TRANSLOCATION AND RESEARCH PROPOSAL
Whorled Eremophila
Eremophila verticillata R.J. Chinnock (Myoporaceae)

1. SUMMARY

Eremophila verticillata was first discovered in 1968. It is a low shrub to 0.8 m in height and spreading to 1 m in width. The leaves are 2.5 – 6 mm in length by 1 mm in width, sessile and occur in whorls (rings) of three. Flowers are sessile, occur singularly in the axil between October and January and violet in colour. Seed germination varies between 44 and 73% (A. Cochrane pers. comm.). Response to fire and soil disturbance is unclear.

E. verticillata is endemic to the Newdegate area, where it grows in soils of powdery brown loam. These soils are associated with layers or nodules of calcrete, adjacent to playa lakes (Thom *et al*. 1984). Associated vegetation is open low *Eucalyptus* woodland of *E. longicornis*, *E. annulata* and *E. flocktoniae* and in association with *Maireana erioclada* and *Threlkeldia diffusa* (Chinnock 1986).

The species is currently known from just two live populations with a total of around 567 individuals. Three other populations have become extinct. Due to the extraction of dolomite close to the extant populations, poor regeneration, vehicle damage, weed invasion, salinity, road maintenance activities and inappropriate fire regimes *E. verticillata* was declared as Rare Flora in September 1987 and ranked as Critically Endangered in September 1998 (Phillimore *et al*., 2002).

An Interim Recovery Plan has been writen for this species and under this plan translocation is a recommended recovery action (Phillimore *et al*., 2002). Due to the small number of individuals of this species and the presence of numerous threatening processes the need for translocation is considered to be high.

The aim of this translocation and research proposal is to conserve the wild genetic stock of the species over a 4 year period. This will be achieved investigating three objectives:

- To identify the most effective technique to promote *in-situ* regeneration of *E. verticillata*,
- To identify the most effective translocation techniques to establish new populations of *E. verticillata*, and
- To increase the population size of two populations of *E. verticillata.*

This proposal outlines the need for translocation of the critically endangered *E. verticillata* and the need for research into techniques to promote natural recruitment. In addition it outlines the site selection process, the design of the translocation and research sites, the provisions for monitoring and the criteria for success or failure of this proposed translocation and research.

2. PROPONENTS

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3. BACKGROUND

3.1 History, Taxonomy and Status

Eremophila verticillata was first discovered in 1968. However, it wasn't until 1986 that it was formerly named verticillata, in reference to the whorled leaves (referring to the leaves forming a ring around the stem). *E. verticillata* is a low shrub to 0.8 m in height and spreading to 1 m in width. The leaves are 2.5 – 6mm in length by 1 mm in width, sessile and occur in whorls (rings) of three. Flowers are sessile,occur singularly in the axil between October and January. The corolla is 5-11 mm in length and violet in colour. Seed germination varies between 44 and 73% (A. Cochrane pers. comm.).

Response to fire is unclear. Richmond and Coates (1995) speculated that it may be a resprouting species. A research burn undertaken by Richmond and Coates (1995), although resulting in some seedling regeneration, was ultimately inconclusive (Graham 1998). Response to soil disturbance is also unclear. Anecdotal evidence suggests that some soil disturbance may result in seedling germination, although the frequency and severity of the disturbance varies considerably between examples as does the results. Population 4 was reported to have had some regeneration after the area was cleared for cropping (Graham 1998). However, no plants have been sighted after the area was cleared a second time and the population is now presumed extinct. Approximately 70 plants were cleared from population 2 in 1992 and no regeneration has been reported from this area (Graham 1998).

The species is currently known from just two live populations. Three other populations are presumed extinct. Due to the extraction of dolomite close to the extant populations, poor regeneration, vehicle damage, weed invasion, salinity, road maintenance activities and inappropriate fire regimes *E. verticillata* was declared as Rare Flora in September 1987 and ranked as Critically Endangered in September 1998 (Phillimore *et al*., 2002).

3.2 Distribution and Habitat

E. verticillata is endemic to the Newdegate area where it is currently known from just two live populations of approximately 567 individuals.

