Draft **Recovery Plan**

Pterostylis sp. 15 (Orchidaceae) Botany Bay Bearded Greenhood Orchid

Draft for public exhibition
September 2000

Natural Heritage Trust
Helping Communities Helping Australia

NSW NATIONAL PARKS AND WILDLIFE SERVICE

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Pterostylis sp. 15 (Orchidaceae) Botany Bay Bearded Greenhood Draft Recovery Plan

Prepared in accordance with the New South Wales *Threatened Species Conservation Act 1995* and the Commonwealth *Endangered Species Protection Act 1992*.

September 2000

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Executive Summary

Introduction

Pterostylis sp. 15 is a terrestrial orchid which grows to about 20 cm tall (Bishop, 1996). The current distribution is extremely restricted and it is known from only one small disjunct population on the Kurnell peninsula in Botany Bay National Park in southern Sydney, in the Central Coast Botanical Division, South Eastern Australia.

This recovery plan describes our current understanding of *P.* sp. 15, documents the research and management actions undertaken to date, and identifies the actions required and parties responsible to ensure the ongoing viability of the species in the wild.

Legislative context

The Threatened Species Conservation Act is NSW's legislative framework to protect and encourage the recovery of threatened species, populations and communities. Under the TSC Act, the Director-General of National Parks and Wildlife has certain responsibilities including the preparation of recovery plans for threatened species, populations and ecological communities. This Recovery Plan has been prepared in accordance with the provisions of the TSC Act.

Preparation of plan

This Recovery Plan has been prepared with the assistance of a recovery team, a non-statutory group of interested parties with relevant expertise, established to discuss and resolve issues relating to the plan. Components within the plan do not necessarily represent the views nor the official positions of all the individuals or agencies represented on the recovery team. The information in this Recovery Plan was accurate to the best of the NPWS' knowledge on the date it was approved.

The plan will be reviewed and updated 5 years from the date of publication.

Implementation of plan

The TSC Act requires that a government agency must not undertake actions inconsistent with a recovery plan. The government agencies relevant to this plan are the National Parks and Wildlife Service, Randwick Council and the federal Department of Finance and Administration. Consequently, the National Parks and Wildlife Service, Randwick Council and the federal Department of Finance and Administration must, as the government agencies responsible for *P.* sp. 15, manage the species and it's habitat in accordance with this recovery plan.

Recovery objectives
Overall objective

The overall objective of the plan is to prevent the extinction of *P.* sp. 15 through appropriate management of the wild population to reduce current and future threats and to maintain self sustaining populations in the wild in the long term.

Recovery criteria
Overall Performance Criteria

The overall performance criteria of the recovery plan is that, the known population and any new populations remain self sustaining in nature in perpetuity.

Recovery objectives
Specific Objectives

Specific objectives of this recovery plan are to:

- maintain a viable (self maintaining in the long term) population at the known site and any new site through protection and management of threats;
- understand essential aspects of the biology and ecology of *P.* sp. 15 which will allow effective management strategies to be formulated for the known and any new populations;
- establish and maintain *ex situ* collections which fully represent the genetic diversity of the known population if required.

Recovery actions

The plan consists of three broad actions which aim to achieve the overall objective:

1. Habitat and threat management

- develop and refine appropriate habitat management strategies based on knowledge of the biology and ecology of *P.* sp. 15;
- protection of populations of *P.* sp. 15 through the implementation of appropriate management strategies by relevant government authorities;
- ensuring appropriate fire management of the known population and possible habitat of *P.* sp. 15.

2. Survey and research

- undertake a systematic survey of potential habitat to further determine the full distribution of *P.* sp. 15;
- monitor the dynamics of the known population for three to five years;
- investigate the biology and ecology of *P.* sp 15;
- undertake trials of response to fire of the known population.

3. *Ex situ* conservation

- determine if *ex situ* conservation is required;
- determining the most appropriate method of *ex situ* storage of *P.* sp. 15*;*
- establishing and maintaining a representative collection.

Performance criteria

The overall performance criteria of the recovery plan for *P.* sp. 15 is that the known population and any new populations remain self sustaining in nature in perpetuity.

- Through protection and management a self maintaining population is maintained at the known site and any new sites, in the long term;
- increased knowledge of the biology and ecology of *P.* sp. 15 is available for formulation of management strategies for the species ;
- representative *ex situ* collections of *P.* sp. 15 established and maintained in a botanic garden if required.

Summary of Implementation Costs

A summary of the funds required to implement this recovery plan are identified below. This recovery plan will be implemented over a 5 year period. Average implementation costs per year will be approximately $7200.

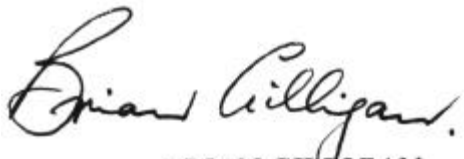
Table 1

Action	Description	NPWS	Unsecured
1	**Habitat and threat management**		
	Interim habitat strategy (track maintenance/minimise access/exclude fire)		
	Formulate habitat management strategy	3,000	
	Implement habitat management strategy	4,500	
	Formulate fire management plans	1,000	
	Stakeholder liaison	1,000	
	Environmental planning and Assessment		
2	**Survey and Research**		
	Targeted survey	7,500	2,000
	Monitoring	4,000	
	Ecological and biological research	500	10,000
3	***Ex situ* conservation**		
	Investigate need for ex situ conservation	2500	
	Investigation of propagation method (if required)	(2500*)	
	Establish and maintain collection (if required)		(10,000*)
	Total	**24,000**	**12,000**

* if action required

Biodiversity benefits

The conservation of areas of habitat in which *P.* sp. 15 occurs provides the opportunity to conserve other species co-existing in the habitat and to conserve the endangered eastern suburbs banksia scrub occurring in the coastal sandstones of eastern Sydney.



BRIAN GILLIGAN
DIRECTOR-GENERAL

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1 Introduction

Pterostylis sp. 15 is a terrestrial orchid which grows to about 20 cm tall (Bishop, 1996). The current distribution is extremely restricted and it is known from only one small population on the Kurnell peninsula within Botany Bay National Park in southern Sydney, in the Central Coast Botanical Division, South Eastern Australia.

2 Legislative context

2.1 Legal status

P. sp. 15 is considered endangered in NSW and is listed on Schedule 1 of the TSC Act.

P. sp. 15 is listed as a nationally endangered species on Schedule 1 of the Commonwealth *Endangered Species Protection Act 1992* (ESP Act). The schedules in the ESP Act are based on the lists compiled by the Australian and New Zealand Environment Conservation Council. Being listed nationally the species is eligible for funding under the federal Endangered Species Program and is protected under Commonwealth legislation.

2.2 Recovery Plan preparation

The Threatened Species Conservation Act (TSC Act) requires that the Director-General of National Parks and Wildlife 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 plan satisfies these provisions.

This Recovery Plan has been prepared with the assistance of a recovery team, a non-statutory group of interested parties with relevant expertise, established to discuss and resolve issues relating to the plan. Components within the plan do not necessarily represent the views nor the official positions of all the individuals or agencies represented on the recovery team. The information in this Recovery Plan was accurate to the best of the NPWS' knowledge on the date it was approved.

2.3 Recovery Plan implementation

The TSC Act requires that a government agency must not undertake actions inconsistent with a recovery plan. The government agencies relevant to this plan are the National Parks and Wildlife Service, the Royal Botanic Gardens Sydney, Randwick Council and the federal Department of Finance and Administration. Consequently, the National Parks and Wildlife Service, Royal Botanic Gardens Sydney, Randwick Council and the federal Department of Finance and

Administration must, as the relevant land manager, manage *P.* sp. 15 in accordance with this plan. Relevant land management issues include fire management, habitat protection and development control. Likewise, the National Parks and Wildlife Service, Royal Botanic Gardens Sydney, Randwick Council and the federal Department of Finance and Administration and their agents, must undertake research in accordance with the priorities identified in this plan and subject to the controls outlined in this plan.

