

Noisy Scrub-bird Recovery Plan

by Alan Danks, Andrew A Burbidge, Allan H Burbidge and
Graeme T Smith for the Noisy Scrub-bird Recovery Team



1996

Wildlife Management
Program No 12

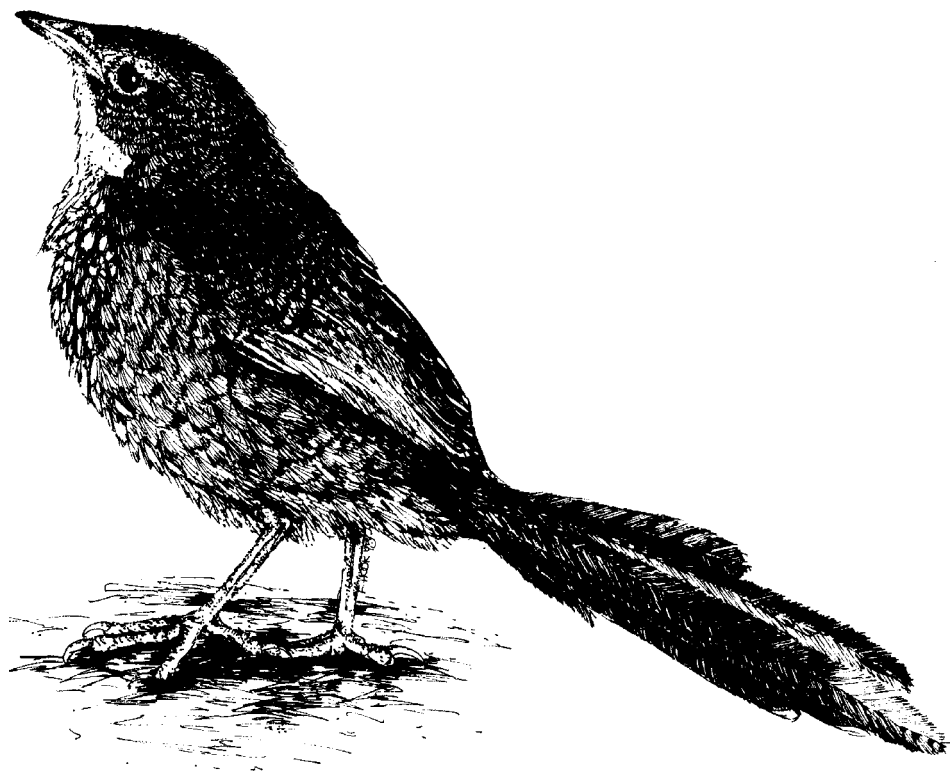


Department of Conservation
and Land Management



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Australian
National
Parks and
Wildlife

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by

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for the
Noisy Scrub-bird Recovery Team

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FOREWORD

The Western Australian Department of Conservation and Land Management (CALM) publishes Wildlife Management Programs to provide detailed information and management actions for the conservation of threatened or exploited species of flora and fauna. Wildlife Management Program No. 2, The Noisy Scrub Bird, was published in 1986 (Burbidge *et al.* 1986) and much of the information and recovery actions provided here are taken from that document. This Recovery Plan provides up to date and more detailed descriptions of actions and accurate costing of them.

Recovery Plans delineate, justify and schedule management actions necessary to support the recovery of an endangered or vulnerable species or ecological community. The attainment of objectives and the provision of 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 nor the official positions of any individuals or agencies represented on the Recovery Team. This Recovery Plan has been approved by the Executive Director, Department of Conservation and Land Management, the National Parks and Nature Conservation Authority and the Minister for the Environment.

Approved Recovery Plans are subject to modification as dictated by new findings, changes in species' status and completion of recovery actions.

Information in the Plan is accurate to December 1994.

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SUMMARY

CURRENT SPECIES STATUS: Threatened species (WA Wildlife Conservation Act), Vulnerable (ANZECC 1991), Endangered (Garnett 1992a & b), Endangered (Draft new IUCN categories). Garnett (1992b) ranks the Noisy Scrub-bird equal ninth in conservation priority of all Australian threatened bird taxa and the fourth most threatened full species. The total population in 1994 was probably around 1100.

HABITAT REQUIREMENTS AND LIMITING FACTORS: Long-unburnt vegetation characterised as low forest (5-15m), scrub/thicket and heath. These formations occur in gullies, drainage lines and the slopes of hills and granite mountains, overgrown swamps and lake margins and in riparian vegetation along rivers and creeks. Occupied sites generally have a post-fire age of ten years or more and contain a dense stratum of shrubs and sedges which provide essential cover for these semi-flightless birds. The maximum post-fire age at which vegetation retains its suitability for scrub-birds has not been determined. On Mt Gardner, however, scrub-birds are still present and breeding in vegetation which has not been burnt for more than 50 years.

RECOVERY PLAN OBJECTIVES: In the Albany Management Zone to achieve and maintain a population of > 300 singing males and to commence the establishment of populations in a western management zone.

RECOVERY CRITERIA:

1. Within the Albany Management Zone the achievement and maintenance of the number of singing males at above 300.
2. Establishment of at least two new populations within a new management zone west of Albany.
3. Completion and implementation of a Management Plan for Two Peoples Bay Nature Reserve.
4. Implementation of management for other CALM-managed lands on which scrub-birds occur.
5. Provision of assistance to owners and managers of other lands where scrub-birds occur.
6. Protection of corridors between population concentrations.
7. Completion of research into translocation site suitability.
8. Maintenance of genetic variability in translocated populations.
9. Dissemination of information on scrub-bird biology and conservation.

ACTIONS NEEDED:

1. Prepare and implement a Management Plan for Two Peoples Bay Nature Reserve.
2. Management of other lands with scrub-bird populations.
3. Translocations.
4. Monitoring of Noisy Scrub-bird numbers.
5. Education, publicity and sponsorship.

ESTIMATED COST OF RECOVERY: 1992 prices in \$000s/year; total cost (TC) and ESP (O) = Endangered Species Program (= TC - CALM contribution)

Actions	(1)		(2)		(3)		(4)		(5)		Total	
	TC	ESP	TC	ESP	TC	ESP	TC	ESP	TC	ESP	TC	ESP
1993	118.5	2.0	69.5	0.0	92.4	41.3	11.3	3.9	3.0	0.0	294.7	47.2
1994	143.5	2.0	69.5	0.0	82.1	31.0	17.3	6.0	3.0	0.0	315.4	39.0
1995	90.0	4.5	69.5	0.0	82.5	31.2	16.7	5.2	3.0	0.0	261.7	40.9
1996	78.5	2.0	69.5	0.0	95.5	41.2	21.4	7.4	3.0	0.0	267.9	50.6
1997	81.0	4.5	69.5	0.0	85.5	31.2	22.6	6.6	3.0	0.0	261.6	42.3
1998	78.9	2.4	69.5	0.0	82.6	28.3	23.1	7.4	3.0	0.0	257.1	38.1
1999	81.4	4.9	69.5	0.0	48.9	12.8	22.6	6.6	3.0	0.0	225.4	24.3
2000	78.9	2.4	69.5	0.0	48.9	12.8	21.4	7.4	3.0	0.0	221.7	22.6
2001	78.9	2.4	69.5	0.0	46.1	10.0	22.6	6.6	3.0	0.0	220.1	19.0
2002	78.9	2.4	69.5	0.0	46.1	10.0	17.3	6.0	3.0	0.0	214.8	18.4
Total	908.5	29.5	695.0	0.0	710.6	249.8	196.3	63.1	30.0	0.0	2540.4	342.4

BIODIVERSITY BENEFITS: Habitat protection and management of the Noisy Scrub-bird has helped conserve a wide variety of other organisms, including some that are threatened. Examples include: the recently rediscovered Gilbert's Potoroo *Potorous tridactylus gilbertii*, Western Ringtail Possum *Pseudocheirus occidentalis*, Western Bristlebird *Dasyornis longirostris*, Western Whipbird *Psophodes nigrogularis*, the vascular plants *Corybas limpidus*, *Banksia verticillata*, *Adenanthos cunninghamii*, *Stylidium plantagineum*, and the moss *Pleurophascum occidentale*. Protection of lakes and streams of the Two Peoples Bay Nature Reserve has helped maintain an extremely rich and distinctive aquatic invertebrate fauna.

