ASSISTED MIGRATION

By Gary Antonides

As the climate changes, both plant and animal species attempt to adapt to the changes. In many cases, it means moving habitats north or to higher altitudes. If the climate changes are gradual, most species can adapt or migrate to more suitable areas. But if the climate changes too fast, many species could disappear. In order to help some species migrate, biologists are planting seeds or seedlings further north (or at different altitudes) than their present range.

In the article https://depts.washington.edu/oldenlab/assisted-migration-good-idea-or-misguided-hope/#:~:text=Assisted%20migration%20(also%20known%20as,in%20response%20to%20climate%20change, Molly Payne, Nov 27, 2017, Freshwater Ecology Conservation Lab wrote "*Assisted migration: Good idea or misguided hope?*" and offered some examples.

The conifer tree *Torreya taxifolia* once grew in abundance in ravines along the Apalachicola River on the Florida panhandle. After decades of decline, the species is now considered critically endangered according to the International Union for Conservation of Nature (IUCN). In a last-ditch effort to save the species from extinction, a group known as the Torreya Guardians translocated saplings far northward to an area in North Carolina where it had never previously existed.

Photo by Torreya Guardians

This seems to be preserving the Florida *Torreya*, but it raises the question of whether or not human assisted introductions of species for conservation purposes are justified despite potential risks of collateral damage. This intentional movement of organisms from current areas of occupancy to locations where the probability of future persistence is predicted to be higher is known as *assisted migration*, and it has come under fierce debate. It's a relatively new concept, born of the perceived need to prevent the extinction of species unable to move or adapt fast enough in response to climate change.

In a different case, a team of researchers transplanted the marbled white butterfly (pictured) to an area north of its native range in England. The butterfly was able to successfully establish a reproducing population without having a negative impact on the native biological community. The researchers cite similarities between the inhabitants of the recipient ecosystem and the inhabitants of the butterfly's native range as the reason for successful integration. In this example, the butterfly was preserved and it did not appear to harm the recipient community.

But many in the scientific community argue that there is considerable uncertainty and risk involved in transplanting a novel species to an unfamiliar and new location. It is difficult to predict how an introduced species will interact with a new community, or what unforeseeable parasites and pathogens it may carry. Further, lagged responses are possible, where an introduced species does not cause damage until several decades later, when it is too late to reconsider translocation.

As an example of a bad outcome, the watercress darter is an endangered fish species that was translocated to a spring outside of its native range, where it successfully established a reproducing population. Unfortunately, unexpected and devastating competition by the watercress darter led to the extinction of the native rush darter just a few years later.

So the scientific community is still unclear on whether to support or abandon the concept of assisted migration. It is a conservation strategy for which there are documented examples of success, but many examples of the dangers of species introduction. There are other options to reducing a species' risk of extinction, including increasing habitat connectivity to allow species to gradually migrate themselves, and reducing habitat loss and extinction rates. But, in some cases, if these are impractical or unsuccessful, it may be decided to utilize assisted migration.

Assisted Migration of Forests

Even though we sited two examples where assisted migration was used for animal life, plant life is naturally more endangered by climate change than animal life due to its lack of mobility. For many reasons, including carbon sequestration, wildlife habitat, mitigating runoff, and supporting the lumber industry, forests have gotten considerable attention with regard to assisted migration.

Some of these efforts are discussed in https://www.fs.usda.gov/ccrc/topics/assisted-migration, by Stephen Handler, et al., US Forest Service Northern Research Station, Houghton, MI. The rest of this article is based on this report.

Recent research has demonstrated that, indeed, many tree species are already undergoing distribution shifts in response to climate change, with different studies highlighting species that are moving poleward and higher in elevation, or moving east-west to track changes in moisture availability.

Many factors can complicate species movement across a fragmented landscape, however, so changes we expect from climate change may be hard to observe. Research on Douglas-fir and ponderosa pine indicates that different genetic subspecies may have different responses to climate change and different levels of vulnerability. Other causes besides climate change that have contributed to tree species movement in the eastern US are ecosystem succession following intensive logging, human land-use changes, and wildfire suppression.

Based on observed and projected rates of climate change, there is an expectation that some important species will not be able to migrate quickly enough. Natural migration over long distances requires several generations because trees require several years to get to reproduction age. Recent estimates indicate that post-glacial migration rates for many tree species were 100 to 500 meters per year. Recent rates of climate change for large areas of the Midwest, Great Plains, Southeast, and isolated locations in the western US have been from 1,000 to 10,000 meters per year.

For species with very specific habitat needs or ranges limited by physical barriers, such as fragmentation or geographic features, the entire species could be at risk of extinction due to climate change.

Two examples where assisted migration was successful:

(1) Transplant studies of white spruce in Quebec suggested that southern seed sources might be used in northern locations.
(2) Trials with whitebark pine demonstrated that seeds can be successfully germinated and grown large distances (500 miles) to the north of the current species range boundary. Seed sources from Oregon and Washington performed well in northwestern British Columbia.

Even if large populations are not planted in new areas, if small populations can survive beyond existing ranges, they may contribute genetic characteristics associated with warmer climates to native populations giving the native populations a better chance to adapt through natural selection.

