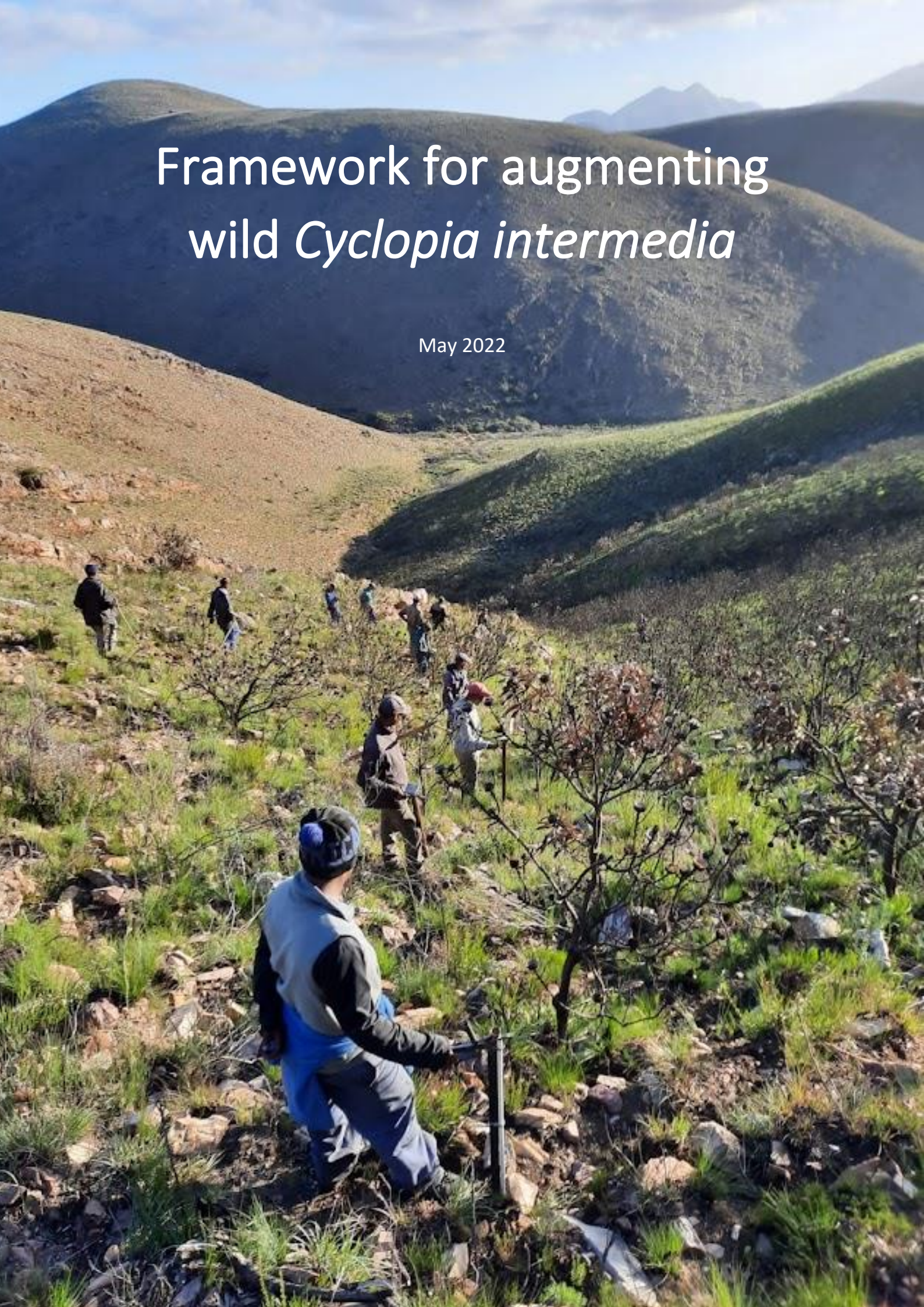
Framework for augmenting wild *Cyclopia intermedia*

May 2022



Contents

Contributors

Matthew Sephton, Roderick Juba and Thelani Grant (Living Lands)

Gillian McGregor and Paul-Luc Michau (Rhodes University). Dr AnneLise Schutte-Vlok (CapeNature)

We would like to thank Quinton and Eunice Nortje of Melmont for sharing so much of their knowledge and for (literally and metaphorically) 'planting the seed' related to wild honeybush augmentation.