1. INTRODUCTION

1.1 Description and history of species

The Noisy Scrub-bird (*Atrichornis clamosus* (Gould 1844)) is a small solidly built bird with a strong pointed bill, powerful legs, graduated tail and short round wings. They are brown above with dark cross barring extending from the head to the tip of the tail. The dark bars are very fine on the head, broader and more obvious on the back and form irregular bands on the tail feathers. The underparts are paler with a buff coloured abdomen grading to bright rufous around the vent. The species is sexually dimorphic in size and plumage. During the breeding season, females have a mean weight of 34.6 g (n = 42, range = 31.5 g - 39.2 g) while males have a mean weight of 51.8 g (n = 56, range = 47.0 g - 57.0 g). Adult males have a dark grey band of variable width across the off-white throat and prominent white side flashes. Females have cream coloured throats and lack the dark band.

Noisy Scrub-birds have very limited flying abilities, being able to sustain flight for no more than a few metres. However, they frequently use their small wings to assist in rapid manoeuvring and short runs on the ground and in leaping from shrub to shrub. They are also agile climbers moving quickly from shrubs and sedges to the low canopy.

The territorial song of the male easily distinguishes the Noisy Scrub-bird from other birds within its range, but the cryptic colour and behaviour combine with the dense habitat to make them difficult to observe. However, they are not as secretive as casual observations would suggest, but are inquisitive birds, moving quickly to investigate the cause of any disturbance in their territory.

Scrub-birds (the Noisy Scrub-bird and the Rufous Scrub-bird *A. rufescens* of north-eastern New South Wales and south-eastern Queensland) form a small endemic monogeneric family of song birds, the Atrichornithidae, whose closest relatives are the lyre-birds (Menuridae) (Bock and Clench 1985, Sibley and Ahlquist 1985, 1990). Bock and Clench (*op. cit.*) place the two families in a superfamily Menuroidea within the sub-order Passeres of the Passeriformes, whereas Sibley and Ahlquist (*op. cit.*) consider the two groups as subfamilies of the Menuridae, which they place together with the treecreepers (Climacteridae) and the bowerbirds (Ptilonorhynchidae) to comprise the superfamily Menuroidea. A recent review of the taxonomy of Australian birds (Christidis and Boles 1994) supports retention of the family status of Atrichornithidae but treats the Climacteridae and Ptilonorhynchidae as not being closely related to the Menuridae. DNA-DNA hybridisation evidence (Sibley and Ahlquist 1985) suggests that the Menuridae originated 40-45 million years ago and that the scrub-birds differentiated from the lyre-birds 30-35 million years ago. *Atrichornis* and *Menura* are considered to be close to the base of one of two evolutionary radiations in the song birds (Fedducia and Olson 1982) and are among the last remaining members of an ancient, probably once more diverse radiation of Australo-Papuan songbirds.

Although the Noisy Scrub-bird with its loud call would have been known to Aboriginal people for many thousands of years, only one Aboriginal name has been recorded: Jeemuluk (pronunciation unknown; may be Djimoolook), from the King George Sound area (Serventy and Whittell 1976). The first European to report the species was John Gilbert, who found it in the Mt William area and at Drakesbrook, near Waroona, in November 1842. Later on the same journey he found it near Augusta and at Cape Leeuwin (Whittell 1951). In 1843 Gilbert travelled from York to Albany along a route similar to today's Albany Highway and noted that he first heard scrub-birds around Mount Barker, with numbers increasing as he approached Albany (Serventy and Whittell 1976, Smith 1977). George Masters collected seven specimens near Albany between 1866 and 1869, and William Webb collected eight specimens, also in the same area in the 1870s. The final nineteenth century specimen was

collected by A. J. Campbell at Torbay in October 1889, and he reported having heard scrub-birds at Boojidup Creek, about 25 km north of Karridale, in November of the same year (Whittell 1943, Smith 1977) (Figure 1). Thus, the Noisy Scrub-bird was recorded from three separate areas in the south west of Western Australia in the first 50 years after it was discovered by Europeans: Mt William - Drakesbrook, Augusta - Margaret River and the Albany area. The birds were apparently most numerous in the Albany area which extended to Torbay 15 km to the west and Mt Barker, 50 km to the north. The birds were probably present in the Two Peoples Bay and Mt Manypeaks area at that time and William Webb considered that they might be found as far east as the Pallinup River (100 km east of Albany) (Whittell 1943), although on current knowledge this seems unlikely.

The apparently sudden disappearance of an unusual and unstudied bird was viewed with concern by ornithologists of the day and, beginning in 1904, extensive searches were mounted for the scrub-bird in its former areas. Despite these efforts no further records of the Noisy Scrub-bird were confirmed and the species was considered by many to be extinct (eg, Campbell 1920, Whittell 1943, 1951, Chisholm 1951) until it was rediscovered at Two Peoples Bay in 1961 (Webster 1962a; see Chatfield in prep. for a history of the rediscovery). Since the rediscovery of the Noisy Scrub-bird, searches elsewhere in its former range have failed to locate further populations.

1.2 Population trends, distribution and abundance

At the time of its rediscovery, the Noisy Scrub-bird population was very small and confined to the Mt Gardner area and near the current picnic area at Two Peoples Bay east of Albany. Between 1962 and 1966 irregular counts confirmed the existence of 40-45 singing males (Webster 1962b, Smith and Forrester 1981), indicating a possible total population of around 100 individuals. Examination of aerial photographs of the Two Peoples Bay area taken in 1946 indicated that, due to extensive fires in the Mt Gardner headland, there was only enough habitat at that time for between 21 and 31 scrub-bird territories (Smith 1985d). It is probable that the scrub-bird population has been as low as about 50 individuals in historical times.

Only singing males can be censused and this census provides an index to the actual population (Smith and Forrester 1981). Since 1970 the number of singing male scrub-birds has been counted annually, except 1978 and 1981. After a small decline the number of singing males began to show a steady increase from 1971. The Mt Gardner population has continued to increase since then showing only minor fluctuations over a 24 year period (Smith and Forrester 1981, Smith 1985a, in prep. c). The annual counts of singing males suggest that the population on Mt Gardner has not yet reached its maximum. In 1994 a total of 179 singing males were counted in this area.

