6 Biology and ecology

6.1 Reproductive Biology

6.1.1 Vegetative reproduction

Grevillea obtusiflora* subsp. *obtusiflora

Personal observations indicate that *G. obtusiflora* subsp. *obtusiflora* is likely to be a clonally reproducing taxon with each plant capable of spreading over a wide area. Makinson (1997) noted that suckering stems may arise at more than approximately 1.5m from a parent ramet. *G. obtusiflora* subsp. *obtusiflora* is apparently wholly dependent on root suckering for reproduction (Makinson 1997). The term 'root suckering' is here used to indicate the initiation of daughter ramets at some distance from the parent plant. It is likely, but not yet confirmed, that the tough wandering "roots" that form inter-ramet connections are in fact rhizomes (modified subterranean stems) rather than true roots. The suckers become effectively independent of the parent plant once established. The rate of recruitment is unknown.

The clonal root system was found to be much more substantial in *G. obtusiflora* subsp. *obtusiflora* than *G. obtusiflora* subsp. *fecunda*, with roots extending for many metres (pers. obs.).

Root suckering species respond favourably to mechanical soil disturbance and often quickly recolonise roadside scrapes. Several Grevilleas have developed vegetative reproduction by root suckers to the complete exclusion of sexual reproduction (Olde & Marriott 1994).

Makinson (1997) has suggested that the Clandulla sub-population of *G. obtusiflora* subsp. *obtusiflora* comprises a very few clonal lines.

Grevillea obtusiflora* subsp. *fecunda

Makinson (1997) found that *G. obtusiflora* subsp. *fecunda* also reproduces through root-suckering. The roots of one plant are capable of spreading over a wide area with numerous genets above ground (pers. obs.). The extent of clonality in this taxon is not known.

6.1.2 Breeding system

Grevillea obtusiflora* subsp. *obtusiflora

G. obtusiflora subsp. *obtusiflora* flowers sparsely in winter and spring with flowering peaking in September (Figure 7). *G. obtusiflora* subsp. *obtusiflora*'s floral morphology indicates it is predominantly pollinated by birds, with bees being potential secondary pollinators (Makinson pers. comm.). The potential reduction or elimination of a specific pollinator may be another cause in failure to set fruit in this taxon. Plant patch structure and interpatch distances may affect pollination within and among patches and therefore affect fruit set (Eriksson and Bremer 1993). *G. obtusiflora* subsp. *obtusiflora* is thought to not produce seed and to only reproduce vegetatively.

Figure 7

It is not known whether the failure to produce seed is the result of inbreeding depression or self-incompatibility (Makinson 1997).

G. obtusiflora subsp. *obtusiflora* flowers and styles on some plants have been noted to wither, and in some cases detach from the plant. Ants were also recorded in some flowers. Flower dissection has not revealed physical factors that may detrimentally affect the ability of *G. obtusiflora* subsp. *obtusiflora* to produce seedpods and seed, additionally, swelling of the ovary was not detected in any *G. obtusiflora* subsp. *obtusiflora* flower (pers. obs.).

Makinson (1997) stated that in most cases, when a Grevillea species exhibited a partial or total 'abandonment' of sexual reproduction, correlated with minor morphological differences, a variably expressed capacity for vegetative reproduction occurred in the 'parental' populations. Makinson (1997) also suggested that an inability to set fruit in clonal populations may result from self-incompatibility or compounded inbreeding depression within populations that may ancestrally have been preferentially out-breeding.

Other biological causes of failure to produce seed may include pollen unviability, stigma non-receptivity or shrunken pollen grains.

Ramets of some clonal plant species alter their rhizome lengths in response to their microenvironment, i.e. they utilise favourable habitat, this is termed 'clonal foraging' (Cain et al. 1996). Personal observations indicate that *G. obtusiflora*

subsp. *obtusiflora* appears to undertake this type of foraging as stems were variably spaced and limited excavation supported the extent of clonality.

The lack of regular new genetic input from sexual reproduction, may also indicate that the genetic diversity of the population is low.

Grevillea obtusiflora* subsp. *fecunda

G. obtusiflora subsp. *fecunda* flowers abundantly and sets copious amounts of fruit (Makinson 1997) (Figure 8). Seed has been collected by the Society for Growing Australian Plants (SGAP). It is possible, in common with other Grevillea species, that the seeds are rapidly gathered and dispersed by ants, as the seeds have elaiosomes that may encourage harvesting by ants.

Due to the particular flower morphology, *G. obtusiflora* subsp. *fecunda* is predominantly pollinated by birds, with bees being potential secondary pollinators (pers. obs.). Birds have been shown to be particularly attracted to the colour red, birds seen feeding on the nectar of *G. obtusiflora* subsp. *fecunda* include the Yellow-tufted Honeyeater and the Eastern Spinebill (pers. obs.).

Figure 8

6.1.3 Seed Production, Phenology and Fecundity.

Grevillea obtusiflora* subsp. *obtusiflora

Fruits, seeds and seedlings have not been recorded for *G. obtusiflora* subsp. *obtusiflora*.

Eriksson (1993) suggested that many clonal plants do not show signs of senescence and as a consequence possess almost unlimited fecundity.

Lack of success in seed production limits the distribution of a species, including the establishment of new sites, as long distance dispersal is reduced without seed production, additionally seeds are the common initiator for new populations (Eriksson 1993).

Grevillea obtusiflora* subsp. *fecunda

Grevillea obtusiflora subsp. *fecunda* flowers profusely and virtually all flowers go on to produce follicles (pod-like fruit) (Figure 9). Although some follicles will not set seed, most will set two seeds. Relative to the number of flowers, seed set is low, a tendency reflected in other Grevilleas (Olde & Marriott 1994). Flower heads in both *G. obtusiflora* subsp. *obtusiflora* and *G. obtusiflora* subsp. *fecunda* were bagged in an attempt to gather seed. A total of 12 seeds were collected from *G. obtusiflora* subsp. *fecunda*.

