



Guidelines for identifying genetic conservation units and seed sources for Asian tree species



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Introduction

Across Asia, thousands of socio-economically important tree species are threatened¹. These species and their genetic resources offer vital sources of income, food and environmental services for hundreds of millions of people. Genetic diversity underlies the species' productivity and allows them to adapt to climate change and other potential threats. Today's large-scale commitments to forest and landscape restoration mean a growing demand for seeds and seedlings of native tree species, the genetic diversity and origin of which determines the survival and growth of the newly established forests into the future. For many species the dwindling natural populations are currently the only available source of seed and seedlings for meeting the restoration targets².

Conserving the genetic diversity and adaptive capacity is the cornerstone of effectively conserving tree species and maintaining quality natural seed sources. This requires a network of viable, large enough tree populations across each species range and the diversity of environments in which they are found and adapted to. Minimum viable population size that minimises the risk of genetic erosion depends on the species and site characteristics such as typical population densities, growth rates, pollen and seed dispersal patterns and mating system³. The minimum number and location of the conserved populations, in turn, depends on the diversity of the environments the species is found and the geneflow patterns that determine how distinct the populations have developed over time.

For many tropical Asian tree species, this information to aid conservation and restoration planning is widely lacking – not only on the genetic diversity patterns and reproductive traits, but even on the distributions of the species⁴. Conservation approaches also vary between countries depending on priority species, socio-economic contexts, resources and capacities, and currently there are no commonly agreed, specific definitions of *in situ* species conservation units. This makes it difficult to assess the conservation status of the species across their distribution ranges and country borders, and to identify spatial conservation priorities.

Objectives

The objectives of this guideline are to:

- enable a regional assessment of the conservation status of native Asian tree species and their genetic resources using readily available information
- enable the identification and recognition of sites that already serve, or have the potential to serve, as genetic conservation units and seed sources for native tree species, so that relevant measures can be taken to safeguard them
- support the identification of priorities and collaboration opportunities for ecological and genetic research on native Asian tree species across country borders

¹ FAO 2014a

² Jalonen et al. 2017

³ Ismail et al. 2014; 2017

⁴ Serra-Diaz et al. 2017

- raise forest managers' and conservation practitioners' awareness about the importance of conserving genetic diversity, by highlighting related gaps and priorities that may differ from gaps and priorities identified solely at species or ecosystem level.

The process contributes directly to the strategic objectives of the Asia Pacific Forest Genetic Resources Programme (APFORGEN) for 2018-2022:⁵

- Make available information about the forest genetic resources in the region
- Develop conservation and sustainable use strategies for regionally important and threatened tree species
- Strengthen tree seed supply systems to facilitate ecosystem restoration, support local livelihoods and climate change adaptation and mitigation

APFORGEN is a regional programme for the conservation, restoration and sustainable use of Asia's vast forest genetic resources. It was established in 2003 to enhance networking and collaborative research and strengthen capacities in genetic conservation and sustainable use. APFORGEN's objectives are aligned with the Global Plan of Action on Forest Genetic Resources⁶ by the Food and Agriculture Organisation of the United Nations, and contribute to the Global Strategy of Plant conservation⁷ of the UN Convention on Biological Diversity. APFORGEN has 15 member countries in South, Southeast and East Asia.

The approach

The tier-based approach is designed to guide prioritisation in contexts where species diversity is extremely high and resources per species therefore limited. By breaking down the process of identifying and designating conservation sites to steps, the approach allows making use of readily available information, setting realistic targets and monitoring and recognising progress. It also allows for flexibility and diversity of implementation approaches appropriate to each context, while enabling comparisons between species and across geographies. For example, finding sufficiently large genetic conservation areas that can be sustained over time may require a combination of protected forest, sustainable management units and patches of forest in agricultural landscapes. This is particularly relevant in Asian countries where human population densities are often high even in rural areas, and livelihood needs of local communities must be considered in conservation planning.

The guidelines consist of four Tiers of tree species conservation sites and seed sources, from the candidate sites at Tier 4 to officially designated species conservation units at Tier 1. Each site has one or more target tree species. New sites can be entered into the system at any level, depending on which Tier's criteria they best meet (Figure 1). By using environmental variation as an indicator of differently adapted populations, it is possible to identify comprehensive networks of sites even in the absence of genetic information on the species⁸. These sites can then be targeted for field

⁵ APFORGEN 2018

⁶ FAO 2014b

⁷ <https://www.cbd.int/gspc/default.shtml>

⁸ Vinceti et al. 2013

studies, and if found suitable, they can be flagged for conservation planning, seed source development and designation as genetic reserves where appropriate.

The proposed minimum population sizes are indicative and are based on generic genetic theory and the few available studies on the minimum viable population and breeding unit sizes for tropical Asian tree species⁹. Population sizes of approximately 50 reproductive individuals correspond to minimum sizes of *breeding units*, required to avoid inbreeding that can lead to a rapid loss of productivity and adaptive capacity in just a few generations. Even smaller populations of 15-20 unrelated individuals can have conservation value for rare or severely threatened tree species for which few, if any, large populations remain – however, to be defined as *in situ* conservation sites, specific management actions must be planned for such populations to expand their size and enhance genetic diversity.