Dispersal of individuals from the growing Mt Gardner population lead to the beginning of a small population around Lake Gardner, 3 km to the west, first recorded in 1979. By this time one male had also reached the west end of Moates Lake. The number of singing males recorded in this area increased steadily, reaching a total of 64 in 1987, and expanded into the area between Gardner and Moates Lakes. In 1988, however, growth in this sub-population was checked by a sudden decline, which, after an initial recovery, was repeated in 1991. The downward trend in the Lakes area has continued and by 1994 only 12 singing males were recorded. The initial decline occurred in the same year as unusually heavy rainfall and flooding of scrub-bird habitat in the lake margins. The subsequent decline, however, has not correlated

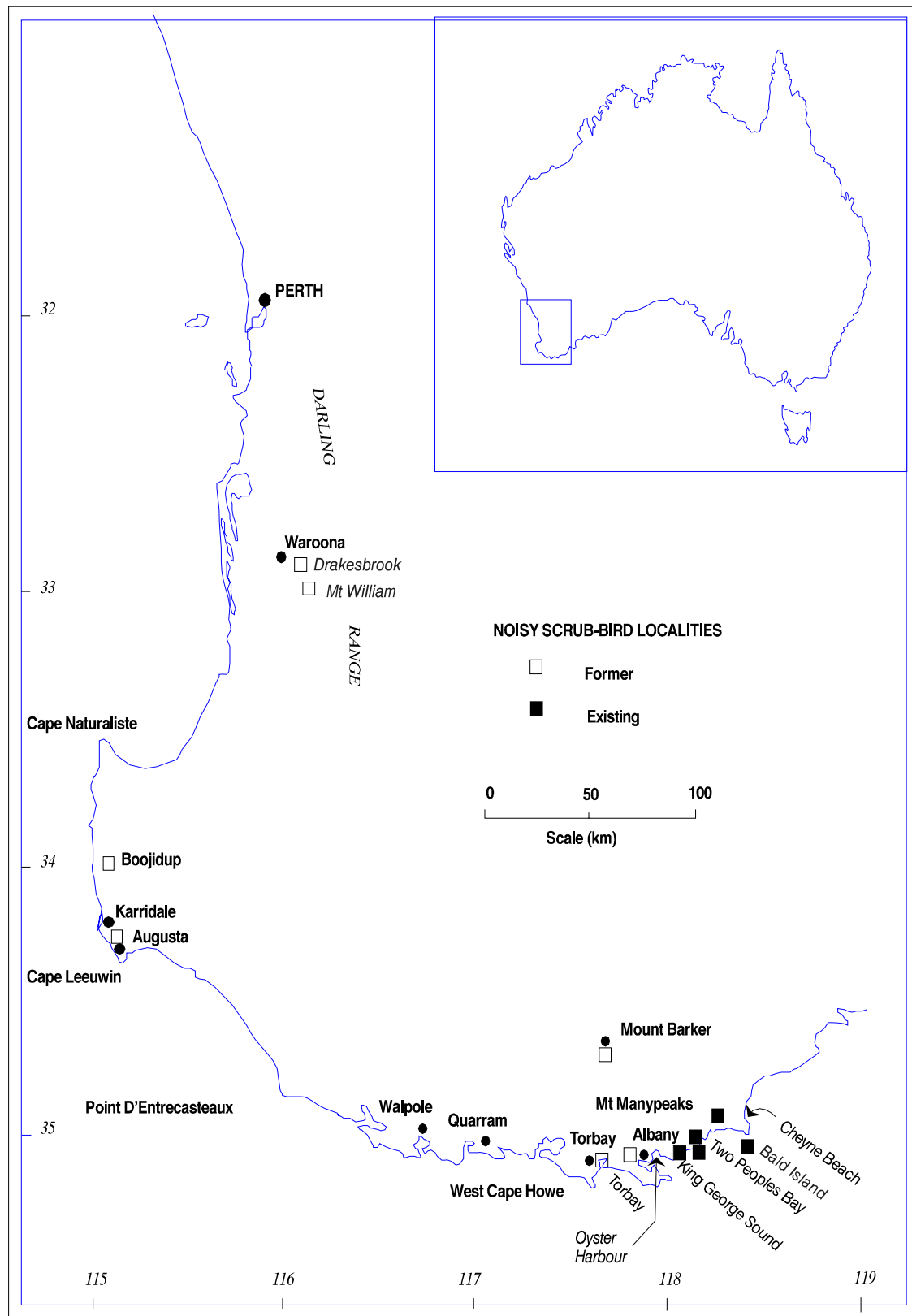


Figure 1.
Former and existing Noisy Scrub-bird localities

with rainfall or flooding and the actual cause of the decrease in numbers of scrub-birds remains unknown.

Noisy Scrub-birds have also dispersed into the Angove River area up to 8 km north of Lake Gardner. One male was heard calling a few times from Angove Lake in 1982. The first male to persist in this area, however, was heard singing in swampy riparian habitat in the upper Angove River in 1987. Numbers have increased since then (Table 1), aided perhaps by continuing immigration, but local breeding has also occurred (Danks 1991). A small sub-population is now present in this area which, for management purposes, is combined with scattered singing males in adjoining country to the east as far as Normans Inlet.

Table 1.
Numbers of singing male Noisy Scrub-birds in each subpopulation in the
Albany Management Zone, plus numbers at recent release sites

	Mt Gardner	Lakes	Many- peaks	Angove- Normans	Mt Taylor	Mermaid	Bald Is.	Stony Hill	Total
1962-1966	40-45*	-	-	-	-	-	-	-	40-45*
1968	50*	-	-	-	-	-	-	-	50*
1970	45	-	-	-	-	-	-	-	45
1971	44	-	-	-	-	-	-	-	44
1972	50	-	-	-	-	-	-	-	50
1973	58	1	-	-	-	-	-	-	59
1974	66	-	-	-	-	-	-	-	66
1975	68	1	-	-	-	-	-	-	69
1976	72	2	-	-	-	-	-	-	74
1977	72	2	-	-	-	-	-	-	74
1978	_#	_#	-	-	-	-	-	-	_#
1979	98	9	-	-	-	-	-	-	107
1980	108	8	-	-	-	-	-	-	116
1981	_#	_#	-	-	-	-	-	-	_#
1982	114	16	-	-	-	-	-	-	130
1983	120	18	4	-	-	-	-	-	142
1984	111	26	4	-	-	-	-	-	141
1985	122	35	12	-	-	-	-	-	169
1986	123	53	10	-	-	-	-	-	186
1987	129	64	15	2	-	-	-	-	210
1988	133	46	26	4	1	-	-	-	210
1989	144	54	33	4	1	-	-	-	236
1990	152	59	60	10	6	-	-	-	287
1991	163	32	81	11	6	-	-	-	293
1992	164	27	100	22	5	4	-	-	322
1993	172	25	156	29	9	3	2	-	396
1994	179	12	223	38	12	1	6	3	474

* estimates, not counts; see Smith and Forrester 1981, Smith 1985a

no count made, only one partial census (Smith and Forrester 1981)

Translocations of Noisy Scrub-birds from the Two Peoples Bay populations to Mt Manypeaks in 1983 and 1985 resulted in a population of Noisy Scrub-birds in the area between Normans Inlet and the Waychinicup River which by 1994 had attained a population index of 223. The rate of increase in recent years has been very rapid and in some areas the density of singing males is approaching that on Mt Gardner. This population concentration now contains the largest number of singing males and there is sufficient habitat for growth and expansion to continue for some time.