2.4 Relationship to other legislation

The TSC act amendments to the Environmental Planning and Assessment Act, 1979 (EPA Act) requires that consent and determining authorities consider relevant recovery plans when exercising a decision making function under parts 4 and 5 of the EPA Act. As the known location of *P.* sp. 15 occurs within Botany Bay National Park, the NSW NPWS will be responsible for assessment, however as new populations may be located on other tenures several relevant determining authorities may be involved. These determining and consent authorities must consider the conservation strategy outlined in this plan when considering any activity which may affect *P.* sp. 15.

Relevant councils (possibly Randwick) must consider the likely effect of any proposed development, planning instrument and management of Council lands on any *P.* sp. 15 population or potential habitat for *P.* sp. 15, within their local government areas. The federal Department of Finance and Administration must consider the impact of any activities undertaken within areas known to contain *P. p. 15* or potential habitat for *P.* sp. 15 in the relevant area within the control of the DFA. The NPWS must consider the impact of hazard reduction and fire suppression activities on *P.* sp. 15 in the Kurnell area.

2.5 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 TSC Act) and a species impact statement is mandatory for all developments and activities proposed within critical habitat.

To date, critical habitat has not been declared for *P.* sp. 15 under the TSC Act.

3 Conservation Status

P. sp. 15 is currently only known from one location at Kurnell in southern Sydney in eastern Australia. The known location occurs close to a major fire trail and could be subject to various threatening processes (described in Section 8). The known population is small (+/-146 plants) and little is known about the genetic diversity of the population and its long term viability.

4 Description

4.1 Taxonomy

P. sp 15 is still to be formally described although it is considered to be a separate taxon. The species should be described within the next two years (D. Jones, pers. comm.). *P.* sp. 15 is also known as *P* sp. aff. *plumosa* (Sydney) as it shares many of the characteristics of *P. plumosa* (Bishop, 1996).

Taxonomic hierarchy:

Order:	Liliales
Family:	Orchidaceae
Subfamily	Orchidoideae
Tribe:	Diurideae
Subtribe:	Pterostylidinae
Genus:	*Pterostylis*
Species:	sp. 15 or sp. aff. *plumosa* (Sydney)
Author:	no author
Date:	no date

4.2. Botanical Description

P. sp. 15 belongs to the plant family Orchidaceae. This cosmopolitan family consists of 25 000 species worldwide, of which many are of commercial value both as living and cut flowers and for culinary purposes e.g. the Vanilla "bean" (Weston, 1993).

The genus *Pterostylis* consists of c.120 species worldwide, c.100 of these species occur in Australia in all states except the Northern Territory (Jones, 1993). The Australian species are distributed mostly over the moister temperate parts of Australia (Dockrill, 1992). The genus is named after the wing-like extensions on the column, from the Greek "*pteron*" meaning wing and "*styles*" meaning style (Sharp, 1970).

The following description is adapted from Bishop (1996); *P.* sp. 15 grows to 20 cm tall. The flowering stems are slender and lean forward towards the top. The flower is solitary, translucent green with dark green veins. The galea (helmet-like arrangement of the dorsal sepal and petals) is strongly inflated at the base and curves to a tapered, upcurved apical beak to 2 mm long. The slender lateral sepals point forwards and down with their tips parallel and held close together. The labellum is weakly arching and is sparsely covered in yellow hairs and has a dark red knob at the apex. Up to 12 narrow-ovate leaves are arranged in a basal rosette with a slightly ascending stem so that the leaves form a pyramid. The leaves are 37mm long and 12 mm wide. *P.* sp. 15 differs from *P. plumosa* as that species has larger more robust and almost erect flowers and is found only on the tablelands and western slopes in NSW. An adult flowering individual is shown in Figure 1 with a close up of the flower shown in Figure 2.

Figure 1. *Pterostylis* sp. 15, adult flowering plant (photograph: M. Bradhurst)

Figure 2. *Pterostylis* sp 15, flower (photograph: M. Bradhurst)

5 Distribution and habitat

5.1 Collection history

P. sp. 15, also known as P. sp *aff. plumosa*, was first collected from Maroubra, a coastal area in eastern Sydney in 1908 by Boyle. At this time it was identified as the species *P. barbata* (Rupp, 1969). More collections of *P. barbata* were made from the Kurnell peninsula in 1960 and 1962 (B. Brinsley, pers. comm.) and in 1966 and 1969 (J. Riley, pers. comm.). The species *P. barbata* was reviewed by Cady in 1969 and *P. plumosa* was separated from *P. barbata* due to geographic and structural differences. The collections from Maroubra and Kurnell were renamed *P. plumosa.* Recently *P.* sp. 15 was recognised as a taxon distinct from *P. plumosa* by taxonomist David Jones of the Australian National Botanic Garden and the collections from Maroubra and Kurnell were reassigned to this new group but the taxon is yet to be formally described (D. Jones, pers. comm.).

5.2 Current distribution

P. sp. 15 is endemic to New South Wales and is currently only known from the one location within Botany Bay National Park on the Kurnell peninsula in southern Sydney South-eastern Australia. Specimens thought to be *P.* sp. 15 from Ben Boyd National Park have recently been identified as *P. tasmanica* (P. Weston, pers. comm.). The taxonomic status of the genus *Pterostylis* is currently being investigated by taxonomist David Jones at the Australian National Botanic Garden Canberra. The current known distribution of *P.* sp. 15 is shown in Figure 3.

5.3 Vegetation and potential habitat

The habitat of the known population of *P.* sp. 15 is coastal heath in moist level sites, in association with *Melalucca nodosa* and *Baeckea imbricata,* on skeletal sandy soils derived from sandstone (Bishop, 1996). *P.* sp. 15 occurs in small localised populations usually in areas within the heath where the canopy allows filtered light to reach the ground. In adjacent areas were *Allocasuarina distyla* and *Banksia ericifolia* formed a more dense canopy no *P.* sp. 15 were located. It is possible that *P.* sp. 15 may be found in other parts of this vegetation community. Further survey is expected to assist in understanding the fine scale distribution of the species. Table 1 lists species which are associated with *P.* sp. 15 at Kurnell.

