CHAPTER 2

Terminology of regeneration, reforestation, restoration, and climate adaptation

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Introduction

There are at least 1000 ways to define a forest, and some countries have multiple definitions (Lund, 2018). Classifications depend on definitions that support the objectives of the classification and facilitate describing relationships (or lack thereof) among groups of similar objects (Sokal, 1974). Similarly, the understanding of forestry terms often differs among forestry professionals, other disciplinary specialists, and their affiliated organizations (e.g., ecologists, wildlife biologists, and conservationists), and the interested public. People working to reverse deforestation and forest degradation, mitigate and adapt to climate change, and conserve biodiversity describe their actions with a wide range of often confusing terms. At a basic level are the differing notions of what constitutes a forest, for example, whether a plantation is a forest. Different objectives can lead to different definitions and classifications (Sasaki and Putz, 2009; Putz and Redford, 2010; Chazdon et al., 2016). Culture and tradition frequently provide multiple words for types of forest, as well as nuance that is lost in translation or introduced by loanwords, leading to confusion. Words are mutable, changing over time. But when terms enter the popular vernacular, they can become vague or "plastic" and loaded with added meaning. Sometimes this is done to accommodate organizational or policy goals.

World views, value systems, and simply different ecological contexts and professional experience shape word meaning and usage. Examples abound; consider natural, native, wild, and wilderness. All have imprecise, common-sense meanings that sometimes are divergent in different countries. Scientific terms, usually regarded as more precise, nevertheless change meaning as new information and understanding develop. Policies and popular understanding based on older scientific underpinnings become obsolete and possibly maladaptive as data accumulate and paradigms change to accommodate new understanding. Case in point, forest ecosystems are not static (steady state) but dynamic, subject to periodic disturbances. Hence, policies and values based on unchanging

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forests and their ecological attributes can be counter-productive, as can be seen in wildfire suppression policies (Kreider et al., 2024).

Importantly, terms evolve over time. As terms become embedded in policies and programs, they take on legal and contractual meaning. The objectives of this chapter are to (1) examine current academic and legal definitions of forests and forestland in European countries, (2) provide nuanced definitions of terms associated with forest transitions, particularly the regeneration phase of forest management that includes reforestation and restoration, and (3) place regeneration and restoration in the wider context of climate adaptation. A simple definition of a forest is an area of land dominated by trees; thus, we begin by describing different ways to define a tree. The definition of a forest varies by country and by intended use of the classification supported by the definition, whether by land cover, land use, or by the condition of the forest (i.e., with geographic, administrative, or ecological qualifiers).

Trees—Concepts and conditions

Trees are defined as large, tall, woody, perennial plants, generally with a single, unbranched, erect, self-supporting stem. Trees have a single main stem, or in the case of coppice, several stems. Trees have branches and a distinct crown (FAO, 2018c). The minimum height of a forest tree varies by country and generally must be at least 1 m tall (Table 2.1). Individual trees are classified taxonomically, with the familiar designation by species or variants. Tree species can be grouped by their life history characteristics or traits; the most common ones are conifer or broadleaf (although some Angiosperms have needle-shaped leaves, and *Ginkgo biloba*, a Gymnosperm, has broad leaves). More detailed trait classifications group tree species into functional clusters of species with similar functional response (Verheyen et al., 2003; Messier et al., 2013; Aquilué et al., 2020). For example, shade-tolerant species with high wood density and relatively large seed size could be one group, while another could be shade-intolerant species with low wood density (the correspondence with successional status is clear in these examples).

The genetic makeup of a tree is another descriptor, beginning with species, the largest group of organisms in which any two individuals of the appropriate sexes or mating types can produce fertile offspring, typically by sexual reproduction, although even this most basic term is open for discussion (Mallet, 1995). Some species, such as *Quercus*, readily hybridize (Rushton, 1993; Petit et al., 2004); that is, hybrids are the progeny of genetically different parents (Deal, 2018). One way to describe seeds or trees is by their provenance, the place where they were growing (Young and Giese, 1990). Provenances of a species may be better adapted to certain climatic conditions, such as drought tolerance, useful for adaptation to future climate (e.g., Kohler et al., 2010; Ray et al., 2022; Wrzesiński et al., 2024).

Table 2.1 Definitions of forest according to the UNFCCC, the UNCBD, and the UNFAO.

UNFCC (2001)
Forest is a minimum area of land of 0.05–1.0 hectares with tree crown cover (or equivalent stocking level) of more than 10%–30% with trees with the potential to reach a minimum height of 2–5 meters at maturity in situ. A forest may consist either of closed forest formations where trees of various stories and undergrowth cover a high proportion of the ground, or an open forest. Young natural stands and all plantations that have yet to reach a crown density of 10%–30% or a tree height of 2–5 meters are included under forest, as are areas normally forming part of the forest area that are temporarily unstocked as a result of human intervention, such as harvesting or natural causes, but which are expected to revert to forest.
UNEP/CBD/SBSTTA/7/INF/3 (2001)
Forest is a land area of more than 0.5 ha, with a tree canopy cover of more than 10%, which is not primarily under agricultural or other specific non-forest land use. In the case of young forests or regions where tree growth is climatically suppressed, the trees should be capable of reaching a height of 5 m in situ and of meeting the canopy cover requirement.
FAO (2001)
Forests include natural forests and forest plantations. It is used to refer to land with a tree canopy cover of more than 10% and an area of more than 0.5 ha. Forests are determined both by the presence of trees and the absence of other predominant land uses. The trees should be able to reach a minimum height of 5 m. Young stands that have not yet but are expected to reach a crown density of 10% and a tree height of 5 m are included under forest, as are temporarily unstocked areas. The term includes forests used for purposes of production, protection, multiple-use, or conservation (i.e., forests in national parks, nature reserves, and other protected areas), as well as forest stands on agricultural lands (e.g., windbreaks and shelterbelts of trees with a width of more than 20 m), and rubberwood plantations and cork oak stands. The term specifically excludes stands of trees established primarily for agricultural production, for example, fruit tree plantations. It also excludes trees planted in agroforestry systems.

Many commercial tree species have undergone genetic selection, by which certain traits become more prevalent, for example, growth rate or disease resistance (Perry, 1998). Some commercially important tree species in Europe have undergone genetic selection (Pijut et al., 2007; Pâques, 2013), but knowledge of non-commercial species is less well-developed (Bozzano et al., 2014; Thomas et al., 2014). Some terms describing forest reproductive material (FRM) are defined in Appendix 2.1, and some recent advances are described in Stanturf et al. (2024a). Information on nursery propagation of some European species can be found in Chapter 11.

The holobiont is another description of a tree, which is a collection of a tree and other closely associated species. The holobiont describes a group of species with complex interactions, such as a tree with associated mycorrhizae and epiphytes. Each species present in a holobiont is a biont, and the genomes of all bionts taken together are the hologenome, or the "comprehensive gene system" of the holobiont (Bordenstein and Theis, 2015; Vandenkoornhuyse et al., 2015; Skillings, 2016; Hassani et al., 2018).

