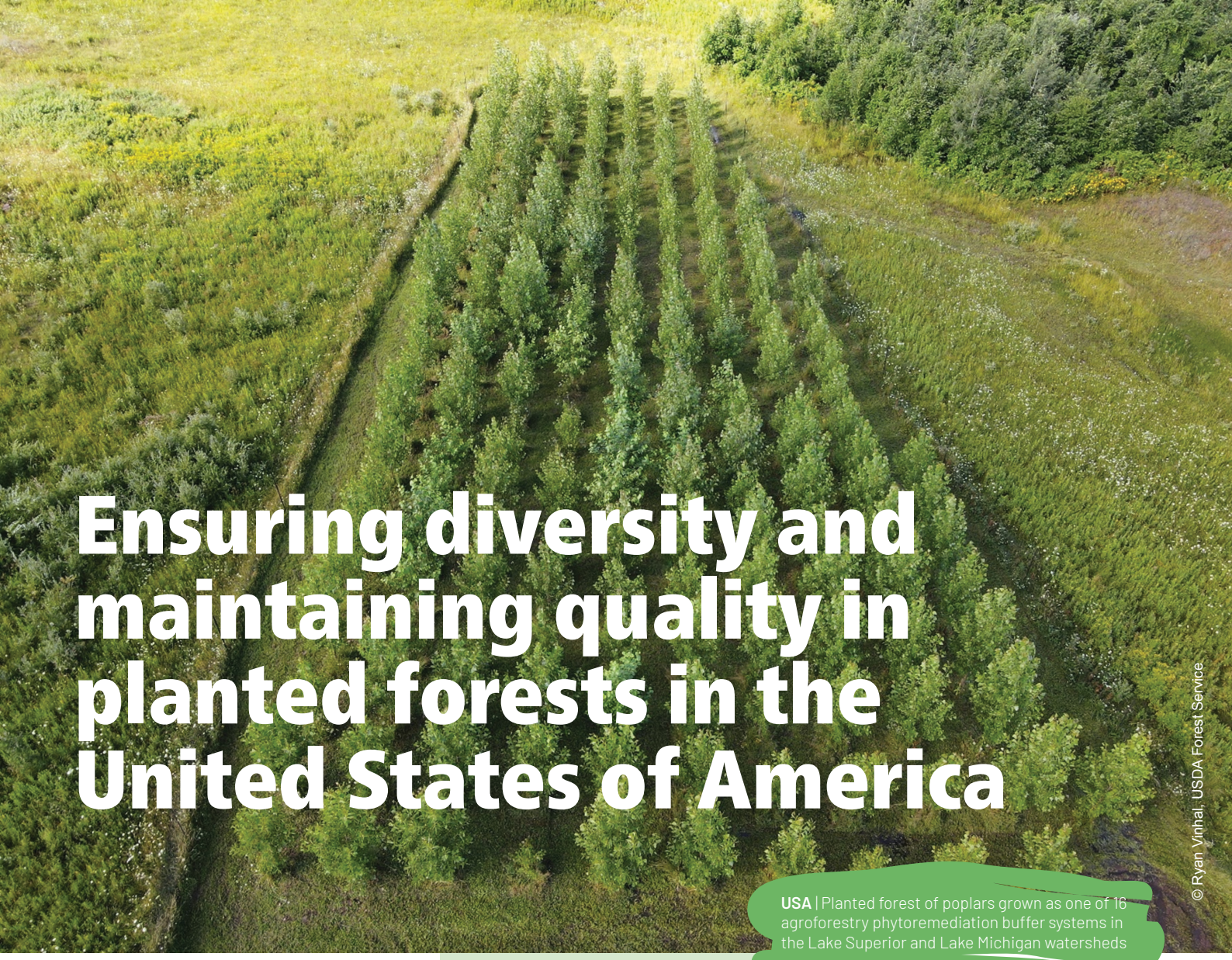
Ensuring diversity and maintaining quality in planted forests in the United States of America



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USA | Planted forest of poplars grown as one of 16 agroforestry phytoremediation buffer systems in the Lake Superior and Lake Michigan watersheds

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Highlights

- Planted forests comprise 11 percent of timberlands in the United States of America.
- Tree-breeding programmes aim to introduce genetic diversity through hybridization and other tree improvement tools and technologies.
- The integration of traditional approaches and new production systems provides an opportunity to enhance the benefits for communities while maintaining profitability for growers.

