

---

# ORANGE-BELLIED PARROT

---

## RECOVERY PLAN

---

1998-2002



---

Prepared by the **Orange-Bellied Parrot Recovery Team**



---

**ORANGE-BELLIED PARROT  
RECOVERY PLAN  
1998-2002**

---

Prepared by  
**Orange-bellied Parrot Recovery Team**  
Nature Conservation Branch  
Resource Management and Conservation Division  
Department of Primary Industries, Water and Environment  
GPO Box 44A, Hobart, Tasmania 7001

Funded by Environment Australia

July 1999

ISBN: 0 7246 6217 0

## FOREWORD

Since 1978 efforts have been made to save the Orange-bellied Parrot from extinction. This is the third Recovery Plan for the species and it contains actions recommended for the period 1998-2002. The earlier Plans for the species throughout its range (Brown and Wilson 1984; Stephenson 1991), and a Victorian action plan (Edgar and Menkhorst 1993), have been implemented. The Orange-bellied Parrot Recovery Team guided the implementation of the two earlier Plans. This Plan was submitted to the Australian Nature Conservation Agency (ANCA) for approval and funding under the Endangered Species Program.

Recovery plans identify, cost and schedule actions needed to implement strategies for the recovery of endangered or vulnerable species, sub-species or ecological communities. Attaining objectives and providing funds is subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views or official positions of any individuals or agencies represented on the Recovery Team. Plans are approved by the responsible Ministers and wildlife conservation agencies of the three range States: South Australia, Victoria and Tasmania. Approved plans are modified subject to new findings, changes in species' status, and completion of recovery actions.

Front Cover photograph by Dave Watts.

This draft is prepared as an application for funding to Environment Australia under the Natural Heritage Trust. The views expressed in it are those of the Recovery Team.

Citation: Orange-bellied Parrot Recovery Team (1998) Orange-bellied Parrot Recovery Plan 1998-2002. Department of Primary Industries, Water and Environment, Hobart.

Copyright © Director, Parks and Wildlife Service, Department of Primary Industries, Water and Environment, GPO Box 44A, Hobart, Tasmania 7001

Apart from fair dealing for the purposes of private study, research, criticism or review as permitted under the Copyright Act, no part may be reproduced by any means without permission of the Director, Parks and Wildlife Service.

## ACKNOWLEDGEMENTS

This Recovery Plan was prepared by the Orange-bellied Parrot Recovery Team for the Parks and Wildlife Service, Tasmania. David Rounsevell co-ordinated the review process and produced early drafts of the Plan. Editing and final production were undertaken by Mark Holdsworth, with the assistance of Dr Sally Bryant and Anna Knee (PWS). Peter Menkhorst (Natural Resources and Environment) wrote the majority of the text pertaining to the species on the mainland and edited several drafts of the Plan. The Tasmanian actions were produced by Peter Brown and Mark Holdsworth (PWS), and Keith Casperson (Environment and Natural Resources) produced the South Australian actions. The Recovery Team would also like to acknowledge the advice, co-operation and continued support provided by Environment Australia, Department of Defence, Department of Natural Resources and Environment (Victoria), Parks and Wildlife Service (Tasmania), Department of Environment and Natural Resources (South Australia), Birds Australia, World Wide Fund for Nature, Healesville Sanctuary, and research collaborators of the Universities of Melbourne, La Trobe, Sydney and Tasmania.

Last, but not least, we thank the hundreds of volunteers who have worked enthusiastically on recovery tasks, without whom our knowledge of the species would be much the poorer.

The Recovery Team members are: Peter Brown, Parks and Wildlife Service; Mark Burgman, Melbourne University; Keith Casperson, Environment and Natural Resources; Mark Holdsworth, Parks and Wildlife Service; John Hopper, Department of Defence; Richard Loyn, Natural Resources and Environment; Bruce Male, Environment Australia; Peter Menkhorst, Natural Resources and Environment; Margaret Moore, World Wide Fund for Nature; Neil Murray, La Trobe University; David Rounsevell and Ian\_Smales, Healesville Sanctuary; Jonathan Starks, Birds Australia.

The following people provided specialist advice to the Recovery Team: Joey Baril, La Trobe University; Sally Bryant, Parks and Wildlife Service; Garry Cross, Sydney University; Martin Drechsler, Melbourne University; Michael Fendley, Birds Australia; Merrill Halley, Healesville Sanctuary; Linda Lee, Melbourne University; Debra McDonald, Healesville Sanctuary; Michael Miller, Healesville Sanctuary; Terry Owers, Environment and Natural Resources.

## ABBREVIATIONS

**AGCSA:** Australian Golf Course Superintendents Association

**ANCA:** Australian Nature Conservation Agency (now Environment Australia)

**ANZECC:** Australia New Zealand Environment and Conservation Council

**BA:** Birds Australia (formerly RAOU)

**BI:** Birdlife International (formerly ICBP)

**CMG:** Captive Management Group (Orange-bellied Parrot)

**DASETT:** Department of Arts, Sport, Environment, Tourism and Territories (DEST)

**DD:** Department of Defence

**DELM:** Tasmania, Department of Environment and Land Management (now Department of Primary Industries, Water and Environment)

**EA:** Environment Australia (formerly Australian Nature Conservation Agency)

**ENR:** South Australia, Department of Environment and Natural Resources

**DEST:** Department of Environment, Sport and Territories

**ECAC:** East Coast Armament Complex (Point Wilson, Victoria)

**ESP:** Endangered Species Program (ANCA)

**HS:** Healesville Sanctuary, Zoological Board of Victoria

**ICBP:** International Council for Bird Preservation (BI)

**ICI:** Imperial Chemical Industries (Australia) Pty Ltd

**IUCN:** International Union for the Conservation of Nature (World Conservation Union)

**MW:** Melbourne Water

**MWA:** Murtcaim Wildlife Area

**MWAMC:** Murtcaim Wildlife Area Management Committee (Victoria)

**NRE:** Victoria, Department of Natural Resources and Environment

**PCD:** Psittacine Circoviral Disease

**PVA:** Population Viability Analysis

**PWS:** Tasmanian Parks and Wildlife Service, Department of Primary Industries, Water and Environment (DPIWE).

**Ramsar:** International Treaty on Conservation of Waterfowl and Wetlands

**RAOU:** Royal Australasian Ornithologists Union (BA)

**TOG:** Tasmanian Operations Group (Orange-bellied Parrot)

**VWG:** Victorian Working Group (Orange-bellied Parrot)

**WWF:** World Wide Fund for Nature (Australia).

## CONTENTS

<b>Foreword .....</b>	<b>2</b>
<b>Acknowledgements .....</b>	<b>3</b>
<b>Abbreviations .....</b>	<b>4</b>
<b>Summary .....</b>	<b>7</b>
<b>Introduction .....</b>	<b>9</b>
Description of Species .....	9
Distribution and Migration .....	9
Habitat .....	11
Food.....	11
Breeding and Longevity.....	11
Conservation Status.....	12
Conservation Measures.....	12
Recovery History and Social Issues.....	12
Conservation and Management of Habitat.....	13
Counting Population During Winter .....	15
Monitoring and Banding Population in Summer.....	15
Captive Breeding, Genetic Diversity and Release.....	16
Psittacine Circoviral Disease .....	17
Population Viability Analysis.....	17
Public Information and Education.....	18
Recovery Team and Management Groups.....	18
Strategy for Recovery.....	19
<b>Recovery Objectives and Criteria.....</b>	<b>20</b>
<b>Recovery Actions.....</b>	<b>21</b>
1. Recovery Co-ordination .....	21
1.1 Recovery Co-ordinator .....	21
1.2 Population Viability Analysis.....	21
2. Managing Habitat and Food.....	21
2.1 Create New Winter Habitats.....	21
2.2 Revegetation and Propagation Trials .....	22
2.3 Effects of Grazing on Food Supply at Murtcaim and Pt Wilson.....	22
2.4 Impact of Finches on Food Availability at Murtcaim Wildlife Area.....	22
2.5 Monitor and Control Human Disturbance at Murtcaim and Swan Island .....	22
2.6 Predator and Pest Control at Murtcaim, Pt Wilson, Lake Connemara and Swan Bay .....	23
2.7 Habitat Protection and Food Supply at Carpenter Rocks.....	23
2.8 Maintain Feral Predator Control at Kingston and Other Known Feeding Sites .....	23
2.9 Maintain Policy on Recreational Vehicle Access to Known Habitats and Feeding Areas .....	23
2.10 Maintain Food Supplies at Breeding Sites with Appropriate Moorland Fire Regimes and Manage Migratory Habitats in Tasmania.....	24
2.11 Control Feral Cats in Migratory Habitat on King Island.....	24
2.12 Provide and Monitor Nest Boxes and Band Juveniles in Breeding Range .....	24
2.13 Management of Aircraft and Other Human Activities at Melaleuca .....	24
3. Monitoring Habitat and Food .....	25
3.1 Survey of Saltmarsh in Orange-Bellied Parrot Wintering Range.....	25
3.2 Observe Orange-Bellied Parrots Using Critical Winter Microhabitats.....	25
3.3 Model Breeding Habitat and Assess Quality and Quantity of Food Available .....	25
3.4 Habitat Management and Population Monitoring at King Island.....	26

4. Monitoring Population .....	26
4.1 Census of Wild Population in Wintering Range.....	26
4.2 Monitoring Breeding Population .....	26
5. Captive Breeding and Release.....	27
5.1 Husbandry of Captive Population .....	27
5.2 Releasing Captive-bred Birds into the Wild .....	27
5.3 Define Standards of Health in Captive and Wild Birds .....	28
5.4 Monitor Genetic Heterozygosity .....	28
5.5 Monitor and Manage PCD in Captive Population.....	28
6. Public Information and Education.....	28
6.1 Fact Sheet on Orange-Bellied Parrot Recovery Process .....	29
6.2 Portable Interpretive Displays on Orange-Bellied Parrot.....	29
6.3 Orange-bellied Parrot Volunteer Newsletter .....	29
6.4 Prepare Media Strategy .....	29
6.5 Orange-Bellied Parrot Recovery Support Group.....	29
<b>References .....</b>	<b>30</b>

## SUMMARY

### Current Species Status

The Orange-bellied Parrot has a single breeding population containing less than 200 mature adults in the wild. When breeding the species occupies an area of approximately 1,600 km<sup>2</sup> but during winter migration it is dispersed widely along the coastline of south-eastern Australia. The species has declined markedly in abundance and range this century. Since 1991, the size of the wild population has not exceeded 200 mature birds. According to the IUCN Red List Categories of Threat (IUCN 1994), the species meets the criteria for critically endangered (CR, C2b). The species has a total population of less than 250 mature individuals (C), has steadily declined in abundance, and its range has contracted markedly since the 1920s, with all individuals now being in a single sub-population (2b). The Orange-bellied Parrot is protected by State and Commonwealth legislation and listed as threatened nationally, and throughout its range in South Australia, Victoria and Tasmania.

### Habitat Requirements and Limiting Factors

The species forages for the seeds of low vegetation in a variety of coastal plant communities, and roosts in shrubland, usually within 10 km of the coast of south-eastern Australia. It breeds only in south-west Tasmania, and migrates to Victoria and South Australia to spend winter in saltmarsh and strandline habitats. Threats are loss of critical winter habitat and food supply from development or damage, competition from feral species for food, predation from foxes and cats, disease, and possibly stochastic factors such as inbreeding depression. Limitations are shortage of mid-winter food supply and secure roosting sites, disease, small numbers, and high mortality in winter. Breeding habitat is sufficient in size for the current population but requires an appropriate fire regime to maintain food diversity and availability.

### Recovery Objective

The objective of this Plan is to improve the conservation status of the species so that it no longer meets the IUCN criteria for the Critically Endangered (CR) category (IUCN 1994) by 2001 and can be placed in a lower threat category. This objective will be met by increasing the number of mature individuals in the wild population to 250 birds, or more; increasing the carrying capacity of critical winter habitat and ensuring that the species persists in its present range; and demonstrating in 2001 that the probability of extinction of the species in the wild by 2011 will be below 50%. The long-term objective of the recovery effort is to down-list the species to Lower Risk-Conservation Dependent (LRcd) within 30 years.

### Recovery Criteria

1. All the following criteria must be met (relative to 1996 levels) by 2001;
2. Increase the area, or carrying capacity, of critical winter habitat by 10%.
3. Actively maintain the carrying capacity of breeding habitat through frequent burning in south-west Tasmania.
4. Increase the probability of mean winter survival, or cohort longevity, of banded birds by 10%.
5. Increase the maximum number of birds counted during the winter census by 100%.
6. Release 20-30 captive-bred birds into the wild during each plan year.
7. Continuously update the model Population Viability Analysis (PVA) to estimate the risk of extinction in the wild within 10 years.

### Actions Needed

1. Recovery co-ordination
2. Managing habitat and food
3. Monitoring habitat and food
4. Monitoring the population

- 
5. Captive breeding and release
  6. Public information and education

### **Cost of Recovery (000's/year)**

Total funds required (TC); Environment Australia's Endangered Species Program (ESP); all other sources (O).

