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APPLICATION

A simple and effective method to collect leaves and seeds from tall trees

Kara N. Youngentob[1,2,3*†], Christina Zdenek[1,4†] and Eva van Gorsel[5]

[1]*School of Biological Sciences, University of Queensland, St Lucia, Qld 4702, Australia;* [2]*Research School of Biology, Australian National University, Canberra, ACT 0200, Australia;* [3]*Land and Water, Commonwealth Scientific and Industrial Research Organisation, Canberra, ACT 2601, Australia;* [4]*Fenner School of Environment and Society, Australian National University, Canberra, ACT 0200, Australia; and* [5]*Oceans and Atmosphere, Commonwealth Scientific and Industrial Research Organisation, Yarralumla, ACT 2601, Australia*

Summary

1. Collecting leaves or seeds from tall trees is a difficult task that many plant physiologists, ecologists, geneticists and forest managers encounter repeatedly. Tree branches are often much higher than a cutting pole or saw can reach. When this happens, the most common solutions involve the use of sharp-shooters, cherry pickers (a.k.a. bucket trucks) or tree climbers. All of these methods can be expense, logistically complicated, and often involve additional permits and licences.

2. We present a cost-effective and simple alternative for collecting leaves and seeds from tall trees using an arborist throw-line launcher. An arborist throw-line launcher is traditionally used to throw a rope over high branches for tree climbing. However, the same instrument can be used to collect leaves and seeds from trees without the need for climbing.

3. In the course of sampling over 4000 trees from a variety of species across multiple continents, we have developed several techniques to optimize leaf and seed sampling with a throw-line launcher at heights up to 40 m. We present these techniques along with several time-saving tips and tricks to increase sampling efficiency and reduce the occurrence of lost weight bags, broken ropes, and hung branches that will not fall.

4. These techniques remove many of the limitations commonly associated with sampling leaves and seeds from tall trees with more traditional methods. Without these limitations, the costs, risks and time associated with this type of data collection are reduced.

Key-words: arborist slingshot, collection, leaf, sample, seed, throw-line launcher, tree

Introduction

Leaf and seed samples are required for a wide range of research and management activities. However, obtaining these materials from the branches of tall trees can be extremely difficult (Barker & Pinard 2001; Lowman 2009). The amount of material collected and the number of trees sampled are often limited by the costs associated with hiring specialist sharp-shooters, tree climbers or expensive equipment such as hydraulic bucket trucks. Other commonly employed methods, such as pole pruners, hand-held saws and hand-catapults (a.k.a. shanghais), are restricted to relatively small trees and shrubs.

An arborist throw-line launcher (Fig 1) is a large but lightweight catapult system that is designed to assist with tree climbing by allowing the operator to hurl a weighted bag attached to a lightweight line over a high, strong branch. Once the initial line is established, sturdier rope can be pulled over the branch to hold the weight of the tree climber (Harris & Medina 2013; Anderson *et al.* 2015). Rather than target strong branches for climbing, the same equipment can be used to throw a lightweight but sturdy nylon line over smaller branches up to 40 m high. Using a series of manoeuvres that we developed to secure the line to the branch from the ground or use the line in conjunction with a flexible saw, force can then be applied to safely break and retrieve branches from a wide variety of tree species. In most situations, the use of a throw-line launcher for leaf and seed collection is faster and less expensive than traditional sampling methods for tall trees. In addition, throw-line launchers, unlike firearms, bow and arrows, tree climbers and hydraulic lifts, generally do not require extra licences or permits beyond the usual sampling and fieldwork permissions.

Our methodology is specific to retrieving branches and differs substantially from branch selection and line handling for tree climbing. We developed these unique techniques over the

*Correspondence author. E-mails: kara.youngentob@anu.edu.au and youngentob@yahoo.com

†Joint first co-authorship.