Although the holobiont and the hologenome concepts are controversial (Egan et al., 2020), particularly in regard to their evolutionary implications, discussion of the theory has broadened the focus beyond the symbiosis of a single microbial partner and a single host. The idea that a "tree" is more than a single taxonomic organism is especially relevant to attempts to move species (i.e., assisted migration (AM)) as an adaptation to climate change (Dumroese et al., 2015; Clark et al., 2022). A related, more general concept incorporating symbioses is ecosystem legacies, which are a physical, biological, or chemical condition (or combination of conditions) of a previous ecosystem element that persists long-term after a disturbance (Johnstone et al., 2016; Jõgiste et al., 2017). Tree-related legacies include buried seedbanks, stumps, or root systems that can resprout, and associated microflora.

The current geographic distribution of tree species is the basis for confusing terms that classify a species by its "naturalness." The relative recency of a species occurrence in a country, along with how aggressively newly arrived species disperse, adds another dimension. An indigenous species is native to a specified area or region, meaning it has not been introduced (Ford-Robertson, 1971). A tree species is considered native if it occurs within its present or past natural range, thereby accounting for locally extirpated species. The natural range recognizes the dispersal potential of a species; that is, within the range it occupies naturally or could occupy without direct or indirect introduction or care by humans (FAO, 2018c).

Exotic, nonnative, or introduced species are plants or species originating from another country or geographic region outside their natural range (Deal, 2018). An exotic species can become naturalized when it has established, grown, reproduced, and maintained itself in areas where it did not originally grow. Naturally regenerated introduced tree species should be considered as "introduced" up to 250 years from the date of original introduction. Beyond 250 years, the species can be considered naturalized (FAO, 2018c).

Nonnative species can exhibit undesirable traits, usually by aggressively dispersing and displacing native species. An invasive species, a term applied to any foreign organism, including plants, is an organism that is nonnative (or alien) to an ecosystem and whose introduction causes or is likely to cause economic or environmental harm or harm to human health (Ford-Robertson, 1971). The confusing terminology of invasion science, referring to all taxa, was reviewed by Soto et al. (2024), and they found 50 terms used to describe native and nonnative species. They proposed three terms that unambiguously described populations of nonnative species: (1) nonnative, (2) established nonnative, and (3) invasive nonnative. Nonnative species have been transported beyond their natural biogeographic range. They are present in, or arriving in, an area where they have no evolutionary history. Established nonnative species have self-sustaining populations in their new location(s) in the wild. Invasive non-natives are populations of established nonnative species that have spread or are spreading rapidly in their invaded range, without human assistance.

The classification of a tree species as nonnative, established nonnative (naturalized), or established nonnative invasive varies by country. As noted in Chapter 1, European countries have a confusing array of regulations governing the acceptability of nonnative tree species, ranging from very few restrictions on the use of nonnative species in forest management to the complete banning of the use of nonnative tree species in forests (Brus et al., 2019; Pötzelsberger et al., 2020). Nevertheless, some countries, such as Austria, are considering using nonnatives to restore degraded forests (Konic et al., 2024).

Forests

Forests are defined primarily for inventory and monitoring of forestland (Smith, 2002; Ferretti et al., 2024). Inventories commonly serve management purposes that are based on the objectives of society and landowners, which have changed over time (Farcy and Devillez, 2005; Duncker et al., 2012). Definitions have been categorized according to administrative criteria, by land cover or land use, or according to condition (e.g., ownership, forest type, protection status, productivity classes, and species groups). A primary distinction is between forest and non-forest, that is, between forest land use and forest cover. Land use indicates how people are using the land (forestry, pasture, row crops, fish ponds, village, city, etc.), whereas land cover indicates the physical land type (trees, grassland, agriculture, water, urban).

Monitoring and forest inventories primarily utilize forest cover (versus non-forest cover), which is readily interpreted from remote sensing data, although transitional conditions such as recently harvested or young stands could be misclassified as non-forest. Remote sensing advances (e.g., LiDAR and multispectral sensors) are making it possible to more accurately and rapidly identify species and measure tree heights (Hill and Thomson, 2005; Holmgren et al., 2008). Sensors mounted on uncrewed airborne vehicles (i.e., drones) offer the opportunity for inexpensive multidate monitoring that more easily captures stand development dynamics (Paneque-Gálvez et al., 2014; Maurya et al., 2022) that could lead to classifications that better characterize forest attributes.

Three international organizations have adopted slightly differing definitions of forest (Table 2.1): the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD), and the Food and Agriculture Organization (FAO). The CBD and FAO definitions have the same thresholds for minimum area (0.5 ha), tree height (5 m) and canopy cover (10%) but the UNFCCC has ranges for thresholds, allowing parties to the Kyoto Protocol to establish numerical values within the ranges of 0.5–1.0 ha, 2–5 m, and 10%–30% for minimum area, tree height, and tree cover, respectively. Other definitional differences are that FAO and UNFCC include temporarily unstocked areas (e.g., regenerating stands) that the CBD excludes, and FAO includes some agroforestry land uses, but the other definitions do not. The three organizations differ in the ways they treat land that has trees but otherwise

does not meet their minimum criteria. This includes other wooded land and trees outside forests (FAO, 2002).

The FAO has harmonized definitions in support of the global forest resources assessments they have coordinated every five to 10 years since 1946; current definitions are compiled in FAO (2018b). These definitions have been modified over time as the focus has broadened from timber inventories to assessments of all aspects of sustainable forest management (SFM) and responsive to international forest policies, such as the Agenda 2030 for Sustainable Development, United Nations Strategic Plan for Forests 2017–30, and the Paris Agreement. At the same time, the FAO definitions are flexible and subject to interpretation to consider national classifications (FAO, 2018c).

Forestland

FAO defines a forest as land of more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10%, or trees able to reach these thresholds. It does not include land that is predominantly under agricultural or urban land use (FAO, 2018c). Although most nations report forest area according to the FAO definition, many nations use more than one definition based on administrative designations, land use, or forest condition (Lund, 2018). The definition of forestland in Europe allows each country to use its own criteria for minimum values for area size, tree crown cover, or an equivalent stocking level, and potential tree height at maturity at the place of growth of the trees.[1] Forestland includes areas with trees, including groups of growing young natural trees, or plantations that have yet to reach the minimum values for tree crown cover or equivalent stocking level or minimum tree height, including any area that normally forms part of the forest area but on which there are temporarily no trees as a result of human intervention, such as harvesting, or as a result of natural causes, but which area can be expected to revert to forest. Trees outside forests are those not belonging to the category of forests, forest lands, or other wooded land; for example, agroforestry and most trees in urban areas.

Many kinds of openings in the forest cover are still considered forestland. Germany, for example, lists tracks, firebreaks, openings and clearings, glades, feeding grounds for game, landings, and rides in the forest. Christmas tree plantations are included in Denmark but excluded in Austria and Luxembourg. Tree nurseries within forests are generally included, but Czechia and Serbia exclude them. Permanent openings such as forest roads are excluded if they exceed a width of 3 m (Croatia) or 5 m (Sweden). Rows of trees less than 10 m wide are not forestland. Some forms of agroforestry are

[1] European Union definitions of forests, by country (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013D0529).

included as forestland in Portugal (montado) and Spain (dehesas), but excluded in Malta. Abandoned agricultural areas greater than 0.5 ha reverting to trees are treated as forestland in Slovenia if more than 20 years old.