Since 1990 scrub-birds have been translocated to Mt Taylor in the Gull Rock National Park (unvested), to an area near Mermaid Point in Waychinicup National Park, to Bald Island Nature Reserve south east of Cheyne Beach and, in 1994, to Stony Hill in Torndirrup

National Park south-east of Albany. This has resulted in a scattering of small population concentrations in the area between Albany and Cheyne Beach.

Overall since 1970, as a result of habitat management and translocation, the Noisy Scrub-bird population has increased and expanded from the original parent population on Mt Gardner and now (1994) occupies an estimated 4330 ha within approximately 50 km of coastal and near coastal country south and east of Albany (Figure 2). In 1994 a total of 474 singing male Noisy Scrub-birds were counted in this area which is referred to as the Albany Management Zone. Based on a rule-of-thumb of 2.5 birds for every singing male, this probably represented around 1100 individual scrub-birds. Six population concentrations were in this area and each is denoted as a subpopulation. Translocated populations (mainly at Mt Manypeaks) accounted for 51.7% of the total number of singing males in 1994.

The total number of singing males and the number present in each of the current population concentrations is given in Table 1 and graphed in Figure 3.

1.3 Habitat

Smith (1985a) studied Noisy Scrub-bird habitat on Mt Gardner during the 1970s. Based on these studies he considers that, historically, scrub-birds in the south west may have been confined to the wetter areas within the distribution of marri (*Eucalyptus calophylla*) and jarrah (*E. marginata*); in particular to the ecotone between forest and swamp vegetation.

In the area between Oyster Harbour and Cheyne Beach, the core areas of male Noisy Scrub-bird territories are found in dense, long-unburnt vegetation characterised as low forest (5-15 m high), scrub/thicket and (rarely) heath. These vegetation formations occur in the gullies and drainage lines of hills and granite mountains and, in lowland areas, in overgrown swamps, lake margins and beside streams. On hillsides singing males may be found in the taller dense vegetation around springs, in depressions and at the base of rock faces. Most male territories on Mt Gardner occur in scrub/thicket associations and this appears to be the preferred habitat type. A smaller number of territories are found in low forest and only a few in heath. Occupied sites generally have a post-fire age of ten years or more and contain a dense stratum of shrubs and sedges, which provide essential cover for these semi-flightless birds, and a thick layer of leaf litter.

Nesting habitat requires the presence of pliable, long-leaved sedges for construction of the nest and dense clumps of sedges, shrubs or piles of debris as nest sites. The nest is lined with a cardboard-like substance made from rotten wood and the presence of decomposing wood may be an important resource for nest construction. More open areas with thick accumulation of leaf litter and a well developed litter fauna are required for feeding habitat. Good scrub-bird habitat appears to contain very dense cover interspersed with small open areas with suitable nesting areas nearby.

Increasing post-fire age seems to favour scrub-birds probably because successional changes result in more suitable vegetation structure and a richer leaf litter invertebrate fauna. The steady rise in the number of singing males in the Mt Gardner area over the last 25 years is generally correlated with the successful exclusion of wildfire from about 1970. In 1994, in the area between Oyster Harbour and Cheyne beach, scrub-birds were only found in sites where the vegetation was between 10 and 50 or more years old. It is possible that the current distribution of scrub-birds in very old vegetation may reflect the lack of younger vegetation in suitable sites, rather than a preference for older vegetation.

Figure 2. Noisy Scrub-bird population concentrations in 1994 in the Albany Management Zone
(not available)

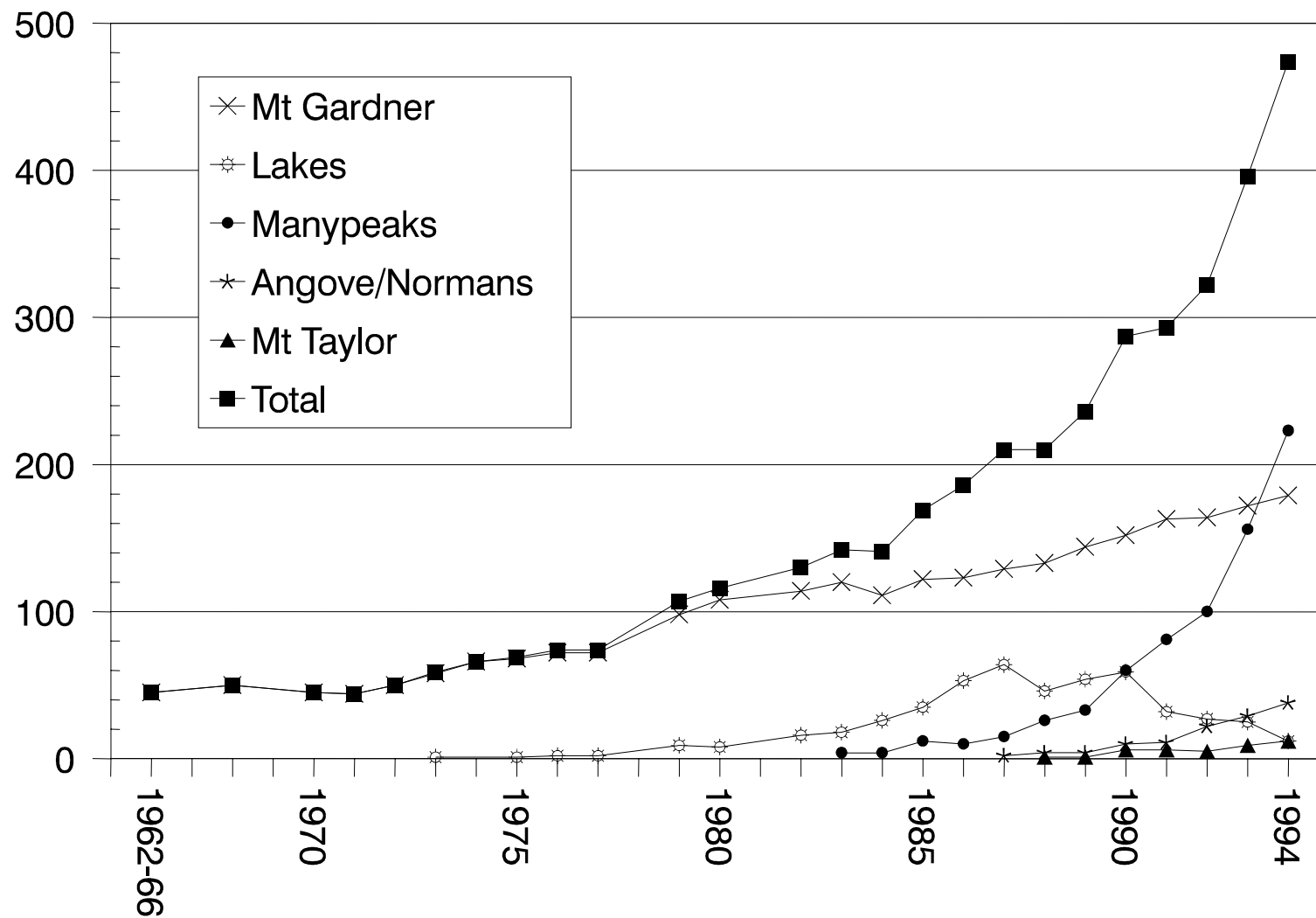


Figure 3.
Total number of singing males and number in each subpopulation

The maximum post-fire age at which vegetation can support Noisy Scrub-birds is not known and it has been suggested (Smith 1977, in prep. a) that there may be an upper limit to the post-fire age suitability of scrub-bird habitat. If this is so, this point appears not to have been reached on Mt Gardner where the post-fire age of the vegetation is 45 to 50 or more years and the number of scrub-birds is still increasing. Females are also still breeding in habitat that has not been burnt for more than 50 years. Given the exceptional age of the Mt Gardner vegetation it is possible that small scale cyclical changes (initiated, for example, by tree falls) may be mitigating the overall effect of post-fire successional changes.