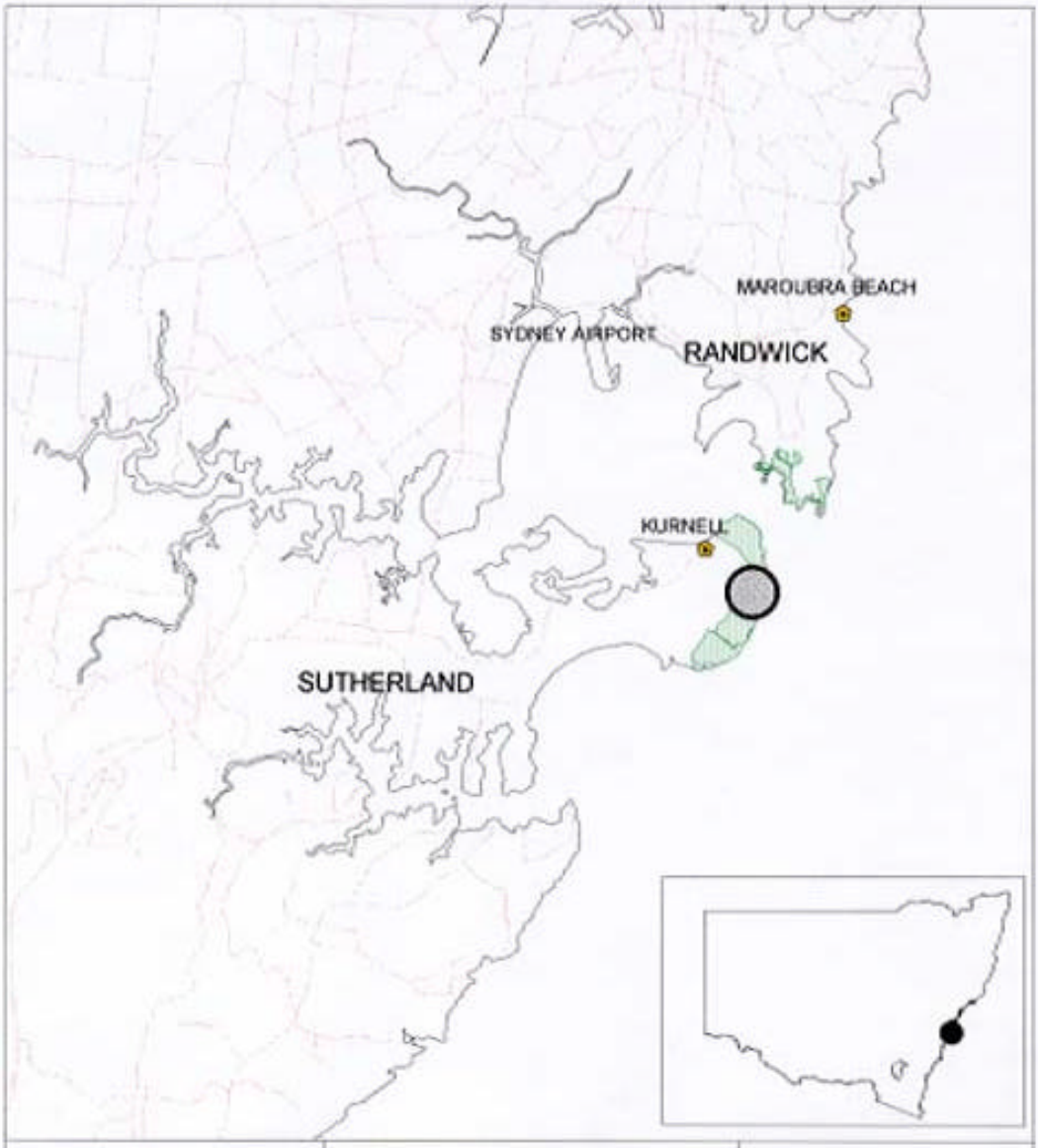
The species was first recorded from "Maroubra" in 1908. While there is no way to find out exactly where the specimen was collected ninety years ago, it is reasonable to assume that the habitat would be similar to that it is found in at Kurnell. There is little native vegetation remaining in Maroubra. The best preserved area of native coastal heathland exists on Malabar headland at the Anzac Rifle Range. This area of approximately 21.5 ha, known as Block 4 (Malabar West) and a small adjacent area, is located at the western end of Malabar Headland. The vegetation communities on the headland include coastal sandstone heath and scrub which is characterised by *B.*

imbricata, *Lomandra longifolia*, *Banksia ericifolia* and *Westringia fructicosa* (Godden Mackay, 1997). Though a number of orchid species have been recorded from this area, *P.* sp. 15 has not been recorded though there has not been any systematic survey for *P.* sp. 15 to date. There is also a small amount of remnant bushland in Arthur Byne Reserve and Cromwell and Pioneers Parks owned and managed by Randwick Council.

Table 1: Species associated with P. sp. 15 in Botany Bay National Park.

Family	**Species**
Apiaceae	Actinotis helianthii
Casuariniacae	*Allocasuarina distyla*
Epacridaceae	*Epacris longiflora* *Leucopogon ericoides* *Woollsia pungens*
Fabaceae	*Acacia sophorae* *Dillwynia retorta* *Mirbelia rubifolia*
Goodeniaceae	*Dampiera stricta*
Haloragaceae	*Gonocarpus teucrioides*
Myrtaceae	*Baeckea brevifolia* *Baeckea imbricata* *Darwinia fascicularis* ssp. *Fascicularis* *Melaleuca nodosa*
Orchidaceae	*Calochilus paludosus* *Corybas undulatus* *C. unguiculatus* *Diuris aurea* *Microtis* sp. *Pterostylis* affin *parviflora* *P. pedoglossa* *Thelymitra pauciflora* *T. carnea*.
Poaceae	*Entolasia stricta*
Proteaceae	*Banksia ericifolia* *Hakea teretifolia* *Persoonia lancelata*
Rutaceae	*Eriostemon buxifolius* ssp. *Buxifolius*
Xanthorrhoeaeae	*Xanthorrhoea resinifera*

Source: M. Matthes NPWS



Pterostylis sp 15

Botany Bay National Park

Roads

Figure 3: Distribution of P. sp 15

SCALE 1: 202,000
Projection: Australian Map Grid, Zone 56

Map Compiled From:
Species records from the NPWS Atlas of NSW Wildlife
Roads, Rivers and Towns from AUSLIG
NPWS Estate from NSW NPWS

0 2 4 Kilometers

Printed By
NPWS Sydney Zone
30 July 1999

5.4 Climate

The climate of the Sydney area varies with topography and distance from the coast. In the eastern suburbs of Sydney the average annual rainfall is 1212 mm. Most rainfall is associated with thunderstorms and major fronts (Chapman and Murphy, 1989). Average daily maximum temperature at Sydney Airport (Mascot) is 26.2 ^{o}C in January and 16.9 ^{o}C in July and average daily minimum temperature ranges from 18.7 ^{o}C in February and 6.8 ^{o}C in July (Bureau of Meteorology, 1999a).

5.5 Landscape and topography

The topography of the Kurnell peninsula is very low rolling rises and sandstone shelves on coastal headlands. Ridges and crests are broad up to 200 m wide. The known site is at an altitude of approximately 40 m above sea level. Rock out-crop covers 30-50 % of the land surface (Hazelton *et al*. 1990). At Maroubra the topography is undulating to rolling low hills with broad convex crests and plateau surfaces. Sandstone bedrock outcrops as wide benches and areas of impeded drainage occur (Chapman and Murphy, 1989).

5.6 Soil landscape

The Kurnell peninsula is overlain by the Bundenna soil landscape. this soils landscape consists of siliceous sands and earthy sands with yellow earths. Gleyed podzolic soils exist on lower slopes (Hazelton *et al*. 1990). At Maroubra the Malabar headland is covered by the Lambert soil landscape which consists of discontinuous earthy sands and yellow earths on crests and benches (Chapman, 1989)

6 Biology and ecology

6.1 Life history

All species of *Pterostylis* are deciduous and die back to fleshy, rounded tuberoids in dry or hot conditions (Jones, 1993) *P.* sp 15 produces a slightly ascending basal rosette of leaves from mid-winter followed by the flowering stem. Bishop (1996) reports that flowering occurs from August to September, however it has been recorded in bud in July (S. Nash, field obs). After the seeds have been released the above ground parts of the plant wither and die and the plant exists as an underground tuberoid. Time of emergence, flowering and withering is dependent on prevailing weather conditions.

6.2 Reproductive biology

6.2.1 Vegetative reproduction

Little is known about the reproductive strategies of *P.* sp 15. The most closely related species *P. plumosa* is a solitary species which does not form colonies by vegetative reproduction of "daughter" tuberoids, but single replacement tuberoids are produced on short roots called "droppers" (Jones, 1993). Hatch, (1985) also reports that in New Zealand *P. plumosa* does not reproduce by multiple tubers and spreads only by seed. It is probable that *P.* sp 15 reproduces in the same way.