[Correction Note: The supporting information section of this manuscript was corrected on 17 May, 2016, after initial publication of the article. Changes were made as the links in the original version were incorrect]

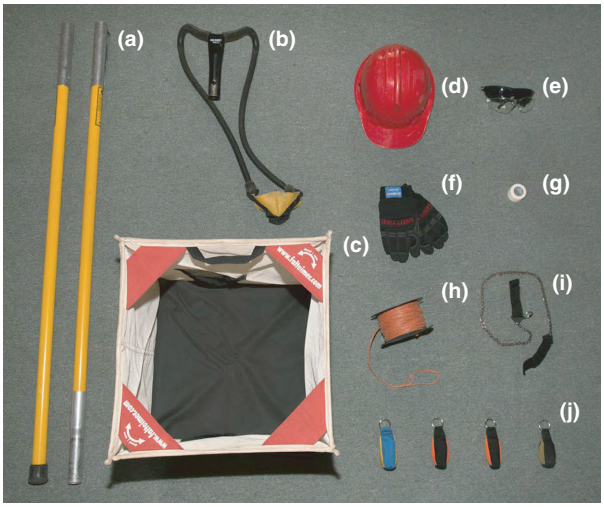

Fig. 1. Basic equipment: A Big Shot throw-line launcher (SherrillTree Inc.), which is comprised of two, four-foot connectable Jameson fibreglass poles (Jameson Inc., (a)) and a rubber head with pouch (b), line storage bag (c), hard hat (d), safety glasses (e), gloves (f), medical tape for wrapping fingers (g), lightweight but sturdy nylon line (h), flexible saw (i) and weighted bags between 8 and 16 ounces (j).

course of sampling thousands of trees for a number of research projects that required leaf and/or seed samples from a variety of tree species. When we started exploring this method, we were unable to find any information to guide our efforts, and learned through trial and error. Since then, we have discovered a few videos and technical papers that describe this or similar equipment being used to remove leaf or seed material directly from the tree (Frischkorn 2012; Coblentz & van Bael 2013). However, the described techniques generally focus on shaking the branches with the line or hitting the branch with a weight bag or rock to knock material free, which we found inadequate for collecting more than a few leaves or seeds. In other papers that mention the use of similar equipment, almost no explanation is provided on how it was used (e.g. Kusumoto, Enoki & Kubota 2013; Ushio *et al.* 2015). Given the large improvement that branch retrieval techniques have made in our ability to collect samples and the lack of information available to guide others, we felt that it was important share these methods with the wider research and management communities.

Description and implementation

The general concept of using a throw-line launcher is relatively simple; however, there are several techniques that will improve user accuracy and the success rate of capturing target branches while avoiding non-target branches and other obstacles. The most difficult aspects of using this equipment to retrieve branches are (i) branch selection and (ii) understanding how force should be applied to cause the target branch to break away from a larger supporting branch or trunk. In addition to reviewing this methodology below, a series of video tutorials on basic equipment set-up, operation, and additional techniques are provided in the Appendices S1–S3. Imperial units of measure are used to describe equipment in some instances to remain consistent with how it is sold.

MATERIALS

We use a Big Shot throw-line launcher (SherrillTree Inc., Greensboro, NC, USA) with lightweight but sturdy nylon line (e.g. 3 mm Slick Line with 118 kg (260 lb) tensile strength, Arbormaster Pty Ltd, Bayswater, VIC, Australia; Fig 1). Other necessary equipment includes a line storage bag, weighted bags (between 8 and 16 ounces), a flexible saw, safety glasses, gloves, medical tape for wrapping fingers for extra protection and a hard hat (Fig 1). The cost for a full set-up is approximately 400 USD.

BRANCH SELECTION

There are several important considerations when selecting a branch. An ideal branch is 3–5 cm in diameter and less than half the diameter of the main branch that supports it (Fig 2). The orientation of the target branch relative to the main branch is also important. The target branch should grow away from the main branch at a 45–90° angle (Fig 2). Selecting a target branch that is substantially smaller than the main branch, with an angle of at least 45°, will help isolate the force of the line on the smaller, target branch. Otherwise, when force is applied to the target branch, the main branch may bend and prevent the smaller branch from breaking by absorbing the force of the line, or the larger branch can break as well. This is undesirable since breaking larger branches could cause unnecessary damage to the tree and poses more risk as they fall to the ground.

