More Than Just Trees.

Hike Nova Scotia AGM

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The plants shown here are native to northeastern North America, but the natural science they represent is worldwide. Throughout this presentation there are hyperlinks in blue to websites which give WONDERFUL deeper insight or references to nature and climate topics. Slide 3 and slide 5 links quite interesting Youtube presentation fungi, coevolved life and the evidence and history of Climate. Left click with your mouse to access the sites. An older hyperlinked version of this article can be found at https://www.hikenovascotia.ca/filemanager/files/Whiston_%20More%20Than%20Just%20Trees%202020-06-03.pdf

Press your down arrow, right arrow, or page down key to see the next slide.

Forests are more than just shade cover for the Appalachian Trail, the International Appalachian Trail (IAT/SIA), National Hiking Trail (NHT) and Cape-to-Cape hikes. These forests are more than just a shaded place for exercise or to pass through to get to a place with a view. These forests are certainly more than just fiber farms for firewood, heating pellets, pulpwood, biomass electric generators, biofuel, or other atmospheric carbon producing activities.

Besides being miniature worlds, beautiful in their own right, when humans actually stop, look closely, and watch, like our forebears did, they discover these forests are more than just trees.

There are many types of forests throughout eastern Canada and northern New England. This presentation has a small sampling of what can be seen in the forest understory.

Parts of the understory do their part in gaining access to mineral nutrients. Other parts contribute to the reforming or sequestering of atmospheric nitrogen, carbon dioxide, and water into other forms of nitrogen, carbohydrates, and the releasing of oxygen. Some parts of the understory redistribute nutrients, carbon, and information underground like the fungus shown here. Finally, other parts contribute to protecting those nutrients which took so long to accumulate.

Starting underground, forests also develop in layers.

In the 1820s, Joseph Fourier, a Frenchman, developed mathematical analysis for heat transfer and “calculated that an object the size of the Earth and at its distance from the Sun, should be [33°C] colder than the planet actually is if warmed by only the effects of incoming solar radiation.” Fourier speculated that the additional heat was caused by interstellar radiation, but also considered that Earth’s atmosphere might be acting as an insulator.

In 1856, Eunice (Newton) Foote, of Bloomfield NY,. confirmed that the heat was caused by Earth’s atmosphere. Using two cylinders, 4 inches wide and 30 inches long, and containing thermometers, Eunice pumped different amounts of air in the cylinders and set them into the sun. The denser air cylinder’s heat rose higher. She then did the experiment with different amounts of moisture (H2O), hydrogen and carbonic acid (CO2). Eunice discovered that adding carbon dioxide caused the temperature to rise to 52°C (126°F) and took many times longer to cool.

In 1859, John Tyndall, of Ireland, unaware of Foote’s experiment, also discovered the atmospheric effects of H2O and CO2 by performing even more elaborate experiments.

Scientists now know that the amount of carbon dioxide in Earth's very early atmosphere would have been incredibly high. Earth CO2 and temperature would later be affected by all kinds of things, including various continental plates' absorption of carbon and Earth's carbon and methane belches.

None of these have had the enduring effect that nature's evolution of carbon sequestering, nitrogen-fixing, gathering nutrients, and co-evolved species' specializations have had. This chart, within Dr. Dan Britt's *The Physics and History of Climate*, shows nature's effect.

	Venus	Earth	Earth w/o Life
Carbon Dioxide	98%	0.03%	98%
Nitrogen	1.9%	79%	1.9%
Oxygen	trace	21%	trace
Surface Temp	477ºC	13ºC	290 ºC
Atm. Pressure (bars)	90	1.0	60

Into water-logged oxygen-deficient swamps without bacteria or animals to eat them, the formerly gigantic club moss fell. Its trunk and its gathered atmospheric carbon contents were covered, and, after tens of millions of years, crushed into coal and stored safely away from the atmosphere until …….. recently.

This is bristly clubmoss. If you touched it, you'd know why. Knowing that the forest is more than just trees, the Blackfeet Indians, of Montana, Alberta, and Saskatchewan, discovered that the plant's spores were a perfect talcum for open wounds and also a diuretic when cleansing was needed.

Humans also discovered that this clubmoss made a great sparkler when lit.

Looking like tiny trees, the club moss genus dates to 325 million years ago. That date is after the creation of Pangaea and before the advent of dinosaurs. Pangaea was the mega continent whose creation brought about the Appalachian, Cobequid, and those European ranges along which the IAT/SIA goes. This club moss is called ground pine.