6.2.2 Breeding system

The breeding system of *P.* sp. 15 is not known at this stage. Only a very few species of *Pterostylis* are self pollinating (Cady, 1988). In *Pterostylis* the flowers are usually pollinated by small winged insects such as small gnats and in some cases by mosquitoes (Jones, 1993). Cady, (1988) reports that insects from the genus *Mycetophilidae, Culcidaeae* and *Chinonidae* are known pollinators for *Pterostylis* species and all species appear to have a specific pollinating insect.

Many species of *Pterostylis* have an "irritable" labellum which is triggered by an insect to close up the flower and forms a tube which traps the insect. After being attracted to the plant by some as yet unknown lure, the insect is forced to crawl out through a tunnel and collects the pollina which is stuck on to the insect by the sticky viscid disc. The insect then visits another flower and is trapped again and this time smears pollen on to the stigma (Cady, 1988). Different *Pterostylis* species have varying degrees of mobility in their labellums. Species in the "*P. plumosa* complex" have little movement in the labellum (Cady, 1988). It is not known what insect is the pollination vector for *P.* sp. 15 or the mechanism used by the species to effect pollination.

6.2.3 Seed biology

Seed germinability and dormancy breaking mechanisms

Orchid seeds do not have specialised storage tissue, but contain tiny lipid bodies within the embryo that serve as a food source. Nearly all species are reliant on a mycorrhizal fungus to support the first stages of growth after germination. *Pterostylis* species grow in association with a soil fungus and seeds require the presence of this fungus to germinate (Cady, 1988). Cady (1988) also recommends that seeds of *Pterostylis* species will germinate more readily in cultivation if in the presence of Casuarina or Radiata pine needles.

Fecundity

There have been no scientific studies to date which document fecundity of *P.* sp. 15. An understanding of fecundity (the quantity of seed produced) is important as it indicates the extent to which a population is reproducing, The more seed which is produced, the more seed that can be dispersed, and probably, the larger amounts of viable and germinable seed available for recruitment. It is important to know whether a population provides an input into the seed bank each year. This is particularly important in understanding the viability of small populations.

Seed dispersal and predation

There have been no scientific studies that specifically document the dispersal of seeds of *P.* sp. 15. The seeds of *Pterostylis* species are minute. Cady, (1988) notes for *Pterostylis* that; "*after the seed capsule has formed the seed takes approximately three months to ripen and the capsule to dehisce. In some species such as P. cucullata the flowering stem elongates to aid in the wind dispersal of the seed*." A survey of P. sp 15 in 1997 found that seed capsules remained on plants in October which had flowered in June (A. Smoothey, NPWS records). The level and impact of seed predation on *P.* sp. 15 is not known.

Seed viability and longevity

We currently have little understanding of the seed viability and longevity of the seed of *P.* sp. 15. The small size of the seed precludes standard methods for testing viability. Techniques have been developed but they are involved and must be optimised for the species of interest (Rasmussen, 1995).

6.2.4 Seedling recruitment

In *P.* sp. 15 the trigger for seedling recruitment is unknown. It is unclear at this stage if recruitment occurs only after disturbance or if there is a continual addition of plants to the population. However "juvenile" plants have been observed in the field

over the last two seasens and all have been located close to adult plants (S. Nash, field obs). Hatch, (1985) in discussing *P. plumosa* in New Zealand, notes that the plants were much more numerous in an area which received frequent fire and was kept open. When conditions changed and the vegetation became more dense, the *P. plumosa* disappeared. However when the area was cleared 32 years later plants reappeared, most probably from seed present in the soil.

6.3 Fire ecology

As discussed in the previous section the closely related species *P. plumosa* flowers more profusely after fire. The site of the known population of *P.* sp. 15 has been burnt in a hazard reduction burn in 1983 (Site 3) and in a wildfire in 1992 (all sites) (NPWS fire records).

While no work has been undertaken on the fire ecology of *P.* sp. 15, some work has been undertaken on the fire ecology of the endangered species *P. gibbosa*. This work found that if a fire occurs after the rosette has emerged, the above ground parts are destroyed. Under these circumstances it is thought that the plant remains dormant until the following season. This means that the plant does not set seed in that season. In the long term, repeated fire at this time of year will probably reduce the diversity of the population. Though, at one population of *P. gibbosa* where there are regular fires, mostly the result of arson, the population is expanding, despite the high frequency of fires (NPWS, in prep)

Though the response of *P.* sp. 15 to fire is still unknown, as for *P. gibbosa* the precautionary approach to fire should be adopted. Until more is known about the fire ecology of P. sp. 15 it is recommended that no prescribed fires should be undertaken. If fires are necessary for management purposes they should be undertaken after flowering and seed dispersal. Monitoring should be undertaken to ensure that rosettes emerge after fire and set seed and recruit (NPWS, in prep).

7 Previous management actions

There have been no previous recovery plans written for *P.* sp. 15. However a number of actions have been undertaken prior to and during the preparation of this plan.

7.1 Survey of the known population

A survey in June 1997 located a total of 82 plants in Botany Bay National Park. By October 1997 only 12 plants were observed (14/10/97) in a sub sample of the area. Most of these plants were withering. Three had seed capsules which were about to burst (A. Smoothey, NPWS records).

As part of the preparation of the recovery plan a survey of the known population was undertaken in August and September 1998 using the method outlined in Appendix 2. A total of 149 plants were recorded. These consisted of adult flowering, adult non-flowering and juvenile individuals. Table 2 outlines the survey results. A brief survey (1 day) was undertaken in September of the remnant habitat on the Malabar Headland, but no plants were recorded.

Table 2. Population Structure at Kurnell, Botany Bay National Park

Site No.	**Date surveyed**	**Adult flowering**	**Adult non-flowering**	**Juvenile**	
1	23/8/98	0	0	0	
		(none above ground this season)			
2		4	8	5	
3	25/8/98	7	28	39	
4	29/8/98	1	5	0	
5	4/9/98	5	0	10	
6	4/9/98	0	2	0	
7	5/9/98	2	3	30	
Total		19	46	84	**149**

7.2 Notification of relevant authorities

As *P.* sp. 15 may occur on the Malabar Headland it was important to notify the relevant authorities as to the importance and sensitivity of the site. Randwick Council and the Department of Finance and Administration were notified and contacts established.

8 Management issues

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

As such, this section identifies the management issues affecting the *P.* sp. 15 including:

- limits of our current understanding of the species's biology and ecology;
- threats and reasons for decline; and
- social and economic factors which may influence the success or otherwise of the recovery plan.

8.1 Level of current understanding

There is a lack of knowledge about the biology and ecology of *P.* sp. 15. Effective management of the species will be much easier if the conditions required for recruitment and the appropriate fire regime for the long term maintenance of the species in its habitat are known.

8.2 Threatening processes

As the known site of *P.* sp. 15 occurs along a major fire trail within a National Park which is heavily visited, there is potential for the population to be adversely effected by human induced threats.

8.2.1 Inappropriate fire regime

Fire, at the inappropriate time of year or occurring at inappropriate frequencies may be a significant threat to *P.* sp. 15. Fire between July and September will destroy the above ground parts of the plant. A single cool fire at this time of year is unlikely to kill individuals but too frequent fires may eventually eliminate plants since there is less opportunity for plants to replenish stored reserves or to produce seed. At Botany Bay National Park there is a possibility of too frequent fire caused by arson, hazard reduction activities and accidental sparking from cigarettes etc, and also too infrequent fire caused by the importance of fire suppression activities to protect human life and property, as an oil refinery in located adjacent to the National Park and pipelines from the oil refinery occur close to the habitat of the species.