Introduction

Production from wild honeybush resources remains the foundation of the industry and an important livelihood for farmers, harvesters and processors of honeybush. Recognizing the importance of keeping ecosystems and livelihoods intact, Living Lands in collaboration with interested landowners and harvesters has developed an approach to bolstering wild honeybush populations by planting seed and seedlings in the veld. This document describes recommended 'Best Practice' with regard to augmenting stands of *Cyclopia intermedia* in a way that is considerate of ecological concerns but will ultimately contribute to improved yields.

We use the term 'augmentation,' to refer to the process of bolstering an existing population of plants, in this case *Cyclopia intermedia*, using genetic material (seeds or seedlings) collected from the same population. Augmentation of natural veld areas is seen as contentious due to the risk of reducing local biodiversity to benefit one single species. However, this is more related to the method of augmentation. As reported for the wildflower industry – commercially important sites may be subjected to low-intensity augmentation methods without compromising overall biodiversity This framework seeks to provide an ecologically-sound methodology towards wild honeybush augmentation in the Langkloof.

The framework is based on on-going augmentation trials conducted by Living Lands with support from landowners, harvesters and Rhodes University researchers at a number of sites, both within and on the edge of existing stands of *C. intermedia*. Seeds collected from these sites were planted back into the veld (either as scarified seed or seedlings) in order to better understand the process of augmentation and asses its viability. This document aims to provide practical information on best practice for augmentation to landowners and land users, detailing the various steps of i) seed collection; ii) seed processing and storage; iii) seed preparation for planting; iv) site selection; v) planting of seed and vi) ongoing management.

We use the term "best practice" in this framework because it describes a method that may be used as a standard recommended for use to produce the desired results. The term is useful because it encompasses scientific evidence, in-field observations and anecdotal evidence from landowners, harvesters and researchers.

Augmentation Framework

1. Best practice for seed collection

Collection of sufficient seed from local populations of *C. intermedia* is one of the most important aspects of successful augmentation, and may be a limiting factor for augmentation. Ensuring that only local seed is used to augment is essential to minimize the risk of genetic contamination that occurs from moving seed across geographic boundaries. Accurate record keeping of the source of collected seed is essential, especially when using larger harvest teams to collect seed. Seed collection methods should aim to collect from a wide sample of plants and should discourage harvesters from picking many seeds from as few plants as possible.

1.1 Timing of seed collection

C. intermedia generally develops buds in autumn months and flowers in spring (September to November) with seed pods developing in November/December. Seed is usually ready to be harvested from late December into January. Ripening of seed is delayed by a few weeks in the eastern parts of *its* range and at higher altitudes. This variation in phenology may also occur within a single stand of *C. intermedia* in which case – more than one seed collection event is recommended to ensure genetic diversity in the collection. Only mature, swollen, dark seedpods should be harvested.

Figure 1 Mature seed pod just prior to having popped

As a resprouter, *C. intermedia*, normally produces significantly less seed than reseeding *Cyclopia* species and in drought years even less seed is produced. The best seed set usually occurs 2-4 years after a fire or harvest with seed production declining thereafter. For the sake of efficiency – it is recommended that emphasis be placed on seed collection in year 2 and 3 after a fire or harvest.

It is best practice to apply a precautionary principle of augmenting with seed collected in a specific area (management block) back to the same block to maintain the genetic make-up of the block. Record keeping of seed collection is therefore essential to maintain ecologically-sound augmentation practices.

1.2 Method of collection

In order to identify the most effective, least detrimental method of seed collection various elements of seed collection were investigated. Use of nets for seed capture, harvesting of pods by hand, harvest team choice, and different payment methods for harvest were tested in order to better understand their limitations and advantages.

Due to the nature of a re-sprouting bush, it is difficult to place a net over the whole bush without losing the seeds between the stems. Individual branches may be covered in netting however it has been found time consuming and results in relatively low seed numbers.

The most efficient seed collection strategy is to employ a team of experienced harvesters with knowledge of the site – to harvest seedpods by hand. The harvesters spend an entire day collecting closed seed pods by hand about a week prior to seed pods opening. This method allows for a coverage of a wide area resulting in a diverse collection of seed from many different plants. This method of seed collecting requires careful attention to be paid to the maturity of seed pods at each site as the optimum collection time varies according to slope aspect, location, prevailing climatic conditions.

Paying harvesters per kilogram for seed collected is not recommended. It yields the highest volumes of seed, but limits the number of plants targeted – with a focus on plants with abundant pods, which are over-harvested (more than 50% of pods removed). This method limits the genetic sample of harvested seed and may affect the maintenance of genetic diversity in the parent population.

Trials have indicated that approximately 50g of cleaned seed (ie: ¼ of a cup) per person per day is a realistic expectation for seed harvesting. In terms of costing for seed collection – this would amount to circa R3000/kg for cleaned seed.

