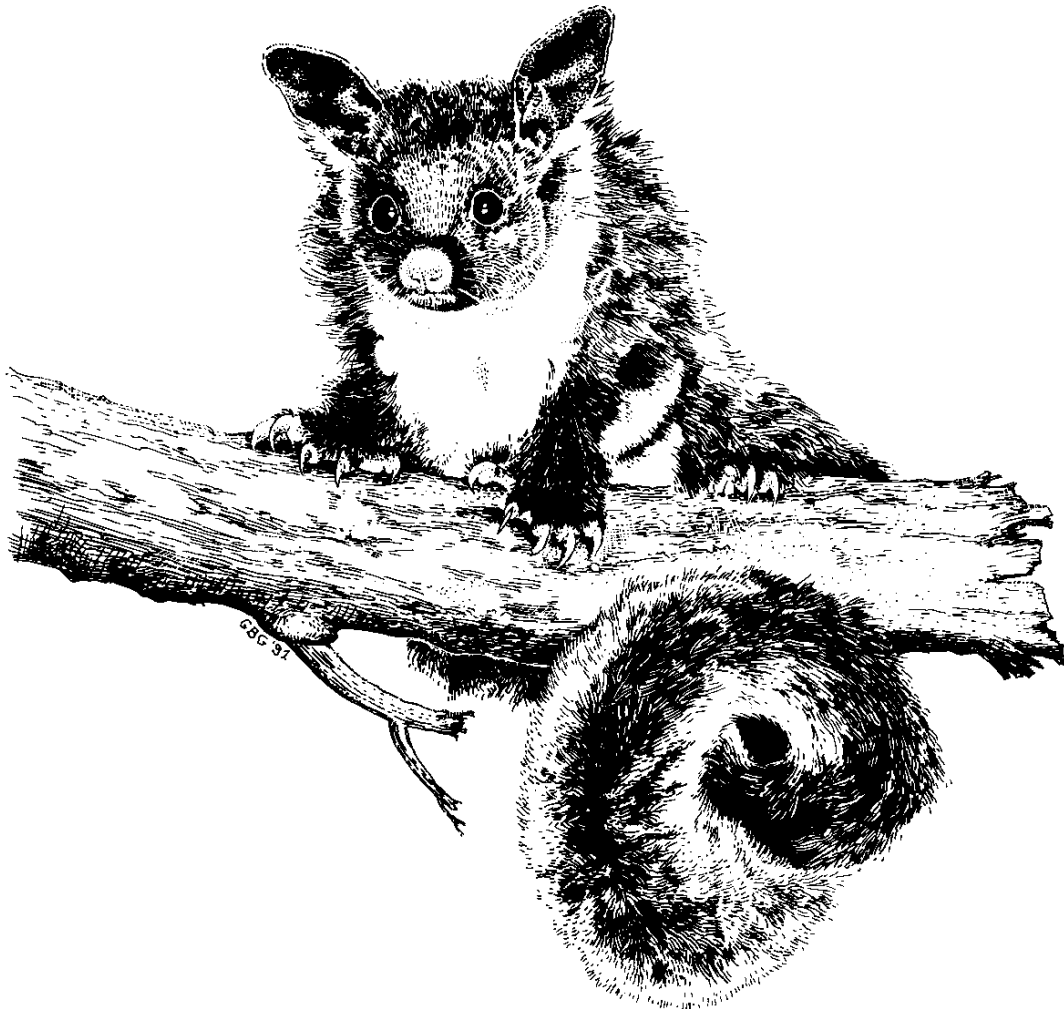




Recovery Plan for the Yellow-bellied Glider (*Petaurus australis*)



February 2003

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Recovery Plan for the Yellow-bellied Glider (*Petaurus australis*)

Foreword

This document constitutes the formal New South Wales State Recovery Plan for the Yellow-bellied Glider (*Petaurus australis*) and, as such, considers the conservation requirements of the species across its known range in NSW. It identifies the actions to be taken to ensure the long-term viability of the Yellow-bellied Glider in nature and the parties who will undertake these actions.

The Yellow-bellied Glider is included as Vulnerable under the NSW *Threatened Species Conservation Act* 1995. The subspecies believed to occur in NSW is not listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999. The species occurs along the east coast of Australia and adjacent ranges. It has a widespread but patchy distribution within a range of tenure including national park, state forest and freehold land.

This Recovery Plan aims to establish a landscape-scale conservation framework and to undertake necessary surveys and research to identify specific recovery actions for significant populations to ensure that the Yellow-bellied Glider persists in the wild in NSW in each area where it presently occurs. The recovery actions detailed in this plan are directed toward protection and management of the species and its habitat, identification and monitoring of significant populations and increasing community awareness.

It is intended that this Recovery Plan will be implemented over a three year period. Actions will be undertaken by the NSW National Parks and Wildlife Service.



BRIAN GILLIGAN
Director-General



BOB DEBUS MP
Minister for the Environment

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1 Introduction

The Yellow-bellied Glider (*Petaurus australis* Shaw 1791) is a large, arboreal marsupial that occurs in coastal and escarpment forests along the east coast of mainland Australia. In New South Wales (NSW) it is listed as a Vulnerable species on Schedule 2 of the *Threatened Species Conservation Act 1995* (TSC Act).

This document constitutes the formal State Recovery Plan for the Yellow-bellied Glider and, as such, considers the requirements of the species across its known range in NSW. This Recovery Plan summarises our current knowledge of the Yellow-bellied Glider and identifies the actions required to ensure the ongoing viability of the species in the wild.

The attainment of this Recovery Plan's objectives is subject to budgetary and other constraints affecting the parties involved. The information in this Recovery Plan is accurate to December 2002.

2 Description and Distribution

The Yellow-bellied Glider weighs up to 700 grams, making it the largest Australian member of the family Petauridae and the second largest glider occurring in Australia. It is grey above, with underparts that range from whitish through yellow to orange with increased age. The distinctive ears are large, pink-grey and bare. The tail is long and fluffy and is relatively much longer than in other gliders, being approximately one and a half times the length of the body (Russell 1995; Menkhorst and Knight 2001). The tail has been described as both prehensile (Strahan 1995) and non-prehensile (Russell 1995). Similar to other members of the family, the Yellow-bellied Glider has long, sharp, protuberant incisors and a prominent dark dorsal stripe that extends to the forehead (Strahan 1995).

There are seven species in the genus *Petaurus*. Four of these, the Yellow-bellied Glider, Sugar Glider (*P. breviceps*), Squirrel Glider (*P. norfolcensis*) and Mahogany Glider (*P. gracilis*), occur in Australia (Strahan 1995). All members of the genus have a gliding membrane that extends from the wrist to the ankle. The term 'wrist-winged glider' distinguishes them from the Greater Glider (*Petauroides volans*), which has a gliding membrane extending from the elbow to the ankle

(Strahan 1995) and the Feathertail Glider (*Acrobates pygmaeus*) which has a gliding membrane extending from the elbow to the knee (Menkhorst and Knight 2001).

The Yellow-bellied Glider is the most vocal of the Australian gliders. Kavanagh and Rohan-Jones (1982) described six basic call types, whilst Russell (1984) provided a subjective classification of 16 call types. Calls range from a short growl of low intensity to a full call that consists of two loud high-pitched shrieks and a long, low throaty gurgle. This full call is the characteristic call of the Yellow-bellied Glider and can be heard up to several hundred metres away. Goldingay (1994) suggested that calls serve a territorial function (see Section 4). The calls may also have an anti-predator function in alerting other members of a family group to the presence of predators such as the Powerful Owl (*Ninox strenua*) (Kavanagh 1997).

The Yellow-bellied Glider has a patchy distribution across a wide range of eastern and south-eastern mainland Australia (Russell 1995; Quin *et al.* 1996). Distribution is mostly continuous from about 50 kilometres east of Melbourne in Victoria, to Sarina near Mackay in central Queensland (Qld), although occurrence becomes patchy in north-eastern NSW and south-eastern Qld. Disjunct populations occur along the western shores of Port Phillip Bay in Victoria to the Otway Range, west of Melbourne. Disjunct isolates also occur along the Victorian-South Australian border and at high altitudes on the Atherton, Carbine and Windsor Tablelands in north Qld (Craig 1985; Russell 1995; Maxwell *et al.* 1996; Menkhorst and Knight 2001).

In NSW, distribution of the Yellow-bellied Glider is essentially coastal, extending inland to adjacent ranges (Figure 1). The species is reported to be more abundant in the south-east of the State when compared with other regions (Kavanagh *et al.* 1995; Kavanagh 1997). The species has also been commonly recorded at high altitudes on the western side of the Great Dividing Range near Tumbarumba and Tumut (Kavanagh and Stanton 1998). Records indicate that a break in the north-south distribution might occur in the Hunter region. Isolates occur to the west and south-west of Canberra in the Australian Alps and south-eastern highlands. There are also isolated records that

may be part of outlier populations of the species within conservation reserves on the central and northern tablelands.