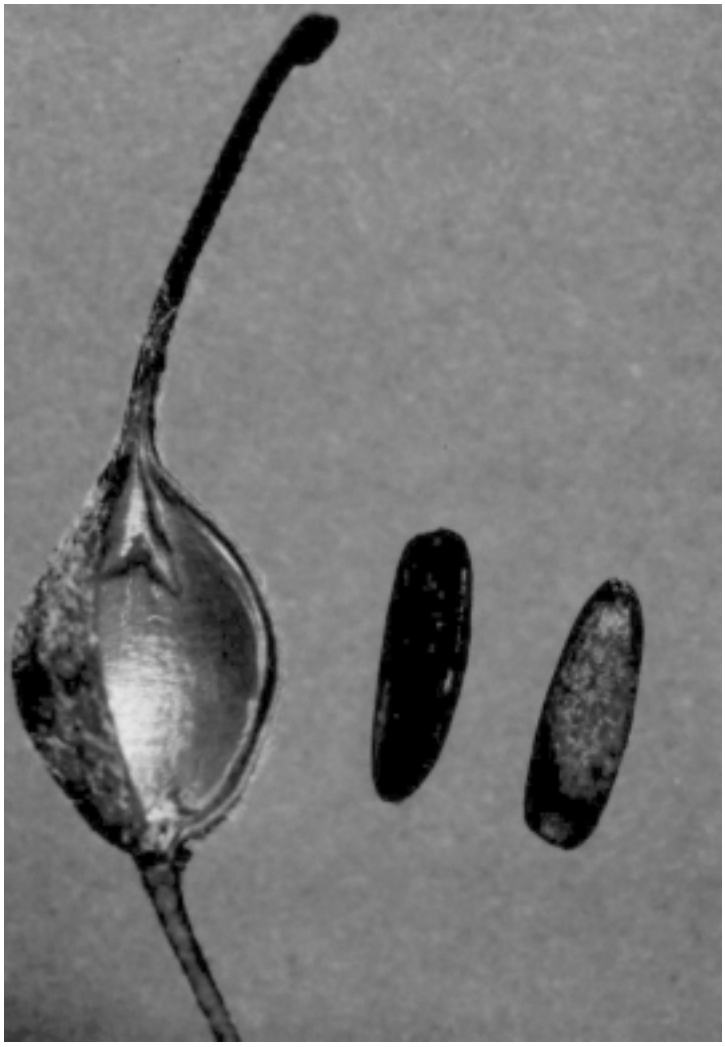

Figure 9 - *Grevillea obtusiflora* subsp. *fecunda* follicle

6.1.4 Seed viability, dormancy and germination factors

Grevillea obtusiflora* subsp. *obtusiflora

As mentioned previously *G. obtusiflora* subsp. *obtusiflora* has not been observed to set seed.

Grevillea obtusiflora* subsp. *fecunda

The dormancy mechanisms, if any, used by *G. obtusiflora* subsp. *fecunda* have not been established.

In Grevillea, dormancy strategies can include chemical barriers, and physical barriers such as durable seed coats and waxy or corky layers. The dormancy mechanism varies from species to species, and Grevillea seed generally requires some combination of the following circumstances to germinate; weathering,

stratification, soaking/leaching, removal of elaiosome, and fire (Langkamp 1987, Olde & Marriott 1994).

6.1.5 Seed dispersal, seedling establishment and growth

Grevillea obtusiflora* subsp. *fecunda

Most fruits in Grevillea fall soon after dehiscence, but in some may persist to the next flowering season and beyond (Olde & Marriott, 1994). Seed dispersal in many Grevillea species is thought to be carried out by ants who carry the seed into nests and eat the elaiosome or waxy wing attached to the seed, this process is termed myrmecochory (Olde and Marriott, 1994). In other Grevillea species germination of seedlings has been noted emerging from ant nests, this process has not been observed in *G. obtusiflora* subsp. *fecunda* to date. Seed in this taxon is most likely dispersed directly below the plant and is distributed by wind, water and ants.

G. obtusiflora subsp. *fecunda* is a pioneer taxon and shows a definite association with mechanically disturbed ground, such as found along the road at one of the sites (Makinson 1997). However, it is not known whether the response to disturbance is the result of seed germination or vegetative reproduction.

Seedlings have been observed at Site F2 in an area of disturbance and after a period of heavy rain, indicating that the seeds of this taxon are viable.

6.2 Population Structure

Grevillea obtusiflora* subsp. *obtusiflora

The number of plants is estimated at approximately 1400 ramets at nine sites within the Clandulla State Forest. Additionally, several plants have been found on freehold land adjacent to the Clandulla State Forest. It is difficult to establish the exact number of genets within the population due to the degree of clonality exhibited by the taxon. There is evidence of recent vegetative recruitment with young suckers (pers. obs.).

Grevillea obtusiflora* subsp. *fecunda

The number of plants is estimated at nine hundred adult plants at three separate sites. The roadside sites tend to be in long ‘strips’ along the roads, with plants growing in clusters within suitable habitat. Numbers remained stable during the survey period. Seedlings have been recorded at site F2 (pers. obs.).

6.3 Herbivory and Seed Harvesting

Grevillea obtusiflora* subsp. *obtusiflora

No herbivory on this plant has been observed to date, despite rabbit droppings being abundant at one of the sites. Feral goats and pigs are also expected to be present in the general locality.

Grevillea obtusiflora* subsp. *fecunda

In Grevillea, seed harvesting is often carried out by ants (Olde and Marriott 1994). The ants are thought to consume the seed's waxy wing or elaiosome, which may assist in overcoming one of the seed's dormancy mechanisms.

As many of the country roads in the locality act as routes for stock transport, there is some potential for the plants to be trampled or grazed. However, herbivory on this taxon has not been recorded.

6.4 Fire Ecology

Grevillea obtusiflora* subsp. *obtusiflora

Within the genus *Grevillea* there are a range of mechanisms in species that allow persistence after a fire event. *G. obtusiflora* subsp. *obtusiflora's* root suckering habit would assist its survival of a fire event. Although the overall effect of fire on the survival of this taxon is not known, numerous suckers resulted from a burn in 1996 at site O2. The main site in Clandulla State Forest (O1) is thought to have burnt approximately 30 years ago (Ken Sampson pers. comm.). Makinson (pers. comm.) suggests that a fire interval in the order of 10 –15 years is likely to favour the taxon.

Grevillea obtusiflora* subsp. *fecunda

G. obtusiflora subsp. *fecunda* appears to have two strategies to assist in surviving a fire event; root suckering, and possibly the burying of seed by ants. Seed that has been buried is likely to have a degree of protection from the high temperatures that are generated in a fire. It is possible that an ashbed response assists germination after fire with the influx of nutrients, and possibly dormancy-breaking smoke compounds into the soil. As it is thought that it would take four to five years after a fire for an adult plant to produce flowers, accordingly, a fire interval in the order of 10-15 years is likely to provide an opportunity for plant maturation and a period of seed production.