<b>Actions</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>Total</b>
1	128.4	457.8	139.6	272.0	322.8	46.0	1366.6
2	128.4	428.4	117.6	218.4	285.8	12.0	1190.6
3	131.6	435.4	66.6	228.8	183.8	32.0	1078.2
4	133.6	299.4	26.6	223.6	143.8	12.0	839.0
5	144.8	313.8	16.6	284.2	185.8	32.0	977.2
<b>Total</b>	<b>666.8</b>	<b>1934.8</b>	<b>367.0</b>	<b>1227.0</b>	<b>1122.0</b>	<b>134.0</b>	<b>5451.6</b>

### **Biodiversity Benefits**

The species is highly mobile, using saltmarsh and coastal plant communities from the mouth of the Murray River to South Gippsland. This recovery process integrates well with the conservation and protection of significant areas of coastal ecosystems in south-eastern Australia that are highly modified and require sensitive management. Developmental research for a vaccine for a virus found in the wild populations of most native Australian parrots (PCD) is supported by the recovery of this species.

## INTRODUCTION

### Description of Species

The Orange-bellied Parrot (*Neophema chrysogaster*) (Latham 1790) is a small 'grass parrot' of coastal south-eastern Australia. It is one of six species of the genus *Neophema* (Family: Psittacidae) (Christidis and Boles 1994). Adults weigh 45-50g, have bright grass-green plumage above, royal-blue leading edges to the wings, and light green to bright yellow feathering on the underside, with a distinctive orange patch on the belly.

The orange patch is often not visible at rest, and is brightest in males, paler in females and small or absent in juveniles. On the forehead, males have a broad blue frontal band which is less distinct in females and often absent in juveniles. The bill is dark grey in adults and yellowish in juveniles. When flushed they make a high-pitched metallic 'buzz' alarm call which is repeated rapidly up to ten times. The flight call is a high-pitched repeated 'tzeet...' given every two or three seconds at the apex of the undulating flight. The appearance of the species is more fully described in Higgins and Davies (*in press*).

The species breeds in coastal south-western Tasmania then migrates to the coasts of Victoria and South Australia for the winter (Brown and Wilson 1982) (Figure 1). Three related 'grass parrots' (Rock, Blue-winged and Elegant) also occur in these coastal areas and may be mistaken for the species. They are olive-green in colour and may have orange colour on their abdomens, but none have the grass-green plumage, the distinctive alarm call, and the bright orange patch of the Orange-bellied Parrot.

### Distribution and Migration

According to summaries of historical records (McGill 1960; Jarman 1965; Loyn and Kinhill Planners 1980; Brown and Wilson 1982, 1984), the Orange-bellied Parrot was formerly more abundant and widespread than now. It ranged from Yorke Peninsula in South Australia, along the coasts to Bruny Island in southern Tasmania, and to Sydney, New South Wales, where small numbers may have bred (McGill 1960).

During the late 1800s, and in the 1920s, the species was reported widely as being common, or locally abundant, in coastal south-eastern Australia. The range and abundance of the Orange-bellied Parrot has declined steadily since the 1920s and is no longer found in New South Wales. It is rarely recorded from west of the Murray River in South Australia, and has not been recorded east of Jack Smith Lake in South Gippsland, Victoria.

The species' current breeding range (Figure 1) is a narrow coastal strip of south-west Tasmania between Birchs Inlet, in Macquarie Harbour, and Louisa Bay on the southern coast. Most pairs breed within 20 km of Melaleuca Inlet, Bathurst Harbour and Port Davey in what is considered one breeding population.

Most adults depart the breeding range in February, leaving juveniles to follow in March and April. During migration, individuals forage on beaches, coastal dunes, heathland and pasture until reaching the saltmarshes of north-west Tasmania and King Island. The first birds arrive at Lavinia Nature Reserve, King Island, in mid-March and have usually left by June. Adults first reach Victoria in late March and disperse east as far as coastal South Gippsland, and as far west as Lake Alexandrina in South Australia, by April. Most of the population overwinters in saltmarsh habitat in central Victoria while the remainder moves west to the coast of South Australia. In September, the first adults leave the Australian mainland for Tasmania, with the last birds departed by November. Pre-breeding migration is more rapid and direct than post-breeding migration. Generally, older birds arrive at breeding grounds earlier than younger birds, that is, 4-6 year olds arrive at Melaleuca in the last week of September or the first week of October, while first-year birds arrive during early November (Holdsworth *et al. in prep*).

In Victoria, up to 70% of the entire population concentrates at three wintering sites around Port Phillip Bay and the Bellarine Peninsula. These are the Murtcaim Wildlife Area (MWA) (particularly The Spit Nature Conservation Area), Lake Connemare and Swan Bay, including Swan Island. In South Australia, the site most regularly used is Carpenter Rocks, south-west of Mt Gambier (Brown and Wilson 1984; Hewish and Starks 1988; Starks *et al.* 1992), but since 1991, fewer records of birds at this site have been reported.

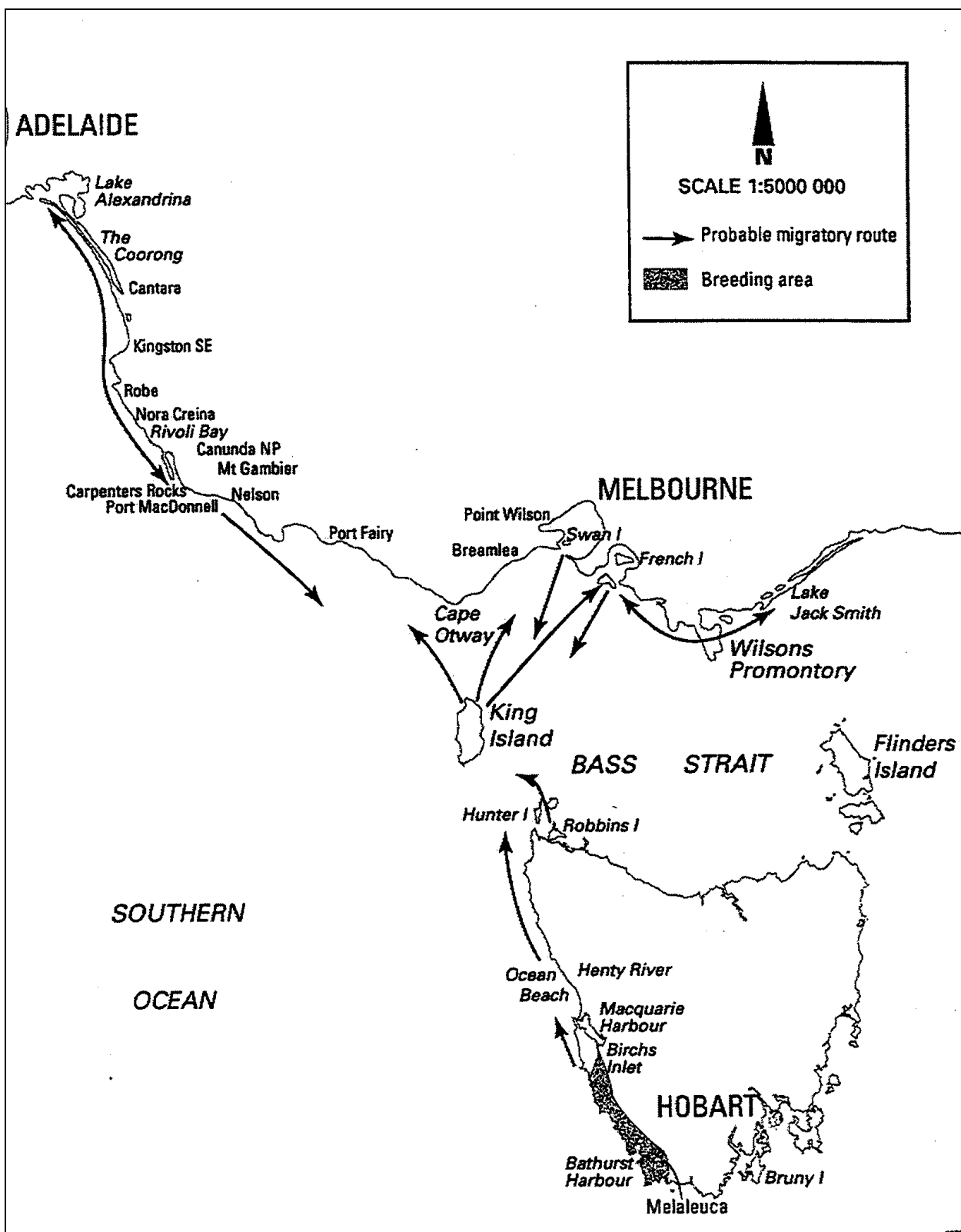


Figure 1: Present range of the Orange-bellied Parrot.

## Habitat

Saltmarshes, coastal dunes, pastures, shrublands, estuaries, islands, beaches and moorlands, usually within ten kilometres of the coast, make up the diverse habitats used by Orange-bellied Parrots.

In Victoria, the species mainly uses natural saltmarshes dominated by Beaded Glasswort (*Sarcocornia quinqueflora*) and Shrubby Glasswort (*Sclerostegia arbuscula*), as well as associated grassy or weedy pastures. In South Australia, as on migration in western Victoria, they also use beaches, dune frontages and adjacent dune systems, and sheltered areas along rocky foreshores where they feed on the seeds of strandline plants such as Sea Rocket (*Cakile maritima*).

Critical winter habitat for the species is saltmarsh along the western shore of Port Phillip Bay at the Murtcaim Wildlife Area, Lake Connemara and Swan Bay, including Swan Island. Other suitable habitat in Victoria is located at Jack Smith Lake, Corner Inlet, Western Port, French Island, Port Fairy, Nelson and Discovery Bay Coastal Park; and in South Australia at Canunda National Park, Lake Bonney, Nora Creina, Robe, Butchers Gap, Blackford Drain, Woods Well, Magrath Flat and Lake Alexandrina, where birds tend to spend less time and occur in smaller flocks than in the key sites in Port Phillip Bay.

Breeding habitat is a mosaic of eucalypt forest, rainforest, and extensive moorland plains dominated by Buttongrass (*Gymnoschoenus sphaerocephalus*), and intersected by wooded creeks, rivers and estuaries within the Tasmanian Wilderness World Heritage Area (Brown and Wilson 1982, 1984; Stephenson 1991). During breeding, Orange-bellied Parrots feed on the seeds and fruits of a range of moorland plants (see Brown and Wilson 1984), nest in eucalypt hollows, and roost in coves of tea-tree (*Leptospermum spp.*) and paper-bark (*Melaleuca spp.*). At Melaleuca and Birchs Inlet, the species favours small forest patches close to feeding areas for nesting, but probably nests within extensive forest at Towterer Creek north of Port Davey (Holdsworth *pers comm*). The structure and dynamic nature of the fire-dependent moorlands are an important feature of the breeding range habitat (Brown and Wilson 1982, 1984).

## Food

Orange-bellied Parrots eat seeds and fruits of

grasses, chenopods, sedges and herbs by foraging on the ground or climbing on food plants. Diet varies according to season and habitat across the range (see Brown and Wilson 1984). The availability of food in the breeding range depends on maintaining, by fire management, a mosaic of moorlands of different ages (Brown and Wilson 1982, 1984). In the non-breeding range in Victoria, there may be a shortage of seed in the available saltmarsh in most years during the critical mid-winter period and the parrots sometimes feed on weeds and introduced grasses in adjacent pastures and golf fairways (Loyn *et al.* 1986). In South Australia, strandline plants are as important as saltmarsh and pasture plants for Orange-bellied Parrots (Gibbons 1984; Casperson 1995). Other species of parrots and introduced finches may compete with Orange-bellied Parrots for food in key saltmarsh and beach habitats in the wintering range (Brown and Wilson 1982, 1984; Loyn *et al.* 1986; Hill 1995).

## Breeding and Longevity

The ecology and life history of the Orange-bellied Parrot is well-known (Brown and Wilson 1982, 1984; Loyn *et al.* 1986; Menkhorst *et al.* 1990; Starks *et al.* 1992; Brown *et al.* 1995). It is known that both sexes breed in their first year and are monogamous (Holdsworth *pers comm*). Maximum recorded longevity of a bird in the wild is 7 years and 2 months (still alive Feb 1998 Holdsworth *pers comm*), and for birds in captivity 13 years (Lewitska 1980), but the average life expectancy of birds in the wild is estimated to be less than 4 years (Holdsworth *et al. in prep*). Reproductive productivity declines after 6 years in captivity (Brown *pers comm*).

Observations at Melaleuca suggest that pair-bonding of older birds probably occurs within wintering grounds prior to pre-breeding migration, as some mating behaviour and nest site selection occurs soon after arrival in October, while first-year birds are usually unpaired until late November (Holdsworth unpublished data 1997). Nesting hollows, mostly in live *Eucalyptus nitida* and *E. ovata*, are selected (often using the previous season's nest site), and nest scrapes prepared by females during November. Broody females spend increasingly more time within the nest chamber from mid-November. During this time, males feed the females at or near the nest site where copulation occurs. One pure white egg (c.23 mm x 19 mm) is laid every second day during late November to early December. Clutches are 1-6 but average 4.5 per female (Holdsworth 1997). Incubation lasts for 21 days and is carried out only by the female (Lewitska 1980). The male feeds the

female at or near the nest site. Eggs hatch every second day during late December and early January, with females continuing to brood chicks for up to two weeks before assisting the male with feeding chicks. Fledging occurs by mid-February, and juveniles form small flocks prior to migration in late March to April.

### Conservation Status

According to the IUCN Red List Categories of Threat (IUCN 1994), the species meets the criteria for critically endangered (CR, C2b). The Orange-bellied Parrot has a single breeding population containing less than 200 mature adults in the wild (C), has steadily declined in abundance, and its range has contracted markedly since the 1920s (2), with all individuals now being in a single sub-population (b).

