GLOBAL TREES CAMPAIGN

BRIEF 9

How to plant and establish threatened trees in the wild

Credit: Hieu Nguyen/CPC

> “It’s the little things citizens do. That’s what will make the difference. My little thing is planting trees.” Wangari Maathai

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Introduction

Planting trees in the wild can directly contribute to the recovery of threatened species. However, establishing trees in their natural habitat requires careful planning in the short-term and a commitment to care for and monitor planted trees in the medium to long-term. The purpose of this brief is to provide guidance on the steps you should take before, during and after tree-planting in order to reinforce wild populations of threatened tree species.

Who is this guidance for?

This brief is for people tasked with the conservation and recovery of threatened tree species, but who have limited experience with tree planting. We assume you or your team already have some knowledge and experience with carrying out conservation projects but are looking for advice specifically related to planning, undertaking and monitoring tree species reinforcement projects.

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Before you start

For threatened tree species, planting can help to increase the size and viability of wild populations (a process known as species reinforcement).

However, before planting your first tree it is essential to evaluate whether reinforcement is appropriate. This involves researching your target species (see Step 1) and identifying appropriate planting sites within the species' natural range (Step 2). Finally, it is important to define clear objectives for your programme (Step 3).

Although guidance in this brief is tailored to the reinforcement of individual species, the methods described are also relevant to species reintroduction and can be integrated with approaches used for wider restoration projects (for guidance on these topics see references on Page 12).

STEP 1: Know your species in advance

For your target species, it is vital to have a basic understanding of its status in the wild as well as its biology and reproductive ecology. This will inform (a) whether or not you decide to reinforce trees in the wild and (b) where, how and when you should do it.

You might be able to obtain this information from published literature, national, regional or global Red Lists (see www.iucnredlist.org), field guides and survey reports, by visiting botanic gardens or herbaria (places where botanical specimens are stored) or by consulting botanists, foresters, local people and conservation groups who may know or use the target species. Try to use this information to answer the following questions:

What is the natural range of the species?

Reinforcement planting must occur within the natural range of your target species. Study known distribution and associated rainfall patterns, geology/soils, topography, elevation or fire regimes to identify appropriate planting sites (see Step 2). Other useful information includes: (a) the location of seed producing **'mother trees'**, (b) preferred **micro-habitats** and (c) **distinct populations** adapted to the environmental conditions of a particular location.

What is its conservation status in the wild?

It is essential to understand why the species became threatened in the first place and if these threats are ongoing. This will inform whether reinforcement should be preceded or accompanied by actions to mitigate threats. Useful information includes: (a) the **population size** of remaining trees, (b) the type and **severity of threat** faced, (c) whether the threat affects **mature trees, natural regeneration** or both, (d) possible **management actions** and (e) if/how local people **use and value** the species and its habitat.

How does the species reproduce and grow in the wild?

Understanding how your species lives and reproduces is crucial for seed collection (see GTC Brief 5) and can help you predict how seedlings will survive and grow in the wild. Useful information includes: (a) **phenology** (when the tree flowers, fruits and drops leaves), (b) **interdependent species** (including pollinators, seed dispersers and 'nurse' trees), (c) whether your tree is a **pioneer** species (i.e. seedlings are likely to require sunlight to survive and grow) or a **climax** species (i.e. seedlings are likely to require shade to survive and grow) and (d) if **seedling growth** is better in particular micro-habitats.

How is the species grown under nursery conditions?

Look for any advice on **propagation** or seedling care. Can you learn from other people's experiences and save time and money? Botanic gardens or nurseries may hold unpublished information and should be consulted on how to propagate or grow the species.

STEP 2: Select one or more appropriate planting sites

After researching your target species, identify potential planting sites based on; (a) ecological suitability, (b) support from and involvement of local stakeholders and (c) the feasibility of accessing the site and returning to it for longer-term care and monitoring.

(a) Ecological suitability:

All possible planting sites should occur within the natural range of your species. They should also be relatively secure from large-scale threats such as conversion to agriculture, fire or logging. Ideally, sites should be large enough to host viable populations for your species or, if not, they should be close enough to other forest patches to ensure that pollen and seed can be dispersed between different populations.

Inside potential sites, you should also assess the degree of habitat degradation. Sites with low levels of degradation (e.g. high forest cover, plentiful sources of regeneration and fertile soil) are often the most appropriate for species reinforcement. In these areas, planting can be carried out in combination with other actions (e.g. grazing or fire management) in order to boost natural regeneration of your target species.