The rural areas in which the largest sites of *Grevillea obtusiflora* subsp. *fecunda* are found have not been burnt for approximately 30 years (Bruce Bell, Rylstone Shire Council).

7 Previous management actions

7.1 Establishment of Species Recovery Team

A species recovery team has been established to supervise and monitor all recovery actions for these taxa. The recovery team may be revised to ensure representation reflects the requirements to conserve *G. obtusiflora*.

Recovery team members include representatives from the NPWS, State Forests of NSW, Australian National Herbarium Centre for Plant Biodiversity Research, Rylstone Shire Council and the community.

7.2 Recovery Plan Actions

Environment Australia has funded recovery actions for *Grevillea obtusiflora* subsp. *obtusiflora* during the 1997/1998 funding cycle:

1. Literature and herbarium searches

   A literature review has been conducted. The information in the literature about *G. obtusiflora* subsp. *obtusiflora* relates primarily to the taxonomic status of the taxon, with little known of the taxon biology or ecology. Journal articles of clonal species and fire ecology have also been collated.

   A search of the NSW herbarium revealed only six collections. All of these were collected in Clandulla State Forest. The type collection is lodged at the British Museum, with an isotype at Kew. Five of the specimens at the NSW herbarium appear to have been collected in the same area (Clandulla State Forest, Site O1), with another specimen collected several kilometres away (Site 02).

2. Field searches and data collection.

   A number of field trips have been conducted to examine the habitat of the taxa, search for further sites and to determine numbers of plants and to gain knowledge of the plant's ecology. These field searches have defined the parameters of existing sites and searched other areas of suitable habitat. No other sites have been found to date. Details of the sites are shown in Appendix 1

   The flowering period of both subspecies was closely monitored, and flowers dissected in an attempt to define a physical reason for the inability of *G. obtusiflora* subsp. *obtusiflora* to form seedpods and seed. Photos were taken of habitats, plants, flowers and macro-photographs taken of flowers, both dissected and whole and of the seed and seedpods of *G. obtusiflora*

subsp. *fecunda*. Pollinator species for *G. obtusiflora* subsp. *fecunda* were noted. Flower heads of both *G. obtusiflora* subsp. *obtusiflora* and *G. obtusiflora* subsp. *fecunda* were bagged in an attempt to gather seed if produced. A total of 12 seeds were collected from *G. obtusiflora* subsp. *fecunda*.

Voucher specimens from each site were collected and submitted to the Herbarium of NSW, and threatening processes in operation at each site were identified.

3. Preparation of a Conservation Research Statement and Species Recovery Plan.

A recovery team has been established comprising representatives from State Forests of NSW, the NPWS, Australian National Botanic Gardens, Rylstone Shire Council and Environment Australia. This recovery plan is the product of this funding component.

In addition to the actions contributed to by Environment Australia, a program of *ex situ* cultivation has been undertaken.

Cultivation of *G. obtusiflora* subsp. *obtusiflora* at Mt. Annan Botanic Gardens and Australian National Botanic Gardens has been successful. Voucher specimens held at the National Herbarium of NSW have been documented and additional specimens have been collected for inclusion in this collection. The Society for Growing Australian Plants also has a Grevillea speciality group who have had success at propagation of this plant. These collections have been random and opportunistic. The degree to which these collections are representative of the genetic material in situ is unknown.

Cultivation of *Grevillea obtusiflora* subsp. *fecunda* clones at both Mt. Tomah and Mt. Annan botanic gardens has been successful. Voucher specimens held at the National Herbarium of NSW have been documented and additional specimens have been collected for inclusion in this collection.

8 Management issues

8.1 Introduction

The management of the conservation of threatened species requires the development of a "recovery program" which considers (i) the biological and ecological aspects of the species; (ii) the social, political and organisational parameters that may affect the success or otherwise of the program; and (iii) the economic factors which may influence the operation of the program's implementation.

As such, this section identifies the management issues affecting *Grevillea obtusiflora* including the;

1. limits of our current understanding of the taxon's biology and ecology,
2. threats and reasons for decline, and
3. social and economic factors which may influence the success or otherwise of the recovery plan.

8.2 Current level of understanding

Knowledge of the biology and ecology of *Grevillea obtusiflora* is far from complete, although previous management actions provide levels of information, particularly relating to reproductive strategies, significant information gaps lie in the areas of seed biology, fruit production, pollinators, genetic variation, and fire ecology.

Monitoring of the effectiveness of the actions in this Recovery Plan provides an opportunity to collect data to assist in understanding the ecology of these taxa and to make further management recommendations to ensure the survival of these taxa.

8.3 Threatening processes

The threatening processes affecting these taxa are: direct clearing associated with agricultural activities, direct damage by vehicular access, inappropriate fire regimes, and roadside management activities such as grading and weed spraying.

8.3.1 Unrestricted vehicular access

Grevillea obtusiflora* subsp. *obtusiflora

The largest sub-population of *G. obtusiflora* subsp. *obtusiflora* (O1) primarily occurs in Clandulla State Forest adjacent to forest roads. It is unlikely that the public will drive off road in these areas as there are few trees of interest to firewood

collectors and present unsuitable conditions for motorcycle use. No such use has been observed at the site.

Clandulla State Forest receives a low level of public use ranging from recreational activities to small-scale removal of fencing timber under licence from State Forests of NSW. The poor timber quality at the site has limited timber production in this area. In planning harvesting operations State Forests of NSW undertakes comprehensive environmental assessments including searches for threatened flora and fauna.

State Forests of NSW may be able to exclude this area from timber harvesting. However, this cannot guarantee these sites will not be affected by activities where people operate outside their licence conditions or without a licence.

The majority of roads in Clandulla State Forest have been established for at least 30 years. Tables and barbeques were added to the picnic area on Carwell Creek in the late 1980s. However, visitor numbers remain low, mainly mountain bike riders and fisherpeople.

Vehicular access may increase the likelihood of introduction of soil pathogens, although the vulnerability of *Grevillea obtusiflora* subsp. *obtusiflora* to these is not known.

Grevillea obtusiflora* subsp. *fecunda

As some sites occur on road verges, there is potential threat from the direct impacts of vehicles driving over plants.