The area under the target branch should be sufficiently clear to allow for movement in the opposite direction from which the main, supporting branch is growing. For example, if the main branch is growing towards the east, the line should be pulled towards the west (Fig 2). Therefore, movement in the westerly direction should be possible without getting tangled in undergrowth or otherwise obstructed (see 'Retrieving the branch', below for more details about the importance of directional force). An ideal branch also has sufficient space around it to enable the throw-line operator to manoeuvre the weight bag to isolate the line on the target branch without capturing neighbouring branches. Manoeuvres to facilitate this under suboptimal conditions (i.e. dense canopies) are reviewed in the additional techniques video (Appendices S1–S3). Branches that are growing sideways from the main branch and horizontal to the ground, rather than straight up from the top of the main branch or straight down from the bottom are preferable for line placement.

RETRIEVING THE BRANCH

Once the branch has been selected, the shooter should be as close to the branch as possible so that the weight bag and line will return in a narrow arc, and land nearby. This will minimize the amount of non-target branches and other vegetation

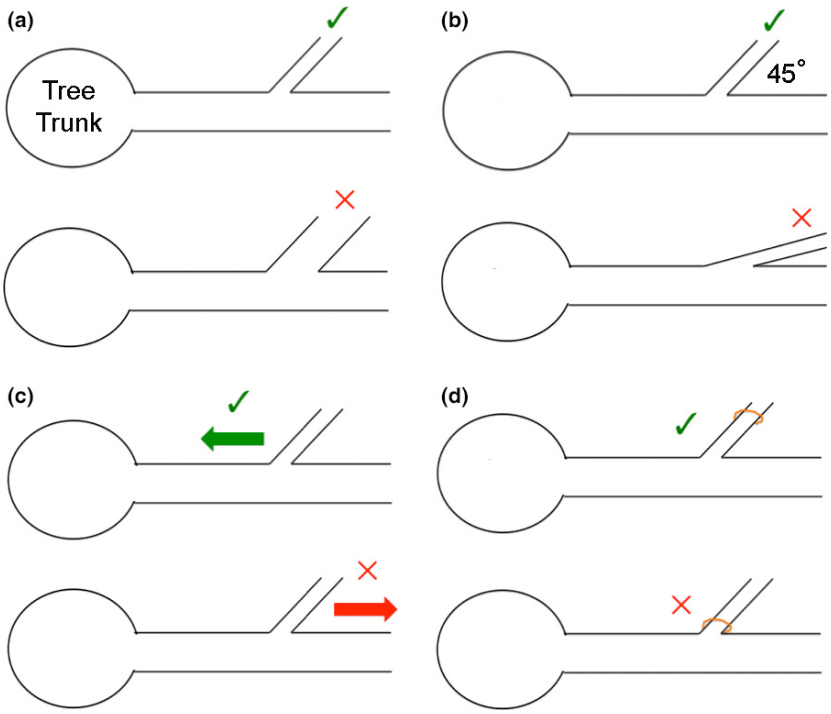

Fig. 2. Considerations for branch selection. Select branches that are half the size or less than the main branch from which they are growing (a). The target branch should grow at an angle of 45° or greater from the main branch (b). The target branch should be pulled against the direction that the main branch is growing (c). Position the throw-line away from the fork of the target branch and the main branch to improve leverage (d).

ensnared in the line. There are several different bag weights from which to choose. The 10-oz bag works best for branches between 10 and 25 m above the ground. Heavier weight bags, at least 12 oz, are needed for very high branches. Otherwise, the length of line required to reach the branch acts as a counterweight and prevents lightweight bags from returning to the ground with the end of the line.

Always wear appropriate safety equipment. Ensure the area is clear of other people or objects that could be hurt by falling branches or weight bags. The line storage bag should be placed in front of the shooter, and the line should be free from tangles and debris. Follow the instructions included with the throw-line launcher for aiming and shooting. While pulling on the throw-line rubber, hold your arm close to the centre of your body for added stability and strength. Aim slightly above the target. Practice is required to gauge the amount of pulling force needed for a specific distance. If the line goes over the wrong branch or too many branches, do not pull the line back through the branches with the bag attached, as both are likely to get stuck. Allow the weight bag and line to return to the ground, remove the weight bag, pull the line back over the branch(s), reattach the weight bag and shoot again. A manoeuvre to help guide the trajectory of the weight bag and the line after shooting to avoid capturing multiple branches is demonstrated in the additional techniques video (Appendices S1–S3).