In moderately degraded sites (dominated by herbaceous weeds but with some trees and soil remaining), planting a combination of appropriate species, alongside the target species, may increase success of the reinforcement programme. This process can be enhanced by planting **'framework species'**: fast-growing and fruit bearing species that help to achieve rapid canopy closure and encourage seed dispersers back into the site.

Highly degraded sites that have lost all their vegetation and soil (e.g. mining reclamation sites) are only suitable for planting highly threatened species if a larger restoration programme is also carried out.

At all sites, it is important to assess whether invasive species and/or grazing pressure may hinder recovery of your target species, and whether this was a causal factor of the initial decline. In such cases, removal of invasive species and/or improved habitat management may need to be carried out before and alongside planting.

(b) Local involvement

Ultimately, the long-term success of tree-planting will depend on the support and involvement of the people living closest to the site. Their participation is necessary to ensure that:

- Tree planting activities have no negative impacts on livelihoods (e.g. planted trees could negatively impact or shade out important medicinal herbs).
- Cultural values attached to the site or the tree species are understood and respected. This may inform when (in relation to significant cultural events) or where (in relation to areas of sacred forest) you plant seedlings. Understanding local values can also provide a basis for raising awareness of the target species.
- Local people have the opportunity to benefit economically from the reinforcement project. This may be by collecting seed, working at the project nursery or by contributing to site preparation and tree planting. You could also use your project nursery to grow other trees of direct economic importance if there is demand from local people to plant them on their land.

(c) Feasibility

Make sure that you have sufficient resources (staff, time and budget) to transport seedlings to your selected site(s) and to travel back to the site(s) for monitoring and after-care (see Pages 9-10). It will cost you more to plant trees in multiple sites and in sites far from your nursery – so you will need to compare costs and benefits of planting within each potential site. If you are planting a species for the first time, start by planting a low number of seedlings in a site that is accessible for monitoring. This will help you to avoid wasting valuable resources.

In summary: selecting sites

Remember, it is **essential** to choose planting sites that meet the following criteria:

- ✓ In an area within the natural range of the target species
- ✓ In an area secure from large scale threats
- ✓ In an area where planting has support and involvement from local stakeholders
- ✓ In an area where planting would have no negative impacts on livelihoods
- ✓ In an area where planting and monitoring would be within your available budget

Ideally, each planting site will also meet these criteria:

- ✓ In an area with low levels of existing degradation (if not, you may need to plant a number of other species to enhance restoration of the site)
- ✓ In an area large enough to host a viable population (if not, in a location close enough to other populations to enable gene flow in the future)
- ✓ In an area with ongoing habitat management to mitigate threats from fire, grazing or invasive species (if not, you may need to work with local stakeholders to develop and implement management plans)
- ✓ In an area that is easy to access for monitoring and after-care (if not, it will be especially important to identify and train local people, who can more easily access the site, to carry out monitoring in the future).

STEP 3: Define your objectives

Clarifying specific and measurable objectives at the start of the project is essential.

Because this brief relates to the reinforcement of threatened species, we assume that a suitable objective will relate to the survival of existing trees and establishment of seedlings in the wild for a particular threatened species, for example:

> “Within five years, all 50 mature trees of species X within the project site are protected and over 80% of 400 planted seedlings (using seed collected from at least 20 different mother trees) have established in the wild.”

Obtain or grow plant material

If you aim to reinforce wild populations it is essential to source plant material from:

- Known **local provenance** (e.g. using seed from mother trees found in the same area and/or habitat type as the planting site). This will increase the likelihood that planted seedlings will survive and adapt to local conditions.
- As many **different mother trees** as possible. This will help to maximize genetic diversity of your restored population

Seed banks or botanic gardens may be able to provide seed/seedlings of known origin. However, for threatened species you may need to **collect and grow your own material**. To do this you will need to carry out one or more of the following steps:

1) Survey an area for threatened trees to identify seed-producing ‘mother trees’ in different locations (see GTC Brief 1 for further guidance).
2) Establish a nursery with basic equipment and resources (see GTC Brief 4).

3) Collect seed from marked mother trees in a way that does not damage existing populations (see GTC Brief 5).

4) Germinate seeds and care for seedlings in your project nursery (see GTC Brief 7).