E. verticillata grows in soils of powdery brown loam. These soils are associated with layers or nodules of calcrete, adjacent to playa lakes (Thom *et al*. 1984). Associated vegetation is open low *Eucalyptus* woodland of *E. longicornis* (Morrell), *E. annulata* and *E. flocktoniae* (Merrit) and in association with *Maireana erioclada* and *Threlkeldia diffusa* (Chinnock 1986).

4. THE TRANSLOCATION AND RESEARCH PROPOSAL

4.1 The Need to Translocate and Undertake Research

E. verticillata is known only from two live populations. Only approximately 567 individuals are known and the species appears to be in decline (Table 1). The Interim Recovery Plan for this species recommends translocation as a recovery action (Phillimore *et al*. 2002)

The two live populations are currently exposed to threats such as problems associated with small population size (such as inbreeding depression), weed invasion, the potential for accidental destruction from the adjacent mining activities and rising salinity. Rising salinity has the potential to become a serious threat to the survival of *E. verticillata*. The species is restricted to areas adjacent to playa lakes, which are flat, shallow lakes. These low lying areas are highly likely to be affected by increasing salinity (Malcolm 1983). The information obtained from this study is vital to enable to successful translocation of this species to new sites should the natural site become uninhabitable due to increased salinity. There is, therefore, an urgent need to increase the number of individuals of this species as well as stimulate the regeneration of another population, to reduce the risk of extinction and to refine translocation techniques.

Table 1. Number of plants of *Eremophila verticillata* in each population at each monitoring period.

Date	Population 1	Population 2	Population 3	Population 4	Population 5
??				3*	
1968					Some (exact no. not known)*
1980	60*		3*	Some (exact no. not known)	0
1986	36		0		
1987	29			0 (presumed extinct)	
1988		~2135*			0 (presumed extinct)
1991	18	~2000			
1992	12	1600			
1993	10	1050	0 (presumed extinct)		
1994	13	1004			
2000	7	~560			

* - denotes when population first discovered.

4.2 Translocation and Research Site Selection

The area where the extant population 2 occurs was chosen as a suitable site for the translocation. This site was chosen because *E. verticillata* already occurs there and therefore the edaphic and hydrological conditions and associated vegetation community is clearly suitable for this species. This can therefore be considered a restocking or augmentation under the definitions provided by Policy Statement 29 and the Guidelines for Translocation of Threatened Plants in Australia.

Experimental regeneration work is proposed for population 3, where no live plants have been seen since 1980. Many Eremophila species are known to have soil stored seed banks (Richmond and Ghisalberti 1996), however, it is not known how long this seed remains viable. Assessments will be made of whether a viable soil stored seed bank is present and then regeneration techniques will be tested in an attempt elicit germination. This work simply aims to see whether it is possible to regenerate the population.

A map of the proposed translocation and experimental regeneration sites are shown in Appendix one. Endorsement for the proposed translocation and experimental work and for the use of these sites was received from the Wheatbelt Region (Appendix two).

4.3 Translocation and Research Design

It is proposed to establish experimental plots at population 2 and 3. No work is proposed for population 1, 4 and 5 due to a combination of site unsuitability (unsuitable land tenure or lack of space around the population to implement treatments) and a need to focus limited resources.

At the area of population 3 (Site A) the presence or absence of a soil stored seed bank will be assessed by the collection of soil in the area where plants were previously known to occur. The soil will then be sieved and visually inspected to locate any *E. verticillata* fruits. Any fruits that are located will be carefully cut open to determine whether there are seed inside. Any seed that appears “good” (ie that is plump and white) will be placed on agar plates at a constant 15^{o}C to assess germinability. If fruit are found where the population 3 occurred then six plots of three metres by three metres will be measured. Three of these plots will be burnt and then fenced, and three plots will just be fenced as control plots. No other regeneration techniques are proposed for site A, as it was decided to focus on population 2 when investigating regeneration techniques. Burning was chosen as the “best bet” method to use at site 3 as previous research (Richmond and Coates 1995) has shown this species responds to fire. Table 2 describes the treatments that are proposed. Appendix 3 shows the proposed site layout and experimental design. As each seed germinates it will be permanently tagged so that each individual will always be identifiable.

Table 2. Description of experimental treatments.

Treatment	Description of Treatment
No treatment applied at site of population 3.	No treatments will be applied to areas where the population 3 occurred.
Burning to stimulate any natural seed bank at site of population 3	Litter on the soil surface will be burnt in areas where population 3 occurred.