Figure 2 Harvesting seed pods by hand

1.3 Maintenance of genetic diversity

To ensure maintenance of genetic diversity it is recommended that a minimum of 500 plants are sampled. However, where stands consist of less than 500 plants the principle of collecting seed from as many plants as possible should be followed. This is to ensure sampling of the diversity of an entire population which reduces the likelihood of artificially skewing genetic material towards individuals that produce more seedpods.

Best practice for seed collection

Use an experienced harvest team to harvest seedpods by hand and pay a competitive daily rate. A precautionary principle should be applied of harvesting between 30% and 50% of the seedpods from any one plant and seedpod harvest should be from as many plants as possible in a stand.

2. Best practice for seed processing and storage

Post-collection seed processing and storage are essential aspects of successful augmentation. Seed processing and cleaning should be done as soon as possible after collection to give the best results. Improper storage and insufficient cleaning result in wastage of valuable seed mostly through pest damage. Properly stored seed remains viable for years and can be brought out at a later stage for use when conditions for augmentation are right.

2.1 Processing seedpods

First seed pods are popped; this can be done by hand or heat. Popping seeds by hand results in almost no lost seeds however it is extremely time consuming. Alternatively, it is possible to place the seed pods in the sun or with some kind of artificial heating to force the pods to pop. It is essential that all the pods are covered as seeds can fall far from the popped pod. Seed pods and seeds will still need to be sorted by hand after the pods pop as many pods will retain some seed inside even after popping. A sieve or colander with holes big enough (3-5mm) for the seed to fall though greatly assists in this process. Seed size does however vary within stands as well as between areas and as such two or more size classes may be required when sieving seed. Pouring seeds from one container to another in a light breeze will allow the remaining fine material to blow out, resulting in clean seed ready for the second phase.

2.2 Seed cleaning

Once seeds have been separated from pods, the second phase of cleaning can commence. Poorly cleaned and stored seed is vulnerable to seed boring beetles and weevils. These pests and can cause drastically reduced germination levels. The use of chemicals to fumigate seeds is not recommended for wild augmentation.

To clean, seeds are placed in a bucket of cold water for 10 min and mixed thoroughly. Viable seeds will sink to the bottom while damaged or unviable seeds will float. Floating seeds are removed and discarded while the remaining seeds should be drained and dried in a cool, shaded area until they are completely dry.

Figure 3 Clean Cyclopia intermedia seed

Figure 4 "dirty" seed with seedpod chaff

2.3 Seed Storage

Cleaned seeds should be dried in a cool, shaded area with a low relative humidity. Storage of damp seeds should be avoided due to the likelihood of them molding and going bad. Seeds can be dried for up to a week before being placed in a brown paper packet or envelope and stored in a fridge. Sealed air tight containers such as Tupperware should be avoided for long term storage. Once the seeds have been adequately cleaned, they have a relatively long shelf life. For instance, *Virgilia* seeds can be kept for 70 years and still germinate. We have recorded over 80% viability in cleaned *C. intermedia* seed collected in 2015 and planted in 2021.

Best practice for seed processing and storage

Thorough cleaning and sorting of seeds will ensure that only good, viable seeds are kept. Storage of cleaned seed in a cool, dry environment will ensure a long shelf life, limit seed destruction by pests and improve the chances of successful germination.

3. Best practice for seed preparation for planting

Preparing seed for planting is an essential aspect of successful augmentation. It must be undertaken carefully to avoid wastage and improve the chances of successful germination.

3.1 Seed scarification

Scarification is an essential factor in successful augmentation. While there are a number of different methods of scarification, the hot water method is effective and simple. The basic principle is that very hot water will help damage the hard outer coating of the seed allowing water through the membrane to swell and ready the seed for germination.

Water just under boiling point is poured over the seeds and they are left for anything from 20 seconds up to a minute depending on the number of seeds and temp of the water. Once successful scarification has occurred seeds will visibly swell. When half of the seeds show swelling the seeds should be removed from the water and dried sufficiently to allow for easy planting by hand or with a planter. It is good practice to leave a small percentage of seeds unswollen minimizing the threat of all seeds germinating at the exact same time providing some resilience to the augmentation site by allowing the possibility of seeds germinating at a later date.

Figure 5 Scarified C. intermedia seed

Figure 6 Well inoculated C. intermedia seedling with nodules on roots

3.2 Inoculation

Being a leguminous fynbos species, scarification and rhizobium inoculation are needed for successful germination. Due to the nature of wild augmentation, inoculating the seeds with rhizobium and mycorrhizae is unnecessary because seeds are planted out into the veld where there naturally will be sufficient quantities of both in the soil. Where seedlings are being planted out it is important not to contaminate the soil with introduced inoculants – Instead we suggest using small amounts of soil from under the plants at the site where seed was collected, mixed in with nursery soil to inoculate the soil used to grow the seedlings in.

