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δ is a carbon sequestration and reforestation project based in Michigan

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What makes this forest different is that all of the seeds that are planted: from the trees to the vines, ferns, wildflowers, and other plants, are native or regional varieties that have been exposed to a dose of radiation that causes an increased amount of genetic mutation and variation.

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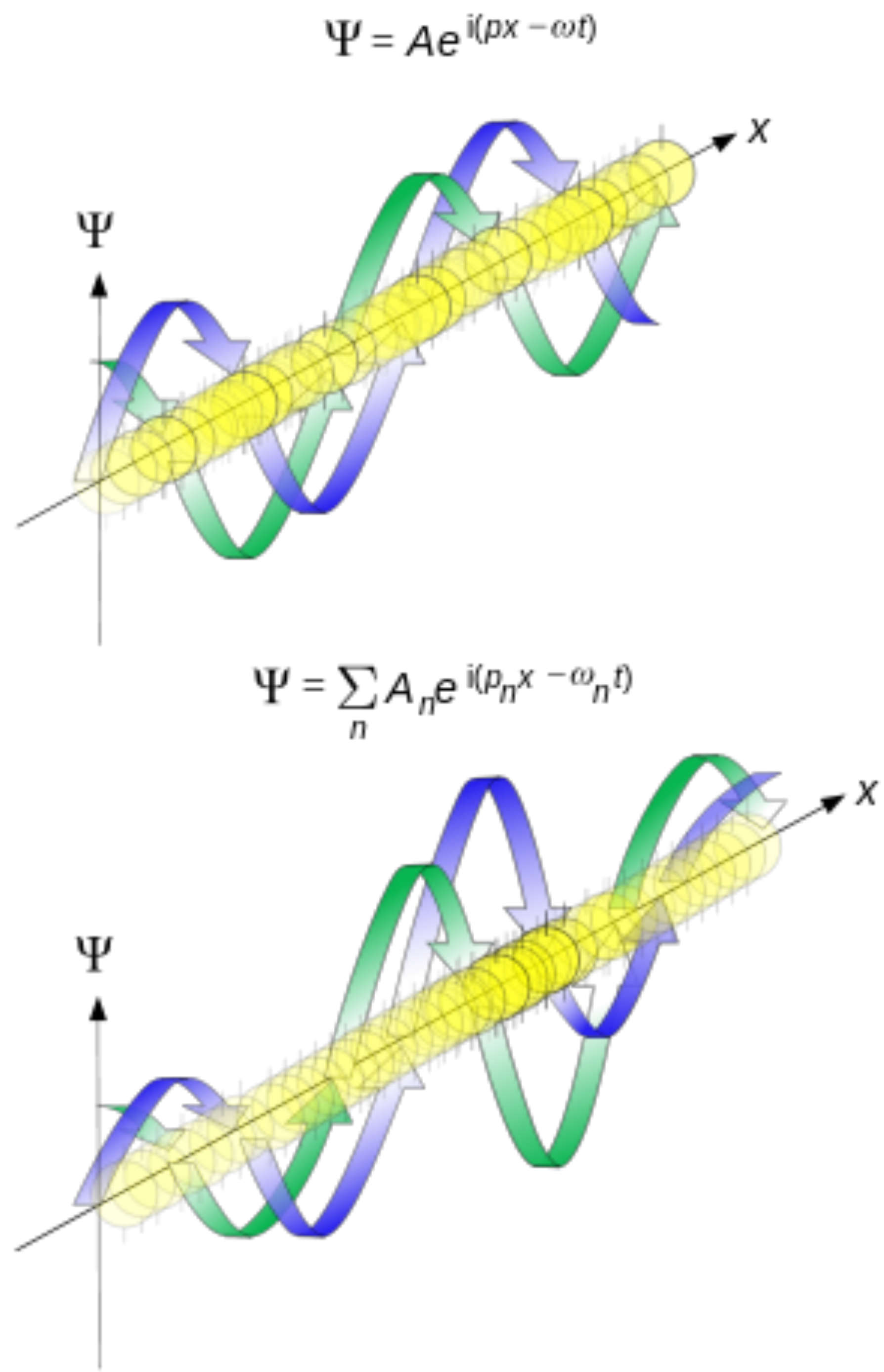

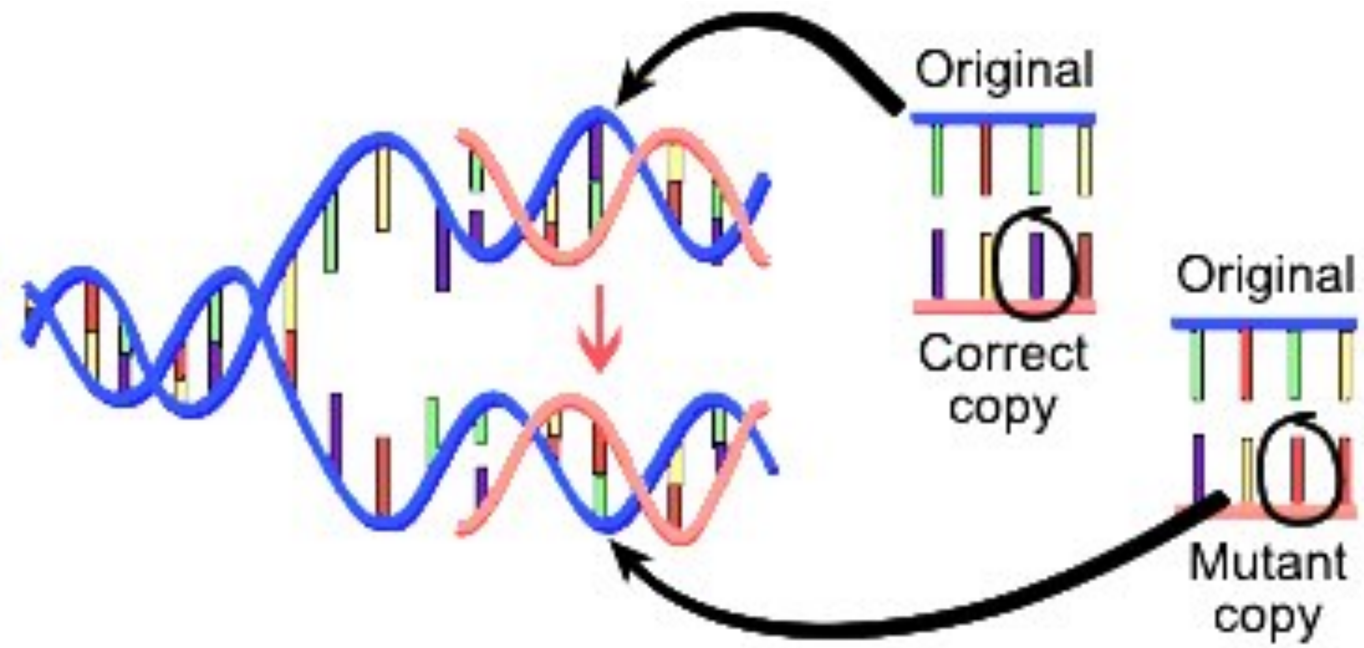

Mutations are a natural process underlying evolution, but they tend to happen on a relatively slow timescale. Given rapidly changing climate conditions, many plant varieties are finding it difficult to adapt within this accelerated timeframe.

This presents problems not only for the overall ecology of these regions, but also raises the possibility of new sources of carbon emissions from forests themselves in certain climate-change scenarios that would cause forest biomass to die off *en masse*—causing additional carbon emissions and global temperature rise in a positive feedback loop.