Note the dry leaves around the ground pine club moss. At ground level, after snows clear and soil thaws, leaves moderate the warmth and protect the soil from leeching, erosion, and consequently the loss of moisture, soil nitrogen, carbon, calcium, phosphate, and other nutrients.

This is running club moss. People have used running club moss as a Christmas ornament, but, because this club moss is very slow growing, this has caused it to become extinct in places.

Like the formerly noted dry leaves, the running club moss covers and protects a different kind of ground, keeping it cool and damp. Therefore, it also helps prevent loss of nutrients and carbon.

Dr. Joanna Clark, Reading University, has said, “There’s three times more carbon stored in soil than there is in the atmosphere, so imagine if all that carbon was released, we’d get runaway climate change. So we need to keep the carbon in the soil.”

Early humans knew that forests were more than just trees. Braided moss is one of many mosses that cover fallen trees. As braided moss doesn’t rot and is antibacterial and antifungal, humans used it for pillows and mattresses.

When trees fall, uncovered and warmed, some of their carbon could go into the atmosphere. Instead, as indicated by Robin Wall Kimmerer in “Gathering Moss”, specific mosses in the forest’s lowest layer cover it, protect the moisture, and enthusiastically suck up the fallen tree’s carbon for their own growth.

Even as the moss helps convert the fallen tree to humus, a few plants have already found this a perfect place to “lay down roots”.

The dinosaurs knew that a forest was more than just trees. 180 million years ago, dinosaurs ate this fuzzy-stemmed fern which grew in wet areas. It is known as cinnamon fern.

A European Saxon god, Osmunder, was said to have hidden his family in it. The Wisconsin Menomini boiled it for food. If you use it, don’t use too much, it’s a carcinogen.

Here, cinnamon fern and the much shorter sensitive fern, in the foreground, live beside Earltown Lake.

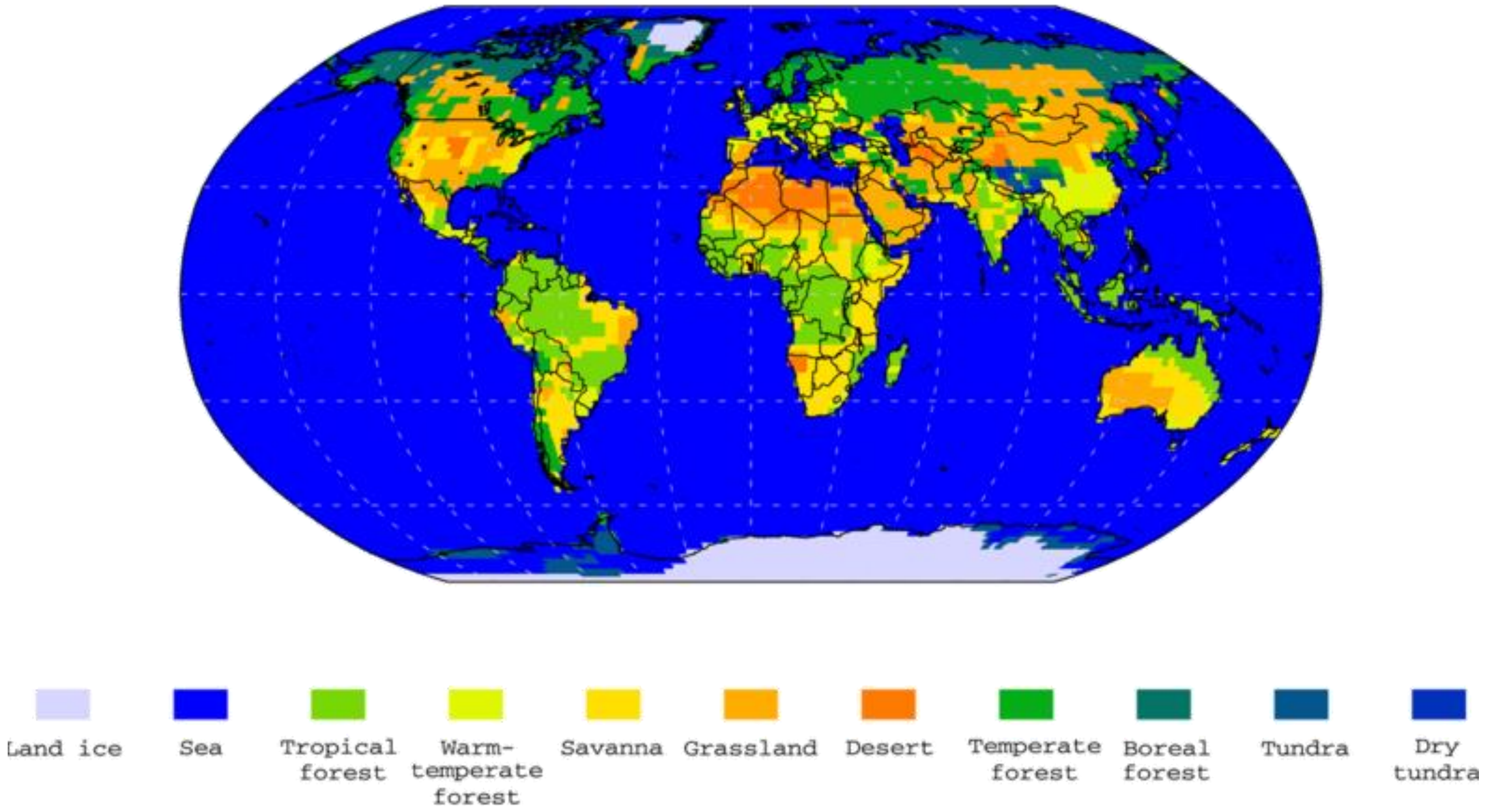
A study reports in "Scientific American", on another water-living fern, azolla, which lived 50 million years ago, when Earth's atmospheric carbon (AC) had reached between 3000 and 2500 parts per million (ppm).