The Orange-bellied Parrot is listed nationally on Schedule 1, Part 1 (endangered) of the *Endangered Species Protection Act 1992*, Schedule 1 in the Commonwealth *Wildlife Protection (Regulation of Exports and Imports) Act 1982*, under the *Convention on International Trade in Endangered Species* (CITES). The species is also recognised as endangered in the Japan-Australia Migratory Bird Agreement (JAMBA). It is listed as threatened under the Victorian *Flora and Fauna Guarantee Act 1988*, Schedule 1 (endangered) of the *Threatened Species Protection Act 1995* in Tasmania; and Schedule 7 of the *National Parks and Wildlife Act 1972* in South Australia.

While the reasons for the population decline are not clear, it is likely that fragmentation of the wintering habitat over the last 100 years (for example Heathcote and Maroske 1996) has been a major contributing factor (Menkhorst *et al.* 1990; Edgar and Menkhorst 1993; Casperson 1995), and is probably limiting population recovery. Alteration and destruction of the species' saltmarsh feeding grounds has been due to industrial and urban development, agricultural practices and recreational activities. Trapping for aviculture, predation by introduced cats and foxes, and competition for food by introduced finches may also have contributed to the decline (Brown and Wilson 1982), and be limiting population growth. Stochastic factors such as disease, loss of genetic variation, storms during migration, and destruction of nest sites, eggs and chicks by fire are important influences on the population's long-term viability.

## Conservation Measures

### Recovery History and Social Issues

The first actions to conserve the Orange-bellied Parrot were taken in 1978 when ICI (Australia) Pty Ltd planned to construct a petrochemical plant near Murtcaim Wildlife Area in Victoria, one of the main over-wintering refuges of the species. The company commissioned research into the use of the area by the Orange-bellied Parrot (Loyn and Chandler 1978; Carr and Kinhill Planners 1979; Lane *et al.* 1980) but economic considerations later resulted in the development being abandoned.

In 1979, the conservation agencies of Victoria, Tasmania, South Australia and the Commonwealth, and representatives from ICI, World Wide Fund for Nature (Australia) (WWF), Birds Australia (BA), and Birdlife International (BI) agreed to co-operate on research into the status and ecology of the species. In 1980, a study of the Orange-bellied Parrot throughout its range was initiated by the Tasmanian Parks and Wildlife Service (PWS), with funds from WWF and assistance from volunteers, non-government organisations and governments (Brown and Wilson 1980, 1981, 1982). Also, in 1980, landholders in the vicinity of Point Wilson formed the Murtcaim Wildlife Area Management Committee (MWAMC) to facilitate local planning and management of the species' habitat in Victoria (Menkhorst *et al.* 1990).

Breeding trials began using two related species (*Neophema chrysostoma* and *N. petrophila*) in 1981 in Hobart, and the first Recovery Plan was written by Brown and Wilson (1984). Actions taken under the first Plan are summarised below and reported by Menkhorst *et al.* (1990). The Orange-bellied Parrot Recovery Team, comprising representatives of the Federal and three State conservation agencies, and nature conservation organisations, formed in 1983. In 1985, the success of captive breeding trials led the team to support captive breeding of Orange-bellied Parrots in 1986.

Willingness to protect the species and its habitat has been demonstrated by effective community actions and co-operation throughout its range. For example, in western Port Phillip Bay proposals for an airfield suitable for Hercules aircraft on Swan Island, and a marina proposal within Swan Bay, were abandoned. Coastal development proposals at Queenscliffe were modified, and alternatives were found to the extraction of shell-grit at Point Wilson and Point Lonsdale (Edgar and Menkhorst 1993) to avoid loss

of habitat. Staff of the Queenscliff Golf Club, which is situated in the Swan Bay Marine Reserve, recently won a national environmental award for managing the course as habitat for the Orange-bellied Parrot (AGCSA 1996).

In 1990, a public observatory was constructed at Melaleuca by the PWS, with World Heritage Area funds provided by the Department of Arts, Sport, Environment, Tourism and Territories (DASETT), to assist with summer population monitoring. The observatory incorporates an interpretative display on the recovery program, and has become an important attraction to visitors to the area.

Observations at Melaleuca indicate that the breeding population has remained stable over the past 10 years and that breeding productivity in this sub-population has been increased through supplementary feeding and the use of nest boxes (Holdsworth *et al. in prep*).

The second Orange-bellied Parrot Recovery Plan (Stephenson 1991) was implemented from 1991 to 1996 with funds from the Australian Nature Conservation Agency (ANCA), under the Endangered Species Program. Progress on actions in this Plan are reported by Edgar and Menkhorst (1993), Brown *et al.* (1995), Menkhorst (1996) and Brown *et al.* (1997), and have been summarised below.

The Victorian Working Group (VWG) was formed in 1990 to co-ordinate actions within that State. After a major fire at Coode Island in the Port of Melbourne in 1991, the Victorian Government commissioned an environmental effects statement for a proposal to build a new port and relocate a storage facility for hazardous chemicals, firstly at West Point Wilson, then subsequently at Point Lillias (Point Lillias Project Unit 1995).

An action statement for the Orange-bellied Parrot for the period 1993-1998 was prepared by Victoria (Edgar and Menkhorst 1993) under the *Flora and Fauna Guarantee Act 1988*, and a second captive breeding colony was established in Healesville Sanctuary in 1994.

Point Wilson was nominated by the Federal Government in April 1994 as the site for the East Coast Armament Complex (ECAC), replacing the Royal Australian Navy Armament Depot at Newington in Sydney. A Commonwealth Commission of Inquiry conducted in 1994-95 into the environmental impact of the complex paid particular attention to the Orange-bellied Parrot (for

example, Hill 1995). The Commission supported the project subject to some modifications, and its recommendations form much of the current environmental work being done by the Department of Defence (DD) at the Point Wilson site (Anon 1996). The purchase and inclusion of the adjacent ICI land and Snake Island have augmented this work by further limiting disturbance to the Orange-bellied Parrot and its habitat at Point Wilson.

The Orange-bellied Parrot Captive Management Group (CMG) was formed in 1995 and the *Threatened Species Protection Act 1995* was promulgated in Tasmania.

The statement of the environmental effects of the Point Lillias proposal concluded that construction at the 36 ha site, which contains wetlands of significance to the Orange-bellied Parrot, would disturb the birds unless remedial action was taken, particularly when combined with the added disturbance of the nearby construction of the ECAC at Point Wilson (Point Lillias Project Unit 1996). The Victorian Government proposed to add significant new areas of high quality habitat to the local International Treaty on Conservation of Waterfowl and Wetlands (Ramsar) sites and to improve management and habitat enhancement work for the Orange-bellied Parrot, but for economic reasons the development has since been abandoned.

In 1996, Australian Titanium Minerals Limited (ATM) applied to the Tasmanian Government to mine sand at King Island, between Naracoopa and the Sea Elephant River, adjacent to critical migratory habitat for the Orange-bellied Parrot in Lavinia Nature Reserve. ATM's consultant ecologist's report (Lane *et al.* 1997) recognised the significance of this proposal on the species, and through negotiations between the company, PWS and the Commonwealth, a 1.5 km Mining Exclusion Zone to protect parrot habitat has been included in a draft Development Proposal and Environmental Management Plan (Anon 1997).

### **Conservation and Management of Habitat**

Most of the areas used regularly by the species are either reserved for nature conservation, or are the subject of co-operative conservation agreements between landholders. Five areas of winter habitat, Corner Inlet, Western Port Bay and western Port Phillip Bay, Victoria, Lavinia Nature Reserve on King Island, Tasmania, and the Coorong in South Australia are currently listed under the Ramsar

Convention as wetlands of international significance.

In South Australia, 10 of the 15 important areas of habitat for the Orange-bellied Parrot identified by Gibbons (1984), are protected through a combination of reservation, heritage agreements, or planning regulations. Management plans have been prepared for the Canunda National Park (NPWS 1986), the Coorong National Park and Coorong Game Reserve (NPWS 1989), Beachport Conservation Park (Sutherland 1990), and Carpenters Rocks Site (Owers 1994).

The entire known breeding range of the Orange-bellied Parrot occurs within Tasmania's South-west Wilderness World Heritage Area (WHA) and the South West Conservation Area, and is subject to the World Heritage Area Management Plan (1992). The use of fire to regenerate food plants is an important consideration in the breeding habitat. Fire management prescriptions for Melaleuca and Birchs Inlet (Marsden-Smedley 1993; PWS 1997), and long-term monitoring of food plant abundance at Birchs Inlet (Askey-Doran 1995) will guide future habitat management in the breeding range. The protection and management of habitat at the Sea Elephant River estuary in Lavinia Nature Reserve, King Island, is included in the aims of management for the reserve (PWS 1998).

The management and protection of winter habitat for the species near Port Phillip Bay, Victoria, in very complex social and ecological contexts, has been an important and difficult feature of the recovery process for this species. The reason is that remnant habitat for the species (possibly of sub-optimal quality) remains on land owned and managed by many different organisations and private landowners (Menkhorst *et al.* 1990).

Since the ecology of the species at Murtcaim was studied by ICI (1.7.1), many detailed studies (such as Loyn *et al.* 1986; McMahon *et al.* 1994) to determine how to manage (such as Carr *et al.* 1991) and improve the supply of food (such as Carr 1987; McMahon and Carr 1988) and the carrying capacity of the habitat (Lane *et al.* 1984; Hill 1995) have provided useful information about a very dynamic system. Winter ecology and survival probably limits the population size, particularly in Victoria, where habitat and food availability for the Orange-bellied Parrot is critical (Loyn *et al.* 1986). Saltmarsh communities capable of providing food throughout the winter have been greatly reduced by grazing, construction of salt evaporation pans, and shell-grit extraction (Carr and Kinhill Planners 1979; Loyn 1982; Yugovic 1984) but, as recognised by Loyn

(1982) and Brown and Wilson (1984), there is great scope for creating supplementary feeding areas for use in mid-winter.

The formation of the VWG has helped focus the implementation of actions in Victoria, and over 50% of the saltmarsh plant communities of Port Phillip Bay are now fenced to protect them from stock grazing. The Spit Nature Reserve and the French Island State Park have been enlarged to include habitat for the Orange-bellied Parrot. Management plans have been prepared with important prescriptions for managing Orange-bellied Parrot habitat in reserves at Swan Bay (Edgar 1991), Jack Smith Lake and Lake Connewarre State Game Reserves (DCE 1991; DCNR 1993).

The recommendations of the Commonwealth Commission of Inquiry into the establishment of the ECAC will significantly improve the protection and management of habitat for the Orange-bellied Parrot at Point Wilson (Anon 1996). In 1996, the DD erected a predator-proof fence around the eastern and southern saltmarsh habitat at Point Wilson, and construction was managed to minimise disturbance to avifauna. Sections of the fence also form the security perimeter for the facility. This fencing and the ongoing pest control are designed to minimise the predation of Orange-bellied Parrots by foxes, particularly in relation to potential 'prey switching' as rabbit numbers become reduced by the rabbit calicivirus disease. Active management of habitat for birds at the former Altona saltworks by Melbourne Parks and Waterways (Lane and Tweedy 1994) will affect the future use of habitat by Orange-bellied Parrots in this area.

Research directed to winter habitat resources is being conducted by tertiary institutions. A new method of remote sensing to identify saltmarsh communities suitable for Orange-bellied Parrots was developed by the Royal Melbourne Institute of Technology (Race 1994a, 1994b), and is to be used in this Plan (3.3.1). In 1993, a postgraduate study (D McDonald) through the School of Botany, University of Melbourne analysed the nutritional content of seeds from the main food plants in the diet of Orange-bellied Parrots. Another postgraduate study at the same institution is currently describing the regenerative ecology of food plants and the feeding behaviour of Orange-bellied Parrots in saltmarsh at Murtcaim (L Lee *in prep*). The information gained through these studies is being used to enhance the effectiveness of the PVA (1.7.7; 3.1.2), which in turn will assist decision-making for habitat restoration.

In each State, the ongoing control of predators (such

as red foxes and cats) and competitors (such as rabbits and European starlings) in Orange-bellied Parrot habitat are significant tasks being undertaken by volunteers, local councils, the DD, Melbourne Water (MW), and State conservation agencies. Research and management of introduced competitors for winter resources, such as the green and gold finches, have also been proposed to improve the quality and quantity of critical winter habitat.

### Counting Population During Winter

Birds Australia has co-ordinated and conducted counts of the winter populations of the Orange-bellied Parrot throughout the recovery period (Menkhorst 1996). Over 100 volunteers regularly participate in the annual weekend count (late July). Birds Australia advertises the counts through regional bird organisations in the quarterly magazine *Wingspan*, co-ordinates volunteer assistance by employing a Threatened Bird Network Co-ordinator, and produces the newsletter *Volunteer* to inform people about Orange-bellied Parrot survey details and news. Details of these counts and volunteer assistance are published regularly by BA (Jessop and Reid 1986; Starks 1988, 1992, 1993, 1994, 1995, 1996 and 1997; Starks *et al.* 1992). State conservation agencies provide staff and logistical support to assist volunteers. Although winter surveys are extensive, often covering most of the winter range, including all known wintering sites and many other areas of potential winter habitat, results have been variable, and over recent years less than the summer population estimates at Melaleuca. The reasons for this discrepancy are not known, but it probably indicates that the species is using abnormal habitat, is dispersing into smaller flocks, or is moving beyond its normal range. Orange-bellied Parrots are occasionally observed feeding with flocks of Blue-winged Parrots and other seed eating birds, particularly in areas outside of western Port Phillip Bay (Starks *et al.* 1992; Klau and Langdon 1994; J R Starks *pers comm*). Re-sighting of banded birds during the winter counts has provided estimates of the average probability of the survival of individuals, and shown that captive-bred birds are capable of normal migration.

