Chapter 1    General Introduction

BACKGROUND

The ability to manage threatened parrots is reliant on the capacity to understand those factors influencing population size and stability (Rowley 2002). The ability to measure the abundance of a species and changes over time requires the knowledge of four basic demographic parameters: reproduction, survival, emigration and immigration (e.g. Krebs 1978; Caughley and Sinclair 1994; Nichols et al. 2004). The successful management of animal populations, whether for control of abundant species, sustainable harvest or for conservation of threatened species, relies on an understanding of these parameters (Caughley and Sinclair 1994). These data allow us to determine population levels and trends and thus inform the public, conservation managers and politicians of the conservation measures required to enhance or control a particular species. In the case of threatened species, some degree of knowledge of this basic information is fundamental to threatened species classification systems (e.g. Garnett and Crowley 2000; International Union for the Conservation of Nature 2002). This information, combined with other environmental and biological factors such as geographic range and number of populations (Master 1991), is used to determine the level of threat to a particular species (Regan et al. 2005). Population monitoring underpins the decision-making process for conservation management of all threatened species in Australia and is a central component of species recovery plans (Male 1994).

In some cases the limits on a bird population (i.e. predation, disease, nest competition and food supply etc) occur during breeding (Newton 1998). When this happens conservation measures can be specifically targeted to improve reproductive success (e.g. control of competitors). Knowledge of the productivity of a species over time provides a method to measure the effectiveness of other conservation actions. In some
cases, comprehensive studies of the breeding biology of a species are invaluable to measure the effectiveness of breeding manipulations designed to increase the rate of productivity. A dramatic example of this is the recovery of the Black Robin *Petroica traversi* in the Chatham Islands (NZ) where the knowledge of reproductive success was fundamental to monitoring the effectiveness of conservation measures. From five remaining Black Robins, including only one productive female 'Old Blue', eggs were cross-fostered into the nests of the Chatham Island Warbler *Gerygone albofrontata* and Chatham Island Tit *Petroica macrocephala chathamensis* and nest boxes were used to reduce nest failure (Merton 1992; Butler and Merton 1992). These actions resulted in the successful recovery of the species with a population of more than 200 individuals (Aikman and Miskelly 2004). A thorough knowledge of the reproductive strategy and success of all these species was fundamental to this outcome.