Once the line is over the target branch, check to make sure that it is not too close to the junction (fork) between the target branch and the main branch (Fig 2). If it is, grab one end of the line in each hand and hold your arms as far apart as possible. Then, carefully walk backwards in the same direction that the branch is growing to apply a slow, even pulling force on the line. This should bend the branch downwards and allow you to pull the line away from the fork. It is very difficult to break a branch using force applied to the fork of the target branch and the main supporting branch. If it is not possible to move the line away from the fork, then reshoot.

A double-twist in the line or a slip knot should then be used to secure the line and keep it from slipping over the end of the branch during retrieval. A double-twist (Fig 3) is preferable to a slip knot because the latter cannot be removed until the branch is retrieved, whereas the twist can be undone anytime. However, if you are confident that the branch can be broken, then a slip knot can be useful. A slip knot involves tying the free end of the line to the other side of the line with a loose, sliding knot, and then pulling that knot up the line until it reaches the branch. A demonstration of the twist and the slip knot can be found in the basic and additional techniques video tutorials (Appendices S1–S3).

If a double-twist is used to secure the line to the branch, then the two ends of the line need to be kept apart while pulling force is applied. Otherwise, the twist will not stay tight against the branch and the line may slide off. A secure twist can be achieved by either tying one end of the line to a solid structure, like a tree trunk, or by using another person to anchor or pull the other end of the line so that the line forms an inverted 'V' shape from the branch to the ground (Fig 4). The position of the puller(s) and/or anchor should be such that the pulling force on the target branch is in the opposite direction from the way the main branch is growing (Figs 2 and 4). Otherwise, the target branch and main branch may bend but not break. If two people are pulling, it is important to apply force to both ends of the line evenly and simultaneously to avoid sawing the line across the branch, which may weaken and break the line. A stick or other long, solid object can be used to wrap the line

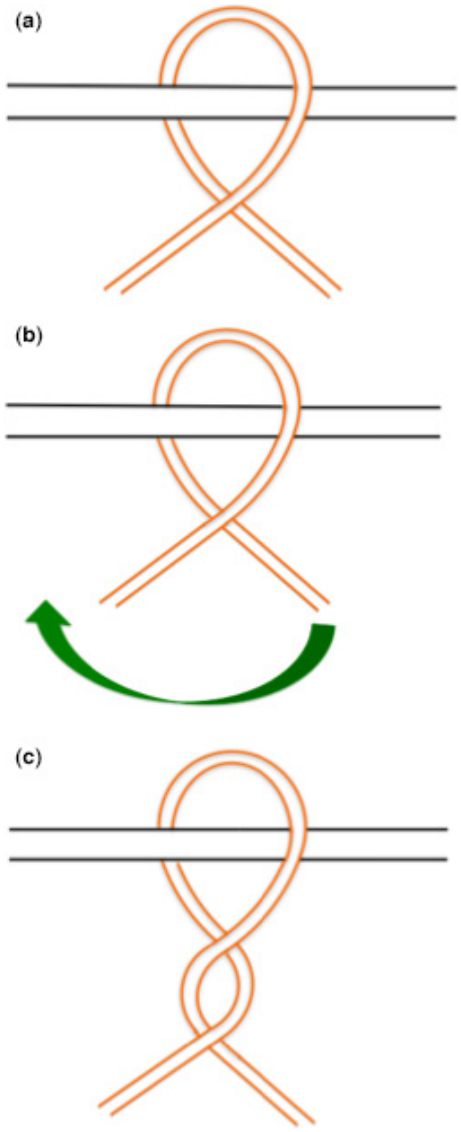

Fig. 3. Grip the target branch with the throw-line by crossing the two ends of the line once (a) and then a second time (b) so that a double-twist forms under the branch (c). This will keep the line from sliding off the end of the branch during retrieval.

