**



Bacterially-dominated soil is made from composting plant matter like food scraps, grass clippings, and leaves.  
Image courtesy of USDA



Fungally-dominated soil is made from composting woody material like wood chips, plant stalks, and twigs.  
Image courtesy of USDA

Revive the Roots heavily relies on wood chip mulch to build their soil because they focus on growing many woody perennials and some herbaceous perennials. They mulch with wood chips instead of tilling the soil, this is known as the **no-till farming** method. As the wood chips break down, they create **humus**, a dark organic matter that is a key component of healthy soil.



Images courtesy of USDA





Mulching with wood chips stores some of the available **nitrogen**, a key nutrient for plant growth, in the decaying material which is not beneficial in the short term. But in the long term, mulching with wood chips creates a strong soil structure with some great benefits:

- Greater soil ability to retain water (**humus** can hold up to 30x its weight in water)
- Greater soil ability to drain water and prevent flooding
- Greater cation exchange capacity which allows nutrients to move from soil to plants
- Creates conditions for a strong mycelium fungal network in the soil



*Image courtesy of  
yardtofeedeverybody.com*

**Mycelium** is a white root-like structure of fungus that spreads underground in the soil. The fungus in the soil works together with the plant roots to transport nutrients and information. Fungi are able to secrete enzymes which can break down minerals and digest that for their own consumption. These broken down minerals then become available for plants to intake for themselves as well.

The network of mycelium also allows plants to communicate to one another through it. If a tree is getting eaten by a caterpillar infestation, it can send signals through its roots and the mycelium threads share the information to other trees nearby. These other trees then activate their own immune response. They prepare their defenses against the caterpillars by releasing bitter tannins in their leaves that the caterpillars do not like. The mushrooms we think of when we think of fungus are the fruiting bodies of fungi, like an apple or a blueberry. If the mushroom is safe and edible, this is the part we eat. Fungi spread through their spores which move through direct contact with other organisms or by the wind. Wood chip mulch creates a good environment for fungi to thrive and fruit.

A **wine cap mushroom** (*Stropharia rugosoannulata*) is an edible mushroom that's similar to a portabella mushroom.

Here's a quick wine cap mushroom recipe courtesy of Andy Goldman:

1. Heat up a pan with some oil in it, when the oil is hot place the chopped up mushrooms in and season with salt
2. Cover the pan with a lid to allow the mushroom to soften and release its juices
3. After a few minutes, uncover and season with herbs, pepper, and a dollop of butter. Cover the pan again to allow the flavors to meld.
4. Uncover the pan and allow some of the liquid/steam to cook off. Once the mushrooms have begun to brown, add a splash of red wine to deglaze the pan.
5. Stir to mix everything together, taste and adjust seasoning as needed, then take off the heat.



**Turkey tail mushrooms** (*Trametes versicolor*) are a powerful medicinal plant packed with antioxidants. It is an adaptogen with strong immune-modulatory effects, which means it helps your immune system respond more favorably to whatever conditions are

present. For example, if you are trying to fight off a cold, turkey tail mushrooms will help ramp up your immune system to fight off the cold. In a different example, if you experience chronic inflammation from an overactive immune system, turkey tail mushrooms will calm down your immune system to decrease the immune response causing the inflammation. You can make it into a tea, infuse it as a tincture, dry it and grind it up into a powder.

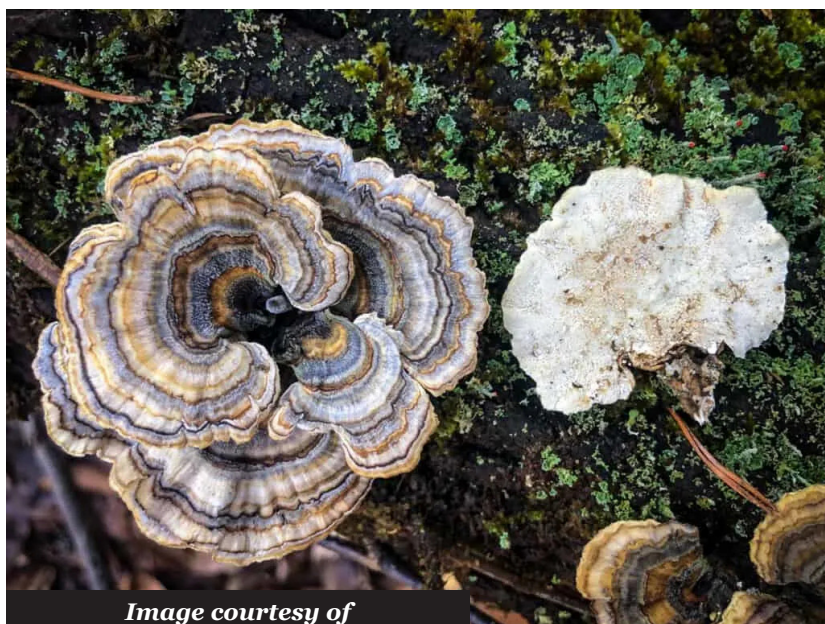


Image courtesy of [thesophisticatedcaveman.com/](http://thesophisticatedcaveman.com/)