Planted forests are an integral part of life for rural and urban communities throughout the United States of America. Beyond wood and wood products, these forests provide essential ecosystem services such as healthy soils, clean and abundant water, and carbon sequestration, while also enhancing livelihoods for producers and consumers (Caputo and Butler, 2017; Domke *et al.*, 2020; Liu *et al.*, 2022). Silvicultural prescriptions for these forests are based on sustainable best management practices that incorporate diversity at the stand and landscape level (through establishment of multiple species and hybrids and clones within species) as well as resilience to changing climates and biological challenges such as diseases and insects (McEwan *et al.*, 2020; Pawson *et al.*, 2013).

The distribution of planted forests throughout the United States follows trends in forest ownership; the western United States is dominated by large tracts of public forest land, while eastern forests are predominantly privately owned (Perry, Finco and Wilson, 2022; Sass, Butler and Markowski-Lindsay, 2020). Across the

country, federal- and family-owned forests account for nearly two-thirds of all forest and woodland area (Oswalt *et al.*, 2019). Most planted forests in the United States are on private corporate lands, which are distributed across 27 percent, 22 percent and 17 percent of regional forestland in the South, Pacific coast and North, respectively (Perry, Finco and Wilson, 2022).

At its peak, the forest and woodland area in the United States reached 333 million hectares (ha) – an area over one-third of the country's total land area, and which contained enough wood volume (28 billion cubic metres) to fill the Roman Colosseum 21 000 times (Oswalt *et al.*, 2019). Today, although two-thirds of forestland is legally available for harvesting, tree removal occurs on less than 2 percent of forestland each year (Oswalt *et al.*, 2019). The timberlands of the United States consist of natural stands (89 percent) and planted forests (11 percent), with over half of all harvests occurring in the "woodbasket" of the country, that is, forest plantations of the Southeast (Oswalt *et al.*, 2019).

Despite a small proportion of its harvestable area being harvested and challenges such as increased occurrence of wildfires and landscape-level insect and disease outbreaks, the United States is the leading global producer of industrial roundwood (17 percent of worldwide production) and has the greatest industrial roundwood consumption per capita (Oswalt *et al.*, 2019). Of the roundwood harvested, 40 percent is used in solid wood products for new housing and furniture manufacturing, while 38 percent is used to produce paper and paper products (Brandeis *et al.*, 2021). The United States also produces 26 percent of global wood pulp and wood pellet supplies, and is the second largest producer and consumer of sawnwood, paperboard, wood-based panels and paper (FAO, 2020). Recent trends have shown that consumption of solid wood products has increased, while consumption of paper, paperboard and pulpwood has decreased, and wood for energy has remained neutral (Brandeis *et al.*, 2021).

Given the broad geographic distribution and varying soils and climate throughout the country, the most common planted species across the United States (i.e. Pacific coast: *Pseudotsuga menziesii* (Mirbel) Franco; Rocky Mountain: *Pinus ponderosa* Doublas ex C.Lawson; North: *Pinus strobus* L., *Pinus resinosa* Sol. Ex Aiton; South: *Pinus taeda* L., *Pinus echinate* Mill.) are those that are regionally adapted and developed to maximize biomass production and other ecosystem services. Diversity and resilience are achieved through extensive tree breeding programmes that aim to introduce genetic diversity through hybridization and other tree improvement tools and technologies (e.g. marker assisted selection or genomic prediction) (Vance, Maguire and Zalesny, 2010). Regional adaptation of deployed trees aids in optimizing resilience to changing climates, insects, diseases and other biotic challenges (Pawson *et al.*, 2013; Ray *et al.*, 2022).

Planted forests of the United States provide social and ecological benefits to communities throughout the country, and newer production systems may contribute to livelihoods in novel ways. For example, planted forests help to reduce stress, lower blood pressure and improve psychological well-being. In addition, there is great potential to use planted forests for ecological restoration of mining areas, brownfields, landfills and other liability sites while providing roundwood supplies and enhancing soil health, water quality and carbon sequestration (Zalesny *et al.*, 2019). Similarly, incorporating planted forests into agroforestry systems increases the diversity and resilience of timberlands (Bishaw *et al.*, 2022) and the production of non-timber forest products (NTFPs) (Trozzo *et al.*, 2021). Overall, integrating traditional approaches with new productions systems provides an opportunity to enhance quality of life and stewardship of ecosystem services while maintaining profitability for growers across the landscape (Caputo and Butler, 2017).

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USA | Native *P. trichocarpa* and planted hybrid poplars along the Snoqualmie river, Carnation, Washington