1.4 Life history and ecological relationships

Various aspects of the biology of Noisy Scrub-birds have been described by Webster (1962a and b), Smith (1976, 1977, 1978, 1985a, b, c and d, in press, in prep. a and b), Smith and Robinson (1976), Robinson and Smith (1976), Smith and Forrester (1981), Smith *et al.* 1983, Smith and Calver (1984), Danks and Calver (1993), Welbon (1993) and Danks and Smith (in prep.).

Noisy Scrub-birds feed mostly on or near the ground, foraging in leaf litter, the bases of sedge clumps, dense shrubs and decaying wood. The diet of adult scrub-birds has been studied recently by examination of faecal material (Danks and Calver 1993). Although the remains of invertebrates from seven orders were found in faecal samples, the major prey items, in order of abundance, were ants, beetles and spiders. Together these three groups comprised 75.1% by number of all prey in faecal samples. Examination of faecal sacs from nestlings showed that young were being fed a range of invertebrates including spiders, grasshoppers, crickets, cockroaches, earthworms, centipedes, millipedes, various insect larvae and, occasionally, small frogs and lizards. Spiders and orthopterans made up 62% of the individual food items fed to nestlings (Smith and Calver 1984).

Further studies of scrub-bird diet aimed at improving the ability to select suitable translocation sites were undertaken in 1992 by an Honours student from Murdoch University. This project examined the species composition and vegetation structure of scrub-bird habitat and assessed potential food resources in nine occupied territories at Two Peoples Bay. All territories were characterised by a dense lower stratum of shrubs and sedges and had abundant leaf litter. Invertebrates from 17 groups were collected from leaf litter and by pit-trapping. The most abundant were beetles, spiders, woodlice, sand hoppers, flies, ants and springtails. The study also examined aspects of feeding behaviour in captivity and determined the nutritional composition of the invertebrates most commonly found in scrub-bird droppings (Welbon 1993).

Male Noisy Scrub-birds are territorial, defending their territories with a loud, directional song that can be heard throughout the year, but which is more frequent during the breeding season of May to October. Between 1973 and 1976, the mean male territory size at Mt Gardner was 6 ha (range 4 to 9 ha), and within this area 80% of the calls were made in a core area that averaged 1.25 ha (0.75 to 2.25 ha) (Smith 1985b). Smith (1985b) also distinguished two types of territory: long-term territories in which the males sing throughout the year and nesting probably occurs every year, and short-term territories where the male sings infrequently during the breeding season and breeding may take place only in some years. With increasing numbers of singing males on Mt Gardner this distinction has become less clear-cut. The majority of males on Mt Gardner currently appear to be occupying sites which would have once been considered of low breeding potential.

Removal of birds for translocation has shown that, in most cases, the territorial male is replaced by another male who then proceeds to sing and defend that territory. In some cases replacement may be rapid, and in one territory three singing males were sequentially removed, and replaced by new males over a period of four days. This and the replacement, after removal of a series of territorial males, by a very young male strongly suggests that the replacement males are not immigrants from other areas but are permanently present in or near the territories of the singing males (Danks and Smith, in prep.). The presence of non-territorial males may reflect the quality of the habitat and the length of time over which breeding has been occurring.

The female builds her nest on the outskirts of, or in between male territories. Territorial males seldom visit these areas. In successive years, the female may build within metres of previous nests but often moves to another site to re-nest and re-lay after disturbance or predation of the nest. A nesting area may be used by the female over many years. Females replacing translocated females will often nest in the same area as the original female, suggesting that nest areas are recognised by other females and that nest site selection is not idiosyncratic. On Mt Gardner several nesting areas are known which have been in use since 1974, and perhaps as early as 1972.

The period from the start of nest building to the last chick leaving the nest may extend from May to November, but more commonly lasts from June to October. Egg laying may begin as early as May but the peak of laying usually occurs in late June. Some eggs, possibly replacement clutches, may be laid late in September or early October. The nest is globular, approximately 18 cm in diameter, with a small side entrance. It is usually sited about 20 cm above the ground in a dense clump of sedge or, less commonly, in a dense shrub or pile of debris. The long leaves of pliable sedges such as *Anarthria scabra* and *Lepidosperma* spp. are used for the construction of the core with the leaves of *Agonis flexuosa*, *Eucalyptus* spp. and *Dryandra formosa*, twigs and strips of paperbark often being used for the outer layers of the nest. The lower half of the nest interior is lined with a papier mache'-like substance made from decayed wood.

Nest building takes two or three weeks and the single egg is laid one to two weeks after its completion. Nest building, incubation and feeding of the nestling are all carried out by the female. Incubation lasts 36 to 38 days (which is unusually long for a passerine of comparable size) and the chick fledges three to four weeks after hatching. Most young hatch in late July or early August, leaving the nest in late August or early September when invertebrate numbers could be expected to be increasing. Chicks have been observed in the company of an adult female up to six months after fledging.

Scrub-birds moult from their juvenile (pre-basic) plumage into a first basic plumage shortly after fledging. They carry this plumage until their second year when they slowly moult again into full adult plumage between October and March (Smith 1985c). The annual moult of adults apparently also occurs during the summer but in some years scrub-birds showing incomplete moult have been captured in June.

In captivity a 22 to 25 month old male did not successfully fertilise females, although he was in adult plumage and singing territorial song (Smith *et al.* 1983). However, the presence of other captive scrub-birds and the resulting aggressive encounters between the birds, may have interfered with copulation. Successful fertilisation was achieved in the male's third year when aviary management had separated the birds and controlled the access of the male to the females. The captive females built nests and laid eggs in their first year and females in the wild are known to breed in their first year (Smith 1978).

Generally only one active nest is found in a nesting area (Smith 1985b) although, on one occasion during nest searching for the translocation program, two active nests were found

which were only 20 m apart. Trapping in two adjacent territories during breeding seasons between 1983 and 1991 resulted in the capture of six non-breeding females and four breeding females (indicated by active brood patches), with only one apparently breeding female being captured during any one trapping season. The male held in captivity, however, mated with three females in one breeding season and some observations suggest that males will mate with more than one female in the wild (Smith 1985a). Males may therefore be opportunistically polygamous.

Of 53 active nests examined during the translocation program one, and possibly one other, were considered to have been predated. Smith and Robinson (1976) report the predation of scrub-bird eggs by the Mardo *Antechinus flavipes* (a small dasyurid marsupial). Snakes such as *Morelia spilota*, *Notechis scutatus* and *Pseudonaja affinis*, together with the goanna *Varanus rosenbergi*, which are all common in scrub-bird habitat, could conceivably prey on scrub-birds, especially nestlings and chicks. However, the timing of the breeding season, which generally coincides with the period of reptilian inactivity, would minimise nest predation by these species. The fox might also be expected to prey on scrub-birds. However, the density of vegetation normally inhabited by scrub-birds probably provides sufficient protection against these introduced predators. Prior to a control program begun in 1988, foxes were often seen in Two Peoples Bay Nature Reserve. The steady increase in scrub-bird numbers on Mt Gardner during the 1970s and 1980s, before fox control was carried out at the Reserve (see Section 2.4.2) suggests that predation by foxes, or any other predator, was not seriously affecting the population.