Initially, winter counts were used as an annual index of the wild population, but the consistently higher Melaleuca counts since 1992 have become more valuable as a population index. Winter surveys will be used primarily to locate banded birds, assess the annual use and condition of favoured feeding and roosting sites, locate new habitats, and encourage

public involvement and awareness of the species. In 1996, the Recovery Team suggested that BIOCLIM habitat models or broader search areas in South Australia may help to locate more birds. From 1996, during the construction and operation of the ECAC site at Point Wilson by the DD, Orange-bellied Parrots will be counted monthly at the site. Counts will be co-ordinated with BA winter surveys and the results will be made available to the Recovery Team.

### Monitoring and Banding Population in Summer

Monitoring of the breeding population of Orange-bellied Parrots at Melaleuca began in 1979. It is centred on the vegetable gardens of the King and Willson families, which have attracted Orange-bellied Parrots for 50 years. Since March 1988, the parrots have been provided with daily supplementary food (canary mix) to attract them for banding and study. Since 1988, 474 birds in the wild population have carried standard Australian Bird and Bat Banding Scheme metal bands, some indicating by colour the year of banding on one leg, and coloured plastic bands identifying individual birds on the other. Every year since 1991, a sample of (33-35) nestlings and/or fledglings have been banded in this manner.

A public observatory and supplementary food station was constructed near the airstrip at Melaleuca in 1990, and it has become an important site for population counts and behavioural studies. In addition, the observatory enables visitors to the area to view the species without disturbance and learn more about the Recovery Program. From October to March, volunteers spend selected two-week periods recording the numbers of parrots visiting the feed station and recording banded birds. This is used in mark-recapture models to estimate the effective population and breeding productivity at Melaleuca (Holdsworth *et al. in prep*). These population estimates are used within PVA models (1.7.7) to assess recovery of the species. Most were banded as juveniles, wild and captive-bred. Annual summaries of the banding effort and results are provided in reports to the Recovery Team.

Data collected at Melaleuca since 1991 has been analysed using a Jolly-Seber model to produce a population estimate and trend over the period (Holdsworth *et al in prep*). The results are consistent with the view that Melaleuca has at least maintained a stable population, however, there is some statistical evidence of population decline in 1994-95 and a recovery in the 1996-97 season. Overall, the data indicates that the efforts of the Recovery Team have

resulted in at the minimum a stable population while there is no statistical evidence to support the alternative scenario of a declining population.

In 1992 nest boxes were erected at Melaleuca to encourage breeding in accessible sites. Both wild and released captive-bred Orange-bellied Parrots have used them (1.7.5). In 1997-98, of a total of 41 boxes at Melaleuca, 14 were occupied by parrots, producing 47 nestlings (Holdsworth *pers comm*). The occupancy rate of these nests and the fledging success of pairs that use them is high. The nestlings in nest boxes are banded prior to fledging, thereby negating the need for mist-netting juveniles as was done in earlier years. In 1994, nest boxes were installed at Birchs Inlet (13) and Towterer Creek (11) to encourage local or released birds to use them for breeding. Only one box at Birchs Inlet has been used (by captive-bred birds released at the site) producing one fledgling in 1996-97.

### **Captive Breeding, Genetic Diversity and Release**

In 1981, an aviary complex was built at Green Point, north of Hobart, for a trial breeding program using two related species, the Blue-winged Parrot (*Neophema chrysostoma*) and the Rock Parrot (*Neophema petrophila*). The success of these trials and the subsequent release of captive-bred progeny of both species into the wild (Brown 1988; Brown *et al.* 1995) gave the Recovery Team the confidence to begin Orange-bellied Parrot captive breeding in 1985.

During the first five years the results of captive breeding were promising, but the survival of juveniles was poor (Menkhorst *et al.* 1990; Brown *et al.* 1995) due to the viral disease, Psittacine Circoviral Disease (PCD). In 1989, the captive breeding facility was relocated to a less-exposed location at Taroon, a suburb of Hobart, in an attempt to reduce the incidence of PCD. Breeding productivity and winter survival consistently improved thereafter (Brown *et al.* 1995). The Recovery Team also supported research on identifying PCD-infected birds to enable them to be isolated from healthy birds, and as a first step in developing a vaccine (1.7.6). Other deaths in captive birds have been caused by accidents, stress during courtship, renal failure and aspergillosis.

The presence of PCD in the captive population delayed the release of captive-bred birds until 1991, when the disease was positively identified in wild Orange-bellied Parrots (Brown *et al.* 1995). Since then the captive population has produced 183 independent young up to 1997, and provided opportunities for research, such as PCD and DNA.

Precautionary measures to maintain genetic diversity and avoid inbreeding depression in both the captive and wild populations have been taken.

By 1994, a second captive colony at Healesville Sanctuary, Victoria was established using founder stock from the Hobart facility. This measure was taken as an insurance against catastrophic events, such as fire and disease, destroying the entire captive population. Adding captive breeding of the Orange-bellied Parrot to the aims of Healesville Sanctuary has provided access to captive management support systems available to threatened species in professional zoos.

The need to avoid inbreeding depression in the small Orange-bellied Parrot population, particularly the captive population, led to the development of methods to measure genetic diversity in individual birds. In 1992, the Department of Genetic and Human Variation at La Trobe University (Dr N Murray and H Allen) began work on developing a probe to identify genetic markers in DNA from the blood of Orange-bellied Parrots. The method detects specific alleles in the genotypes of individual birds from which estimates of genetic heterozygosity in the captive and wild populations can be made. From 1994, the methods have been refined (by J Baril), identifying the alleles of many of the captive birds and some wild birds. A new technique using only Orange-bellied Parrot feathers is also being developed to avoid the collection of blood. The information gained allows the CMG to avoid matings of closely-related individuals, and maintain the level of genetic heterozygosity in the captive-bred population.

Since 1991, 38 captive-bred birds have been successfully introduced into the wild at Melaleuca, where the original stock was captured and the breeding population is most easily observed. Each bird was banded with a unique combination of coloured bands (1.7.4), and held in the release aviary for up to a month. This 'soft' release method is described in Brown *et al.* (1995). Observations from the Melaleuca observatory clearly indicated that released birds remained in the area, and most of them paired with other released birds, or wild birds, and many successfully raised young. By breeding so readily after release, progeny is rapidly added to the population, regardless of winter survival, thus ensuring that the release program is at least partially effective. Captive-bred birds tend to migrate later than wild-bred adults and a small number of them are seen in Victoria during winter and/or in Tasmania in up to three successive breeding seasons (Brown *et al.* 1995), confirming that captive-bred

birds can migrate successfully and breed for years after their release. Some were not seen again, either in the wintering range, or at Melaleuca during the following year. To date, no banded birds have been seen in South Australia.

In an effort to establish a second breeding population, 15 birds were released at Birchs Inlet in 1994, and 13 in 1996. The location, where the species had bred until 1985, is approximately 120 km north-west of Melaleuca. The release method was similar to that used at Melaleuca (Brown *et al.* 1995). One of the 1994 birds was seen during the winter at Point Lillias in 1995 (Starks 1997), and another was seen at Birchs Inlet in 1997. Only one pair of the 1996 release were known to have bred, producing one fledgling. One of the 1996 released birds was resighted the following spring at the release site, thus indicating the presence of another breeding area between Melaleuca and Birchs Inlet, and possibly a sub-population.

In addition, six birds were successfully released at Point Wilson Explosives Area during 1996 (P Menkhorst *pers comm*). The aim of this release was to determine whether the birds could survive at the site, migrate to Tasmania to breed, and then return to the same (or another) wintering site. None of these have been sighted after release. To date, a total of 72 captive-bred birds have been released.

### Psittacine Circoviral Disease

A significant cause of death among captive Orange-bellied Parrots during the breeding program in 1986-1991 was Psittacine Circoviral Disease (PCD) (Brown 1988). The disease was first positively diagnosed histologically in Orange-bellied Parrots by Dr David Pass of Murdoch University and shown to be caused by a virus (Wylie and Pass 1987). The virus multiplies in the liver (Raidal *et al.* 1993a), is shed in faeces, and affects the developing feather follicles, distorting the new feathers and causing them to be shed. The loss of plumage and thermal insulation causes birds to die of secondary infections such as pneumonia. The virus can be transmitted orally or cloacally in faeces or feathers, and birds differ in their ability to produce antibodies to cope with the infection.

Since 1990, mortality due to PCD has been practically eliminated in captive-bred stock through the relocation of the Hobart facility to a warmer, more sheltered site. Assay methods and serum antibody to identify infected birds, and to provide more-informed care and better hygiene in captive

management was undertaken by the Department of Animal Health, University of Sydney. In addition, assays for the virus and serum antibody were developed (Raidal *et al.* 1993c). These studies established that wild and captive Orange-bellied Parrots were exposed to the virus, and most captive-bred birds survived infection and developed antibodies.

The pathogenesis of the virus is still poorly understood, but it is probably the most recognisable disease of wild and captive psittacine birds. It has been reported in more than 61 psittacine species (such as Raidal *et al.* 1993b; Raidal *et al.* 1993c), including other threatened psittacines (such as the Swift Parrot (*Lathamus discolor*) and the Norfolk Island Parrot (*Cyanoramphus novaehollandiae cookii*) (G Cross *pers comm*). PCD virus can affect psittacine birds of all ages, but it generally affects juveniles or young adults. A vaccine for this disease would benefit psittacines in aviculture and any captive breeding programs for other threatened psittacines.

### Population Viability Analysis

Population viability analysis (PVA) uses a computer model to synthesise information about the population dynamics of a species to produce estimates of the risk of extinction. The model is reliant on detailed biological information, such as reproductive rates, re-sighting of birds in winter and summer habitat, population estimates, and survival. The results of Orange-bellied Parrot PVA are used by the Recovery Team to guide the recovery strategy and refine actions.

The first PVA, prepared in 1990 (McCarthy *et al. in prep*), showed that high juvenile mortality was the greatest limitation to population increase, and emphasised the value of the captive-breeding program. It predicted that the most effective use of the captive-breeding program was to release 40-60% of captive-bred birds annually. Captive breeding and the supply of artificial nests was important in reducing the risk of extinction, but winter survival was critical. The management of winter food resources and the control of sources of mortality for over-wintering birds was most important.

A PVA based on a stochastic simulation model (such as Burgman *et al.* 1993) to estimate parameters for the wild population is currently being developed. Because there is uncertainty in some of these parameters, a serious estimate of the extinction risk of the population is not available, but survivorship is likely to be more limiting than reproduction,

regardless of the uncertainties (M Drechsler *pers comm*). The PVA identifies that the quality of winter habitat is important to the species. The postgraduate work being undertaken at University of Melbourne (L Lee) on traditional winter habitat and its use by Orange-bellied Parrots at the Murtcaim Wildlife Area will further enhance the PVA model, and predictions may assist the order of priority for developing winter habitat areas.

### Public Information and Education

Public awareness of the endangered status of the Orange-bellied Parrot, and the efforts to save the species are high. The opportunity for visitors to land at the airstrip at Melaleuca and view Orange-bellied Parrots from the observatory is an asset to scenic flight operators in the Tasmanian Wilderness World Heritage Area. The continuing high level of enthusiastic participation in winter counts and the summer observer programs are evidence of public support for the recovery effort.

Two coloured brochures have been published, one which assists in identifying Orange-bellied Parrots, and the other explains the endangered status of the bird and the co-operative recovery effort. The latter, which has been very effective and widely distributed for public information, was updated in 1997. Members of the Recovery Team have publicised the recovery effort by writing articles, giving talks to local and national organisations, attending conferences, and encouraging television and radio coverage. Birds Australia has appointed a volunteer network co-ordinator to support the recovery of threatened bird species, including the Orange-bellied Parrot. Education officers of the State conservation agencies publicise the plight of the species in a range of ways using note sheets, broadsheets, endangered species packages for schools, and the Internet (such as PWS <<http://www.del.mtas.gov.au/esl/>>). Interpretive signs have been provided for visitors at Carpenter Rocks and the Melaleuca observatory. In 1998, the interpretive material at Melaleuca was updated, and now incorporates a video-surveillance system, allowing visitors and observers to view nest box activity. Posters and note cards, published privately, continue to be very popular. New tasks in this Plan, including the production of a regular newsletter, and the appointment of a co-ordinator will build further public interest in the recovery process.

### Recovery Team and Management Groups

Participation in working to benefit this species and its habitat is shared by people in the community who are volunteers, landowners, land managers, and Friends of Parks groups, and many other organisations. Responsibility for implementing this Plan is shared by many groups and individuals.

An Orange-bellied Parrot Recovery Team was first established in 1983 to guide, evaluate and review progress on implementing a recovery plan, and was the first for the recovery of a threatened species in Australia. It has met annually since 1984, in one of the three range States on a rotational basis. It provides the opportunity for local land managers, research workers, volunteers and observers to participate. The team includes representatives of the following organisations:

Environment Australia  
 Department of Defence  
 Parks and Wildlife Service (Tasmania)  
 Dept. of Environment and Natural Resources (South Australia)  
 Dept. of Natural Resources and Environment (Flora and Fauna Branch and Port Phillip Area, Vic)  
 La Trobe University (School of Genetics and Human Variation)  
 Melbourne University (School of Botany)  
 Birds Australia  
 World Wide Fund for Nature (Australia)  
 Healesville Sanctuary (Zoological Board of Victoria)  
 Birdlife International (formerly ICBP, was a founding member but in 1995 it affiliated with, and is now represented on the Recovery Team, by BA.)