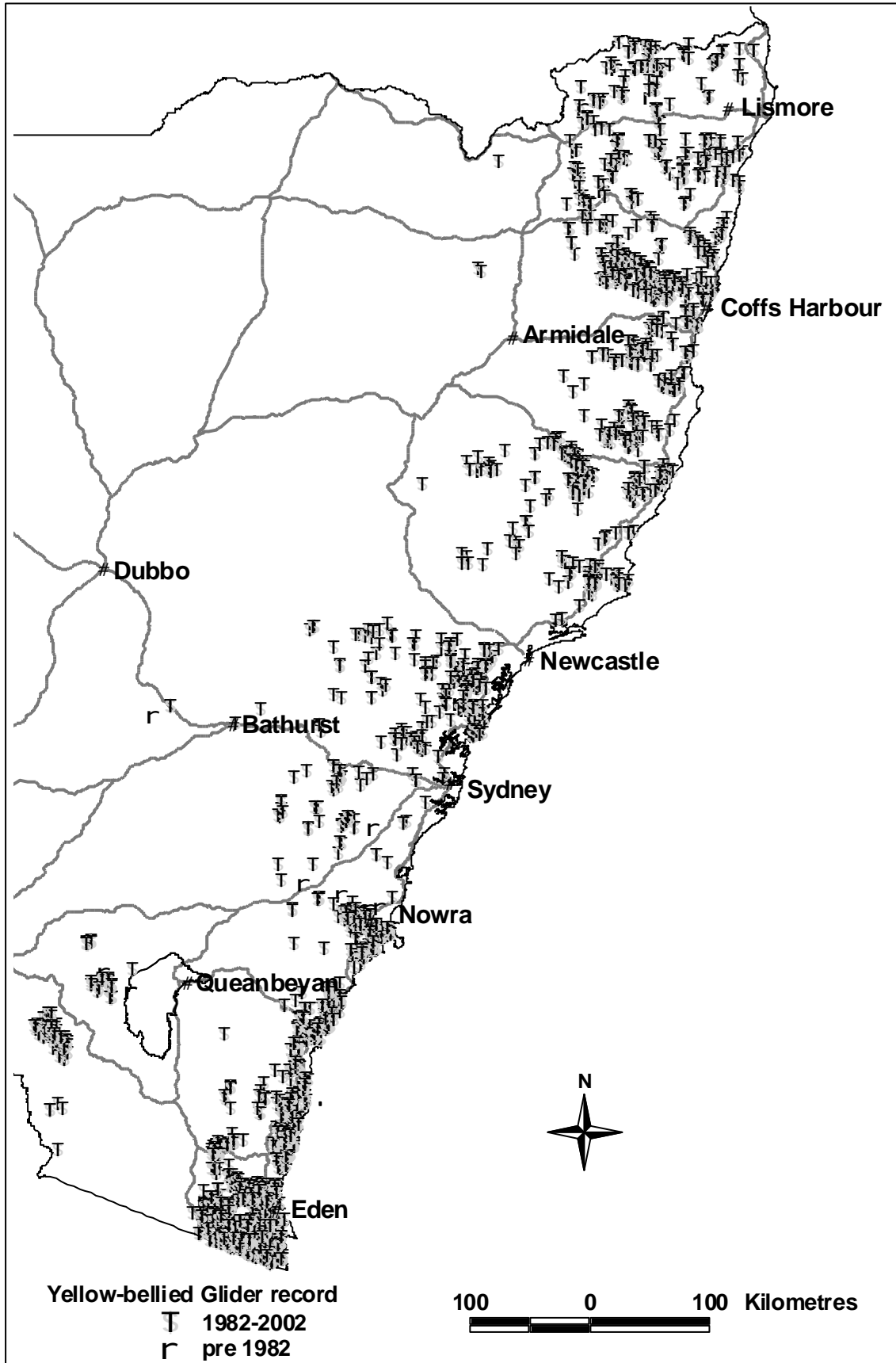


Figure 1: Yellow-bellied Glider records in NSW

There is confusion over the subspecies taxonomy of the Yellow-bellied Glider. Russell (1995) referred to the isolated Atherton, Carbine and Windsor Tablelands populations in north Qld as *P. a. reginae* and those occurring in south-eastern Australia to central Qld as *P. a. australis*. Maxwell *et al.* (1996), however, considered the north Qld populations to be a separate, unnamed northern subspecies due to the fact that the *P. a. reginae* type specimen was collected from Gin Gin, which lies within the extent of occurrence of the more southerly *P. a. australis* subspecies.

3 Current Conservation Status

Although widespread in south-eastern Australia the Yellow-bellied Glider is found at low population densities in habitat that is patchily distributed (Goldingay and Kavanagh 1991; Gibbons and Lindenmayer 1997). This, in combination with a large home range and long-term family groupings, ensures that the species is seldom locally abundant (Goldingay and Kavanagh 1991). The area occupied by the species in NSW is reported to have declined by 26-50 percent since European settlement (Lunney *et al.* 2000).

A summary of the conservation status of the Yellow-bellied Glider is provided in Table 1. Confusion over the taxonomy of the species has

led to inconsistency in the naming of the taxa that appear on conservation lists.

4 Habitat and Ecology

The Yellow-bellied Glider occurs in a diversity of habitats and climates across its range. It typically occurs in tall, mature eucalypt forest in regions of high rainfall, but is also known to occur in drier areas (see Carthew *et al.* 1999). It inhabits a wide range of forest types but prefers resource-rich forests where mature trees provide nesting hollows and tree species composition provides year-round continuity of food resources (Craig 1985; Kavanagh 1987a; Goldingay and Kavanagh 1991).

In north-eastern NSW, preferred habitat is described as either mixed sclerophyll forests of the coastal plains, sub-coastal mid- to high-elevation forests and moist and dry escarpment forests (Gilmore and Parnaby 1994) or dry sclerophyll forests with a grassy or xeric understorey (Mackowski 1986). In southern NSW, preference differs with altitude (Kavanagh 1987b). At lower elevations preferred habitat consists of moist gullies and creek flats in mature coastal forests (Recher *et al.* 1980; Kavanagh 1987b), whilst at higher altitudes, tall montane forests on flat topography are preferred (Kavanagh 1984).

Table 1: Summary of conservation status of the Yellow-bellied Glider

Legislative or scientific list	Taxon	Status
NSW TSC Act	<i>P. australis</i>	Vulnerable
South Australian <i>National Parks and Wildlife Act 1972</i>	<i>P. australis</i>	Endangered
Qld <i>Nature Conservation (Wildlife) Regulation 1994</i>	<i>P. a. reginae</i> (northern subspecies)	Vulnerable
Commonwealth EPBC Act	<i>P. australis</i> unnamed subsp. (Wet Tropics)	Vulnerable
Action Plan for Australian Marsupials and Monotremes (Maxwell <i>et al.</i> 1996)	<i>P. a. australis</i> (S subspecies) <i>P. australis</i> unnamed subsp. (N subspecies)	Lower Risk (near threatened) Vulnerable
2000 IUCN Red List of Threatened Species (Hilton-Taylor 2000)	<i>P. australis</i> <i>P. a. australis</i>	Lower Risk (near threatened) Lower Risk (near threatened)

Note:

EPBC Act – Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

IUCN – International Union for the Conservation of Nature and Natural Resources

Plant and insect exudates provide the bulk of the Yellow-bellied Glider diet. These exudates include nectar, sap, honeydew and manna (Smith and Russell 1982; Henry and Craig 1984; Goldingay 1986, 1989a, 1990; Kavanagh 1987a, 1987b; Quin *et al.* 1996; Carthew *et al.* 1999). Dietary protein is obtained from arthropods and, to a certain extent, pollen ingested whilst nectar feeding. The Yellow-bellied Glider is relatively large for an arboreal mammal with an exudate-based diet. Consequently, it must dedicate up to 90 percent of its active time to foraging (Goldingay 1989, 1990), which is the highest proportion known for any mammal (Goldingay and Kavanagh 1991).

The importance of different food types in the Yellow-bellied Glider diet varies with location and season. Food resource availability and the importance of particular food items at a given location is linked strongly to climatic factors (Carthew *et al.* 1999) and the phenological pattern of the tree species within a forest (Kavanagh 1987a; Goldingay 1990). Therefore, events such as flowering or bark decortication can lead to seasonal patterns in foraging behaviour, resource exploitation and use of tree species. A breakdown of the variation in diet of the Yellow-bellied Glider across its range has been provided in Carthew *et al.* (1999).

The fluctuation in availability of food resources also means that preferred Yellow-bellied Glider habitat is often characterised by a mosaic of tree species associations likely provide a continuous, year-round food supply (Kavanagh 1987a; Eyre and Smith 1997). Furthermore, the patchy distribution of the Yellow-bellied Glider over its range may be due to differences in floristic diversity and complexity within a forest mosaic (Kavanagh 1987a; Recher *et al.* 1987). Exceptions to this habitat preference are the largely monotypic Mountain Ash (*Eucalyptus regnans*) forests of Victoria (Milledge *et al.* 1991) and the Manna Gum (*E. viminalis*) and Brown Stringybark (*E. baxteri*) dominated forests of far western Victoria (Carthew *et al.* 1999).

