

Interim Lake Macquarie *Grevillea parviflora* subsp. *parviflora* Planning and Management Guidelines



Lake Macquarie City Council June 2013

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Photo credits

Colin Driscoll

Contents

Executive Summary	5
1. Background.....	6
2. Legislative and planning context.....	7
3. Biology and ecology.....	8
4. Information gaps.....	12
5. Strategic planning issues	15
6. Land management issues	20
7. Scientific research priorities.....	22
8. Planning and management strategy	24
9. Planning and management guidelines	25
10. Conclusions.....	28
Glossary	28
References	29
Appendix A.....	30
Appendix B.....	33



Executive summary

Grevillea parviflora subsp. *parviflora* is a small shrub occurring in native woodland vegetation, growing as scattered plants or in multi-stemmed patches. It may be difficult to differentiate from some other *Grevillea* species from the Linearifolia sub-group of which *G. parviflora* subsp. *parviflora* is a member, particularly in the absence of flowers. It has a limited geographic distribution, which includes parts of Lake Macquarie local government area.

The species is listed as a threatened plant under both NSW and Commonwealth legislation, and is a matter of national environmental significance (MNES). Development projects and activities occurring within the LGA can often impact on *G. parviflora* subsp. *parviflora* and the significance of this impact must be taken into account where the species occurs or is likely to occur. It is estimated that up to 1,000 ha of modelled *G. parviflora* subsp. *parviflora* habitat is likely to be subject to development pressure to 2050 in Lake Macquarie LGA.

There is very limited scientific understanding of the biology of *G. parviflora* subsp. *parviflora*, and important areas of scientific research have been identified in the guidelines to inform future planning and management. These primarily relate to improving the taxonomic identification of the species (especially in the field), better understanding reproductive biology, and understanding the genetic characteristics of local populations to inform decisions about the significance of development impacts. Further investigation of the species management requirements is also important.

The key objectives of the report are

1. to summarise relevant knowledge for the species to inform planning and management
2. to provide interim guidelines for land use planning and management activities, and
3. to identify scientific research priorities.

The Interim Guidelines support future land use planning and management, and subject to targeted further scientific research, will lead to an improvement in certainty when planning future development and assessing the impact of development proposals on *G. parviflora* subsp. *parviflora*, and planning future conservation requirements for the species. They are intended to be updated following the completion of further scientific work when the biology of *G. parviflora* subsp. *parviflora* is better understood (hence their interim status).

The Interim Guidelines are intended to integrate with strategic land use planning, and include a review of the consequences of projected land use change, and future conservation planning requirements for the species. Interim guidelines are proposed for field survey and for assessing the significance of development impact. They will have relevance for the local government areas where *G. parviflora* subsp. *parviflora* is known to occur.

This plan has been prepared in consultation with both NSW Office of Environment and Heritage and Australian Government Department of Sustainability, Environment, Water, Population and Communities with the support of these agencies.



1. Background

G. parviflora subsp. *parviflora* is a geographically restricted endemic plant species listed as vulnerable at the state and national level under the Threatened Species Conservation Act 1995 and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The species is poorly represented in conservation reserves and is subject to clearing arising from urban and mining related development.

The distribution of the species is restricted from south of Sydney to the Lower Hunter region, with separated north and south regional populations. The north regional population primarily occurs within the Lake Macquarie, Cessnock and Wyong local government areas. The southern regional population primarily occurs within Campbelltown and Wollondilly local government areas. There are also some outlying populations.

In co-operation with the NSW and Commonwealth governments, Lake Macquarie City Council convened a scientific workshop in 2013 to review the limited scientific knowledge of the species. This was informed by a review of the ecology and biology of *G. parviflora* subsp. *parviflora* prepared by Colin Driscoll for Lake Macquarie City Council (Driscoll 2013). This document is based on the workshop outcomes (Appendix A) and consultation with a range of stakeholders.

These Interim Planning and Management Guidelines summarise the current knowledge of *G. parviflora* subsp. *parviflora* and review the implications of this understanding for land use planning and management within the Lake Macquarie local government area. They are interim in nature because they are expected to be updated following the completion of further scientific investigations when the biology of the species is better known. The purpose of this document is to provide information to inform land use decision-making and biodiversity conservation planning. It provides planning and management guidelines which may be included in other local government planning documents.

The information in this document should be used as a reference for strategic planning and project development assessment where potential impacts on *G. parviflora* subsp. *parviflora* may occur. It has been prepared by Lake Macquarie City Council for the purposes of informing strategic and management planning within the City. It may also be relevant to decision-making over the full range of the species, and by organisations other than Lake Macquarie City Council.

This document:

- Compiles and summarises current scientific knowledge and presents this information in an accessible way for land use decision-making.
- Reviews likely land use and development impacts on the species in the medium to long term within Lake Macquarie local government area.
- Outlines planning and management objectives for the species and matters for consideration in relevant strategic planning documents.
- Proposes scientific research priorities to enable the biology of the species to be better understood, specifically to improve future planning and management practice.
- Provides interim land management guidelines for public and private landowners with *G. parviflora* subsp. *parviflora* on their property.

These Interim Planning and Management Guidelines are not a recovery plan for the species. Recovery plans are a measure included in threatened species legislation, and provide for actions to prevent adverse impacts on a species to prevent extinction of populations and/or the species.



2. Legislative and planning context

G. parviflora subsp. *parviflora* is listed as a threatened species under both the NSW Threatened Species Conservation Act 1995 and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. Although not listed as a rare or threatened Australian plant (ROTAP) (Briggs & Leigh 1995) it would qualify for listing.

There is a legislative requirement for impacts on listed threatened species to be considered as part of planning and development approval processes. Since *G. parviflora* subsp. *parviflora* is listed as threatened under both NSW and Commonwealth legislation, two approval frameworks exist where developments or activities are likely to impact upon the species.

Lake Macquarie City Council is a local planning and consent authority for most development in its LGA, and has responsibilities under the *Threatened Species Conservation Act* 1995 and *Environmental Planning and Assessment Act* 1979 to consider the significance of potential impacts on threatened species. The preparation of planning and management guidelines are an effective way in which Council can enact these responsibilities.

As a land manager, the Council also has responsibilities for actions potentially affecting the species. Relevant strategic land use planning documents taken into account in reviewing potential future impacts on *G. parviflora* subsp. *parviflora* are the Lower Hunter Regional Strategy (NSW Department of Planning 2006), Lake Macquarie City Lifestyle 2030 Strategy (Lake Macquarie City Council 2013), and Lake Macquarie Local Environmental Plan 2004 and Draft Lake Macquarie Local Environmental Plan 2013.

The Interim Planning and Management Guidelines will inform Local, State and Commonwealth based decision-making processes affecting *G. parviflora* subsp. *parviflora* and specifically its habitat within the Lake Macquarie LGA. By providing locally specific information that can be used in decision-making, this document complements other actions these levels of government may undertake. In particular, the plan will be relevant for recovery planning, including implementation of the NSW Threatened Species Priorities Action Statement (NSW Department of Environment and Climate Change 2007) and the Lower Hunter Regional Conservation Plan (NSW Department of Environment and Climate Change 2009). At this stage, no recovery plan for the *G. parviflora* subsp. *parviflora* is being prepared under either Commonwealth or NSW legislation.

3. Biology and ecology

An understanding of biological and ecological characteristics is important for informing future planning and management actions. The ecology and biology of *G. parviflora* subsp. *parviflora* was reviewed by Driscoll (2013). It was concluded that the species is poorly understood and the high variability exhibited by the *Grevillea* genus suggests that it is difficult to draw any inferences about its characteristics.

Grevillea parviflora subsp. *parviflora* is a small shrub occurring in native woodland vegetation communities, and plants can grow up to 1 metre high. While the biology of *G. parviflora* subsp. *parviflora* is poorly understood, planning and management decisions need to be made on an ongoing basis and should be based on informed judgements.

Biological and ecological characteristics of the species important for planning and management purposes within Lake Macquarie local government area are summarised in Table 1. This shows that while information for decision-making does exist, there are important knowledge gaps.

Table 1:
Summary of important characteristics of *G. parviflora* subsp. *parviflora*

Characteristic	Review and comment
Growth habit	A small shrub growing to a height of around 1m, often suckering. Occurs as scattered shrubs and multiple close stems which makes distinguishing individual plants and determining abundance difficult. Plants can be quite variable in their morphological features, at least in the Lower Hunter area. Very shallow root system, limited to A0 and A1 soil horizons.
Habitat	Found in heath, woodland and open forest vegetation communities in a range of topographic positions, including riparian areas.
Flowering & fruiting cycles (reproductive phenology)	Flowering normally occurs annually between late September and early December. No detailed knowledge of flowering or seed viability exists, but is likely to be insect pollinated.
Propagation & reproduction	No specific information is available for the species. May reproduce clonally or by seed, or both. Requires investigation.
Genetics	No knowledge of the genetics of the species, or of a larger complex of <i>Grevillea</i> species of which <i>G. parviflora</i> subsp. <i>parviflora</i> appears to be part. Requires investigation of the complex, which also includes <i>G. virgata</i> , <i>G. sericea</i> , <i>G. linearifolia</i> and <i>G. humilis</i> . Hybridisation of <i>G. parviflora</i> subsp. <i>parviflora</i> does not seem to occur.
Environmental conditions	No information available on soil associations. Occurs on a wide range of topographic locations up to 300m elevation, generally on infertile, sandy or light clay soils. Some Sydney populations show an association with ironstone gravels particularly on the Lucas Heights and Berkshire Park soil landscapes.
Vegetation community associations	Within Lake Macquarie LGA, most records and habitat occurs within the Coastal Plains Smooth-barked Apple Woodland community, with the Coastal Plains Scribbly Gum Woodland community including most of the remainder.