Caughley (1994) identified two alternative approaches to conservation biology—the small-population and declining-population paradigms. The small-population paradigm concerns the effect of smallness (of population size) on the persistence of a population, while the declining-population paradigm concerns the cause/s and cure/s of population smallness. The causes of decline and conservation management of New Zealand’s critically endangered Kakapo *Strigops habroptilus* is a classic example of a declining-population paradigm. The species, once widespread throughout New Zealand (e.g. North, South and Stewart islands), suffered from the full complement of 'the evil quartet' as described by Diamond (1989) of overkill, introduced predators, habitat destruction, and chains of extinction. The Kakapo, a large flightless parrot, was easily hunted firstly by the Maori (Polynesians from c. AD 950) for sustenance and feathers, and later by European settlers (from c. 1843) (Butler 1989). This hunting pressure was exacerbated by the introduction of a range of predators including Kiore *Rattus exulans* (Polynesian Rat) and Kuri *Canis familiaris* (Polynesian Dog) by the Maori. Not to be outdone, Europeans introduced Norway Rat *Rattus norvegicus*, Black
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Rat *R. rattus*, Stoat *Mustela erminea*, Weasel *M. nivalis*, Ferret *M. putorius* and Brush-tailed Possum *Trichosurus vulpecula*, all of which are now known to feed on Kakapo nestlings and eggs (Bulter 1989). The Maori and Europeans embarked on widespread habitat destruction to aid hunting and agriculture, which in turn eventually resulted in isolation of just a few small populations of Kakapo. The species had been extirpated on the North Island by 1927 (Williams 1956) and by the 1970s was restricted to Fiordland (South Island) and Stewart Island (Merton 1985; Butler 1989). By 1977 there were only 167 Kakapo remaining and the population continued to decline to a low of 51 in 1993 (Powlesland *et al.* 2006). While the decline of the species is well known, the solutions were not easily resolved and so conservation efforts, initially, focused on *ex situ* management of the species. By 1992 the New Zealand Department of Conservation had captured the entire known population of Kakapo and relocated them to three small offshore islands (Little Barrier Island, Maud Island and Codfish Island, Powlesland *et al.* 2006). These refugia have been intensively managed to eradicate or control introduced stoats, cats and rats. While the survival rate of translocated Kakapo has been over 90%, the breeding success proved to be disappointingly low (Clout and Craig 1995). This led to the discovery that supplementary feeding of high protein foods, *i.e.* nuts and sweet potato, was a key factor needed to stimulate breeding activity and subsequently resulted in several successful breeding attempts (Higham 1992; Clout and Craig 1995). However, continued low productivity prompted a major review of the Kakapo recovery program in 1994, the results of which seriously questioned the rationale for translocation and highlighted the need to better understand the social interactions and reproductive ecology of the species. Subsequent changes to the management strategy have resulted in significant improvement in the reproductive success of the Kakapo in recent years with the population gradually increasing to now number 86 individuals (Powlesland *et al.* 2006).
Caughley (1994) identifies only one convincing example of species recovery in Australia, that of the Lord Howe Island Woodhen *Tricholinna sylvestris*, where the application of small-population and declining-population paradigms have been applied together. In this case the species, once found only throughout the 25 km² Lord Howe Island, was by 1920 reduced to as few as 6 breeding pairs and restricted to 25 ha of habitat on the precipitous Mt Gower (Fullagar 1985; Miller and Mullette 1985). The agent of decline was first thought to be the Black Rat *Rattus rattus*, but concerted field studies by Miller proved that Feral Pigs *Sula scrofa* were in fact the culprits (Miller and Mullette 1985). Pigs were found to be capable of eating incubating birds, eggs and nestlings, but incapable of scaling the cliffs surrounding Mount Gower. An examination of pig stomachs revealed the remains of Providence Petrels *Pterodroma solandri* proving further that they were more than capable of killing and eating Woodhens (Hutton 1991). Following this discovery, an eradication program was commenced and by 1981 Feral Pigs had been exterminated (Miller and Mullette 1985). A captive breeding and reintroduction program was then established which included intensive techniques associated with managing a small-population. By 1988 the recovery program had successfully reintroduced the species across Lord Howe Island with a population estimate of c. 200 birds consisting of at least 52 wild breeding pairs (Hutton 1991).

Conservation of the Orange-bellied Parrot *Neophema chrysogaster* has attempted to bring together the small-population and declining-population paradigms through habitat management, and captive breeding and reintroduction. However, application of these conservation efforts has been hampered by the lack of empirical data on the cause of decline and a limited understanding of the factors influencing the survival of this species. There is therefore a need to examine more closely the reproductive success and demography of the Orange-bellied Parrot to assist with the application of these conservation measures.
SPECIES OVERVIEW

Description
The Orange-bellied Parrot *Neophema chrysogaster* (Order: Psittaciformes, Family: Psittacidae, Subfamily: Psittacinae, Tribe: Platycercini, Subgenus: Neonanodes) is one of six species of ‘grass parrot’ of the genus *Neophema* (Schodde 1997). The *Neophemas* are most closely related to the Ground Parrot (*Pezoporus*), Budgerigar (*Melopsitticus*), Red-crowned Parakeet (*Cyanoramphus*) and Burke’s Parrot (*Neopsephotus*) (Christidis *et al.* 1991; Christidis and Boles 1994; Schodde 1997).

The first specimen of an Orange-bellied Parrot was collected from Adventure Bay, Tasmania during Captain James Cook’s voyages in 1773 or 1777 (Hutchins and Lovell 1985). The species was first described by Latham (1790) and other authors (*e.g.* Eades 1998; Eades and Marsack 1998; Higgins 1999) have since provided detailed descriptions of its morphology and taxonomy.