One characteristic of Yellow-bellied Glider feeding behaviour is the incision of tree bark for phloem sap. This sap is obtained by cutting notches into tree trunks and branches to the depth of the cambial layer using the lower incisors (Henry and Craig 1984; Goldingay 1987). These notches are

characteristically triangular or V-shaped, although they can range from horizontally or vertically linear to almost circular (Mackowski 1988; R. Wellington pers. comm.).

Utilisation of sap and selection of sap trees appears to be a complex behaviour. The number and species of trees used varies between location and season. It has been suggested that usage is determined by the pattern of sap flow within individual trees (Goldingay 1987). Yellow-bellied Gliders may select trees with unusual patterns of sap flow. They then sample these trees on a periodic basis, which enables them to utilise the sap resource when the flow rate increases (Goldingay 1987, 1991, 2000). Trees with this unusual pattern of sap flow possess unique properties that are neither constant nor predictable (Goldingay 1987) and may account for less than one percent of all trees in a given stand of forest (Lindenmayer 2002). These trees are often large, vigorous specimens (Craig 1985; Kavanagh 1987a; Mackowski 1988) which can be utilised by Yellow-bellied Gliders for more than 10 years (Goldingay 1991). Sap trees also serve as important focal points for group social exchange (Russell 1984).

A large number of tree species are used as sap trees throughout the range of the Yellow-bellied Glider. At any one location, however, use is restricted to a small number of individual trees of a few particular species (Wakefield 1970; Henry and Craig 1984; Goldingay 1987, 2000; Mackowski 1988). Furthermore, species used at one location are not necessarily used at another (Kavanagh 1987a, 1987b; Goldingay 1991).

In NSW, the tree species utilised as sap trees are mostly eucalypts (*Eucalyptus* and *Corymbia* species - see Appendix 1). At one location on the mid north coast, however, the Yellow-bellied Glider is reported to use Brush Box (*Lophostemon confertus*) exclusively (Bell and Bell 1997). There are also single reports of individuals utilising *Acacia mearnsii* (Kavanagh 1987b), *Acacia mabellae* (Goldingay 1990) and *Angophora subvelutina* sap (Mackowski 1988).

Yellow-bellied Gliders live in small family groups, with actual numbers varying between locations. In Victoria and the southern tablelands of NSW, a group typically consists of two to three individuals

comprising a single breeding pair in a monogamous relationship, with or without offspring (Henry and Craig 1984; Craig 1985; Goldingay and Kavanagh 1990). This is in contrast to north Qld and the south coast of NSW, where breeding systems alternate between monogamy and polygyny and groups may contain up to six individuals (Russell 1984; Goldingay 1992). The differences in family group dynamics and breeding systems are thought to be linked to reliability and availability of food resources (Goldingay 1992), although polygyny, monogamy and polyandry have each been reported in different groups of the north Qld population at any one time (Goldingay *et al.* 2001).

The Yellow-bellied Glider has low breeding potential. A single young is usually produced each year, but breeding may sometimes occur in alternate years (Goldingay and Kavanagh 1990). Despite the female pouch having two compartments separated by a well-developed furred septum there have been only two records of twins in the species (Craig 1986; Goldingay *et al.* 2001). Maximum longevity observed in the wild is six years (Russell 1984; Goldingay and Kavanagh 1990), although an individual living in captivity in Victoria was estimated to be over 16 years old (Slater 1997).

Population densities of the Yellow-bellied Glider are typically low. In Victoria and the southern tablelands of NSW, densities were found to be in the order of 0.04-0.06 individuals per hectare (Henry and Craig 1984; Goldingay and Kavanagh 1993). On the south coast of NSW density was found to be 0.1-0.16 individuals per hectare (Goldingay 1992). As with breeding systems, these differences in density are believed to reflect differences in forest productivity and food availability (Goldingay 1992).

Yellow-bellied Glider family groups occupy large home ranges of approximately 20-85 hectares (Henry and Craig 1984; Craig 1985; Goldingay 1992; Goldingay and Kavanagh 1993; Goldingay *et al.* 2001; Lindenmayer 2002). This is in contrast to other arboreal marsupials with an exudate-based diet such as the Squirrel Glider (3-5 hectares (Quin 1995; Lindenmayer 2002)), Sugar Glider (0.9-7.1 hectares (Smith 1980; Suckling 1984)) and also the large, folivorous Greater Glider (0.7-3.0 (Henry 1984; Kehl and Borsboom 1984, Lindenmayer 2002)).

It is presumed that the Yellow-bellied Glider requires a large home range to ensure that a continuity of dispersed and variable food resources remains available throughout the year (Goldingay and Kavanagh 1991). The home range is virtually exclusive to a family group, with little overlap occurring between adjacent home ranges. Therefore, the home range of a family group is effectively a territory, and the loud vocalisations common to the species appear to advertise and maintain these territories (Goldingay 1994).

5 Relevant Legislation

5.1 Responsibilities under the *Threatened Species Conservation Act 1995*

Recovery plan preparation and implementation

The TSC Act provides a legislative framework to protect and encourage the recovery of Endangered and Vulnerable Species, Endangered Populations and Endangered Ecological Communities in NSW. Under this legislation the Director-General of National Parks and Wildlife has a responsibility to prepare Recovery Plans for all species, populations and ecological communities listed as Endangered or Vulnerable on the TSC Act schedules. The TSC Act includes specific requirements for both the matters to be addressed by Recovery Plans and the process for preparing Recovery Plans. This Recovery Plan satisfies these provisions.

The TSC Act requires that a government agency must not undertake actions inconsistent with a Recovery Plan. The actions identified in this plan for the recovery of the Yellow-bellied Glider in NSW are the responsibility of the NPWS. Other public authorities may have statutory responsibilities relevant to the conservation and protection of the Yellow-bellied Glider. Public authorities with core legislative responsibilities relevant to the protection and management of the species and its habitat are listed in Appendix 2.

Critical Habitat

The TSC Act makes provision for the identification and declaration of Critical Habitat for species, populations and ecological communities listed as Endangered. Once declared, it becomes an offence to damage Critical Habitat (unless the action is specifically exempted by the TSC Act)

and a Species Impact Statement (SIS) is mandatory for all developments and activities proposed within Critical Habitat.

The Yellow-bellied Glider is not currently eligible for declaration of Critical Habitat because it is not listed as Endangered under Schedule 1 of the TSC Act.

Key Threatening Processes

As of December 2002 there were 16 Key Threatening Processes listed on the TSC Act. Of these, 'clearing of native vegetation' has been identified as having an adverse effect on the Yellow-bellied Glider. In addition to this, a range of other processes are recognised as threatening the survival of the species in NSW.

Licensing

Any activity not requiring development consent under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) which is likely to harm the Yellow-bellied Glider requires a Section 91 licence from the NPWS under the provisions of the TSC Act. If the impact is likely to be significant a SIS is required.

Other conservation measures

The TSC Act includes provision for other measures that may be taken to conserve the Yellow-bellied Glider or its habitat, including the making of a Stop Work Order or Joint Management Agreement.

5.2 Other State legislation

National Parks and Wildlife Act 1974

The NSW *National Parks and Wildlife Act 1974* (NPW Act) is administered by the NPWS. Under this Act it is an offence to 'harm' or knowingly 'damage the habitat of' the Yellow-bellied Glider. Certain circumstances may provide a defence from prosecution, including where actions are approved under the EP&A Act or licensed by the NPWS under the NPW Act or TSC Act.

The NPW Act allows for the reservation of areas as national parks, nature reserves and other categories of protected area under the management of the NPWS. A number of national parks and nature reserves in NSW provide important habitat for the Yellow-bellied Glider.

Owners of private properties with significant habitat values for the Yellow-bellied Glider may enter into Voluntary Conservation Agreements (VCAs) under the NPW Act, whereby the NPWS can provide assistance in the protection and management of these values on the property. Properties under VCAs may qualify for rate exemptions.

Environmental Planning and Assessment Act 1979

This Act provides for the consideration of the Yellow-bellied Glider in land use planning issues. Areas providing important habitat for the species can be protected under appropriate environmental protection zoning in Local Environmental Plans prepared under Part 3 of the EP&A Act.

Consent and determining authorities are required to consider potential impacts on the Yellow-bellied Glider and its habitat when considering an activity or development proposal under Part 4 or Part 5 of the EP&A Act. An action included in this Recovery Plan is the preparation and dissemination of environmental impact assessment guidelines for the Yellow-bellied Glider to assist consent and determining authorities and environmental consultants in undertaking eight part tests under Section 5A of the EP&A Act.

Where a consent or determining authority considers that a proposed development or activity may result in a significant effect on the Yellow-bellied Glider or its habitat, a SIS is required to be provided and approval cannot be granted without the concurrence of the NPWS.

Local Government Act 1993

The *Local Government Act 1993* requires councils to have regard for the principles of ecologically sustainable development. Included in Section 8(1) of this Act is a principle requiring a council to manage, develop, protect, restore, enhance and conserve the environment of the area for which it is responsible, in a manner that is consistent with, and promotes the principle of, sustainable development. This includes the integration of biodiversity considerations into the decision-making process. The Act also requires councils to have regard for the content of Recovery Plans when preparing plans of management for community land.