Characteristic	Review and comment
Distribution	Endemic to mid coastal NSW from south of Sydney to the Lower Hunter Region. Comprises two apparent regional populations (possibly metapopulations), the northern distributed between Wyong, Lake Macquarie and Cessnock. Some small outlying populations exist. The area of occurrence is known with confidence although there is a need for surveys of occurrence of the species within the modelled habitat area where few records exist. Density of occurrence varies and is relatively unknown.
Population size	No estimates of population size are available across the range of its species, although populations on sites subject to surveys have been estimated. Based on modelling, about 4,900 ha of suitable habitat occurs within Lake Macquarie LGA, with approximately 50% of this habitat being on private land and 20% on Crown land.
Significant populations	The significance of populations cannot be estimated without further understanding of the biology and genetic characteristics of the species.
Population viability	Population viability cannot be estimated without further understanding of the biology and genetic characteristics of the species.
Conservation status	The species is listed as vulnerable under the NSW Threatened Species Conservation Act 1995 and vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. Habitat modelling suggests that around 40% of suitable habitat for the species has been lost from the area of the northern regional population since European settlement. The only significant conservation reserve containing suitable habitat for this species is Sugarloaf State Conservation Area with about 10% of modelled extant habitat.
Bush fire response	Plants regenerate and sucker after bush fires.
Disturbance response	Response to disturbance has not been studied or documented. It appears that plants recover following slashing and persist in power line easements.
Translocation response	Although not a conservation strategy, a small number of translocations of plants have been successful over short distances. No translocation from seed has been attempted, although the plant is known to propagate from cuttings.
Fragmentation & connectivity	Fragmentation is a long-term issue for the viability of the species, primarily the potential importance of pollinators for facilitating sexual recombination and hence promoting novel genetic diversity, and for genetic material to be dispersed. With no information available on plant reproduction or genetics, it is not possible to evaluate connectivity requirements, or the consequences of population fragmentation.

Notes:

1. Information in the table is from the scientific workshop held on 10 April 2013 and information in Driscoll (2013).
2. This table has been compiled for the Lake Macquarie local government area. Some characteristics may differ across the full geographic range of the species (e.g. associated vegetation characteristics).

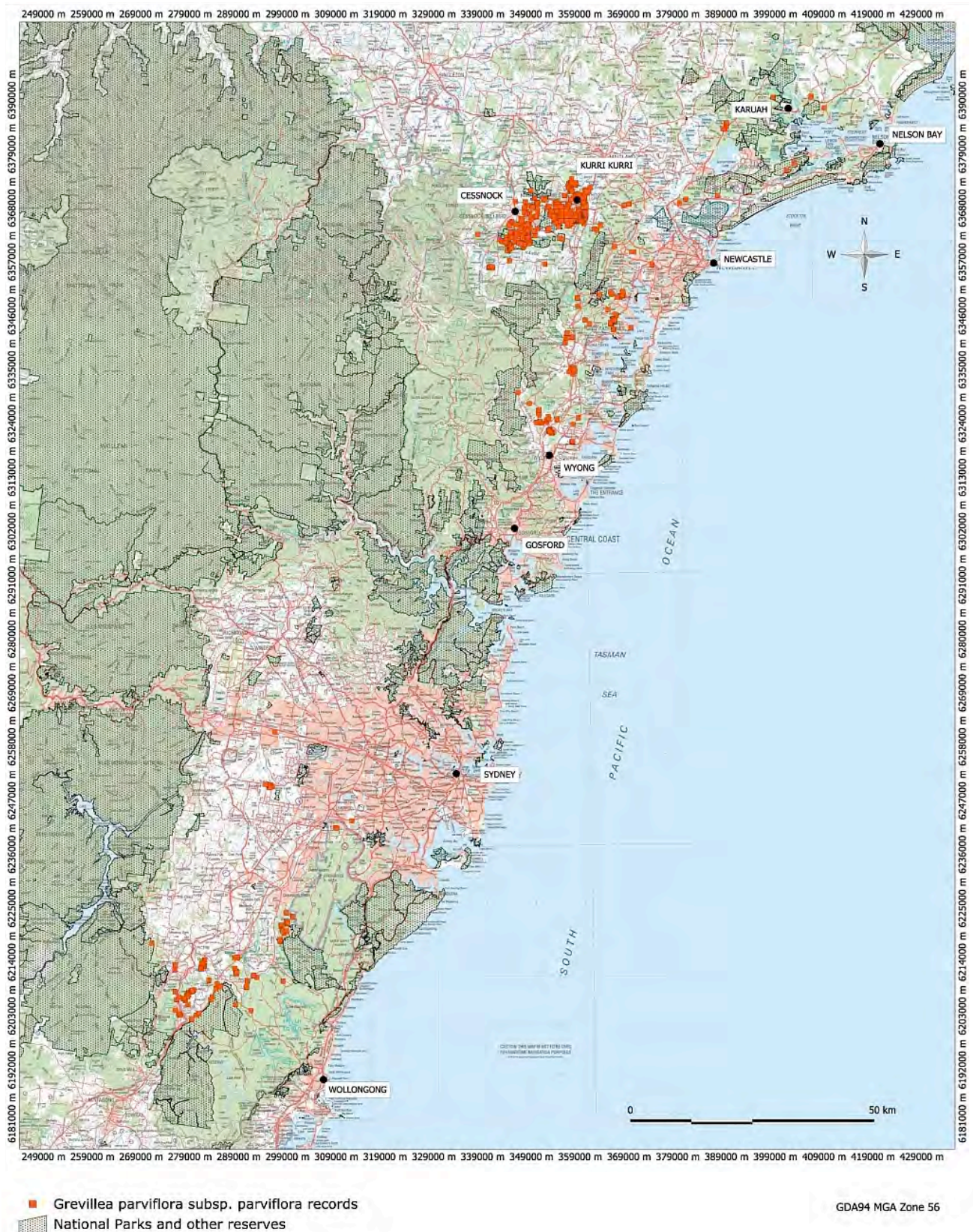
Driscoll (2013) concludes that little is known about *G. parviflora* subsp. *parviflora* biology and outlines a list of research priorities focusing on reproductive biology. Further scientific research is essential to be able to determine conservation requirements for the species and to assess the significance of development impacts on the species as required by relevant legislative processes.

Given the lack of knowledge, vulnerability of the species is difficult to assess for evaluating conservation requirements. However, it appears that historically the range of the species is declining (especially around Sydney), and it is subject to continuing decline in its habitat due to development pressures.

The current known distribution of *G. parviflora* subsp. *parviflora* is shown on Map 1 and appears to comprise two regional populations, one in the Lower Hunter and Central Coast regions, and the other generally south west of Sydney. There are also small outlying populations occurring in the Port Stephens, Great Lakes, Singleton, Campbelltown, Wollondilly and Wingecarribee local government areas.

Map 1:

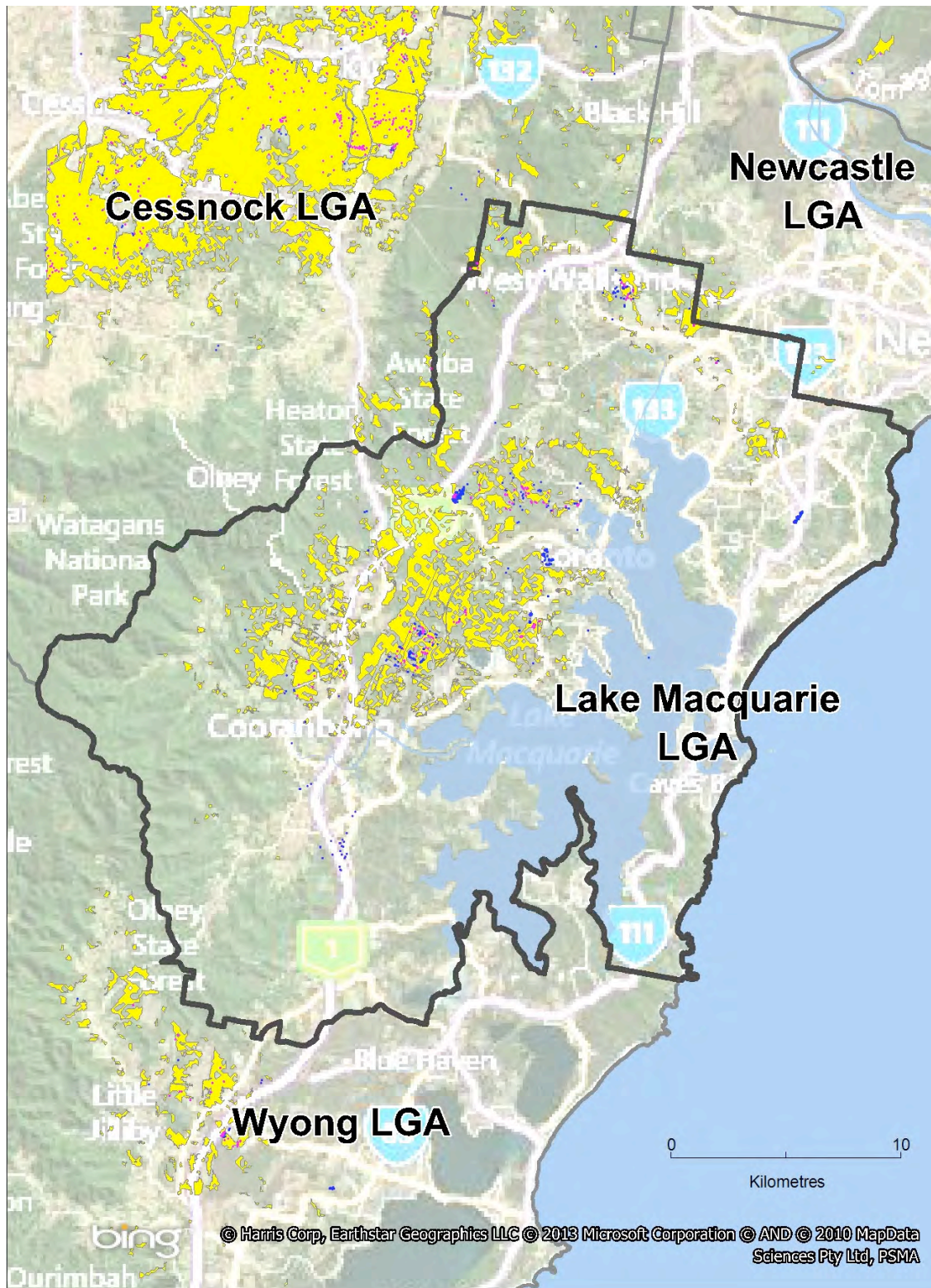
Distribution of *G. parviflora* subsp. *parviflora* (from Driscoll 2013)



Habitat modelling by Driscoll (2013) for the Lake Macquarie local government area is shown in Map 2. About 37% of modelled potential habitat within Lake Macquarie LGA has been lost since 1750. Within Lake Macquarie, there are clusters of records of the species, mostly on the western side of the lake, but distribution is known to be patchy and much of the modelled habitat area contains no records and has largely not been subject to field surveys.

Map 2:

Modelled *G. parviflora* subsp. *parviflora* habitat and records (from Driscoll 2013)



- Modelled suitable GPP habitat
- LMCC Flora database records
- GPP record inside model extent
- GPP record outside model extent

There are only 85 records of occurrence of *G. parviflora* subsp. *parviflora* within conservation reserves, although of the extant modelled habitat for the species, Driscoll estimates that 4,159 ha comprises conservation reserves (21% of extant habitat). Over 80% of records from conservation reserves are from Werakata National Park and State Conservation Area in the Cessnock LGA, and virtually no records are in conservation reserves in Lake Macquarie LGA, although there are also some records on council reserves.



4. Information Gaps

As indicated above, the biology and ecology of the species is not well understood. Further scientific knowledge is essential for informing future planning and management. Important knowledge gaps relate to identification, reproduction, population size, and assessing the impacts of development on the species.

Key scientific issues affecting planning and management are as follows:

- 1. Identification and taxonomy** – The distribution of *G. parviflora* subsp. *parviflora* overlaps with *G. humilis* over some of its range especially in the Lake Macquarie LGA, and it is difficult to differentiate between the two species in the field, especially in the absence of flowers. While there has been a reasonable degree of survey for *G. parviflora* subsp. *parviflora*, very few records of *G. humilis* exist. Potentially *G. humilis* could meet the criteria for listing as a threatened species.
- 2. Population characteristics** – While the distribution of *G. parviflora* subsp. *parviflora* is reasonably well understood, the characteristics of populations (especially their variability) is not known. In particular, there is no understanding of the size, viability or interactions between populations. Thus, its conservation security and population viability is not clear.
- 3. Reproductive biology** – The reproduction of *G. parviflora* subsp. *parviflora* plants is unknown, but it shows evidence of clonal (asexual) reproduction as well as production of seed (sexual reproduction). Furthering this knowledge is particularly important for determining habitat connectivity requirements and assessing development impacts.

- 4. Bush fire response** – Seed germination and resprouting characteristics after fire are not known. This information is important especially in areas that may be subject to frequent fires, or the absence of fire.

These key issues are discussed in more detail below, including an outline of important research questions for future planning and management.

4.1 Identification and taxonomy of *G. parviflora* subsp. *parviflora*

Under the current legislation there is a significant difference in the planning process depending on whether a species is listed as threatened or not. Misidentification affects how a development proposal is assessed in the planning system and whether biodiversity offsets are required or not.

Driscoll (2013) has identified an overlap between the modelled habitat for *G. parviflora* subsp. *parviflora* and *G. humilis*, and notes the difficulties in differentiating between these species, especially in the absence of flowers. Correct field identification is essential to inform planning and management and build a database of records for each species that will support future modelling and analysis. It has been requested that all specimens of *G. humilis* be sent to the National Herbarium of NSW to assist in documenting the natural variation of this species, to assist in the identification process, and build up records of this species.



As a consequence, a high priority is to develop tools to support correct species identification in field surveys. Knowledge of the genetic characteristics of *G. parviflora* subsp. *parviflora* is an important first step in addressing the gaps. A preliminary research project is proposed to address this issue in the short term, involving a taxonomic review with a view of producing an identification tool, supported by genetic analysis.

4.2 Population characteristics

Understanding the *G. parviflora* subsp. *parviflora* population is essential for effective land use planning and the long-term conservation of the species, especially population size requirements and the impacts of habitat fragmentation. Population density and the relationship to population viability are also unknown.

Habitat suitability modelling can assist with the interpretation of records of the species for planning purposes. This is used to estimate the distribution, and habitat preferences of plant species where records for the species are limited. In principle, habitat suitability modelling compares environmental conditions at known target species presence sites (some methods also include known absence data) against all other locations within the model area. All locations within the model area are then scored according to their degree of similarity to the conditions at known/unknown locations. Environmental variables can include, for example, soil landscape type, aspect, elevation, rainfall, solar radiation, and distance to streams. Driscoll (2013) used presence only data for a 100 metre square grid (1 ha) over the full known range of *G. parviflora* subsp. *parviflora* adjusted for sampling bias to estimate probability of habitat suitability. The modelling indicated that the main predictors of occurrence within the Lower Hunter are soil type, geology/conglomerate lithology and average annual rainfall of 800 – 1,000mm.

This was used to estimate the pre-1750 distribution, and the loss of suitable habitat to 2007 using extant vegetation mapping from aerial photography. *G. humilis* habitat modelling was based on only 15 records and indicated that the main predictors of occurrence are soil type and elevation of <50 metres above sea level. Given the overlap in area between *G. parviflora* subsp. *parviflora* and *G. humilis* habitat modelling and the few *G. humilis* records, there is merit in undertaking additional targeted field surveys for *G. humilis* in areas of modelled habitat where few records exist, and then reviewing modelling results.

Improving the reliability of records through better taxon identification and standardised population counting is an important first step in improving information in on populations and development impacts.

There is about 4,900 ha of modelled suitable habitat for *G. parviflora* subsp. *parviflora* within the Lake Macquarie local government area comprising about 11% of the total vegetated area of the City. This represents about 25% of the northern regional population. As at May 2013, there were approximately 900 records of *G. parviflora* subsp. *parviflora* within the LGA, which represent an unknown number of plants. However, in the absence of information about reproductive biology of the species, what this means in terms of the long-term presence of the species cannot be determined.

For land use planning and environmental assessment, there are both legislative and practical requirements for understanding *G. parviflora* subsp. *parviflora* populations. Consideration needs to be given to what habitat for the species is important, and to what populations are important. Determining the significance of potential impacts on the species requires an understanding of impacts on populations, local populations and viable local populations. Habitat modelling can assist in understanding these characteristics and is also helpful for managing land



on which *G. parviflora* subsp. *parviflora* occurs or potentially occurs.

Conservation requirements are largely based on requirements for a self-sustaining population. For *G. parviflora* subsp. *parviflora* this is currently not possible to determine. However, as a general principle, larger populations and plants with seed are more important for conservation purposes, as well as populations with a high density, plants growing in rare or uncommon habitat, and at the margins of the geographic range of the species.

4.3 Reproductive biology

In the absence of an understanding of the reproductive biology of the species, especially whether it reproduces sexually or clonally, or both, it is not possible to make realistic judgements about threats to the species, population size and the significance of development impacts.

Driscoll (2013) has identified the priority scientific question relating to reproductive biology as being to determine whether, or to what degree pollen is transferred from anthers to presenter at anthesis.

