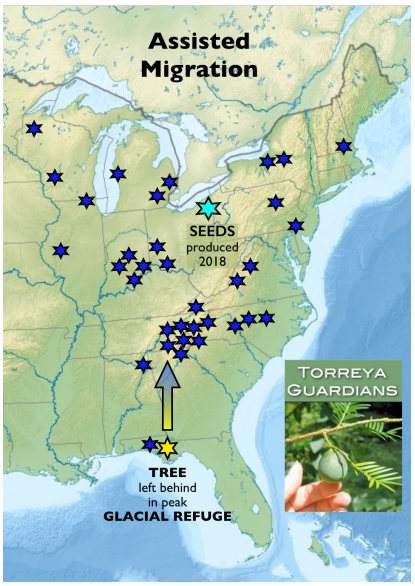
Utilizing Torreya Guardians Experience for SSA and Recovery Planning

by Connie Barlow, founder of Torreya Guardians
July 25, 2024 • Comment for **"Five-Year Revision" re Florida Torreya**

The Species Status Assessment is where Torreya Guardians can contribute vital information unavailable elsewhere. Recommended actions follow each conclusion.



As volunteers, **our form of citizen science** (PDF-01) is not constrained by the need to generate numbers at scales that measure up to the kind of "statistical significance" required for publication under peer review.

Instead, we seek to reveal the breadth of "**natural history**" observation and documentation, using both text and images published on updateable webpages on the **TorreyaGuardians.org** website. Via these postings, professionals can offer diverse interpretations and hypotheses without needing to visit the sites.

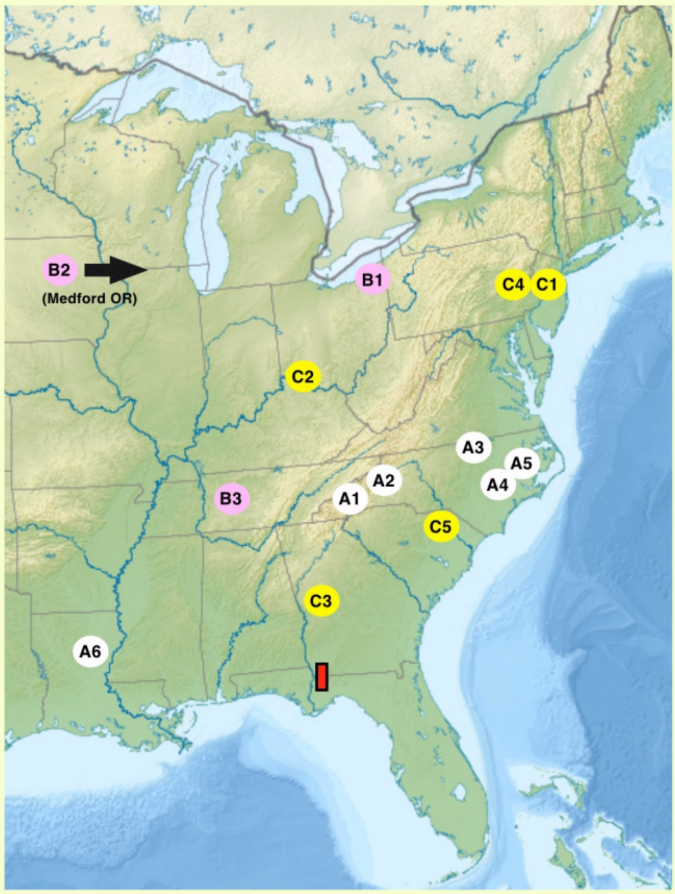
We bring **20 years of experience** (PDF-02) in documenting species health and habitat conditions of old and new horticultural plantings of **Florida torreya** (PDF-03) far north of its historical range in north Florida.

Because the **Endangered Species Act of 1973** provides an "exception" for plants that does not apply to animals, Torreya Guardians has utilized seeds produced in ***horticultural plantings*** for our own experiments, while **documenting the health, seed production, and full naturalization of established horticultural plantings** (PDF-04)

Conclusive Information and Recommended Actions

In this time of ongoing **anthropogenic climate change**, perhaps the most important ecological characteristic of this species is its paleoecological identity as a **glacial relict**. An entire webpage on the **TorreyaGuardians.org** website documents that Florida torreya is indisputably a **glacial relict** (html or PDF-05).

Our documentation of old horticultural plantings center on **the mountains of western North Carolina which are some 350 to 450 miles north of historical range**. At the **Biltmore Gardens** near Asheville NC (PDF-06) and **Harbison House** near Highlands NC (PDF-07), we have documented in text, image, and video full naturalization of the species at those latitudes and altitudes. *Visit our **Historic Groves** webpage (or PDF-04) for details.*



Horticultural Plantings of Florida Torreya

Sites documented north of Florida by Torreya Guardians

Naturalized Groves (with healthy offspring)

A

Mature Trees (producing seeds)

B

Mature Trees (but no seeds)

C

Eastward of the mountains are **private plantings that also demonstrate full naturalization**: the (former) Kennedy residence at **Clinton NC** (html or PDF-08) along with the nearby Bullard residence at **Mt. Olive NC** (html or PDF-09). With their permission, our group has **collected seeds and/or cuttings** from all four of these sites. At Clinton and Mt. Olive, we have additionally **collected seedlings** that had established naturally in places where the homeowners wanted them removed.

LEFT: **More than 1,000 seeds** were harvested at the home of our **Cleveland, Ohio volunteer** (PDF-10) in 2023.

In our quest to discern the northern-most latitudes where survival / thrival is possible in today's climate, we launched experiments **up to 3,800 ft altitude** (**Franklin, NC** PDF-19)

and **up to 1,200 miles** beyond historical range in **New Hampshire** (html or PDF-11), **Michigan** (html or PDF-12), and **Wisconsin** (html or PDF-13). If outright failures do ensue in any of these locations, we will have succeeded in **establishing a northern limit for siting of scientifically credible experimental populations.**

Meanwhile, ongoing seed production and **escalation of annual seed counts at our volunteer planting in Cleveland, Ohio** (html or PDF-10) indicate that experiments even in northern states are indeed sound activities.

CONCLUSION 1: Current recovery efforts focusing on replenishment of this glacial relict, subcanopy tree in its HISTORICAL RANGE are no longer scientifically credible.

The fact that seed production is occurring **outdoors in Ohio** (PDF-10) **of a relictual Florida species** that ceased reproduction in its historical range more than 30 years ago is confirmation that the geographic focus for ultimate recovery (with the goal of eventual delisting) **must shift substantially northward**. At the bottom of the **Historic Groves** page (html or PDF-04) you will find titles, excerpts, and links to **7 academic papers that espouse the importance of studying poleward horticultural plantings** in this time of rapid climate change.

• **Action Recommendation 1A: Review the "Natural History" page** (html or PDF-29) **and the "Endangerment Causes" page** (html or PDF-28) **on the Torreya Guardians website when preparing the Species Status Assessment. Also scroll through our "Learnings" page** (html or PDF-26).