Similar to that occurring within Clandulla State Forest, a level of illegal off-road vehicle use occurs within Gardens of Stone National Park. Again similar to the Clandulla State Forest circumstance, there is no evidence to suggest that this activity is having an impact on *Grevillea obtusiflora* subsp. *fecunda.*

8.3.2 Fire

Despite *Grevillea obtusiflora* having fire survival strategies, fire can have a major influence on post-fire community composition and therefore habitat within an area. Habitats and the natural processes occurring within them need to be maintained in as natural a state as is possible. Inappropriate fire regimes can alter the operation of ecological processes, leading to changes in taxon presence and abundance, population composition and structure, as well as affecting associated factors such as pollinators and soil biota, all of which may play a role in the health of the plant and its habitat.

Grevillea obtusiflora* subsp. *obtusiflora

Prescribed burns are effected by the State Forests of NSW when fuel loads need to be reduced. In the habitat of *G. obtusiflora* subsp. *obtusiflora*, records show that regular fire events are uncommon. Ground fuel levels are low, possibly due to the low site quality producing less fine fuel, hence contributing to the infrequent fire regime. The main potential ignition sources are lightning, escapes from agricultural burning, and arson.

A firebreak was established during a wildfire in Clandulla State Forest in 1994 to protect private property and the township of Clandulla. This firebreak can be utilised to manage the fire regime within areas of *G. obtusiflora* subsp. *obtusiflora* habitat.

Grevillea obtusiflora* subsp. *fecunda

Due to their proximity to freehold land, some of the *G. obtusiflora* subsp. *fecunda* sites may be affected by future hazard reduction programs. This effect may be exacerbated by fuel reduction programs that incorporate regular prescribed burning regimes. It would be expected that a short inter-fire interval would be detrimental to *G. obtusiflora* subsp. *fecunda*. Prescribed burns for fuel reduction are carried out as required by Rylstone Shire Council.

G. obtusiflora subsp. *fecunda* habitat occupies a range of land tenures, hence is subject to widely varying fire management practices. These practices have been formulated without regard for the ecological requirements of this taxon. It is desirable that the ecological requirements of this taxon be considered when fire management actions or plans are being formulated.

8.3.3 Road Management Activities

8.3.3.1 Grading and Slashing

Road widening works and slashing of roadside vegetation (up to two metres on immediate shoulders) is carried out by Rylstone Shire Council. This activity has the potential to direct affect the taxon at sites O2, F1 and F2.

8.3.3.2 Weed Control

Grevillea obtusiflora* subsp. *obtusiflora

Herbicide application is a standard form of weed control carried out on roads by Rylstone Shire Council. Inadvertent application of herbicide to *G. obtusiflora* subsp. *obtusiflora* may cause plant death or reduced vigour. Road side herbicide spot spraying is a potential threat for this taxon, especially at Site O2.

Grevillea obtusiflora* subsp. *fecunda

Numerous agricultural weeds occur at Sites F1 and F2, as these sites adjoin cleared agricultural land. It is not known whether the weeds effectively compete with *G. obtusiflora* subsp. *fecunda.* As with *G. obtusiflora* subsp. *obtusiflora,* inadvertent application of herbicide may cause plant death or reduced vigour and fecundity.

As *G. obtusiflora* subsp. *fecunda* occurs on roads, it is subject to similar herbicide application and its potential effects, as have been described for *G. obtusiflora* subsp. *obtusiflora.*

8.4 Translocation

Translocation is defined as the "deliberate transfer of plants or regenerative plant material from one place to another, including existing or new sites or those where the taxon is now extinct" (Australian Network for Plant Conservation 1997). Translocation may also involve the removal of plant material to undertake an *ex situ* conservation program.

The translocation of *G. obtusiflora* subsp. *obtusiflora* and subsp. *fecunda* is not considered to be an appropriate conservation mechanism for the following reasons:

- taxa numbers appear to be stable,
- numbers of individual plants have not reached a critical stage, and
- with the implementation of the recovery actions outlined in this Recovery Plan, the taxa should be adequately protected from further decline.

8.5 Social and economic issues

8.5.1 Social Issues

The main social impacts resulting from the implementation of this recovery plan will affect the local community in the vicinity of the sites. Increased awareness regarding the conservation of threatened species in a rural setting will help to bring about changes in social behaviour. These changes relate to the recognition of the value of remnant vegetation and responsibility for habitat management.

Negative social impacts are not expected, as the implementation is not expected to affect public land usage to any great extent, and modification of private land management patterns will occur on a consultative basis.

Another impact may be consideration of the taxa in any environmental impact assessment for proposed development. As an endangered species listed on the TSC Act, *G. obtusiflora* and its habitat must be considered prior to approval or consent being granted for a proposed development. Due to lack of development pressure in this area, it is not likely that a significant number of development proposals will be proposed in areas where the taxon or its habitat is present.

The continued consultation and liaison with the local community, Rylstone Shire Council, and relevant agencies will address and minimise social impacts arising from the conservation of the taxa.

8.5.2 Economic Considerations

The economic consequences of this recovery plan are those that are associated with its implementation. These include on-ground habitat management, conducting biological research and monitoring, establishing and disseminating to land managers ecological and population dynamics information, improved environmental assessment of activities which potentially impact on the taxa (including hazard reduction activities), community education and participation, and on-going recovery team coordination. These costs can be minimised by:

- implementing a long-term strategic framework for managing the taxa and their habitat;
- seeking funds from external sources, including research grants;
- maintaining accurate information on the distribution and status of sub-populations; and
- adopting a cooperative approach to management with the relevant land managers and the local community.

8.6 Taxa's ability to recover

It is not known whether *G. obtusiflora* subsp. *obtusiflora* and subsp. *fecunda* have always been naturally uncommon, or have suffered minor or substantial declines in populations and/or distributions. The long term persistence of these taxa in the wild will depend on maintenance of the existing populations and their habitat.

The maintenance of this taxon within botanical collections is important for the preservation of the genetic stock.

8.6.1 Taxa rarity

Grevillea obtusiflora has a restricted distribution and is only known to occur in the Cudgegong and Capertee valleys in the Central Tablelands of NSW. A low number of individual plants are present, threats to the taxon are operating, and the taxon's ecology makes it susceptible to threats and subsequent decline. Only one sub-population of *G. obtusiflora* subsp. *fecunda* is conserved within a conservation reserve (National Park or Nature Reserve) (Site F3).