Before seedlings are ready for planting they need to be **hardened-off** in your nursery. This involves preparing them for the physiological stress involved with transport, planting and tougher field conditions. The process can last for several weeks and consists of a gradual decrease in irrigation and fertilization and – for species to be planted in open environments – increased exposure to sunlight. Seedlings will be ready for planting when they (i) become harder and woodier with a well-developed root system and (ii) reach heights above 30cm (for fast-growing species), between 40-60cm (for slower-growing species) or above 60cm (for species which are susceptible to browsing).

TOP TIP

If it's not possible to acquire seed from your target species you could consider two alternative methods for growing trees:

1) Collect wild seedlings (wildlings). Wildings found within 5m of the parent tree have low survival rates, so collecting a small proportion of these to grow in the project nursery should have minimal impact on natural regeneration. However, wildings often have highly sensitive roots and may suffer high mortality during transport to the nursery. Take great care when uprooting and handling wildlings and keep roots covered during transport to stop them drying out.

2) Vegetative propagation involves cloning individuals from a part of the living tree (e.g. from leaves, buds, stems or roots). This may be the only option for species with few remaining individuals that are failing to regenerate. However there are genetic issues related to planting cloned trees into a wild population and measures should be taken to maintain as much genetic diversity as possible (e.g. vegetative propagation from multiple mother trees). Take care not to cause lasting damage to the mother tree when using this method.

Track key milestones for your target species by making a nursery production calendar. This will help to ensure that seedlings will be the right size for planting by a set planting date (e.g. in the seasonal tropics, seedlings need to be planted at the start of the wet season). To perfect this production schedule you will need to keep records on the time of fruit production, time to seed germination and seedling growth rate.

Sample Production calendar

Species (include local name)	Approx. # of seedlings required in Year 1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov/Dec (planting season)	
Species A	150												
Species B	500												
Species C	200												

Key:

- Seed collection, viability testing and pre-treatments
- Time in storage
- Sowing date / germination time
- Seedling growth
- Harden off seedlings
- Planting

TOP TIP

Keep records on the mother trees and the seedlings grown from each tree within your project nursery. This will help to inform where you should plant seedlings (e.g. in the same population as the mother tree) and will help you to track different survival rates of planted seedlings back to individual mother trees.

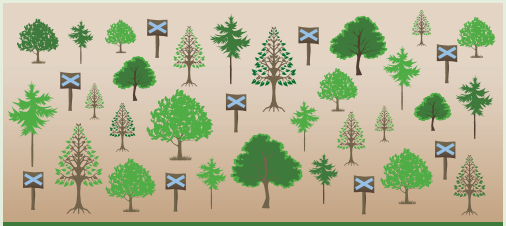
Preparing to plant

Planting must be carefully planned. Make sure your team is ready, you have necessary tools, the planting site is prepared and the nursery seedlings are ready for transport.

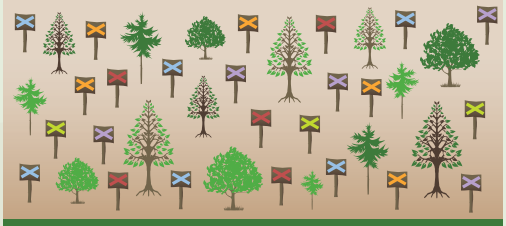
1 Develop a planting plan

Develop a planting plan to indicate where in your site you plan to plant individual trees. Refer back your research in Step 1 and select locations that suit your target species. For example, is the species found within particular microhabitats, at certain elevations or within open or closed canopy forest? If you're not sure which conditions will be optimal, you could plant seedlings in slightly different conditions, and monitor where rates of growth and survival are highest (see more on Pages 10-11).

For reinforcing threatened trees, avoid planting trees too close together or in single rows (like a plantation), but instead try as much as possible to mimic the species' natural distribution and density while spacing trees randomly throughout appropriate areas of the site (see Box A)



Box A: Example planting arrangement for reinforcement of one species into a forest with low levels of degradation.



Box B: Example planting arrangement for restoration of several species into a moderately degraded forest.

If you are planting a range of species (perhaps because you also aim to restore a degraded habitat) then you can plant individual seedlings as close together as 1.8m. Arrange seedlings from different species in a random fashion across the site (see Box B).