Other questions are:

- What is the flowering and fruiting phenology?
- Do flowers have anthers, and if so are they functional?
- How viable is the pollen?
- What pollinators exist, and what role do honeybees play?
- What is the pattern of fruit production?

The questions above are of long-term interest in improving an understanding of the conservation requirements of the species.

4.4 Bush fire response

Driscoll (2013) has identified a gap in knowledge about bush fire responses, especially seed germination and resprouting. This is a significant long-term management issue, which should be the subject of further research. Research questions identified by Driscoll are:

- How long do seedlings and resprouts (following fire) take to reach sexual maturity?
- What is the level of seed germination following fire?

5. Strategic planning issues

This section considers important issues for strategic conservation and development planning, and how *G. parviflora* subsp. *parviflora* conservation requirements can be integrated in planning and development processes. It draws on the scientific knowledge of the species and seeks to integrate conservation planning issues with development planning requirements.

Approximately 1,000 ha and 20% of modeled suitable habitat within Lake Macquarie LGA is likely to be subject to development pressure to 2050, and long term planning issues of land use impacts are likely to arise for the species. This is based on the extent of development foreshadowed in the relevant planning documents for the Lake Macquarie LGA and the Lower Hunter Region, including the Lake Macquarie Lifestyle 2030 Strategy and the Lower Hunter Regional Strategy. Map 3 shows potential long-term land use impacts on *G. parviflora* subsp. *parviflora* modelled habitat within the area.

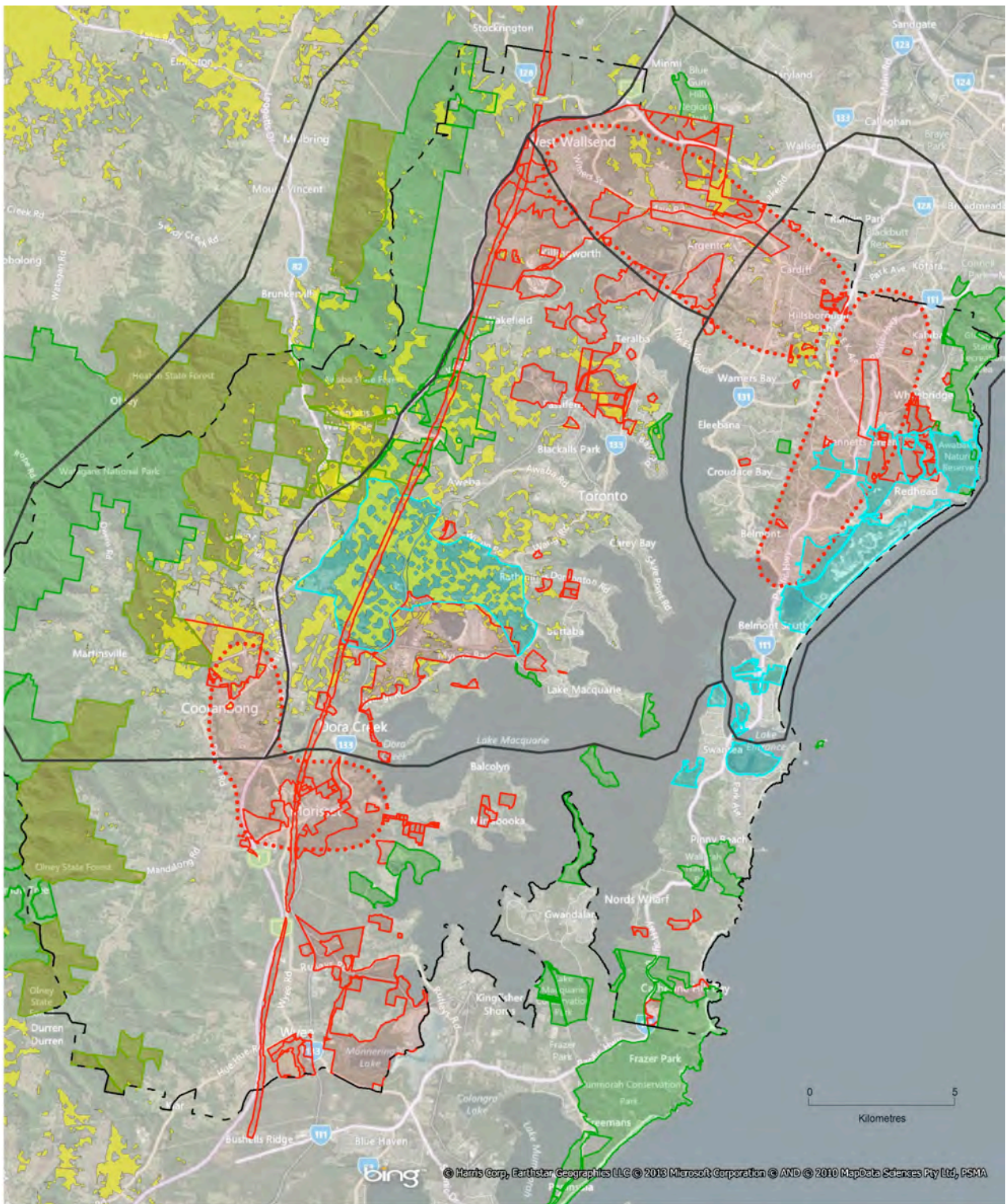
Matters of importance for conservation are discussed below, including species specific conservation issues, data and information issues, determining significant impacts arising from development, biodiversity offset issues, strategic planning objectives, and implementation mechanisms. These issues are discussed in more detail later in this section and provide a basis for strategic planning and development guidelines, including the determination of planning objectives.

Key questions to be resolved in determining a planning and management strategy are outlined below and include the following:

1. Over what time frame does the conservation of the species in Lake Macquarie LGA need to be considered?
2. What are the minimum conservation requirements for the species within Lake Macquarie LGA?
3. Is there a minimum site area requirement for effective conservation of the species?
4. What loss of population and/or area of species habitat is acceptable?
5. Are there any important populations or areas of habitat within which losses are more significant for the persistence of the species (e.g., areas of high stem density, areas of high genetic diversity, outlying populations, land providing habitat connectivity or having distinct environmental characteristics)?
6. Is climate change likely to significantly influence the distribution or persistence of the species in the future, or require a change to management practice?

Map 3:

Indicative future urban development and land use in Lake Macquarie LGA to 2100



- Likely & potential urban development
- Indicative likely impacts
- Existing Conservation Area - National Park
- Modelled GPP Habitat
- State Forests
- Indicative sub-population boundaries


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Note: Major connectivity barriers for pollination and genetic transfer have been used to identify indicative sub population boundaries.



5.1 Conservation issues

Specific matters important for the conservation of the species are:

- Conservation status (i.e. extent of extinction threat and protection)
- Conservation reserves and requirements
- Important (or significant) populations
- Connectivity requirements
- Buffers around populations to mitigate impacts

Currently, there is no reasonable knowledge of the size of the population within the Lake Macquarie LGA, or whether these represent multiple populations, and how they relate to the northern regional population. While the modelled habitat area provides an estimate of the suitability of habitat, it is not certain that the species occurs over the full area of habitat identified as suitable, nor that it occurs at a consistent density. Surveys have shown that the distribution is patchy, but the density of this patchy distribution is not known because few counts have been reported.

Because almost nothing is known about the genetic diversity of the species, the diversity across the range of occurrence is not known, nor the life cycle or reproductive biology of the plants. Therefore, minimum sizes of viable populations and minimum area requirements and conservation status cannot be reliably estimated.

Nevertheless, it may be possible to provide interim (speculative and precautionary) guidelines for maintaining habitat connectivity or isolation criteria. A key issue here is the requirement to support populations of pollinators. It is generally believed that *G. parviflora* subsp. *parviflora* is insect pollinated.

Little information exists about native bee flight distances, but it is likely that maximum flight distance would be around 300 – 400 metres (Payne, pers. Comm. 2012), with much greater distances for bird pollination. Studies of plant species having similar sized native bee pollinators suggest a flight distance of around 30 metres on average.

Priority areas for conservation should be areas containing large populations and high plant (or stem) density. Critical habitat sizes relate most importantly to connectivity and management requirements, and it is probable that areas of less than 5 – 10 ha of native vegetation enclosed by urban areas cannot be ecologically viable and maintain ecosystem functioning in their pre-development state into the long term. At a micro level, threatened plant species may be able to be retained in situ for lengthy periods in an urban context on sites as small as 1,000 square metres, but long-term persistence is likely to require active management and a change in ecosystem function is reasonable to expect. A minimum buffer area of 20 metres around populations is considered reasonable to reduce adverse impacts from adjoining development or land use.

It is possible to produce an interim map of sub-populations within the City (Map 3), with a view to limiting disturbance to land on which the populations occur and identifying conservation reserve priorities. Suggested criteria for determining important populations are those with a patch size of over 40 ha, and/or with more than 500 *G. parviflora* subsp. *parviflora* stems or plants. Identifying these areas should be the subject of further investigation with preference given to identifying important areas where these are identified for long term conservation land use (e.g. Environment Protection zones) and where they are connected by native vegetation to other *G. parviflora* subsp. *parviflora* populations, and where they are in a secure land tenure (e.g. conservation reserve).