The Orange-bellied Parrot is approximately 21 cm long and 45 g in weight and is not sexually dimorphic in size. The body feathers are bright grassy-green above, grading to light green on the upper breast, to bright yellow on the abdomen and vent (Figure 1.1). As the name suggests, Orange-bellied Parrots have a bright orange patch on the belly, though this is not diagnostic for the species. All other species of the genus *Neophema*, particularly males, can exhibit orange abdomen patches to varying degrees. The orange patch is brightest and more extensive in male Orange-bellied Parrots, pale in females and small and/or diffuse in juveniles. Males are also distinguished from females and juveniles by a distinct two-toned blue frontal band (Figure 1.1). The bill is black, grading to dark grey in adults and yellowish-orange in juveniles up to approximately two months of age (M. Holdsworth unpublished data).
Compared to other parrots, the Orange-bellied Parrot is a relatively quiet species (Low 1980), but can produce a range of calls with a metallic buzzing quality. While feeding in flocks, Orange-bellied Parrots occasionally produce soft warble and chirruping contact calls or a harsher buzzing-squawk during agonistic squabbles—usually within sexes and combined with bill gap threat posture (Holdsworth pers. obs.). When startled, the Orange-bellied Parrot makes an explosive, rapidly repeated
‘zzzzzzzizi.’ alarm call (Pizzey and Knight 2003). The species habitually emits a 5.5 and 8.0 kHz call repeated about once a second during transit flights (Wilson and Holdsworth 2005) and described as a repeated ‘tzeet’ emitted at the apex of an undulating flight (Orange-bellied Parrot Recovery Team 2006).

Only one other species of Neophema naturally occurs within the breeding range of the Orange-bellied Parrot—the Blue-winged Parrot *N. chrysostoma*. This species can be easily mistaken for the Orange-bellied Parrot, but is generally more olive-green in appearance and the calls have a softer quality. The Blue-winged Parrot is rare within the breeding range of the Orange-bellied Parrot. Conversely, both species can be encountered within the migratory and wintering range.

**Life history**

Others (*e.g.* Brown and Wilson 1980, 1981, 1982, 1984; Loyn *et al.* 1986; Menkhorst *et al.* 1990; Starks *et al.* 1992; Brown *et al.* 1995) have described the life history of the Orange-bellied Parrot in detail. In summary, the Orange-bellied Parrot breeds only in Tasmania and the known breeding range is confined to the far southwest of the island (Figure 1.2), which is characterised by perhumid rainfall (Gentilli 1972) and sedgeland vegetation zones (Jackson 1965). The species is one of only two obligate migratory parrots in the world (Higgins 1999)—the other being the Swift Parrot *Lathamus discolor*—both of which are breeding endemics to Tasmania (Forshaw 2002). The Orange-bellied Parrot’s winter range encompasses a variety of coastal habitats in Victoria, South Australia and New South Wales (Figure 1.2). The Orange-bellied Parrot breeds during the Austral summer (Nov–Feb) in near-coastal areas of southwest Tasmania between Birchs Inlet, in Macquarie Harbour, and Louisa Bay on the southern coast (Stephenson 1991). Most breeding has been reported within the Melaleuca Inlet, Bathurst Harbour and Port Davey region, and at Birchs Inlet (Brown and Wilson 1980, 1981, 1982, 1984; Orange-bellied Parrot Recovery Team unpublished reports, Figure 1.2).
Figure 1.2. Distribution map of the Orange-bellied Parrot showing key sites, breeding range, wintering range and migratory paths (courtesy of Environmental Resources Information Network©).
Both sexes are known to breed in their first year and have been reported to be monogamous (Brown and Wilson 1980). Pair bonding prior to spring migration has been recorded, but it has been assumed pairing mostly occurs between October and December within the breeding range (Brown and Wilson 1984). Until the 1980s, there was speculation the species nested underground on offshore islands (e.g. Legge 1888, Lendon 1979), as is the case with the Rock Parrot *N. petrophila* (Higgins 1999). However, Brown and Wilson’s studies during the early 1980s disproved this theory. Nesting mostly occurs in hollow limbs or trunks of living trees1. Mostly Smithton Peppermint *Eucalyptus nitida* within small forest patches is favoured (Brown 1984 – see Figure 1.3), but occasionally Black Gum *E. ovata* are used (Brown 1984). Observations have shown the same hollow can be used in consecutive years but few data exist on pair or individual fidelity to these sites. Since 1992, custom-made nest boxes (see Chapter 2) have been erected at Melaleuca, primarily to aid banding and reproductive studies.