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One crucial climate change “tipping point” scenario is the “boreal forest dieback” which would cause a particularly large and rapid emission of CO_2 and likely runaway warming, since the boreal forests are the largest land biome on Earth.

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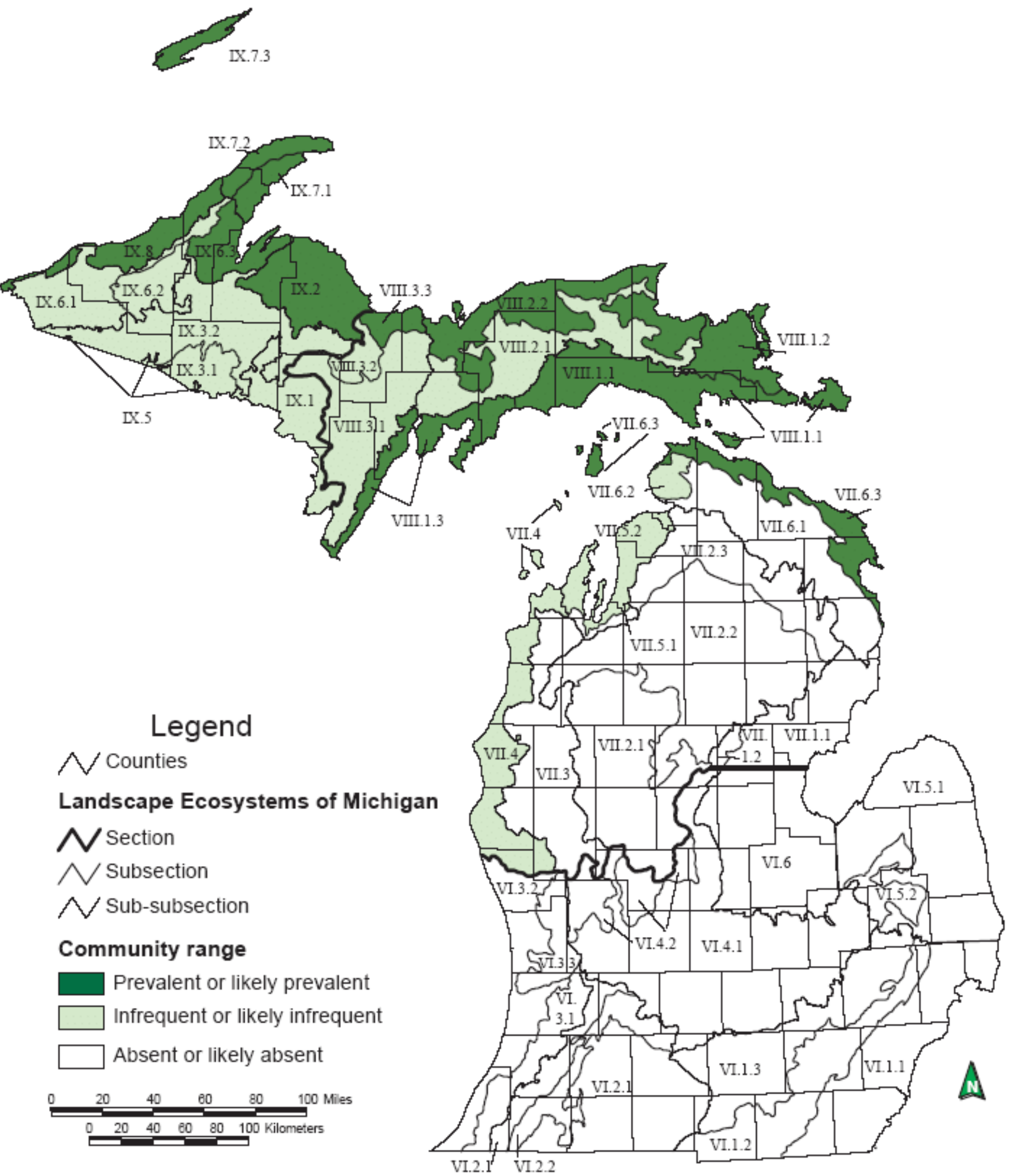
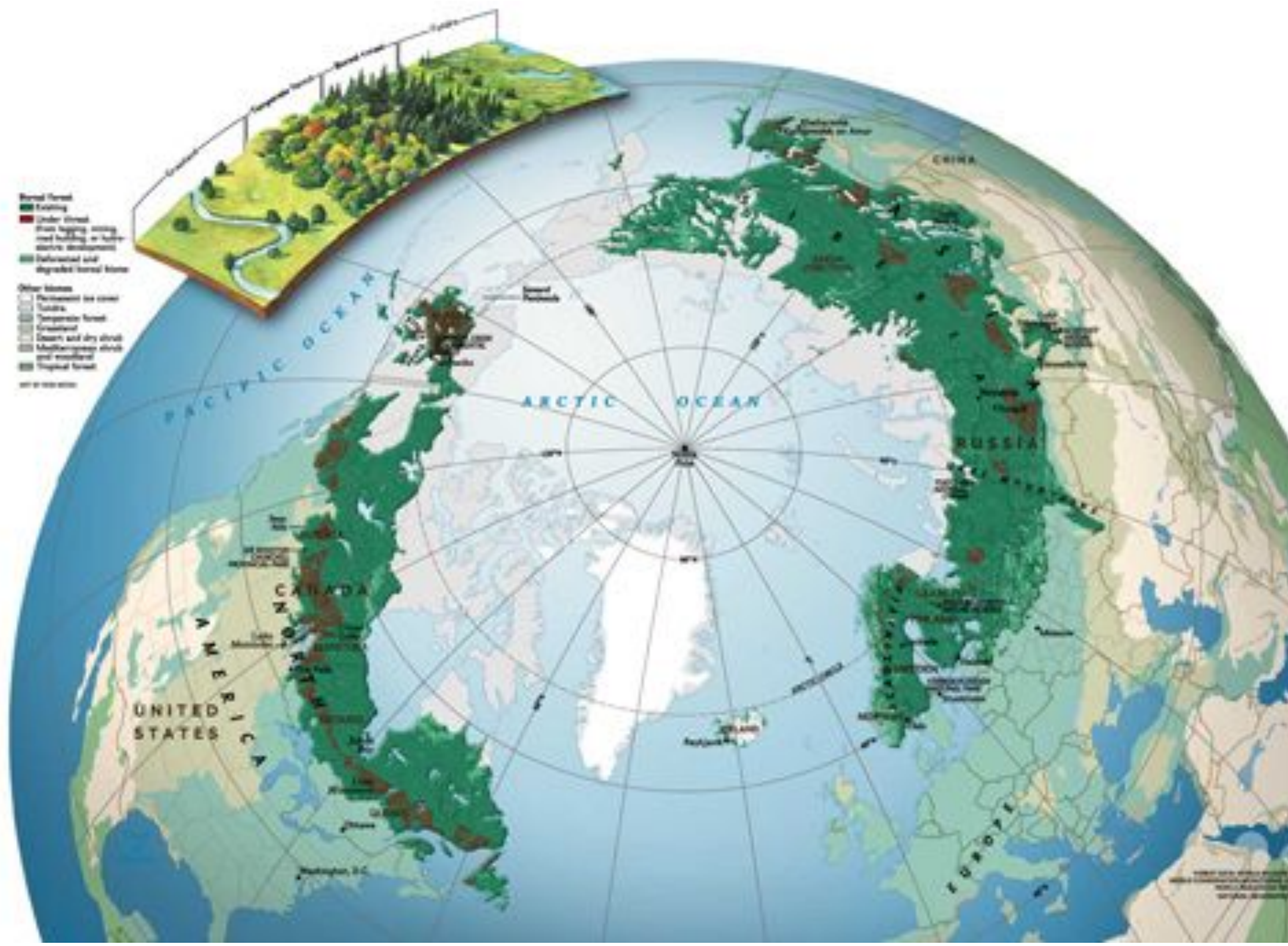
https://www.airclim.org/sites/default/files/documents/Boreal-forrest-dieback-may-cause-runaway-warming.pdf
https://www.nrcan.gc.ca/climate-change/impacts-adaptations/climate-change-impacts-forests/forest-change-indicators/tree-mortality/17785





Some of the southernmost boreal forests occur in Michigan and these and other local forest varieties are part of the long-term focus of this project.