• **Action Recommendation 1B: Review the California torreya page** (html or PDF-24) **on the Torreya Guardians website when preparing the Species Status Assessment.**

By the time botanists began to study Florida torreya in its historical range, **all of the very old trees would already have been cut and used for housing and river docks** because it has the most water- and rot-resistant wood of all native trees. Therefore, it is important to be aware of **the natural history of *Torreya californica*** in the Coast and Sierra Mountains of California, especially noticing the age and size that this genus can become. The fact that Asian species of genus *Torreya* also reach massive trunk widths (though not height) suggests that the parsimonious conclusion is that **Florida torreya is likewise capable of such forms**. An entire webpage devoted to **natural history observations of California torreya** is on our website (html or PDF-24). Connie Barlow also posted a 2-part video series on that species.

• **Action Recommendation 1C: Include the groves at Biltmore Gardens** (PDF-06)**, Harbison House** (PDF-07)**, and Cleveland** (PDF-10) **when evaluating SSA Stage 1 "species needs" and SSA Stage 2 "current species condition."**

• **Action Recommendation 1D: Approach Biltmore Gardens** (html or PDF-06) **and Harbison House** (html or PDF-07) **in North Carolina for collaborative designation of their Florida torreya horticultural groves and next-generation saplings as "PRE-EXISTING experimental populations."**

Retroactively categorizing prior plantings as "experimental populations" is indeed the only way for the agency to obtain adequate documentation of "best available scientific data" that **confirm an ability to thrive, reproduce, and naturally establish seedlings in northward locales in anything less than two or three decades.** Indeed, retroactive designation could establish full naturalization capabilities at specific latitudes, altitudes, climates, and habitat types almost immediately and in accordance with IUCN guidelines for translocations.

Begin by reviewing the Torreya Guardians **Historic Groves** page (html or PDF-04) to see the full set of **pre-existing horticultural plantings** that we have documented as having mature trees. Biltmore Gardens and Harbison House are most important because they (a) entail a half-dozen or more mature trees and (b) evidence full naturalization. Then seek institutional collaboration for continuing natural history documentation and monitoring at those two sites.

• **Action Recommendation 1E: When developing the Recovery Plan itself for posting in the Federal Register, consider reaching back to the 2010 plan update to restore the "experimental populations" language used there:**

> **Translocation (introduction of a species to a site outside the known historical range), could offer a best management option if the site provides the only place safe from the threats that brought the species to endangerment,** and should only be considered if it can be shown that there is a net gain for the species conservation, i.e., recovery unit. This management option should be carefully evaluated, and planning should be done with the very best biological science. **If a population has been already translocated, it could potentially be evaluated as an experimental population.**

This language appears on page 19, which is the final paragraph prior to the references. Notice that the agency already adopted an official position open to "translocation." Notably, **this 2010 statement suggests retroactively labeling earlier horticultural plantings as veritable "experimental populations."**

• **Action Recommendation 1F: Carefully consider your choice of terminology when speaking of "translocation" of the species into experimental populations for the purpose of "climate adaptation."**

Consult this webpage on the Torreya Guardians website: **"Assisted Migration or Assisted Colonization: What's In a Name? Chronological History of the Debate on Terminology"** (html or PDF-25)**.** There you will find that, while the choice of conservation biologists has often been "**managed relocation**," research scientists in the forestry agencies of the USA and Canada use the term "**assisted migration**."

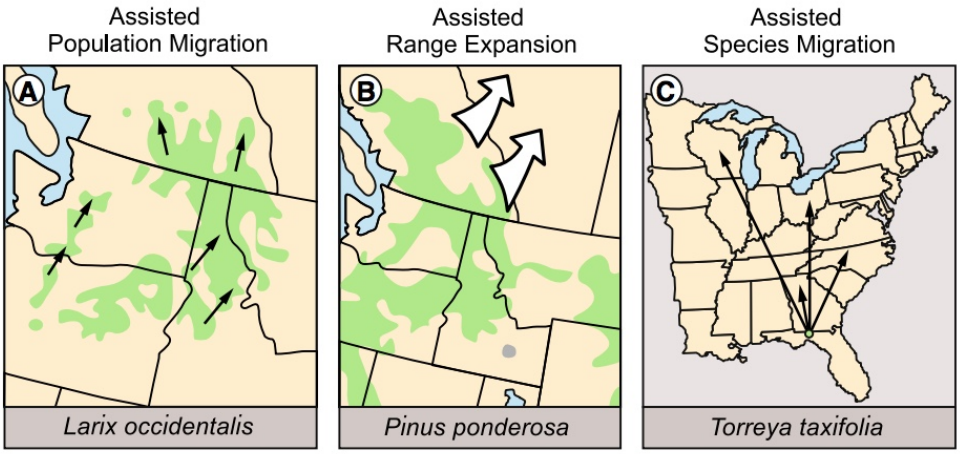


Fig. 3 Seed migration can occur as assisted population migration in which seed sources are moved climatically or geographically within their current ranges (*shaded*), even across seed transfer zones; e.g., moving *Larix occidentalis* 200 km north within its current range (**a**). Seed sources can also be moved climatically or geographically from current ranges to suitable areas just outside the range to assist range expansion, such as moving seed sources of *Pinus ponderosa* from British Columbia into Alberta, Canada (**b**). For assisted species migration, species could be moved far outside current ranges to prevent extinction, such as planting *Torreya taxifolia* in states north of Florida where it naturally occurs (**c**). (Terms from Ste-Marie et al. 2011; Winder et al. 2011; Williams and Dumroese 2013; maps adapted from Petrides and Petrides 1998; Torreya Guardians 2015)

CONCLUSION 2: It is highly unlikely that Florida Torreya is the only GLACIAL RELICT plant whose range size and northward extent have been severely constricted by an inability to track post-glacial Holocene warming.

• **Action Recommendation 2A: Evaluate all endangered and threatened plants for the possibility that they might be glacial relicts.**

Consider developing an agency priority for implementing **assisted migration testing via northward experimental populations for this category of plants.** For example, **Relict trillium** would be the ideal species to begin with because (a) its very name denotes its relictual status and (b) the **Relict trillium SSA** was already posted in 2023 and includes documentation of translocations already established. **Leedy's roseroot** is also a relictual species, and its recovery plan revision is happening simultaneously along with that of Florida torreya.

Florida yew is another prospect. Also an indisputable glacial relict, its range is even smaller than that of Florida torreya. Its disease-free health has apparently precluded its federal listing — but it is listed as "**critically endangered**" by the IUCN (PDF). A Torreya Guardian did the online research and posted a list of "**Florida Yew: Ex situ specimens**

of *Taxus floridana*" (PDF). Several Torreya Guardians — **Ocoee TN** (html or PDF-14) and **Capac MI** (html or PDF-12) — are experimenting with horticulturallly acquired specimens of Florida yew by planting in the same forest patches as they have chosen for Florida torreya. Review **APPENDIX A: "Recovery Planning for "Special Needs" Endangered Species"** (PDF)

• **Action Recommendation 2B: Study the history of the relictual *Franklinia alatamaha* — which was extirpated in its refugium in coastal Georgia, but successfully planted horticulturally in New England — as an ideal case study to validate the scientific credibility of aiming for Florida torreya delisting by establishing experimental populations far to the north.**

The image on the preceding page shows the **Franklin Tree's historical range** near the outlet of the **Altamaha River**. The image here points to the PDF of a lengthy article that appeared in 2014.

The Nature Conservancy attempted to repatriate to historical range some seedlings from horticulturally grown specimens in the northeastern states, but the effort failed.