Differing thresholds for defining forestland in European countries make comparisons and aggregations difficult without attention to these details. Nevertheless, international reporting to FAO for the periodic Forest Resource Assessment (FAO, 2020, 2022) or to the IPCC for determining greenhouse gas emissions (IPCC, 2006) provides consistent data across countries. The UNFCCC allows a range of minimum forest area (0.05 ha–1 ha), cover (10%–30%), and tree height (2–5 m) that encompasses the FAO minima. Of the 40 countries shown in Table 2.2, 30% use 0.1 ha and 34% use 0.5 ha as the minimum area for a forest. Only two countries are outside of the UNFCCC area threshold (Israel has no defined minimum, and North Macedonia uses 2 ha). Most countries use a forest cover criterion within the UNFCCC range of 10%–30%; Liechtenstein and Switzerland are exceptions (20%–60%), and North Macedonia has no minimum criterion. Only Turkey has a different tree height criterion (8 m) than the UNFCCC (2–5 m). Presumably, all countries use the FAO and IPCC thresholds when reporting to these agencies.

Forest condition

Forests are a vegetation assemblage dominated by trees. Forests are one of the four global terrestrial biomes (in addition to grassland, desert, and tundra) in hierarchical classification systems based on climate (i.e., temperature and precipitation). Early investigations into the correlation of vegetation types with climate began with continental-scale approaches by Merriam (1889), Holdridge (1947, 1967), and Thornthwaite (1948), informed by local investigations that often were based on elevational gradients, for example, von Humboldt's work in the Andes (Morueta-Holme et al., 2015).

The forest biome is divided at the highest level into tropical, temperate, and taiga or boreal forest. Current global classifications continue in the tradition of hierarchical classes based on broad climate-vegetation correlations, for example:

- IUCN Global Ecosystem Typology 2.0 https://portals.iucn.org/library/node/49250
- Canadian National Vegetation Classification http://cnvc-cnvc.ca/
- US National Vegetation Classification https://usnvc.org/about/
- European Forest Types (EEA, 2007), and
- European Nature Information System https://eunis.eea.europa.eu/

The IUCN Global Ecosystem Typology breaks from the strict hierarchical constraint in that the lowest Levels 5 and 6 are not embedded in Level 4. That is, non-climate variables are defining factors in Levels 5 and 6, such as topography, soils, and disturbance regimes. These more local levels correspond to the stand level classifications commonly

Table 2.2 Criteria for forestland by country, based on minimum area, crown cover percentage, and tree height in meters at maturity (actual or potential), compared to the UNFCCC definition.

Area (ha)	Country	Crown cover (%)	Tree height (m)
0.05–1	UNFCCC	10–30	2–5
	Israel	10	4
0.05	Austria, Czech Republic	30	2
0.0625–0.25	Liechtenstein, Switzerland	20–60	3
0.1	Bosnia and Herzegovina, Croatia, Poland,	10	2
	Bulgaria, Germany	10	5
	United Kingdom	20	2
	Ireland, Latvia	20	5
	Belarus	30	
	Albania	30	3
	Lithuania, Ukraine	30	5
0.25	Romania	10	5
	Slovenia	30	2
	Moldova- Republic of	30	5
0.3	Slovakia	20	5
Greece	25	2	
0.5	Serbia	30	
	Iceland	10	2
	Denmark, Finland, France, Italy, Luxembourg, Monaco, Norway, Sweden	10	5
	Belgium	20	5
	Netherlands	20	5
	Estonia	30	2
	Hungary	30	5
1.0	Portugal	10	5
	Turkey	10	8
	Spain	20	3
2	North Macedonia		

used by foresters. Foresters describe forest types at the local (stand) scale based on co-occurring overstory species (e.g., Eyre, 1980), sometimes with understory indicator plants to indicate relative productivity (Cajander, 1949; Löhmus, 2004).

Older timber-oriented classifications were based on productivity classes, specifically the potential yield of the dominant commercial species. Normal yield tables and site index are two productivity classifications mainly suitable for even-aged silvicultural systems. They have limited application to forest stands with more complex composition and/or structure. A normal yield table is based on two independent variables, age and site (species constant), and applies to fully stocked (or normal) stands. Another approach, the site index, is based on the height of dominant trees attained at an index age that depends on the species.

Terms describing forests based on condition, landscape position, or legal status are commonly in use, but can be ill-defined or have nuanced differences in meaning when used by different groups. Some common terms in English are shown in Table 2.3. Qualifier terms are used as general descriptors and may or may not denote legal or regulatory status. For example, conservation or protection forests may simply describe their primary management objective (often as opposed to production forests), or the descriptor may indicate that some management interventions, such as any form of harvesting, are prohibited or constrained.

The FAO definition of forest has been criticized as insufficiently nuanced, failing to provide sufficient information on forest condition and quality, and being unable to distinguish restoration and regeneration dynamics (Sasaki and Putz, 2009; Putz and Redford, 2010; Chazdon et al., 2016; Sexton et al., 2016). The argument is that although most existing forest definitions are useful for assessing rates of forest loss (i.e., deforestation), they are based on static views of forest cover that are less useful in determining forest gain by restoration and reforestation, that is, in forest land use dynamics. The requirements for minimum area and structure (i.e., tree height and cover), in the FAO definition, exclude significant carbon and biodiversity resources in small, remnant forest patches, windbreaks, agroforests, and isolated trees in mosaic landscapes (Chazdon et al., 2016; Zomer et al., 2016). Importantly, this static view can be perverted to allow natural forests to be converted to monoculture plantations, including non-tree species such as oil palm (Tropek et al., 2014; Zhai et al., 2014) and still qualify as zero-deforestation or for the vague definition of afforestation to allow native grasslands to be converted to tree plantations (Putz and Redford, 2010; Veldman et al., 2015).

The most contentious condition has been about the relative "naturalness" of the forest and whether a "plantation" is a forest. Contributing to the disagreement has been the ambiguity of what constitutes a plantation, and how it fits within the FAO category of planted forest (as opposed to naturally regenerated forest). The extreme archetype of plantation forestry is a single, nonnative species, uniform planting density, even age classes, shorter rotation than natural forest, managed for wood production. Plantations are

Table 2.3 Terms qualifying or describing forest condition, landscape position, or legal status.

Term	Meaning	Source
Ancient	Ancient and endangered forests are defined as intact forest landscape mosaics, naturally rare forest types, forest types that have been made rare due to human activity, and/or other forests that are ecologically critical for the protection of biological diversity. May have a date criterion such as "before 1600."	https://canopyplanet.org/solutions/ancient-forest-friendly/ancient-forest-friendly-defined/
Antique	The oldest of the old: forests that have been around long enough to accumulate, among other things, a rich assemblage of old-growth epiphytes. Such forests seem invariably to be more than 300–350 years old, and many, in many cases, have been in existence much longer than the most ancient trees within them. The last point is important. A 150-year-old tree in a 500-year-old forest may well support more old-growth indicators than a 250-year-old tree in a forest dating from a fire of equivalent vintage.	Goward (1994)
Clonal	The large-scale deployment of relatively few (10–50), known-superior clones that have proven their superiority in clonal tests.	https://www.environmentalpollution.in/forestry/clonal-forestry/clonal-forestry-meaning-application-and-advantages-forestry/4768
Community	Any situation that intimately involves local people in forestry activities.	FAO https://www.fao.org/3/u5610e/u5610e04.htm
Conservation	A forest where the management objective is	FAO (2018a), (2018b), (2018c)

Table 2.3 Terms qualifying or describing forest condition, landscape position, or legal status.—cont'd