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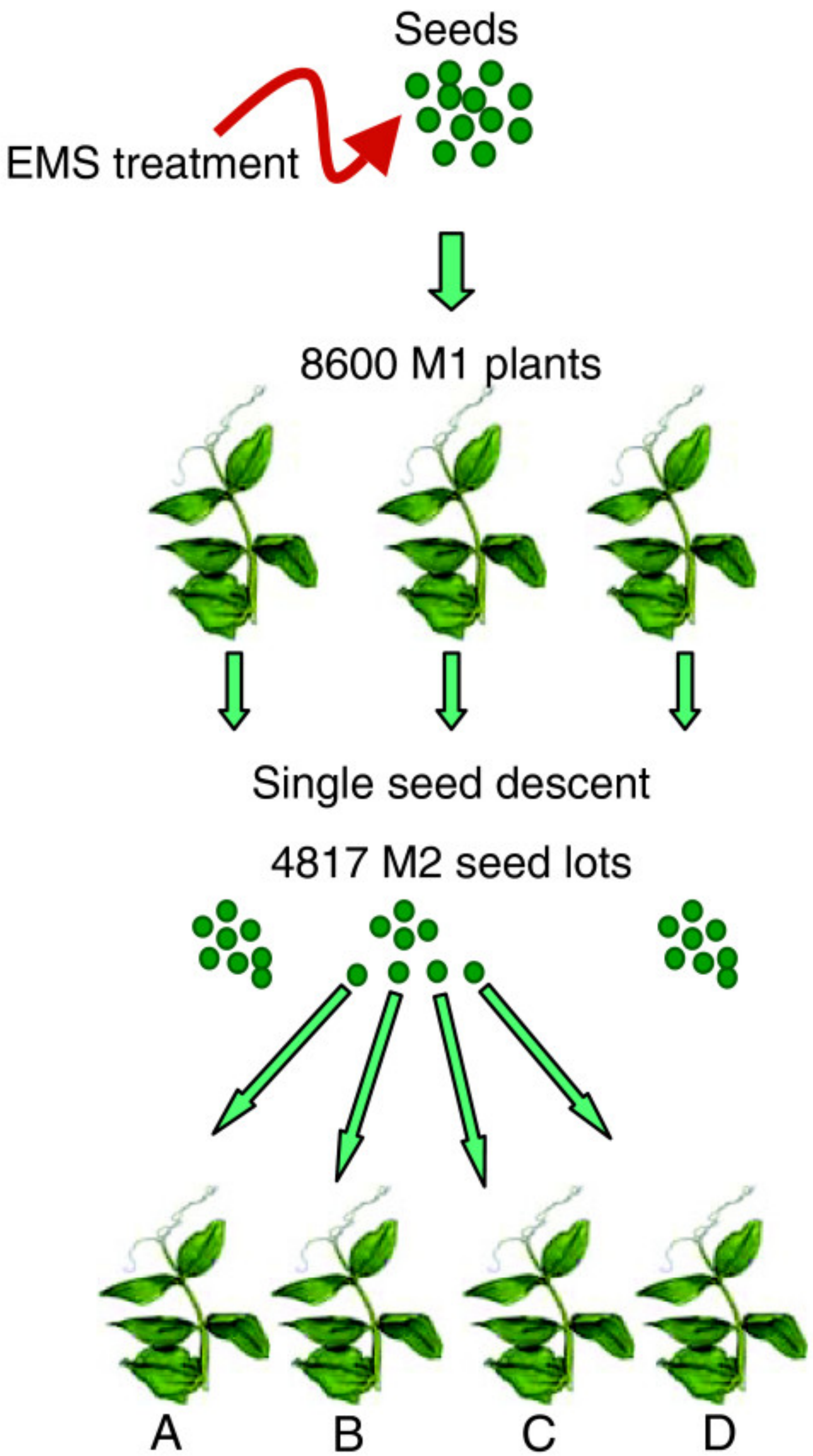
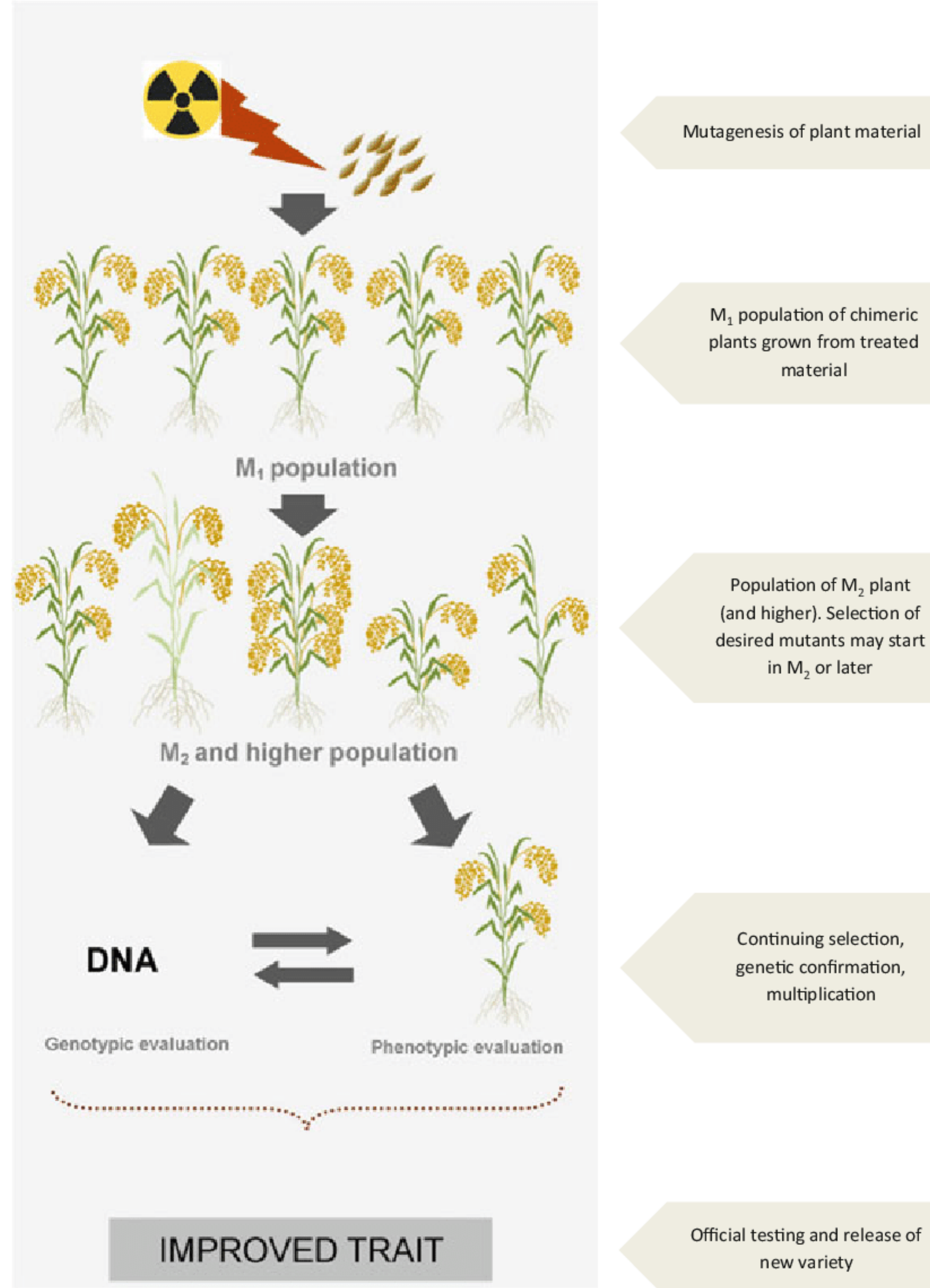
https://www.researchgate.net/publication/273831271_Natural_Community_Surveys_of_Michigan's_Coastal_Zone