3.3 Seeds vs Seedlings

Initial results show (unsurprisingly), improved survival rates for the seedlings rather than seeds. Despite this, augmentation with seedlings has not been recommended in the Augmentation Framework as a result of:

1) Fear of contamination: we consider it a large risk to the natural veld if incorrect growing medium is used to propagate seedlings. Ideally, soil from the planting site would be used but this is impractical, and therefore it is likely that incorrect growing medium will be used. Given the symbiosis of *Cyclopia* with specific soil microbes, it is important not to introduce contaminated material into natural areas.
2) Practicalities: transportation of seedlings from the site of propagation to field sites is impractical.
3) Cost: it is very expensive to grow seedlings. Given the low survival rates there is no cost benefit to growing and transplanting seedlings compared with planting seeds.

Best practice preparation of seed for planting

Prior to planting – scarification of seed through soaking in hot water is required to break the hard outer seed casing and ready the seed for germination. Where seedlings are used, naturally occurring soil microbes collected in soil samples from the seed collection site should be mixed with the nursery growth medium. Because seedling production is costly – we recommend augmentation though planting of seeds.

4. Best practice for site selection

Selecting a site for augmentation should not be overly complicated but it is critical for good results. The site should be within 500m of where the seed was collected and within the same management unit or block. Two different site selection options are recommended for choosing where to augment.

1) Augmenting an existing *C. intermedia* population. This requires seed collected from a population be planted within and around the edge of the same population bolstering the size of it and adding to the multiple ages already present. This approach poses the lowest threat of genetic contamination as it merely enlarges an existing stand of *C. intermedia*. This is the recommended method of selecting where to augment.

2) Augmenting into an area without any *C. intermedia* within the recommended 500m radius of the seed collection site to limit genetic contamination. Consideration of the physical characteristics of where *C. intermedia* naturally grows when choosing a site will give the best chance of germination and survival. Choose sites carefully, they should be relatively free of large shrubs (*Protea, Leucadendron* etc.) to reduce competition in the short and long term. Stands overgrown with taller shrubs result in tall, leggy *C. intermedia* with lower sprouting stems than adjacent harvested populations in more open veld.

Figure 6 Distribution map of C. intermedia

4.1 Physical site characteristics

To increase the chances of germination and survival, sites should be selected where honeybush would naturally occur and should include consideration of:

- Fire history: ideally plant within 6 months of a fire.

- Elevation: between 300m and 1800m.
- Rainfall: from 250mm-1500mm/year.
- Aspect: South and south-west facing (but not exclusively).
- Cooler, wetter slopes: this includes areas where mist often occurs even if it does not fit the exact recommended aspect.

Best practice for site selection

For successful augmentation, whether planting in an existing population or at a nearby site – choose areas which closely resemble the physical characteristics of existing *C. intermedia* sites.

5. Best practice for seed planting

Much of the information about where to place the seed within the site is based on anecdotal evidence developed from walking hundreds of kilometers of transects, observing where *C. intermedia* grows. *C. intermedia* populations can generally be grouped into similar ages across the stand or the block. Seedlings are scarce – but where seedlings are found, they are numerous and all of approximately the same age. It seems that in years where the conditions are favorable, good germination will occur but survival of the seedlings into maturity requires favorable factors well after germination has taken place.

Augmentation can take one of two paths: a) a small amount of seed is planted every year in the hopes of high survival rates in one good year or: b) seed is stored and only planted in a year where the conditions are favorable in the hopes of a mass germination with a significant portion surviving to maturity. While the first suggestion spreads the risk it is by far the most time consuming and least cost effective. For this reason, we recommend the second suggestion of collecting and storing seed until the optimum time for augmentation.

Anecdotal evidence from harvesters suggests that *C. intermedia* populations occur where the mist sits on saddles and in mist belts on the mountains (sites which may not fit the typical physical characteristic preferences for *C. intermedia*). There is much better seedling survival in these areas – a clear indication that a key contributor to seedling germination and survival is moisture availability.

Planting in cooler autumn months, within 6 months of a fire, ahead of a cold front or a few days of rain gives the seeds the very best chance of germination and survival. In addition to this seed placement within the site plays a role in successful germination but perhaps more importantly – its survival to maturity (a site in Misgund has shown survival rates of up to 50% in an area that catches the mist while an area without mist, but with the same aspect, soil and plant communities has a survival rate of only 6%).