1.5 Effective population size

The relationship between the census size (ie, the number of singing males) of a population of the Noisy Scrub-bird, the effective population size (ie, the number of breeding adults, N_e) and total population size (N) is not known. Attempts to define these relationships in the field would be very difficult because:

1. The species is cryptic and lives in dense habitat, making the counting of individuals by observation extremely difficult.
2. Determining the number of breeding birds would require finding active nests. However, nests are difficult to find so failure to find a nest in any given territory does not necessarily indicate lack of breeding.
3. Within each habitat type the carrying capacity in terms of the number of breeding females and/or sub-dominant males may vary. Hence, estimating carrying capacity, even by sampling of habitat types, would be difficult.
4. Data on breeding potential can not be transferred from one area to another because the number of reproductively active birds may vary with population density; for example, the first subdominant male at Two Peoples Bay was recorded in 1975, but by 1983 all territories where males were captured for translocation appeared to have one. A similar situation probably applies to females.

Thus, when considering the population objectives for this plan, the only reliable population index remains the number of singing males. Estimates of N_e and N require assumptions, the accuracy of which are unknown. Despite these limitations, it is worthwhile to attempt to estimate N_e so as to provide a rough guide to the status of the population.

Smith (in press) has calculated a range of values for N_e using the formula of Ewens *et al.* (1987) and a range of assumptions about the number of breeding females in a territory in

relation to the habitat type. These assumptions are based on limited data and are at best crude estimates. Smith (*op. cit.*) considers that the following two assumptions (his assumptions 2 and 3) probably span the real productive potential. The first assumption is that all territories except those in heath have one breeding pair and 50% of territories in low forest have one extra breeding pair. The second is that all territories in low forest and tall thicket have one breeding pair, 50% of territories in low thicket have one breeding pair and 25% of territories in low forest have one extra breeding female.

The values of N_e calculated from the population and habitat data at Two Peoples Bay from 1987 and 1988 are provided in Table 2. Based on these assumptions, Smith (*op. cit.*) suggested that to reach a N_e of 500 (see 1.6 below) would require between 208 and 311 territories, if the proportion of habitat types remained the same. However, at Mt Gardner, most new territories are now in thicket and hence a larger number of territories would be required. There is insufficient habitat data from other population concentrations to allow an estimate of N_e for them.

Table 2.
Effective population size, N_e , using Smith's
(in press a) assumptions 2 and 3
(for the Two Peoples Bay population)

	1987	1988
No of singing males	193	179
N_e , Assumption 2	432	395
N_e , Assumption 3	382	345

As stated above, the relationship between the number of singing males and total population (N) is also unknown, but we suggest a rule of thumb of $N = 2.5$ times the number of singing males. At the present time (1994) N is estimated to be 1185.

1.6 Reasons for threatened status

The disappearance of the Noisy Scrub-bird from most of its former range is thought to have been due primarily to a major change in fire regimes following the breakdown of Aboriginal society by the 1880s and the subsequent changes wrought on the environment by Europeans. Formerly, Aboriginal people deliberately burnt certain areas for hunting, ease of access and other purposes, which maintained generally low fuels but prevented any one area being burnt too frequently. Under this regime there must have been considerable areas of dense, long-unburnt vegetation around swamps to allow for the former relative abundance of scrub-birds. The fire regime altered when Aborigines left the land, allowing fuels to build up over large areas, and fires that did occur were probably hot and extensive. Further, as cattle grazing became established in coastal heaths and swamps, the practice developed of burning this country every two or three years to provide new growth suitable for feed. The clearing and draining of swamps for agriculture would also have contributed significantly to the loss of habitat (Smith 1977, 1985d).

The small population which remained on Mount Gardner was protected from the effects of frequent or extensive fires for several reasons. The peninsula on which the mountain is situated juts south-easterly into the Southern Ocean and is unlikely to be burnt by large scale

wildfires running before the predominantly easterly winds of summer. Furthermore, the mountain has extensive areas of exposed granite which act as natural fire breaks and a number of deep, wet gullies. In this landscape fires would probably have been confined to relatively small areas and a single fire would have been unlikely to affect all of the gullies which provided refuge for the Noisy Scrub-bird. This fortuitous combination of geographic features is not repeated anywhere else in the scrub-bird's former range.

There has been some disagreement about the status of the Noisy Scrub-bird. In 1990, the Royal Australasian Ornithologists Union (RAOU) listed it as Rare (Brouwer and Garnett 1990), even though the compilers of the text for this species (two of the authors of this Recovery Plan) recommended it be listed as Endangered. In 1991 the Australian and New Zealand Environment and Conservation Council (ANZECC) listed it as Vulnerable (ANPWS 1991). However, more recently, the Action Plan for Australian Birds prepared by RAOU for the Australian National Parks and Wildlife Service (Garnett 1992b) lists it as Endangered, and ranks it equal ninth in priority for conservation action among all Australian bird taxa (including many subspecies). This listing is repeated in Garnett 1992a. These differences have occurred because of the subjective nature of allocating taxa to the IUCN categories of Endangered, Vulnerable, Rare and Indeterminate used in those times.

In 1991, a re-evaluation of the IUCN Threatened Species categories for vertebrates recommended that three categories be employed: Critical, Endangered and Vulnerable, and that categorisation be based on the probability of extinction over time (Mace and Lande 1991). Under this draft system a species meeting two of the following: a total effective population (N_e) of less than 500, having a fragmented population with five or less subpopulations, each with N_e less than 100 and immigration rates of less than one per generation, or subject to periodic catastrophes is categorised as Endangered.

In 1994, the total number of singing males in the whole Albany Management Zone was 474 and N_e for the total population probably now exceeds 500 (see Section 1.5). However, the species still clearly meets the Mace and Lande (*op. cit.*) criteria for classification as "Endangered" because the population is fragmented with no known gene flow between populations and it is subject to catastrophic crashes (due to wildfire). Also the total population is well below the figure of 2 500 given by Mace and Lande (1991) as the upper limit for endangered taxa.

In November 1994, IUCN adopted the new Red List Categories of Critically Endangered, Endangered and Vulnerable together with criteria for evaluating taxa (IUCN 1994). During 1995, a Scientific Ranking Panel set up by CALM evaluated all taxa that were listed as threatened using the IUCN criteria as a guide. This Panel recommended that the Noisy Scrub-bird be categorised as Endangered and this recommendation was endorsed by the Minister for the Environment.

2. EXISTING CONSERVATION MEASURES

2.1 Creation of Two Peoples Bay Nature Reserve

At the time of the rediscovery of the Noisy Scrub-bird late in 1961, the Two Peoples Bay area was a collection of unvested reserves and vacant Crown land. The area was used by professional fishermen and there was a growing number of squatters' holiday shacks near the southern end of Two Peoples Bay. Consideration was being given to the declaration of a town site, to be known as Casuarina, to cater for holiday makers and anglers (Chatfield in prep., Coy *et al.* a in prep.).