This project uses a seed irradiation technology that has long been used in the food sector to create more genetic variety in crops and to isolate useful mutations such as drought tolerance, disease resistance, and increased yield.

The project uses this (perceived-as) “unnatural” technology counterintuitively to bolster “natural” ecosystems by speeding up the evolutionary process and increasing the likelihood of beneficial mutations that will help plants resist diseases, loss of genetic diversity, changing climate, and other causes of forest dieback.

Wild type
Red-purple 73A-B

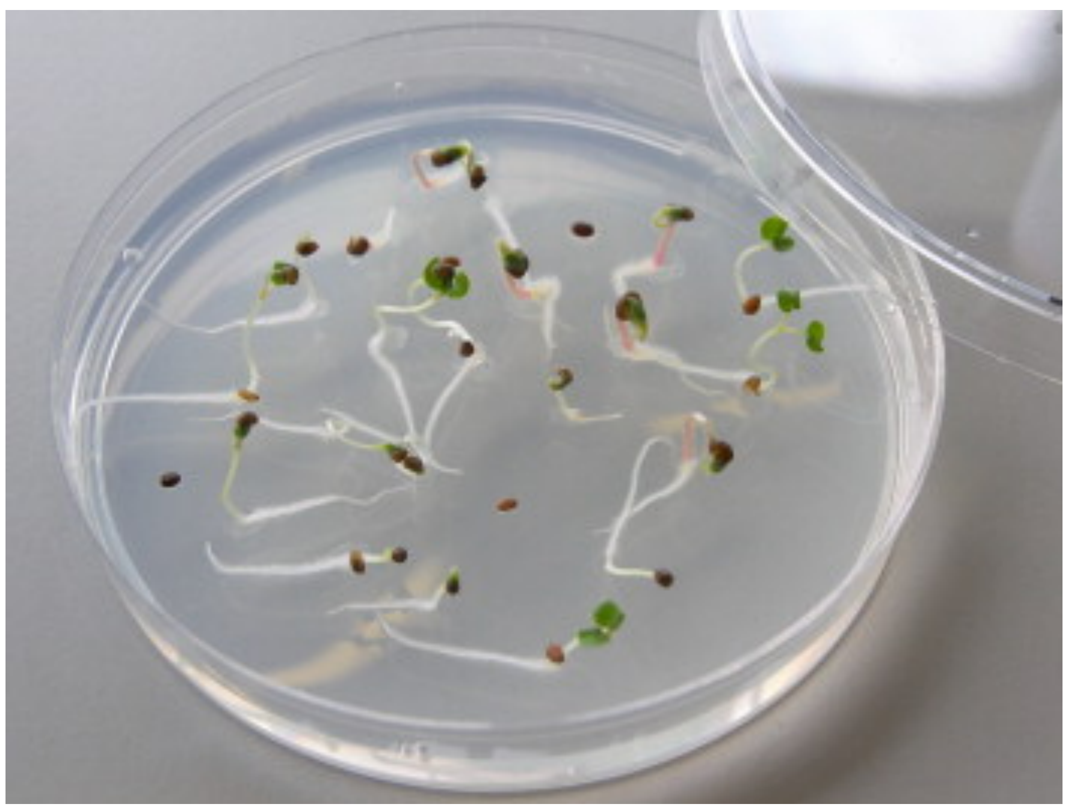
1916-10
Purple-violet N81B

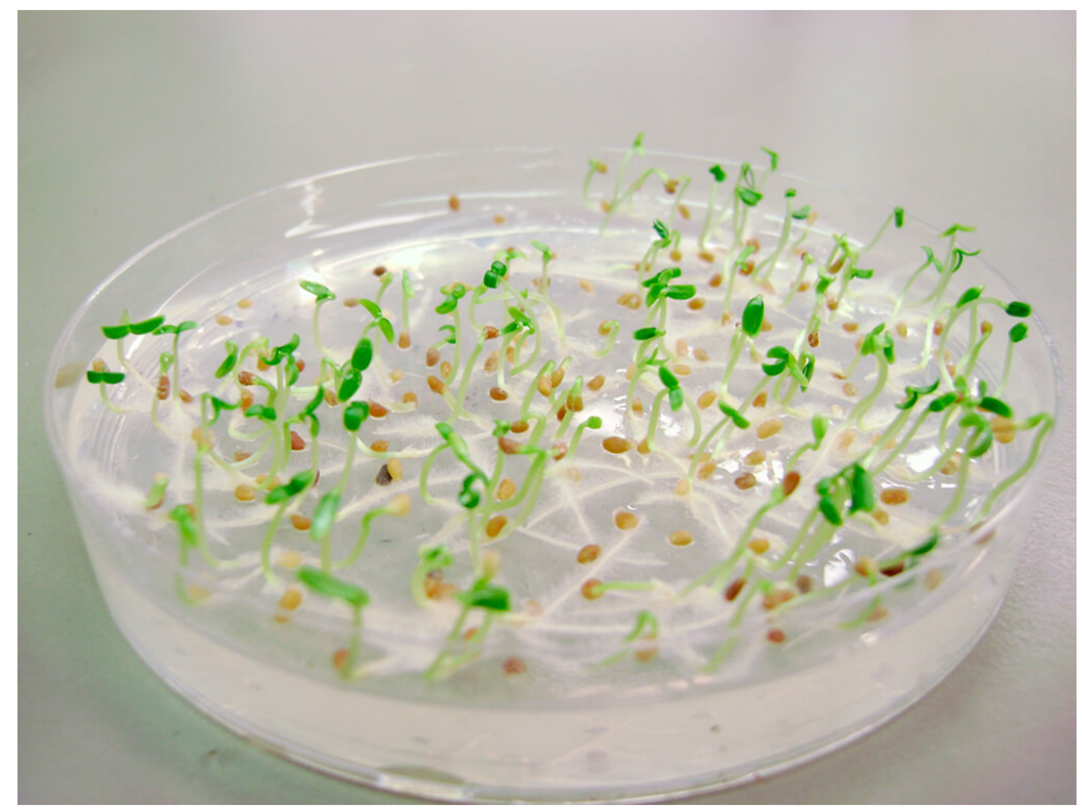
1916-25
Purple 76C

1916-18
Violet 85D

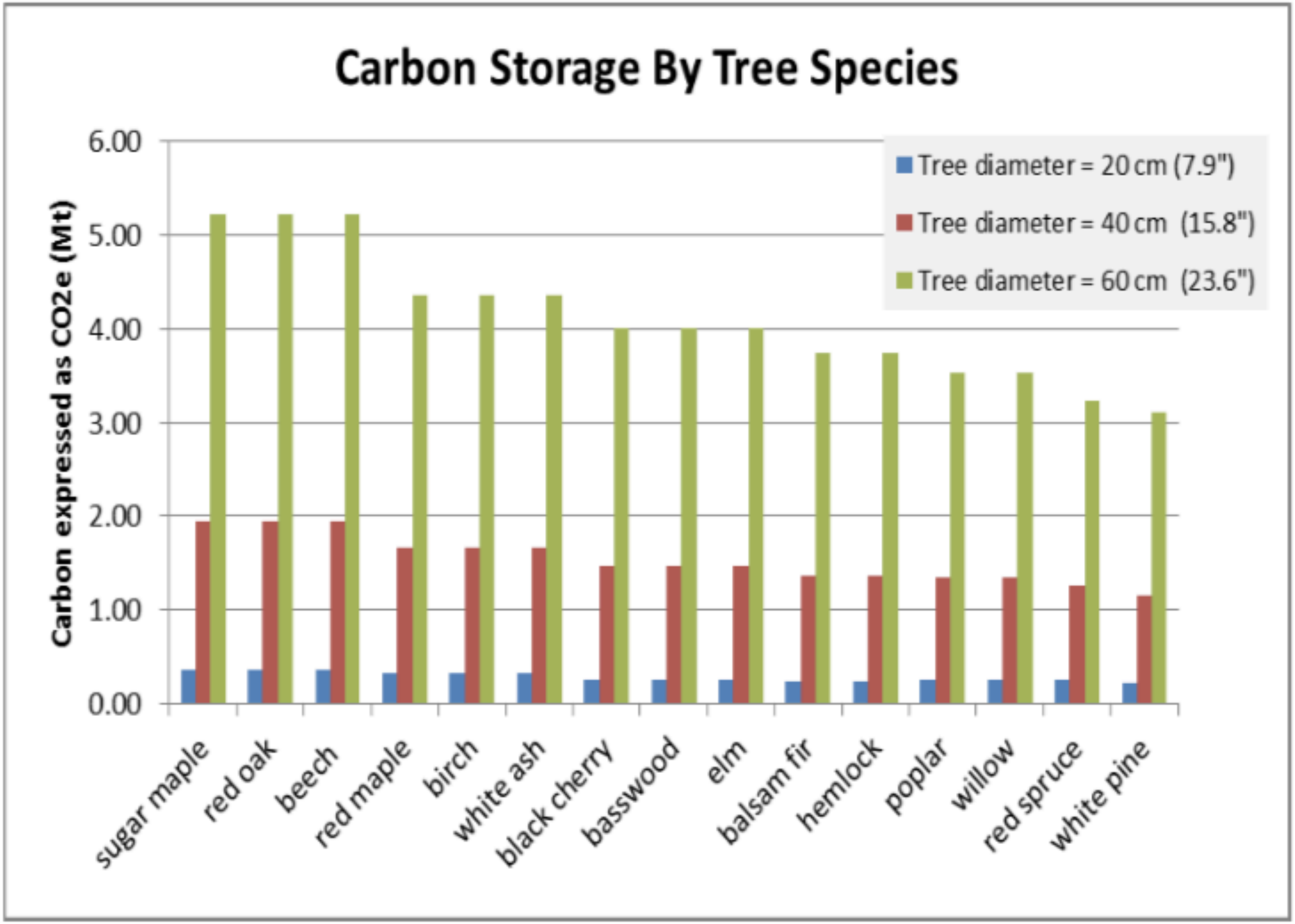
1916-12
Violet-blue 94B

1916-23
Blue 100C