After pair formation, both sexes actively inspect prospective nests soon after returning to the breeding areas (Oct–Nov). Usually only the female enters the hollow and prepares a nest bowl by chewing and scratching the rotten wood material within the base of the cavity (Brown and Wilson 1984). The male feeds the female every 2—4 hours throughout the nest preparation, copulation, egg-laying and incubation stages. As the female nears egg laying (Nov–Dec) she progressively spends more time within the nest to the point from which she rarely ventures unless being fed by the male. Up to six slightly glossy-white eggs (c. 21 mm x 18 mm) are laid, one every second day (North 1904; Hinsby 1947; Brown and Wilson 1984). Eggs hatch 21—24 days after laying (Lewitzka 1974; Brown and Wilson 1984). Newly hatched young have sparse off-white down, are blind for the first week and are semi-altricial and nidicolous. The

1 Brown and Wilson recorded one nest in a dead *Eucalyptus ovata* at Birchs Inlet during the period 1979-81.
female continues to incubate for up to 10 days post-hatching, after which both parents feed their brood (Brown and Wilson 1984). Fledging is reported to occur at 30-35 days, from late January to mid-February (Lewitzka 1974; Brown and Wilson 1984).

There is no confirmed record of second clutches in the wild; however, Brown and Wilson (1984) speculated secondary attempts might follow early failed first clutches. Second clutches are known to occur in the captive population but are usually less successful than first clutches (M. Holdsworth pers. comm.). Young Orange-bellied Parrots are dependent on their parents for 1–2 weeks post-fledging after which adults move away from the breeding area during February–March to begin the northern migration. Juveniles form flocks and outnumber adults by March (Brown and Wilson 1984) and most start their northern migration by April (B. Willson pers. comm.).
During migration, Orange-bellied Parrots can be found in a range of coastal habitats including saltmarshes, strandline vegetation, coastal dunes, heathland, herbfield swales and degraded pastures (Higgins 1999). All recent evidence indicates the northern and southern migratory routes are confined to the west coast of Tasmania through the Fleurieu Group (i.e. Hunter, Three Hummock, West Kangaroo, Walker and Robbins islands) to King Island (Figure 1.2). The passage across the waters of western Bass Strait is not clear but is likely to be influenced by favourable prevailing winds (i.e. southerly during autumn migration and northerly during spring migration) in relation to the proximity of islands and landfalls. The majority of the known population over-winters in saltmarsh and other coastal communities from south-eastern Victoria to south-eastern South Australia; however, in some years a small number may venture as far north and east as Sydney and west to Spencer Gulf.

The key wintering sites are mostly within the Port Phillip Bay and Bellarine Peninsula regions in Victoria, including the Western Treatment Plant (Werribee), Point Wilson, Lake Connewarre and Swan Bay. In recent years the species has also been frequently observed at Yambuk Lake near Port Fairy in western Victoria. The Orange-bellied Parrot is infrequently observed in South Australia, with most observations occurring between the Victorian border and the southern part of the Coorong National Park (e.g. Brown and Wilson 1984; Hewish and Starks 1988; Starks et al. 1992; Starks 1999; J. Starks pers. comm.). The southern (spring) migration commences in September with older birds arriving at breeding grounds earlier than younger birds (Higgins 1999).