Native Vegetation Conservation Act 1997

The clearing of native vegetation in NSW is subject to consent from the Department of Land and Water Conservation (DLWC) in accordance with the *Native Vegetation Conservation Act 1997* (NVC Act). The NVC Act is integrated with the EP&A Act, and requires that threatened species are taken into account when considering clearing applications under Part 4 of the EP&A Act.

Where an activity or development that may impact upon the Yellow-bellied Glider or its habitat is not subject to approval under the EP&A Act, an approval may nevertheless be required under the NVC Act or the TSC Act. These approvals should also take the strategy in this Recovery Plan into consideration.

The NPWS is represented on the Regional Vegetation Committees (RVCs) that are responsible for the preparation of these plans and will seek appropriate identification and protection of relevant Yellow-bellied Glider habitat under them.

Landholders may enter into Property Agreements with the DLWC whereby government assistance can be provided to protect significant native vegetation.

Rural Fires Act 1997

The *Rural Fires Act 1997* requires that all parties involved in fire suppression and prevention must have regard to the principles of ecologically sustainable development when exercising their functions and when preparing Plans of Operations and Bush Fire Risk Management Plans. Consideration of these principles must include the conservation of biological diversity and ecological integrity. Within this, consideration must be given to the impact on threatened species and their habitats, including the Yellow-bellied Glider.

The *Rural Fires and Environmental Assessment Legislation Amendment Act 2002* amends the *Rural Fires Act 1997* and several environmental assessment-related Acts. This Act provides for development of a draft Bush Fire Environmental Code that will allow for an alternative assessment process for hazard reduction works in some circumstances. Threatened species will be

considered under the Code and, in certain circumstances, ameliorative measures will be developed for species adversely affected by hazard reduction activities.

Forestry and National Park Estate Act 1998

In NSW, an Integrated Forestry Operations Approval (IFOA) granted under Part 4 of the *Forestry and National Park Estate Act 1998* regulates the carrying out of certain forestry operations, including logging, in the public forests of a region. The terms of the Threatened Species Licence of the IFOA for each region outlines the minimum protection measures required to limit the impact of forestry activities on threatened species and their habitats, and forms the basis for NPWS regulation of those activities. The Threatened Species Licence for the Upper North East, Lower North East and Eden Regions and the Southern and Tumut Sub-regions of the South Coast Region all include measures for the protection of the Yellow-bellied Glider.

6 Management Issues

6.1 Threats and reasons for decline

The Yellow-bellied Glider was originally listed as threatened in NSW because it was recognised that (NPWS 1992):

- the population has been severely reduced;
- distribution has been reduced;
- threatening processes are severe;
- the species is an ecological specialist; and
- the species has poor recovery potential.

The current major threat to the Yellow-bellied Glider across its range is habitat alteration and reduction. This is due to one or more of the following agents (Goldingay and Kavanagh 1991):

- heavy logging of forests managed for timber production (see Kavanagh *et al.* 1995; Kavanagh and Bamkin 1995; Kavanagh and Webb 1998);
- clearing of forests for agriculture and urban development; or
- wildfire.

Whilst logging is seen as a major agent of Yellow-bellied Glider habitat alteration and reduction, the effect on local populations is unclear. Studies in NSW, Qld and Victoria have shown that the species occurs more frequently in mature and old-growth forests and is sensitive to logging (Lunney 1987; Davey 1984; Milledge *et al.* 1991; Andrews *et al.* 1994; Eyre and Smith 1997). Other studies have suggested that Yellow-bellied Gliders persist in logged areas (Kavanagh *et al.* 1995; Kavanagh and Webb 1998) and will also occur in older aged regrowth forests where den trees and other essential resources are available in adjacent areas (R. Kavanagh pers. comm.). Therefore, it appears that the effect of logging depends on several factors, including the silvicultural system in place, the location of the logged area in the landscape and whether logging removes preferred forest types or critical resources of the Yellow-bellied Glider.

There have been no comprehensive studies of the impact of wildfire on Yellow-bellied Gliders. At the very least wildfire can impact on short-term food supply, increasing reliance on sap and sap trees (Goldingay and Kavanagh 1991). A wildfire at Eden on the south coast of NSW in 1980 killed all Yellow-bellied Gliders residing in the area (R. Kavanagh unpublished data, in Goldingay and Kavanagh 1991). A study by Lunney (1987) in forests on the south coast of NSW indicated that wildfire can compound the effects of logging on arboreal mammal species. It was found that, although Yellow-bellied Gliders remained in the general area, a marked shift in distribution occurred, with the species becoming more reliant on unburnt refugia located in gullies.

Each of the above forms of habitat alteration can adversely affect the Yellow-bellied Glider in several ways. Any loss or fragmentation of habitat, including a change in spatial configuration, can increase the already considerable amount of effort required by an individual to forage for dispersed food resources (Recher *et al.* 1987). Such an increase may have long-term effects including reproductive failure, decline in group size or decrease in Yellow-bellied Glider density. Another effect is the loss of critical food resources such as sap trees or, alternatively, alteration to the mosaic of forest types that are necessary to ensure a continual supply of food resources

throughout the year (Goldingay and Kavanagh 1991).

Habitat alteration and reduction can result in the loss of hollow-bearing trees in an area. The ability of eucalypts to form hollows varies with species and management history, although hollows of suitable size for vertebrates will generally not occur in eucalypts less than 120-180 years old. Larger sized hollows generally occur in trees that are at least 220 years old. (Gibbons and Lindenmayer 2002).

Yellow-bellied Gliders typically occupy tall, large diameter trees with large hollows (Recher *et al.* 1980; Russell 1984; Mackowski 1987; Goldingay and Kavanagh 1990, 1993), with family groups using up to 13 den trees within their large home range (Henry and Craig 1984; Goldingay and Kavanagh 1990, 1993). Removal of this class of tree can lead to a reduction in suitable dens for the Yellow-bellied Glider (Goldingay and Kavanagh 1991).

Alteration and reduction of habitat might also increase the predation risk on individuals from predators, which include the Powerful Owl, Sooty Owl (*Tyto tenebricosa*), Carpet and Diamond Python (*Morelia spilotes* subspecies) (Kavanagh 1997; Lunney *et al.* 1990; D. Quin pers. comm.). Remains of the species have also been found in the scats of terrestrial predators such as the Fox (*Vulpes vulpes*), Dingo (*Canis lupus dingo*) and Dog (*C. familiaris*) (Triggs *et al.* 1984). These may not have been a direct result of predation, although fragmentation of habitat may have the potential to increase the predation risk from terrestrial predators.

The greatest long-term effect of habitat alteration and reduction is probably the creation of barriers to movement and the reduction in size of forested areas (Goldingay and Kavanagh 1991). Any cleared area that is wider than the distance over which an individual can glide has the potential to act as a dispersal barrier. Although the species has been known to glide up to 140 metres, gliding distance is related to site conditions. Consequently, clearings or gaps considerably less than 140 metres can form a significant barrier to movement. Creation of such barriers can increasingly isolate populations or family groups. This can, in turn, reduce gene flow, decrease population viability and

increase the risk of localised extinction due to random environmental and demographic events.

In north Qld, Yellow-bellied Gliders are known to feed extensively on nectar and pollen of *Banksia integrifolia* during autumn and winter (Quin *et al.* 1996). At Mallacoota Inlet near the NSW-Victorian border they also feed on nectar and pollen of *B. serrata* (D. Quin pers. comm.). Therefore, land management practices in potential habitat that negatively impact on banksias, such as frequent burning or grazing, may impact on Yellow-bellied Gliders.

More localised threats to individual populations include fragmentation of habitat and isolation of populations due to urban development. In NSW, this is particularly the case on the central coast and on the south coast, where subdivisions in suitable coastal habitat have the potential to disrupt movement, isolate habitat and remove food resources.

Other potential threats might not act directly on the species. For example, drought, in isolation, might not represent a threat. It might, however, act to compound the effects of other threats such as fire or logging (Lunney 1987).

6.2 Biodiversity benefits

Protection of the Yellow-bellied Glider can provide for conservation of a wider suite of forest values. Large home range requirements, naturally low densities, a sedentary habit and specialised foraging and denning requirements indicate that the species is sensitive to land use practices and management activities. This has led to the Yellow-bellied Glider being identified as a possible indicator or umbrella species for effective management of forest-dependent fauna (Milledge *et al.* 1991; Kavanagh 1991; Goldingay and Kavanagh 1993; Kavanagh and Bamkin 1995). The presence or absence of such species can indicate habitat quality for a range of other species or communities and can be targeted when managing and designing conservation reserves so that greater amounts of habitat will be provided for species with smaller home ranges (Goldingay and Kavanagh 1991; Goldingay and Possingham 1995). A further advantage of the Yellow-bellied Glider as an indicator or umbrella species is that habitat requirements relate to measurable features of the

forest overstorey that are easily mapped (Kavanagh 1991).

The Yellow-bellied Glider is also likely to have a role as a pollinator of forest trees including eucalypt, rainforest and banksia species (Goldingay 1990; Quin *et al.* 1996). Therefore, its conservation will contribute to the maintenance of important ecosystem processes.

Three of the four Australian *Petaurus* species are considered threatened at State, National or International levels. Of the seven species in the genus worldwide, four are considered threatened. Recovery of the Yellow-bellied Glider will assist in developing knowledge that will contribute to the conservation of other *Petaurus* species.