There are multiple stages in the δ process, including the Miyawaki forest planting method (discussed in the FAQ section) that ensure that the healthiest individual plant genotypes become the most prevalent in the forest ecosystem.



In addition to increasing the genetic diversity and resilience within a given space of new forest, the project also sequesters CO_2 from the atmosphere—forests are still one of the best and most efficient technological means of doing this.

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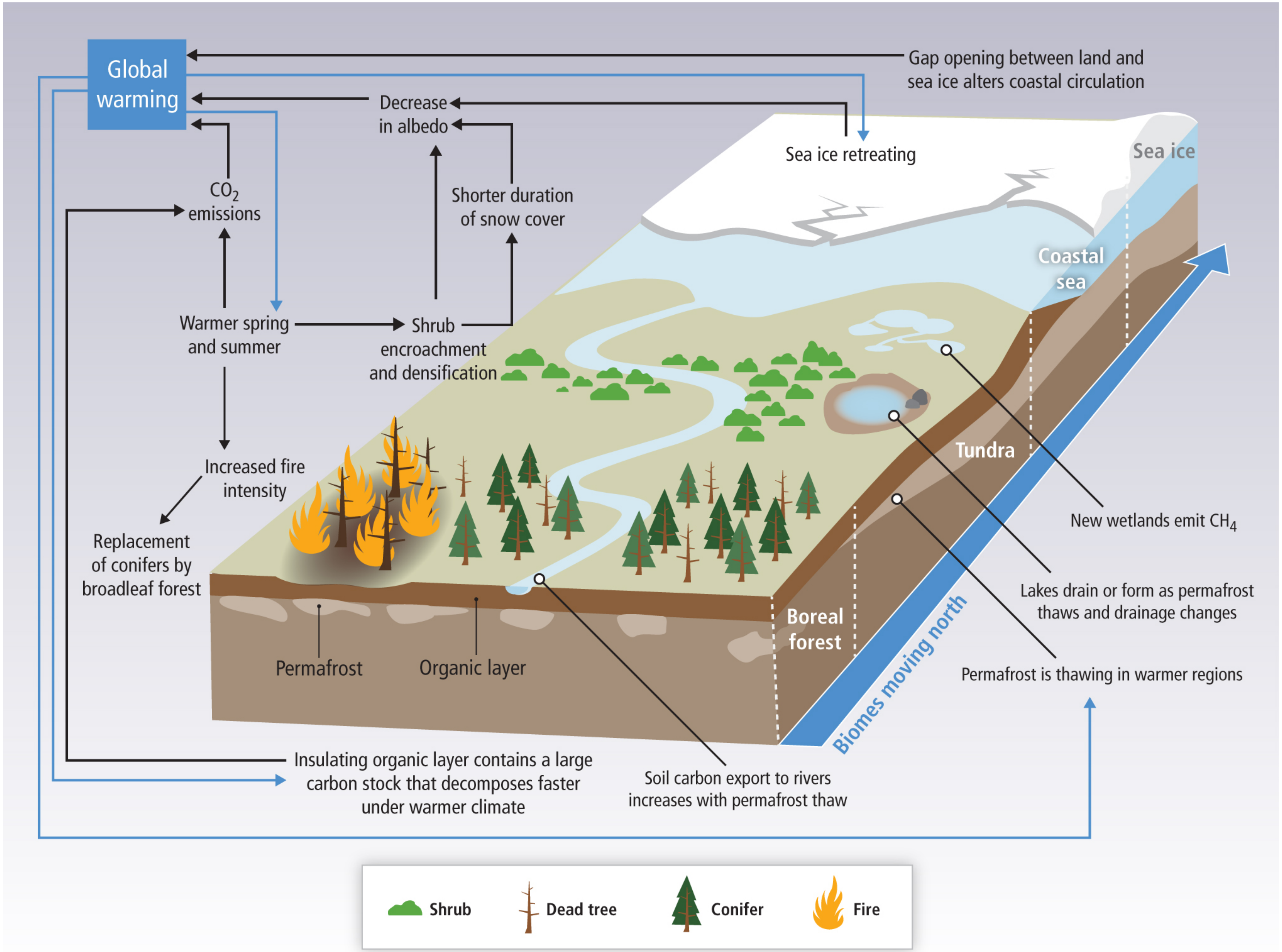

In the present moment, it is crucial that art and other social endeavors not just talk about the threat of climate change, but rather, produce actual material impacts on the global atmospheric problem of greenhouse gases. This project is designed to be highly scalable in that regard—reforesting more land and removing more carbon as additional resources become available to it.