Considerably larger populations, likely of hundreds of reproductive individuals, are needed to avoid the negative impacts of genetic drift (random loss of genetic diversity in relatively small populations). Such populations may already be rare for many threatened and socio-economically valuable tree species in Asian countries that have witnessed a rapid loss of natural forest in the past decades. However, attempts should be made to locate and include such remaining large populations, and where they are found, they can be specifically recognised under the existing Tier categories.

The proposed minimum population sizes should be reviewed and updated as needed as knowledge on the species' genetics accumulates.

For implementing this guideline, the information on species potential distributions across ecoregions, and potential impacts of climate change on the species are drawn from a regional project *APFORGIS – Establishing an Information System for conserving native tree species and their genetic resources in Asia-Pacific*. The project is implemented from 2017 to 2019, coordinated by Bioversity International and funded by the Government of Germany through the Federal Office for Agriculture and Food.

The guidelines

Aspirational targets at the levels of species' ranges, countries and ecoregions:

- At least 10% of the species potential distribution in each ecoregion is conserved within sites at Tier 2-4 levels.
- In each ecoregion within each country, there are at least two sites within Tier 2-4 levels
- Where less than 10% of the species potential distribution remains, or if the ecoregion is predicted to become largely unsuitable for the species under progressive climate change, the emphasis should be on germplasm collection and *ex situ* conservation

⁹ Lee et al. 2003; 2006; 2013; 2018; Chua et al. 2016; Ng. et al. 2019

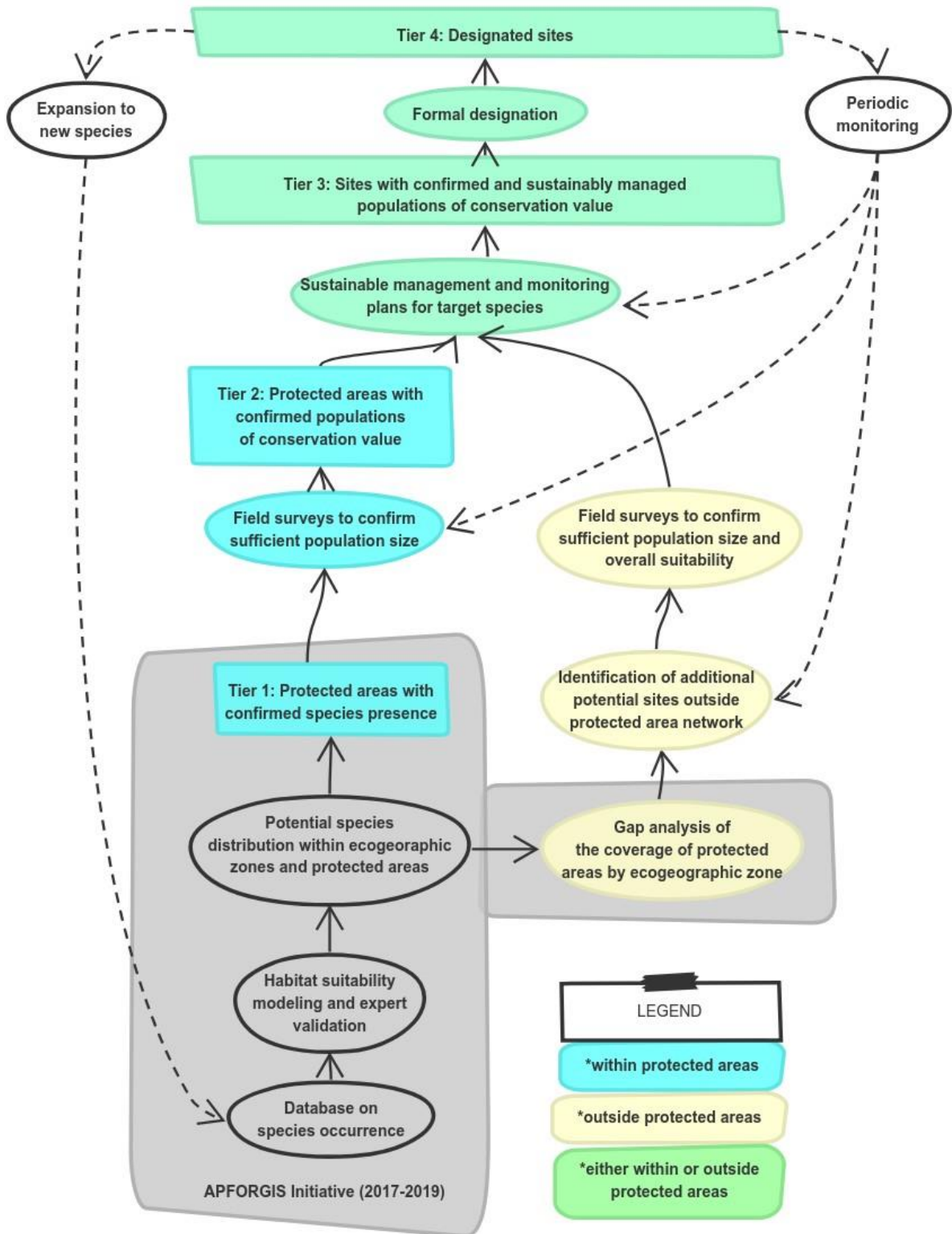


Figure 1. Process of identifying genetic conservation sites and seed sources.

