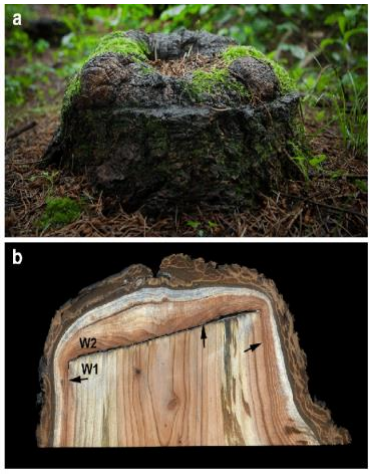
Living stumps.

Throughout forests there are many stumps left behind from trees that fell long ago. Over time most will rot, but others heal and eventually show no sign of injury; these are living stumps. It's easy to walk right past them without noticing, but once you're aware of their existence you'll realize living stumps are everywhere! Beneath your feet lies the answer to why some stumps can continue living on long after the tree has fallen, sometimes hundreds of years.

Even though a stump has no green foliage to produce energy through photosynthesis they can still survive with the help of surrounding trees. A single tree may be connected to most of its neighbours through its root system. When a tree is injured, it communicates through its roots sending a signal to neighbouring trees triggering them to share nutrients. Thus, keeping the stump alive and helping heal the wound.

Resin, which is a thick sticky fluid produced by trees, soaks into the exposed wood which helps prevent pathogens and decay from entering. Once the exposed wood is soaked in resin, the stumps growth layer (cambium), which is just underneath the bark, forms a callus to heal the wound. This may continue until the stump is fully capped and could result in it looking like a mushroom top. This is a very slow process. The photo to the right shows a Douglas fir cut 30 years prior, having 4 cm of growth topped with a cork-like layer of tissue. It will never sprout a new tree but will grow in girth over the years.



Douglas fir stump 30 years after being cut. W1 is wood before cutting, W2 is growth later after cutting.

How a stump circulates nutrients has scientists scratching their heads as the nutrient transfer in a living stump doesn't work in the way a tree was designed. Typically, sap is pulled up a tree by green foliage as water evaporates out through the leaves. Living stumps have no foliage yet are still able to pull sap into itself and circulate it back out. Stumps appear to have created their own pathways for nutrients to enter and leave vs. the typical pathway of root to crown and out through the leaves. It is a very unique and complex process which piques curiosity and leaves many questions unanswered.

It is also unclear whether the relationship between healthy trees and living stumps is mutually beneficial, or if the trees even know the stump has lost its greenery. It has been observed that trees and stumps never feed at the same time. Stumps are only active at night or during heavy rainfall when the healthy trees are inactive.

The wood wide web.

A tree's ability to share resources through its root system is thanks to a complex network of fungi called a mycorrhizal network, which scientists refer to as the wood wide web. Roots are grafted together through these fungi to relay information like a natural form of internet. Root grafting has been documented in approximately 150 species of trees however scientists believe that nearly all tree species and plants have this ability.

So how does it work? Fungus grows in threads called hyphae forming a network called mycelium. These colonies of threads live among the roots of the trees either by coating the root and spreading between the cells, or actually piercing the root and entering its cells.

The relationship between the trees and fungi is symbiotic, meaning both provide benefit to each other. Once a network is formed, food produced by trees in the form of glucose sugars can be shared with the fungi. In return the fungi absorb soil nutrients in the form of phosphates and nitrates which is passed on to the tree.

Mother trees

The biggest and oldest trees are referred to as mother trees and are usually the most connected in the fungal network. A healthy forest is a well-connected forest and usually has many mother trees, allowing it to overcome random changes and challenges more effectively. A strong network allows a forest to communicate better and enhances the ability to gain knowledge of its surroundings.

Seedlings have an especially tough time growing in the shade of larger trees due to limited access to sunlight for energy. Luckily for the seedlings the surrounding trees can share nutrients. Even though mother trees can be connected to many other trees, even different species, they are known to be able to identify their own offspring and are more likely to share nutrients with them, ensuring their survival.

Because mother trees are so crucial to a healthy forest, it is important for humans to recognize this and protect the last of our old growth forests. Mother trees are the nurturers of new generations of tree stands. They pass on information to young seedlings about how to defend themselves against pests and where to find water and nutrients. Without mother trees a forest would be far more vulnerable.

Pros and cons of being connected.

Being connected has some ups and downs. A vast root system increases surface area to gain nutrients and water, acts as an anchor and gives trees more ground stability, and provides a warning system to communicate if there are threats. Although this fungal network is key to influencing survival, it can also be devastating.

Lending a helping root to a stump in need is very neighbourly, however poses some risk to the healthy trees. A tree can't willingly disconnect from the grafted root system so during bad conditions where limited resources are available, having to support a stump is a burden. Valuable resources are continuously shared with stumps which are contributing nothing in return. Without adequate nutrients healthy trees are more vulnerable to disease and potential starvation.

Disease and infestations can spread quickly through a forest and this fungal network can do both good and bad. Through this connected root system trees can send assistance to their neighbours in the form of nutrients. They may also relay a message warning other trees of danger from infestation or disease by releasing certain chemicals. Early warning helps neighbouring trees protect themselves by going into defense mode. An example of this would be trees increasing the release of toxins or repellents to deter pests or producing airborne compounds in order to attract natural enemies of the invading pest.

Satellite image of laminated root rot passed tree to tree via root system.

A connected root system can also pass along a pathogen causing disease to rapidly spread. This has been seen in Dutch elm disease which devastated Eastern U.S. forests, and laminated root rot which is common in Douglas fir forests. If a forest is facing disease or infestation, dying trees have been documented acting altruistically, passing the last of their resources to neighbouring trees before they die. These nutrients provide surrounding trees added energy to combat the threat, giving them a better chance of survival.

Knowing that trees can communicate opens up a new way of thinking about them. They are more than just another thing in the environment. With the assistance of the mycorrhizal network trees are able to support one another. A forest may appear to be made up of individual trees, but it's actually one large, connected organism. They send messages to warn each other of threats and share nutrients to help their young or weak neighbours thrive. Trees even keep their fallen friends, the living stumps, alive. At the end of life, they make one final altruistic action and pass on their remaining resources, giving the whole stand of trees a better chance of survival.