6.3 Social and economic consequences

The social and economic impact of conserving the Yellow-bellied Glider involves a range of costs and benefits. These impacts would be difficult to quantify and to separate out from the costs and benefits of broader forest management and conservation measures.

Comprehensive Regional Assessments have provided a process to determine conservation measures for public forests in NSW. These assessments of forest environments were used to determine levels of reservation, levels of timber production and the nature of timber harvesting prescriptions that apply to public forests. As part of that process the social and economic impact of the forest management options have been assessed. Options for compensation go beyond the role of this Recovery Plan and are dealt with in the broader forestry reforms.

This Recovery Plan estimates that the total cost of implementing the recommended actions will be \$66 500 over the three year period covered by the plan. The proposed recovery strategy seeks to minimise economic impacts through the identification of significant Yellow-bellied Glider populations, which will then become priorities for active management. Since many populations occur within NPWS estate, conservation of the Yellow-bellied Glider can be readily incorporated into other objectives of reserve management.

Conservation of the Yellow-bellied Glider will assist in the conservation of native forests, including old-growth forests. As a potential indicator or umbrella species (see Section 6.2), conservation of the Yellow-bellied Glider can assist in the conservation of other forest species and communities at no additional cost. This will result in increased aesthetic value and recreational and educational potential of native forests.

The Yellow-bellied Glider is a distinctive species. Increasing its profile through education has the potential to capture public attention due to its natural rarity, distinctive appearance and autecology.

Without a strategic approach to managing this Vulnerable species in the present, it is possible that the species will be reduced to a level where it is at risk of becoming Endangered in the future. Preventing this from occurring will provide long-term social and economic benefits.

7 Previous Actions Undertaken

7.1 Surveys and research

Considerable surveys and research on the Yellow-bellied Glider have already been undertaken. Surveys are conducted in all state forests throughout the range of the Yellow-bellied Glider in NSW prior to timber harvesting. In addition, surveys have also been carried out to assist with Regional Forest Agreement processes.

Research and associated surveys have been undertaken in most regions of NSW where the Yellow-bellied Glider is found (e.g. Mackowski 1988; Kavanagh and Peake 1993; Kavanagh *et al.* 1995; Kavanagh and Bamkin 1995; Goldingay and Daley 1997; Kavanagh and Stanton 1998). Much of this research was conducted in state forests of south-eastern and north-eastern NSW and focused on the ecology of the species. State Forests of NSW (SFNSW) research and surveys have resulted in a major increase in information and records for the species.

Research undertaken by the University of Melbourne, in consultation with SFNSW and NPWS, is currently determining detectability rates of several forest dwelling species in the Eden area, including the Yellow-bellied Glider (B. Wintle pers.

comm.). Results of this research may be of use in improving the accuracy of surveys for monitoring and environmental impact assessment.

7.2 Protection of population and habitat

Areas of forest predicted as being important for the Yellow-bellied Glider are contained within the existing conservation reserve system in NSW. The NPWS Atlas of NSW Wildlife contains records for the species in 121 national parks, nature reserves and state recreational areas (Appendix 3).

Measures for the conservation of the Yellow-bellied Glider in wood production areas of state forest are detailed in the Threatened Species Licence of the IFOA for each forest region of NSW. Implementation of the conditions set out in each IFOA is the responsibility of SFNSW, whilst the NPWS is required to monitor and enforce compliance with conditions. These conditions include:

- riparian buffers ranging from 10-50 metres either side of mapped streams at 1:25 000 scale;
- retention of ridge and headwater habitat;
- retention and protection of hollow bearing trees and recruitment trees;
- retention of winter flowering eucalypts;
- exclusion zones around Yellow-bellied Glider den trees;
- retention of identified sap feed trees and potential feed trees of the same species; and
- the protection of old-growth forests.

Measures on other land tenures aimed at protecting populations and habitat of the Yellow-bellied Glider have included:

- retention of habitat and maintenance of habitat linkages as part of concurrence conditions for a development near Batemans Bay, including preparation of a policy for the conservation of the Yellow-bellied Glider by a local council;
- pre-clearing surveys, protection of hollow bearing trees and provision of artificial hollows and launching poles for Pacific Highway upgrades; and

- pre-clearing surveys and protection of hollow bearing trees at an open cut mine site and a rock quarry.

8 Species' Ability to Recover

The Yellow-bellied Glider lives in small family groups with large, virtually exclusive home ranges (Goldingay 1992; Goldingay and Kavanagh 1993). Therefore, the species naturally occurs at low densities throughout its range and populations require large areas of forested land to remain viable. This, in combination with the low fecundity of the species, means that the capacity for recovery of small or stressed populations may be limited.

Yellow-bellied Gliders are sensitive to habitat fragmentation through degradation of existing habitat and creation of dispersal barriers. This restricts the ability of the species to persist and to colonise new or isolated areas. The long-term effect of this is the further reduction in the viability of small or isolated populations. Dependence upon resources that are best represented in mature, old-growth or older aged regrowth forests may further restrict this species' capacity to colonise new habitat.

Due to the above, continued viability of Yellow-bellied Glider populations in the wild in NSW will rely on large areas of unfragmented forest with available hollows and a floristically diverse overstorey. Where these large areas of forest are absent or are being fragmented and cleared, the ability of the Yellow-bellied Glider to recover may be reduced.

Mackowski (1986) suggested that a viable population of 500 individuals in northern NSW would require 15 000 hectares of unfragmented suitable habitat. Population viability analysis (PVA) by Goldingay and Possingham (1995) suggested that a minimum of 150 Yellow-bellied Glider family groups is required for a population to be viable. This minimum viable population equates to between 18 000 and 35 000 hectares of unfragmented forest. Given these predicted area requirements, many existing conservation reserves are unlikely to support large viable populations.

These viability estimates for the Yellow-bellied Glider should be viewed with caution. The

estimates of Mackowski (1986) are probably underestimates because the area calculation assumes a single interconnected area of suitable habitat. The area estimate resulting from the PVA of Goldingay and Possingham (1995) relates only to areas where all habitat is interconnected (R. Goldingay pers. comm.) Furthermore, 150 family groups is possibly an underestimate of a viable population because it has not taken into account catastrophic events such as wildfire and drought (R. Goldingay pers. comm.). The PVA does provide an indication that populations, particularly those of less than 150 family groups, are acutely sensitive to individual mortality, particularly mortality within the adult (breeding) population.

Population viability analysis is a form of risk assessment that indicates how populations of the species might react to changes in the environment or the loss of individuals from the population. In a fragmented landscape, localised extinction and recolonisation of habitat patches is a dynamic and natural process. It is, therefore, important that existing and potential habitat and associated landscape elements are maintained to enable potential recolonisation of habitat fragments.

Some populations that would not be considered viable according to the above definition may, nonetheless, be significant. In these instances, such populations may require active management or other forms of intervention to remain viable. A precautionary approach must be taken in regard to considering a small population non-viable. For the purposes of assessment of viability, populations must be considered viable unless the contrary can be conclusively demonstrated. Management activities such as retention, rehabilitation and creation of habitat and corridors represent viable alternatives to removal of habitat of populations considered to be non-viable.

9 Recovery Objectives, Actions and Performance Criteria

The Yellow-bellied Glider is widely distributed across the landscape at low densities. This can lead to difficulties in identifying specific threats and management issues of individual populations. This three year plan aims to establish a landscape-scale conservation framework and to undertake

necessary surveys and identify research to ensure that the Yellow-bellied Glider persists in the wild in NSW in each area where it presently occurs.

The overall objective of this Recovery Plan is to achieve multiple viable populations of the Yellow-bellied Glider dispersed throughout its range in NSW and across environmental gradients. This is expected to take longer than the three year life of the plan.

Objective 1: To co-ordinate the recovery of the Yellow-bellied Glider in NSW

Action 1.1

The NPWS will co-ordinate the implementation of the actions outlined in this Recovery Plan.

Effective implementation of a recovery program for a threatened species, population or ecological community is a complex task. A co-ordinated approach is essential to oversee and assist in the implementation of the actions outlined in this Recovery Plan in a timely, cost-effective and efficient manner. Some of the tasks undertaken during the co-ordination of this plan will overlap with other identified actions, particularly liaison and consultation with other State government agencies and local governments.

Performance Criterion: The NPWS co-ordinates the recovery actions included in this Recovery Plan.

Action 1.2

The NPWS will integrate recovery actions of the Yellow-bellied Glider with those of other threatened species, populations and ecological communities.

A number of other threatened species, populations and ecological communities are likely to co-occur with the Yellow-bellied Glider (e.g. large forest owl species). Other threatened arboreal marsupials, such as the Squirrel Glider, will be subject to a Recovery Plan in the future and may be exposed to similar threats to the Yellow-bellied Glider. By integrating recovery actions, limited resources can provide better conservation benefits.

Performance Criterion: Where practicable, recovery actions have been integrated with those of other threatened species, Endangered

Populations or Endangered Ecological Communities.