• **Action Recommendation 2C: Regard the SSA and Recovery Plan processes for Florida torreya as an opportunity to produce documents that serve as the first and well-supported example of the agency building climate adaptation into its endangered species management.**

Owing to the early actions by Torreya Guardians in utiilizing the horticultural seed exception in the ESA as **a legal means for proceeding with "assisted migration"** prior to governmental concurrence, our citizen group has garnered a great deal of **attention in the media and in academic writings**. Our **"History of Torreya Guardians"** webpage (html or PDF-15) includes excerpts that mention us in these news publications: *New York Times, Los Angeles Times, Boston Globe, The Economist, Audubon, Sierra Magazine, Earth Island Journal, Orion, Yale Environment 360, Mother Jones, Deutsche Welle*. Our group is also mentioned in these academic journals: *Nature, Science, Scientific American, Nature Climate Change, Conservation Biology, Forestry Chronicle, Trends in Ecology and Evolution.*

Be aware that currently on the Torreya Guardians website is a page titled, **"Case Study of Agency and Institutional Failures in Endangered Species Management of Florida Torreya"** (html or PDF-27). Connie Barlow wrote this list as an individual, and she forthrightly presented **13 distinct failures** based on her personal experience since her first contact with the agency in 2003. Also, please **eliminate the erroneous and slanderous description of Torreya Guardians** on page 6 of the 2020 plan.

CONCLUSION 3: Discerning *where* to plant Florida torreya is, in our experience, easier than implementing PLANTING TECHNIQUES and devices that will prevent native vertebrate herbivores from devastating a project.

This is why the **"Propagate, Plant, Tend"** page on our website (html or PDF-16) has become incredibly long and sometimes contradictory. The latter happens when volunteer planters interpret their results in different ways. *Note:* The 2021 FWS official response to Barlow's 2019 downlist petition noted that **Torreya Guardians had indeed made "Improvements to Propagation Practices" and "Documentation of Historical Groves."**

• **Action Recommendation 3A: Recommend to collaborators in all future experimental plantings that the Torreya Guardians "Propagation" page** (html or PDF-16) **should be consulted.**

Our strongest findings include: (a) **shaking off the potting soil** when outplanting seedlings (html or PDF-23) (possibly adding **small rocks** to the pit in order to deter rodent tunneling), (b) building **sturdy cages** tall enough to deter bucks from antler rubbing, (c) wild-planting seeds in forest landscapes **no less than 4 inches deep,** while (d) preferentially choosing sites where the fronds of evergreen Christmas ferns can supply **camouflage** (LEFT) for the early years.

Finally, (e) avoiding sites underlain by **rodent tunnels** is crucial. Techniques include **staying away from logs and large fallen branches.** Also, plunge a table knife into the ground to **test for the feel of existing vole tunnels** before planting seeds or seedlings.

• **Action Recommendation 3B: Screen potential planting sites for where there are trustworthy reports of very low deer populations.**

Our own experience suggests that steep, **closed-canopy deciduous mountain slopes far from open fields and farming** are generally deer-free, such as **Waynesville NC** (html or PDF-20). Two other rural sites have evidenced little or no deer herbivory probably owing to the prevalence of year-round deer-hunting by residents living on fixed or low income: **Ocoee watershed TN** (html or PDF-14) and **Shoal Sanctuary FL** (html or PDF-21). As well, if **cougars** make a comeback in the eastern USA, then even regions lacking mountains can offer relatively deer-free zones in **deep ravines**, especially where the sound of rapids or waterfalls would mask the sound of a predator approaching.

CONCLUSION 4: ANNUAL SEED PRODUCTION at the 2 ex situ groves in northern Georgia is so substantial that experimental northward plantings can begin to include direct planting of very large numbers of seeds into forested landscapes.

As reported in the existing recovery plan, Atlanta Botanical Garden confirmed and then published in 2012 that **the seeds of Florida torreya are recalcitrant**. They cannot be held in long-term storage either by drying or by freezing. The only long-term option is highly technological: embryos are removed from seeds and cut into pieces small enough for instant deep freezing in liquid nitrogen. Recovery of a living specimen at a later time can be achieved by "**somatic embryogenesis**" (html).

Consequently, with **no method for long-term storage** of large numbers of seeds, there are only two options for managing annual seed production at the ex situ groves in northern Georgia: (1) **find legal collaborators** who will begin experimental populations via direct planting of hundreds or thousands of seeds into their intended ultimate destinations within forested lands, or (2) **leave the seeds uncollected where they fall** and preclude others from gathering them. The latter approach was the norm from at least 2007 through 2017, as documented in the agency response to an **FOIA query by Connie Barlow in 2018**. Full FOIA correspondence can be accessed via the **FOIA webpage** (html) on the Torreya Guardians website or via Researchgate in PDF.

The official communications suggest that **hundreds of thousands of seeds have, to date, been "wasted"** owing to lack of collecting and initiative to distribute seeds by the two botanical gardens in charge. As well, **given the absence of annual seed estimates, there is no numerical way to track maturation and health of the ex situ groves over time**. This is a severe failure of a fundamental aspect of standard scientific monitoring at an ex situ planting, and it was one of the main factors that prompted Connie Barlow to write and post in May 2021 a new webpage: **"Case Study of Agency and Institutional Failures in Endangered Species Management of Florida Torreya"** (html or PDF-27).

• **Action Recommendation 4A: Insist that the two botanical gardens in charge of the ex situ groves in northern Georgia submit annual seed production reports to the agency.**

Annual estimates of numbers of seeds produced is a crucial factor for (a) **monitoring the health of the groves** and (b) deciding whether existing and potential experimental plantings can be **awarded seeds numbering in the thousands**, such that direct seed planting is a practical and low-cost option.

Note: **Dozens or even hundreds of seeds planted per acre is suggested**, even in deer-free areas, owing to the **large toll of above-ground herbivory** by slugs, rabbits, and even rodents cropping new plants from their home territories. The first summer can be devasting, owing to the time it takes for these non-toxic leaves to develop stiff points that exceed the sharpness of spruce needles. Examples include

Torreya Guardians plantings near **Cincinnati, OH** (html or PDF-22) and **Greensboro, NC** (html or PDF).

• **Action Recommendation 4B: Review the direct planting ("freeplanting") webpage of Torreya Guardians** (html or PDF-17) **toward the goal of actively soliciting land trusts to conduct direct planting of multitudes of torreya seeds as experimental populations on conservation easements.**

Note: Only two of our private volunteer planting sites are protected by conservation easements: **Hayward, WI** (html or PDF-13) and a failed site owing to first-season herbivory in **northern Michigan** (html).

• **Action Recommendation 4C: Actively work toward shifting the current policies of Atlanta Botanical Garden and State Botanical Garden of Georgia that have effectively shut off large-scale distribution of the tens (possibly hundreds) of thousands of seeds produced annually in the two ex situ orchards in northern Georgia that they manage: Blairsville and Smithgall Woods.**

Now that "historical range" is no longer a constraint on the siting of experimental populations, an opportunity arises for initiating experimental plantings (and supplementing existing plantings) in **a vast geography of potential sites** already demonstrated to be climatically favorable. The only obstacle is policy set by the ex situ managers. Apparently, **fear of spreading a possibly non-native fungal disease** — propagules of which have been found **"in all tissues and seeds"** (html or PDF) — is the reason that seed distribution has been almost entirely shut down for a half-dozen years. This leads to the final conclusion:

CONCLUSION 5: The discovery of propagules of a newly named FUNGUS, *Fusarium torreyae*, "in all tissues and seeds" (html or PDF) is strong evidence of a mutualistic endophyte that creates disease cankers only when the tree is environmentally stressed.