5.2 Data and information issues

Appropriate information for decision-making is important and requires consistent survey methods, especially plant counting. The Lake Macquarie Flora and Fauna Survey Guidelines (LMCC 2013) refer to requirements for *G. parviflora* subsp. *parviflora*. Importantly, they do not identify the difficulty in differentiating between identification *G. parviflora* subsp. *parviflora* and *G. humilis* and differ from the proposals agreed in the scientific workshop as outlined in Appendix B.

The scientific workshop proposed revised survey guidelines for *G. parviflora* subsp. *parviflora*:

1. Surveys should be undertaken between late September and early December
2. The boundary of the whole population/patch is to be determined
3. The density of the population/patch is to be determined
4. Where it is possible, individual stems should be counted and spatially referenced, and where there are multiple stems in close proximity the stem density should be estimated within a spatially defined polygon.
5. A 10-metre separation distance between patches might indicate different plants
6. Observations should include an estimate of the amount of fruit set

The Lake Macquarie Flora and Fauna Survey Guidelines for *G. parviflora* subsp. *parviflora* should be replaced by the Interim Planning and Management Guidelines above.

5.3 Determining significant impacts

Determining significance of impacts in development assessment is important for the purpose of meeting requirements under the NSW and Commonwealth legislation. In making land use decisions and approving activities affecting *G. parviflora* subsp. *parviflora*, authorities are required to consider the significance of impacts arising. The criteria for assessing significance differ between the Commonwealth Environment Protection and *Biodiversity Conservation Act* 1999 and the *NSW Threatened Species Conservation Act* 1995.

Determining significant impact is complicated by species identification, as it is not necessary for species that are not listed as threatened such as *G. humilis*.

Making reasonable decisions on impact significance is difficult in the absence of adequate scientific information, especially the determination of what constitutes a viable local population. The targeted scientific research proposed in Section 6 will support legislative planning and assessment requirements.

5.4 Biodiversity offset requirements

Biodiversity offsets are measures used to compensate for the loss of biodiversity values when impacts cannot be avoided or otherwise mitigated. Offsets which increase security of remaining *G. parviflora* subsp. *parviflora* habitat and appropriate management have merit in supporting the persistence of the species. It is useful to provide some guidance about offset requirements within Lake Macquarie local government area, recognising that land management practices alone are unlikely to increase population size.



There are a number of offset methodologies available, but none specifically refers to *G. parviflora* subsp. *parviflora* and in practice, offsets are generally negotiated. The NSW BioBanking Assessment Methodology is applied extensively as a benchmark for determining offset ratios.

For *G. parviflora* subsp. *parviflora* two issues arise in the use of this method:

1. Counting of stems of clonal plants cannot differentiate plants and no accurate indication of separate plants can be derived to provide a reasonable basis for calculating offsets.
2. The methodology assumes that the number of plants can be increased by management actions. This assumption appears incorrect in relation to *G. parviflora* subsp. *parviflora* management actions will stop loss of plants, but will not increase plant numbers.

It is therefore recommended that the Office of Environment and Heritage review the credit calculator for *G. parviflora* subsp. *parviflora*, the appropriate survey methods to be used, and the species credits that can be achieved by certain management actions.

5.5 Regional Strategic planning objectives

Planning objectives document and provide the basis for implementation of planning measures. Objectives are helpful for clarifying desired outcomes and for incorporating in strategic planning documents.

In the absence of good scientific knowledge, interim objectives for the species within Lake Macquarie LGA are appropriate to support consistent decision-making.

The Lower Hunter Regional Conservation Plan (Department of Environment and Climate Change 2009) applies the agreed national and state (Commonwealth of Australia 1997) targets for forested environments to the Lower Hunter as follows:

- A general principle of 15% reservation of the pre-1750 distribution of each forest ecosystem.
- Where forest ecosystems are recognised as vulnerable, then at least 60% of their remaining extent should be reserved (e.g. endangered ecological communities listed under the TSC Act 1995).
- All remaining occurrences of rare (geographic range of <10,000 ha, total area of <1,000 ha in region or path sizes of generally <100 ha), endangered and vulnerable (approaching 70% reduction in area) forest ecosystems should be reserved or protected by other means as far as is practicable.

5.6 Implementation mechanisms

Mechanisms for planning implementation include biodiversity offsets, acquisition of conservation reserves, recovery plans, legal conservation/planning agreements, development assessment requirements, and management frameworks (including monitoring).

6. Land management issues

This section reviews the management of *G. parviflora* subsp. *parviflora* populations, both where these are sought to be protected and where these occur in areas identified for future development.

Management of land with known *G. parviflora* subsp. *parviflora* populations or containing suitable habitat within which *G. parviflora* subsp. *parviflora* has potential to occur should be managed appropriately. Land management practices have the potential to affect *G. parviflora* subsp. *parviflora* and this section provides guidance in relation to how to manage land to maintain populations. It must be recognised that significant information gaps exist in knowledge about the species, and that more detailed guidelines may become available in the future.

Management should have regard to the planning objectives outlined in the previous section. Where land use plans identify that natural bushland and ecological systems are to be retained (e.g. conservation zonings), land management should have an objective to retain bushland in a natural condition and to actively manage the land to support the retention of important ecological values and processes, such as *G. parviflora* subsp. *parviflora* populations. Where land use plans have not been finalised or development has not been approved, then existing ecological values must be retained and maintained.

Note: in some circumstances development proposals may be at an advanced stage of planning, and re-designing the development to comply with these guidelines may be unreasonable.

Matters that need to be considered when managing land include:

- Relevant land use plans, or restrictions on development
- Development consent conditions or requirements (e.g. protection of habitat or rehabilitation of land)
- Bushfire asset protection requirements
- Bushfire regimes (fire frequency and intensity) required to maintain the species
- Management plans applying to the land such as vegetation management plans, rehabilitation plans or plans of management for public land
- Legislative provisions that may restrict vegetation clearing or use of the land or impose management obligations (e.g. noxious weed control)
- The nature and impact of adjoining land uses or activities
- Legal restrictions on land such as easements or covenants
- Pest and disease management

Land management is an important consideration later in the process of development, particularly after plans have been determined, and is especially important at the construction stage. Management issues are summarised in Table 2 below and should be taken into account in planning and development approval. Specific guidelines for management actions are outlined later. It is important to note that many of the management issues are closely interrelated and must form part of integrated management programs.

Table 2: Management issues for *G. parviflora* subsp. *parviflora*

Issue	Comment
Management planning	<p>Public lands such as Council reserves and conservation reserves managed by the Office of Environment and Heritage normally require the preparation of management plans meeting legislated requirements.</p> <p>Private land may also require the preparation of a management plan in connection with an offset arrangement, development consent condition, or other agreement. Plans may relate to protection of habitat, restoration of native vegetation, monitoring and the like.</p> <p>Where management plans applying to <i>G. parviflora</i> subsp. <i>parviflora</i> habitat are being prepared, these plans should refer to these guidelines and include the <i>G. parviflora</i> subsp. <i>parviflora</i> management actions.</p>
Bushfires	<p>It appears that <i>G. parviflora</i> subsp. <i>parviflora</i> plants are relatively resilient to bushfires and resprout after fire. However, the frequency and intensity of fire affects its habitat and its pollinators. Bushfire may also contribute to the establishment and dispersal of weeds.</p> <p>Bushfire hazard reduction and asset protection activities also have the potential to adversely affect <i>G. parviflora</i> subsp. <i>parviflora</i> through disturbance to plants, including clearing and track construction.</p> <p>Maintaining <i>G. parviflora</i> subsp. <i>parviflora</i> habitat relates to the ecology of the vegetation communities and requires periodic fire. Management of <i>G. parviflora</i> subsp. <i>parviflora</i> should be considered in context with the requirements of other threatened species occurring concurrently.</p> <p>Fire frequency should not be shorter than the time taken for plants (from resprouts and seed germination) to develop to reproductive maturity, and go through one or more reproductive cycles to replenish the seed bank. The absence of fire for long periods (over 30 to 50 years) is probably undesirable.</p>
Weeds	<p>No specific weed threats to <i>G. parviflora</i> subsp. <i>parviflora</i> have been identified to date. However, over the long term, weeds have the capacity to transform native vegetation, usually in combination with disturbance and changes to natural soil and water processes (e.g. stormwater disposal)</p>
Roads and tracks	<p>Roads and tracks are associated with soil disturbance and changes to surface and groundwater flows. Ongoing usage and periodic maintenance can contribute to the introduction of weeds or pathogens, which may be harmful to natural ecosystems. Therefore, it is important to limit road and track usage and to carefully locate the construction of any new tracks to minimise impacts.</p>
Easements	<p><i>G. parviflora</i> subsp. <i>parviflora</i> populations occur in water and electricity easements, which are subject to vegetation clearing and periodic maintenance. This means that plants are potentially subject to regular adverse impacts. The effects of clearing or slashing <i>G. parviflora</i> subsp. <i>parviflora</i> habitat within easements is unknown, and monitoring of populations over time is appropriate to review impacts.</p> <p>Clear guidelines for maintaining easements are required, including survey and monitoring of <i>G. parviflora</i> subsp. <i>parviflora</i> populations and timing of slashing to avoid the flowering period.</p>
Vegetation clearing and maintaining habitat connectivity	<p>Vegetation clearing for purposes of development, fencing, grazing and bush fire asset protection is probably the most significant management issue affecting <i>G. parviflora</i> subsp. <i>parviflora</i>. Habitat clearing should only be undertaken following appropriate environmental assessment and in accordance with necessary approvals and guidelines.</p> <p>Pollination and seed dispersal mechanisms are influenced by the connectivity of native vegetation. Therefore, connecting of <i>G. parviflora</i> subsp. <i>parviflora</i> habitat to other areas of native vegetation to allow pollinator and seed dispersal mechanisms to occur will be important for long-term population viability.</p>
Soil and water management	<p>Soil disturbance, changes to surface, and groundwater flows have potential to impact on <i>G. parviflora</i> subsp. <i>parviflora</i> as well as its habitat. However, it appears that soil moisture is not a major limiting factor for <i>G. parviflora</i> subsp. <i>parviflora</i> growth and survival.</p> <p>Urban development uphill of a <i>G. parviflora</i> subsp. <i>parviflora</i> population require careful consideration (especially fertilisers and nutrients) and should be avoided where possible or incorporate native vegetation buffers of adequate width. Stormwater discharges can result in a change to the whole vegetation structure and to facilitate weed invasion.</p> <p>Dispersal of <i>G. parviflora</i> subsp. <i>parviflora</i> seed is unknown, and soil disturbance may affect seed dispersal. Similarly, disturbance may introduce soil pathogens.</p>
Propagation, translocation and re-establishment	<p>Although options of last resort, potential active species protection measures are translocation of stems, or propagation from cuttings. Translocation is at an experimental stage, but reasonable plant survival rates have been observed.</p>
Monitoring <i>G. parviflora</i> subsp. <i>parviflora</i> populations and habitat	<p>Monitoring is an important management tool for reviewing the ongoing impact of management activities, and for adapting to changes over time. It is important to prioritise management activities.</p> <p>Normally, a monitoring program should form part of a management plan where this is required. Monitoring of <i>G. parviflora</i> subsp. <i>parviflora</i> clumps and distribution is essential, but associated environmental conditions such as habitat for pollinators, bush fires, or pollinator populations may also need to be monitored to provide useful information.</p>

