Evaluating direct seeding as a cost-effective revegetation technique

Healthy Waterways Strategy 2018-2028
Port Phillip & Westernport, Victoria

Melbourne Water

Strategic alignment

Regional Performance Objectives (RPOs):

- RPO 45: Research partnerships with universities and other research institutions are in place to address the key research areas and build our knowledge and capacity to efficiency and effectively achieve the HWS performance objectives and targets.

Key Research Areas:

- Streamside vegetation and instream habitat: Identifying critical constraints to revegetation success and opportunities to improve vegetation outcomes.

Summary

Direct seeding is the process whereby seed is sown, by hand or by machine, onto a prepared seed bed. As a means of revegetating riparian areas, direct seeding has been used less frequently than planting nursery grown stock in the past. This is despite it being a highly effective and widely used revegetation technique in non-riparian areas.

The lower cost of seeds and sowing in comparison with planting nursery-raised stock makes direct seeding an attractive option, particularly for revegetating large areas. However, a number of factors can limit the effectiveness of direct seeding programs, including weed competition. To better understand the factors which influence the outcomes of direct seeding operations and to develop more effective revegetation programs in the future, this project conduct a series of field trials to test operational activities in research context.

Direct seeding has an important value for Melbourne Water, with large Healthy Waterways Strategy targets centred around revegetation. If applied appropriately at suitable sites, this approach can save substantial money over the life of the strategy.

The outcomes of several surveys have been variable. At sites where high levels of soil moisture were maintained through summer and spring, and weed loads and herbivory were managed, plant establishment and growth were excellent.

At other sites where soil moisture was limiting and/or weed control or herbivore control was ineffective, plant establishment and growth rates were lower. These results high the need for good weed control, herbivore control and the provision of adequate soil moisture to ensure successful outcomes from direct seeding.

Recommendations

- Direct seeding should be used when the site is large, relatively flat and accessible
- Direct seeding should be used when the primary objective is to establish overstory
- Direct seeding should be used when Melbourne Water condition scores are 1-3
- This method is successful when there is an effective weed control post-sowing
- When full EVC restoration is desired, this is an effective method
- MW should consider establishing seed raising nursery, which will supplement seed supply for demand, which is currently being considered as part of WTP Future Land Use Plant Phase II

What did we do?

A number of trials were conducted at different sites and in different years, comparing the potential impacts such as: the timing of sowing, weed management techniques and the influence of pest animals.

Bass River trial

This trial was about 5km from Grantville in 2014/2015. It was designed to test for the following: i) spring vs autumn sowing; ii) the effect of mycorrhizae in direct sowing success; and ii) the impact of different weeding control techniques (hand weeding monthly vs spraying (monthly and quarterly). Each treatment combination resulted in 9 replicates. Nine tree and shrub species were sown in the trial. Trial included calculation of appropriate amount of seed, the need for any seed pre-treatment and post-sowing treatment (weed control).

Emu Creek & Cardinia Creek Retarding Basin Revegetation trials

These trials tested the impact of site preparation and revegetation technique by applying the following treatments and were conducted in 2016/2017. Trial was re-established in 2019 with 21 species tested over the whole period. These trials include direct seeding, planting tubestick with different weed control prior to sowing/planting.

What did we find?

Hand casting seeds during the establsihment of trial plots at the Bass River site.

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Quick guide to direct seeding riparian areas

A synopsis of the Best Practice Guidelines: Direct Seeding of Riparian Areas

Choosing to direct seed

Consider: the desired diversity of species; the suitability of the land; the abiotic conditions of the site; your capacity to control weeds (before and after seeding); and community expectations.

- Direct seeding typically results in lower species diversity; is not recommended for reestablishing rare species and is most likely to improve condition in sites scoring 1-3 on Melbourne Water's condition scale.
- Effectiveness of direct seeding can be reduced by compacted or higher fertility soils and elevated phosphorous.
- Successful direct seeding is more likely when the riparian area is still connected to the waterway.
- If adequate weed control is unlikely, then direct seeding is unlikely to be effective.
- Direct seeding is well suited to large, relatively flat sites where a mechanical seeder can sow several hectares in a few hours.
- Sites in full public view and those with an engaged local community may be better suited to planting, where results are instantly visible.
- When full EVC restoration is desirable, a combination of planting and direct seeding might be best.

Site preparation

Consider: potential weed competition (at the time of sowing and as plants establish); animal pest control; soil cultivation; and the timing of your sowing.

- Weed competition is the biggest single limiting factor to successful direct seeding. Woody weeds should be removed 1 - 2 years prior to sowing and other weeds some months before sowing.
- Generally, weed control in spring and in autumn prior to sowing, and then approximately 2 weeks before sowing should be sufficient.
- Time sowing to avoid: temperatures extremes; very low soil moisture levels; and waterlogging and floods (until plants are established).
- For wetter sites (east, north-east of MW's region): sow in spring.
- For drier sites (west, north-west of MW's region): sow in autumn – winter, after the autumn break.
- Consider the need for and options to control invertebrate and vertebrate pets.
- Intensive cultivation of riparian soils prior to direct seeding is NOT recommended, although some small scale cultivation may help.

Sowing seed

Consider: the timeline for ordering seed; seed storage and preparation; how much seed you will need; and the most appropriate sowing methods.

- Order seed at least 12 months prior to sowing, storing in cool, dry conditions.
- Some species are more likely to germinate if pre-treated (such as abraded or smoke water).
- In general, 250 – 500 g/km of seed will be required per kilometer (which equates to about 750-1500g/ha).
- Sowing seed can be done either by machinery (allows large areas to be sown in a relatively short time) or hand (when the topography and landscape features prevent vehicle access to the site).
- Collect seed from a range of individuals to ensure genetic diversity.