LEFT: **Fungal cankers** on a torreya stem in Torreya State Park. Photo 2004 by Connie Barlow.

Access her Site Visit video.

As a **retired science writer** (html and Researchgate), specializing in evolutionary ecology (4 books), Torreya Guardian **Connie Barlow** was motivated in 2023 to use Google Scholar to find and then read more than **50 scientific papers pertaining to both the proximate and ultimate causes of the historical range becoming inhospitable** for torreya's current and future ability to survive in northern Florida.

Connie discovered that a **paradigm shift** is underway, evident by her using two key search terms: **"plant microbiome"** and "**seed microbiome**" (html, PDF-18, and VIDEO). Heretofore, detection of **fungal propagules** known to manifest in deleterious ways have been regarded as **pathogens** or as **latent pathogens**. Now, however, the understanding is growing that all plants contain their own version of a "plant microbiome" in all their tissues. These "**endophytes**" are either **commensal or mutualistic**, but may manifest as pathogenic when the plant is stressed ("latent pathogen"). See **REVIEW: "The Seed Microbiome: Origins, Interactions, and Impacts"** by Eric B. Nelson, 2018, *Plant and Soil* (html). Excerpt: "While microbial interactions during flowering, seed dispersal, and dormancy in the seed bank may all impact the microbial legacy of a seed, **the interactions of seed-associated microbes with the soil microbiota during seed germination may have the strongest impacts on overall plant fitness**."

Another paper offers this:

> ... The **endophytic interaction is defined as balanced antagonism** (Schulz et al. 2015) because the recognition of the plant as a host **requires the activation of virulence mechanisms for colonisation and the triggering of host defences** by these events. **While an equilibrium exists in this interaction, the fungus survives of nutrients from the host plant and, in exchange, provides benefits, including tolerance to biotic and abiotic stresses** (Bamisile et al. 2018).... Fungi are able to act as antagonists of plant pathogens through the use of a diverse range of mechanisms, such as the **production of metabolites (antibiotics, volatile compounds and enzymes), engagement in competition (for space, carbon sources, nitrogen and minerals) and parasitism, induction of systemic resistance by the plant and increases in plant growth, resulting in the reduction of the activity of the pathogens** (Vega et al. 2009; Vidal and Jaber 2015; Vega 2018; Lr 2018; Quesada- Moraga 2020).
>
> ... Some fungal endophytes are able to colonise a wide range of plant species, while others are more specific and occur only inside a restricted number of plants. Additionally, specificity can also be present in relation to the portion of the plant that is colonised (Aly et al. 2011; Bamisile et al. 2018). Apparently, **vertically transmitted fungi seem to present plant associations with a more mutualistic profile than horizontally transmitted fungi**, which are more likely antagonists (Aly et al. 2011).... Horizontal transmission occurs when vegetative propagules or spores are produced by the endophyte and spread to the plant population through the air or via some vector, while **vertical transmission consists of the transference of the fungi to the plant progeny via seeds**. **"Endophytic fungi: a tool for plant growth promotion and sustainable agriculture"**, by Noemi Carla Baron & Everlon Cid Rigobelo, *Mycology* (PDF).

Most relevant for understanding the inherent role of ***Fusarium torreyae*** (PDF) are the papers focusing on the **"seed microbiome"** (html) subset of the **"plant microbiome"** (html) papers. Indeed, that its propagules have been found **"in all seeds"** is **the strongest signal of mutualism**. See "Insights into the Seed Microbiome and its Ecological Significance in Plant Life" by War et al., 2023, *Microbiological Research* (PDF)**.** Key excerpt:

> **Given these growth-promoting roles of seed microbiome, plant species conservation needs a PARADIGM SHIFT from the present approach of plant-specific protocols to envisaging a role for microbiome in the species**

> **conservation programmes.** It implies that a plant species cannot be conserved without conserving its integral seed microbiome (Berg and Raaijmakers, 2018).... **Laboratory experiments do not capture the complexity of seed-microbiome-plant interaction that exists in natural settings.**

Papers specific to genus Fusarium on this paradigm shift include:

> EXCERPT: "... **The taxon *Fusaria* is a complex one and more than one hundred formae speciales have been described**. It represents rhizosphere microflora that are plant pathogens or saprophytes. Even the pathogenic isolates survive as saprophytes and once they reach the corresponding host they infect and enter into parasitic life style. **Non-pathogenic isolates are capable of colonising root surfaces and protect even susceptible varieties from the highly virulent pathogenic isolates.** From asymptomatic roots, avirulent *Fusarium* isolates can be isolated." REVIEW: "**Biological control of Fusarium wilt in crop plants using non-pathogenic isolates of *Fusarium* species**", by Suresh Patil & S. Sriram, 2020 *Indian Phytopathology*. (PDF)

Action Recommendation 5A: Recruit an inter-agency working group of two federal employees (USDA) along with other specialists who can review, discuss, and draw actionable conclusions from the set of recent papers that challenge traditional understandings of fungal and bacterial propagules when "endophytic" within plant tissues.

Recruit USDA research pathologists who have already published on *Fusarium torreyae*: Kerry O'Donnell and Tyler J. Dreaden. Also invite the original lead of the first *Fusarium* paper: Jason A. Smith, who was at University of Florida but is now at the University of Mount Union in Ohio. Also recruit the lead extension specialist in forestry pathogen research in California: Matteo Garbelotto.

Action Recommendation 5B: After the inter-agency group reaches a conclusion in their review of academic papers, invite participation by staff from the two botanical gardens and the two dedicated citizen groups of stakeholders, Torreya Guardians and TorreyaKeepers, to contribute actual field observations that can:

DETERMINE CURRENT GEOGRAPHIC RANGE: Compile all documented observations of *Fusarium torreyae* in order to map its current range extent. Include this report of a Gainesville documentation in a citrus grove: **"Genome Sequence and Assembly of 18 *Fusarium* Isolates from Florida Citrus under High Huanglongbing Disease Pressure and California Citrus under Low Huanglongbing Disease Pressure"** by Tania Kurbessoian et al., 2023, *Microbiology Resource Announcements* (PDF).

DISTINGUISH PATHOGENIC FROM ASYMPTOMATIC OCCURRENCE: Distinguish whether documentation of presence of *Fusarium torreyae* was obtained by testing visibly diseased tissues (notably, stem cankers) or from asymptomatic tissues (including seeds) on outdoor specimens.

DETERMINE ENVIRONMENTAL STRESS: Record and utilize qualitative natural history observations of degrees of environmental stress for each record of *Fusarium torreyae.* Analyze the set of occurrences to determine if asymptomatic occurrences signify climatic zones and site-specific habitat condtions (re heat and water stress) less stressful than the historical range.