The Victorian Working Group (VWG) was established in 1990, to give added impetus to the recovery effort in Victoria (Stephenson 1991). It meets 3-4 times a year to ensure co-ordination and co-operation in implementing tasks locally, and comprises local members of the Recovery Team, land managers, land owners, researchers and volunteers. The Captive Management Group (CMG) was formed in 1995, to manage the captive population housed in the facilities at Hobart and Healesville, and the release of captive-bred birds from those facilities into the wild population. It comprises members of the Recovery Team and other specialist members who consult regularly. The Tasmanian Operations Group was formed in 1996 to co-ordinate Tasmanian tasks and, like the VWG, it is comprised of local members of the Recovery Team, regional land managers, researchers and volunteers. It reports to the Recovery Team.

## Strategy for Recovery

The results of actions implemented from previous Recovery Plans (Brown and Wilson 1984; Stephenson 1991) are referred to in Section 1, and they lay the foundation for developing strategies in this Plan, and for long-term recovery. Actions within this Plan include some ongoing actions from the previous Plan (Stephenson 1991), and some new actions. Organisational changes include recommending the appointment of a recovery co-ordinator, and stronger action in public information and education. Strategies to improve the rate of increase in the size of the wild population of the Orange-bellied Parrot are listed below in order of priority.

1. Creating additional winter-feeding habitat in locations traditionally used by the species (Tasks 3.2.1, 3.2.2, 3.2.7, 3.3.2) for approximately 100 birds.
2. Reducing the risks of predation and competition for the birds by removing and excluding feral animals from traditional feeding sites, and protecting and managing core habitat (Tasks 3.2.3, 3.2.4, 3.2.5, 3.2.6, 3.2.8, 3.2.9, 3.2.10, 3.2.11, 3.2.12, 3.2.13, 3.3.3, 3.3.4).
3. Counting (Task 3.4.1) and locating the balance of the wild population in winter by searching in potential habitat beyond the known wintering range (Task 3.4.1), and, inside the known wintering range, by discovering new feeding areas of saltmarsh habitat with new survey methods (Task 3.3.1).
4. Breeding healthy birds in captivity, and successfully releasing them into the wild population, and being able to locate them after release by radiotelemetry (Tasks 3.5.1, 3.5.2, 3.5.3, 3.5.4).
5. Developing a PCD vaccine to increase the fitness of captive and released birds (Task 3.5.6).

## RECOVERY OBJECTIVES AND CRITERIA

The long-term objective of this recovery effort is to down-list the species to Lower Risk-Conservation Dependent (LRcd) within 30 years. The objective of this Plan is to improve the conservation status of the species so that it no longer meets the IUCN criteria for critically endangered (CR), and can be down-listed to endangered (EN) within five years (2002) by increasing the size of the wild population to more than 250 mature individuals.

The objectives of this Recovery Plan and the criteria for successfully achieving the objectives (relative to 1998 values) are:

Specific Objectives	Criteria	Actions
1. Increase the carrying capacity of critical winter habitat, and ensure that the species persists in its present range.	<ul style="list-style-type: none"> <li>• 1. Increase the area, or carrying capacity, of critical winter habitat by 10%.</li> <li>• 2. Actively maintain the carrying capacity of breeding habitat through frequent burning.</li> </ul>	<ul style="list-style-type: none"> <li>• 2. Managing habitat and food (3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.7).</li> <li>• 3. Monitoring habitat and food (3.3.1, 3.3.3)</li> </ul>
2. Increase the number of mature individuals in the wild population to 250 birds or more.	<ul style="list-style-type: none"> <li>• 3. Increase the probability of mean winter survivorship, or cohort longevity, among banded birds by 10%.</li> <li>• 4. Increase the number of birds counted during the winter by 100%.</li> <li>• 5. Release 20-30 captive-bred birds each year into the wild population.</li> </ul>	<ul style="list-style-type: none"> <li>• 2. (3.2.10, 3.2.12)</li> <li>• 2. (3.2.5, 3.2.6, 3.2.8, 3.2.9, 3.2.11, 3.2.13).</li> <li>• 4. Monitoring the population (3.4.1).</li> <li>• 5. Captive breeding and release (3.5.1, 3.5.2, 3.5.3, 3.5.4, 3.5.5).</li> </ul>
3. In 2001, the probability of extinction of the wild population will be <50% in 2011.	<ul style="list-style-type: none"> <li>• 6. Continuously update the model PVA to estimate the probability of extinction in the wild within 10 years.</li> </ul>	<ul style="list-style-type: none"> <li>• 1. Recovery co-ordination (3.1.2)</li> <li>• 3. (3.3.2, 3.3.4)</li> <li>• 4. Monitor population (3.4.2).</li> <li>• 6. Public information and education (3.6.1, 3.6.2, 3.6.3, 3.6.4, 3.6.5)</li> <li>• 1. Recovery co-ordination (3.1.1)</li> </ul>

It is not anticipated that the Orange-bellied Parrot will be removed from National and State threatened fauna lists within the time frame of this Recovery Plan (5 years) because of the slow rate of growth in the population. The Orange-bellied Parrot and its habitat will require longer-term management beyond the life of this Plan.

## RECOVERY ACTIONS

The recovery actions are tasks based on currently available knowledge and the experience gained from implementing the previous Recovery Plans (Brown and Wilson 1984; Stephenson 1991). Included for the first time in the recovery of this species is the proposal to employ a full-time (or equivalent) recovery co-ordinator. The priority, cost and responsibility for carrying out the tasks is shown in the Implementation Schedule (Section 4).

### 1. Recovery Co-ordination

#### 1.1 Recovery Co-ordinator

A full-time (or equivalent) co-ordinator will be appointed to help implement all aspects of this Plan, including liaison with appropriate government agencies, non-government organisations, Friends of and Landcare groups, and the public. The co-ordinator will report directly to the Recovery Team through its convenor. The co-ordinator will contribute to and integrate the outcomes of Orange-bellied Parrot management groups (1.7.9), produce the *Orange-bellied Parrot Newsletter* (3.6.3), and co-ordinate the submission of any grant applications and co-operative proposals to support the recovery process (3.2.1). The co-ordinator will have access to, and copies of, all information from implementing these actions during the recovery process, be able to advise the Recovery Team on their progress, and will facilitate the analysis and curation of data and its publication. The co-ordinator will help to implement those tasks most directly associated with the core strategies of this Plan (2.1) of highest priority in each range State; the participation of volunteers; research; and the co-ordination of public education and media strategies. The position will integrate field tasks done by core staff in the Department of Natural Resources and Environment, Victoria (NRE), PWS, the Department of Environment and Natural Resources, South Australia (ENR), and BA, and will guide the research projects undertaken by other institutions.

Throughout the life of this Plan it is suggested that the co-ordinator and staff of PWS, NRE and ENR co-operate to prepare and assist community groups with preparation of applications to grant programs such as Landcare, Bushcare, Waterwatch and Coastcare to fund land management tasks not identified in this Plan. Through liaison with the co-ordinator, the VWG, or by other means, the resources can be employed in improving, protecting,

and restoring coastal saltmarsh communities of highest priority at known or potential feeding sites for the Orange-bellied Parrot under this and other tasks (3.2.1, 3.2.7, 3.2.8, 3.2.9, 3.3.1)

The co-ordinator may be required to work in Tasmania and Victoria, alternately, for periods of approximately six month's duration, and will be required to travel for field work, and attend recovery meetings in each of the range States. An annual salary, plus overheads (28%) amounting to \$51,200, travel costs of \$4,500 pa, and \$3,500 pa for office and computer rental will be required. Government agencies will meet the cost of attendance of their own representatives to Recovery Team meetings.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
64.2	64.2	65.8	66.8	67.4	328.4

#### 1.2 Population Viability Analysis

A PVA is required to help choose management and research options in implementing the recovery strategy. This will enable better predictions of the changes in the risk of decline associated with the tasks. It is also a method of evaluating the assumptions underlying the research and management tasks to be performed. The PVA model of the Orange-bellied Parrot population must be kept up to date by providing information from actions to the co-ordinator. To provide a prediction of the probability of extinction by 2011 under this Plan some part-time programming assistance (\$5,000) will be needed in 2002.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
				5.0	5.0

### 2. Managing Habitat and Food

#### 2.1 Create New Winter Habitats

By 2000 the VWG will identify, from a range of locations in Victoria, up to 10 sites where sufficient new winter habitat may be created, with a sustainable food supply for at least 100 additional Orange-bellied Parrots (in addition to the 40 using the area in 1996). By promoting common goals and co-operation with existing landowners, sites not currently used by the species (such as disused lagoons at the Western Treatment Complex) may be converted to provide secure and useful winter habitat. Previous habitat improvement has been limited to two methods, removing grazing stock and

planting food crops. New approaches will be tested and planned at up to three sites, simultaneously. Sites will be chosen where support is available from landowners, volunteers, and the local community (Task 3.3.1 for community grants applications), and where winter resources (shelter, water and food) can be provided in a secure environment. Water, soil and plants will be manipulated to create a landscaped habitat with features attractive to Orange-bellied Parrots, such as islands, varied topography and access to freshwater, as well as food. The sites will be selected and their conversion planned and created progressively at currently unused sites according to principles approved by the Recovery Team. Sites can be tested for suitability by using them to release captive-bred birds and providing supplementary food. Volunteers will assist with counting the birds using the results to assess the value of the sites as winter habitat for the species.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
45.0	55.0	65.0	45.0	45.0	255.0

## 2.2 Revegetation and Propagation Trials

To rehabilitate winter feeding habitat for Orange-bellied Parrots in Victoria, research on the propagation and cultivation of their food plants is required. Glasshouse trials on seeds, cuttings and tissue culture will be used to investigate propagation methods for plant species identified in Task 3.3.2. Planting tube stock, direct seeding and natural regeneration will be used in cultivation trials. A research student project in Plan Year 2 trialing glasshouse germination methods is proposed to begin this task. Costs are for glasshouse expendables (\$2,000) and student travel (\$1,000).

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
	3.0				3.0

## 2.3 Effects of Grazing on Food Supply at Murtcaim and Pt Wilson

The current practice for managing saltmarsh feeding sites for Orange-bellied Parrots at Murtcaim and Point Wilson is to exclude grazing stock in order to increase the abundance and biomass of several key food plant species (Carr *et al.* 1991). However, the increased plant biomass produced has not been followed by an increase in use of the areas by Orange-bellied Parrots. Light grazing may actually increase food availability in some food plants. Research into floristic composition and seed production in plots of saltmarsh subjected to various

regimes of grazing by sheep and/or rabbits, and in ungrazed control plots, is needed to resolve management options. The work will involve detailed floristic analyses prior to, and, at intervals after, different amounts of grazing on food plants. Monitoring of food selection by sheep and rabbits will be included.

The work will be done as a research project over three years. A stipend of \$20,000 pa plus travel (\$2,000 pa) is needed. Fencing materials and sheep will be provided by NRE, and NRE staff will provide project supervision.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
29.0	28.0	25.0			82.0

## 2.4 Impact of Finches on Food Availability at Murtcaim Wildlife Area

Brown and Wilson (1984) and Loyn *et al.* (1986) suggested that introduced seed-eating finches at Murtcaim Wildlife Area (MWA) may reduce the availability of food for Orange-bellied Parrots. A study of the food and feeding behaviour of the House Sparrow, European Greenfinch, and European Goldfinch at MWA is proposed to investigate the dietary overlap and foods of these species. Because they are not native species, crop and gut contents may be obtained to accurately measure the types and relative amounts of seed taken. Coupled with data on flock sizes, this will allow food consumption rates to be estimated. Sample counts of seed availability will provide estimates of the seed crop available to the birds, and hence of the proportion consumed by each species. It is also desirable to investigate food sources and breeding sites during the spring and summer, with the expectation that this will lead to management recommendations for controlling the populations of these three species in the general area should this be necessary. A three-year university study to parallel Task 3.3.2 will require a student stipend (\$20,000 pa) plus costs for travel (4,000 km/pa @ \$0.50/km) at \$2,000 pa, and equipment (hide, spotting scope, tripod) at \$3,000.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
26.0	23.0	23.0			72.0

## 2.5 Monitor and Control Human Disturbance at Murtcaim and Swan Island

The Murtcaim Wildlife Area Management Committee (MWAMC) controls access to the Murtcaim Wildlife Area to protect the many values

of the area, including Orange-bellied Parrots, from being disturbed by people visiting the area. The cost of this security and monitoring will be met by Melbourne Water. At Swan Island permits are required before access for bird-watching purposes. Permits are issued by NRE and enforced by the Department of Defence (DD). Public education and information about the species is discussed in Tasks 3.6.1 and 3.6.5.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
6.0	6.0	6.0	6.0	6.0	30.0

## 2.6 Predator and Pest Control at Murtcaim, Pt Wilson, Lake Connewarre and Swan Bay

The control of introduced predators and rabbits is needed at Point Wilson, Murtcaim, Lake Connewarre, Swan Bay and Swan Island to increase the carrying capacity of habitat, and the probability of survival of Orange-bellied Parrots wintering in these areas. Foxes are known to have killed Orange-bellied Parrots at Murtcaim, and are common at Lake Connewarre. Intensive fox control programs are required at these two sites, and feral cat control is required at Swan Island. Responsible cat ownership is encouraged in public education programs conducted by local government and NRE. The recommendations for pest control at Swan Island and Lake Connewarre are in management plans for these reserves, and need to be kept under review.