Maintenance

Consider: the need to monitor the growth of seedlings and the re-emergence of weeds; plan for on-ongoing maintenance.

- The first inspection should be within 4-6 weeks of sowing; to check for emergence of seedlings & weeds and browsing pressure
- Ideally, maintain a weed-free radius of 1m around the seedlings for the first year.
- Field trials indicate that hand weeding within sown areas is the most effective post-sowing weed control technique.
- Usually herbicide application is not possible during seedling establishment if the direct seeding is on a broad scale and not in niches, due to the risk of damaging seedlings. Hand weeding is likely to be the most effective weed control during seedling establishment, with herbicide applications possible once there is a low risk of off-target damage."
- If soil moisture is limited during early growth, additional watering will be required.

Figure 1: *Quick Guide for direct seeding of riparian areas*

managed, plant establishment and growth were excellent. At other sites where soil moisture was limiting and/or weed control or herbivore control was ineffective, plant establishment and growth rates were lower. These results high the need for good weed control, herbivore control and the provision of adequate soil moisture to ensure successful outcomes from direct seeding.

Bass River Trial

- Direct seeding at this site has resulted in the successful establishment of several tree and shrub species.
- Applying mycorrhizae to plots did not have any effect on total plant numbers or plant numbers on a species basis in either of the seasons.
- Total number of plants were unaffected by season of sowing, with different species responding differently to sowing seasons.
- There as an effect of post-sowing weeding treatment, with more plants in hand weeded sub-plots than in sprayed sub-plots in both seasons.
- More plants emerged in hand weeded plots than in sprayed plots, but there was no effect of weeding treatment on rates of plant survival.
- Plant growth of all species except *G. ovata* was been restricted by sustained browsing by vertebrate herbivores, including wallabies and deer. Browsing pressure appeared to be higher in spring sown plots with many plants repeatedly browsed, often resulting in plant deaths. Wombat activities such as digging and dung deposition in plots have also resulted in some plant deaths.
- Overall, only 5% or less of the viable seed sown resulted in an established plant that was still present at either 12 months after sowing (spring sown plots) or 6 months after sowing (autumn sown plots).
- A range of physical factors have also affected plant establishment and survival, with low winter temperatures limiting growth of autumn sown plants, and frost damage observed on some plants.

Emu Creek trials

- Fencing with cattle, rabbit and macropod proof fencing at the outset is likely to improve plant survival and growth;
- Mallee guards at sites with macropods are not highly effective, but their effectiveness could be improved by using much stronger wire;
- One year of pre-sowing weed control is generally required at a site, but 2 years of weed control may be required to control dense *Phalaris aquatica* infestations;
- Weed control prior to sowing/planting must be followed up with effective post-establishment weed control to optimise plant establishment, survival and growth.
- In addition to effective weed and herbivore control, adequate watering during dry periods is required to optimise plant establishment and growth;
- More species established in planted areas than sown areas, despite more species being sown than planted; 2
- More than 90% of planted species were still present at 2 and 3 years after planting;
- Tube-stock plants were taller than their direct sown counterparts in both Phases 1 and 2;
- At this site, both direct seeded and tube-stock plants were vulnerable to herbivory, adverse environment conditions and weed competition;
- However, tube-stock plants were better able to withstand these stressors than direct seeded plants;
- Species which can be reliably used on direct seeding in similar sites, provided adequate weed management, herbivore management and watering are all carried out, include *Acacia spp*., *Allocasuarina verticillata*, *Dodonaea viscosa* and *Eucalyptus spp*.;
- Other shrub species, including *Banksia marginata*, *Bursaria spinosa*, *Callistemon sieberi*, *Cassinia arcuata*, *Melicytus dentatus*, *Muehlenbeckia florenta* and *Myrsine howittiana* should be planted rather than sown, in order ensure their establishment.

Cardinia Creek trial

- Benefits of the initial hand weeding persisted and increased over time, due to on-going weed suppression by sown species;
- Weeded lines contained 3.8x more plants than unweeded lines at 3 years after sowing, with fenced, weeded lines containing 8.6x more plants than unfenced, unweeded lines;
- These results shows that competition between sown species was less injurious than competition between sown species and unsown (weedy exotic) species;
- At this site, 3 months of hand weeding was sufficient to provide a competitive advantage to the sown species to ensure their successful establishment;
- At other sites, less weeding may be required to achieve similar outcomes;
- Hand weeding direct seeded lines was cheaper than not weeding, on a per plant basis; Fencing costs were 2–3x greater than hand weeding costs, on a per plant basis;
- For tube-stock plants at this site, it was more cost-effective to guard plants than to fence them;
- At this site, direct seeding has resulted in more plants than tube-stock planting for most species, with higher growth rates;
- The success of direct seeding means that under the conditions of the trial, direct seeding has been much more cost-effective than planting in establishing a native shrub community.
- The findings of these trials have been consolidated into a Quick Guide (Figure 1), that offers recommendations and considerations for adopting direct seeding in Melbourne Water.

How are we sharing findings?

Technical reports

- 18.5 Direct Seeding Research Project: Progress Report, 2018.
- 17.4 Direct Seeding Research Project: Progress Report,

2017.

- 16.2 Direct Seeding Research Project: Progress Report, September 2016.
- 15.8 Direct seeding research trials: progress report October 2015.
- 14.2 Direct seeding as a revegetation technique in riparian areas: A review.
- 14.4 Yarra River direct seeding trial: Final report.

For more details on the research outcomes of this project, or other projects of the MWRPP, please contact:

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