Confirmation of the scrub-bird's presence began a process which, through the efforts of many conservationists, including H.R.H. the Prince Philip, Duke of Edinburgh, eventually resulted in the cancellation of the town site and the gazettal, in 1967, of the Two Peoples Bay Nature Reserve with the purpose "Conservation of Fauna". As a Class A reserve, the tenure and purpose can only be changed through an Act of the Western Australian Parliament.

The first written management plan for the nature reserve was adopted in 1971. Public use of Two Peoples Bay Nature Reserve is restricted and no camping is allowed. Nevertheless, the reserve is a popular tourist destination in the Albany area and receives about 35 000 visitors per annum. A Reserve Manager has been stationed on the reserve since 1970 and the staffing level was increased to two in 1985 with the appointment of an assistant. A new, more comprehensive draft Management Plan (according to the provisions of the Conservation and Land Management Act 1984) was released for public comment in June 1993 (CALM 1993). Following analysis of public submissions to the draft, a final Management Plan was prepared and has been approved by the Minister for the Environment. Under this Plan the Reserve is proposed to become a National Park.

2.2 Ecological research

Initial studies on the Noisy Scrub-bird were reported by Webster (1962b). CSIRO involvement with the Noisy Scrub-bird started in 1966 with the transfer of Canberra biologist F.N. Robinson to Perth. Robinson commenced a part-time study, concentrating on vocal behaviour, but also started some ecological studies, including surveys of former locations and other areas where the species may have survived. Much of this work was done in collaboration with the late H.O. Webster. In 1968 the Western Australian Wildlife Authority (in which the Two Peoples Bay Nature Reserve was vested) decided to ask the then CSIRO Division of Wildlife Research to expand its work at Two Peoples Bay. Following discussions with the Chief of the Division, Dr H.J. Frith, a research proposal was agreed to, and a research scientist, Dr G.T. Smith, was appointed, commencing work in June 1970. As well as studying the ecology of the Noisy Scrub-bird, Smith also studied the Western Bristlebird and Western Whipbird, additional threatened birds that occur at Two Peoples Bay.

These ecological studies continued until mid-1977; however, monitoring the Noisy Scrub-bird population continued until 1985, assisted by G.L. Folley of then Department of Fisheries and Wildlife. After 1985, the senior author undertook the bulk of the monitoring and CSIRO involvement ceased at the end of 1988. Opportunities for further research on scrub-birds have been provided by the translocation program because it involves regular capture of birds that are difficult to observe in the wild. Recent studies have included post-release radio-telemetry of translocated birds, diet studies and determination of prey availability.

2.3 Captive breeding

The small population and an apparent decline in the number of singing males at Mt Gardner in the late 1960s lead to an attempt to breed the Noisy Scrub-bird in captivity (Davies *et al.* 1982, Smith *et al.* 1983). If successful, captive breeding might have provided birds for reintroduction to new sites. In 1975 and 1976 four nestling Noisy Scrub-birds were removed from nests at Two Peoples Bay and taken to Perth where they were hand-reared and became the founders of a captive population at the CSIRO's Helena Valley Research Station. In 1979, when access of the male to the females was controlled, he successfully mated with all three females. Unfortunately, the chicks died soon after hatching. However, one of the females nested again later in the same breeding season, and raised her chick to adulthood - this was the only captive born chick to reach adulthood. Two chicks which died in the following year were diagnosed to have suffered from nutrient deficiencies (Smith *et al.* 1983). The program was terminated in 1981.

Although not successful in reaching its main objective the program did show that it was possible to hand rear scrub-bird chicks, to maintain the birds in captivity for long periods and to get them to mate, nest and lay eggs in captivity. Observation of the captive birds also improved knowledge of their breeding biology and behaviour. The program highlighted difficulties with aviary management, food production and nestling mortality and was very expensive.

2.4 Habitat management

Noisy Scrub-birds require vegetation which has not been burnt for relatively long periods (see section 1.3). The aim of habitat management is therefore to maintain occupied and potential habitat free of fire for as long as possible. As mentioned previously, it is possible that very long periods without fire may result in reduced suitability for scrub-birds although there is no evidence of this to date. If there is an upper limit to the post-fire age suitability of scrub-bird habitat it is likely to first show up in the Mt Gardner area because the post-fire ages of vegetation communities in this area are much older than in other areas occupied by scrub-birds. Population and habitat monitoring must continue in this area so that any detrimental successional changes can be detected.

Unfortunately, increasing post-fire age also produces a large build up of fuels which could mean more extensive and damaging wildfires. The growth of granite community vegetation over very long periods can reduce the area of exposed rock thereby limiting the ability of these areas to act as firebreaks during fire events. Successful fire exclusion necessarily means considerable effort must be put into protection and suppression measures.

To protect an area from wildfires originating outside the area may require the construction of firebreaks and/or fuel reduction burning in strategic locations. Fire prevention within an area may require control of visitor activities, the enforcement of fire regulations and constant surveillance during fire-risk periods and the development of contingency plans for dealing with fires within or threatening the area. Wildfires caused by lightning strike or people in locations remote from vehicle access present a particular problem and their effective control requires specially trained ground crews.

Dieback disease, caused by the fungus *Phytophthora cinnamomi*, kills many plant species and causes extensive and dramatic damage to many plant formations. Broadscale mapping of Two Peoples Bay Nature Reserve over the period 1989 - 1992 has shown that the reserve is extensively infected. The fungus has probably been present at Two Peoples Bay for many decades (Hart in prep.) and its effects pre-date research into Noisy Scrub-birds. In the short term it is likely that infection could have significant detrimental effects on scrub-bird habitat,

but in the longer term re-invasion by resistant species of plants, eg, sedges, can lead to the development of habitat that continues to support breeding birds. The continuing growth of the scrub-bird population on Mt Gardner in spite of the presence of *P. cinnamomi* is evidence for this.

While the effects of dieback disease on scrub-bird populations may be tolerable in the longer term, great care needs to be taken to prevent further spread of the disease, especially to translocation release areas where it may have devastating results for other threatened species as well as reducing the suitability of habitat for scrub-birds during the initial phase of population establishment. Effective vehicle and boot hygiene methods and accurate dieback maps are needed to limit artificial spread of the disease.

2.4.1 Two Peoples Bay Nature Reserve

From the time of rediscovery until the establishment of additional, translocated populations, all Noisy Scrub-birds were contained within Two Peoples Bay Nature Reserve. Prevention and control of wildfire was the most important aspect of reserve management. A number of firebreaks were constructed and a low fuel buffer system developed. Successful exclusion of fire from scrub-bird habitat allowed the vegetation to mature, increasing its suitability for scrub-birds and resulted in a steady increase in numbers (Figure 3).

Despite the establishment of other subpopulations (see section 2.4) Two Peoples Bay Nature Reserve remains the single most important area for scrub-birds. Although the Mt Gardner area no longer (1994) contains the largest number of singing males, it presumably contains all or almost all of the species' genetic variability. It is also likely to continue to be the major source of birds for the translocation program. Continued protection and management of scrub-bird habitat within Two Peoples Bay Nature Reserve is therefore an essential part of Noisy Scrub-bird recovery.