Objective 2: To encourage and assist in improving the protection and management of the Yellow-bellied Glider and its habitat

Action 2.1

The NPWS will develop standard survey and environmental impact assessment guidelines for the Yellow-bellied Glider and distribute them to all relevant consent authorities.

A standard minimum survey effort should be undertaken when determining if the Yellow-bellied Glider is present in or near an area of potential development. Presence of the species should require implementation of effective mitigation measures to reduce the impact of proposed developments or activities.

Mitigation should not be considered a substitute for habitat retention and rehabilitation. However, where mitigation is required as a last resort it should offer protection to the Yellow-bellied Glider that is at least of the standard provided by SFNSW for forestry activities. These activities are outlined in the Threatened Species Licence of the IFOA for each forest region.

Assessment of impacts of proposed developments and activities should account for:

- protection of Yellow-bellied Glider habitat types, sap trees and sap tree species;
- populations within highly fragmented habitat or urban and rural areas, where specific mitigative measures will need to be developed;
- size and shape of habitat, and corridors. Strategies should attempt to reduce edge effects, minimise foraging distances, increase the types of resources available and reduce the linear nature of the habitat (see Recher *et al.* 1987);
- the fragmentation effects of infrastructure works and vegetation clearance; and
- the area requirements for viable populations of the Yellow-bellied Glider.

Mitigation should include a range of integrated measures and incorporate the trialling of structures such as knotted ropes, launching poles, nest boxes

and overpasses in combination with retention of habitat and rehabilitation of alternative potential habitat. In highly fragmented areas, such as urban environments, networks of retained linear corridors and forested 'stepping stones' should be used to link reserves and other habitat.

The University of Melbourne is in the process of preparing a research project to determine optimal monitoring and design strategies for several forest dependant species in the Eden area (B. Wintle pers. comm.). The project will be undertaken in partnership with SFNSW and the NPWS, both of which plan to commit substantial financial and human resource to the project. Results from this research may provide recommendations relating to preparation of Yellow-bellied Glider surveys for monitoring and environmental impact assessment purposes.

The standard survey and assessment guidelines will also include recommendations for monitoring programs.

Various versions of the guidelines will be prepared in order to target specific agencies and consultants. Preparation will be incremental over the first two years of this Recovery Plan, with priority given to agencies with the responsibility of assessing developments and activities on private tenure.

Performance criterion: Standard survey and environmental impact assessment guidelines have been incrementally developed and distributed within 2 years from the commencement of this Recovery Plan.

Action 2.2

The NPWS will provide for Yellow-bellied Glider populations in reserve management and planning.

Research currently being proposed by the University of Melbourne, in collaboration with SFNSW and NPWS, aims to identify target species suitable as indicators for monitoring forest management (B. Wintle pers. comm.). The Yellow-bellied Glider has the potential to be an important management indicator species. Conservation of the species will provide for conservation of a wider suite of forest values and increase the amount of habitat available to species

with smaller home ranges. Therefore, the NPWS should consider the species in reserve management and planning.

Management activities conducted on NPWS estate are assessed through existing means such as Reviews of Environmental Factors (REFs) and associated 8-part tests. The guidelines developed in Action 2.1 will assist in the preparation and assessment of these REFs. Therefore, once the guidelines are developed they will be distributed to relevant NPWS estate managers.

To assist with general management of the Yellow-bellied Glider on NPWS estate, a range of explicit statements relevant to the management of the species will be developed. These statements should be considered by NPWS land managers where management documents state that recovery plans will be implemented. Statements should address:

- protection of Yellow-bellied Glider habitat types, sap trees and sap tree species in Plans of Management;
- size and shape of habitat, reserves and corridors. Strategies should attempt to reduce edge effects, minimise foraging distances, increase the types of resources available and reduce the linear nature of habitat (see Recher *et al.* 1987);
- protection of Yellow-bellied Glider habitat in Fire Management Plans. There are no known prescriptive fire requirements for the species, although the effect of fire on the Yellow-bellied Glider has been identified as a possible research subject (see Appendix 4). Current fire management involving Yellow-bellied Glider habitat should be directed toward protection of key resources during managed hazard reduction, rather than any habitat manipulation of vegetation communities using a particular regime;
- the fragmentation effects of infrastructure works, including road, firebreak or management trail construction and maintenance. This should include the identification of linear gaps as narrow as 50 metres and consideration of amelioration measures; and
- the area requirements for viable populations of the Yellow-bellied Glider when determining

additions to the existing conservation reserve system.

A list of conservation reserves in which the Yellow-bellied Glider has been recorded is provided in Appendix 3.

Performance criterion: Conservation of the Yellow-bellied Glider has been given priority in ongoing conservation reserve management and planning.

Action 2.3

The NPWS will encourage State government agencies and local governments to consider the inclusion of regional-based Yellow-bellied Glider habitat types, sap trees and sap tree species in planning instruments.

Habitat alteration and removal is the major threat to the Yellow-bellied Glider, especially on private land and in urban areas. Planning instruments already in place should address the alteration and removal of habitat that is important for the species at local and regional levels. Survey and environmental impact assessment guidelines used for such assessments will be provided for in Action 2.1.

There are currently 58 local government areas of NSW that contain records of the Yellow-bellied Glider within their boundary (see Appendix 5).

Performance criterion: State government agencies and local governments have been approached by NPWS regarding regionally significant Yellow-bellied Glider habitat types, sap trees and sap tree species within 18 months from the commencement of this Recovery Plan.

Action 2.4

The NPWS will encourage Catchment Management Boards (CMBs), RVCs and Bush Fire Management Committees (BFMCs) to consider regionally significant Yellow-bellied Glider habitat types, sap trees and sap tree species in Catchment Management Blueprints, Regional Vegetation Management Plans, Bush Fire Risk Management Plans and Plans of Operations.

Habitat alteration and removal is the major threat to the Yellow-bellied Glider. A regional approach

to conservation of the species and its habitat requires regional and landscape based management plans to address this threat. Information used in such assessments will be provided for in Action 5.1.

With regard to Bush Fire Management Plans and Plans of Operations, there are no known prescriptive fire requirements for the species, although the effects of fire on the Yellow-bellied Glider has been identified as a possible research subject (see Appendix 4). Current fire management involving Yellow-bellied Glider habitat should be directed toward protection of key resources during managed hazard reduction, rather than any habitat manipulation of vegetation communities using a particular regime.

Performance criterion: Regionally significant Yellow-bellied Glider habitat types, sap trees and sap tree species have been considered in Catchment Management Blueprints, Regional Vegetation Management Plans, Bush Fire Management Plans and Plans of Operations throughout the duration of this Recovery Plan.

Action 2.5

The NPWS will liaise with DLWC to achieve retention of Yellow-bellied Glider sap trees, sap tree species, den trees and a mosaic of forest types when assessing private native forest logging and vegetation clearance applications.

A large proportion of Yellow-bellied Glider populations and habitat types are likely to be located in privately owned and managed forests. Assessment of private logging and clearance applications should consider this habitat and offer protection to the Yellow-bellied Glider. The existing benchmark for amelioration of impacts is the prescriptions applied by SFNSW in state forests, which are outlined in the Threatened Species Licence of the IFOA for each forest region. The standard of protection on private land should be at least of the standard provided for by SFNSW.

Where possible, monitoring of the effectiveness of these amelioration measures should be undertaken.

Performance criterion: Retention of Yellow-bellied Glider sap trees, sap tree species, den trees and a

mosaic of forest types on private land is being considered in private logging and clearing assessments within one year from the commencement of this Recovery Plan.

Action 2.6

The NPWS will liaise with relevant government agencies and utility providers to ensure that appropriate consideration is given to the isolation of Yellow-bellied Glider habitat in design of roads, easement corridors and other linear clearings (including access and maintenance trails).

Creation of gaps and clearings such as roads and easement corridors can isolate Yellow-bellied Glider populations, fragment habitat and increase the risk of predation. Because maximum potential gliding distance is related to local conditions, gaps as narrow as 50 metres can act as dispersal barriers. The best conservation outcome in such instances is the retention of habitat. Where this is not possible mitigation should include a range of integrated measures. Structures such as knotted ropes, launching poles, nest boxes and overpasses should be trialled in combination with rehabilitation and remediation of alternative potential connective habitat.

Performance criterion: Government agencies and utility providers have been made aware of the effects of linear clearing in potential Yellow-bellied Glider habitat and associated ameliorative measures within the first year of commencement of this Recovery Plan.

Action 2.7

The NPWS will consolidate survey results and records, including existing records that do not appear in the NPWS Atlas of NSW Wildlife, to identify the status of the Yellow-bellied Glider on privately-owned and public forested land.

The status of the Yellow-bellied Glider on privately-owned forested land is largely unknown. A comprehensive body of records is required to enable this status to be accurately assessed. Private consultants and non-government organisations may already be in possession of this information and represent a potential source of records for the species on private land.

The NPWS will also encourage State government agencies and local governments to provide private and public land records for the species. This information will be collated and incorporated into the Atlas of NSW Wildlife. Information gained from this action will assist in completion of Action 3.1.

Performance criterion: Collation of survey records from private and public land has commenced within two years of the commencement of this Recovery Plan.