DETERMINE PRESENCE OR ABSENCE OF CANKERS ON NEARBY TREES OF OTHER SPECIES AND DETERMINE THE CAUSAL PATHOGEN. If cankers attributed to *Fusarium torreyae* are confirmed on nearby trees of other species, specify whether the specimens of those species are stressed either by being distant from their native geographical range (or altitude) and/or were planted in habitats that induce heat or water stress atypical of their customary habitats in the wild. Note: This is a crucial study because the apparent primary reason that the managers of the two ex situ groves in n. Georgia have stopped distributing the massive annual seed production is **fear of spreading *Fusarium torreyae*** into the natural habitats of other native trees that may (or may not) be susceptible to the pathogenic phase of this fungus (html or PDF).

Action Recommendation 5C: It may be useful to seek identification of the latent pathogen that has been attributed to causing cankers on California torreya (html or PDF-24)**. If it is a *Fusarium*, is it genetically more closely related to *Fusarium torreyae* or to another native or non-native "pitch canker" species? Also, do basic natural history observations suggest that this *Fusarium* manifests pathogenically only in heat- or water-stressed environmental contexts? Finally, is this *Fusarium* present as part of the seed microbiome?** Page 10 of the Florida Torreya recovery plan (2020 PDF) as well as p. 8 of the 2010 plan includes this:

> The recovery plan suggests grafting [asexual propagation where the tissues (vascular cambium) of one plant are fused with those of another] with **T. californica**. However, T. californica is exhibiting some issues with cankers caused by pathogens with a different Fusarium species which is killing the cambium.

Action Recommendation 5D: If the agency concludes that (a) *Fusarium torreyae* is only a latent pathogen, and (b) that other native plants nearby do not evidence cankers (or that the cankers do not ID to *F. torreyae*), then develop policies to ensure that existing experimental plantings by Torreya Guardians have access to the wild-genetic seeds from the ex situ orchards in northern Georgia.

Several volunteer planters in the Torreya Guardians network have made an effort to diversify the genetics of their groves as much as possible. Our **Capac MI** (html or PDF-12) and **Ocoee TN** (html or PDF-14) planters are leading in this. The latter recently gave his best estimates of relative differences in viability of seeds: Seedlings from a nursery in Georgia "significantly outstrip" all the others. "Seeds from Harbison House and Clinton / Mt. Olive are not particularly vigorous growers and Medford [Oregon] seeds were poor performers. Columbus [GA] has also performed poorly." (pers. comm. 14 July 2024)

Note: **Inbreeding deterioration** will likely worsen via seeds planted from a provenance with only 1 female producer (Clinton) and a pair of trees at Mt. Olive that were grown from seeds produced by the Clinton tree. While the **Cleveland OH** female (html or PDF-10) is prolific, volunteers who receive those sibling seeds may notice inbreeding deterioration when their own seedlings mature. Hence, **it is very important for all existing horticultural plantings to be offered seeds born of the wild genetics in the official ex situ orchards.**

REFERENCES:

Several academic papers are fully referenced and linked within the above text. The numbered PDF (and linked) references are listed here. All PDFs that are versions of corresponding html pages on the TorreyaGuardians.org website were captured July 2024, and thus are the same documents referenced throughout this comment essay.

PDF-01 "**Citizen Science as Sleuths: Searching for poleward naturalization of native plants in mature horticultural settings**" (Researchgate)

https://www.researchgate.net/publication/351938918_Citizen_Scientists_as_Sleuths_Searching_for_poleward_naturalization_of_native_plants_in_mature_horticultural_settings?channel=doi&linkId=60b0e15292851cd0d97df122&showFulltext=true

PDF-02 "**Torreya Guardians**" (Wikipedia)
https://www.torreyaguardians.org/wikipedia-2024-torreya-guardians.pdf

PDF-03 "**Torreya taxifolia**" (Wikipedia)
https://www.torreyaguardians.org/wikipedia-2024-torreya-taxifolia.pdf

PDF-04 "**Historic Groves**"
https://www.torreyaguardians.org/pdf-historic-groves-torreya.pdf

PDF-05 "**Paleoecology and the Assisted Migration Debate**"
https://www.torreyaguardians.org/pdf-paleo-perspective-torreya.pdf

PDF-06 "**Biltmore NC**"
https://www.torreyaguardians.org/pdf-nc-biltmore-torreya.pdf

PDF-07 "**Harbison House NC**"
https://www.torreyaguardians.org/pdf-nc-harbison-house-torreya.pdf

PDF-08 "**Clinton NC**"
https://www.torreyaguardians.org/pdf-nc-clinton-and-mt-olive-torreya.pdf

PDF-09 "**Mt. Olive NC**"
https://www.torreyaguardians.org/pdf-nc-clinton-and-mt-olive-torreya.pdf

PDF-10 "**Cleveland OH**"
https://www.torreyaguardians.org/pdf-oh-cleveland-torreya.pdf

PDF-11 "**Mason NH**"
https://www.torreyaguardians.org/pdf-nh-mason-torreya.pdf

PDF-12 "**Capac MI**"
https://www.torreyaguardians.org/pdf-mi-capac-torreya.pdf

PDF-13 "**Hayward WI**"
https://www.torreyaguardians.org/pdf-wi-hayward-torreya.pdf

PDF-14 "**Ocoee TN**"
https://www.torreyaguardians.org/pdf-tn-ocoee-torreya.pdf

PDF-15 “**History of Torreya Guardians**”
https://www.torreyaguardians.org/pdf-torreya-guardians-history.pdf

PDF-16 “**Propagate, Plant, Tend**”
https://www.torreyaguardians.org/pdf-propagating-torreya.pdf

PDF-17 “**Freeplanting**”
https://www.torreyaguardians.org/pdf-freeplanting-seeds-torreya.pdf

PDF-18 “**Extinction papers**”
https://www.torreyaguardians.org/pdf-extinction-papers.pdf

PDF-19 “**Franklin, NC**”
https://www.torreyaguardians.org/highlands-2.html

PDF-20 “**Waynesville, NC**”
https://www.torreyaguardians.org/pdf-nc-waynesville-torreya.pdf

PDF-21 “**Shoal Sanctuary, FL**”
https://www.torreyaguardians.org/pdf-fl-shoal-sanctuary-torreya.pdf

PDF-22 “**Cincinnati, OH”**
https://www.torreyaguardians.org/pdf-oh-cincin-torreya.pdfD

PDF-23 “**Brevard, NC**”
https://www.torreyaguardians.org/pdf-nc-brevard-torreya.pdf

PDF-24 “**California Torreya**”
https://www.torreyaguardians.org/pdf-california-torreya.pdf

PDF-25 “**Assisted Migration Terminology**”
https://www.torreyaguardians.org/pdf-assisted-migration-name.pdf

PDF-26 “**Learnings**”
https://www.torreyaguardians.org/pdf-learnings-torreya.pdf

PDF-27 “**Case Study of Agency and Institutional Failure**”
https://www.torreyaguardians.org/pdf-case-study-torreya-failure.pdf

PDF-28 “**Endangerment Causes**”
https://www.torreyaguardians.org/pdf-endangerment-causes.pdf

PDF-29 “**Natural History of Torreya taxifolia**”
https://www.torreyaguardians.org/pdf-natural-history-torreya.pdf

Two APPENDIXES follow:

APPENDIX A

Recovery Planning for "Special Needs" Endangered Species

Florida torreya as exemplar · 2023 regulation change as impetus

Recommendation of a new SSA category by Connie Barlow
founder of Torreya Guardians
PDF of 26 July 2024

1. CATEGORY DEFINITION AND PARAMETERS: The "**Special Needs**"designation would be awarded only to species that have long been listed as "endangered" and whose status is deemed "declining." This designation would be a nonregulatory adjunct for the purpose of assisting the agency in establishing priorities for staff attention and possibly funding.