Tier 1: Candidate sites: Protected areas with species presence

Protected areas of at least 1,000 ha that have suitable forest type for the target species, where the species is confirmed to occur, and that are predicted to remain suitable habitat for the species under progressive climate change

- Since population sizes of the target species are not known, the sites under this Tier need to be **relatively large** to increase the likelihood that the species are found in sufficient numbers to form viable populations.
- Similarly, sustainable use is not possible without information about population sizes, and, therefore, the considered sites should **fall under the IUCN categories** for protected areas I or II (strict nature reserves, wilderness areas or National parks).
- Identifying and designating *in situ* conservation areas is a long-term effort, and the candidate sites should, therefore, **remain suitable habitat for the species during progressive climate change**¹⁰. Species populations in protected areas that will likely become unsuitable habitat for the target species in future should be prioritised for *ex situ* conservation.
- After identification of Tier 1 sites, the next step would be to conduct field studies to confirm population size that enables moving the sites to Tier 2. Candidate sites may be prioritised for field surveys using relevant criteria, including their size, stability and species richness

Tier 2: Protected areas with confirmed populations of conservation value

Protected area of at least 500 ha where the target species is confirmed to have at least 50 reproductive individuals, or 15 unrelated individuals if the species is rare or threatened, and that is predicted to remain suitable for the species under progressive climate change

- Sites can be smaller than candidate sites (Tier 1), since sites at this Tier are confirmed through field studies to have a sufficient population size for conservation value and seed production. Records of field surveys are maintained by or accessible to the stakeholder who nominates the site as a conservation unit or seed source.
- Sufficient regeneration should be present as a sign of population viability
- Population densities and minimum viable population sizes vary between species depending on their reproductive traits. The minimum size of a conservation unit can be adjusted based on target tree species and other considerations as relevant.
- Species that are likely to require relatively larger populations to ensure viability include dioecious species, species that can reproduce vegetatively, species where fecundity varies largely between individuals, and species with strong spatial (genetic) structure.
- Sites with large populations of target species (typically at least 200-500 trees) can be recognised separately for their conservation value in avoiding genetic erosion (genetic drift) over long term.

Tier 3: Sites with confirmed and sustainably managed populations of conservation value

Protected area, community forest, seed stand or a forest area of otherwise secure tenure where the target species is confirmed to have at least 50 reproductive individuals, or 15 unrelated individuals if

¹⁰ Information on predicted climate change impacts by 2050 is currently available for 65 tree species through project APFORGIS.

the species is rare or threatened, and where there is a sustainable management plan and monitoring in place to help ensure the species persistence and adaptive capacity over long term.

- **Other than strictly protected areas can be included** as conservation sites and seed production areas from this Tier, because management plans and monitoring are required as a safeguard to ensure sustainability. *Ex situ* conservation sites may also be included under this category. Sites may be prioritised using relevant criteria, including their size, stability, species richness, tenure security, or synergies between conservation and local livelihood needs.
- Sufficient regeneration should be present as a sign of population viability
- Where relevant, the **management and monitoring plans should include specific actions to maintain genetic diversity and adaptive capacity** of the target tree species. These may include silvicultural techniques such as thinning, selective cutting that favours random mating, assisted natural regeneration and liberation of regeneration. Management and monitoring plans are maintained by or accessible to the stakeholder who nominates the site as a conservation unit or seed source.
- For *in situ* conservation sites, natural regeneration should be favoured and assisted where possible. If the site includes artificially regenerated trees of the target species, they should be established using **reproductive material of documented origin that is collected following good seed collection practices**. The reproductive material should be obtained either within the same region of provenance (under similar environmental conditions), or (partly) from a different region of provenance if this is justified to support the population's capacity to adapt to the changing environment.

Tier 4: Designated sites with confirmed and sustainably managed populations of conservation value

Protected area, community forest, seed stand or a forest area of otherwise secure tenure where the target species is confirmed to have at least 50 reproductive individuals, or 15 reproductive individuals if the species is rare or threatened; and where there is a management plan and monitoring in place to ensure the species persistence and adaptive capacity over long term. Area is officially designated as a genetic conservation unit, seed source or both, by national or sub-national authorities.

- As Tier 3 above, but with a **designated status** (either administrative or legal) as a genetic conservation unit or seed source for the target species.

Documentation

Database of the genetic conservation sites and seed sources will be maintained by APFORGEN and Bioversity International. National Coordinators of APFORGEN, forestry authorities, conservation practitioners and other relevant stakeholders who own or manage forest areas can nominate sites for inclusion in the database by submitting relevant documentation. Exact location of sites does not need to be made available for sensitive species. However, location and description of sites by ecogeographic zone must be available upon request to support range-wide conservation planning and related research of the target tree species.

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