Having very long inter fire periods may alter the habitat of the known sites to the detriment of *P.* sp. 15, by altering the species composition and the age structure of the vegetation. Alternatively too frequent fires may encourage fire tolerant species that may exclude *P. sp. 15. Allocasuarina distyla and Banksia ericifolia,* native

species which are widespread in the area may be favoured by more frequent fire. No *P.* sp. 15 have been found where these two species dominate the overstorey. Frequent fire may also change the drainage patterns in the soil and alter the microhabitat to the disadvantage of *P.* sp. 15.

8.2.2 Habitat degradation related to unrestricted access

Uncontrolled site access could lead to the degradation of the site. The habitat of *P.* sp. 15 is coastal heath on shallow sandy soils of the Bundeena soil landscape. The erosion hazard for these soils is high to very high (Hazelton *et al*. 1990). On Malabar headland at Maroubra rubbish dumping, numerous tracks have lead to some habitat degradation (Godden Mackay, 1997).

8.2.3 Unauthorised collection

As a rare orchid *P.* sp. 15 is unfortunately a possible target for unscrupulous amateur orchid enthusiasts and professional orchid propagators. It is clear that no collection could be sustained by the population and it is illegal to collect (harm or pick) a threatened species without a licence from the NPWS.

8.2.4 Insecure tenure

At Malabar Headland the potential habitat for *P.* sp. 15 mostly occurs on land which is currently zoned 2B residential, in the Randwick Local Environment Plan 1998. The land is in the ownership of the Commonwealth and is managed by the Federal Department of Finance and Administration. Randwick Council currently has an amendment to this LEP, Randwick Local Environmental Plan 1998 (Amendment No. 6), which proposes that the land be rezoned to 8B (Proposed National Park). As yet this amendment has not been passed by the Department of Urban Affairs and Planning therefore there is the potential for the land to be developed for residential purposes in the future.

8.3 Translocation

Translocation is defined as “deliberate transfer of plants or regenerative plant material from one place to another, including existing or new sites or those where the taxon is now extinct” (Australian Network for Plant Conservation 1997). Translocation may also involve the supplementation of a declining population with new individuals. Propagation may be a component of a translocation program and is used as a source of plants for the above. Translocation programs are usually devised to assist in the conservation of a threatened species, within the context of a broader recovery strategy (NPWS 1997). Translocation programs can provide a measure of security for critically endangered populations in the event of catastrophes such as the impacts of fire or disease.

As at June 1999, the translocation of *P.* sp. 15 is not considered to be an appropriate conservation mechanism due to the current lack of knowledge of the species and the means by which to carry out translocation and the relative security of the tenure of the habitat. With species such as *P.* sp. 15, the amount of commitment required and the probability of failure with any trial of translocation is high and the use of translocation as a conservation tool is not required at this time.

8.4 Social and economic issues

8.4.1 Intrinsic ecological value

P. sp. 15 has intrinsic ecological value as a distinct taxon that has the capability to affect and be affected by other living organisms. *P.* sp. 15 has the same right of existence as any other native species in its appropriate habitat, free from pressures which may increase the likelihood of its extinction. It is possible that the species plays an important role in the ecological functioning of its habitat.

8.4.2 Scientific value

Conservation of *P.* sp. 15 will mean that this species and its habitat will be available for future scientific studies. Delineation of the preferred habitat of *P.* sp. 15 through targeted survey will benefit the scientific community by increasing knowledge about the species and also about its habitat. Orchid species are of particular interest to many groups in the community and knowledge gained through the *ex situ* propagation of *P.* sp. 15 would be useful in both the conservation of other threatened taxa and the cultivation of species for horticultural and aesthetic purposes.

8.4.3 Social considerations

As the known site occurs within the boundary of a national park, the primary responsibility for management will fall to the NSW National Parks and Wildlife Service. If the species occurs on land at Maroubra owned by the Department of Finance and Administration then it may effect the management of that land. In co-operation with the DFA, local bush fire authorities and Randwick Council, management of fire and access issues should be addressed with no adverse social consequences.

The major social consideration raised by the recovery process is the need for the continued secrecy of the exact location of the known population to prevent unauthorised collection of individuals of *P.* sp. 15 by unscrupulous orchid enthusiasts.

8.4.4 Economic considerations

The economic consequences of this recovery plan are related to the cost of implementing the actions required to protect the species from further decline. These include management of the habitat of the known population, targeted survey, further liaison with landholders/managers, better environmental assessment of any activities which may impact on potential *P.* sp. 15 habitat, and research into the biology and ecology of the species. Costs will also be involved in the maintenance of an *ex situ* population if required. As the known population occurs on land managed by the NSW NPWS most of the cost for management of the habitat on site will be borne by the NPWS. Other costs may be met by; seeking external funding for research and *ex situ* propagation, and maintaining an integrated, co-operative approach to survey, fire management and environmental assessment with the department of Finance and Administration, the community and Randwick Council.

8.5 Species ability to recover

The actions in this recovery plan are focused at protecting and maintaining the known population, rather than actions which are directed at manipulating an increase in population size. Natural regeneration and dispersal will be encouraged though habitat management, including appropriate fire regimes and protection from degradation.

The consequences of not implementing the recovery program as outlined in the plan is to maintain the high risk of extinction in the wild over the next 10-20 years. Without the co-operation of land managers and planners *P.* sp. 15 is likely to be adversely impacted by threats as described in section 8.2

8.5.1 Species rarity

P. sp. 15 is considered a threatened species due to its extremely low numbers existing in only one population. The number of populations is likely to have been decreased through loss of habitat in the eastern suburbs of Sydney and a change in the fire regime experienced by the habitat of *P.* sp. 15 on the Kurnell peninsula.

8.5.2 Species viability

The overall objective of the recovery plan is to prevent the extinction of *P.* sp. 15 by maintaining the viability of *P.* sp. 15 in the wild. A viable species is one that is successfully self-replacing in the wild in perpetuity. Either by production of germinable seed from which seedlings establish and mature to reproductive adults which produce germinable seed, and so on into the future, or by some other mechanism.

There is currently little information as to the viability of the known population of *P.* sp. 15. Although seed set and juvenile plants have been observed in the field, the extent to which this seed is germinable and survives in the habitat is unknown.

8.5.3 Likelihood of recovery

At the time this draft recovery plan was prepared, *P.* sp. 15 is one of the more endangered species in NSW. Even though the known population occurs in Botany Bay National Park, it is very small, its location is still vulnerable to threats and its long term viability is unknown. At present the known population appears to be setting seed and existing as subterranean tubers from season to season. More research and monitoring of the known population is required, however, due to the security of the tenure of its habitat the likelihood of recovery of the species is good.

9 Overall recovery aim and recovery strategy

9.1 Overall objective

The overall objective of the plan is to prevent the extinction of *P.* sp. 15 through appropriate management of the wild population to reduce current and future threats and to maintain self sustaining populations in the wild in the long term.

9.2 Overall Criteria

The overall performance criteria of the recovery plan for *P.* sp. 15 is that the known population and any new populations remain self sustaining in nature in perpetuity.

9.3 Recovery actions

The plan consists of three broad actions which aim to achieve the overall objective:

1. Habitat and threat management

- develop and refine appropriate habitat management strategies based on knowledge of the biology and ecology of *P.* sp. 15*;*
- protection of populations of *P.* sp. 15 through the implementation of appropriate management strategies by relevant government authorities;
- ensuring appropriate fire management of the known population and possible habitat of *P.* sp. 15.