**Diet and food resources**

The diet of the Orange-bellied Parrot is described in detail by other authors (e.g. Brown and Wilson 1980, 1981, 1984; Gibbons 1984; Askey-Doran 1995; Higgins 1999; Lee 2000; Lee and Burgman 2001). In summary, throughout its range the Orange-bellied Parrot feeds on a wide range of seeds and fruits of grasses, chenopods,
sedges and herbs (Brown and Wilson 1984). Usually the species forages on or close to the ground in low vegetation communities (*i.e.* buttongrass sedgelands, herbfields, heathlands, saltmarshes and degraded pastures). During the northern (autumn) migration and throughout the winter, the Orange-bellied Parrot has been observed feeding on 32 different species of plants (Orange-bellied Parrot Recovery Team 2006). Of these the key species are within saltmarsh communities (Figure 1.4) and include Beaded Glasswort *Sarcocornia quinqueflora*, Southern Sea-heath *Frankenia pauciflora*, Shrubby Glasswort *Sclerostegia arbuscula*, Buzzy *Acaena novae–zelandiae* and Sea Rocket *Cakile maritima*. However, in recent years a range of grassy or weedy pastures associated with coastal vegetation communities have increasingly been used by the species (Orange-bellied Parrot Recovery Team 2006).

![Figure 1.4. Typical Orange-bellied Parrot winter saltmarsh habitat at The Spit Nature Conservation Reserve, Port Phillip Bay (Vic). The bushy vegetation is Shrubby Glasswort *Sclerostegia arbuscula* and the low vegetation is Beaded Glasswort *Sarcocornia quinqueflora* (red) fringed by Southern Sea-heath *Frankenia pauciflora* (dark-green) (Photo M. Holdsworth).](image)
Within the breeding range, the Orange-bellied Parrot forages in extensive buttongrass and sedgeland plains (Figure 1.5). The species has been observed feeding on more than 20 species of plants in Tasmania with Paper Daisy *Helichrysum pumilum*, Flat Cord-rush *Eurychorda complanata*, and Tiny Flannel-flower *Actinotus bellidioides*, among others, favoured during the breeding season (Figure 1.6). The availability of these plants is influenced by fire and it is generally believed that frequent burning of moorlands between two and fifteen years produces favourable foraging habitat for the species (Brown and Wilson 1981). Tasmanian Aborigines are known to have used fire throughout the Holocene and strongly influenced the extent and condition of moorland vegetation (Jackson 1968; Bowman and Brown 1986), providing ideal conditions for the Orange-bellied Parrot. Europeans have continued the use of fire in these habitats to varying degrees and as a result produced favourable conditions for the species, particularly at Melaleuca where fire has been used frequently as part of tin mining operations over the past century. Accordingly, habitat management burns within the breeding range of the Orange-bellied Parrot have been used as a management tool to maintain a mosaic of different vegetation age classes for the benefit of the species, particularly at Melaleuca (Brown and Wilson 1982, 1984; Marsden-Smedley 1993, 1997, 2000; Orange-bellied Parrot Recovery Team 2006).
Figure 1.5. Buttongrass plains Low Rocky Track, Birchs Inlet – typical foraging habitat of the Orange-bellied Parrot (Photo M. Holdsworth).
Figure 1.6. Important food plants favoured by the Orange-bellied Parrot in the breeding range; a) Paper Daisy *Helichrysum pumilum*, b) Flat Cord-rush *Eurychorda complanata*, c) Tiny Flannel-flower *Actinotus bellidioides* (Photos M. Holdsworth).
Previous studies and population decline
In 1839 John Gould reported the Orange-bellied Parrot as being plentiful in coastal areas between Port Adelaide and Holdfast Bay, South Australia (Hutchins and Lovell 1985; Dawes 2004). Gould was also familiar with the Orange-bellied Parrot during his earlier visits to Hobart and the Actaeon Islands in 1838 where he believed they were breeding (Gould 1848). The species was reputed to be common and locally abundant during the late 1800s and early 1900s (Jarman 1965). While no estimates of population size were made during this period, anecdotal observations of the species in the Robe-Beachport area of South Australia suggest the population was many thousands (Hutchins and Lovell 1985). However, concerns for the plight of the species was soon reported (e.g. Matthews 1917) and repeated by other authors throughout the twentieth century. The introduction of predators (European Fox Vulpes vulpes, Domestic Cat Felis cattus) and competitors (Common Starling Sturnus vulgaris, European Goldfinch Carduelis carduelis, European Greenfinch C. chloris and House Sparrow Passer domesticus) are believed to have contributed to the decline of the species (Stephenson 1991). The population was further threatened by trapping pressure in South Australia for the aviculture trade during the 1940s (Brown and Wilson 1982). However, the primary influence on the species has been the degradation and loss of significant areas of winter habitats (Menkhorst et al. 1990), particularly in the Port Phillip Bay area (Vic) and throughout coastal South Australia.