As an ecological and scientific endeavor that is also an artwork, δ is taking advantage of its interdisciplinary status to provide urgently needed research that would otherwise be slow to fund through more traditional scientific/academic channels. In the process it is also restoring ecosystems, bolstering them against climate change, increasing genetic diversity, and removing carbon from the atmosphere.

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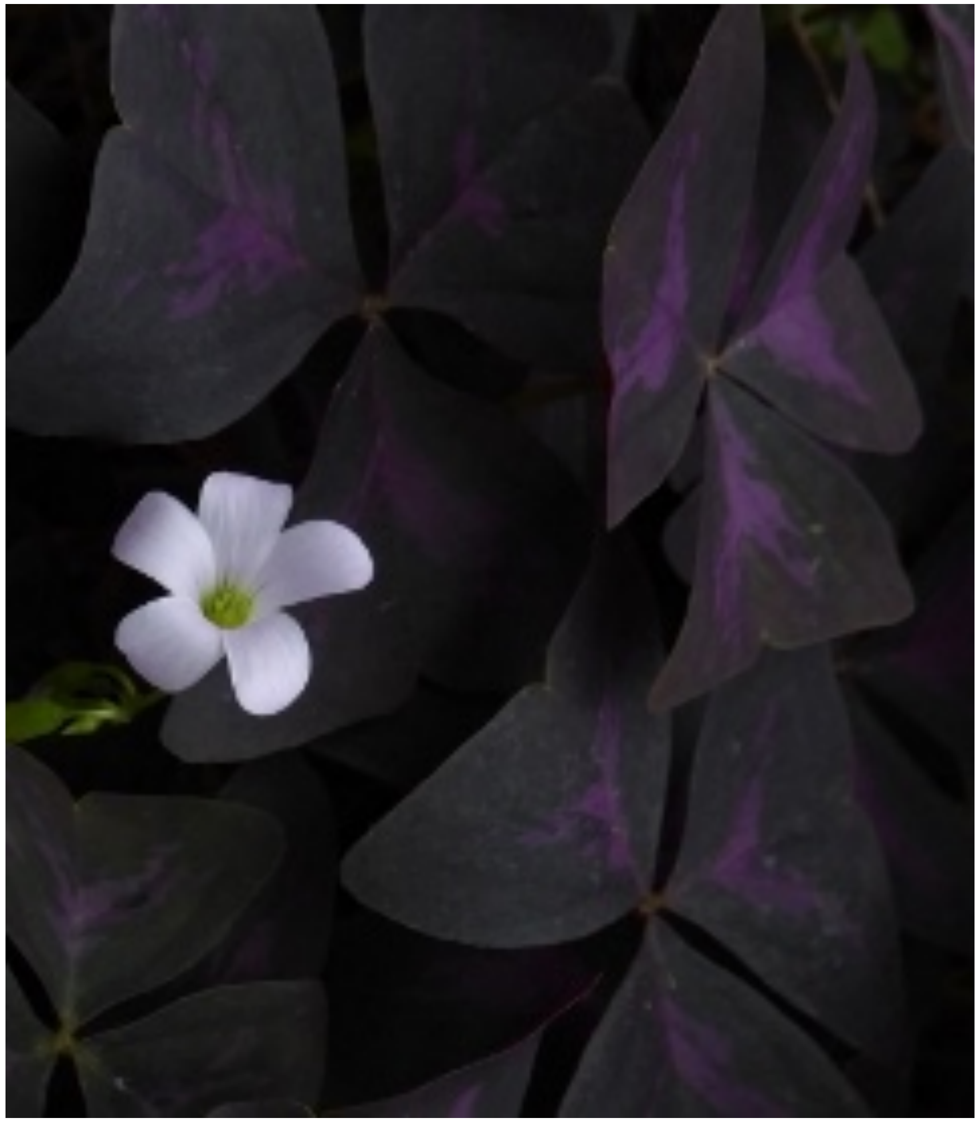
A Selection of Forest Species That Are Part of δ



Oxalis triangularis

Oxalis violacea

A Selection of Forest Species That Are Part of δ

Robinia pseudoacacia

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Trillium grandiflorum

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Betula papyrifera

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Onoclea sensibilis

Campsis radicans

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Acer rubrum

Acer rubrum

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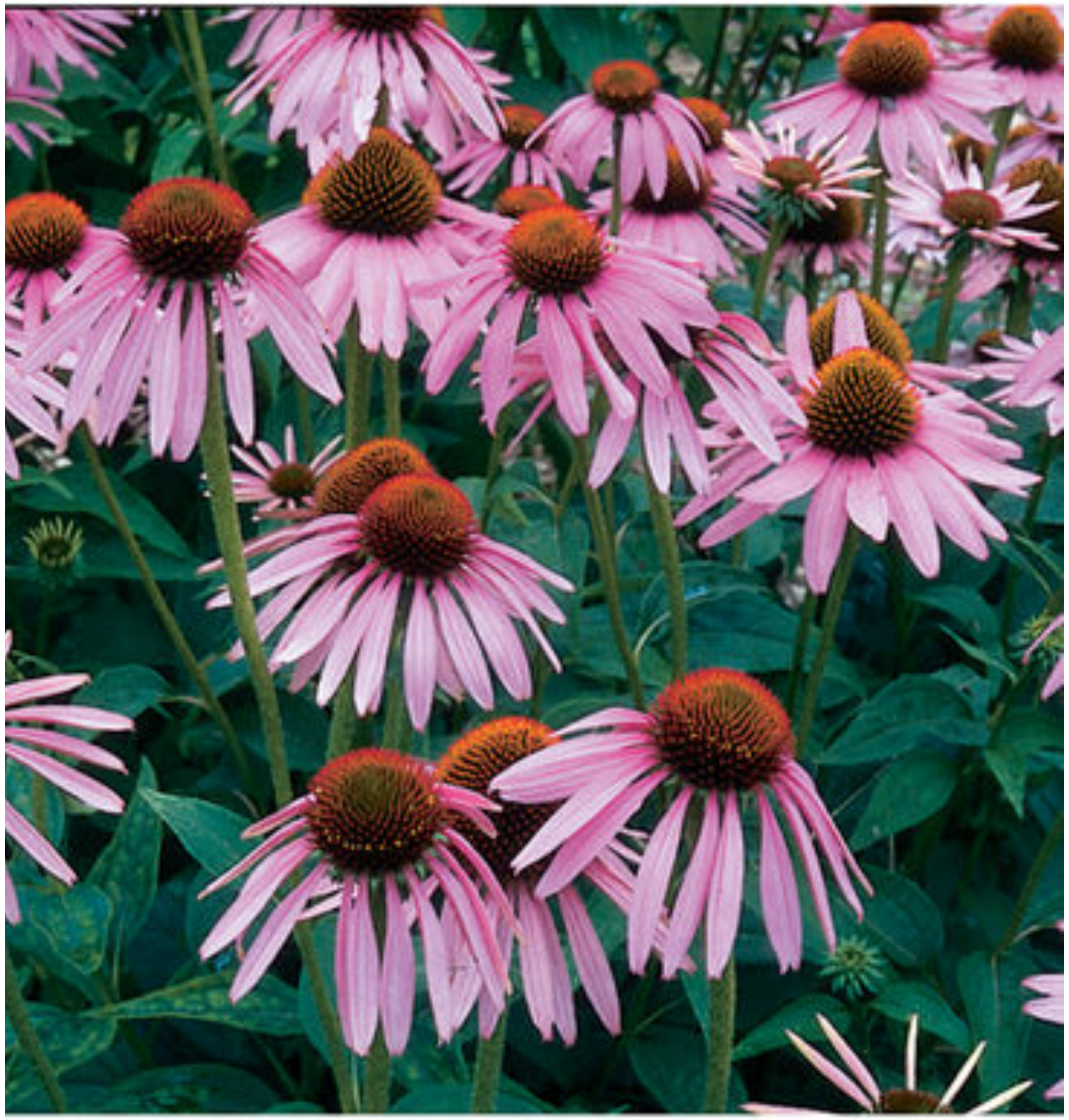