Term	Meaning	Source
	conservation of biological diversity. Includes but is not limited to areas designated for biodiversity conservation within the protected areas. This includes wildlife reserves, high conservation values, and key habitats. And a forest designated or managed for wildlife habitat protection.	
Coppice	A forest that has been regenerated vegetatively by allowing regrowth from cut stumps or root suckers, or both. Normally grown on a short rotation for small poles, but sometimes, e.g., some eucalypt species, to a substantial size.	IUFRO (2005)
Coppice with standards	A coppice system in which selected stems are retained as standards at each felling to form an uneven-aged overstory which is removed selectively on a rotation constituting some multiple of the coppice rotation; a crop partly of vegetative and partly of seedling origin.	Burley et al. (2004)
Core	The inner forest areas, assumed to be 10 km beyond the edge of the forest. This is usually the undisturbed forest area.	http://www.fao.org/docrep/007/t0830e/T0830E04.htm
Degraded	**1.** Changes within the forest that negatively affect the structure or function of the stand or site, and thereby	http://www.fao.org/docrep/009/j9345e/j9345e08.htm

Continued

Table 2.3 Terms qualifying or describing forest condition, landscape position, or legal status.—cont'd

Term	Meaning	Source
	lower the capacity to supply products and/or services.	
	2. A secondary forest that has lost, through human activities, the structure, function, species composition, or productivity normally associated with a natural forest type expected on that site.	Convention on biological diversity https://www.cbd.int/forest/definitions.shtml
Disturbed	Any forest type that has in its interior significant areas of disturbance by people, including clearing, felling for wood extraction, anthropogenic fires, road construction, etc.	http://www.globalchange.umich.edu/globalchange2/current/lectures/deforest/deforest.html
Dominant	Core forest surrounded by at least 60% forest.	Riitters et al. (2004)
Floodplain	Forests growing on alluvial, mineral soils associated with riverine systems. Soils are inundated during flood events, but are usually somewhat well-drained for much of the growing season.	Shaw and Fredine (1971)
Frontier	Large, ecologically intact, and relatively undisturbed forests that support the natural range of species and forest functions.	http://www.wri.org/ffi/lff-eng/
High	A stand of trees, generally of seedling origin, that normally develops a high, closed canopy.	Ford-Robertson (1971)
High (conservation, nature) value	Forests of outstanding and critical importance due to their high environmental, socioeconomic,	http://www.hcvnetwork.org/resources/assessments/BPFM_report_E_book_part1.pdf

Table 2.3 Terms qualifying or describing forest condition, landscape position, or legal status.—cont'd

Term	Meaning	Source
	biodiversity, or landscape values.	
Interior	Core forest surrounded by a window containing at least 90% forest.	Riitters et al. (2004)
Late-Successional	Forest seral stages that include mature and old-growth age classes.	http://www.forestenterprises.co.nz/cfi/investmentstructure.htm
Lowland	A forest that grows on flat lands near or below the level of the sea or elevations generally less than 1000 m.	https://www.collinsdictionary.com/us/dictionary/english/lowland-forests
Managed	Managed forests and other wooded land can be defined as areas managed in accordance with a formal or an informal plan applied regularly over a sufficiently long period (5 years or more).	http://ec.europa.eu/agriculture/analysis/external/supply-wood/full_text_en.pdf
Mature	A loose term for the stage at which most forest components have attained full development, particularly in height and seed production. Mature stands generally contain trees with a smaller average diameter, less age class variation, and less structural complexity than old-growth stands of the same forest type.	Martin et al. (2016)
Natural	Forests composed of tree species indigenous to the area.	http://europa.eu.int/comm/dg08/forests/en/en4_6.htm
Old-Growth	A classification of forest stands that describes an ecologically mature ecosystem. Where information is not available	Bolsinger and Waddell (1993)

Continued

Table 2.3 Terms qualifying or describing forest condition, landscape position, or legal status.—cont'd

Term	Meaning	Source
	for ecological classification, age, or size of dominant trees, or both, are used.	
Original	That estimated to have covered the planet about 8000 years ago, before large-scale disturbance by modern society began.	http://www.wri.org/ffi/lff-eng/
Plantation	Planted forest that is intensively managed and meets all the following criteria at planting and stand maturity: One or two species, even age class, and regular spacing. Specifically includes short-rotation plantation for wood, fiber, and energy. Excludes forest planted for protection or ecosystem restoration and forest established through planting or seeding, which at stand maturity resembles or will resemble a naturally regenerated forest.	FAO (2018b)
	A stand composed primarily of trees established by planting or artificial seeding. A plantation may have tree or understory components that have resulted from natural regeneration. Depending on management objectives, a plantation may be pure or mixed species, treated to have uniform or diverse structure and age classes, and have wildlife species commensurate with its stage of development and structure. Plantations may be grown on short rotations	Ford-Robertson (1971)

Table 2.3 Terms qualifying or describing forest condition, landscape position, or legal status.—cont'd

Term	Meaning	Source
	for biomass, energy, or fiber production, on rotations of varying length for timber production, or indefinitely for other values.	
Pristine	See primeval or old-growth.	
Production	Forest where the management objective is production of wood, fiber, bioenergy, and/or non-wood forest products. Includes areas for subsistence collection of wood and/or non-wood forest products.	FAO (2018b)
Protection	Forest where the management objective is the protection of soil and water. Harvesting of wood and non-wood forest products may (sometimes) be allowed, but with specific restrictions aimed at maintaining the tree cover and not damaging the vegetation that protects the soil. Buffer zones along rivers and restrictions on wood harvesting on slopes exceeding a certain steepness are designated for the protection of soil and water. This includes forest areas managed for combating desertification and protection of infrastructure against avalanches and landslides.	FAO (2018b)
Riparian	A riparian forest or riparian woodland is a forested or wooded area of land adjacent to a body of water	https://www.sciencedirect.com/topics/earth-and-planetary-sciences/riparian-forest

Continued

Table 2.3 Terms qualifying or describing forest condition, landscape position, or legal status.—cont'd

Term	Meaning	Source
	such as a river, stream, pond, lake, or marshland. Forests near a river are called riverine.	
Secondary	Forests regenerating largely through natural processes after significant disturbance of the original forest at a single point in time or over an extended period and displaying a major difference in forest structure and/or composition with respect to nearby primary forest on similar sites.	Chokkalingam and De Jong (2001)
Semi-natural	Forest/other wooded land of native species, established through planting, seeding, or assisted natural regeneration. Includes areas under intensive management where native species are used and deliberate efforts are made to increase/optimize the proportion of desirable species, thus leading to changes in the structure and composition of the forest. Naturally regenerated trees from other species than those planted/seeded may be present. May include areas with naturally regenerated trees of introduced species. Includes areas under intensive management where deliberate efforts, such as thinning or fertilizing, are made to improve or optimize desirable functions	http://unfccc.int/files/methods_and_science/lulucf/application/pdf/060830_killmann.pdf

Table 2.3 Terms qualifying or describing forest condition, landscape position, or legal status.—cont'd