8.6.2 Taxa viability

The viability of a taxon depends on the effectiveness of its reproductive mechanism, and this mechanism must also ensure the maintenance of genetic integrity. The genetic integrity of the populations of both *G. obtusiflora* subsp. *obtusiflora* and subsp. *fecunda* is not known.

Due to the lack of regular new genetic input from sexual reproduction and the exclusive clonality of *G. obtusiflora* subsp. *obtusiflora* the genetic diversity of the population may be low. However, Eriksson (1993) suggested that many clonal plants do not show signs of senescence and as a consequence possess almost unlimited fecundity.

8.6.3 Likelihood of recovery

The likelihood of the recovery of *G. obtusiflora* subsp. *obtusiflora* and subsp. *fecunda* is high if the recovery actions outlined in this plan are implemented, monitored and amended as required.

9 Overall recovery aim and recovery strategy

9.1 Overall recovery aim

The overall objective of this recovery plan is to stabilise *G. obtusiflora*'s status as an endangered taxon pursuant to the provisions of the TSC Act. Recovery relates specifically to the prevention of the decline in the number of sub-populations and individuals of *G. obtusiflora* extant in the wild, by protecting sub-populations from threats.

9.2 Overall performance criteria

The overall performance criteria of the recovery plan is that the number of sub-populations and individuals of *G. obtusiflora* subsp. *obtusiflora* and subsp. *fecunda* extant in the wild does not decrease over the five years of plan operation.

9.3 Recovery strategy

The recovery strategy for this plan is to identify actions for each management issue, and to identify agencies responsible and a time frame for the implementation for these actions.

10 Habitat Management

Threatened species are best managed in their natural habitat where the complex interactions required for their survival are continued. To achieve this aim it is essential to implement in situ management to reduce the impact of threatening processes on the plants and their habitats.

10.1 Objectives

The objectives of the habitat management program are;

- to encourage management of sites in a manner that maintains populations,
- to prevent the continuation of factors that are detrimentally affecting the taxa or their habitat, and
- to prevent the occurrence of activities that may affect the taxa or their habitat.

10.2 Recovery Actions

- The NPWS will liase with private landholders, State Forests of NSW and Rylstone Shire Council in relation to fire, road management, access restrictions on the management of *G. obtusiflora* habitat.

- State Forests of NSW will establish a "Special Emphasis – Flora and Fauna" area under the *Forestry Act* 1916 for Site O1 in Clandulla State Forest, and indicate this area on maps to inform potential users of the uses permitted in the area. State Forests of NSW will manage this area in accordance with its conservation value.

- The NPWS will encourage and provide advice to landholders, on whose land the taxon occurs, to manage habitat in a manner sympathetic to the recovery of the taxon, and advise of the benefits of Voluntary Conservation Agreements.

- Rylstone Shire Council will install "Significant Roadside Environmental Area" signs adjacent to roadside sites of *G. obtusiflora* in Home Hills Rd (Site F1), Port Macquarie Rd (Site F2) and the Clandulla-Kandos Rd (Site O2).

- The Rylstone Shire Council (in consultation with the NPWS) will assess the potential impact of any proposed roadside management activities in accordance

with the environmental impact assessment guideline included as Appendix 4. If any new sites are identified during the course of Council roadside activities, works must not commence until the site is investigated and management actions agreed upon.

- The NPWS, State Forests of NSW, and Rylstone Shire Council will ensure that measures to protect *G. obtusiflora* are incorporated in fire planning instruments (ie. FMP's) and in the planning of actions associated with a fire event. The NPWS will advise the Bush Fire Management Committee of the need to address the conservation of *Grevillea obtusiflora* and its habitat in Bush Fire Risk Management Plans relevant to the locality.

10.3 Performance Criteria

- Management practices for *Grevillea obtusiflora* sites that are performed in a manner that does not detrimentally affect sub-populations of this taxon are commenced within five years.
- Factors detrimentally affecting the *Grevillea obtusiflora* or its habitats are reduced to a level where their effect is not significant within five years.

11 Survey and Monitoring

The distribution of *G. obtusiflora* is described in Section 5 of this plan. Survey has confirmed existing records and ascertained approximate population sizes, and potential habitat adjacent to known sites has also been surveyed. No further sites have been located. However, it is likely that further sites of *G. obtusiflora* subsp. *obtusiflora* and subsp. *fecunda* exist.

A program of monitoring that maintains records of populations will provide the data on which the recovery of the species can be assessed, and assist in identifying the operation of threatening processes.

11.1 Objectives

To obtain further data on the distribution of *G. obtusiflora* subsp. *obtusiflora* and subsp. *fecunda,* and to compile population parameter data to guide future recovery efforts.

11.2 Recovery Actions

- The NPWS will formulate and implement a program to identify areas of potential habitat of *G. obtusiflora* subsp. *obtusiflora* and subsp. *fecunda* and undertake survey of the identified potential habitat. The NPWS will encourage the participation of the local community and educational institutions in this program.

- The NPWS will formulate and implement a program to monitor the condition of *G. obtusiflora* subsp. *obtusiflora* and subsp. *fecunda* populations, and maintain records of factors that are acting as threatening processes. The monitoring data will be used to review management actions as more knowledge is gathered. Monitoring will assess;

    ' Seedling/ramet recruitment and survival,
    ' age to reach reproductive maturity, and
    ' the effects of any disturbance events.

11.3 Performance Criteria

- Fifty percent of the identified potential habitat of *G. obtusiflora* subsp. *obtusiflora* and subsp. *fecunda* has undergone survey within five years.

- Recovery actions are reviewed on the basis of the data collected during the monitoring program at five years.

12 Research

Many facets of the biology and ecology of *Grevillea obtusiflora* are not known. A program of biological and ecological research provides the opportunity to collect and analyse this information. This information will guide future management practices.

12.1 Objectives

The objectives of the research program are to;

- encourage research into aspects of the ecology of *G. obtusiflora* that is likely to provide information valuable to the recovery of the taxon, and
- understand essential aspects of the ecology of *G. obtusiflora*.

12.2 Recovery Actions

- The NPWS will encourage and facilitate research on the;
  - seed biology (dormancy and germination) of *G. obtusiflora* subsp. *fecunda*,
  - fruit production of *G. obtusiflora* subsp. *obtusiflora*,
  - pollinators of *G. obtusiflora* subsp. *obtusiflora* and subsp. *fecunda*,
  - response to fire of *G. obtusiflora* subsp. *obtusiflora* and subsp. *fecunda*,
  - effect of soil-borne pathogens on *G. obtusiflora*, and
  - genetic variation in *G. obtusiflora* subsp. *obtusiflora*,

  in order to address specific information gaps in the understanding of the taxa's ecology.