**Soil blocks** are utilized at the Revive the Roots nursery for their effectiveness at starting vegetable seedlings.

Seedlings grown in typical plastic trays often become **root-bound**, when a plant's roots have no more room to grow outward they begin to spiral around themselves in the limited container space.

- This limits the plants growth
- This also puts the seedling through a lot of stress when it gets transplanted into the ground and the roots must be untangled

Soil blocks prevent seedlings from becoming root-bound. The roots air prune themselves, i.e. they stop growing when they reach the edge where they meet open air. Seedlings in soil blocks experience less transplant shock and grow two weeks faster than their counterparts from trays.

You can mix your own soil to make soil blocks. Revive the Roots uses Vermont Compost's Fort Vee soil mix to make their soil blocks with this soil block tool:

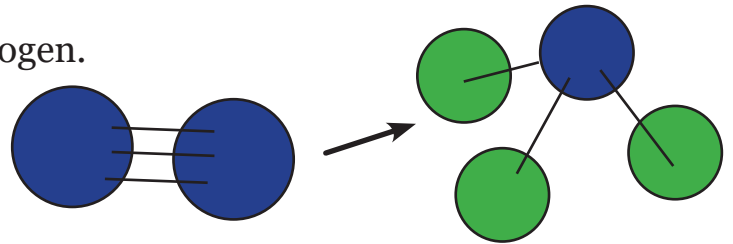


## Nitrogen and Plant Relationships

Some plants fix nitrogen, which means to convert nitrogen from an unusable form to a usable one for other plants.

Clover is an example of a plant that fixes nitrogen.

It absorbs  $N_2$  nitrogen from the air and converts it to ammonia  $NH_3$ , which other plants can use from the clover's tissues as it decays over time.



- An example of its relationship and symbiosis with other plants in the nursery is demonstrated by planting closely with oak trees and mountain mint
- The oak tree needs nitrogen to grow fully, the clover needs to grow in a place where it will not be disturbed, and mountain mint wants to sprawl.
- The mint can be directed to grow in a perimeter around the clover and the oak trees which will keep away rodents and other pests due to its smell.
- The clover will fix nitrogen and distribute that to the oak trees and the mint. The flowers of the clover will also attract pollinators for the oak trees and mint.
- The oak trees will have sufficient nitrogen available to grow and pest damage will be minimal.

Alder tree is another example of a plant that fixes nitrogen.

- At the nursery, an apple tree and an alder are growing next to each other. When the alder tree gets too tall and starts blocking light from the apple tree, they will go in and prune it back to let in more light.
- The cut parts of the alder are then used to mulch around the apple tree, which helps it retain water, suppress weeds, and also feeds it nitrogen over time. This technique of pruning and mulching with the cuttings is known as the **chop and drop** technique.



*Image courtesy of intotheulu.com*

## Growing Trees from Seed



To grow trees, the seed or nut is buried underground over the winter to break the seed's dormancy. Revive the Roots uses the following process:

- Drill holes into the top and bottom of a bucket for drainage
- Fill the bucket with sawdust
- Bury the seeds in the sawdust
- Bury the bucket in the ground outside over the winter

The seeds will be ready and awake in the spring. You can also mimic this process indoors by placing the seed in a plastic bag covered in moist soil or sawdust or paper towels.

Many nut and stone fruit trees grow with a **tap root**, which is a large and central root that grows downwards. Other smaller roots grow off of this central root. The tap root can grow as long as 1-3 feet before any leaves of the tree start growing above ground.

- If you plant this tree directly in the ground and try to move it once the leaves grow, you risk breaking the long tap root while transplanting.
- If you plant this tree in a container, the tree will become root-bound and undergo stress during transplant.

**Air-prune beds** are used to propagate and transplant tree seedlings. An air-prune bed is an elevated container where the bottom is enclosed with wire mesh instead of a solid material such as wood. The tap root of the tree will grow down, poke its way through the mesh, then stop growing because it has sensed oxygen and light. Instead, secondary fibrous roots will grow outward from the tap root instead of it growing further downward, both preventing a large immovable tap root and preventing becoming root bound.

All tree seedlings get transplanted when they are **dormant**, when the autumn/winter comes and the leaves drop.



## Water Management

The best place to store water is in the soil.