The first concerted attempts to determine the Orange-bellied Parrot's population status began in the 1970s (Milledge 1972; Lane and Kinhill Planners 1979). These searches attempted to locate breeding birds in southwest Tasmania without success, although there were strong indications the species favoured the Melaleuca area. This was followed by detailed studies of the species in 1978 to determine the importance of winter habitat at Point Wilson (Victoria) as part of an Environmental Impact Assessment for a proposed petrochemical complex on ICI Australia Limited land.
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(Loyn and Chandler 1978; Lane et al. 1980). These studies found the ICI land was indeed important to the species and development did not proceed. However, the ICI investigations led to further studies and increased interest in the species (Silva 1989).

Melaleuca was reported to be an important breeding area for the Orange-bellied Parrot by the resident tin miner Charles Denison 'Deny' King who had observed the presence of the species in the region since the late 1940s (Lane and Kinhill Planners 1979). King noted in his personal diaries the first spring returns and incidental records of the Orange-bellied Parrot in the area from the 1959/60 breeding season, but no detailed records were kept (Lane and Kinhill Planners 1979). The first concerted effort to study the species at Melaleuca was conducted by D. Milledge from 1966—1969 (Milledge 1972). This was followed by expeditions by B. Lane, R.I. Drummond and J. Reid in 1975 and 1977 (Lane and Kinhill Planners 1979) and then in January 1979 by B. Lane and C. Chandler, as a result of the ICI study (see above). However, despite their best efforts and finding reasonable numbers of Orange-bellied Parrots, none of these observers were able to confirm breeding or locate nests, although they all concluded that breeding most likely occurred in the area. In late 1979 the World Wildlife Fund (Australia) financed a comprehensive study of the species throughout its range and during the 1979/80 and 1980/81 breeding seasons Peter Brown and Rolland Wilson confirmed the species bred in the Melaleuca area (Brown and Wilson 1980, 1981).

Since 1985, the Orange-bellied Parrot population at Melaleuca has been the subject of continued observations of breeding behaviour and conservation management under several Orange-bellied Parrot Recovery Plans (Brown and Wilson 1984; Stephenson 1991; Orange-bellied Parrot Recovery Team 1999, 2005). While breeding is not confined to the Melaleuca area, all available evidence suggests a significant proportion of the population breeds there, in what is considered to be one breeding population (Brown and Wilson 1984).
Conservation program

Winter population counts coordinated and documented Starks (1988, 1992, 1993, 1994, 1995, 1996, 1997, 1999), breeding studies by Brown and Wilson (1980, 1981, 1984) and unpublished reports by the Orange-bellied Parrot Recovery Team indicate the adult population has not exceeded 200 individuals in recent times. The species was recorded as breeding at Birchs Inlet in 1918 (Hinsby 1947), but had declined to an estimated five breeding pairs by 1980 (Brown and Wilson 1981) and was extirpated by 1984 (P. Brown pers. comm). Brown and Wilson’s studies provided the first empirical data on population size and breeding biology for the species. This information was used to determine the conservation status of the Orange-bellied Parrot and has guided the recovery of the species over the past two decades.