12.3 Performance Criteria

- A research project on an aspect of biology or ecology of *G. obtusiflora* subsp. *obtusiflora* or subsp. *fecunda* is commenced within three years.

13 Community Awareness and Involvement

Local community awareness can play a vital role in the conservation of endangered species. Community activities such as monitoring and survey will be encouraged.

Community involvement is an ongoing necessity and will be extended to include all the landowners in the areas where *G. obtusiflora* has been found.

13.1 Objectives

The objectives of the community awareness and involvement program are;

- to increase community awareness of *G. obtusiflora*;
- to guide and assist the owners and managers of *G. obtusiflora* habitat in the recovery efforts on their lands; and
- to ensure that local, State government and Commonwealth agencies make informed decisions on matters that affect the conservation of *G. obtusiflora*.

13.2 Recovery Actions

- The NPWS will produce and disseminate to local and State government agencies a species information sheet and an environmental impact assessment guideline (Appendix 4) on *G. obtusiflora*.

- The NPWS to present talks on *G. obtusiflora* to local community groups, and encourage participation of these groups in recovery actions.

13.3 Performance Criteria

- Land management practices that are sensitive to the recovery of *G. obtusiflora* are implemented by land managers and owners within five years.

- Rylstone Shire Council decision reports on proposals affecting *G. obtusiflora* or its habitat include specific consideration of *G. obtusiflora* within one year.

14 Implementation

14.1 Implementation Schedule

The following table allocates responsibility for the implementation of recovery actions specified in this plan to relevant government agencies for the period 2000 to 2005.

Table 3: Implementation schedule

Action	Description	Responsibility	Timeframe	Priority
1	Habitat Management			
	• liaison	NPWS	Life of plan	High
	• reclassifying S.F.	SF	Immediate	High
	• signage	RSC	Immediate	High
	• impact assessment	RSC	Life of plan	High
	• fire planning	NPWS, SF, RSC	Life of plan	High
2	Survey and Monitoring			
	• potential habitat	NPWS	3 years	High
	• monitoring	NPWS	life of plan	Med
3	Research		5 years	Med
4	Community Awareness			
	• community talks	NPWS	Life of plan	Med
	• information sheets	NPWS	1 year	High

14.2 Implementation Funding

The recovery actions and recommendations identified in this plan state what must be done to ensure the recovery of the endangered taxon *Grevillea obtusiflora.* Appendix 5 identifies the funding required to implement those actions that require funding for implementation.

15 Preparation details

This recovery plan was prepared by Margaret Turton (Contractor) and Simon Nally Senior Threatened Species Officer NPWS, in conjunction with the *Grevillea obtusiflora* species recovery team.

15.1 Date of last amendment

This document is the first recovery plan for *Grevillea obtusiflora.* No amendments to the plan have been made.

15.2 Review date

This recovery plan will be reviewed five years after the date of publication.

16 Contacts

The coordinator of the *Grevillea obtusiflora* recovery team can be contacted at the following address:

Coordinator – *Grevillea obtusiflora* recovery team
NSW National Parks and Wildlife Service – Central Directorate
PO Box 1967,
HURSTVILLE 2220

ph. 02 95856678
fax 02 95856442

Other useful contacts:

Organisation	Postal address	Contact numbers
NSW NPWS Blue Mountains Region Mudgee Area	Shop 1 160 Church St MUDGEE 2850	ph. 02 63727199 fax 02 63727850
NSW NPWS Blue Mountains Region Upper Mountains Area	Heritage Centre Govetts Leap Rd BLACKHEATH 2785	ph. 02 47878877 fax 02 47878514
State Forests of NSW Western Region	PO Box 865 DUBBO 2830	ph. 02 68845288 fax 02 68844771
Rylstone Shire Council	PO Box 42 RYLSTONE 2849	ph. 02 63791205 fax 02 63791313
National Herbarium of NSW, Royal Botanic Garden Sydney	Mrs Macquaries Road SYDNEY 2000	ph. 02 92318111 fax 02 92517231
Mt Annan Botanic Garden	Mt Annan Road MT ANNAN 2567	ph. 02 46482477 fax. 02 46482465

17 References

Australian Network for Plant Conservation (1997) *Guidelines for the Translocation of Threatened Australian Plants.* Australian Network for Plant Conservation, Canberra.

Benson, John (1991) Species Recovery Plan : *Grevillea beadleana*. Australian National Parks and Wildlife Service, Endangered Species Program. Project No. 155.

Briggs, J.D. and Leigh, J.H. (1996) *Rare or Threatened Australian Plants*, CSIRO, Canberra.

Cain, M.L., Dudle, D.A. & Evans, J.P. (1996) Spatial models of foraging in clonal plant species. *American Journal of Botany*. 83:76-85.

Clarke, T., Reading, R. and Clarke, A. (1993) Endangered Species Recovery: Finding the Lessons, Improving the Process. Island Press, Washington.

Eriksson, O. (1993) Dynamics of genets in clonal plants. *TREE.* 8:9.

Eriksson, O. & Bremer, B. (1993) Genet dynamics of the clonal plant *Rubus saxatilis. Journal of Ecology*. 81: 533-542.

Keith, D. (1996) Fire-driven extinction of plant populations: a synthesis of theory and review of evidence from Australian vegetation. *Proceedings of Linnean Society*. 116: 37-78.

Langkamp (Ed) (1987) *Germination of Australian Native Plant Seed* Inkata Press Melbourne

Makinson, R.O. (in press) Grevillea In *Flora of Australia*.

Makinson, R.O. (1997) *Grevillea obtusiflora* subsp. *fecunda* (Proteaceae : Grevilleoideae), a new subspecies from New South Wales. *Telopea* 7(2): 143-148

McGillivray, D.J. (1993) *Grevillea (Proteaceae) - a taxonomic revision*. Melbourne University Press. Melbourne.

Olde, P.M. & Marriott, N. (1994) A taxonomic revision of *Grevillea arenaria* and *Grevillea obtusiflora* (Proteaceae: Grevilleoideae). *Telopea* 5(4): 711-733.