The Department of Defence is implementing an Operational Environmental Management Plan for the ECAC facility at Point Wilson, with the help of an environmental manager who is involved in the environmental aspects of the Construction Environmental Management Plan. An ECAC environmental code of practice, as part of the conditions of employment at the site, and representation on the MWAMC with neighbouring land managers are some of the initiatives planned to benefit the Orange-bellied Parrot recovery as recommended by the Commission of Inquiry.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
19.0	19.0	19.0	19.0	19.0	95.0

## 2.7 Habitat Protection and Food Supply at Carpenter Rocks

Orange-bellied Parrots have been recorded at Carpenter Rocks more often than at any other site in South Australia in recent times (Gibbons 1984). The nature of the habitat at this site is most recently described by Casperson (1995). Experimental

manipulation of the strandline and sowing seeds has shown the potential to augment the supply of Sea Rocket (*Cakile maritima*), a food of the Orange-bellied Parrot. This work will be continued, as necessary, in years when the natural growth of *C. maritima* is minimal due to storms or other conditions. In future, this action may make the site a suitable place for releasing captive-bred birds.

Management and control of important Orange-bellied Parrot habitat is under the Carpenter Rocks Site Management Plan (Owers 1994), and will be maintained by co-operation with the Port MacDonnell Council and the community.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
3.0	3.0	3.0	3.0	3.0	15.0

## 2.8 Maintain Feral Predator Control at Kingston and Other Known Feeding Sites

Casperson (1995) describes the known feeding sites of Orange-bellied Parrots in South Australia. Trapping for feral cats was done by volunteers in May 1996 at the feeding and roosting sites used by the birds at Carpenter Rocks. A site at Kingston, because of its proximity to a rubbish dump, has a high feral cat population, and, therefore, is a high risk to birds using the area. Feral cat monitoring and trapping has been, and will continue to be, done by volunteers belonging to Friends of Parks groups at this and other reserves (such as *The Tattler* No. 7, ENR), with the support of local government and ENR as required. Extensive fox-baiting programs were conducted in autumn and spring in south-eastern South Australia during 1996 (T Owers *pers comm*), and will continue throughout the life of this Plan. This will also help to protect birds at feeding and roosting sites, and may also protect released captive-bred birds in the future.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
9.5	9.5	9.5	9.5	9.5	47.5

## 2.9 Maintain Policy on Recreational Vehicle Access to Known Habitats and Feeding Areas

As a result of management policy on Coorong ocean beaches (such as ENR, *The Tattler* No. 7), known Orange-bellied Parrot feeding sites in South Australia are less accessible to, and less able to be disturbed by, recreational off-road vehicles. This Recovery Plan supports ENR and local government in continuing to co-operate on managing access to best protect coastal values on the Coorong.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
2.0	2.0	2.0	2.0	2.0	10.0

**2.10 Maintain Food Supplies at Breeding Sites with Appropriate Moorland Fire Regimes and Manage Migratory Habitats in Tasmania**

Appropriate fire regimes are essential to maintain food plant requirements in the breeding habitat at Melaleuca and Birchs Inlet. Planned patch burning by PWS will be done when the birds are absent between April and September every year. All habitat burning is designed to minimise any chance of escape, and natural boundaries are used where possible. Feeding habitat at Birchs Inlet was burned in September 1995, and burns A to E should be attempted in 1999 and 2000 at Melaleuca (Marsden-Smedley 1993). In 1994, a botanical survey of feeding habitat at Birchs Inlet (Askey-Doran 1995) recommended the preparation of a long-term habitat monitoring strategy, or regular long-term monitoring (3.3.3). In the Melaleuca Valley small annual asset-protection burns (25-50 hectares) may be required in addition to those recommended for habitat maintenance (Marsden-Smedley 1993). Burning regimes will be carried out in accordance with the Melaleuca-South-west Cape Fire Management Plan (1997), and will cost \$6,250 annually. Teams of 4-5 people will be required on site at each location for up to three days.

As part of World Heritage Area (WHA) weed control programs the PWS will be undertaking eradication and monitoring of the invasive weed, Marram Grass (*Aminophila arenaria*) throughout coastal South-west Tasmania. This will protect important mid-migration feeding areas. In addition, PWS will undertake a review of land management practices on Crown Lands throughout the migratory range, with the view to ensuring that the species' habitat is protected and enhanced. This particularly relates to removal or restriction of grazing leases along the north-west coast and off-shore islands.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
36.3	36.3	36.3	36.3	36.3	181.5

**2.11 Control Feral Cats in Migratory Habitat on King Island**

From 1992-1995 feral cats were trapped from autumn to winter around a feeding site for migrating Orange-bellied Parrots in the Lavinia Nature Reserve, King Island. With supplementary funding

provided by the Feral Pests Program of Environment Australia (EA), a local contractor was employed to perform the work and the results were reported annually to the Recovery Team. Since the closure of the Naracoopa rubbish tip in 1995, cat numbers have reduced dramatically in the area, and therefore only low level trapping is required to control and monitor numbers. Funding is sought to purchase, maintain and operate traps. Should a licence be granted, Australian Titanium Minerals Ltd (ATM), as part of their proposal to mine mineral sands adjacent to Lavinia Nature Reserve, have undertaken to have a 'no cats on site' policy, secure all refuse and conduct cat trapping throughout the course of the mining operations. This in-kind support is estimated to be \$5,000 pa.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
7.0	7.0	7.0	7.0	7.0	35.0

**2.12 Provide and Monitor Nest Boxes and Band Juveniles in Breeding Range**

Since 1992 wild Orange-bellied Parrots have successfully bred in artificial nests at Melaleuca, and increased the productivity per pair. The design of the nests has been improved and they are now installed at Birchs Inlet and Towterer Creek. At Melaleuca, pairs using boxes produce 30-50 nestlings each year which are banded prior to fledging. Colour banding of juvenile Orange-bellied Parrots (1.7.4) is necessary to recognise individuals and cohorts in the wild population, and enables monitoring of demographic trends. A nest box that will last for up to four years costs approximately \$60. It is planned to install and service up to 100 nest boxes at Melaleuca and 30 nesting boxes at each of the other two locations during the next five years. Equipment and materials needed to maintain them (climbing gear, water proofing and tools) is \$750 pa. Travel (sometimes using 1 hr (\$1,200) of helicopter time) and allowances for PWS staff to install and revisit nests costs \$2,500 pa. Teams of 2-4 experienced volunteers assist this program.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
27.1	20.4	19.9	19.9	27.1	114.4

**2.13 Management of Aircraft and Other Human Activities at Melaleuca**

Melaleuca is the central arrival and departure point each year for several thousand bushwalkers and day visitors to the South-west National Park Wilderness World Heritage Area. Access is gained by boat,

walking track or light aircraft. Over recent years, visitor numbers have increased steadily and use of the landing strip will significantly increase the frequency of aircraft traffic and numbers of people in the area. A study is required to quantify the tolerance levels of Orange-bellied Parrots to this increased activity at nest sites, feeding areas and roost sites. A comprehensive study of noise levels and direct disturbance will be undertaken to provide guidelines for future development and management of the area. This project will be carried out in close association with the Melaleuca Advisory Committee, PWS, WHA managers, tourism operators and aircraft companies. A consultant will investigate all sources of disturbance within the Melaleuca area, and will quantify the tolerance and behaviour of birds to a variety of stimuli. The consultant will also provide guidelines on the effect of any planned extensions to the airstrip and limitations on development. PWS staff and volunteers will assist with data gathering and monitor the effectiveness of prescriptions over the life of the Plan.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
19.0	2.0	2.0	2.0	2.0	27.0

### 3. Monitoring Habitat and Food

#### 3.1 Survey of Saltmarsh in Orange-Bellied Parrot Wintering Range

Surveys of saltmarsh from the mouth of the Murray River to the Gippsland Lakes using satellite TM imagery and airborne multi-spectral imagery are needed to measure saltmarsh availability and quality. This method has been used to accurately classify and map saltmarsh plant communities at Point Wilson and Murtcaim (Race 1994a, 1994b). It is desirable to use this technique to survey all saltmarshes within the known mainland range of the Orange-bellied Parrot in 1998 and 1999. Analysis of satellite imagery will give a broad overview of the distribution and diversity of saltmarsh communities along the entire mainland coast from the mouth of the Murray River to the Gippsland Lakes. Airborne multi-spectral imagery will then be used to investigate in more detail the distribution and extent of significant saltmarsh communities for the Orange-bellied Parrot. Accurate knowledge of the distribution, quality and area of winter habitat will allow planning for habitat management, identification of potential release sites, and assist in winter population counts and locating areas to search for wintering birds outside the currently known sites. Areas of potentially useful habitat will be surveyed using these

techniques at least once every 10 years to assess their likely role in the recovery program should primary habitat be alienated or over-utilised. (Purchase of satellite images \$15,000; airborne scanner flights \$3,000; image processing \$15,000; graphics and consumables \$2,000; and travel \$2,000).

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
21.5	15.5				37.0

#### 3.2 Observe Orange-Bellied Parrots Using Critical Winter Microhabitats

As part of a study of population limiting factors, an investigation of how the species uses the habitat at the important wintering sites (Murtcaim, Lake Connewarre, Swan Island and, possibly, Carpenter Rocks) is needed. The aim is to accurately quantify temporal variation in dietary preferences, feeding and drinking behaviour, roosting requirements, etc., and to investigate any behavioural differences between sex and age classes. A minimum of two winter-spring periods is required for data collection. Direct observation, where possible from a hide, will be the main activity. Radio-tracking may be used to locate birds for observation and to track them to roosting sites. (Student stipend \$20,000 pa for 3 years, equipment \$3,000 and travel \$3,000 pa for 2 years).

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
29.0	24.0	21.0			74.0

#### 3.3 Model Breeding Habitat and Assess Quality and Quantity of Food Available

Botanical surveys are needed to monitor the long-term effects of fire management on food plant diversity and other moorland values at Melaleuca and Birchs Inlet (3.2.10). Vegetation quadrats set up at Birchs Inlet in 1994 will be resurveyed in 1999. PWS will hire a consultant botanist to measure qualitative and quantitative vegetation changes resulting from the patch burning program (\$3,000). Similar monitoring studies of the effects of fire on food plants will be undertaken in 2001 at Melaleuca (\$4,000) and long-term habitat monitoring strategies will be prepared (Askey-Doran 1995).

To better define the potential carrying capacity of both occupied and unoccupied breeding habitat, a CORTEX model of habitat will be prepared from data available to PWS (Askey-Doran (1995), TASFORHAB plots and other sources) and new data from habitat surveys and searches. High resolution data from Landsat imagery will be

incorporated into the model to produce a map showing the quality and quantity of breeding habitat within the breeding range. A consultant will be employed to prepare the habitat model and conduct some ground truthing surveys.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
11.0	11.0	4.0	5.0		31.0

### 3.4 Habitat Management and Population Monitoring at King Island

Non-resident PWS staff and volunteers are required to monitor the use of Orange-bellied Parrot habitat at Lavinia Nature Reserve and other sites on King Island. In addition to the control of feral cats on King Island (3.2.11), local PWS staff will undertake various tasks to protect habitat from disturbance and wildfire in accord with the management plan (PWS 1998). Should a licence be granted, ATM as part of their proposal to mine mineral sands adjacent to Lavinia Nature Reserve, have undertaken to form a 1.5 km Mining Exclusion Zone (MEZ) around Orange-bellied Parrot feeding areas. The MEZ will incorporate all the known and potential roosting habitats, and will be further enhanced by a 1 km mining restriction zone from the boundary of the MEZ while the parrots are on the island (March-June). Funding from ATM will be sought to monitor mining operations and the impacts on parrots.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
8.3	8.3	8.3	8.3	8.3	41.5

## 4. Monitoring Population

### 4.1 Census of Wild Population in Wintering Range

Birds Australia (BA) employs staff to co-ordinate the annual winter surveys and census the wild population with volunteer assistance. In 1996 the Recovery Team suggested that BIOCLIM or broader search areas in South Australia may help to locate more birds in winter (1.7.3). Surveys include an annual count of the winter population, monitoring of the main wintering habitats, and searching for colour-banded birds and additional wintering sites. They also provide information on the daily and seasonal use of habitats, identify potential threats and competition, and other general information about Orange-bellied Parrots and their winter habitat. On alternate years searches cost more because they focus on wintering areas in remote

parts of South Australia, Tasmania and Victoria. The average annual costs for BA to employ a co-ordinator to lead the Orange-bellied Parrot winter survey are salary and on-costs (29%) (\$16,500), office expenses (\$4,000), travel and field costs (\$3,500), report production (\$650), and supervision (\$1,200). State conservation agencies provide vehicles and staff to participate and assist in the co-ordination of field work. Costs included are volunteers' travel, vehicle running costs and equipment (depreciation), staff allowances, and vehicle running costs of State agencies (such as NRE).