Soil microbial communities must be taken into account with regard to germination and survival rates at augmented sites. It is assumed that plantings in close proximity to existing *C. intermedia* populations will benefit from the concentration microbes (like rhizobium), essential for the survival of seedlings.
Naturally occurring *C. intermedia* seedlings tend to grow on the sheltered (leeward) side of a rock or a plant, in a shady spot, with accumulated soil that holds moisture but is not waterlogged. In this 'nursery' environment – the seedlings seem to have the best chance of survival. We recommend that

care be taken when planting to locate the seed in this kind of setting in order to improve the success of augmentation.

Figure 7 Wild C. intermedia established plant and seedling in "nurse" environment

Observation of teams carrying out augmentation has shown that there is a tendency to place the seed in an open patch of ground, where the soil surface is capped and hard away from other plants. This practice should be discouraged: selecting a site with the correct nursery conditions may be the biggest factor in successful augmentation practices.

The most suitable nursery conditions include (but are not limited to):

- The downhill or southern side of a rock, shrub or grass tuft.
- The shaded and or leeward side of a rock, shrub or grass tuft.
- A loamy area that retains moisture longer than its surroundings.

5.1 Planting the seed

Once a general area has been selected for planting, each individual seed placement needs to be considered carefully.

- Seeds should be planted in the cooler autumn months, preferably before some rain.
- Plant the seeds using a planter or by hand.
- Seeds should be planted approximately 4-8mm deep.
- Seeds may be planted in sandy loamy soil as well as rocky soil with pockets of loam.
- Plant seeds at a density of 5000 to 10 000 seeds per hectare = 1 or 2 seeds every 2m x 1m.

Considering that the natural *C. intermedia* densities across the Langkloof range between 100 and 3000 plants per hectare and assuming a realistic survival rate of 10% of the seeds planted, augmentation that results in an increase of 500-1000 plants per hectare may be considered successful. While

landowners may push for a larger increase than this, we believe this rate of increase to be both economically viable while ecologically sound.

Figure 8 Planter dropping seed in optimal site

Figure 9 Note selection of area below "protective" rocks acting as a nursery for the seedling

To give an indication of costs and time, in up-scaled trials, approximately 10 people planted 60 000 seeds over 6 hectares in 1 day, resulting in a cost per hectare of circa R1900.

Best practice for seed planting

When placing seed in the ground – aim to find 'nursery' conditions where the seed will have the best chance of surviving and growing to maturity. A slightly protected site with soft soil and some moisture holding capacity is best. Avoid hard exposed ground. Plant seeds at a density of 5000 to 10 000 seeds per hectare.

6. Ongoing management

Augmentation sites must be monitored for a number of years after planting to truly quantify the increase in *C. intermedia* populations. A transect such as the one laid out in the Wild Honeybush Harvesting Field Guide must be walked before planting, 1 year after planting and then again over the next two harvest cycles in order to understand the long-term efficacy of augmentation. Records of densities and yields will be needed to assess the economic viability of wild *C. intermedia* augmentation.

It should be noted that augmentation of populations is a long-term approach to bolstering wild honeybush resources. Plants may not be harvestable for a further 6-12 years depending on climatic conditions and fire. To ensure the best conditions for the plants to establish, the area should not burn in first 4 years after planting.

Conclusion

Due to the economic value of honeybush and the positive effects for local, rural economies, it is understandable that landowners would want to boost wild honeybush populations and rehabilitate areas where honeybush has been lost or declined. It is hoped that this Augmentation Framework will provide landowners and other interested parties with enough information to implement best practice augmentation of *C. intermedia* in an ecologically-sound manner.

Bibliography

The various documents and experts consulted in drawing up this document are listed below.

Galuszynski, G. (2020) Applied phylogeography: mapping the genetic resource of Honeybush across the Cape Floristic Region. PhD.

Joubert, E., Gelderblom, W.C., De Beer, D. (2009) Phenolic contribution of South African herbal teas to a healthy diet. Nat Prod Commun. 4(5):701-18. PMID: 19445319.

McGregor, G.K. (2017a). Guidelines for the sustainable harvesting of wild honeybush. Department of Environmental Affairs and Development Planning, Western Cape Government, Cape Town.

McGregor, G.K. (2017b). Ecological Review: Fynbos ecology and its implications for Cyclopia species. Department of Environmental Affairs and Development Planning, Western Cape Government, Cape Town.

McGregor, G.K. (2018). The Wild Honeybush Harvesting Field Guide. Department of Environmental Affairs and Development Planning, Western Cape Government, Cape Town.