Because azolla had nitrogen-fixing bacteria living within it and lived in a hot shallow nutrient-rich lake, it sequestered atmospheric carbon and nitrogen at amazing rates. In half a million years, it dropped the carbon to 1500 ppm. Nature then took 47 million years to drop carbon to between 190 ppm and 270 ppm during the Pleistocene Era, the era in which hominids developed.

By May 2020, AC readings at Mauna Lua Observatory were reported as 417 ppm.

May's 417 ppm is higher than the Pliocene Era, 5.3 – 2.6 million years ago, when atmospheric carbon was between 245 and 410 ppm (parts per million), and temperatures were 2-3 degrees higher. In the Pliocene much of Earth's land was in partial or perpetual drought and much of the land was savannah, grassland, or desert as this Giorgiogp2 / CC B-SA map from Wikimedia shows.

The Pliocene was also when Earth's ocean waters were warmer, cyclones and hurricanes ruled, seas were 50-75 ft. higher, and much of Earth's islands and peninsulas (like Nova Scotia and Florida) were under water.



Deer love the crunch and the cucumber taste of the leaves of this three-leaved plant. Humans long ago discovered the younger leaves made a great salad.

Eastern chipmunks eat the blue bead-like berries, but, for humans, the berries are poisonous.

This plant is called bluebead lily or Clintonia, named for Dewitt Clinton, an early governor of New York.

Deer, bear, grouse, and songbirds know forests are more than just trees. The animals eat the bunched-up red berries of this plant called, not surprisingly, bunchberry. Caution, unripe berries can cause stomach aches.

Amerindians made tea with the plant for headaches, fevers, pains, and coughs. Its roots were used for colicky babies.

The bunchberry covers portions of the mid-springtime floor. Before the forest's canopy fully takes its turn, the bunchberry, needing less sunshine, contributes to absorption of atmospheric carbon.

Moose, deer, and hares have known our forests are more than just trees. In the shrub layer, these animals would have eaten the buds and twigs of this heavily veined leafed hobblebush for protein. Game birds and small mammals eat its inedible-for-humans fruit.

The Amerindians used the hobblebush's leaves for migraines and its bark for cramps.

The hobblebush's leaves are green because they have used nitrates and limited light to convert atmospheric carbon and water to carbohydrates and oxygen.

The shrub layer and each layer of the forest contributes to lowering atmospheric carbon. A study reported by Virginia Commonwealth University has shown forests of structurally variable and multiple layers of leaves outperform structurally simple forests in sequestering carbon. This is part of the reason why plantations can only sequester one quarter of the carbon dioxide a mixed forest can.

70 million years ago, dinosaurs would have used this fuzzy-ended shrub, the willow, as our game birds and forest mammals do now, for food.

Thousands of years ago, Native Amerindians and Eurasians separately discovered the willow as a pain reliever. That reliever, salicylic acid, found in the plant and particularly its bark had aided the willow and its neighbor trees' "resistance to a multiple of pests and fungal, bacterial, and viral diseases". In a recent study the willow has been found to activate up to 13 defense mechanisms as a mulch treatment with other trees.