2 Form a planting team

Tree-planting can be an exhausting task – make sure your team is large enough to share the effort. Roughly, each team member is able to plant ten trees per hour. Therefore, if you aim to plant 500 seedlings, and have five hours available for planting, you would need ten people in your team (with each person planting around 50 trees during the five hours). For large groups appoint a few team leaders to help organize planting activities. Brief your team leaders in advance on planting methods. This is essential for threatened species as you don't want to lose any individuals as a result of bad planting.

Tree-planting provides an excellent opportunity for raising awareness of the importance of conserving your target species. If possible, encourage school children, students, volunteers or local media to join your team and learn about your work.

3 Acquire tools and materials for site preparation and tree planting

You will need to acquire, borrow or rent multiple copies of certain tools for your team.

- Access to a vehicle - to transport the project team and seedlings to planting sites
- Shade netting – to cover seedlings during transportation
- Baskets and/or wheelbarrows - to distribute seedlings across the project site
- Gloves, hats and boots - to protect workers
- Supplies of water, food and first aid kits to keep workers safe and happy
- Bamboo stakes - to mark the position of seedlings in the site
- Knives – if required to cut seedlings loose from plastic bags

- Spades, shovels or hoes - for digging holes and removing weeds
- Buckets, watering cans and access to a water supply – for watering seedlings before transportation and after they are planted
- Labels or tape to mark seedlings in the wild
- Mulch mats and organic fertiliser – if required to put around planted seedlings
- Notebooks, datasheets, pens and pencils – for record keeping

4 Prepare your planting site

To help planted trees survive and grow in the wild, you may need to carry out a series of actions to prepare the project site. Depending on the state of the site, preparation may need to be carried out over several days or weeks before planting takes place.

First and foremost, remember that it is **essential to involve local communities** and authorities (who may own, manage, live in or use the project site(s)) and gain their permission to carry out these tasks. For example, removal of an invasive species from the site may aid the survival of seedlings from the target species, but could negatively affect people if they harvest the invasive species to support their livelihoods.

- Begin preparing your site by **marking existing natural regeneration** (i.e. seedlings, saplings or sprouts) from any species that you want to preserve. This will help you to protect them from being trampled on during the planting day or being damaged during any weeding activities.
- If you are sure it won't negatively affect local people, **remove invasive species** from the site, especially if they are likely to compete directly with your planted seedlings for light, water and nutrients.
- Following the planting plan developed using guidance on Page 6, **place bamboo poles** into the ground to indicate where you plan to plant seedlings.
- **Remove any weedy, herbaceous vegetation** found by your bamboo poles (this might be less of an issue when reinforcing species into intact forest). Taking care not to damage the natural tree regeneration, cut or hoe the surrounding weeds. A hoe will enable you to remove weeds by the roots, making it easier for your planted seedlings to develop strong rooting systems.
- Finally, you might find it useful to **dig holes by each of your bamboo poles.** On the planting day, this will reduce time that seedlings' delicate root systems are exposed to sun and wind.

5 Selecting seedlings for planting

To maximise the genetic diversity of the planted populations, select seedlings from a range of mother trees. To help seedlings adapt to local conditions ensure that their associated mother tree originates from the same provenance as your planting site.

Plant only seedlings that are free of disease in order to reduce the risk of transmission to wild populations.

Prepare labels with a unique code and then attach to each seedling (or to a wooden stake if seedlings are small and could be damaged by the label). Note all codes down on a datasheet with any information you have on the provenance of each seedling. You can use the codes to track the survival and growth of individuals in the wild (see Page 10).

For threatened species, it is recommended to retain a small back-up collection in case the first seedlings planted in the wild do not survive.

Planting your seedlings

Before the big day double-check that:

- ✓ Your team are ready and has been briefed on your planting plan
- ✓ You have the necessary equipment and supplies
- ✓ The planting site is as prepared as possible
- ✓ Seedlings are labelled and ready to plant

If possible, avoid planting on days with extreme weather conditions. Remember that your seedlings will be sensitive to exposure to heat, sun and wind. It may be out of your control, but mild, damp and still days are generally best for tree-planting.

Water all seedlings before loading them (in an upright position) into your vehicle for transport to the project site. Seedlings will be vulnerable to stress so avoid packing them too close together or on top of each other. Finally, if you're using an open truck, place a layer of shade netting over the seedlings to reduce exposure to wind and sun.