Population 2 contains the largest extant population of this species. It is proposed to implement some treatments where there is a soil stored seed bank of *E. verticillata* (Site B) and some treatments in a gravel pit adjacent to the population where no plants have previously been recorded and there is no soil stored seed bank (Site C). This work firstly aims to investigate which regeneration techinque is most effective in promoting seedling recruitment, and secondly to investigate whether these techniques are more effective on the current season seedbank or the previous seasons seedbank.

Presence and absence of a soil stored seed bank will be assessed via the collection of soil samples as per the same method described above for population 3 (Site A). This sampling will then be used as an indicator to locate plots in Site B and C. A total of 24 plots of 5 m by 2 m will be measured, 12 in Site B (located where a natural seedbank is present) and 12 in Site C (located where no natural seedbank occurs). Prior to the treatments being implemented at Site C, fresh seed will be buried in a grid pattern. The depth that this fresh seed needs to be buried will assessed before planting via glasshouse experiments (where fresh seed will be buried in trays of soil at various depths, from the surface down to 60mm, then a light layer of leaf litter burnt over the soil surface and any resulting germination scored). Four treatments will be applied to the two sites; burning, application of smoke water, soil disturbance and control (no treatment) (see Table 3). Proposed site layout is shown in Appendix three. After treatments have been applied each plot will be fenced with rabbit proof netting to prevent herbivory. As each seed germinates it will be permanently tagged so that each individual will always be identifiable.

Native vegetation will not be cleared at population 2 or 3 and care will be taken to avoid damage to any plants of *E. verticillata.* In this way there will be minimal disturbance to the natural vegetation. All equipment used during this project will be maintained under strict disease hygiene. There appears to be no reason that there would be adverse effects on the conservation values of this area from this translocation.

Table 3. Description of experimental treatments.

Treatment	Description of Treatment
Natural seed bank with no other treatment	No treatments will be applied to areas where there is known to be a natural soil stored seed bank
Natural seed bank stimulation using burning	In areas where there is known to be a natural soil stored seed bank litter on the soil surface will be burnt.
Natural seed bank stimulation using smoke water application	In areas where there is known to be a natural soil stored seed bank smoke water will applied
Natural seed bank stimulation using soil disturbance	Soil above areas where there is know to be a soil stored seed bank will be disturbed by vigourous raking using a hand held rake
Direct seeding with no other treatment	Seed will be buried in the soil.
Direct seeding with burning	Seed will be buried in the soil and then litter on the soil surface above the seeds burnt.
Direct seeding with smoke water application	Seed will be buried in the soil and then the area where watered with smoke water
Direct seeding with soil disturbance	Seed will be buried in the soil and then the soil surface above the seeds disturbed using rakes.

Monitoring of the effectiveness of the regeneration work will be undertaken at approximately three monthly intervals for a one year period and then annually thereafter. Monitoring will include counting the number of germinants and thereafter the number of germinants surviving, height of the surviving plants, width of the crown of the surviving plants in two, reproductive state, number of flowers and fruit, whether second generation plants are present and general health of the plants.

Monitoring of the original extant populations will also occur every third month in conjunction with monitoring of the translocated populations. This will provide essential baseline data for assessing the performance of the translocated population. Plots set up as controls in Site A, B and C will be monitored in the same way as experimental plots. In addition monitoring plots will be set up in population 1 in a similar manner to those plots used at Site A, B and C. Any live plants in plots at population 1 will be tagged with an individual number. Monitoring at population 1 will include counting the number of individuals (including any germinants), height and crown width of the individuals, reproductive state, number of flowers and fruit and general health of the plants.

4.4 Source of Plants

Seeds were collected from a bulk of 50 plants in population 2 on 28th of February 2001 and from a bulk of 25 plants in population 2 in April and May 2002.

4.5 Criteria for Success or Failure

Each criteria listed has a general statement followed by a quantifiable specific statement, which is derived from very limited ecological data. Therefore these specific statements may need to be modified as ecological data is collected as part of the research component of this project. Therefore the project will also be considered successful if information derived from the experiments can be utilised for further management of the species.