1A. TIMING: This status designation could be added to an existing SSA at any time. If the designation is written into the SSA during a formal "Five-Year Review," it would also be posted in the status section of the Recovery Plan itself.

1B. HISTORY AND CURRENT CONDITION: A candidate species for this category must have spent at least two decades on the list. Based on the trend in its population numbers, range size, and/or health, its status has been certified as "declining." At least some conservation actions must already have been implemented, but it has been concluded that they have yielded no substantial and enduring success. Ex situ holdings for genetic safeguarding may or may not be doing well. But no interventions have yet halted species decline "in the wild" in its "historical range."

1C. ACTION POTENTIAL: Grounds for "special needs" designation is strongest if agency staff become aware of new types of actions that offer prospects for halting or even reversing decline and that could be achieved without extraordinary levels of staff time and without exposing the agency to legal challenges. Institutions are encouraged to do the groundwork themselves in proposing such actions, in volunteering to implement them, and in securing funding sources from outside the agency budget.

2. HOW THE CATEGORY CAN HELP INITIATE "ASSISTED MIGRATION" EXPERIMENTS:

Agency staff are framing and testing best practices for eventual field application of the 2023 regulatory change that removed "historical range" as a geographical constraint on siting **experimental populations**. (Barlow's comment on the proposal here.) Selecting one or more species to initially think-test possible parameters would be assisted by focusing on those already categorized as having "special needs." According to policy statements issued in support of the new regulation, species whose "historical range" is no longer suitable to its needs (especially if **climate change** or **invasive species** are the ultimate cause) can be authorized new geographical prospects for experimenting toward recovery.

Because **"special needs"** species certifications require specifying one or more suggested actions (1C. ACTION POTENTIAL), choosing from the list a species already paired with "assisted migration" (more broadly, "translocation") would easily match the needs for creating process standards for implementing the new regulation.

3. BENEFITS OF APPLYING "SPECIAL NEEDS" FIRST TO PLANTS:

3A. Plants almost always are far **less controversial** for listing and implementation than are animals.

3B. Field actions for plants require **less equipment, money, and technical expertise** than do field actions for animals.

3C. Opportunities for volunteer helpers and citizen science are greatest with plants, as are opportunities for actions on private conservation lands secured by land trusts.

3D. Local landowners near a prospective experimental site who are hostile to the federal government and/or endangered species policies have little to fear that an endangered plant might walk, fly, or swim over to their properties and thereby invite restrictions on their land use choices. Torreya Guardians has found that landowners are thrilled to host specimens of an endangered plant**.** If, however, a plant siting becomes problematic in the recipient ecosystem, all specimens would be easy to remove. Indeed, the experiment would qualify as beneficial for having made clear where *not* to attempt recovery plantings. (Some of the most important learnings by Torreya Guardians can be attributed to failed experiments that have helped us hone our lists of best propagation practices that we provide to volunteer planters.)

3E. Prospects for accelerating recovery of the **immense backlog of long-listed, small-range or highly disjunct plants** are now available via the **new implementation tool of translocation**. Indeed, any plant that is already characterized as "relictual" is almost certainly capable of living elsewhere. Its preferred habitats should be easy to describe, find, and test. By definition, any "glacial relict" is a species that was stranded in one or more "refugia" marked by cooler or moister habitats than its current surrounds. Inhospitable surroundings have thus blocked natural modes of seed dispersal into potentially habitable sites elsewhere, and perhaps has done so for thousands of years. **If a relictual population is declining now, then ongoing climate change ensures its extirpation or outright extinction. Therefore, translocation experiments must begin immediately**. *Note: "Recovery" is, of course, still limited to "historical range." But success in testing "assisted migration" in new experimental plantings, along with already demonstrated success in established horticultural plantings, will surely make regulatory amendment achievable in the near future*

4. BENEFITS OF CHOOSING FLORIDA TORREYA AS TEST CASE:

4A. A "5-Year Review" process was initiated June 5, 2024.

4B. Barlow plans to submit SSA and Recovery Plan recommendations for this species by the August 5 deadline. Indeed, the "special needs" idea came to her while working on those recommendations.

4C. Florida Torreya ranks as the 5th highest recipient of federal funds of all listed plants. Listed "endangered" in **1984**. All recovery plan updates conclude it is declining.

• **1984 Federal Register**. EXCERPTS: The Service determines *Torreya taxifolia* (Florida torreya) to be an endangered species pursuant to the Endangered Species Act. This plant is endemic to the Apalachicola River area in Florida and Georgia. **It is endangered by a fungal disease**, which kills trees before they reach seed-bearing size.... An evergreen tree reaching 18 meters tall, *Torreya taxifolia* (Florida torreya) was first discovered in 1834 and formally described in 1838. The Florida torreya and other endemics of the Apalachicola River system have received much attention from scientists and local residents. The **relictual nature of this area** accounts for the presence of many unique species (James, 1967). **During recent glaciations, species migrated southward by way of the Apalachicola River system, which served as a refugium during cooling periods. The Apalachicola River is the only Deep River system that has its headwaters in the southern Appalachian Mountains. With the receding of the glaciers, cool moist conditions persisted on the bluffs and ravines of the Apalachicola River after climatic change rendered the surrounding area much drier and warmer.** The entire Apalachicola River bluff system today is an extremely diverse and unique ecosystem, of which *Torreya taxifolia* is a part. ... All mature viable trees are located in botanical gardens and arboreta. The wild trees do not now have good long-term survival prospects. The initial focus of recovery will be to address controlling the disease. After

the disease has been overcome, recovery efforts would address reintroduction of the species into the wild."

4D. Torreya Guardians has already documented mature horticultural plantings in North Carolina. Two of the oldest are fully "naturalized" (wild-dispersed seedlings and saplings nearby). Owners could be approached to have these certified as **pre-existing experimental populations**: Biltmore Gardens (grove planted in 1939) and Harbison House (ca. 1922)

4E. **Torreya Guardians is regularly in the media** (most recently in *Sierra Magazine* and *New York Times Magazine*).

4F. An opportunity to **restore the good relationship** Torreya Guardians used to have with the U.S. Fish and Wildlife Service. The good relationship was from 2004 through the "Five-Year Review" in 2010. We were included in the 2010 decision process and were referred to as collaborators in the plan itself. The bad relationship emerged when staff changes happened at the State Botanical Garden of Georgia and Atlanta Botanical Garden (ca. 2016); the agency necessarily had to maintain good relationships with the two botanical gardens that initiated and managed the ex situ safeguarding locales in northern Georgia. This page on the Torreya Guardians website provides details of the deterioration: "Case Study of Agency and Institutional Failures of Endangered Species Management of Florida Torreya."