Term	Meaning	Source
	of the forest. These efforts may lead to changes in the structure and composition of the forest.	
Upland	It occurs on land lying above the level where water flows or where flooding occurs. Drainage is sufficient so that soils do not become saturated for extended periods of time.	https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/upland-forests
Urban	Forests in, next to, or near a specific urban area, of which the decision-making processes on desirable functions are dominated by local actors and their objectives, resulting from their perceptions, norms, and values.	http://www.efi.fi/publications/Working_Papers/12.html
Virgin	Areas that have never been disturbed by human intervention show natural development in structure and dynamics. The soil, climate, entire flora and fauna, and life processes have not been disturbed or changed by timber management, cattle grazing, or other direct or indirect anthropogenic influences.	Schuck et al. (2002)

often intensively managed with competition control and fertilization. Essentially, plantations are maintained in the stand initiation stage of stand development, before the stem exclusion stage when competition intensifies, and density-dependent "self-thinning" occurs (Oliver and Larson, 1996). Commercial plantations of native species, such as extensive *Pinus taeda* forests of the southeastern USA (Stanturf et al., 2003), meet all these criteria, and some plantations are established for protection, rather than production objectives. Therefore, the distinguishing feature of a plantation vis-à-vis a planted forest is

the intensity of ongoing management. Over time and less intensive management, many planted forests appear natural; examples include all or parts of the New Forest (UK), the Black Forest (Germany), Forêt de Compiègne (France), the forests of Denmark (Evans, 2004), and Sierra Espuña in Spain (Vadell et al., 2016).

Forest land use transitions

Major differences arise in the definitions of transitions of forest land use, terms including forestation, afforestation, reforestation, deforestation, proforestation, restoration, and degradation (Fig. 2.1). Forestation is a general term for the process of regenerating forests on land damaged or disturbed (e.g., harvested) or on currently unforested land. Forestation includes the widely used terms describing establishing a forest under different circumstances, corresponding to forest restoration, reforestation, and afforestation (Ford-Robertson, 1971).

A logical starting point for making sense of the terms describing forest land use transitions is the native, intact forest, an area meeting the FAO definition of a forest. On the one hand, this hypothetical forest can be actively managed in a sustainable manner, providing a variety of ecosystem services that benefit humans, or passively managed for protection and biodiversity conservation. On the other hand, this forest can be degraded, having lost the structure, function, species composition, or productivity normally associated with the native forest. Hence, a degraded forest delivers a reduced supply of goods and services, with limited biological diversity. The CBD[2] and FAO (2011) differ in their definition of degradation; CBD ascribes the degradation to human activity, while FAO includes any changes that negatively affect the structure or function of the stand or site, and thereby lower the capacity to supply products and/or services.

Note that although degradation negatively affects the condition of the forest, the land remains in forest land use. If the forest cover is removed and the land is converted to non-forest land use, this is deforestation (FAO, 2018b). Specifically, this includes permanent reduction of the tree canopy cover below the minimum 10% threshold. Deforestation may be caused by human activity such as conversion to agriculture, pasture, water reservoirs, mining, roads, or urban areas. The term also includes areas where, for example, the impact of disturbance, overutilization, or changing environmental conditions affects the forest to an extent that it cannot sustain a canopy cover above the 10% threshold. The term specifically excludes areas where the trees have been removed as a result of harvesting or logging, and where the forest is expected to regenerate naturally or with the aid of silvicultural measures.

[2] Convention on Biodiversity definitions of forests; https://www.cbd.int/forest/definitions.shtml

A sustainably managed forest can be re-established following harvesting by various silvicultural methods (Matthews, 1991). Reforestation is the re-establishment of forest through planting and/or deliberate seeding on land classified as forest, without any intervening period in another land use. Reforestation includes planting or seeding of temporarily unstocked forest areas as well as areas with existing forest cover, including coppice from trees that were originally planted or seeded. Reforestation, however, excludes natural regeneration (FAO, 2018b).

Natural regeneration is the process of forest regrowth through natural processes, from reproductive material existing on-site or dispersed to a site by various mechanisms (e.g., wind, water, and animals). Most forests in Europe are regenerated naturally (Chapter 1) and could include protection from herbivores by fencing or be aided by soil preparation. Natural regeneration can also occur outside of forest land, for example, by natural recolonization of abandoned farmland or pasture (Stanturf et al., 2014a).

SFM is based on silviculture. Silviculture and forest restoration seemingly overlap, lacking a clear separation (Wagner et al., 2000; Sarr and Puettmann, 2008). Certainly, restoration uses many techniques common to silviculture (Stanturf et al., 2014a). However, severely degraded, damaged, or destroyed forest ecosystems require extraordinary effort to recover functioning (Stanturf, 2005; Putz and Redford, 2010). Once underlying ecological processes are functioning, many restored forests can be managed by sustainable silvicultural practices, although climate change and novel ecosystems may require adjustments (Lugo et al., 2020; Achim et al., 2021; Girona et al., 2023).

Forest restoration is the process of reversing the effects of degradation and deforestation. Depending on objectives, forest restoration can seek to re-establish the structure, composition, or both that existed before degradation or deforestation. Often this describes the objectives of ecological restoration. Alternatively, the objective of forest restoration can be to regain forest functioning (Stanturf et al., 2014b; Mansourian and Parrotta, 2019). Both functional and ecological forest restoration focus primarily on the biophysical aspects of forests. Alternatively, forest landscape restoration (FLR) places emphasis on both regaining ecological functionality and enhancing human well-being (Stanturf and Mansourian, 2020; Mansourian et al., 2021).

Forest restoration to reverse deforestation involves not only regaining a functioning forest but also a change from another land use to forest. One method is afforestation, establishing a forest through planting and/or deliberate seeding on land that, until then, was under a different land use (FAO, 2018c). A key ill-defined feature of this definition is the length of time an area has to have been in non-forest land use. Earlier definitions were vague, such as "within living memory" (FAO, 2001). Different sources define this period as five or more years, depending on how intensively the area was used. As noted above, Slovenia defines land abandoned for 20 years and naturally

regenerating as forest. European legislation (Eurolex[3]) is more demanding, requiring a period of at least 50 years in non-forest land use. The FAO (2018b) definitions of afforestation and reforestation differ from the way the terms are used in the IPCC guidelines for greenhouse gas reporting. The IPCCC guidelines imply a land use change for both afforestation and reforestation. Revegetation is the IPCCC term that approximates the FAO reforestation (FAO, 2018a).

Afforestation is an old term, dating from at least the beginning of the last century (Schlich, 1903), but the practice is much older, at least to the 1500s when the word first appeared in English. There are at least 34 different definitions of afforestation; 20 implied a change in land cover, and 14 specified a change in land cover and use (Lund, 1999). Afforestation has a negative connotation in some usage: (1) Government sponsored tree planting programs on common lands without regard for traditional use by local communities (Kanowski, 1997; Overbeek et al., 2012); (2) Single-species plantations, often of non-natives for timber production or watershed protection (Dodet and Collet, 2012); and (3) Afforestation of native grasslands for land cleared for pasture (Veldman et al., 2015, 2017). Opposition to afforestation for legitimate restoration of degraded land has arisen due to association with these practices.

The emphasis on forests in climate change mitigation and adaptation has led to some new terms. Prestoration is utilizing species in restoration efforts for which a site represents a suitable habitat now and into the future. Thus restoration is not simply acknowledging that different species may be useful in the future, but rather focusing on those species that can be established now and that will likely maintain significant populations for some time (Butterfield et al., 2017; Svensson et al., 2023). Prestoration recognizes that the "local is best" dogma may be irrelevant in the face of climate change (Breed et al., 2013; Prober et al., 2015); nevertheless, the emphasis seemingly remains on native species (Butterfield et al., 2017).