2. Survey and research

- undertake a systematic survey of potential habitat to further determine the full distribution of *P.* sp. 15;
- monitor the dynamics of the known population for three to five years;
- investigate the biology and ecology of *P.* sp 15;
- undertake trials of response to fire of the known population.

3. *Ex situ* conservation

- determine if *ex situ* conservation is required;
- determining the most appropriate method of *ex situ* storage of *P.* sp. 15*;*
- establishing and maintaining a representative collection.

10 Habitat and threat management

The most effective and cost efficient method of management of threatened species is to maintain self sustaining populations in the wild in perpetuity. This *in situ* management requires securing the long term management of the habitat of the threatened species and managing that species to minimise threats. This action is directed towards the protection of both the known population and any new populations which may be discovered in the future.

Effective management also requires co-operation between the relevant public authorities. The authorities involved in the implementation of this action include; the National Parks and Wildlife Service, the federal Department of Finance and Administration and Randwick Council. This action will take place over the life of the plan.

10.1 Objectives

Through protection and management threats are minimised and a viable (self maintaining in the long term) population is maintained at the known site and any new site.

10.2 Recovery Actions

Botany Bay National Park

1. The NPWS in consultation with the recovery team and experts in the field will develop and refine a Habitat Management Strategy for the known population based on the outcomes of the research of the biology and ecology of *P.* sp. 15.

2. The NPWS will implement the Habitat Management Strategy when it is prepared and will incorporate these actions into the next update of the Botany Bay National Park Plan of Management. In the interim the NPWS will manage the population by ensuring the maintenance of the fire trail and discouraging access to the known sites.

3. The NPWS will develop and apply appropriate fire interval guidelines for known and potential habitat of *P.* sp. 15 as part of the Habitat Management Strategy. The NPWS will incorporate these guidelines into the Botany Bay National Park Reserve Fire Management Plan. In the interim the NPWS will as far as possible prevent wildfire from burning the population and no

prescribed burns will be carried out in the vicinity of the known population without reference to the recovery planning co-ordinator.

4. The NPWS will ensure that the locations of the known population are forwarded for entry into the Wildlife Atlas and that this data is up-dated when required.

Malabar

P. sp. 15 may occur in remnant habitat on Malabar Headland. This area is within Randwick Local Government Area. Randwick is responsible for the environmental assessment of development which is proposed on land within their LGA, as well as developing or modifying Local Environmental Plans. The Council manages areas of open space on Malabar Headland which may contain suitable habitat for *P.* sp 15. Block 4 of Anzac Rifle Range (Malabar West), an area of remnant coastal heathland and Eastern Suburbs Banksia Scrub, is currently zoned 2B (Residential), therefore there is the potential for the land to be subject to development proposals in the future. The DFA owns and oversees the management of Anzac Rifle Range on Malabar Headland. Current and future management of this area may impact on areas of potential habitat of *P.* sp. 15.

5. Randwick Council will consider potential habitat of *P.* sp. 15 in the management of Council managed land (particularly in Pioneers Park, Cromwell Park and Arthur Byrne Reserve). The Councils will ensure the protection of any populations of *P.* sp. 15 found to occur on public land with reference to the recovery plan through the implementation of the appropriate Habitat Management Strategy. A permanent record will be made of the exact location of *P.* sp. 15 populations at these sites so that due consideration can be given to the species in relation to future activities, plans of management, before hazard reduction activities and during emergency fire situations.

6. Randwick Council will ensure that any proposed development or activity will not adversely affect *P.* sp 15 or its habitat by; a) assessing the application with reference to the recovery plan and any future advice from the NPWS regarding its distribution and biology/ecology, b) ensuring that searches for *P.* sp. 15 are carried out by development proponents by a suitably qualified botanist during the main flowering period (Aug - Sept) following the survey techniques are outlined in Appendix 3. The Council will notify the NPWS regarding the location of new populations, as well as update their own records.

7. The NPWS will liaise with the DFA and Randwick Council to achieve and maintain a permanent record of the exact location of any *Pterostylis* sp. 15 populations from the Malabar area so that due consideration can be given to the species in relation to future activities, plans of management, before hazard reduction activities and during emergency fire situations.

8. In the event that *P*. sp 15 is confirmed as occurring at Anzac Rifle Range, the NPWS will liaise with the DFA to ensure that: a) an appropriate Habitat Management Strategy is implemented; b) when determining whether any *P*. sp 15 plants or populations occur in the vicinity of any proposed activity, site surveys are undertaken by a suitably qualified botanist during the flowering period (July - Sept) according to the survey techniques outlined in Appendix 3 (of the recovery plan); c) all relevant on-site managers are familiar with the locations where *P*. sp. 15 has been found or where potential habitat exists.

9. The DFA will notify the NPWS regarding the location of new *P*. sp 15 populations discovered during the course of any surveys undertaken.

10.3 Performance Criteria

- Through protection and management a self maintaining population is maintained at the known site and any new sites, in the long term.

11 Survey and research

As outlined in Section 6 of this recovery plan very little is known about the biology and ecology of *P.* sp. 15. Knowledge of the key attributes of the biology and ecology of the species is crucial to its effective management. A program of research combined with a low impact monitoring program will be undertaken to provide information which can be used in the management of the known population and any new populations.

A knowledge of the life history of *P.* sp. 15 including seed biology is crucial to the understanding of the long term viability of the known population. Collection of data on seed viability and dormancy will provide insight into the type of recruitment, the specific conditions required for seed germination and the ability of populations to be self maintaining in the long term.

11.1 Objective

To understand essential key aspects of the biology and ecology of *P.* sp. 15 which will allow effective management strategies to be formulated for the known and any new populations.

11.2 Recovery Actions

The current known distribution of *P.* sp. 15 is outlined in Section 5 of this recovery plan. Currently the species in known from one locality. However as outlined in Section 5, more populations of the species may exist in Botany Bay National park and possibly in the vicinity of Malabar Headland/Anzac Rifle Range. A targeted survey for the species will be carried out. The technique for carrying out targeted survey and the survey forms are in Appendix 2.

1. The NPWS in consultation with the recovery team will co-ordinate a systematic survey of potential habitat to further determine the full distribution of *P.* sp. 15. This survey effort will be carried out during the flowering season July-Sept over a number of seasons to attempt to counteract temporal changes in the distribution of the species.

2 The NPWS will co-ordinate volunteers including members of the Australian Native Orchid Society who will be invited to participate in this survey effort.

3 The NPWS will ensure that all survey data is entered into the Atlas of NSW Wildlife Atlas and all relevant data made available to Randwick Council and the DFA.

4. All relevant authorities and groups will communicate information of new sites and populations of *P.* sp. 15 located through both targeted survey (e.g.

for environmental assessment purposes) and casual sightings. All groups will ensure that their dataset is updated accordingly.

5. The NPWS will facilitate an annual monitoring of the known population within Botany Bay National Park for 5 years as outlined in Appendix 2.

6. A program of biological and ecological investigation will be co-ordinated and facilitated by the NPWS. Research institutions (including the Royal Botanic Gardens Sydney) universities and Native Orchid groups will be encouraged to participate in components of this program and external funding will be sort to finance this work.

Annual Census at known sites

An annual census of the known population will provide baseline data on the population structure and reproductive success over a number of years. It will also develop a record of biological information and response of *P.* sp 15 to disturbance and management actions. Monitoring should be conducted during peak flowering and fruiting times (July-September). The census will be undertaken using a modification of the method on Whelan and Kohler (1991) for *P. gibbosa*. The method is outlined in Appendix 2.

Ecological Research program

A five year research program is briefly outlined below A method such as that used by Whelan and Kohler (1991) for *P. gibbosa* would be suitable. The need for further studies will be evaluated and prioritised after a two year program.