As part of the conservation management of the Orange-bellied Parrot a captive-breeding program was established in 1985 (Brown 1988) and now contains 120—160 birds at two main facilities—Taroona (Tas) and Healesville Sanctuary (Vic). The primary purpose of the captive population is to ensure the species does not become extinct. This population also provides an opportunity to use captive-bred birds for reintroduction programs to re-establish or bolster the wild population. Since 1992/93 a total of 249 captive-bred birds has been released at Melaleuca and Birchs Inlet (Tas), and Point Wilson (Vic) (Orange-bellied Parrot Recovery Team 2006; M. Holdsworth unpublished data). Of 219 captive-bred birds released since 1994/95, only 27 have been resighted at least one year post-release at Birchs Inlet. These have produced 42 fledglings, 15 of which have also returned after at least one year post-fledging (Brown et al.1995; Menkhorst 1997; Smales et al. 2000b; Orange-bellied Parrot Recovery Team 2006; M. Holdsworth unpublished data).

Due to the species’ low population size and likely decline over the last century, the Orange-bellied Parrot was among the first species in Australia to be listed as
threatened under State and Commonwealth legislation. The species is currently listed as:

- Endangered under the Commonwealth’s *Environment Protection and Biodiversity Conservation Act 1999*
- Threatened under the Victorian *Flora and Fauna Guarantee Act 1988*
- Endangered under the Tasmanian *Threatened Species Protection Act 1995*
- Endangered under the South Australian *National Parks and Wildlife Act 1972*
- Endangered under the New South Wales *Threatened Species Conservation Act 1995*

The Orange-bellied Parrot is considered to be Critically Endangered by the International Union for the Conservation of Nature (BirdLife International 2000, 2005).

Conservation of the species has been guided by four recovery plans (Brown and Wilson 1984; Stephenson 1991; Orange-bellied Parrot Recovery Team 1999; Orange-bellied Parrot Recovery Team 2006). The objectives of the current recovery plan (Orange-bellied Parrot Recovery Team 2006) are as follows:

1. To monitor the population size, productivity, survival and life history of the Orange-bellied Parrot.
2. To identify all sites used by Orange-bellied Parrots and better understand migration movement.
3. To increase the carrying capacity of habitat through active management of sites throughout the species’ range.
4. To identify and measure threats, particularly in migratory and winter habitats.
5. To increase the number of breeding sub-populations.
6. To maintain a viable captive population.
AIMS OF THIS STUDY

This thesis presents an analysis of data collected from the study of the Orange-bellied Parrot's breeding biology in the wild, with particular emphasis on reproductive success and population demographics. This study has been developed through the auspices of the Orange-bellied Parrot recovery plans (Brown and Wilson 1984; Stephenson 1991; Orange-bellied Parrot Recovery Team 1999; Orange-bellied Parrot Recovery Team 2006) and represents the implementation of various recovery actions since 1985 consistent with the recovery objectives as described above. In particular, this study focuses on aspects of the breeding biology and population demography under Objective 1 of the recovery plan. In addition, some components of Objectives 2 (understanding migration) and 4 (understanding threats) are documented in this study.

The aims of the thesis are:

1. To analyse and describe aspects of the breeding ecology of the Orange-bellied Parrot including:
   - reproductive success
   - nest site competition
   - nesting success compared to other species of *Neophema* and other psittacids.

2. To quantify survivorship, fecundity and other demographic parameters of the breeding population to improve the capacity to model population viability and assess the effectiveness of recovery management actions.

3. To assess the results of this research in relation to other population studies and discuss implications for conservation of the species.
This thesis does not attempt to comprehensively describe every aspect of the breeding biology of the Orange-bellied Parrot, but rather to concentrate on important elements which may have important implications for conservation management of the species. The author undertook all components of the study during the period August 1987 – February 2005. A large number of employees and volunteers assisted the author to collect the raw data presented in this thesis (see Acknowledgments).

All research activities were conducted under scientific permits issued by the Department of Primary Industries Water and Environment (and its predecessors) under the National Parks and Wildlife Act 1970, Threatened Species Protection Act 1995 and Nature Conservation Act 2003. The author conducted most of the banding under Australian Bird and Bat Banding Scheme authority. Methodologies used within the research and conservation program for the species were approved by the Tasmanian Animal Ethics Committee under the Animal Welfare Act 1993. This research was also conducted in accordance with the advice of the Orange-bellied Parrot Recovery Team.