

FOREST LANDSCAPE RESTORATION IN THE USA: PRESENT AND FUTURE CHALLENGES AND OPPORTUNITIES

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Forest land area in the United States of America (USA) ranks fourth globally, with nearly one-third of the landscape covered by forests and woodlands and more than half (58%) in private ownership (Oswalt *et al.*, 2019). Forest and landscape restoration (FLR) in the USA occurs on both public and private land, with financing from public and private sources.

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The Collaborative Forest Landscape Restoration Partnership (CFLRP), focused on land managed at the national level (the National Forest System) by the US Forest Service, is a prominent public approach to FLR; whereas notable private sector programmes have been organized around specific forest types, for example the Loblolly Pine Initiative (ALRI, 2020), or bottomland hardwoods in the Lower Mississippi Alluvial Valley (NFWF, 2019). Major conservation organizations, including The Nature Conservancy, National Wildlife Federation, and American Forest Foundation, are financing restoration programmes on both private and public land with conservation and carbon management objectives. Many other restoration projects are underway at smaller spatial scales, some of them quite local, and often focusing on biodiversity and ecological integrity. These would not be considered FLR as they are not at landscape scale and most do not have a livelihoods component.

In the USA, FLR is primarily undertaken on existing forest stands, where silvicultural techniques are employed toward obtaining desired goals, and through the planting of nearly a billion tree seedlings annually. In order to conserve and protect native forests, increased demand for wood-based carbon materials must be met from forests that are sustainably managed and that originate from afforestation and reforestation, components of functional restoration (Stanturf *et al.*, 2014).

Restoring existing forests

The specific Bonn Challenge commitment of 15 million ha was made by the Forest Service, to be achieved through CFLRPs, on National Forest System lands, involving state, local groups, and tribal authorities. The programme began in 2010 and currently comprises 23 collaboratives. The landscapes and community groups are diverse, but face some common challenges (Walpole *et al.*, 2017). The objectives of most of the CFLRPs include overcoming a century or more of fire suppression and restoring natural fire regimes. The CFLRPs faced three challenges: developing trust and collaborative capacity, uniting stakeholders around multiple objectives, and integrating ecological science and social values in decision-making. Addressing consensus issues can build relationships and advance long-term goals (Susskind *et al.*, 2012), and targeting improved ecosystem resilience as a shared objective has, for example, been effective in overcoming controversial topics such as thinning. Another major challenge is the scale of FLR needed within the National Forest System; of the 78 million ha managed by the Forest Service (about one-third of the nation's forested land), potential FLR needs are between 26 and 32 million ha (Buford *et al.*, 2015). The National Forest System provides only a small amount of the nation's forest products (Oswalt *et al.*, 2019). Thus, FLR efforts do not typically pay for themselves, but rather require subsidizing. Funding for the CFLRPs has been at least US\$915 million from the Forest Service, and totals more than US\$1.2 billion over 10 years (www.fs.fed.us/restoration/CFLRP/).

Silvicultural techniques, mindful of changes in climate, are essential to successful restoration activities. Silviculture can be used to modify stand densities and species composition toward increasing resilience and biodiversity, and thereby reduce potential impacts from changes in climate (D'Amato *et al.*, 2011; Guldin, 2019). This ongoing conversation – which has, for example, included discussions about site conditions, species vulnerabilities, and basic ecophysiological characteristics of the trees – has led to the Adaptive Silviculture for Climate Change project designed to identify barriers and subsequent science-based, robust, operational concepts, methods and tools that can be used to integrate silviculture across a gradient of conditions with climate change considerations (Nagel *et al.*, 2017).

Restoring through afforestation and reforestation

Nationally, the USA has relied heavily on federally funded programmes for large-scale tree planting initiatives. Globally, large-scale tree planting initiatives are now being promoted for restoration and as an efficient climate mitigation technique (Waring *et al.*, 2020). The Conservation Reserve Program (CRP) and Wetlands Reserve Program (WRP) are two such national ongoing programmes that include tree planting and are administered through the Department of Agriculture; they target fragile and marginal private farmland. The CRP initially focused on highly erodible soils and has evolved to include wildlife, water and air quality, and other conservation goals. The CRP has enrolled 12.7 million ha; annual payments average US\$21.45/ha at a total yearly cost of US\$1.7 billion. Similarly, the WRP is aimed at reversing loss of wetlands that have been converted to agriculture. These programmes provide financial and technical assistance to private landowners in return for limited or perpetual conservation easements. Since 1995, landowners have voluntarily enrolled more than 1 million ha into the WRP (NRCS, 2015). Easement payments are based on the income forgone by the landowner, thus varying by region, crop and productivity (Jenkins *et al.*, 2010). In one study in the Lower Mississippi Alluvial Valley where the bulk of WRP easements occur, the estimated potential market value of US\$1035/ha/yr obtained from emerging ecosystem markets for greenhouse gas and nitrogen mitigation as well as wildlife habitat provision could be more than twice the restoration opportunity costs (Jenkins *et al.*, 2010).