1. Pollination vectors

Extrapolation from other *Pterostylis* species suggests that *P.* sp. 15 may be pollinated by gnats or mosquitoes. It is important to know the breeding system employed by a species for two reasons; it may indicate any problems the population is facing if the pollinator is missing and, it will indicate what management options are appropriate (e.g. if a disturbance is required for the species to reproduce).

2. Breeding System

The breeding system of *P.* sp. 15 could be researched by field observation and simple experiments using comparisons of successful seed set in bagged flowers (to test self compatibility), flowers whose anthers had been removed (to test for apomixis and control flowers (flowers left open for pollination from all pollen sources).

3. Seed biology

Seed biology is an important aspect of plant biology. In orchids species the seed is very small and can be difficult to work with, therefore the extent to which laboratory and *in situ* buried seed trials are possible is not known at this stage. Examining seed biology would help to answer the following questions are important for the management of *P.* sp. 15 and would also assist in the research into the *ex situ* conservation of the species:

4. Response to fire

The response of *P.* sp. 15 to fire will be investigated at the known site. Anecdotal evidence suggests that fire may be an important factor in the ecology of *P.* sp. 15. Fire may be a factor which influences flowering and seed production. As there is only one known population a cautious experimental approach to investigate fire response will be used. When the response to fire of *P.* sp. 15 is known and aspects of the seed biology and fecundity is better
understood, management decisions about fire management can be made.

11.3 Performance Criteria

Increased knowledge of the biology and ecology of *P.* sp. 15 is available for formulation of management strategies for the species.

12 *Ex situ* conservation

Because *P.* sp. 15 is currently known from only one population, it may be important to establish and maintain a store of genetic material *ex situ*. This is an important safeguard against possible catastrophe causing extinction of the known population.

12.1 Objective

To establish and maintain *ex situ* collections which fully represent the genetic diversity of the known population, if required.

12.2 Recovery Actions

This action is focused at establishing the most appropriate storage of *ex situ* material if ex situ conservation is deemed to be required.

1. The NPWS in consultation with the Royal Botanic Gardens and the recovery team will determine whether *ex situ* conservation of *P.* sp. 15 is appropriate.

2. The NPWS in consultation with the Royal Botanic Gardens will undertake a program to determine the most appropriate method of *ex situ* storage of *P.* sp. 15.

3. A representative ex situ collection of *P.* sp. 15 will be established and maintained at a suitable botanic garden.

12.3 Performance Criteria

Representative *ex situ* collections of *P.* sp. 15 established and maintained in a botanic garden if required.

13 Implementation

13.1 Implementation Schedule

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

Table 3: Implementation schedule

Action	Description	Responsibility	Year 1	Year 2	Year 3	Year 4	Year 5
1	**Habitat and threat management**	NPWS	●	●	●	●	●
		Randwick Council	●	●	●	●	●
		DFA	●	●	●	●	●
2	**Survey and research**	NPWS/ Consultant/ University	●	●	●	●	●
3	***Ex situ* conservation**	NPWS	●	●	●	●	●

13.2 Implementation Costs

The recovery actions and recommendations identified in this plan state what must be done to ensure the recovery of the endangered species *P.* sp. 15. Appendix 4 identifies the costs needed to implement those actions which require funding for implementation.

14 Preparation details

This recovery plan was prepared by Sharon Nash, Senior Threatened Species Officer, Threatened Species Unit, Central Directorate NPWS, in consultation with experts and the stakeholders.

14.1 Date of last amendment

This document is the first recovery plan for *P.* sp. 15. No amendments to the plan have been made.

14.2 Review date

This recovery plan will be reviewed after 5 years of the date of publication.

15 Contacts

The co-ordinator of the *P.* sp. 15 Recovery Team can be contacted at the following address:

Co-ordinator - *P.* sp. 15 Recovery Team
NSW National Parks and Wildlife Service
Threatened Species Unit, Conservation Programs and Planning
Central Directorate
PO Box 1967,
HURSTVILLE 2220

ph. 02 95856444
fax 02 95856442

Other useful contacts:

Organisation	Postal address	Contact numbers	
NPWS Botany Area, Sydney South Region	Botany Bay National Park, PO Box 375, KURNELL NSW 2231	ph.	02 9668 9111
		fax	02 9668 9548
Randwick Council	31 Francis St RANDWICK NSW 2031	ph.	02 9399 0999
		fax	02 9319 1510
National Herbarium of NSW, Royal Botanic Garden Sydney	Mrs Macquaries Road SYDNEY 2000	ph.	02 92318111
		fax	02 92517231
Mt Annan Botanic Garden	Mt Annan Road MT ANNAN 2567	ph.	02 4648 2477
		fax.	02 4648 2465
Department of Finance and Administration	GPO Box 1920 CANBERRA ACT 2601	ph.	02 6275 3000
		fax.	02 6275 3206

References

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

Bishop, A. (1996) *Field guide to the orchids of New South Wales and Victoria*. University of New South Wales Press, Kensington.

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

Bureau of Meteorology (1997) Climate averages for Sydney Airport (Sydney Airport MO/AWS), station. World Wide Web Page (www.bom.gov.au/climate/averages).

Cady, L. and Rotherham, E.R. (1970) *Australian Native Orchids in Colour*. Reed Publishers, Frenches Forest.

Cady, L. (1988) The genus *Pterostylis* in Australia and New Zealand: Part 2. *Orchadian* **(9)**3: 52-62.

Carolin, R.C. and Tindale, M.D. (1994) Flora of the Sydney Region. Fourth Edition. Reed Publishers, Chatswood.

Chapman, G.A. and Murphy, C.L. (1989) *Soil Landscapes of the Sydney 1: 100 000 sheet.* Soil Conservation Service of NSW, Sydney.

Cropper, S.C. (1993) *Management of Endangered Plants*. CSIRO Australia, Melbourne.

Dockrill, A.W. (1992) *Australian Indigenous Orchids, Vol 1, The epiphytes, the tropical terrestrial species*. Surrey Beattie and Sons, Chipping Norton.

Given, D.R. (1994) *Principles and Practice of Plant Conservation*. Timber Press. Portland Oregon.

Godden Mackay, (1997) *Heritage Assessment Anzac Riffle Range*. Report by Godden Mackay Heritage Consultants prepared for the Department of Finance and Administration.

Hatch, E. D. (1985) *Pterostylis plumosa (barbata)* in the Cornwallis area, New Zealand. *Orchadian* **(8)**3: 62.

Hazelton P.A., Bannerman, S.M. & Tille, P.J. (1990) *Soil landscapes of the Wollongong - Port Hacking 1:100 000 sheet*. Soils Conservation Service of NSW, Sydney.

Heberle, R. (1981) A further look at *Pterostylis barbata* Lindley and *Pterostylis plumosa* Cady - and six other possible "bird orchids" in Western Australia. *Orchardian* **(7)** 2: 36-37.

Jones, D. L. (1983) *Pterostylis* in: *Flora of NSW* Vol 4. (G.J. Harden ed.) New South Wales University Press, Kensington.

Jones, D.L. (1993) *Native Orchids of Australia*. Reed Australia.

NPWS (1996) *Threatened Species Management, Information Circular No. 2 Threatened Species Assessment under the EP&A Act: The '8-part Test' of Significance*. November 1996. NPWS, Hurstville.

NPWS (in prep), *Pterostylis gibbosa Illawarra Greenhood Orchid draft recovery plan.* NSW National Parks and Wildlife Service.

Rasmussen, H. N. (1995*). Terrestrial orchids from seed to mycotrophic plant*. Cambridge University Press, London.