Proforestation is the practice of protecting existing intact forests or allowing forests to recover naturally if they have been degraded (Moomaw et al., 2019). Proforestation advances the argument that restricting active forest management and leaving existing forests intact to grow to their ecological potential is a better climate mitigation approach than forest restoration, or at least is an undervalued strategy (Dellasala et al., 2020; Mackey et al., 2020).

Forests and climate adaptation

Much has been written on the effects of climate change on the world's forests and how forests can be adapted to future climate (e.g., Lindner et al., 2008). There are two senses

[3] European Union definition of forests, by country; https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013D0529

here to adaptation: (1) the adjustment of forest ecosystems to a new or changing environment that exploits beneficial opportunities or moderates negative effects (U.S. National Climate Assessment) and (2) the evolutionary processes whereby a population undergoes modification to heritable traits through natural selection that permits continued persistence in a given environment (Deal, 2018). Similarly, forest management must adapt, including landowners, practitioners, and the organizations in which they work, who must also cope with climate change effects. Their ability or "adaptive capacity" to adjust to the effects of climate change will determine how well they can moderate potential damages, take advantage of opportunities, or cope with the consequences (Kolström et al., 2011; Schoene and Bernier, 2012; Rodriguez-Franco and Haan, 2015).

Climate-smart, climate-adaptive, or climate-adapted forestry are all terms describing a "targeted approach or strategy to increase the climate benefits from forests and the forest sector, in a way that creates synergies with other needs related to forests. The approach builds on three pillars: reducing and/or removing greenhouse gas emissions to mitigate climate change, adapting forest management to build resilient forests, and active forest management aiming to sustainably increase productivity and provide all benefits that forests can provide".[4] Climate-smart forestry is a future-oriented version of SFM, defined as "a dynamic and evolving concept intended to maintain and enhance the economic, social and environmental value of all types of forests, for the benefit of present and future generations" (FAO, 2018c).

Sustainability has a long tradition in forestry, in a limited sense, as sustained yield of multiple benefits from forest ecosystem services. Sustainability in a broader sense is the long-term capacity to maintain the health, productivity, diversity, and overall integrity of forests, ranging from stands to ecoregions, in the context of human activity and use (Deal, 2018). This concept of sustainability dates back to 1987 when the United Nations Brundtland Commission defined it as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). Originally applied to the use of natural resources and the environment, sustainability has morphed into a social good, meeting current needs without compromising the ability of future generations to meet their own needs. Economists have divided sustainability into "weak" or "strong" sustainability, which both differ from ecological definitions (Ayres et al., 2001). At the core, the differences from the economists' perception revolve around whether manufactured capital can be substituted for natural capital. Under weak sustainability, natural capital is fully substitutable, while, in contrast, strong sustainability recognizes the limitations imposed by the criticality of natural processes in support of human society. Arguably, this is not a binary distinction, but rather a choice of how much modification of a natural system is allowable or desirable, to meet human

[4] Climate Smart Forestry, published on 28.03.2018; https://efi.int/articles/climate-smart-forestry.

needs now and in the future. This social choice nature of sustainability results in contentious differences in how forest management is viewed by society.

Nature-based solutions (NBS) are a newly emergent umbrella term for approaches that promote nature and natural processes to mitigate and adapt to climate change as well as to achieve important co-benefits, including halting or reversing land degradation, and conserving biodiversity (Eggermont et al., 2015). Despite its relative newness, forest management (broadly "forestry") has long been concerned with managing land using natural processes; hence, it should be considered a NBS. The two standard definitions of NBS are fairly broad and somewhat vague, making it difficult to define "nature" or "natural" (Nesshöver et al., 2017).

The EU Commission (European Commission et al., 2015) introduced the use of NBS as a term for natural approaches that replace structural engineering solutions, primarily in urban contexts, such as "blue-green infrastructure" (Albert et al., 2017). The other definition by IUCN captures all land uses: "Actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (Cohen-Shacham et al., 2016). This is the definition best suited for addressing the interconnected challenges of climate change and biodiversity decline (Seddon et al., 2021), therefore more applicable to SFM, as long as the social and economic drivers of these challenges are considered (Chausson et al., 2023).

Nature-based climate solutions (NBCS) are a variant form of NBS (Buma et al., 2024) that allows for adapting an ecosystem beyond its current/historical condition. This distinguishes NBCS from natural climate solutions (e.g., conservation and ecological restoration) that do not move ecosystems further from their natural state (Ellis et al., 2024). Thus, NBCS would consider AM of species in forestry (Pedlar et al., 2012; Dumroese et al., 2015; Stanturf et al., 2024b) an appropriate strategy, while some conceptions of NBS would not (Ellis et al., 2024).

Recent descriptions of forests have treated them as complex adaptive systems that are managed to increase tree functional diversity and redundancy in a landscape-level network (Puettmann et al., 2012; Messier et al., 2013, 2019). Forests are managed for resilience in the face of uncertainty amplified by climate change. The focus is on integrating species traits at the stand level into a functional complex network with high spatial connectivity of forest stands in terms of seed dispersal and establishment. Rather than a new silvicultural system, it is a method for integrating past, present, and proposed forestry practices at a large and integrated spatial scale to improve forest resilience and adaptability. This approach recognizes that forests in the landscape are social-ecological systems, biogeophysical units with associated social actors and institutions, consisting of a mixture of natural ecosystems, production systems, and sometimes developed land, functionally interrelated both in ecological and socioeconomic terms (Young et al., 2006).

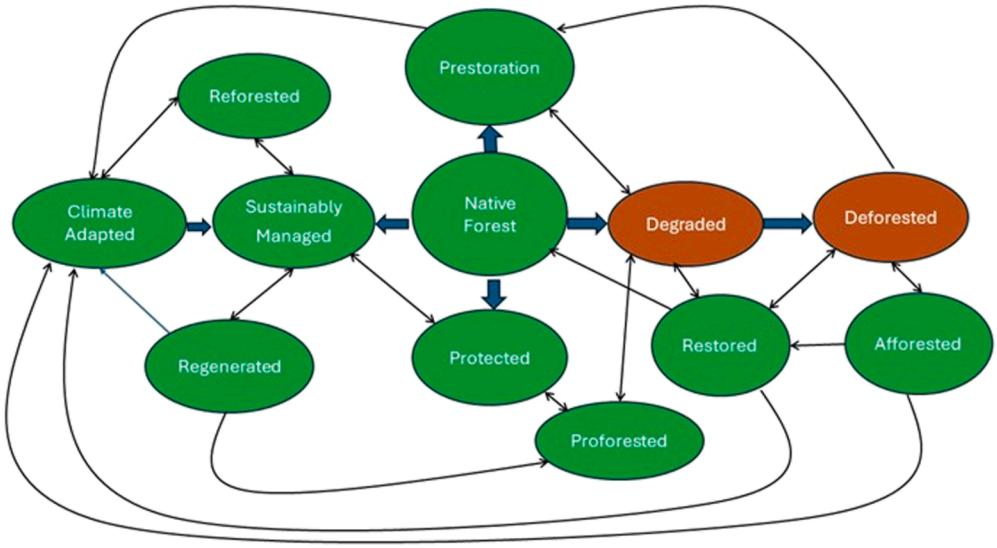

Fig. 1 Relationships among terms used to describe transitions of forest land use (see the text for definitions). Native forests are idealized forests with little or no human influence. It may be degraded, leading to deforestation and conversion to another land use, sustainably managed, or protected. Managed forests can be naturally regenerated or reforested (i.e., planted) with species and methods that are adapted to the future climate. Degraded and deforested lands can be restored and potentially adapted to climate change. Prestoration refers to management practices that favor or introduce climate-adapted species. Proforestation advocates retaining forest stands as long as possible to sequester and store carbon. *(Credit: John Stanturf.)*