Echinacea purpurea

Lilium philadelphicum

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Quercus rubra

Quercus rubra

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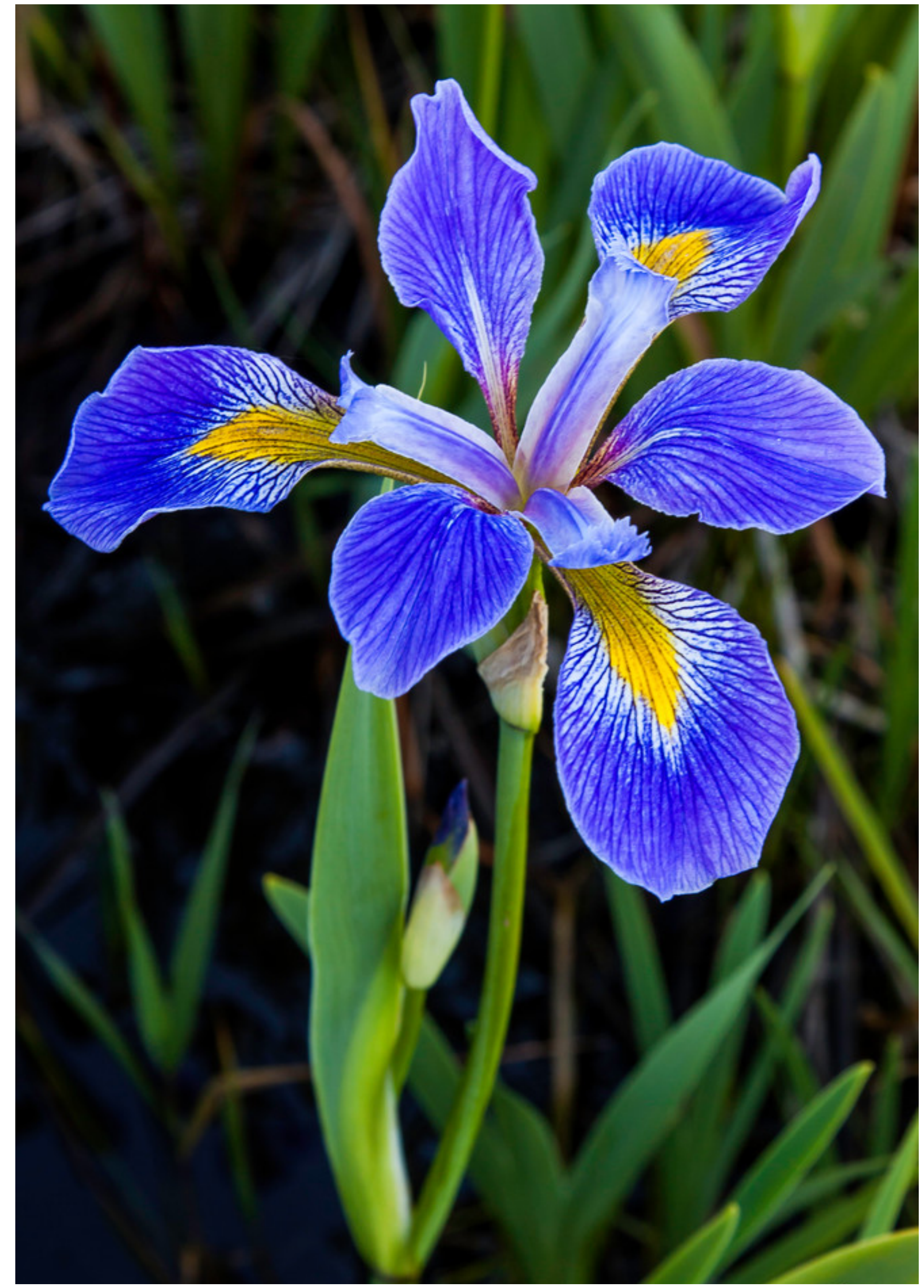
Iris versicolor



Iris versicolor

Is reforestation the ‘solution’ to climate change?

To be clear, there is no single ‘silver bullet’ solution to the climate crisis. We have to use an ‘all of the above’ approach. The most immediate imperative is to rapidly phase out fossil fuel production and use. The food system also needs a drastic overhaul to reduce its land, water and carbon footprint. However, even if we immediately stopped the combustion of fossil fuels and changed the food system, global temperature rise would continue to increase due to the large amounts of excess carbon that have been released into the atmosphere since the industrial revolution.

Reforestation alone would not be enough to remove the needed proportion of the extra carbon that is in the atmosphere within the crucial 2030 timeframe. It will need to be used in combination with other technologies, and large-scale changes in the economy. However, these technologies are still in development and reforestation is currently one of the most effective carbon removal applications at present.

How much CO_2 will δ remove from the atmosphere?

The total amount depends on the land-area scale of the project and the timeframe of the calculation.

In general, each acre of δ will remove an estimated **25 – 75 tonnes*** of CO_2 by the end of the first 10 years and an estimated **250 – 300 tonnes** of CO_2 at full maturity.

The 25 – 75 tonnes removed in the first 10 years is the equivalent of the average annual emissions of 5 – 17 cars or the equivalent of 19 – 57 return flights from New York to Los Angeles (economy class). And the 250 – 300 tonnes removed at full maturity is the equivalent of the average annual emissions of 50 – 70 cars or 189 – 227 return flights from New York to Los Angeles (economy class). (Flights in first class or business class are generally calculated to produce three to five times as much CO_2 emissions, so the quantity of these flights sequestered per acre would be 20% - 33% of the economy class number per acre).

*The reason for the range in the per-acre carbon removal estimate at 10 years has to do with the more rapid speed of forest growth using the Miyawaki method (discussed below). Many sources estimate that the method leads to growth that is ten times more rapid than conventional forestry methods (on which the low end of the estimates are based). However, we have chosen to use a more conservative figure of three times the speed of conventional forest growth to make sure our estimate does not exceed the actually sequestered carbon amount.

How is the carbon sequestration timeframe calculated?

Given the urgency of the climate crisis at this point in history δ has chosen January 1, 2030 as the "maturity" or "sequester by" date. This means that its calculations of carbon removal refer to how much carbon will be removed by that time.