APPENDIX B

Comment by Connie Barlow

to U.S. Fish & Wildlife Service re Florida Torreya

RE: Proposed Rule Docket (FWS-HQ-ES-2021-0033)

"Endangered and Threatened Species: Designation of Experimental Populations"

Submitted August 5, 2022 • 5 pages PDF

I, **Connie Barlow**, founded the citizen group **Torreya Guardians** in 2005, and I have been its webmaster and chief networker ever since. We have no formal organization, so I communicate here as an individual. I do not speak for the group. I draw upon my experience and what I have learned about best practices for assisting the northward migration of an ESA listed endangered tree: **Florida Torreya**. *Learn about this plant on its* ***Torreya taxifolia wikipedia page****.*

COMMENT ON THE PROPOSED REGULATION:

I support the regulation exactly as proposed. Details on how and when to use this new and essential climate adaptation tool are best kept out of the formal regulation. Instead, policies and practices can be developed and adapted over time, region by region, with some details remaining species-specific. Moreover, it is crucial to develop implementation guidelines that are **distinctly different for plants than for animals**, as I outline below.

SUGGESTED IMPLEMENTATION POLICIES FOR PLANTS:

- **1. Create implementation frameworks and policies that are distinct for plants.**

  Do not burden recovery of listed plants with the same kinds of decision frameworks, safeguards, research needs, and funding requirements that necessarily pertain to animals because:

  (a) In contrast to animals, **plants do not require expensive capture, handling, transport, and release protocols** when they are authorized for experimental assisted migration projects.

  (b) In contrast to animals, **rooted beings stay where they are put until they begin to produce seeds.** Therefore, so long as seeds of a listed species are not dispersed by wind (and to a lesser extent, not by birds), the entire experimental population can easily be monitored and, if necessary, removed if an ecological problem develops in the recipient ecosystem.

  (c) In contrast to terrestrial vertebrate animals listed as endangered, **plants tend to produce great numbers of seeds upon maturation**. If those seeds are **recalcitrant** (such as they are for genus *Torreya*), whole seeds **cannot be stored by drying, freezing, or in liquid nitrogen (cryo)**. Ex situ plantings are thus the only modes of long-term "storage" for plants with recalcitrant seeds. Yet failure to recruit in advance northward partners with large acreages or to arrange donations of surplus seeds for unregulated distribution by commercial nurseries may result in a reprise of the embarassing situation that has occurred with Florida torreya under the official recovery plan: For the past dozen years, **tens of thousands of *Torreya taxifolia* seeds have annually gone uncollected, and quietly undocumented,** at the two large ex situ reserves in northern Georgia. Fortunately, if utilized as **a case study**, this sad outcome for Florida torreya could help prevent massive seed losses of other listed plants that, likewise, thrive in their ex situ habitats. Point 2 below is a proven way to prevent this "problem" from afflicting other plant recovery efforts.

- 2. **Encourage nongovernmental entities to use the ESA "exception" for plants.**

  BENEFITS FOR ENDANGERED PLANTS: The **"exception" for plants in the ESA law itself** will continue to allow citizens, botanical gardens, universities, conservation organizations, and others to move ahead *on their own* with northward experimental migrations of listed plant species — whether or not the new regulation is approved and no matter how slow or weak its implementation. This is because the ESA allows cuttings and seeds collected from **horticulturally grown specimens outside of the historical range** to be transported and used without limitation, so long as interstate transfer is not commercial. In this way, **the Endangered Species Act could devolve into a back-up approach, while incentivizing the conservation community to do-it-themselves**.

  Accordingly, there would be **fewer petitions for plant species listings, fewer legal entanglements, fewer delays in achieving positive outcomes, and likely a heck of a lot more creativity and collegial sharing of best practices.** Full recovery — even rewilding — could be achieved by nongovernmental entities utilizing their own private lands for northward plantings. Ideally, **land trusts would play the leading role**, establishing migrated populations within conservation easements already in place.

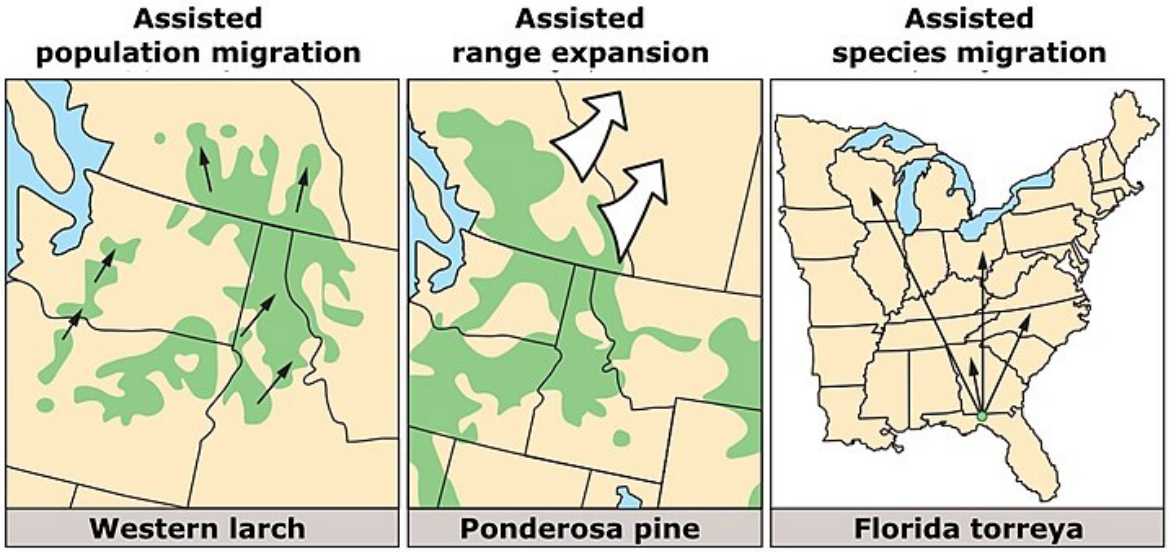
  BENEFITS FOR ENDANGERED ANIMALS: The USFWS is going to have immense demands and difficulties in applying the new regulation to listed animals. By

encouraging nongovernmental entities to take leadership in recovery of listed plants, a far greater share of limited taxpayer money could be used for the complex tasks involved in recovery of listed animals.

- 3. **Follow the lead of the USDA Forest Service.**

Research scientists within the **U.S. Forest Service** have been publishing papers since the 1990s, while conferring internationally with colleagues (especially Canadian foresters) on climate adaptation practices. In 2011, USFS research staff in northern Michigan began collaborating with university researchers in a new regional organization: **The Northern Institute for Applied Climate Science**. In addition to a standard USFS agency page, this group has a distinct website whose homepage currently features three USFS researchers awarded by outside organizations for their leadership in interdisciplinary climate science and adaptive management achievements. Notably, NIACS (and now **all USDA regions**) have been able to incorporate climate-responsive shifts in communications and practices with no changes in its grounding laws and regulations.

USDA can therefore offer practical guidance in bringing climate adaptation understandings, tools, and stakeholder involvement into how the new USFWS climate adaptation regulation can be smoothly integrated into existing ESA protocols and agency practices for **plants**.