Mixed species planting used on Wetland Reserve Program land. Fast growing Eastern cottonwood (*Populus deltoides*) were planted two years before slower growing Nuttall oak (*Quercus texana*) that were interplanted between each cottonwood row. This technique mimics natural stand development on sites along the Mississippi River.



Future challenges and opportunities

Reforestation is often included as part of forest restoration efforts, with healthy forests critical for social sustainability (Parrotta *et al.*, 2012). Successful restoration of degraded forests through tree planting can meet multiple objectives, including maintaining ecosystem functions (Stanturf *et al.*, 2014), increasing biodiversity (Pawson *et al.*, 2013), and fostering resilience to disturbance (Spathelf *et al.*, 2018). Climate change will increase the area in need of restorative treatments (Seidl *et al.*, 2016), and it is also occurring at a rate that is faster than tree species can naturally respond to (Williams and Dumroese, 2013; Zhu *et al.*, 2012).

New approaches are needed to meet emerging priorities and objectives resulting from intended and unintended consequences of policy implementation, climate change, funding and wildfires (Jacobs *et al.*, 2015). Reforestation efforts have suffered from the increasing frequency and severity of drought events, and the need to restore burned areas has increased (Dumroese *et al.*, 2019). Extensive and early use of prescribed fire will be needed to build resilience to wildfires and drought events.

Restoration can be important for climate change mitigation and adaptation, and transformational approaches including assisted migration have been proposed as strategic responses (Williams and Dumroese, 2013; Stanturf *et al.*, 2018). The intentional movement of species or their populations to counter effects of climate change is preferred where natural regeneration is unlikely to meet management objectives. Given the incongruence between suitable future habitat locations for tree species and their inability to naturally migrate in a timely manner, more reliance on tree planting may be necessary to move species and their populations across the landscape. The Forest Service is currently seeking to define emerging definitions surrounding assisted migration, when and how it can be implemented, and associated risks with its implementation.

Effective assisted migration requires knowledge about seed origin. Collaborative efforts between federal, state and private concerns are now underway in the eastern USA to establish known seed collection zones (Pike *et al.*, 2020), whereas in the western USA seed zones have been a regular part of operational forestry for nearly a century. This knowledge would allow land managers the potential to mix local and non-local seed sources as a hedge-betting response against future climatic conditions. Researchers are developing climate-based seed transfer guidelines that decrease reliance on static seed zone maps (Cooke *et al.*, 2019). These evolving efforts have potential to improve efficient use of seed supplies and better match existing and future seed collections to future climatic conditions.

Planting will also be the most efficient way to reintroduce native tree species traditionally bred or bioengineered for resistance to introduced pests that have decimated their populations (Dumroese *et al.*, 2015; Showalter *et al.*, 2018), as has recently been proposed for American chestnut (*Castanea dentata*), and elm (*Ulmus* spp.) bred for resistance to non-native pests (Jacobs *et al.*, 2013; Martín *et al.*, 2019).

Successful restoration requires adequate resources for planning and long-term commitment. A supply chain of activities is necessary; focusing only on planting ignores the necessary infrastructure, personnel expertise and resources needed to get to the point of planting seedlings, including seed collection, processing and nursery practices through to caring for seedlings after planting (e.g. monitoring, competition control, and protections from ungulate browsing). Successful tree planting requires planting stock grown with specific traits to meet the challenges of particular sites and the objectives of the landowner (Dumroese *et al.*, 2016). Meeting the restoration challenge will require more seedlings, including a greater diversity of species, than are being currently produced, as well as additional professionals well trained in seedling production and deployment (Haase and Davis, 2017).

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FINANCIAL STRATEGIES FOR FOREST AND LANDSCAPE RESTORATION

For the latest data and information please see:

Bonn Challenge (2021)

A global goal to bring 350 million hectares of degraded and deforested landscapes into restoration by 2030. Available here: <https://www.bonnchallenge.org/>

Initiative 20x20 (2021)

A country-led effort that aims to change the dynamics of land degradation in Latin America and the Caribbean and bring 50 million hectares of degraded landscapes into restoration by 2030. Available here: <https://initiative20x20.org/>

AFR 100 (2021) African Forest Landscape Restoration Initiative

A country-led effort to bring 100 million hectares of land in Africa into restoration by 2030. Available here: <https://afr100.org/>

Forestry and Climate Change Fund (2021)

<https://www.forestryandclimate.com/>

Ejido Verde (2021)

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