Objective 3: To identify and monitor significant populations of the species

Action 3.1

The NPWS will, on a NPWS directorate basis, identify significant Yellow-bellied Glider populations and the specific management issues associated with them. The NPWS will support monitoring of these populations and, where possible, implement appropriate management.

A significant population is one that is essential to the ongoing viability and diversity of a larger regional population. Significance should be based on a balance between the contribution of a population to the diversity and viability of the species, the level of active management required for long-term viability and the associated cost. Significant populations are not necessarily populations that are naturally viable in the long term and may require active management to remain viable.

Identification of significant populations will be undertaken in consultation with local governments, State government agencies and research scientists and will include collation of all Yellow-bellied Glider records, including those made by consultants and non-government organisations on private land (see Action 2.7). The process will also require an inventory of existing mapped and modelled Yellow-bellied Glider habitat.

Initial mapping of records will utilise the existing structures provided for in the NPWS Atlas of NSW Wildlife database.

Any monitoring programs prepared for these populations will be in accordance with the survey

and environmental impact assessment guidelines prepared in Action 2.1 and, where possible, will include a component that monitors the effectiveness of management activities.

A research project currently being proposed by the University of Melbourne, in collaboration with SFNSW and NPWS, aims to develop survey protocols for regional-level monitoring programs to detect trends in abundance of several forest-dwelling species (B. Wintle pers. comm.). This may assist with determining the response of identified indicator species such as the Yellow-bellied Glider to management programs.

Performance criterion: Significant populations and associated management issues have been identified prior to the three year review date of this Recovery Plan.

Objective 4: To facilitate strategic research into the ecology of the Yellow-bellied Glider that is relevant to its conservation

Action 4.1

The NPWS will liaise with research institutes, tertiary institutions, State government agencies and other public authorities to facilitate strategic ecological research that is relevant to the conservation of the Yellow-bellied Glider.

A large body of research already exists for the Yellow-bellied Glider. Continuation of this research requires a strategic approach to maximise the conservation outcomes using limited resources. Such an approach will rely on identification of funding sources and also identification and prioritisation of further research activities.

A list of potential research topics is identified and prioritised in Appendix 4. Some of these topics are already the subject of research in NSW.

All research conducted on the Yellow-bellied Glider will be subject to the licensing and ethics approval requirements current at the time.

Performance criterion: Funding sources for research have been identified and research activities have been identified and prioritised within two years from the commencement of this Recovery Plan.

Objective 5: To increase community awareness of the Yellow-bellied Glider and encourage community involvement in its conservation

Action 5.1

The NPWS will develop and distribute an information package to provide guidance to CMBs, RVCs, BFMCs, local governments, Landcare groups and individuals to assist in the identification of Yellow-bellied Glider habitat, sap trees, protection strategies and habitat enhancement as part of conservation and revegetation programs.

Successful planning and implementation of conservation and revegetation programs will rely on accurate and up to date information that is easy to access. The package will contain information directed towards landholders and individuals who wish to identify, enhance or protect Yellow-bellied Gliders and their habitat on private land, including a description of cost-effective methods of surveying for the species. This package will complement the survey and environmental impact assessment guidelines developed in Action 2.1.

Performance criterion: Information packages have been developed and distributed within two years from the commencement of this Recovery Plan.

Action 5.2

The NPWS will develop and distribute information on the Yellow-bellied Glider to the general community.

The profile of the Yellow-bellied Glider should be raised throughout the community using a range of information and techniques. A Yellow-bellied Glider threatened species profile has already been prepared by the NPWS, although this profile requires updating to reflect recent research and survey results for the species. A pamphlet-sized threatened species information sheet should also be developed for distribution at NPWS visitor centres and national parks.

Performance criterion: The ongoing development and distribution of information has occurred throughout the duration of this Recovery Plan.

10 Implementation

The NPWS is responsible for the implementation of recovery actions specified in this plan. Estimated costs and priorities are presented in Table 2. These actions are to be implemented for a period of three years from the time this Recovery Plan is adopted.

11 Preparation Details

This document was prepared by Shane Ruming of the NPWS Northern Directorate Threatened Species Unit in consultation with Dr Darren Quin, consultant; Dr Rod Kavanagh, Forest Research Division, SFNSW; Dr Ross Goldingay, School of Environmental Science and Management, Southern Cross University; and Ross Wellington, NPWS Central Directorate Threatened Species Unit.

12 Review Date

This Recovery Plan will be reviewed within three years of the date of publication.

13 Acknowledgments

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14 Acronyms Used in this Document

BFMC – Bush Fire Management Committee

CMB – Catchment Management Board

DLWC – Department of Land and Water Conservation

EP&A Act – NSW *Environmental Planning and Assessment Act 1979*

EPBC Act – Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

IFOA – Integrated Forestry Operation Approval

IUCN - International Union for the Conservation of Nature and Natural Resources

NP – National Park

NPW Act – NSW *National Parks and Wildlife Act 1974*

NPWS – NSW National Parks and Wildlife Service

NR – Nature Reserve

NSW – New South Wales

NVC Act – NSW *Native Vegetation Conservation Act 1997*

PVA – Population Viability Analysis

Qld – Queensland

REF – Review of Environmental Factors

RF Act – *Rural Fires Act 1997*

RVC – Regional Vegetation Committee

SFNSW – State Forests of New South Wales

SIS – Species Impact Statement

SRA – State Recreation Area

TSC Act – NSW *Threatened Species Conservation Act 1995*

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16 Implementation Schedule

Table 2: Estimated costs of implementing the actions identified in the Yellow-bellied Glider Recovery Plan.

Action number	Action title	Priority	Estimated cost/year			Total cost	Responsible party/ funding source	In-kind	Cash
			Year 1	Year 2	Year 3				
1.1	Co-ordinate actions	1	8 400	4 200	4 200	16 800	NPWS	16 800	
1.2	Integrate recovery actions	3					NPWS		
2.1	Develop impact assessment guidelines	1	1 750	700	700	3 150	NPWS	3 150	
2.2	Consider species in reserve management and planning	1	700	700	700	2 100	NPWS	2 100	
2.3	Consider species in planning instruments	1	700	700	700	2 100	NPWS	2 100	
2.4	Consider regionally significant habitat	1	700	700	700	2 100	NPWS	2 100	
2.5	Liaise with DLWC	1	700	700	700	2 100	NPWS	2 100	
2.6	Liaise with agencies and utility providers	1	700	700	700	2 100	NPWS	2 100	
2.7	Consolidate records	3	1 750	2 000		3 750	NPWS	1 750	2 000
3.1	Identify significant populations and management issues	3	1 750	7 875	9 625	19 250	NPWS		19 250
4.1	Research	2	1 050	5 700	700	7 450	NPWS	2 450	5 000
5.1	Stakeholder awareness	2	1 750	350	350	2 450	NPWS		2 450
5.2	Community awareness	2	1 750	700	700	3 150	NPWS		3 150
Total			21 700	25 025	19 775	66 500		34 650	31 850

Priority ratings are: 1 - action critical to meeting plan objectives; 2 - action contributing to meeting plan objectives; 3 - desirable but not essential action.

'In-Kind' funds represent salary component of permanent staff and current resources.

'Cash' funds represent the salary component for temporary staff and other costs such as the purchasing of survey and laboratory equipment.

Appendix 1 Identified Yellow-bellied Glider Sap Tree Species in NSW

Scientific Name	Common Name/s	Region
<i>Acacia mabellae</i>	Mabel's Wattle	South Coast
<i>A. mearnsii</i>	Black Wattle	South Coast
<i>Angophora subvelutina</i>	Broad-leaved Apple	North-east
<i>Corymbia gummifera</i>	Red Bloodwood	South Coast
<i>C. henryi</i>	Large-leaved Spotted Gum	North-east
<i>C. intermedia</i>	Pink Bloodwood	North-east
<i>C. maculata</i>	Spotted Gum	South Coast, North-east
<i>Eucalyptus amplifolia</i>	Cabbage Gum	North-east
<i>E. andrewsii</i>	New England Blackbutt, Gum-topped Peppermint	North-east
<i>E. angophoroides</i>	Apple-topped Box	South Coast
<i>E. bancroftii</i>	Orange Gum, Bancroft's Red Gum	North-east
<i>E. bosistoana</i>	Coast Grey Box	South Coast
<i>E. botryooides</i>	Bangalay, Southern Mahogany	South Coast
<i>E. cypellocarpa</i>	Monkey Gum, Mountain Grey Gum	South Coast
<i>E. dalrympleana</i>	Mountain Gum	Southern Tablelands
<i>E. deanei</i>	Mountain Blue Gum, Round-leaved Gum	North Coast and adjacent ranges
<i>E. dunnii</i>	White Gum	North-east
<i>E. eugenioides</i> (includes <i>E. nigra</i>)	Thin-leaved Stringybark	North-east
<i>E. fastigata</i>	Brown Barrel, Cut-tail	Southern Tablelands
<i>E. grandis</i>	Flooded Gum, Rose Gum	North-east
<i>E. laevopinea</i>	Silvertop Stringybark	North-east
<i>E. moluccana</i>	Grey Box	North-east
<i>E. obliqua</i>	Messmate	South Coast, North-east
<i>E. ovata</i>	Swamp Gum	South Coast, Southern Tablelands
<i>E. pilularis</i>	Blackbutt	North-east
<i>E. pilularis/C. maculata</i> hybrid		South Coast
<i>E. piperita</i>	Sydney Peppermint	South Coast
<i>E. propinqua</i>	Grey Gum	North-east
<i>E. punctata</i>	Grey Gum	Central Coast, South Coast, North Coast and adjacent ranges
<i>E. racemosa</i>	Narrow-leaved Scribbly Gum	North Coast
<i>E. saligna</i>	Sydney Blue Gum	North Coast and adjacent ranges, South Coast
<i>E. sclerophylla</i>	Hard-leaved Scribbly Gum	South Coast
<i>E. seeana</i>	Narrow-leaved Red Gum	North-east
<i>E. signata</i>	Scribbly Gum	North-east
<i>E. tereticornis</i>	Forest Red Gum	North Coast and adjacent ranges
<i>E. viminalis</i>	Ribbon Gum, Manna Gum	South Coast, Southern Tablelands
<i>Lophostemon confertus</i>	Brush Box	North Coast