Criteria for Success

1. germination of translocated seed
   ⇒ based on the observation that 12% of fruit have seed and germination under laboratory conditions is 44% we can expect up to a maximum of 5% of fruit will germinate
2. establishment of seedlings grown from translocated seed
3. survival of seedlings to reproduction
   ⇒ based on the observation that 24% of seedlings survive to reproductive age (Richmond and Coates 1995) we can expect a maximum survival to reproduction of 24% of seedlings
4. production of flowers and seed
5. a soil stored seed bank has been established, with levels of seed viability similar to the natural population (see sub point under Criteria for Success no. 1).

Criteria for Failure

1. failure of translocated seed to germinate
2. failure of seedlings grown from translocated seed to establish
3. failure of seedlings to survive to reproductive age
4. failure of plants to produce flowers and seed
5. a soil stored seed bank fails to establish

5. TIMETABLE

Time	Action
February 2001	Translocation and research site selected.
January 2002	Translocation and research proposal submitted for review.
May 2002	Translocation of seed into Population 2 and implementation of experimental regeneration techniques.
May 2002 – April 2003	Three monthly monitoring of translocation and research plants.
May - June 2003	Further translocation and regeneration work if deemed necessary.
June 2003 – April 2006	Once or twice yearly monitoring of plants resulting from translocation or experimental regeneration work and maintenance of translocation sites.
August 2006	Final Report

6. FUNDING

This project is funded under the Salinity Action Plan Translocation project. Newdegate Land Care District members have also obtained funding from the World Wide Fund for Nature, Threatened Species Network to assist in setting up and monitoring the sites.

7. ACKNOWLEDGMENTS

Mal Graham and Robyn Phillimore are thanked for their input in selecting suitable translocation sites. The members of the Newdegate Land Care District, in particular Anne Rick, Rochelle Straun and Sam Walsh have also provided enthusiastic support for the project.

8. REFERENCES

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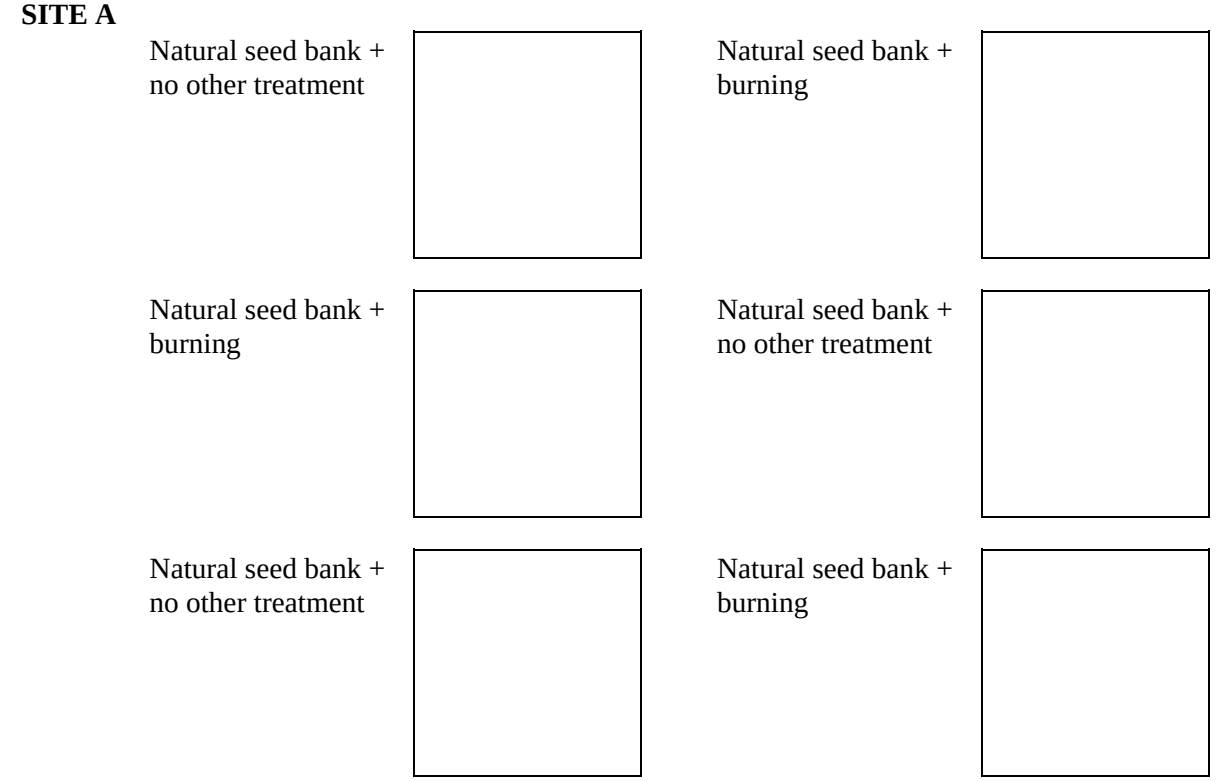
Appendices One and Two may be available on contacting the authors.