A changing climate with increasing frequency and severity of extreme events (e.g., heat waves, drought, pest and disease outbreaks, windstorms, altered wildfire regimes, and sea-level rise) threatens long-lived forest trees (Aitken et al., 2008; Alberto et al., 2013). The challenge to forest management and restoration is that it is untenable to continue to assume a stable climate and that locally adapted species today will persist into the future (McKay et al., 2005; Bucharova et al., 2017; Alía et al., 2022). Rather, it is likely that some species and populations will need to be moved to a more hospitable habitat, and other species with similar functional traits could replace species unable to thrive. This intentional movement of species, termed assisted migration (AM), facilitates natural range expansion, adapting to a changing climate (Aitken and Bemmels, 2016; Sang et al., 2021).

AM, also called species translocation (Dumroese et al., 2015; Stanturf et al., 2024b), moves seeds or other FRM from one bioclimatic zone to another. The objectives for the use of AM are to preserve economic goods, sustain ecosystem services, or avoid species extinction. Three target migration distances differentiate AM: assisted population

migration (moving species or provenances within their current range), assisted range expansion (moving from the current range to suitable areas adjacent to the current range), or assisted species migration (moving a species far outside its current range) (Williams and Dumroese, 2013; Ferrarini et al., 2016). The target migration distance, along with the objectives of AM, provides a framework for examining the potential ecological risks and benefits of AM (Aubin et al., 2011; Breed et al., 2013; Clark et al., 2022).

Conclusion

Words are fluid, with nuance and changing meaning that affect policy and practice. Although English is the default language for international policy and academic publications, forests and forestry have long traditions with specific words in native languages that might not translate from one country to another through the intermediary of English. International attention to the role of forests in the carbon cycle (Chapter 10) means that defining the occurrence and condition of forests, as well as transitions into and out of forest cover and land use, has legal ramifications. Requirements for spatial and temporal resolution have outstripped traditional forest inventory methods. Emerging technology, such as LiDAR and uncrewed aerial vehicles (UAVs), is integrating inventory and monitoring and enhancing remote detection of forest properties.

Related to the emphasis on carbon, but with a distinct and broader concern for climate mitigation and adaptation, multiple terms have emerged to describe forest dynamics and land use transitions. With the progression from forest restoration, forest (and) landscape restoration to preforestation, the differences reflect broadening concerns, from stand level to landscape, from mostly biophysical to socioecological objectives, and from looking backward to an altered climate future (Fig. 2.1).

Despite the fact that most forests in Europe are naturally regenerated (Chapter 1), programs in several countries to increase forest cover by planting will increase the demand for FRM, largely bareroot and container seedlings (Chapters 5 and 11). In addition, the large areas stricken by drought and beetle infestation require speedy restoration with more climate-adapted species, adding to the demand for FRM. Adapting European forests to an altered climate with increased extreme events and novel disturbance regimes potentially requires introducing provenances of native species from distant populations, nonnative species, or both through AM. The result could be novel forest ecosystems that require adapting traditional silvicultural systems or developing new ones. Introducing new FRM will require adapting nursery production methods as well. Throughout the process of adapting to future conditions and emerging requirements, precise communication among professionals, practitioners, and the public will be critical.

Appendix 2.1 Common terms describing forest reproductive material (FRM).

Term	Meaning	Source
Clonal mixture	A method of deploying clones in a planting, whereby equal numbers of ramets for each component clone are randomly located within individual stands, or dividing the total number of clones into two or more subsets and deploying a mosaic of subsets of clones to plantations within a region. Alternatively, established mosaics of single-clone stands.	Roberds and Bishir (1997)
Clones	A group of individuals (ramets) derived originally from a single individual (ortet) by vegetative propagation, for example, by cuttings or micropropagation. Unless somatic mutation or error, individuals of the same clone have the same genotype.	Nanson (2001)
Coppice	**1.** A plant derived by coppicing. **2.** Any shoot arising from an adventitious or dormant bud near the base of a woody plant that has been cut back.	Burley et al. (2004)
Cutting	A small shoot taken from near the end of a branch or the stem of a plant. Planted in the ground, it will produce roots and develop into a new plant that will be genetically identical to the original plant.	Nieuwenhuis (2000)
• Leaf	A cutting consisting of a leaf instead of a shoot.	https://www.lexico.com/en/definition/leaf_cutting
• Root	A cutting from the belowground parts of trees.	https://www.lexico.com/en/definition/root_cutting
• Stem	A cutting from the principal axis of a plant from which buds and shoots develop; [stem cuttings are often taken from material developed in stool beds].	https://www.merriam-webster.com/dictionary/stem%20cutting

Continued

Term	Meaning	Source
Flower induction	The stimulation of the inset of flowering or the number of flowers.	Deal (2018)
Forest reproductive material	Forest tree seeds or plants that have been collected, processed, and raised.	Ivetić et al. (2016)
• Qualified	Components (trees, clones) of relevant basic materials that have undergone a phenotypic selection at the individual level.	Nanson (2001)
• Selected	Material that has undergone a phenotypic selection at the level of the population.	Nanson (2001)
• Source-identified	Material identified by the region of provenance or the seed source, or the stand delineated with altitude. Material has thus not been submitted to any selection.	Nanson (2001)
• Tested	Genetically superior material evaluated either through a foregoing genetic evaluation of the components of basic material or comparative experiments of candidate reproductive materials as compared to "standards."	Nanson (2001)
Genetic selection	The process by which certain traits become more prevalent in a species than other traits.	Perry (1998)
Hybrid	The progeny of genetically different parents (intraspecific is mating within species, interspecific is mating between species)	Deal (2018)
Multiclonal variety	Multiclonal varieties or multiclonal mixtures, a mixture of many genetically superior hybrid clones sufficiently similar in their growth requirements to be grown in random mixtures.	Muhs (1993)
Parents (of families)	Defined groups of trees (clones) producing open-pollinated or controlled-pollinated families. These families are afterward mixed for production. Most often, this mixture of families is vegetatively bulk propagated.	Nanson (2001)

Term	Meaning	Source
Orchard, seed	A plantation consisting of clones or seedlings from selected trees for early and abundant production of seeds and to promote balanced, random mating.	Dean (1947)
• Clonal	A seed orchard established by clonal material (usually scions) from selected mother trees, which is raised by (usually) grafting.	Mbora et al. (2009)
• Seedling	Seed orchards classified as ordinary seed orchards or breeding seed orchards depending on their base material.	Mbora et al. (2009)
Plant parts		
• Cone	A mass of ovule-bearing or pollen-bearing scales or bracts in most conifers or in cycads that are usually arranged on a somewhat elongated axis.	https://www.merriam-webster.com/dictionary/cone
• Explant	Part of the plant by which a whole plant can be produced through the plant tissue culture technique.	https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/explant
• Fruit	The ripened ovary of a seed plant and its contents.	https://www.merriam-webster.com/dictionary/fruit
• Infructescence	Branched or unbranched axis upon which fruits are arranged.	https://torontobotanicalgarden.ca/blog/word-of-the-week/botanical-nerd-word-infructescence/#:~:text=Infructescence%3A%20Branched%20or%20unbranched%20axis,inflorescence%20(arrangement%20of%20flowers).
• Scion	A twig, bud, or other vegetative cutting to be grafted onto the root system of another plant.	https://www.esf.edu/for/maynard/GENE_GLOSSERY.html#-H-
Planting stock	Plant material used in planting, seedlings, transplants, cuttings, or wildlings.	Deal (2018)