ADOPT USDA TERMINOLOGY. Beginning nearly a dozen years ago, the forestry profession initiated **terminology that defused controversy** about implementing "assisted migration" as a climate adapation tool. Instead of one term, **there are now three that make the practice gradational**, as shown in the image below. Notice that **Florida torreya** is the type species for the most extreme form of climate adaptive assisted migration: "Assisted species migration." In context, the two grades of assisted migration foresters consider (and already implement to a degree) are moderated and thus less controversial. RETIRE LANGUAGE OFFENSIVE TO WILDERNESS ADVOCATES. While forestry scientists and managers have rarely used terms other than variants of ***assisted migration*** (as in the image above), conservation biologists began using alternatives that imply less assistance and more control: ***assisted colonization***

and ***managed relocation***. As a science writer who contributed essays in the 1990s to *Wild Earth* journal (including "Rewilding for Evolution"), I was on board with the original term, *assisted migration*. But the replacements that became dominant in conservation biology papers carried connotations that I found offputting — and so did my colleagues. Hence, I request that the agency use the original term, and in this way also follow the lead of USFS.

RETIRE LANGUAGE OFFENSIVE TO INDIGENOUS PEOPLES. Both *assisted colonization* and *managed relocation* entail terms offensive to peoples in the USA who have suffered from the colonization of their homelands and, later, via the "Indian Relocation Act of 1956." As I report (and link) in a lengthy webpage I created on this topic, Australian conservation biologists have recently jettisoned the former term for the same reason that those in the USA should. Please visit the section titled "**Decolonizing Scientific Language**", within my lengthy webpage, "**Assisted Migration or Assisted Colonization: What's In a Name?**"

- 4. **Facilitate respectful dialogue and understandings of worldview differences.**

EXPLORE AND VALIDATE WORLDVIEW DISTINCTIONS: The last thing we biodiversity champions need at this time is to foment within-group antagonisms and to proffer hostile judgments of opposing camps in our publications — and especially when queried by journalists. This is not something agency staff are positioned to deal with. But one or more **national conservation organizations could initiate and carry this conversation as an early element in taking agency for climate adaptation of endangered plants.**

Prior to discussing the pros and cons of new tools and methods, sincere discussion about worldview distinctions that will inevitably affect professional judgments should be explored and understood. What are the rational and scientifically grounded bases of each perspective? What are the emotions — and emotionally driven action imperatives — that derive from each?

SHIFTS IN STAKEHOLDER PERSPECTIVES. Again, utilizing the history of *Torreya taxifolia* as a case study, one learns that conservationists in recipient ecosystems are now eager to help endangered North American plants from outside home regions. In practice, and at this stage of the climate emergency, fears of invasiveness have evaporated. Indeed, **Corneille Bryan Native Plant Garden**, near Waynesville NC, welcomed Torreya Guardians to introduce potted seedlings as the return of a once-native. In contrast, it was the home-region conservationists (professional and amateur alike) who regarded this endemic of northern Florida as theirs to keep — even forming a subset of the Florida Native Plant Society in 2018 called "**TorreyaKeepers**".

DEEP-TIME UNDERSTANDING OF WHAT IS NATIVE AND HOW PLANTS GOT WHERE THEY ARE. In my experience with **Torreya Guardians**, beginning with participating in an **"Assisted Migration for an Endangered Species" forum debate** published in the Winter 2004/2005 issue of *Wild Earth* magazine, it was clear that the **paleoecological foundation** that myself and my coauthor (Pleistocene ecologist, **Prof. Paul S. Martin**) drew upon put us in marked disagreement with the author of the opposing opinion, **Prof. Mark W. Schwartz**, conservation biologist at U.C. Davis. Paul Martin died in 2010, but Schwartz and I continued putting forth opposing positions in subsequent years. I still regard the set of oppositional statements published 18 years ago in *Wild Earth* as the most direct expressions of the incommensurable worldviews that drive disagreements about what and where is native. Both papers are available in several places online. The Torreya Guardians website is where **both together** and each

separately can be accessed in pdf (**for assisted migration** and **against assisted migration**). As well, Paul Martin took the lead in creating an appendix to our paper; but there was no room in *Wild Earth* to include it. Titled "**Standards for Assisted Migration of Plants**", Paul suggested using a scalar set of terms to replace the entrenched "native v. non-native" binary. Paul suggested (and offered definitions for): "current range, historic range, near-time range, deep-time range, and target range." (Excerpts of the forum arguments can be found in the assisted migration section of the *Torreya taxifolia* wikipedia page.)

NATURAL HISTORY IN PRACTICE. Another worldview distinction shapes my sense of how decisions should be made in **choosing northward sites** for plant migration and experimentation in the current decade of too-rapid climate change. (I grant that my worldview is rare among professional conservation biologists.) My personal priorities for geographically allocating torreya seeds for planting by volunteers have been broad. I do hold firmly to "**east of the Mississippi River.**" Other than that, I have prioritized topographically rich terrain and moist deciduous forests. Also, torreya is a vulnerable species until its new leaves harden into very sharp points. Thus, landscapes with overpopulated deer are exceedingly dangerous for unprotected, rewilded, *Torreya* seedlings.

As well, instead of opting for soil chemistry data, details on aspects and canopy conditions (and, thus, the kinds of habitat data likely to be required by professionals implementing the new regulations), **I opted for the simplicity of a natural history approach for assessing habitat suitability.** To begin, always a deciduous canopy. Next, does the site contain plants that indicate well-drained, mesophytic habitat? Or does the plant community indicate too dry or periodically flooded conditions?

Given the necessity of doing away with pots and fencing when **needing to find good homes for annual seed harvests numbering in the thousands**, I began to suggest **planting seeds directly beneath the fronds of Polystichum acrostichoides.** These native ferns not only signal ideal habitat for torreya; they provide camouflage against winter-hungry deer. I also learned how to **avoid planting seeds in habitats of ground-burrowing rodents** by staying away from patches of fallen branches and logs, and testing for hidden tunnels elsewhere by plunging a table knife into the ground here and there.

Again, a **paleoecological worldview** underlies these choices. In the eastern USA we know that **native plant populations have migrated repeatedly hundreds of miles as the glaciers waxed and waned**. The pollen record in bog sediments suggests starkly novel communities of wind-pollinated trees migrating at different speeds, and apparently able to accomplish their migrations with few plant extinctions. And whether seed dispersal was accomplished by **wind, birds, squirrels, or hindgut mammals,** migration was accomplished by random natural processes**.** Scientific scrutiny and leadership can certainly make human-assisted plant migrations more efficient and in greater leaps than historically the norm. But our assistance need not be complicated, nor costly. I emphasized this conclusion in my choice of title for one of the episodes in my **"Climate, Trees, and Legacy" video series** on youtube: **Episode 6: "Becoming Passenger Pigeon"**.

ACCOMMODATING DIVERSITY ON THE DOOM SCALE. Given climate, societal, and economic trends today, it is no longer reasonable to assume that a solid majority of professional conservationists (much less stakeholders) still support a business-as-usual, and thus necessarily slow, approach for endangered species recovery. Some (including me) sense that **the world is already in a climate emergency** — especially for plant species regarded as glacial relicts. Some (including me) have **rapidly declining confidence that federal governance** will maintain the levels of budgets, professional

staffing, and political will as we have grown accustomed to relying upon in past decades.

Thus for biodiversity advocates, like me, who have slipped a long way down the scales of climate "doom" and societal "collapse," it is an imperative that **conservation-minded citizens and our organizations voluntarily step into leadership and forge new traditions that will carry forward no matter what**. We resolve to carry forward biodiversity conservation — endangered plant recovery — whether or not institutions carry forward that have hitherto done it for us.

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END OF COMMENT BY CONNIE BARLOW