Arriving at the site

After arriving at the planting site, gather your team and explain the plan for the day (including where and how to plant seedlings and any safety precautions). Make sure everybody is clear on their particular role. Different tasks include carrying seedlings into the site, transporting water from nearby streams and planting the trees themselves.

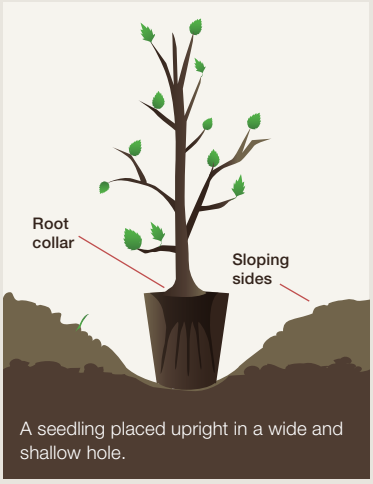
If you have prepared your site in advance, bamboo poles should already be in place, signaling to your team where planting should take place. Seedlings can be distributed from the truck to the position in the field by placing them inside baskets or wheel-barrows. Take care not to damage other planted seedlings or natural regeneration.

Monkey puzzle *(Araucaria araucana)* seedlings before being planted in Chile. Credit: Cristian Echeverria

Planting techniques

If not already prepared in advance, dig a hole for each seedling next to each bamboo pole.

The hole should be twice the volume of the seedling's container and deep enough so that the seedling's root collar (the swollen area that marks the transition between the roots and the stem) is level with the soil surface. The hole needs to be shallow and wide – with slanted sides – rather than deep and narrow. This will help the seedling's roots to grow outwards through the soil. Make a solid mound at the centre of the hole for the seedling's roots to rest upon. With your hoe, remove any weeds that have grown back since your last trip to the site. Remove each seedling from its container and place it upright in the prepared hole.



A seedling placed upright in a wide and shallow hole.

Next, fill the hole around the root-ball with loose soil. Use both hands to press down gently on the soil surface so that the stem stands firm.

After each seedling is safely in the ground consider applying organic fertilizer to the surrounding soil (e.g. in a circle around 20 cm from the seedling's stem). Most trees respond well to application of fertilizer, helping them to boost growth and better compete against herbaceous weeds. Organic fertilizers are generally cheaper than chemical fertilizers and can be produced locally from animal waste.

You might also want to apply mulch (organic material or pieces of cardboard) around each planted seedling. Mulch helps to retain moisture in the soil and reduces the rate that seedlings dry out. Dead weeds can be placed around the seedling or you can place down a cardboard mulch mat, pinning it to the ground with a bamboo stake.

With care, provide each seedling with 2-3 litres of water.

Fill out a datasheet (see an example on Page 11) recording the location and other key information about each seedling. This will be vital for future monitoring.

At the end of the day, carry out an inspection, making sure each seedling is placed upright, has been watered and has retained its label. Pick up any leftover plastic bags, poles or mulch mats.

Finally, make sure you reward and thank your planting team afterwards. As you will see below, you may need their help again in the near-future.

After planting your seedlings

Providing after-care

Species reinforcement is a significant task. By this point, you may have carried out a great deal of research, talked to many different people, managed a tree nursery and expended a lot of energy getting seedlings into the field.

However, your work here is not yet done. Planted seedlings are vulnerable to hot, dry or sunny conditions, frosts or flooding. They may also come up against grazing (from wild or domestic animals), fire or intense competition from herbaceous weeds. To increase the survival prospects of your seedlings, you may need to take a number of measures, collectively known as **after-care.**

Through careful site selection (see Pages 3-4), your chosen site should be relatively well protected from large-scale habitat loss or degradation. However, even within well managed sites, seedlings will require after-care to improve their survival prospects.

Removal of herbaceous weeds may be necessary for up to three years after planting. How often you weed will depend on how quickly weeds grow (weeds will grow more quickly in the tropics, in degraded sites with an open canopy or during the wet season) but expect to return to your planting site around every eight weeks. When weeding, take care not to damage your seedlings. Pulling weeds out by the roots – although often essential - can damage the seedling's own rooting structures.

Applying organic fertilizers helps to promote seedling growth (up to a height of 1.5m, when the effect tends to wear off). Fertilizers can be applied around the base of the tree (although not directly touching the stem) around every eight weeks after planting.