7. Scientific research priorities

The scientific workshop reviewed the priorities for scientific research to support effective planning and management of *G. parviflora* subsp. *parviflora*, and the outcomes are presented in Appendix A.

With little information known about the species, research priorities are as follows:

1. Improving species identification
2. Undertaking preliminary genetic analysis to support an understanding of reproductive biology, genetic diversity and population characteristics
3. Identifying the response of the species to bush fires

Driscoll (2013) proposed a number of other areas of research, primarily to address the question of reproductive biology and population viability. While important, these are secondary in comparison to the priorities outlined above.

7.1 Improving species identification

The distribution of *G. parviflora* subsp. *parviflora* overlaps with *G. humilis* over some of its range especially in the Lake Macquarie LGA, and it is difficult to differentiate between the two species in the field, especially in the absence of suitable flowers. It is essential to be able to provide tools to differentiate between *G. parviflora* subsp. *parviflora* and the similar *G. humilis* in the field. Morphological differences should be complemented by a genetic analysis to improve the clarity of differentiation.

While there has been a reasonable degree of survey for *G. parviflora* subsp. *parviflora*, very few records of *G. humilis* exist, and potentially this species could meet the criteria for listing as a threatened species. The state of knowledge of *G. humilis* is much less than for *G. parviflora* subsp. *parviflora*.

A locally based on-line field identification tool would support better identification of the species, as identified in the scientific workshop. This would support decision-making, and is proposed to be undertaken as soon as possible, subject to funding.

7.2 Preliminary genetic analysis

To support taxonomic differentiation of the species and to provide a basis for resolving unknowns in relation to reproductive biology and population characteristics, preliminary genetic analysis is proposed to be undertaken.

The focus of genetic work is to:

- To support identification of the taxa, and confirm species. There needs to be work undertaken on the complex of 5 apparently related species. This would give confidence that the correct species are being protected and facilitates implementation of the *TSC Act* and *EPBC Act*.
- To determine the degree of clonality present. This will help indicate the number of populations that occur, and how related individuals are in a space.
- To determine population structure of the species as a whole, including whether there really are two metapopulations, and what is happening in the species overall.



7.3 Species response to bush fire

Reproduction and persistence of the species is probably significantly affected by bush fires and associated land management practice. It is proposed that preliminary work be undertaken to establish field scientific reviews of bush fire responses.

The specific priority is to determine whether *G. parviflora* subsp. *parviflora* seeds germinate after fire, and whether, and how long seedlings and resprouting stems take to reach sexual maturity after fires. This could be proposed as a university research project.

7.4 Other research

Other complementary research to inform planning and management is:

- Testing and refining a standardised counting methodology and documenting evidence of seeding
- Undertaking field surveys to check occurrence within modelled areas of *G. parviflora* subsp. *parviflora* and *G. humilis* habitat where field records are absent, especially in areas where development growth is likely. With improved records, the habitat model should be reviewed
- Reviewing genetic diversity within populations and across the species range, and determining whether populations are reproducing clonally or sexually. This has implications for viable population size and long-term conservation and recovery requirements.
- Undertake a review of population densities to determine their spatial variability.

The research identified above would be facilitated by ensuring use of the new counting methodology in field surveys required for development proposals.

8. Planning and management strategy

This section outlines the proposed strategy for planning and managing *G. parviflora* subsp. *parviflora* within Lake Macquarie LGA. It provides information to be incorporated within or used in updates of current planning documents, including Lower Hunter Regional Strategy, draft Lake Macquarie Lifestyle 2030 Strategy, Lake Macquarie Development Control Plan No. 1, and local environmental studies to support draft local environmental plan proposals.

The following objectives have been determined for planning and managing *G. parviflora* subsp. *parviflora* based on the review undertaken:

Table 3: Planning and management objectives for *G. parviflora* subsp. *parviflora*

Apply consistent field survey methods across the City and by all levels of government
Retain a viable population across the full geographic range of the species in the City in the long term (100+ years)
Identify important populations where no loss of population is acceptable
Improve the conservation status within the City by identifying areas suitable for reserves within each identified sub-population, and protecting at least 20% of the modelled habitat and at least 20% of known plant populations in conservation reserves (e.g. Crown land)
Ensure at least 50% of the area of modelled habitat in Lake Macquarie LGA is zoned for conservation under relevant planning instruments in the long term (currently about 1,400 ha or 28% is zoned for conservation)
Ensure that any loss of population of <i>G. parviflora</i> subsp. <i>parviflora</i> from development or other actions is to be offset with suitable measures
Support scientific research to inform planning and management
Undertake surveys on Council owned and managed land to document populations and management issues
Incorporate objectives and measures to protect threatened species in relevant Council strategic planning and management documents

9. Planning and management guidelines

These Interim Planning and Management Guidelines are specific to Lake Macquarie LGA, and are intended to be taken into account in the application of strategic plans and policy documents including Lake Macquarie Development Control Plan No. 1 and Lake Macquarie City Council Flora and Fauna Survey Guidelines (LMCC 2013). These should also be considered in the review of the Lower Hunter Regional Strategy and proposed Commonwealth strategic assessment under the *Environment Protection and Biodiversity Conservation Act 1999*.

Interim Guidelines for the planning and management issues identified earlier in the document are outlined in the tables below. These differentiate between guidelines for planning land use and assessing development proposals (Table 4), and guidelines for the ongoing management of land (Table 5) which are normally incorporated in management or vegetation plans. The guidelines are intended to be applied until further scientific research into the species is available to further clarify the matters discussed previously.