Olde, P.M. & Marriott, N. (1994) *The Grevillea Book Vol. 1*. Kangaroo Press. Sydney.

Olde, P.M. & Marriott, N. (1995) *The Grevillea Book Vol. 3*. Kangaroo Press. Sydney.

Robertson, G. (1997) *Grevillea obtusiflora* subsp. *obtusiflora* Progress Report. NPWS Sydney Zone, *Report to Environment Australia*.

Watkinson, A.R. & Powell, J.C. (1993) Seedling recruitment and the maintenance of clonal diversity in plant populations – a computer simulation of *Ranunculus repens*. *Journal of Ecology*. 81:707-717.

Appendices

Appendices

Appendix 1 Site Details

Appendix 2 Associated Species

Appendix 3 Monitoring Results.

Appendix 4 EIA Guidelines

Appendix 5 Implementation Costs.

APPENDIX 1
Site Information

Site O1: **Clandulla State Forest**
Location: Clandulla, NSW. Map Ilford 8832-2-S. 1:25,000

Plant group sites AMG grid refs; not for public release

Date surveyed: numerous visits over 1998-99
Number of *Grevillea obtusiflora* subsp. *obtusiflora* plants: approximately 1300 plants,
Size of the habitat: 400m^2
Aspect: Northerly,
Altitude: 710m asl
Slope: 2 °
Geology: Shale conglomerate and sandstone.
Vegetation structure: Woodland.
Dominant species:
Canopy : *Eucalyptus crebra*; *E. dealbata*; *E. tenella*.
Middle stratum : *Callistemon linearis*, *Acacia buxifolia*, *Acacia elongata*,
Understorey : *Leucopogon sp*., *Caustis flexuosa*, *Dianella sp*, *Patersonia sp*.

The canopy is comprised predominantly of stringybark (*Eucalyptus tenalla*) and tumbledown red gum (*E. dealbata*). The slopes above Carwell creek and the hilly country west of the creek were dominated by grey gum (*E. punctata*), stringybark (*E. tenalla*) and ironbark. (*E. crebra*). *G. obtusiflora* subsp. *obtusiflora* was not found in these areas.

Fire history: Last burnt 1968
Council zoning and land tenure:
Classified as State Forest, Dedicated 1917.

General description: This is the largest sub-population and area of habitat of *Grevillea obtusiflora* subsp. *obtusiflora*, there is a high priority to keep this site intact and undisturbed.
The area is in a section of forest with a large number of tracks, both access and logging tracks.

There are a number of potential threats:
- fire, particularly frequent fires, lightning/burn-off escapes/arson

Site Information

Site O2: Clandulla State Forest/Council Roadside (on boundary)
Location: Area 2.1 km north of Clandulla State Forest turn off, right hand side of Bylong Valley Way, on way to Kandos. AMG not for public release. Map: Ilford 8832-2-S 1:25,000
Date surveyed: numerous visits over 1998-99
Number of *Grevillea obtusiflora* subsp. *obtusiflora* plants: 100 plants,
Size of the habitat: 400m^2
Aspect: Northerly.
Altitude: 700m asl
Slope: 2°
Geology: Shale, conglomerate and sandstone.
Vegetation structure: Woodland
Dominant species:

Canopy:	*Eucalyptus crebra*; *E. dealbata*; *E. tenella*.
Middle stratum :	*Callistemon linearis, Acacia buxifolia, Acacia elongata*,
Understorey :	*Leucopogon sp., Caustis flexuosa, Dianella sp, Patersonia sp*.

Fire history: Last burnt 1996.
Council zoning and land tenure:
State Forest, Council road.

General description: This site is adjacent to a sealed road, which is the main route from the Great Western Highway to the town of Kandos. The site is located only a few metres from the road.

There are a number of potential threats:

- road management activities, such as grading and weed spraying.
- fire

Site Information

Site F1: Home Hills Rd
Location: Roadside area, 2.2 km from turn off from Kandos-Glen Alice Rd. Extends for approximately 50 metres. AMGR: not for public release Map : Bogee 8932-111-S 1:25,000.
Date surveyed: numerous visits over 1998-99
Number of *Grevillea obtusiflora* subsp. *fecunda* plants: approximately 50 plants
Size of the habitat: 50 x 20 metres.
Aspect: ENE
Altitude: 570m asl
Slope: 3°
Geology: shale, conglomerate and sandstone.
Vegetation structure: low shrub
Dominant species:

Canopy :	*Eucalyptus tenella, E. fibrosa, E. macrorhyncha, E. punctata, Callitris endlicheri*
Middle stratum :	*Acacia buxifolia, Leptospermum continentale, Monotoca elliptica.*
Ground stratum :	*Persoonia linearis, Indigofera sp., Pomax umbellata.*

Fire history: Last burnt 1968 (approx)
Council zoning and land tenure:

Council roadside reserve and freehold.

General description: This site is located on raised roadside verges between an unsealed road and cleared agricultural land.

There are a number of potential threats:

- roadside maintenance activities such as grading and weed spraying.
- clearing or grazing of habitat on freehold land.
- fire, particularly frequent fires, lightning/burn-off escapes/arson.

Site specific management actions:

Site Information

Site F2: Port Macquarie Rd.
Location: Sub-population starts just past property "The Pines" and continues virtually continuously for 1 km. AMGR: not for public release. Map: Bogee 8932-111-S 1:25,000.
Date surveyed: numerous visits over 1998-99
Number of *Grevillea obtusiflora* subsp. *fecunda* plants: approximately 500 plants
Size of the habitat: 600m x 200m
Aspect: North/east
Altitude: 550m asl
Slope: 3°
Geology: shale, conglomerate and sandstone**.**
Vegetation structure: Callitris woodland.
Dominant species:
Canopy : *Eucalyptus tenella, E. fibrosa, E. macrorhyncha, E. punctata, Callitris endlicheri*
Middle stratum : *Acacia buxifolia, Leptospermum continentale, Monotoca elliptica.*
Ground stratum : *Persoonia linearis, Indigofera sp., Pomax umbellata.*
Fire history: 1968 (approx)
Council zoning and land tenure:

Council roadside reserve and freehold farmland.

General description: This is the largest site of *Grevillea obtusiflora subsp. fecunda,* and there is a high priority to keep this site intact and undisturbed. It is located on an unsealed road, and borders freehold farmland.