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
60.2	57.9	63.1	60.5	66.3	308.0

### 4.2 Monitoring Breeding Population

Since 1992 over 170 volunteers have assisted PWS with observations and daily records of Orange-bellied Parrots at Melaleuca between November and March. Volunteers are provided with a return flight from Hobart to Melaleuca, a food subsidy and accommodation. From the observation hide they record numbers of Orange-bellied Parrot adults, juveniles and individually colour-banded birds. The information from banded wild or captive-bred birds is particularly valuable for PVA (3.4.3). The volunteers provide the daily food supplement for the birds, interpretation for visitors, and also monitor competition from starlings for nest sites, the presence of feral cats, and human traffic levels and disturbance (3.2.13). Estimated volunteer time and expense are equivalent to \$24,000 pa. Seed supplement for Melaleuca birds is \$500 pa. Volunteer transport (16 flights @ \$350 each) is \$5,600 pa, and food subsidy (\$100 per person for 2 weeks) is \$2,800 pa. Preparing and analysing the results of monitoring for use by the Recovery Team and for publication will cost \$4,000 pa.

Surveys of the entire breeding range will be conducted in Years 1 and 5 to determine population changes outside Melaleuca. This will involve up to 15 teams of two volunteers and/or PWS staff searching key areas throughout south-west Tasmania over a three day period in December. Funding is required to charter planes, vessels and helicopters to access isolated areas (\$10,000 pa), and to provide basic safety equipment (\$3,000 pa). The cost in the first year may be substantially less, as it is planned to share transport costs with the WHA/Surf Riders Association beach clean up project.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
75.8	51.3	51.3	51.3	75.8	305.5

## 5. Captive Breeding and Release

The Captive Management Group (CMG) manages the implementation of this action for the Recovery Team. The CMG was formed to enable the management of all captive birds in the program as one population after the two facilities at Hobart and Healesville began producing birds. The CMG liaises closely with field managers and researchers as required and reports annually to the Recovery Team. The captive breeding program is described in Section 1.7.5.

### 5.1 Husbandry of Captive Population

Maintenance and management of the captive population is essential for research and trials, and for implementation of the Plan. The CMG aims to maintain up to 40 pairs of Orange-bellied Parrots in the two facilities, and to produce 30 birds annually for release. It will also undertake other tasks to increase the security of the captive population and to promote the survival of the species.

The CMG will experiment with cross-fostering, and nest box and aviary designs that may improve the productivity of the captive-bred stock in both aviary facilities. The breeding stock will be managed to maintain a balance between the reproductive and genetic contributions of individuals to the captive population. Protocols for handling, quarantine or screening of birds to be transferred between facilities and to or from the wild population will be developed by the CMG with advice on veterinary aspects and genetics. Veterinary supervision and post-mortem services will be improved by the recruitment of specialists, and specialist aviculturists, to assist the CMG in the captive breeding program. Husbandry of the captive breeding stock will be integrated with all other tasks detailed in this action.

The CMG is responsible for maintaining standardised collection, storage and retrieval of data for breeding, health, genetics and other aspects of managing the captive population, and to provide information for PVA. A studbook and species management plan for the captive population of Orange-bellied Parrot will be established and maintained by Healesville Sanctuary using existing ISIS computer software.

In 1998, the CMG will compile a husbandry manual for the maintenance of the Orange-bellied Parrot in captivity by pooling and recording the information and experience gained during the recovery (\$500). Contingency plans containing possible strategies for terminating the captive population, or coping with the demise of the wild population will also be prepared before 2000.

The cost of this task includes the cost of food for the captive birds, staff time, veterinary supplies and materials for aviary maintenance at both the Healesville and Hobart facilities.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
31.5	32.5	32.5	32.5	33.5	162.5

### 5.2 Releasing Captive-bred Birds into the Wild

The release program will operate annually during the term of this Plan. It is planned to release 20-30 captive-bred birds in alternate locations each year. Attaching radio transmitters to the birds may be the best way of monitoring their survival and movements after release. Radio telemetry will also be useful for other tasks in this Plan. Radio telemetry trials were conducted in preparation for a winter release of Orange-bellied Parrots at Murtcaim in 1996 (Menkhorst 1997). Elegant Parrots (*Neophema elegans*), an analogous species in captivity at Healesville Sanctuary, were used to successfully trial the attachment of radio transmitters.

The release program is described in Section 1.7.5. Juveniles have been released in South-west Tasmania at Melaleuca and Birchs Inlet during the breeding season (Brown *et al.* 1995). In the first winter release at Murtcaim a portable release aviary was used successfully to hold birds as described in Menkhorst (1997). Birds were acclimatised for up to four weeks in a release aviary and are monitored continuously. Release costs include the transport and erection of an aviary at a release site in Victoria or South Australia (\$1,500) and at an established release site in Tasmania (\$1,500). Birds will be released during winter on mainland Australia (May-July) and in Tasmania in October.

A release in Tasmania will require the continuous presence of experienced staff prior to and following release, and then volunteers until the birds depart. At sites such as Birchs Inlet, where the species formerly bred, some birds will be retained in the aviary to breed and then be released when breeding has begun in order to encourage them to remain in the release area. Release costs include regular travel by boat or

aeroplane to the sites for 2 people for visits or staff changeovers (\$4,400), food and allowances for 2 people @ \$100/week (\$4,000), and the cost of feeding (\$1,000) and radio-tracking equipment (\$3,000). Total annual cost of release in Tasmania will be \$13,900.

Releases at sites in Victoria and South Australia will also include radio tracking of birds from the ground using hand-held radio antennae. Travel costs for specialist radio-tracking staff manning the release sites are needed (vehicle running and allowances up to \$1,000/day), with additional costs if tracking from aircraft (hire of aircraft \$220/hr) using an experienced air-radio tracker (at a cost of \$100/hr) for up to one day is required. Total costs for tracking released birds at each site will be \$7,000, plus the cost of radio transmitters (\$500 each), erection of the release aviary (\$1,500), and husbandry costs (\$1,000). The annual cost of these releases will be \$13,500 and will involve some volunteer assistance. Future releases at other sites in each State are planned, but are dependant on the success of captive breeding.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
55.4	35.4	55.4	35.4	55.4	237.0

### 5.3 Define Standards of Health in Captive and Wild Birds

The CMG recommends that blood be collected from some captive and wild birds for analysis of serum components. Profiles of normal values from healthy birds would then be available to compare with those of sick birds (such as Melrose *et al.* 1995). Such a reference would quickly provide a diagnostic tool for husbanding both wild and captive-birds and improve the efficiency of treating ailing birds.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
0.5					0.5

### 5.4 Monitor Genetic Heterozygosity

Early concern for accumulating inbreeding depression in the captive population of Orange-bellied Parrots led to the identification and screening of alleles from the DNA in the blood of individuals. This work estimates the allelic heterozygosity in the captive population (1.7.5), and provides a basis for future pairing of adults to avoid inbreeding. A method using only feathers instead of blood is being developed.

The range of alleles found in the captive population was less than that of the wild population. To remedy

this problem the CMG recommends monitoring and controlling allelic heterozygosity in the captive population by adding founders from the wild population (with different alleles). In 1996, the whole captive population was screened for allelic variation.

Samples are processed at the School of Genetics and Human Variation, La Trobe University. Updates on heterozygosity will be provided to the CMG. The annual cost of this service (\$100/sample) is \$3,000.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
3.0	3.0	3.0	3.0	3.0	15.0

### 5.5 Monitor and Manage PCD in Captive Population

At present captive-bred Orange-bellied Parrots are tested for Psittacine Circoviral Disease (PCD) (1.7.7) prior to their release into the wild population so that only birds that have developed antibodies to the disease are released. Tests are done at the Department of Animal Health, University of Sydney (\$1,000 pa). This cost may be unnecessary once a vaccine has been developed.

A vaccine for PCD can be developed in two years by employing a research assistant at the Department of Animal Health, University of Sydney (salary Year 1 \$38,000, Year 2 \$39,500, plus on-costs (30%) and operational costs). The operational costs include travel (3,100 km @ 0.59/km, \$1,829); glassware, chemicals, gamma irradiation (\$4,300); 400 HA/HI tests @ \$20 each (\$8,000); and virology materials including foetal calf serum, electron microscopy and PCR materials (\$4,100). Parrot food will be supplied by the sponsors. The production of a vaccine could assist in conserving other species of parrots and benefit parrot aviculture globally. The Recovery Team should help to identify private sponsors to develop a commercially available product.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
71.0	72.0	1.0	1.0	1.0	146.0

## 6. Public Information and Education

Community education, awareness and the support of volunteers are important components of this Recovery Plan. The Orange-bellied Parrot has a high public profile and their survival is a prominent issue for industrial and urban developments close to key wintering habitats. Particularly in Victoria, but throughout its range, significant social and economic issues are associated with the conservation of the

Orange-bellied Parrot, mostly related to public access to, and future development of, habitat adjacent to densely populated coastal settlements. Volunteers are needed to participate in tasks essential to the recovery of the Orange-bellied Parrot. Three methods will be used to inform and involve the general community and volunteers. Educational material to be incorporated into school kits will be prepared by the staff of BA, WWF, PWS, NRE and ENR. The Orange-bellied Parrot colour brochure, which was updated in 1996, will be circulated to all stakeholders and interest groups. A community and public awareness program will be used to report progress of this Recovery Plan via a variety of media, such as news items, documentaries and publications. A 'Friends of the Orange-bellied Parrot' group will be supported as a focus for public participation in the recovery of the species.

### 6.1 Fact Sheet on Orange-Bellied Parrot Recovery Process

A fact sheet is the first of three community education tasks that will provide the community with up-to-date information on the recovery program. This will be produced by the Orange-bellied Parrot co-ordinator, in co-operation with WWF and scientific staff in the conservation agencies. It will be mailed from organisations within each State as an insert for the *Orange-bellied Parrot Newsletter* (Task 3.6.3) and the newsletters of existing groups (such as BA's *Threatened Bird Network Newsletter*). It will include a clip coupon for joining the Orange-bellied Parrot Friends group. The publication will be an A4 double sided sheet, full colour one side, black or one colour on white on the other, with images and design assumed donated. Cost includes printing and postage for 30,000 copies.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
15.0		10.0		10.0	35.0

### 6.2 Portable Interpretive Displays on Orange-Bellied Parrot

Public display material is needed to complement the mailed material for public education. High public and community interest in the recovery of the Orange-bellied Parrot has demonstrated the need to construct portable Orange-bellied Parrot interpretive displays for use in zoos, libraries and schools in each range State, and for use in special events (such as World Environment Day), and to support the work of the Recovery Co-ordinator. The displays (one in

each State) will be made using funds from WWF sponsorships.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
2.0					2.0

### 6.3 Orange-bellied Parrot Volunteer Newsletter

A quarterly newsletter is necessary to support networking and long-standing volunteers, and to maintain the interest of the general public in the recovery of the Orange-bellied Parrot. It will be written, designed and produced by the Orange-bellied Parrot co-ordinator, in co-operation with WWF and scientific staff in the conservation agencies, and mailed to groups as well as members of the Orange-bellied Parrot Friends group. Costs for printing and postage of 2,000 copies, 4 x A3 double-sided folded down to A4, 2 colours on white, or black and white are as follows.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
1.0	1.0	1.0	1.0	1.0	5.0

### 6.4 Prepare Media Strategy

The Orange-bellied Parrot attracts positive media interest. An integrated media strategy is needed to report publicly on progress with actions such as winter census, breeding, releases or other events. A strategy will be developed for each State. Events in one State will be passed on to other States for local adaptation. Scientists, or other 'on camera' persons, will be nominated in each State to do this, and good images will be made available for use in each State. This task is to plan and co-ordinate and carries negligible costs.

### 6.5 Orange-Bellied Parrot Recovery Support Group

It is necessary to support and maintain an Orange-bellied Parrot group which could span the three range States. There is a growing interest in the community and regional newspapers in long-term recovery action. Starting and servicing the group will require additional time from the WWF and the recovery co-ordinator. (Cost of WWF staff time split between the three range States).