Table 4: Interim planning guidelines for *G. parviflora* subsp. *parviflora*

Planning issue	Guideline
Survey guidelines	<ol style="list-style-type: none"> 1. Surveys should be undertaken between late September and early December 2. Taxonomic identification must be certain to ensure there is no misidentification with <i>G. humilis</i> 3. The boundary of the whole population/patch is to be determined 4. The density of the population/patch is to be determined 5. Where it is possible, individual stems should be counted and spatially referenced, and where there are multiple stems in close proximity the stem density should be estimated within a spatially defined polygon. 6. A 10-metre separation distance between patches would indicate different plants 7. Observations should include an estimate of the amount of fruit set 8. Details of the spatial location of records are to be provided to the NSW Wildlife Atlas and Lake Macquarie City Council.
Population viability	Any population occurring on a site is assumed to be a viable population in the absence of adequate scientific information that shows this is not the case
Habitat connectivity and buffer areas	<p>Plant populations are assumed to be biologically connected if they are separated by a distance of less than 500 metres.</p> <p>A minimum buffer distance of 20 metres is required to protect plants from the impacts of adjacent land uses, developments or activities.</p>

Planning issue	Guideline
Protecting important populations	<p>For planning purposes, an important population is one in an area of land which includes suitable <i>G. parviflora</i> subsp. <i>parviflora</i> habitat and:</p> <ol style="list-style-type: none"> 1. has an area of over 40 ha and/or 2. contains more than 500 <i>G. parviflora</i> subsp. <i>parviflora</i> stems or plants, and/or 3. is connected by native vegetation to other <i>G. parviflora</i> subsp. <i>parviflora</i> populations, or 4. is in a secure conservation land tenure (e.g. conservation reserve).
Conservation reserve requirements	<p>Minimum conservation reserve size should be 10 ha, or adjoin an area of at least 10 ha.</p> <p>Suitable land tenures for conservation reserves are all lands reserved under the <i>National Parks and Wildlife Act 1974</i> and Biobank sites established under the <i>Threatened Species Conservation Act 1995</i>.</p> <p>Based on the existing restricted number of records potential conservation reserves to protect <i>G. parviflora</i> subsp. <i>parviflora</i> should be investigated within each of the indicative sub-population boundaries shown on Map 3. Potential reserve areas could be identified in the future as a result of further survey work.</p>
Acceptable loss of plants and populations	<p>No loss of plants, populations or suitable habitat is acceptable within identified important populations.</p> <p>Where loss of plants cannot be avoided on a site, no more than 25% of the on-site population is to be lost, unless a strategic area wide assessment has been undertaken, and an area based plan prepared which includes suitable provision of biodiversity offsets.</p>
Applicable conservation standard	<p>No net loss of plant populations within Lake Macquarie local government area (i.e. not maintain or improve)</p>
Determining the significance of environmental impacts	<p>For the purposes of administering the <i>NSW Threatened Species Conservation Act 1995</i>, a significant impact on <i>G. parviflora</i> subsp. <i>parviflora</i> includes one which:</p> <ol style="list-style-type: none"> 1. removes 25% or more of the total number of plants on a site, or total connected population (where the number plants on a site or in the population is more than 100, and/or covers an area of more than 1.0 ha), and/or 2. the population is small, isolated or at the edge of the species geographic distribution, or 3. there are other biological or ecological characteristics (e.g. connectivity or local variation) which require special consideration. 4. isolates a <i>G. parviflora</i> subsp. <i>parviflora</i> plant group from other patches of native vegetation 5. causes any loss of <i>G. parviflora</i> subsp. <i>parviflora</i> plants in an important population <p>Note: These estimates are more applicable to a sexually reproducing population than a clonal one. The priority for protecting the species is for the retention of genetically diverse, sexually reproducing individuals rather than clonal stems, but differentiating between these is not possible until further research is undertaken.</p>
Biodiversity offset requirements	<p>Where there is no alternative to the loss of <i>G. parviflora</i> subsp. <i>parviflora</i> plants a suitable biodiversity offset is to be provided.</p> <p>Suitable offsets are:</p> <ol style="list-style-type: none"> 1. replacement ratio of 5:1 for loss of area of known habitat or modelled habitat, or 2. replacement ratio of 2:1 for plants lost <p>Offsets which protect identified important <i>G. parviflora</i> subsp. <i>parviflora</i> populations are preferred.</p> <p>Securing a viable population in public ownership with conservation management (e.g. within conservation reserves or Biobank sites) is preferred.</p>

Specific guidelines for management actions which may affect *G. parviflora* subsp. *parviflora* are outlined in Table 5 below. These guidelines will be useful to refer to when considering planning and development consent requirements. Many of these actions are consistent with guidelines for managing other threatened plant species.

Table 5: Interim management guidelines for *G. parviflora* subsp. *parviflora*

Management action	Guideline
Preparing a management plan	<p>Survey and map the <i>G. parviflora</i> subsp. <i>parviflora</i> population using the survey method outlined in Section 4.</p> <p>Include map of known <i>G. parviflora</i> subsp. <i>parviflora</i> habitat in relevant plan of management (but not specific plant locations), and specific management guidelines if appropriate.</p> <p>LMCC to maintain a spatial layer showing accurate distribution of <i>G. parviflora</i> subsp. <i>parviflora</i> clumps across the LGA. This is to be able to be linked with plans of management.</p>
Protecting assets from bush fires	<p>Where <i>G. parviflora</i> subsp. <i>parviflora</i> occurs in existing bush fire asset protection zones, where possible disturbance should be avoided or minimised. If no alternative to removal of the vegetation exist, this habitat should be periodically slashed to reduce hazards rather than subject to removal of vegetation. Disturbance to soil and vegetation at ground level is to be avoided and plant response should be monitored.</p> <p>Where asset protection zones are proposed as part of a new development, appropriate site planning should occur to avoid the creation of an asset protection zone that includes <i>G. parviflora</i> subsp. <i>parviflora</i>.</p>
Responding to bush fires	Maintaining <i>G. parviflora</i> subsp. <i>parviflora</i> habitat requires periodic fire, and periodic fires with an interval of between 7 and 30 years is probably desirable. This guideline is expected to be subject to future review.
Controlling weeds	Weeds in <i>G. parviflora</i> subsp. <i>parviflora</i> habitat are to be adequately controlled to prevent significant environmental changes and impacts on <i>G. parviflora</i> subsp. <i>parviflora</i> plants. Where necessary weed control activities are undertaken, these shall avoid adverse impacts, such as broad scale spraying.
Maintaining access roads and tracks	Road and track maintenance should be undertaken during dry weather, and preferably during the flowering time to enable plants to be identified and therefore disturbance to be avoided.
Maintaining electricity and water easements	No broadscale spraying of herbicide is to be undertaken. Acceptable options for weeds or vegetation control are slashing or targeted spraying of Eucalypts. It is preferable not to clear or slash <i>G. parviflora</i> subsp. <i>parviflora</i> when it is flowering or seeding from September to February. Surveys of potential <i>G. parviflora</i> subsp. <i>parviflora</i> habitat shall be undertaken prior to any works, during the flowering period in Spring months in accordance with survey guidelines.
Habitat clearing	<i>G. parviflora</i> subsp. <i>parviflora</i> habitat or plants are not to be cleared except where necessary prior approvals have been given, and where this is in conjunction with an approved or permissible development or associated activity.
Grazing or slashing vegetation	<p><i>G. parviflora</i> subsp. <i>parviflora</i> is able to cope with slashing. The height of slashing does not appear to be important. However, slashing frequency may be a problem if done too regularly. Grazing has similar impacts to mechanical slashing.</p> <p>For regular maintenance works, it is preferable not to clear or slash <i>G. parviflora</i> subsp. <i>parviflora</i> when it is flowering or seeding from September to February.</p>
Excavating or disturbing soil	Excavation or soil disturbance in the vicinity (i.e. within 10 metres) of <i>G. parviflora</i> subsp. <i>parviflora</i> clumps should be minimised. Urban development uphill of a <i>G. parviflora</i> subsp. <i>parviflora</i> population should be avoided where possible, and where this occurs, there should be provision of appropriate native vegetation buffers and water management for ensuring no adverse impacts to the species or its habitat result.
Monitoring vegetation and populations	Where a site-specific management plan exists, this should include provision for monitoring sufficient to determine changes in <i>G. parviflora</i> subsp. <i>parviflora</i> populations or in the distribution of clumps on a site.
Propagating and translocating <i>G. parviflora</i> subsp. <i>parviflora</i>	In most circumstances, translocation is not supported. Where attempted, a plan for watering and handling of plants is needed, for the prevention of potential plant pathogens, and subsequent monitoring and reporting of effectiveness. Such guidelines should form part of a specific management plan for this activity. Propagation from cuttings can potentially be used for landscaping works. Refer to translocation guidelines in Vallee et al (2004).



10. Conclusions

These Interim Planning and Management Guidelines outline current knowledge of the biology and ecology of *G. parviflora* subsp. *parviflora* and will inform decision-making in relation to the species within Lake Macquarie local government area. These identify the requirements for the conservation of the species in the long term, and provide improved certainty for development within the local government area.

The measures proposed in the guidelines have relevance across the full range of the species, and may be applicable to a number of other local government areas within which *G. parviflora* subsp. *parviflora* occurs. They may also prove useful to other organisations making decisions about the management of this species.

The habitat for *G. parviflora* subsp. *parviflora* is expected to be subject to development impacts over the next 37 years and beyond and these Interim Guidelines outline the possible scale of the impacts and conservation measures that are available based on current knowledge of the species and potential development until 2050.

Given the limited current knowledge of the species, these guidelines are interim in nature and should be reviewed:

- when scientific information becomes available that would change the management and planning guidelines
- when future planning and development scenarios change
- if conservation status of the species changes

Additional scientific research to improve knowledge of the species will contribute to improved planning and

management certainty in the future. Should the required level of information become available then more detailed guidelines for the species should be prepared.

Glossary

Important population is a concept applied for planning and management and refers to populations that have been identified to be important for conservation of the species in the long term. Criteria for determining important *G. parviflora* subsp. *parviflora* populations within the Lake Macquarie LGA are included in Table 4.

Local population means a population spatially segregated from other local populations, and occupying a suitable, discrete habitat patch. Local populations form part of a metapopulation. Sometimes the terms “population” and “local population” are used interchangeably.

Metapopulation means a group of populations of the same species between which genetic material can potentially be transferred as a result of recurrent extinction/recolonisation patterns. Metapopulations often occur in fragmented habitats.