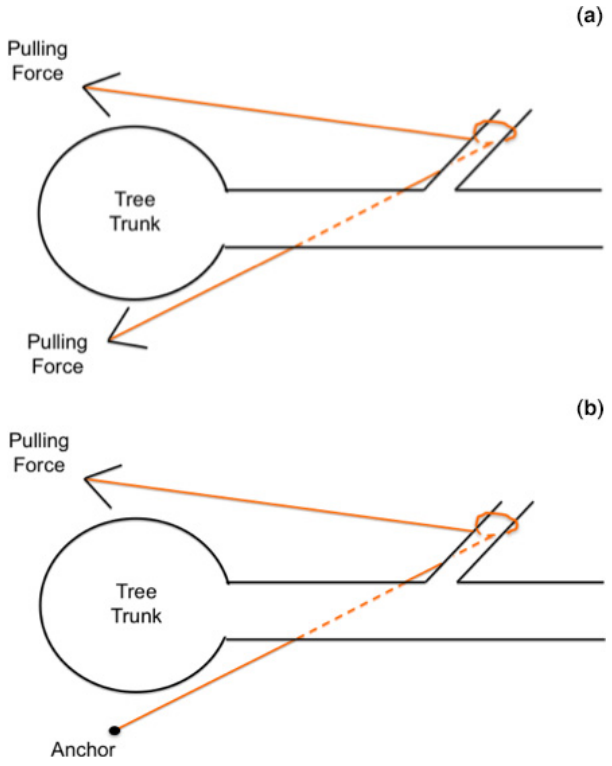

Fig. 4. Keep the twist tight against the target branch by maintaining a distance between the two ends of the line. This can be done with two people pulling the line in the appropriate direction relative to the main branch (a) or with one person pulling and one person standing as an anchor (b). If there is only one person, a tree trunk or other stationary object can be used as an anchor.

around several times. This creates a handle that will help grip and control the line while pulling.

As the target branch bends downward in response to the pulling force, keep the two ends of the line taut and in the inverted 'V' position. To remove any slack in the line, move further away from the branch and/or wrap more of the line around the stick/handle. When two people are pulling, good communication is critical to maintain equal tension and force. Once sufficient force is applied, the branch should break free of its main supporting branch. If the falling branch becomes caught on other foliage, maintain tension on the line in the inverted 'V' formation to continue to grip the branch (via the twist). Manipulate the branch until it is clear from obstacles and falls to the ground.

Some tree types, such as conifers, have branches that evolved to bend and not break under pressure (e.g. the weight of snow). These branches are nearly impossible to break in the manner described above. Instead, we recommend using the throw-line launcher in combination with a flexible saw to cut the branch down (Fig 1i). To do this, select a main branch that is growing off the trunk, rather than a side shoot that is growing off a main branch. You will need a sturdier branch to provide resistance against the saw. Aim your shot so that the line lands a few centimetres from the fork of the main branch and the trunk. Unlike the technique for breaking the branch, the line should be closer to the fork where the branch is strong enough to provide some resistance against the sawing action. However, avoid placing the line directly on the fork because the saw can get stuck more easily at that exact junction.

After the line is over the target branch, remove the weight bag from the line. Secure that end of the line to one end of a flexible saw, and secure another line onto the other end of the saw. Pull the saw up and over the branch. Have one person hold each free end of the line and stand on opposite sides of the branch. We recommend wrapping the line ends around a sturdy stick several times to create a handle to grip the line while pulling. Stand far apart so that the flexible saw is held over the branch in a position nearly horizontal to the ground, rather than hung over the branch in an upside-down U shape. This will help keep the saw from getting stuck as it cuts through the branch. Each person should take turns pulling on the line to create a sawing motion. The sawing motion between

partners will eventually cut the branch from the tree. Be careful to stay clear of the falling branch and saw. We found that flexible saws with teeth, such as small chainsaws, work better than wire saws because the latter get stuck more easily in the branch and often break under the force required to free them.

Conclusion

The described methodology to obtain leaf and seed samples from tall trees is efficient, safe and generally does not require extra licences or permits beyond the usual sampling and fieldwork permissions. By applying some of the techniques that we have developed through sampling thousands of trees from a variety of species, researchers can obtain plant materials in a relatively quick and cost-effective manner.

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Data accessibility

No data were used in this article.

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Supporting Information

Additional Supporting Information may be found in the online version of this article.

Appendix S1. Basic Techniques. https://www.youtube.com/watch?v=hOKcQ87-do8

Appendix S2. Equipment Set-up and Storage. https://www.youtube.com/watch?v=GK8_Jnwf40o

Appendix S3. Additional Techniques. https://www.youtube.com/watch?v=oNf9X-vjrLo