This also means that sequestering the same amount of carbon through δ will likely increase in expense over time. For example, one acre planted in 2020 will have 10 years to reach its maturity date and sequester its carbon. But in order to sequester the same amount of carbon starting in 2029, ten acres would need to be planted to reach the equivalent amount of carbon by 2030.

Because of the accumulating, exponential nature of climate change, carbon that is sequestered in the future has less effective value than carbon that is sequestered now. For example, 100 billion tonnes of CO2 removed from the atmosphere *after* the tipping points for runaway global warming have been "switched on" will have a much smaller effect on global temperatures than 100 billion tonnes of CO2 removed from the atmosphere *today*. This is in part because 100 billion tonnes of CO2 removed at the present moment in history will be able help to decrease the likelihood of "switching on" runaway warming tipping points (such as the boreal forest dieback). But after climate change tipping points are switched on, humans' ability to mitigate climate effects will be greatly reduced.

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How is the carbon sequestration timeframe calculated? (continued)

For context, there is roughly ~1000 billion tonnes* of additional CO_2 (1000 $GtCO_2e$) currently in the atmosphere as a result of human activity. However, an additional ~1000 billion tonnes is stored in the arctic permafrost which is subject to release as temperatures warm (another of the runaway warming tipping points).

*calculated as the difference in ppm CO_2 concentration between the pre-industrial revolution time period (~280 ppm) and today (~410 ppm). The resulting ~130 ppm is then multiplied by 7.81 billion tonnes which is the corresponding weight of 1 ppm of CO_2 in the Earth's atmosphere. CO_2 levels fluctuate on a seasonal basis and they are obviously rising each year so a more precise figure is difficult to calculate.

https://www.carbonbrief.org/doha-infographic-gets-the-numbers-wrong-underestimates-human-emissions

https://nsidc.org/cryosphere/frozenground/methane.html

https://scripps.ucsd.edu/programs/keelingcurve/

How is δ different than a ‘carbon offset’?

Unfortunately, there are a great deal of problems with the methodology and practice of carbon offsets today. This has been the subject of multiple reports and there is far too much too fully detail here. Among the problems are: ineffective calculations, greatly overestimating or duplicating the claimed carbon amounts, lack of oversight or monitoring of actual effectiveness of emission reduction projects, and many documented cases of fraud. Unless a significant effort of due diligence has been done by the buyer, it is not reasonable to assume that an amount of carbon that is claimed to be ‘offset’ is in any way effectively removed from the atmosphere or otherwise ‘offset’ or reduced.

Because of this, for δ we prefer to use the term “carbon sequestration” to avoid the ambiguity and other problems associated with offsets. We set an explicit maturity date in the near future (January 1, 2030) and we reference a specific range of carbon that will be directly removed from the atmosphere at that time while taking growth measurements to verify this. Importantly, we plant forests on land in the US which is among the countries that is historically most responsible for the climate crisis. This avoids the issue of a kind of climate-based neo-colonialism of using ‘undeveloped’ regions as the sites of climate “clean up” for developed countries’ emissions. Unfortunately, this latter dynamic is often associated with the offsets industry and can potentially cause negative ecological and economic effects in these regions.

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How is δ different than a ‘carbon offset’? (continued)

The ecological value of δ is not only in removing CO_2 from the atmosphere but also—of equal importance—in creating a functional, biologically diverse ecosystem and a site of ecological research. We avoid the problems of monoculture forest planting, and also the often-uncounted emissions related to fertilizer use and administrative activities such air transportation to and from the planting site. For example, rather than using fertilizer, δ makes use of varieties of tree such as the black locust (*Robinia pseudoacacia*) that are native to the Michigan region and that fix nitrogen from the air, thus enriching the soil for other species in the ecosystem.

Are mutations dangerous or bad for the environment?

Mutations are part of the evolutionary process and are necessary for species and ecosystems to change and adapt over time. It is believed that the development of life on Earth itself benefited from cosmic radiation that caused chemical changes and variation needed to eventually arrive at the right chemical combinations needed to produce self-replicating, living systems.

In general, mutations occur in every individual organism and we as individuals all have them. But given the rapidly changing climate, many species aren't mutating fast enough to adapt in time. In recent history we have seen an approximately 50% loss of species and genetic diversity. This already compares to other mass extinction events in Earth's history and the rate of loss is continuing to accelerate.

For an individual organism a mutation may be adaptive, neutral, or maladaptive to their present environment. However, at a population level, more genetic variation and diversity is generally a positive marker of robustness and resilience. It increases the chance that at least some of the individuals in the population will be able to adapt to and thrive in a changing environment and pass their beneficial genetic mutations on to their descendants. One of the early indicators of the threat of species extinction is when populations become geographically isolated from each other and lose genetic variation through inbreeding and other processes.

Has there been scientific research on “synthetic biodiversity”?

Yes, though it is a new area, it has been a topic of discussion within the scientific community. In a paper published in the journal Cell by Antoinette J. Piaggio and other scientists called: “Is It Time for Synthetic Biodiversity Conservation?” the authors argue that tools such as gene editing should be used for the benefit of ecosystems. They note that the conventional conservation movement has failed to stop the drastic loss of species and biodiversity occurring at present, and the propose a re-thinking of the anti-technology biases of the conservation community and others.

https://www.cell.com/trends/ecology-evolution/fulltext/S0169-5347(16)30197-5

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Does δ require regulation ?

Organisms with genetic variation produced through randomized mutation such as radiation are not considered ‘GMOs’ from a regulatory perspective in the US. As such, they are not required to go through a regulatory approval process. (For the record, ‘GMOs’ themselves are generally safe and can be a valuable tool in more ecologically efficient food production among other benefits).

The land that δ will inhabit is former farmland with rural/agricultural zoning and there are no restrictions on tree planting.

What is the Miyawaki method?

The Miyawaki method—named for the Japanese botanist Akira Miyawaki—is a type of reforestation that is closer to rewilding than conventional, often monoculture-based, forestation methods.

In brief, it plants a deforested area with a dense population of seedlings of native/regional plant varieties. Because of the very dense planting (30 to 50 plants per square meter in a temperate forest) the plants compete against each other to grow taller and obtain more sunlight. This competition for sunlight causes the plants to grow much faster than they otherwise would, creating a mature forest in a fraction of the time (as little as 10 years as opposed to 60 – 100 years).

It also results in the slower growth of less well-adapted plants while the better-adapted plants grow larger more quickly and take their place within the forest ecosystem. The result is a kind of sped up evolutionary process that leads the forest to both evolve and grow at a faster pace while also containing more variety and effectively integrating soil microbes, pollinators, and other animals into its ecosystem. Once the initial seedlings are planted, the Miyawaki method proposes a “hands off” approach with minimal to no human intervention after the first one to two years.

What is the current stage of δ ?

As of February 2020, the first, large batch of seeds has been irradiated at a dose of 24 Grays (2400 rad). This batch will be enough to plant several acres of the initial forest. The seeds are now in the process of being germinated and grown.

What is the ultimate goal or vision of the project?

We want δ to scale as much as possible—to reforest as much land and sequester as much carbon as possible. Ultimately we look to concepts such as the half Earth as a guiding principle of planetary design. The concept of the half Earth, associated with the biologist E. O. Willson, proposes that humans set aside 50% of Earth's surface as wilderness to preserve what remains of Earth's biodiversity. We hope that δ can help provide an early contribution to this wilderness region and test new methods of actually increasing biodiversity.

How can I contribute to δ ?

For inquiries, please email Sean Raspet at seanraspet@gmail.com

Thank You

seanraspet@gmail.com

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