With these characteristics, it shouldn't surprise us that the willow was an early pioneer after the last ice age. It is also a pioneer to former farms and newly cleared areas and additionally protects soil from erosion.

Here, an alder, having nitrogen-fixing bacteria in its roots, seen in a wet, high-nutrient area, safely converts the atmospheric nitrogen, to ammonium, nitrites and nitrates. With nature-controlled nitrates, alders and their fortunate neighbors are able to photosynthesize and sequester more atmospheric carbon for growth.

A recent study from the Cary Institute of Ecosystem Studies has found “The presence of trees that fix nitrogen could double the amount of carbon a forest stores in its first 30 years of regrowth.”

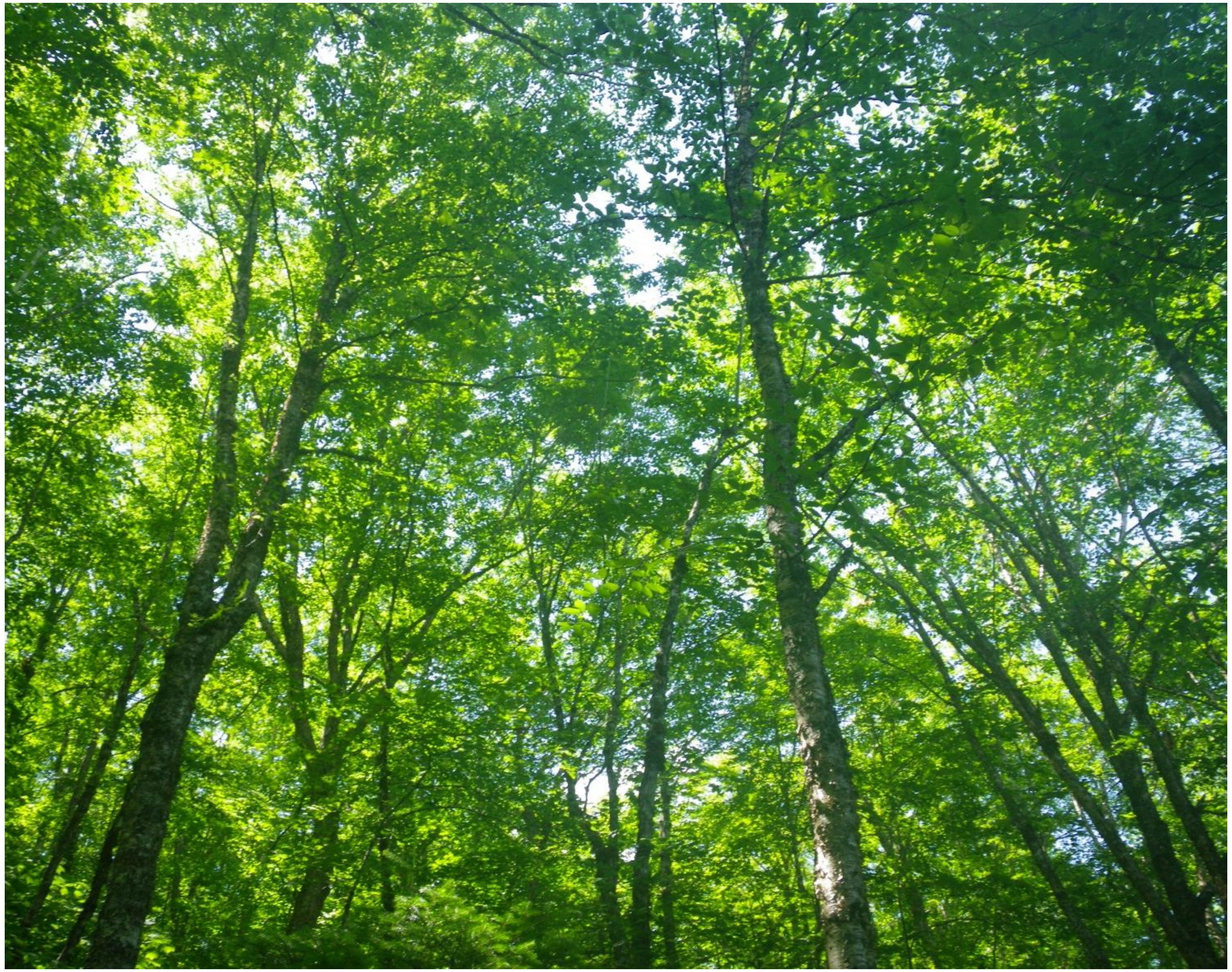
Rabbits, muskrats, deer, and moose feed on the alder’s twigs. Ruffed grouse and humans nibble on the alder’s young buds.