Rupp, H.M.R. (1969) *The orchids of New South Wales*. National Herbarium of NSW, Sydney, Flora of New South Wales, No 48 Orchidaceae. Government Printer of NSW.

Sharp, W.W. (1970) *Australia's native orchid*s. The Everbest Printing Co. Ltd. Hong Kong.

Walker, P.H. (1960) *A soil survey of the county of Cumberland Sydney Region, New South Wales.* NSW Department of Agriculture, soil survey unit Bulletin No. 2.

Weston, P.H. (1993) Orchidaceae in: *Flora of NSW* Vol 4. (G.J. Harden ed.) New South Wales University Press, Kensington.

Whelan R. J. & Koher G. (1991) *Study of the Illawarra Greenhood Orchid Pterostylis gibbosa reproduction and pollination*. Australian Flora and Fauna Research Program University of Wollongong.

APPENDIX 1 Site Information

NOT FOR PUBLIC EXHIBITION

Appendix 2 Site assessment and monitoring

Site assessment

A site assessment proforma should be completed upon the discovery of new populations/individuals of *P*. sp 15. This proforma is designed to provide location, population details, habitat and threatening process information in a systematic and consistent manner.

Monitoring procedures

Monitoring of existing populations is required on an annual basis to develop a record of biological information and response of *P.* sp 15 to disturbance and management actions. Monitoring should be conducted during peak flowering and fruiting times (July-September).

The following procedures should be followed:

1. Permanent quadrats are established at selected sites. A numbered metal stake is to be placed at the south eastern corner of each site and bearings taken from the stake to each group of orchids. Each group of orchids to be marked with flagging tape in the nearest shrub to allow relocation of the orchids during that season.

2. Individual plants/groups should be consecutively numbered with reference to the fixed stake and marked accordingly.

3. The number of adult and seedling plants should be recorded M = mature and S = seedling

4. The number of plants of each status in the group should be recorded. The following codes are suggested: A=Alive, D=Dead, W= Withered, FL = flowers, B= buds, Fr=fruits; C=Chewed.

5. General notes should be made including: evidence of predation, fauna interactions (including pollinators), recent disturbance, threatening processes, other general observations.

6. This census is to be undertaken at the beginning and repeated at the end of the flowering season to allow individual plants to be monitored for reproductive success.

Monitoring results should be summarised and a copy of the proformas sent to:

P. sp. 15 Recovery Team Coordinator,
NSW NPWS
Conservation Programs and Planning
Central Directorate
P.O. Box 1967 HURSTVILLE NSW 2220

1. Threatened Flora Site Assessment (New Site)

DATE: **RECORDER:**

THREATENED SPECIES:

LOCATION (description):

Map number/sheet	
Grid Reference	
Accuracy:	

SITE DESCRIPTION:

Land Tenure	Local/state/federal government/freehold/National Park/other
Topography	Ridge/ upper slope /mid slope /gully /wetland /other
Understorey:	Developed / suppressed
Current Land Use	
Past Land Use	
Time Since Last Fire/ Fire History	

POPULATION DETAILS: (follow with an E if an estimate)

Local Abundance	Frequent / occasional / rare
No. of adult plants	
No. of seedling plants	
Area covered by sub-population (m)	
Plant Distribution	Small scattered clump/ large continuous clump / other
Breeding Status	Buds / flowers / fruit

HABITAT CHARACTERISTICS:

ASPECT: SLOPE: ALTITUDE:

GEOLOGY:

Soil Landscape/Type:	
Texture:	Sand/loam/clay
Drainage:	Waterlogged/damp/well drained dry/well drained moist
Depth	Skeletal/shallow/deep
Disturbance:	Intact/ topsoil removed/ landfill/ other

VEGETATION STRUCTURAL FORMATION:	TM (Open Forest)	TS (Woodland)	TV (Open Woodland)	TD (Closed Forest)

(refer to Atlas of NSW Wildlife Field Data Book)

SPECIES ASSOCIATIONS (list dominant species):

- Canopy:

- Understorey:

- Groundcover:

- Vines/Climbers:

- Other Threatened Flora/Fauna Species Recorded:

THREATS:

Weed Invasion	(specify species): % cover
Trampling/Grazing	: feral/domestic/native
Isolation/fragmentation	
Erosion	
Inappropriate Fire Regimes	
Fire trail maintenance	
Rubbish dumping	
Other	(specify)

OTHER RECORDS:

Collection Made	Yes / No
Type of Collection	Seed / cutting / plant
Photographs Taken	Yes / No
Extent of Survey	complete/ incomplete /unknown

OTHER OBSERVATIONS:

2. *P. sp. 15* monitoring proforma

DATE : **RECORDER:**

Site Name:

Location:

Monitoring year: 1 2 3 4 5

Total number of adult plants:

Total number of seedling plants:

Plant population census

Group No.	**No. of Plants**	**Plant Status**	**No B/Fl**	**No Fr**	**Notes**
1	13M	13A	10Fl	3	Evidence of flower predation on two plants
	4S		1B		

Group no.	No. of Plants	Plant Status	No Fl	No Fr	

Appendix 3

Techniques for surveying potential habitat

Targeted survey for *P. sp. 15* in areas of potential habitat should be carried out during the main flowering season (July to September). Areas of potential habitat (as described in section 4.6) should be sampled using a "random meander" (*sensu* Cropper 1993, Given 1994) and by a person experienced in the identification of this and similar species.

The representative coverage will be determined by the size of the area of vegetation to be searched, and the composition of the vegetation. For example the meander must adequately sample all the vegetation communities present on the site.

Meanders must occur within both open and closed habitat. Sides of tracks and areas of disturbance should also be included in the area searched. A vegetation map indicating the variation in vegetation present and the coverage of the site should be included with the survey results.

It must be remembered that this methodology does not conclusively prove the **absence** of the species from the site. However, it provides an opportunity for populations to be located, so that potentially detrimental impacts can be assessed and managed appropriately.

Appendix 4 Implementation costs

Action	Description	Year of implementation						Source		
		1	2	3	4	5	Total	NP **Central** recurrent funds	**WS Directorate** Program funds	**Unsecured**
1	**Habitat and threat management**									
	Interim habitat strategy (track maintenance / minimise access / exclude fire)	√	√							
	Formulate habitat management strategy	1500	1500				**3000**	3000[1]		
`	Implement habitat management strategy			3000	1000	500	**4500**	3000[1]	1500[3]	
	Formulate fire management plans	√	500	500	√	√	**1000**	1000[2]		
	Stakeholder liaison	√	500	500	√	√	**1000**	1000[2]		
`	Environmental planning and Assessment	√	√	√	√	√				
2	**Survey and Research**									
	Targeted survey	2500	2500	1500	1500	1500	**9500**	7500[1,2]		2000
	Monitoring	1000	750	750	750	750	**4000**	4000[1,2]		
	Ecological and biological research		500	5000	5000		**10,500**	500[1]		10000[5]
3	***Ex situ* conservation**									
	Investigate need for ex situ conservation	1250	1250				**2500**	2500[1]		
	Investigation of propagation method (if required)			(2500*)			**(2500*)**	(2500[1*])		
	Establish and maintain collection (if required)				(5000*)	(5000*)	**(10000*)**			(10000*)
	Total	**6,250**	**7,500**	**11,250**	**8,250**	**2750**	**36,000**	22,500	1500	12000

Key
[1] Central Directorate EFT
[2] Recurrent Area operational fund
[3] Funded by program funds
[4] Recurrent Council funds
[5] Funding subject to successful research stipend granted to an appropriate Tertiary institution
[6] Subject to annual budget
√ No direct cost
* If action is determined to be required

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