Source:

Bell and Bell (1997); Ecotone Ecological Consultants (1995a, 1995b); Goldingay and Kavanagh (1990); Goldingay (1986, 1987, 1989a, 1989b, 1990, 1991, 2000); Kavanagh (1984, 1987a, 1987b); Mackowski (1988, unpub. in Smith and Russell 1982); Smith *et al.* (1994).

Also see Threatened Species Licences of the IFOA for the Eden Region, Southern Sub-region and Tumut Sub-region.

Appendix 2 Public Authority Responsibilities

Public authority	Relevant responsibilities
NSW NPWS	<ul style="list-style-type: none"> • Assessment of Section 91 licence applications under the TSC Act. • Assessment of Section 120 licence applications under the NPW Act. • Advice to determining and consent authorities, with a possible concurrence role under the EP&A Act. • Co-ordination of Recovery Plan implementation.
Relevant local governments	<ul style="list-style-type: none"> • Preparation of Local Environmental Plans under Part 3 of the EP&A Act. • Consent authorities for development proposals under Part 4 of the EP&A Act. • Approval authorities for council works under Part 5 of the EP&A Act. • Responsibilities under the <i>Rural Fires Act 1997</i>. • Management of council reserves with potential habitat. • Consideration of the content of Recovery Plans when preparing plans of management for community land under the <i>Local Government Act 1993</i>.
Department of Land and Water Conservation	<ul style="list-style-type: none"> • Approval authority for native vegetation clearance applications under the NVC Act. • Management of crown land with potential habitat. • Co-ordination of RVCs, CMBs and Landcare programs.
State Forests of New South Wales	<ul style="list-style-type: none"> • Implementation of prescriptions detailed in IFOA terms of licence granted under Part 4 of the <i>Forestry and National Park Estate Act 1998</i>.
Planning NSW	<ul style="list-style-type: none"> • Development of policy and strategies for land use planning and environmental assessment. • Advice and assistance on environmental planning matters. • Assessment of major development applications.
Rural Fire Service	<ul style="list-style-type: none"> • Preparation of Bush Fire Risk Management Plans and Plans of Operations. • Fire management.
Other State government agencies	<ul style="list-style-type: none"> • Management of public lands with potential habitat. • Approval authorities for activity proposals under Part 5 of the EP&A Act.

Appendix 3 Conservation Reserves of NSW Containing Yellow-bellied Glider Records

Bago Bluff NP	Cullendulla Creek NR	New South Wales Jervis Bay NP
Bangadilly NP	Deua NP	Ngambaa NR
Banyabba NR	Dharug NP	Ngulin NR
Barool NP	Dorrigo NP	Nightcap NP
Barrington Tops NP	Dunggir NP	Nymboi-Binderay NP
Basket Swamp NP	Eurobodalla NP	Nymboida NP
Bell Bird Creek NR	Fortis Creek NP	Oxley Wild Rivers NP
Bellinger River NP	Ghin-Doo-Ee NP	Queens Lake NR
Ben Boyd NP	Gibraltar Range NP	Ramornie NP
Bermagooe NR	Gulaga NP	Richmond Range NP
Berowra Valley Regional Park	Guy Fawkes River NP	Sherwood NR
Biamanga NP	Hortons Creek NR	Single NP
Bindarri NP	Iluka NR	South East Forest NP
Biriwal Bulga NP	Juugawaarri NR	Tabbimoble Swamp NR
Blue Mountains NP	Kanangra-Boyd NP	Talawahl NR
Bondi Gulf NR	Khappinghat NR	Tapin Tops NP
Boonoo Boonoo NP	Kooraban NP	Tarlo River NP
Border Ranges NP	Kosciuszko NP	The Glen NR
Bournda NR	Kumbatine NP	Toooloom NP
Bowraville NR	Mallanganee NP	Toonumbar NP
Brindabella NP	Mann River NR	Torrington SRA
Budawang NP	Maria NP	Tuggolo Creek NR
Bugong NP	Mebbin NP	Ulidarra NP
Bundjalung NP	Meroo NP	Wadbilliga NP
Bungawalbin NR	Mimosa Rocks NP	Wallabadah NR
Bungawalbin NP	Monga NP	Wallingat NP
Bungonia SRA	Mooball NP	Wambina NR
Burraborang SRA	Morton NP	Washpool NP
Cambewarra Range NR	Mount Canobolas SRA	Watagans NP
Captains Creek NR	Mount Imlay NP	Werrikimbe NP
Carrai NP	Mount Jerusalem NP	Willi Willi NP
Cascade NP	Mount Nullum NR	Winburndale NR
Cattai NP	Mount Pikapene NP	Windsor Downs NR
Chaelundi NP	Mount Royal NP	Woko NP
Clyde River NP	Mummel Gulf NP	Wollemi NP
Cockle Bay NR	Murramarang NP	Woollamia NR
Colymea SRA	Myall Lakes NP	Yabba NP
Conjola NP	Nadgee NR	Yengo NP
Coorabakh NP	Nattai NP	Yoorigan NP
Corramy SRA	Nattai SRA	Yuraygir NP
Cottan-Bimbang NP	New England NP	

Note:

NP – National Park

NR – Nature Reserve

SRA – State Recreation Area

Appendix 4 Identified Potential Yellow-bellied Glider Research Topics

High priority

- Continuation of studies into effectiveness of wildlife corridors in dispersal and survival of individuals (Goldingay and Kavanagh 1991).
- Investigate Yellow-bellied Glider use and reliance on unlogged patches (unlogged compartments, corridors or reserves) within the logging mosaic (Kavanagh 1997).
- Estimation of population sizes to determine whether adequate area has been reserved for viable populations, especially in isolated reserves (Goldingay and Kavanagh 1993).
- Determine the effectiveness of mitigation measures involving structures put in place to reduce the effects of linear corridors, urban expansion and road construction.
- Research and monitoring programs to determine the effectiveness of sap tree retention as a logging prescription (Goldingay 2000) and other mitigative measures provided in the conservation protocols and other TSC Act approvals.

Medium priority

- Investigate significance of habitat destruction associated with agriculture and urban development (Goldingay and Kavanagh 1991).
- Investigate effects of fire on Yellow-bellied Glider habitat and populations (Goldingay and Kavanagh 1991) and identify appropriate fire regimes.
- Investigate the efficacy of possible restoration and enhancement of disturbed habitat and corridors.
- Investigate use of the Yellow-bellied Glider as an indicator and umbrella species in NSW forest ecosystems and if management will cater for other sensitive species.
- Develop protocols for monitoring that ensure practical and cost-effective strategies.
- Test accuracy of existing habitat models and developing new models to reliably predict high quality habitat.
- Investigate time-budget, group size and home range size of the Yellow-bellied Glider prior to, during and after logging (Goldingay and Kavanagh 1991; D. Quin pers. comm.).
- Further research into determining minimum viable population, including genetic studies of several populations (Goldingay and Kavanagh 1991).
- Continuation of sap tree research that has been undertaken previously.

Low priority

- Investigate gaps in the distribution of the species and the consequences for long-term genetic diversity.
- Investigate the role of the species as a pollinator of forest flora.

Appendix 5 Local Government Areas of NSW Containing Yellow-bellied Glider Records

Armidale Dumaresq	Gundagai	Ryde
Baulkham Hills	Guyra	Rylstone
Bega Valley	Hastings	Scone
Bellingen	Hawkesbury	Severn
Blue Mountains	Hornsby	Shoalhaven
Bombala	Kempsey	Singleton
Byron	Kiama	Sutherland
Cabonne	Kyogle	Tallaganda
Campbelltown	Lake Macquarie	Tenterfield
Cessnock	Lismore	Tumbarumba
Coffs Harbour	Lithgow	Tumut
Cooma-Monaro	Maclean	Tweed
Copmanhurst	Mulwaree	Walcha
Dungog	Muswellbrook	Wingecarribee
Eurobodalla	Nambucca	Wollondilly
Evans	Narrabri	Wollongong
Gloucester	Nundle	Wyong
Gosford	Oberon	Yarrowlumla
Great Lakes	Quirindi	
Greater Taree	Richmond Valley	



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