Protecting seedlings from grazing or trampling from livestock or wild animals may be necessary. Grazing management is too broad a topic to cover in detail within this brief, but some potential actions include: erecting small fences around key areas within the planting site or placing tree guards around individual seedlings.

Protecting seedlings from fire may be necessary for particular sites, especially during the dry season. Fire management is too broad a topic to cover in detail within this brief, but some potential actions to complete include: removing flammable material from the planting site during the dry season (e.g. dead branches and dead weeds), creating fire breaks or providing education for people on the dangers of accidentally starting fires.

Establishing a monitoring programme

Regular monitoring of your tree seedlings can allow you to: (a) demonstrate the success of your project to donors and stakeholders, (b) respond to new threats faced by the seedlings and (c) compare the effectiveness of different planting techniques.

In this brief we assume that monitoring is focused on measuring the growth and survival of **planted seedlings.** However, for threatened species, monitoring should also focus on the **mature trees** found in and around the project site. Monitoring their condition in the wild will help you to respond to new threats and track species phenology (when they flower and fruit) in order to guide future seed collection efforts. For more guidance on monitoring trees see GTC Brief 3.

What to measure

Try to keep monitoring as simple as possible. Unless you have a large research budget, complicated monitoring programmes are difficult to sustain in the long-term.

At its simplest, monitoring may involve recording which of your planted seedlings have **survived**. Survival rates are a good indicator of success for your project. Monitoring survival also allows you to replace dead seedlings with new recruits from the nursery.

Growth of seedlings can also be monitored by measuring the 'root collar diameter' (measured with calipers at the base of the tree), seedling height and 'crown diameter' (both measured using a tape measurer). Measuring the root collar enables you to track growth and recovery when the top of the seedling has been browsed by animals.

Seedling **health** is another indicator of success. Elliot, *et al.* (2013) provide a simple scale that you can use to rate the health of each seedling (0 = dead; 1= tree is in poor condition with discoloured leaves and insect damage; 2 = some signs of damage but healthy foliage; and 3 = near perfect or perfect health). To minimise subjective bias among observers, one person should carry out a demonstration to all staff involved before surveying commences.

Example datasheet

Date	22/11/2015	Location	Tree National Park	Observer	A. Alves

Seedling ID	Position ID	Species	Height (cm)	Crown Diameter (cm)	Root Collar Diameter (mm)	Health score (0-3)	Notes
0001	A1	Species A	55	30	26	3	–
0002	A2	Species B	62	54	31	3	–
0003 etc.	A3	Species A	20	5	23	1	Evidence of browsing

For more advanced experiments you could set up different plots to test whether certain factors have an effect on seedling survival or health. For example, you could test whether seedlings perform better in shady or open environments. This involves demarcating several small plots (e.g. 10 m x 10 m), with some plots allocated to one treatment (e.g. in shade) and other plots under a different treatment (e.g. in open environment). By replicating the plots several times (e.g. 4 plots for each treatment) you improve the overall reliability of your results.

TOP TIP

Taking photographs of the site is a great visual way of showing change over time and can be a useful resource for education and fundraising. Take photos from a particular point and then return later to exactly the same point to take new photos.

Monitoring can be done at the same time as other tasks (e.g. weeding). If people use or visit your site you might be able to train and employ them to collect data on your seedlings. Monitoring should take place regularly (up to every 3 months) throughout the first two years after planting when seedlings are vulnerable. Data collected during this time can inform any required changes in management. As the trees establish, frequency of monitoring can be reduced. At least, aim to monitor at the end of Year 1 and Year 2 after planting.

What Next?

Your measurements should be recorded on datasheets and uploaded to a database (e.g. MS Excel) to support ongoing analysis of your findings.

Results should be fed back and communicated to anyone who has been involved in the project. Don't be afraid to communicate failures as well as successes. By learning why tree planting was successful or not you can improve your project. If you make your data publically available you can also help others to learn from your results.

With your project team, take time to reflect on what you have achieved. How has the situation changed since you started to research your species in Step 1? Have the threats to the species changed, is tree-planting aiding the recovery of the species and what other actions should take place next? The recovery of threatened species will require a long-term commitment. Be prepared to adapt and adjust your plans over time.

Nature reserve staff monitor a Ziyuan fir *(Abies ziyuanensis)* seedling. Credit: Lin Wuying FFI

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For more information, or to download the other briefs in this series, visit **www.globaltrees.org/resources/practical-guidance**

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