Appendix Three.
Diagram of the proposed layout of the treatments and plots.

Scale: 1m

* Denotes planted seed
Denotes fence around plot

SITE A

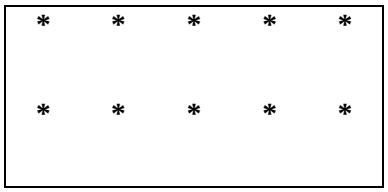


SITE B

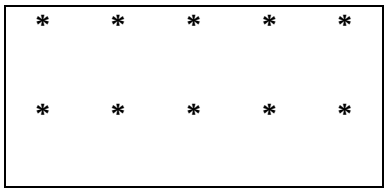
Natural seed bank + no other treatment		Natural seed bank + burning	
Natural seed bank + no other treatment		Natural seed bank + smoke water	
Natural seed bank + soil disturbance		Natural seed bank + burning	
Natural seed bank + smoke water		Natural seed bank + soil disturbance	
Natural seed bank + no other treatment		Natural seed bank + soil disturbance	
Natural seed bank + smoke water		Natural seed bank + burning	

SITE C

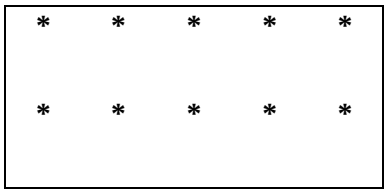
Direct seeding + no other treatment



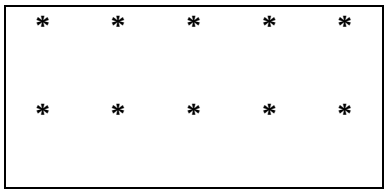
Direct seeding + burning



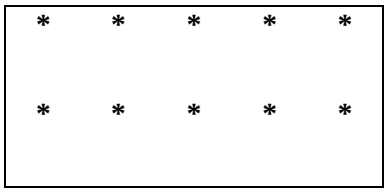
Direct seeding + no other treatment



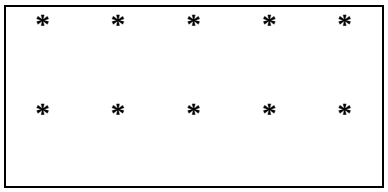
Direct seeding + smoke water



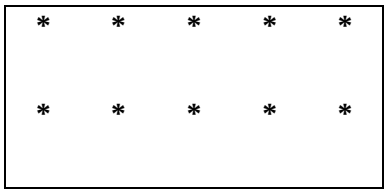
Direct seeding + soil disturbance



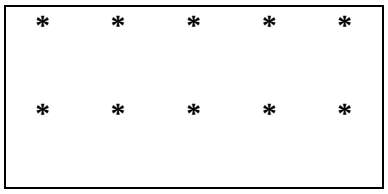
Direct seeding + burning



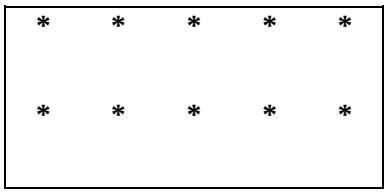
Direct seeding + smoke water



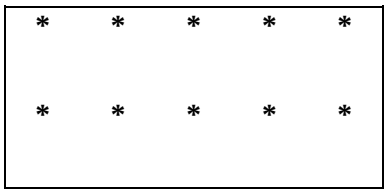
Direct seeding + soil disturbance



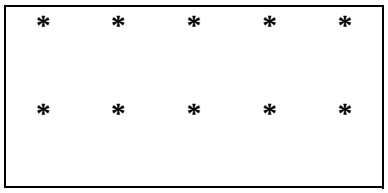
Direct seeding + no other treatment



Direct seeding + soil disturbance



Direct seeding + smoke water



Direct seeding + burning