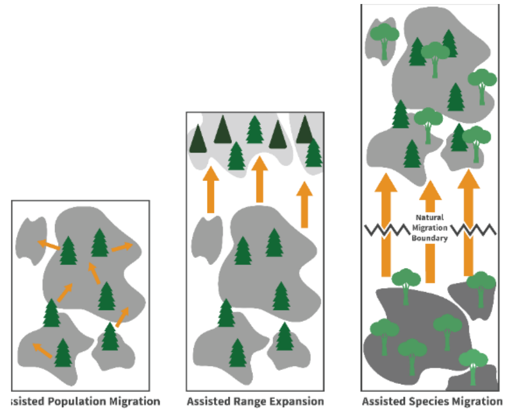
Assisted migration falls into three categories:

- **Assisted population migration** (also assisted genetic migration) – moving seed sources or populations to new locations *within the historical species range*
- **Assisted range expansion** – moving seed sources or populations from their current range to suitable areas *just beyond the historical species range*
- **Assisted species migration** (assisted long-distance migration) – moving seed sources or populations to a location *far outside the historical species range and beyond locations accessible by natural dispersal.*

Assisted migration may be motivated by a variety of different goals. Clearly articulated goals will help determine which kinds of assisted migration actions are most suitable and also help evaluate the benefits and risks. Possible goals are:

- maintaining or enhancing genetic diversity within a population
- protecting a species or population from extinction
- mimicking natural dispersal interrupted by human habitat barriers
- maintaining ecosystem functions
- enhancing the productivity of a commercially valuable species.

New tools exist to help foresters decide when and where to use assisted migration, namely the Forest Service's Climate Change Tree Atlas for species-level considerations and the Seedlot Selection Tool.



In some cases, assisted migration will directly conflict with established conservation principles and existing agency policy (e.g. Forest Service seed transfer zones). But it might be clear that climate change and other factors make the risk of doing nothing greater than the risk of intervening.

Some of the important considerations associated with assisted migration include:

- Newly introduced species may become invasive
- Newly introduced species may hybridize with local species, such as with different types of spruce, pine, poplar, and oak
- Species introductions may unknowingly introduce pests or diseases into new areas, particularly with longer transfer distances
- Long-distance transfers based on projected climate conditions at the end of the century raise the likelihood that *current* habitat may not yet be suitable.
- Some species have smaller climatic transfer limits than others. For example, Douglas-fir and lodgepole pine have smaller transfer limits than eastern white pine
- Appropriate seed sources in sufficient quantities may not be available for species with limited ranges or for species that are not commercially utilized
- Factors other than climate, such as soil type, moisture regime, animal feeding, competition, pests and pathogens may preclude successful establishment
- If assisted migration is used to establish a species in many different locations with a range of conditions, it reduces risk from uncertain climate impacts

Current Applications

The movement of species and populations has been practiced before, for various reasons, but doing so as a climate change adaptation strategy is fairly new, although it already seems to be fairly common, at least for purposes of conducting trials.

The Assisted Migration Adaptation Trial (AMAT), led by the British Columbia Ministry of Forests, Lands, Natural Resource Operations, and Rural Development working with the USDA Forest Service, timber companies, and other partners, is a long-term research project that is testing climate tolerances of different seedlots across a broad territory from northern California to the southern Yukon. See: (https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/tree-seed/forest-genetics/seed-transfer-climate-change/assisted-migration-adaptation-trial). Researchers are testing the growth and health of seedlings from 15 different species, including ponderosa pine, lodgepole pine, western larch, yellow cedar, and Douglas-fir. Information from this project will be used to revise tree species and seed source selection guidelines for British Columbia.

The Adaptive Silviculture for Climate Change (ASCC) project, as the name indicates, involves assisted migration specifically for climate adaptation. (www.adaptivesilviculture.org). ASCC study locations around the country are designed to represent a range of climate adaptation pathways. For example, at the ASCC study location on the Cutfoot

Experimental Forest on the Chippewa National Forest in northern Minnesota, the assisted migration study includes white oak, bitternut hickory, and ponderosa pine. These species movements represent movements of dozens of miles to hundreds of miles outside the natural range of these species.

Along with projects like AMAT and ASCC, which explore species-level assisted migration, many past and on-going research exists that examine questions of genetic variation within species and the effects of climatic transfer on their growth and survival. For example, a large lodgepole pine project in British Columbia involving 140 distinct populations and 62 planting sites was able to establish a reliable basis for predicting the influence of climate on different lodgepole seed sources. In addition, there was a Douglas-fir Seed Source Movement Trial in Oregon and Washington that revealed within-species differences in drought tolerance and cold hardiness. More information is forthcoming.

In the 2012 report *Genetic Resource Management and Climate Change: Genetic Options for Adapting National Forests to Climate Change,* the USDA Forest Service recommended that large scale population transfers to match seed sources to projected future conditions be done only for species where experience or research has demonstrated appropriate climate transfer limits. The authors of this report also discourage basing assisted migration decisions on projections of climate conditions at the end of the century, but they advocate for using a 20-year time frame as the basis for setting suitable transfer distances. This would tend to reduce risk of mismatches between seedlings moved from warmer to colder climates.

National Forests are able to request permission to introduce novel species for assisted migration with longer transfer distances, but these actions are primarily permitted for limited research purposes.

Similarly, the Canadian Forest Service and Provincial forestry departments in Canada are encouraging limited use of assisted migration as a climate change adaptation practice. British Columbia began allowing seed transfers to higher altitudes in 2008, and formally amended the *Chief Forester's Standards for Seed Use* policy in 2018 to allow for climate-based seed transfer. Alberta, Ontario, and Quebec currently allow seed zone exceptions with appropriate review.

In addition to these large-scale studies, many foresters and land managers are exploring assisted migration on their own. They are establishing many pilot-scale projects that involve some degree of assisted migration. For example, Providence Water is responsible for managing 13,000 acres of forested pubic land surrounding the state of Rhode Island's major freshwater reservoirs. For over a century, they have been maintaining a forest that is resilient to disturbances that could negatively impact water quality. Many northern species in this property will face increasing stress from climate change, so Providence Water is experimenting with assisted migration as a climate adaptation practice, planting southerly species such as black oak, black locust, persimmon, sweetgum, and others. These kinds of examples from early adopters will contribute valuable information.