Continued

Term	Meaning	Source
• Bareroot	A seedling grown in an outdoor nursery bed; roots are free from the medium in which they were grown.	https://www.lawinsider.com/dictionary/bare-root-seedling.
• Clone	An individual (ramet) derived originally from a single individual (ortet) by vegetative propagation, for example, by cuttings or micropropagation.	Nanson (2001)
• Barbatelle	A rooted cutting.	Stanturf and van Oosten (2014)
• Container	A seedling grown in a receptacle containing the medium (soil) in which it has developed from a seed or transplant.	Deal (2018)
• Cutting (rooted, unrooted)	A shoot, twig, or other plant part removed from a plant and made to develop into a new plant.	Deal (2018)
• Pole	Young tree larger than 10 cm dbh, up to about 20–23 cm dbh.	Deal (2018)
• Seedling	A young plant raised from seed and not from a cutting. Differentiated from sapling by height (criteria vary by nation and region).	Deal (2018)
• Set (whip, stake)	Unrooted cutting 1.5 to 5 or 6 m in length.	Stanturf and van Oosten (2014)
• Steckling	A rooted set.	Stanturf and van Oosten (2014)
• Wildling	A naturally grown seedling, sometimes transplanted, and used in forest planting when nursery stock is scarce; may be transplanted and nurtured in a nursery before outplanting.	Deal (2018)
Plus tree	A tree selected based on its outstanding phenotype but not yet clonally or progeny tested.	Deal (2018)
Pollination	Deposition of pollen on the receptive part of the female flower or strobilus.	Deal (2018)
• Control	To purposely pollinate the female flowers of a tree with pollen from a known source, usually one specific tree.	https://www.esf.edu/for/maynard/GENE_GLOSSERY.html#-C-

Term	Meaning	Source
• Open	Pollination occurring due to wind or insects.	https://www.esf.edu/for/maynard/GENE_GLOSSERY.html#-C-
Progeny	The offspring of a particular tree or mating.	Deal (2018)
• Tested	A planting generally designed to evaluate parents by comparing the performance of their offspring or to provide for the selection of future parents from within the planting itself.	Deal (2018)
Provenance	Natural origin of seeds or trees, usually synonymous with "geographic origin," or a plant material having a specific place or origin.	Young and Giese (1990)
• Natural regeneration	n., Natural seedlings, sprouts, and saplings on a site.	Colloquial
• Advance regeneration	n., Seedlings or saplings that develop or are present in the understory (also called advance reproduction or advance growth) before a regeneration harvest.	https://www.fs.fed.us/restoration/reforestation/glossary.shtml#:~:text=Advance%20Regeneration%20(also%20called%20advance,divided%20for%20classification%20or%20use.
Seed	The ripened ovule of a plant containing an embryo, a seed coat, and nutritive tissue.	Deal (2018)
• Bank	Dormant, viable seeds on the forest floor.	Deal (2018)
• Bed	In natural regeneration, the soil or forest floor on which seeds fall; in nursery practice, a prepared area over which seed is sown.	Deal (2018)
Seed stand	A plus stand that is upgraded and opened by the removal of undesirable individuals and then cultured for early and abundant seed production.	Mbora et al. (2009)
• Autochthonous	Continuously regenerated in the same stand or by material from other autochthonous stands in close proximity.	Sagwal (2020)

Continued

Term	Meaning	Source
Seed transfer guideline or recommendations	Used to guide the movement of seed source to manage the risk of maladaptation for reforestation and restoration	Deal (2018)
Seed zone	An area within which seed can be collected from any natural stand and planted in any new site without fear of maladaptation.	https://www.esf.edu/for/maynard/GENE_GLOSSERY.html#-H-
Seeding (sowing)	The distribution of seed by hand or machine in regeneration.	https://forestrypedia.com/sowing-methods-season-depth-pros-and-cons/
• Aerial	The broadcast sowing of seeds, seed pellets from aircraft.	Deal (2018)
• Direct	The manual or mechanical sowing of tree seed on an area, either in spots or broadcast.	Deal (2018)
Seedling	A young plant raised from seed and not from a cutting. Differentiated from sapling by height (criteria vary by nation and region).	Deal (2018)
Shrub	Woody perennial plant, generally more than 0.5 meters and less than 5 meters in height at maturity and without a single main stem and definite crown.	FAO (2018)
Sib(ling)	An offspring that has one or both parents in common with another individual.	Deal (2018)
• Half	One parent in common.	Deal (2018)
• Full	Both parents in common.	Deal (2018)
Somatic embryogenesis	A process by which somatic (diploid) cells are differentiated into somatic embryos.	Deal (2018)
Sprout	A shoot arising from the base of a (woody) plant, whether from the stool or a sucker.	Deal (2018)
• Root	A shoot arising below group from the roots, some distance from the main stem; also called a sucker, root sucker.	Lazdina et al. (2017)

Term	Meaning	Source
• Seedling	A sprout developed (resprouted) from a seedling root system, e.g., after browsing, fire, or logging disturbance has removed the aboveground portion of the seedling.	Clark and Hallgren (2003)
• Stump	Regeneration of shoot growth from either adventitious or dormant buds from a cut tree stump.	Deal (2018)
Stool	A living stump (capable of) producing shoots.	Lazdina et al. (2017)
Stool bed	Stool or stooling beds are hedge-like rows of mother plants that are established in bareroot nurseries or in vacant fields. They have been a traditional way of propagating poplars and willows in forest and conservation nurseries. The term "stool beds" or "stooling beds" is unique to forestry; in horticulture, they are known as "stock hedges."	https://rngr.net/publications/fnn/2007-winter/articles/new-stock-types-and-species-from-stooling-beds/at_download/file
Transplant	Seedling after it has been lifted and replanted, i.e., moved one or occasionally more times in the nursery, in contrast with a seedling planted out directly from the seed bed.	Deal (2018)
Vegetative propagation	The propagation of plants by asexual means; the genotype of the resulting ramets is identical to that of the original plant (ortet)	Deal (2018)
• Ortet	The original plant from which the members of a clone have descended.	https://www.merriam-webster.com/dictionary/ortet
• Ramet	Any of the individuals in a group of clones.	https://www.collinsdictionary.com/us/dictionary/english/ramet
• Cutting	A piece cut off from a plant that can be used to grow another plant of the same type.	https://dictionary.cambridge.org/us/dictionary/english/cutting

Continued

Term	Meaning	Source
• Graft	To implant (living tissue) surgically.	https://www.merriam-webster.com/dictionary/graft
Wildling	A naturally grown seedling, sometimes transplanted, and used in forest planting when nursery stock is scarce; may be transplanted and nurtured in a nursery before outplanting.	Deal (2018)

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