Bayberry, sweet fern along with legumes, such as clovers, lupins and black locust, which live in other unique ecosystems, also have nitrogen-fixing bacteria in their roots. Nitrogen-fixing plants are usually among the first found on edges of roads and on poor soil.

Humans know forests are more than just trees. The canopy, seen here, is the level which has kept the lower flora and other life shaded and cooler in the hot summer and, protected against wind chill, and so warmer in the winter.

Because of this, like the layers below it, the tree canopy protects moisture and prevents loss of nutrients and carbon.

Underground, using the fungi mycorrhizal network, as well as their inter-tree grafted roots, these trees and the other layers exchange water, carbohydrates, nutrients, and chemical defence messages. These exchanges, like those within our own human bodies, are unseen and taken for granted.



From the canopy layer, lovers of springtime sweets know that forests are more than just trees. For millennia, the sap of older yellow birch and sugar maple has been drunk straight from the tree, boiled for syrup, or fermented to make beer, wine or vinegar. Red squirrels also bite through bark to get the sweet sap.

A US Department of Interior study of 673,046 trees has found that those oldest trees sequester atmospheric carbon best. “In some old growth American forests, the biggest trees comprise 6% of the forests but accounted for a third [33 1/3%] of the growth.”

i-tree tools show the oldest trees also intercept the largest amounts of storm water, absorb more ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO) and particulates (PM_{10}), and provide habitat for birds and insects. Humans the world over use this “forest bathing” to clear many medical problems. Forest air even feels cleaner. A Toronto Dominion report found ““Large, healthy trees absorb up to 10 times more air pollutants, 90 times more carbon, and contribute up to 100 times more leaf area to our urban forest canopy relative to smaller trees.

On the bark of the canopy layer grow epiphytic life. Like the tree, this life also intercepts things from the air and, with less light, photosynthesizes atmospheric carbon.

Because insects stayed away from this feathery moss, a sign of an old undisturbed forest, feather flat moss was discovered by Amerindians to be an insect repellent. That trait is certainly useful to the tree on which it grows. As Diana Beresford-Kroeger and others indicate, the natural world is full of their own various chemical defenses. Those defenses potentially are also medically useful to humans.

2000 years ago and currently, in Europe, with the feather flat moss being waterproof, it was and is used to plug seams and holes in boats and canoes.

The Labrador pictured is Maggie-the-famous-hiker-dog. Between 2007 and 2012, she supervised the exploration, building, maintenance, and photography of Rogart, Earltown Lakes, Portage and the Gully Lake Trails of Earltown and Kemptown, Nova Scotia.

Flying squirrels know the forest is more than just trees. The squirrels make nests from the horsehair lichen which dangle from the canopy's spruce in 100-year-old forests. They then eat the lichen over winter when they are hungry.

Two native groups in British Columbia found they could make a black powder from grey horsehair lichen, which they used for paint.

Like those trees, tree lichen catch particulates and nutrients blowing in the wind. When the various tree lichen eventually drop to the ground, they are processed by microorganisms, stored or shared by fungi, and become nutrients for the local flora.

The pictured black tree jelly lichen and the green lung lichen assist older trees they live on by fixing atmospheric nitrogen in their bodies and margins respectively. Once the N2 is fixed into forms the lichen can use, each lichen is able to sequester more atmospheric carbon and with, at least, certain lichen are known to grow faster. Rain will wash the extras down the tree's trunk to its roots which then helps the tree grow faster as well.

The lung lichen was eaten by moose. For early humans, the lung lichen had many uses including treatment of tuberculosis, tanning hides and, as used by Europeans, Indians, and Siberian Monks, creating a bitter beer.

Our human ancestors were scientists, who looked closely and watched for consistencies in nature. The most observant learned which parts of the forest would feed them and their animals. They learned which would cure them, repel insects, shelter them, help them in transportation, clothe them, and color their cloth.

Animals and our forebears knew that forests were more than just shade cover for their travels. Besides being miniature worlds, beautiful in their own right, when we actually stop, look closely, watch, and hopefully consider Earth's current climate dilemma, we can discover forests are …

more than just trees.

Thank you to Maggie-the-famous-hiker-dog, fellow hikers, fellow builders, fellow botanists and the unmet thousands of scientists and researchers who each took this author deeper into the forest in so many different ways. A special thanks to Elise Bresnik for helping with the wording.

Most of all I appreciate Earth's biochemistry, how it manages to make life awesomely structured, and at the same time, so beautiful.

Norris

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