Plant group refers to a group or collection of plant stems occurring in one location or site. Given the difficulties in determining what constitutes a population, the term may co-incide with a local population.

Viable local population is a term referred to in Section 5A of the TSC Act 1995 and refers to the ability of a population to persist and to avoid extinction. Quantification of species habitat requirements can enable estimation of minimum viable populations over certain time periods and may allow reserve and connectivity requirements to be determined. For *G. parviflora* subsp. *parviflora* no viable or critical population size has been able to be determined.



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Appendix A

Report on scientific workshop

Scientific workshop outcomes - *Grevillea parviflora* subsp. *parviflora*

Background to the workshop

Grevillea parviflora subsp. *parviflora* is a listed threatened plant species, both at the NSW and national levels. This species is widespread in parts of Lake Macquarie local government area and subject to the impacts of development and land use change. Because of the impact of projected development on the species and its impact on development proposals, Lake Macquarie City Council commissioned a review of scientific knowledge of the species by Colin Driscoll.

To review the outcomes of the scientific review, and to reach agreement on the most effective steps to improve planning and management for the species, a workshop was held on Wednesday 10 April 2013 at Lake Macquarie City Council offices. The workshop was attended by representatives of the Commonwealth and NSW Governments, scientific specialists with relevant knowledge of taxonomy, field biology and genetics, and representatives of three local government areas, and a Catchment Management Authority.

Those attending the workshop were:

Bob Makinson, Royal Botanic Gardens, Sydney
Colin Driscoll, Hunter Eco
Stephen Bell, Eastcoast Flora Survey
Elizabeth James, Royal Botanic Gardens, Melbourne
Susan Hoebee, La Trobe University
Dianne Blair, SEWPAC
Karen Thumm, OEH
Martin Fallding, LMCC
Robbie Economos, LMCC
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The scientific review was circulated to all workshop participants prior to the day, and issues to be discussed were identified as part of the program for the day, which included a field inspection. The workshop agenda is appended.

The outcomes of the workshop discussions are summarised for each of the topics presented below. Key issues to be followed up to facilitate future planning and management for the species are outlined and proposed actions are suggested where appropriate.

Species identification

The distribution of *G. parviflora* subsp. *parviflora* overlaps with *G. humilis* over some of its range especially in the Lake Macquarie LGA, and it is difficult to differentiate between the two species in the field, especially in the absence of suitable flowers. It is essential to be able to differentiate between *G. parviflora* subsp. *parviflora* and the similar *G. humilis* in the field. Morphological differences should be complemented by a genetic analysis to improve the clarity of differentiation.

While there has been a reasonable degree of survey for *G. parviflora* subsp. *parviflora*, very few records of *G. humilis* exist, and potentially this species could meet the criteria for listing as a threatened species. The state of knowledge of *G. humilis* is much less than for *G. parviflora* subsp. *parviflora*.

An on-line identification tool would support better identification of the species. This in turn would assist the conservation of the species and allow a database of records for *G. humilis* to accumulate. This could be relatively easily compiled.

Survey methodology (determining individuals and patches)

It is essential to estimate the size of a population or patch. It may be hard to differentiate between an individual plant and a patch. Having a standard method of counting will enable a useful database of records of the species to be compiled.

The survey and counting method proposed by Colin Driscoll was found reasonable, and some additional observations should also be undertaken.

This involves:

1. Surveys should be undertaken between late September and early December
2. Determining the boundary of the whole population/patch
3. Determining the density of the population/patch
4. Where it is possible, individual stems should be counted and spatially referenced, and where there are multiple stems in close proximity the stem density should be estimated within a spatially defined polygon.
5. Observations should include an estimate of the amount of fruit set

A 10 metre separation distance between dense, multi-stemmed patches may indicate clumps of genetically different plants.

The density of the number of stems may give an indication of whether the species is reproducing clonally or not. Details of stem density in field surveys should therefore be provided, both within the survey site and within polygons containing multiple stems.

It was noted that the NSW Biobanking Assessment Methodology may not adequately assess the species because it refers to individual plants and does not take into account clonality, and therefore not differentiating between clonal or seeding populations. This matter should be discussed further with OEH to confirm that stem counts are appropriate and how they are accounted for in the methodology. A revised counting method may need to be incorporated in OEH species profiles and guidelines.

Determining what constitutes a population

Without understanding the species biology better, including the genetics, it is impossible to determine what constitutes a population for conservation purposes, or determining population size.

Assuming that *G. parviflora* subsp. *parviflora* may be insect pollinated, then plants separated by a distance of 500 metres or less might be considered to form part of one population.

Determining what is a significant impact

Determining significant impacts under the NSW Threatened Species Conservation Act requires a review of what is a viable local population.

At this stage, without further genetic work it is not possible to determine what constitutes a population, let alone a viable population. In the interim, in accordance with the Threatened Species Assessment Guidelines (DECC 2007) plants could be mapped and stem density documented.

Given that the extent of clonality is not known but could be high, population seeding is significant where and if it occurs. Therefore, plants that are known to produce seed are important to conserve. Evidence of seeding is important to observe in field studies and should be documented in reports.

Conservation objectives

A precautionary approach is essential for the species to be conserved, given the lack of knowledge about it. Occurrences of the species should be conserved, and any species loss could reasonably be considered significant.

Known habitat near Sydney is becoming degraded and populations are declining.

The less that is known about a species, the more conservative planning and management guidelines need to be.

Translocation

Translocation is a last resort, and does not represent an offset for loss of plants. It is not a realistic conservation strategy. However, where plants are lost it is sensible to not waste plant material and in such cases there may be a role for experimental translocation trials, provided there is adequate monitoring.

G. parviflora subsp. *parviflora* grows from cuttings, and translocation has occurred at Awaba in association with the development of a haul road with some success. Monitoring for 3 years has shown survival of at least 50% of plants translocated, and significant growth of additional stems in subsequent years.

Rechecking of identification of specimens

Due to poor quality specimens, there may be some that have been misidentified in the past. It has been suggested that Council ask the Royal Botanic Gardens Sydney to review and recheck voucher specimens which have been collected outside the area identified as suitable habitat in the modelling undertaken by Colin Driscoll.

Genetic analysis

It would be very valuable to undertake preliminary genetic analysis to help solve some of the problems identified in identification and reproductive biology, determining the significance of impacts and connectivity requirements.

Specifically, priorities for genetic work are:

1. To support identification of the taxa, and confirm species. There needs to be work done on the complex of 5 apparently related species. This would give confidence that the correct species are being protected and facilitates implementation of the TSC Act and EPBC Act.
2. To determine the degree of clonality present. This will help indicate the number of populations that occur and how related individuals are in a space.
3. To determine population structure of the species as a whole, including whether there really are two metapopulations, and what is happening in the species overall.

Initially, a small study of *G. parviflora* subsp. *parviflora* and related taxa should be undertaken as a pilot using microsatellites. Cost is dependent on number of specimens, but probably 10 samples for each each of 5 core taxa would be reasonable to ensure it works for the whole range. Cost was roughly estimated at \$10 – 20,000 for an initial pilot excluding any salary costs.

Management issues

Although plants can resprout after fire and flowering has been observed 2 years after fire, it is not known how long after fire it takes the plant to produce seed.

Further field surveys

There is little understanding about the extent and density of *G. parviflora* subsp. *parviflora* within the city and region. Additional surveys in areas subject to high development pressures would assist with land use impact assessments, particularly 7 part test questions that require knowledge of the extent and distribution of the local population.

Additional field surveys of modelled habitat with few records and outliers would be appropriate. This could be done in conjunction with the collection of material to be used for genetic analysis.

Appendix B

Lake Macquarie Flora and Fauna Survey Guidelines 2012 references to *Grevillea parviflora* subsp. *parviflora*

The Lake Macquarie Flora and Fauna Survey Guidelines (LMCC 2013) refer to survey requirements for *G. parviflora* subsp. *parviflora* including counting of plants and identification of the area of stems, and notes that the recommendations may be updated.

The guidelines indicate the desirable survey period for *G. parviflora* subsp. *parviflora* as July to February and an optimal survey period of August to December (pages 95, 125). Survey recommendations (page 130) are that each plant clump should be located and that a stem separation distance of at least 2 metres be applied to calculate plant clumps.

It is noted that *G. parviflora* subsp. *parviflora* is associated with the Alluvial Bluegum - Paperbark Forest (5a) and the Coastal Foothills Spotted Gum – Ironbark (15) vegetation communities (page 145).

The Flora and Fauna Survey Guidelines currently do not identify the potential difficulty in differentiating between identification *G. parviflora* subsp. *parviflora* and *G. humilis* and differ from the proposals agreed in the scientific workshop in the following respects:

1. The workshop proposed a 3 – 4 month optimal field survey period compared with 5 months in the Flora and Fauna Survey Guidelines.
2. A 10 metre separation was suggested by the workshop to differentiate between different plant clumps, compared to 2 metres in the Guidelines.
3. The workshop proposes more detailed requirements to calculate population density, and also estimates of fruit set to indicate possible sexual reproduction.



Lake Macquarie
City Council