There are a number of potential threats:

- roadside management such as grading or weed spraying.
- clearing or grazing of sites on freehold land
- fire, particularly frequent fires, lightning/burn-off escapes/arson.

Site Information

Site F3: Pantoneys Crown
Location: Lower slope of Pantoneys Crown within Gardens of Stone National Park**.** AMGR: not for public release Map : Ben Bullen 8931-IV-S 1:25,000.
Date surveyed: 27th November 1998
Number of *Grevillea obtusiflora subsp. fecunda* plants: approximately 350 plants,
Size of the habitat: 400m x 150m.
Aspect: North/east
Altitude: 540m asl
Slope: 12 °
Geology: shale and sandstone
Vegetation structure: Open forest.
Dominant species:
Canopy : *Eucalyptus crebra, E. beyeriana.*
Middle Stratum : *Acacia buxifolia, Acacia ixiophylla, Isopogon aneminifolius*.
Ground Stratum : *Lomandra glauca, Styphelia triflora, Goodenia sp.*
Fire history: Last burnt 1975-1980 (field estimate only).
land tenure: The site is in Gardens of Stone National Park.
General description: This is only site of *Grevillea obtusiflora subsp. fecunda* within an existing conservation reserve. It is located in a remote area only visited by bushwalkers and is not accessible by road.

The only potential threats to this site would be a series of frequent intense fires which could eliminate the adult plants before they were able to re-establish root stock and produce flowers, fruit and a soil seed stock.

APPENDIX 2

Associated species found with *Grevillea obtusiflora* subsp. *obtusiflora*.

Acacia elongata	Swamp Wattle
Dillwynia sericea	Parrot-pea
Pultanaea microphylla	Spreading Bush-pea
Acacia buxifolia subsp. *buxifolia*	Box-leaf Wattle
Acacia lanigera	
Aristida ramosa	Wire Grasses
Bossiaea buxifolia	Matted bossiaea
Bossiaea obcordata	
Brachycombe ptychocarpa	
Callistemon linearis	Narrow-leaved Bottlebrush
Cassinia sp.	
Caustis flexuosa	Old Man's Whiskers
Choretum glomeratum	Common sour bush
Dianella longifolia var. *longifolia*	Lily
Dillwynia phybicoides	
Diuris sulphurea	Tiger Orchid
Echinopogon caespitosus	Tufted Hedgehog Grass
Eremophila sp.	
Eucalyptus cannonii	Capertee Stringybark
Eucalyptus crebra	Narrow-leaved Ironbark
Eucalyptus dealbata	Tumble-down Redgum
Eucalyptus rossii	White Gum
Eucalyptus tenella	Small-leaved Stringybark
Gompholobium uncinatum	Wedge-pea
Helichrysum collinum	
Hibbertia riparia	Erect Guinea Flower
Leptospermum divaricatum	
Leucopogon appressus	Beard-heath
Leucopogon ericoides	Beard-heath
Lissanthe strigosa	Peach Heath
Lomandra multiflora	Many-flowered Mat-rush
Lomandra sp.	Mat-rush
Mirbelia platylobioides	
Patersonia sericea	Silky Purple-flag
Persoonia subsp. *marginata*	
Platysace ericoides	Heath Platysace
Pultanaea procumbens	Bush-pea
Pultenaea villafera ?	Bush-pea
Styphelia triflora	Red five-corners

Associated species found with *Grevillea obtusiflora* subsp. *fecunda.*

Sites F1 and F2

Acacia buxifolia	Box-leaf Wattle
Callitris endlicheri	Cypress
Eucalyptus fibrosa	Broad-leaved Ironbark
Eucalyptus macrorhyncha	
Eucalyptus punctata	Grey gum
Eucalyptus tenella	
Indigofera sp.	
Leptospermum sp.	Tea tree
Monotoca elliptica	Tree Broom-heath
Persoonia linearis	Narrow-leaved Geebung
Pomax umbellata	

Site F3

Eucalyptus crebra	Narrow-leaved Ironbark
E. beyeriana	Beyers Ironbark
Melichrus urceolatus	
Caladenia caerulea	Blue Caladenia
Glossodia major	Wax lip Orchid
Dillwynia floribunda	
Isopogon anemenifolius	Drumstick
Lomandra glauca	
Acacia buxifolia	Box leaf Wattle
Acacia ixiophylla	
Pomax umbellata	
Leucopogon microphyllus	
Goodenia sp.	
Brachyloma daphnoides	Daphne Heath
Callistemon linearis	Narrow-leaved Bottlebrush
Styphelia triflora	
Oxylobium pultanea	
Xanthorrhoea arborea	Broad-leaf Grass-tree

Appendix 3. Monitoring

Searches

A number of field trips have been conducted to examine the habitat of the sub-populations, search for further sites and to determine numbers of plants and to gain knowledge of the plant's ecology. These field searches have defined the parameters of existing sites, this is shown in Appendix 1. Searches in other areas of suitable habitat have been carried out and maps showing area of searches accompany this report. No other sites have been found.

Monitoring

The flowering period of both subspecies was closely monitored, and flowers dissected in an attempt to define a physical reason for the inability of *G. obtusiflora* subsp. *obtusiflora* to form seedpods and seed. Photos were taken of habitats, plants, flowers and macro-photographs taken of flowers, both dissected and whole and of the seed and seedpods of *G. obtusiflora* subsp. *fecunda*. Pollinator species for *G. obtusiflora* subsp. *fecunda* were noted. Flower heads in both *G. obtusiflora* subsp. *obtusiflora* and *G. obtusiflora* subsp. *fecunda* populations were bagged in an attempt to gather seed if produced. A total of 12 seeds were collected from *G. obtusiflora* subsp. *fecunda*. Propagation trials have not commenced with these seeds to date.

In *G. obtusiflora* subsp. *obtusiflora*, flowers and styles on some plants were noted to wither, and in some cases just drop from the plant. Ants were also found in some flowers. No swelling of the ovary was detected in any *G. obtusiflora* subsp. *obtusiflora* flower.

The clonal root system was investigated and found to be much more substantial in *G. obtusiflora* subsp. *obtusiflora* than *G. obtusiflora* subsp. *fecunda*, with roots extending for many metres. Pathogens were looked for and in the case of *G. obtusiflora* subsp. *obtusiflora* detected, in the form of a *Mycosphaerella* fungus on *several* plants.

Samples from each site were collected and submitted to the Herbarium of NSW.
Threatening processes were identified and are addressed in this recovery plan.