- Soil with a high organic matter content will hold more water
- Soil that is mulched will hold more water
- Soil that is covered with plants will hold more water, especially as the plants transpire

***Bare soil must always be avoided.***

Tree canopies are a major mover of water across continental land whereas fields of grass stop the water in its movement across the sky.

Because trees carry and hold so much water, along with the shade they provide to the soil, the temperature around trees is also much lower. This allows for resilience in the face of a warming climate.

**Slow it, spread it, sink it.**

The growing beds at Revive the Roots are built on contour to the flow of water, i.e. perpendicular to the flow of water. As the water flows downhill naturally, it slows down when it meets the raised bed, spreads out across the plateau of the bed, and slowly infiltrates (sinks) into the soil.

- The beds were made through observation during rain events and watching the way water moves.
- In order to design these beds on the landscape, an A-frame level was built to figure out which parts of the land were at the same elevation. This resulted in irregular shaped but level growing beds for the nursery.



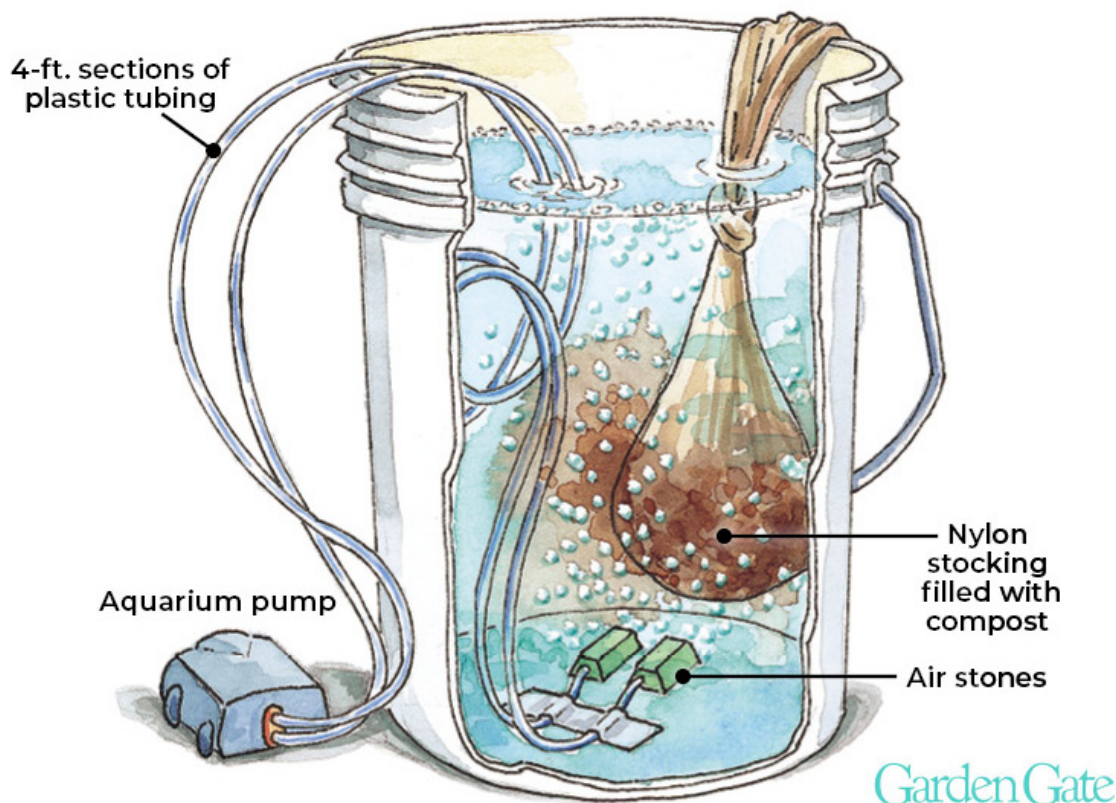
**Compost tea** is a microbe and nutrient rich soil additive that can be used to fertilize plants.

A specific compost tea recipe is listed below (courtesy of Piedmont Master Gardeners):

- 5-gallon bucket
- 4 gallons of unchlorinated water
- 4 lbs of compost (1 lb of compost per 1 gallon of water in the bucket)
- 2 tablespoons of molasses, raw cane sugar, fruit juice, or some other natural sugar
- An aquarium pump to aerate the water

To make compost tea, put compost in a mesh bag, place the bag in a large container, fill it with water, then aerate the container with a pump and some air stones over the course of 1-2 days.

It helps to add a source of sugar as well to help the microbes metabolize and break things down. An easy source of sugar is whatever rotting fruit is in season at the time.



Garden Gate  
Illustration by Carlie Hamilton