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
5.0	5.0	5.0	5.0	5.0	25.0

## REFERENCES

- A.G.C.S.A.** (Australian Golf Course Superintendents Association) 1996. Claude Crockford Environmental Award *Golf and Sports Turf Australia* (August): 6-8.
- Anon** 1996. Commonwealth Commission of Inquiry East Coast Armaments Complex Point Wilson, Victoria. Report Volume 1 Findings and Recommendations. Jan 1996 AGPS.
- Anon** 1997. Mineral Extraction-King Island, Development Proposal and Environmental Management Plan. Prepared by Stephenson EMF for Australian Titanium Minerals Ltd.
- Australian and New Zealand Environment and Conservation Council 1995 List of Australian endangered vertebrate fauna. ANCA, Canberra.
- Askey-Doran, M.J.** 1995. Orange-bellied Parrot Recovery Plan: Distribution and abundance of food plants at Birchs Inlet, western Tasmania. DELM, Hobart. pp.53.
- Brown, P.B.** 1988. A captive breeding program for Orange-bellied Parrots. *Aust. Aviculture* 42 (7): 165-175.
- Brown, P.B., Holdsworth, M., Menkhorst, P. and Casperson, K.** 1997. Review of the recovery process for the orange-bellied parrot. Unpublished report to ANCA. PWS, Hobart.
- Brown, P.B., Holdsworth, M.C. and Rounsevell, D.E.** 1995. Captive breeding and release as a means of increasing the Orange-bellied Parrot population in the wild. In: *Reintroduction Biology of Australian and New Zealand Fauna*, (M. Serena, ed ) Surrey Beatty, Chipping Norton.
- Brown, P.B., Wilson, R.I., Loyn, R.H. and Murray N.** 1985. The Orange-bellied Parrot-RAOU Conservation Statement. *RAOU Report* 14. RAOU, Melbourne.
- Brown, P.B. and Wilson, R.I.** 1980. A survey of the Orange-bellied Parrot in Tasmania, Victoria and South Australia. A report for World Wildlife Fund (Australia). NPWS, Hobart.
- Brown, P.B. and Wilson, R.I.** 1981. A survey of the Orange-bellied Parrot in Tasmania, Victoria and South Australia. A report for World Wildlife Fund (Australia). NPWS, Hobart.
- Brown, P.B. and Wilson, R.I.** 1982. The Orange-bellied Parrot. In: *Species at Risk: Research in Australia* (eds R.H. Groves and W.D.L. Ride) pp. 107-115. Australian Academy of Science, Canberra.
- Brown, P.B. and Wilson, R.I.** 1984. Orange-bellied Parrot Recovery Plan-Management Recommendations to the Governments of Tasmania, Victoria and South Australia. NPWS, Hobart.
- Burgman, M.A., Ferson, S. and Akcakaya, H.R.** 1993. Risk assessment in Conservation Biology. Chapman & Hall, London.
- Carr, G.W.** 1982. Vegetation. In: *The Hydrology of The Spit, Point Wilson*. (Eds.Kinhill Pty Ltd ) Report prepared for ICI Australia.
- Carr, G.W.** 1987. Report on the biology, ecology and management of the Orange-bellied Parrot food plant, *Chenopodium glaucum* (glaucous goosefoot), at MMBW Farm, Werribee, Victoria. Ecological Horticulture Pty Ltd, Melbourne.
- Carr, G.W. and Kinhill Planners** 1979. Survey of Victorian coastal saltmarsh in relation to the habitat of the Orange-bellied Parrot. ICI Australia, Melbourne.
- Carr, G.W., Race, G.J. and McMahon, A.R.G.** 1991. Sheep grazing and the saltmarsh habitat of the Orange-bellied Parrot (*Neophema chrysogaster*) at Murtcaim Wildlife Area and Point Wilson, Victoria. Ecological

Horticulture Pty Ltd. Report prepared for Murtcaim Wildlife Area Committee of Management. pp. 28 plus appendix.

**Carr, G.W., Schulz, M. Bedggood, S.E. and Peake, P.** 1994. Point Henry Flora and Fauna: Management Study. Report prepared for Alcoa Australia Ltd.

**Casperson, K.D.** 1995. Orange-bellied Parrot (*Neophema chrysogaster*) habitats in south east South Australia. ENR, Adelaide pp92.

**Christidis, L. and Boles, W.** 1994. The Taxonomy and Species of Birds of Australia and its Territories. *RAOU Monograph 2* pp112.

**Dept. of Conservation and Natural Resources** 1993. Lake Connearre State Game Reserve Management Plan. DCNR, Geelong, Victoria.

**Dept. of Conservation and Environment** 1991. Jack Smith Lake State Game Reserve Management Plan. DCE, Yarram, Victoria.

**Edgar, B.** 1991. Swan Bay Marine and Wildlife Reserves Draft Management Plan. DCE, Geelong.

**Edgar, B. and Menkhorst, P.** 1993. Orange-bellied Parrot, *Neophema chrysogaster*, Action Statement No 43. DCNR, Melbourne. pp8.

**Forshaw, J.M. and Cooper, W.T.** 1981. Australian Parrots, 2nd Edition. Lansdowne, Melbourne.

**Garnett, S.** 1992. The Action Plan for Australian Birds. ANPWS, Canberra.

**Gibbons, P.** 1984. The Orange-bellied Parrot: an assessment of the habitat of the Orange-bellied Parrot (*Neophema chrysogaster*) in the south-east of South Australia. NPWS, Adelaide.

**Heathcote, J. and Maroske, S.** 1996. Drifting sand and Marram grass on the south-west coast of Victoria in the last century. *Victorian Nat.* 113 (1):10-15.

**Hewish, M. and Starks, J.** 1988. Orange-bellied Parrots at Lake Connearre, Victoria. *Geelong Nat.* 24: 100-128.

**Higgins, P.J. and Davies, S.J.J.F.** In press. Handbook of Australian, New Zealand and Antarctic Birds vol. 4. Oxford University Press South Melbourne.

**Hill, R.** 1995. The Orange-bellied Parrot, *Neophema chrysogaster*, and shorebirds at Point Wilson: a summary of existing knowledge and a report on field studies in 1993. *RAOU Report Series* 95 Melbourne, pp33.

**Holdsworth, M.** 1997. Orange-bellied parrot 1996-97 interim summer population observations and Birchs Inlet release. Unpublished report to the OBP Recovery Team.

**Holdsworth, M., Brown, P.B., Menkhorst, P. and Casperson, K.D.** 1997. Review of the recovery process for the orange-bellied parrot. Internal report prepared for ANCA.

**Holdsworth, M., Wilkinson, E., Connor, B., and McPherson, G.** (In prep) Population estimates using mark recapture models of the Orange-bellied Parrot at Melaleuca, Tasmania.

**IUCN** 1994. International Union for the Conservation of Nature Red List Categories. Species Survival Commission. Gland, Switzerland.

**Jarman, H.** 1965. The Orange-breasted Parrot. *Aust. Bird Watcher* 2: 155-167.

**Jessop, A. and Reid, T.** 1986. Winter surveys of the Orange-bellied Parrot *Neophema chrysogaster* in Victoria, 1984 and 1985. *RAOU Report* 19.

- Lane, B.A., Carr, G.W., Bezurjen, M.R. and McMahon, A.R.G.** 1997. The flora and fauna and potential impacts of the proposed ATM Ltd mine lease area, King Island Tasmania. Ecology Australia Pty Ltd report for Stephenson EMF Consultants. Fairfield, Victoria.
- Lane, B.A., Loyn, R.H. and Kinhill Planners** 1980. Avifauna study. ICI Point Wilson Development Progress Report, June-Nov 1979.
- Lane, B.A., Schulz, M. and Wood, K.L.** 1984. Birds of Port Phillip Bay. Coastal Unit Technical Report No 1. Ministry for Planning and Environment, Melbourne.
- Lane, B.A. and Tweedy, J.** 1994. Hydrological management plan for Cheetham Saltworks, Laverton. WBM Oceanics report to Melbourne Parks & Waterways.
- Lewitska, F.** 1980. Breeding of the orange-bellied parrot. *Bird Keeping in Australia* April- May pp47-8, 58-60.
- Loyn, R.H. and Chandler, C.** 1978. Avifauna study, ICI Point Wilson Development. ICI Australia, Melbourne.
- Loyn, R.H.** 1982. Orange-bellied Parrots, ideas for management of a wild populations. In: *Rare, Endangered and Limited Gene Pool Species in Australia* (ed C.B. Banks. pp. 16-21 Australian Society of Zookeepers, Melbourne.
- Loyn, R.H. and Kinhill Planners** 1980. Historical records of Orange-bellied Parrots. ICI Australia, Melbourne.
- Loyn, R.H., Lane, B.A., Chandler, C. and Carr, G.W.** 1986. Ecology of Orange-bellied Parrots *Neophema chrysogaster* at their main remnant wintering site. *Emu* 86: 195-206.
- Marsden-Smedley, J.** 1993. Orange-bellied Parrot Recovery Plan: Operational prescriptions for habitat management burns. Report to the DELM, Hobart. pp33.
- McCarthy, M.A., Brown, P.B., Holdsworth, M., Menkhorst, P.W. and Starks, J. (In prep) Population viability analysis of the orange-bellied parrot.
- McGill, A.R.** 1960. Parrots of the genus *Neophema* in New South Wales. *Emu* 60: 40-61.
- McMahon, A.R.G. and Carr, G.W.** 1988. Report on experimental field trials aimed at promoting the standing crop of *Chenopodium glaucum*-food plant of the Orange-bellied Parrot, at the MMBW Farm, Werribee, Victoria. Ecological Horticulture Pty Ltd, Melbourne.
- McMahon, A.R.G. Race, G.J. and Carr, G.W.** 1994. Vegetation survey and remote sensing of Victorian saltmarshes in relation to Orange-bellied Parrot *Neophema chrysogaster* habitat. Ecology Australia Pty Ltd pp. 98 plus appendix. Report to DCNR, Melbourne.
- Melrose, W.D., Brown, P.B., Holdsworth, M.C. and Bryant, S.L.** 1995. Haematology and Red Cell Enzymes of the Australian Orange-bellied Parrot, *Neophema chrysogaster*. *Comparative Haematology International* 5: 7-9.
- Menkhorst, P., Loyn, R.H. and Brown, P.B.** 1990. Management of the Orange-bellied Parrot. In: *Management and Conservation of Small Populations* (eds Clark T.W. & Seebeck J.H.), Chicago Zoological Society, Chicago, pp.239-252.
- Menkhorst, P.** 1996. Australia's wetland parrot. *Wingspan* 6 (1): 10-13.
- Menkhorst, P.** 1997. Trial release of captive-bred Orange-bellied Parrots in Victoria, July-October 1996. *Eclectus* 3:17-21.

- National Parks and Wildlife Service** 1986. Canunda National Park Draft Management Plan. Dept. of Environment and Planning South Australia.
- National Parks and Wildlife Service** 1989. Coorong National Park and Coorong Game Reserve Draft Management Plan. Dept. of Environment and Planning South Australia.
- Owers, T.** 1994. Orange Bellied Parrot: Carpenter Rocks Site Management Plan. ENR, Adelaide pp24.
- Point Lillias Project Unit** 1995. Point Lillias port and bulk liquid chemical storage facility environmental effects statement. Point Lillias Project Unit, Department of Business and Employment Industry Services, Melbourne. 3 volumes and 19 volumes of appendices.
- PWS** 1997. Melaleuca-South West Cape fire management plan. PWS, Hobart.
- PWS** 1998. Lavinia Nature Reserve draft management plan. PWS, Hobart.
- Race, G.J.** 1994a. The application of Landsat TM image data to Orange-bellied Parrot habitat survey. In: Proceedings of 7th Australasian Remote Sensing Conference, Melbourne, March 1994. Remote Sensing and Photogrammetry Association Australia Ltd pp 779-787.
- Race, G.J.** 1994b. The application of remote sensing techniques to conservation management. In Proceedings of Resource Technology '94: New opportunities, best practice. University of Melbourne.
- Raidal, S.R., Firth G.A. and Cross G.M.** 1993a. Vaccination and challenge studies with psittacine beak and feather disease virus. *Australian Veterinary Journal* 70: 437-441.
- Raidal, S.R., McElnea C.L. and Cross G.M.** 1993b. Seroprevalence of psittacine beak and feather disease in wild psittacine birds in New South Wales. *Australian Veterinary Journal* 70: 137-139.
- Raidal, S.R., Sabine M. and Cross G.M.** 1993c. Laboratory diagnosis of psittacine beak and feather disease by haemagglutination and haemagglutination inhibition. *Australian Veterinary Journal* 70: 133-137.
- Starks, J.** 1988. Orange-bellied Parrot *Neophema chrysogaster* winter surveys in south eastern Australia in 1986 and 1987. *RAOU Report Series* 36. Melbourne.
- Starks, J.** 1992. Winter surveys of the Orange-bellied Parrot *Neophema chrysogaster* in south eastern Australia in 1988 and 1989. *RAOU Report Series* 87.
- Starks, J.** 1993. Winter surveys of the Orange-bellied Parrot, *Neophema chrysogaster*; in south-eastern Australia in 1990 and 1991. *RAOU Report Series* 88.
- Starks, J.** 1994. Winter surveys of the Orange-bellied Parrot, *Neophema chrysogaster*; in south-eastern Australia in 1992. *RAOU Report Series* 89.
- Starks, J.** 1995. Winter surveys of the Orange-bellied Parrot, *Neophema chrysogaster*; in south-eastern Australia in 1993. *RAOU Report Series* 91.
- Starks, J.** 1996. Winter surveys of the Orange-bellied Parrot, *Neophema chrysogaster*; in south-eastern Australia in 1994. *RAOU Report Series* 96.
- Starks, J.** 1997. Winter surveys of the Orange-bellied Parrot, *Neophema chrysogaster*; in south-eastern Australia in 1995. *Birds Australia Report Series* 3.
- Starks, J., Brown P.B., Loyn, R. and Menkhorst, P.** 1992. Twelve years of winter counts of the Orange-bellied Parrot, *Neophema chrysogaster*. *Australian Bird Watcher*, 14: 305-312.
- Stephenson, L.** 1991. The Orange-bellied Parrot Recovery Plan: Management Phase. DPW&H, Tasmania. pp. 54.

**Sutherland, A.** (ed) 1990. Beachport Conservation Park Management Plan. NPWS, DEP, Adelaide.

Parks and Wildlife Service 1996. Preliminary draft Lavinia Nature Reserve Ramsar Site Management Plan. Dept. of Environment and Land Management, Hobart.

**Yugovic, J.Z.** 1984. The Grey Glasswort *Halosarcia halocnemoides* in coastal Victoria and some implications for the Orange-bellied Parrot. *Victorian Nat.* 101: 234-239.

**WHA** 1992. Tasmanian wilderness World Heritage Area management plan 1992. PWS, Tasmania.

**Wylie, S.L. and Pass, D.A.** 1987. Experimental reproduction of Psittacine Beak and Feather Disease-French Molt. *Avian Pathology* 16: 269.



**ORANGE-BELLIED PARROT RECOVERY PLAN 1999-2002**  
Prepared by the **Orange-Bellied Parrot Recovery Team**