Scrub-bird habitat burnt by wildfires becomes unsuitable for Noisy Scrub-birds for varying periods. The wetter gullies and lake edges may regenerate fast enough to become suitable again within four to ten years, but other, less moist areas may not become suitable for decades. Frequent or extensive fires in scrub-bird habitat would render it useless for scrub-bird conservation. Between 1964 and 1994 no wildfire affected habitat occupied by Noisy Scrub-birds. A lightning strike on Mt Gardner in December 1989 burnt an area adjacent to occupied habitat that may have been used by scrub-birds. Fortunately, cool conditions and rapid suppression actions by CALM staff allowed the fire to be contained within a very small area. In January 1992, lightning caused a wildfire which burnt an area containing two scrub-bird territories at the eastern edge of the Mt Manypeaks population.

2.4.2 Other areas

In the absence of a full management plan, Interim Management Guidelines for the Waychinicup area (which includes Waychinicup National Park Stage 1 and part of Stage 2 as well as Mt Manypeaks Nature Reserve) have been written as a guide to management actions and directions. The Mt Manypeaks area in 1994 contained the greatest number of singing male scrub-birds and, in the absence of fire, the population is likely to continue to increase. This area also houses important populations of Western Whipbird, Western Bristlebird and Ground Parrot in addition to Noisy Scrub-birds. The exclusion of fire from the mountain range is a major strategy in these guidelines.

A fire management strategy for the Angove Creek Catchment Area (vested in the Western Australian Water Authority (WAWA)), where a small but important population concentration of scrub-birds now occurs, is being developed in association with WAWA. The Mt Taylor

area in Gull Rock National Park will be covered by an Interim Management Guidelines when this area becomes managed by CALM.

The management of other areas associated with Noisy Scrub-birds such as the Nuyts Wilderness release site in Walpole - Nornalup National Park and potential release sites in Leeuwin - Naturaliste National Park, are covered by area management plans. No area management plan or interim guidelines yet exist for Quarram Nature Reserve.

2.5 Translocation

The establishment of new populations by translocation of wild-caught scrub-birds will provide additional security against wildfire, the major threat to the species and will allow the total population to expand and grow more rapidly to a greater size than would be possible on Mt Gardner.

2.5.1 History of Noisy Scrub-bird translocations

Translocation of the Noisy Scrub-bird was first attempted as an experiment in 1983 when D.V. Merton of the New Zealand Wildlife Service (now part of the New Zealand Department of Conservation), G.L. Folley of the former Department of Fisheries and Wildlife and the senior author developed techniques for capture and transfer of scrub-birds. Capture techniques have been improved with time and experience but the same basic strategy of capture in the wild, temporary holding in captivity, transport and release at a pre-selected release site, followed by monitoring of the release area and the donor population, has been followed since 1983. Danks (1994) gives an overview of Noisy Scrub-bird translocations from 1983 to 1992.

In June and July 1983 ten male scrub-birds and four females were released in two large gullies north-west of the main peak of Mount Manypeaks about 15 km east of Mt Gardner. A further two females were translocated to these gullies in November of the same year. By the winter of 1984 at least four of the translocated males were defending territories. Another two singing males were detected in early 1985.

A further 16 scrub-birds from Two Peoples Bay were released at four separate sites in the Mt Manypeaks area in 1985. Territorial males sang at most of these sites for several months following release but, one year later in the 1986 breeding season, no scrub-birds were detected at the 1985 release sites. Males continued to sing at the 1983 sites and other males established themselves in other locations on the mountain. In 1988, five years after the first releases, there were more males singing on Mt Manypeaks than had been released, indicating local breeding was occurring. Since then the number of singing males has increased rapidly and they have spread into almost every gully between Normans Inlet and the Waychinicup River. In 1994 the number of singing males on Mt Manypeaks reached 223 representing 47.1% of the total for the area between Oyster Harbour and Cheyne Beach.

In 1986 and 1987 a total of 31 (16 males, 15 females) Noisy Scrub-birds from Two Peoples Bay Nature Reserve were released in two areas in the Nuyts Wilderness area of Walpole - Nornalup National Park 150 km west of Two Peoples Bay. Three males were heard singing in one of these areas late in 1986 and, in 1988, two were heard in the second release area. However, despite regular searching, no others have been detected and this transfer is deemed to have failed. The cause of this failure is not known but, as capture, transfer and release techniques were almost identical to those used at Mt Manypeaks, it is likely that site-related factors may be involved.

Based on habitat similarities between Owingup Swamp in Quarram Nature Reserve and the Lakes area at Two Peoples Bay where scrub-birds were flourishing, a translocation to

Quarram was undertaken in 1989 and again in 1990. Although four males were heard singing in the release area shortly after the 1989 translocation, no further males have been detected. The apparent failure of this transfer may be related to the reasons for the decline in number around Lake Gardner that occurred in 1988 and 1991, which was thought to be due to flooding.

The discovery, in 1988, of a single male in the Mt Taylor area, 14 km west of Mt Gardner, signalled the presence of suitable habitat and it was considered likely that a small subpopulation could be quickly established there by translocation from Two Peoples Bay. The initial release, in 1990, consisted of five males and two females and a further two females were released in 1991 when six males were singing in the area. Another male and two females were released in 1992, when only five singing males were counted; however, in May 1993, the number of singing males had increased to nine. By August 1994 there were 12 singing males in the area around Mt Taylor.

The small number of birds involved in the Mt Taylor translocations represented a departure from previous strategies when 15 to 18 males and a similar number of females were transferred to each release area. At Mt Taylor, only one female was released with the initial batch of males. More females followed only after persistence of males at the site had proven its suitability for Noisy Scrub-birds. Subsequent translocations have used a similar strategy: a small group of males is released initially and their persistence monitored. If these males continue to defend territories in the release area females are then translocated.

In 1992 translocations were initiated to the Mermaid area (Figure 2.) and, following approval by the Director of Nature Conservation and the National Parks and Nature Conservation Authority, to Bald Island Nature Reserve. Five male scrub-birds were introduced to Bald Island, courtesy of the Channel 10 helicopter, in June 1992. Monitoring in April and May 1993 revealed that at least two survived the summer, suggesting that there was a good chance of establishing a population on the island following further introductions. Since then three females and three males have been added to those already on the island and monitoring in 1994 revealed six males singing.

The most recent translocation of Noisy Scrub-birds occurred in June 1994 when five males were released at Stony Hill in Torndirrup National Park south of Albany.

In summary, up to 1994, a total of 125 Noisy Scrub-birds have been translocated to seven areas over a period of eleven years. Translocations to Mt Manypeaks and Mt Taylor, both relatively close to Two Peoples Bay and therefore close to the species' known historical range on the south coast, can be considered successful. The two more distant translocations, Nuyts Wilderness and Quarram, have apparently failed. Translocations to the Mermaid area, Bald Island and Stony Hill are too recent for evaluation. Longer term success with local breeding and rapid population growth has so far occurred only in the Mt Manypeaks area. Experience has shown that the creation of a thriving population by translocation may take ten years from the initial selection of release sites.

2.5.2 Reasons for failure of some translocations

The reasons for the lack of success at Quarram and Nuyts are not known, but habitat suitability is an obvious possibility. It is important to try to understand why these translocations of scrub-birds have been unsuccessful so that procedures for site selection and transfer techniques can be improved. Griffiths *et al.* (1990) surveyed 134 translocations of birds (including the translocation of Noisy Scrub-birds to Mt Manypeaks) and 64 translocations of mammals in four countries over the period 1973 to 1986. Only 44% of these translocations were considered successful. Their data show that the habitat quality of the release area is the most important determinant for successful translocation and that releasing

large numbers of animals does little to increase the probability of success of translocations. Experience with translocation of scrub-birds since 1983 is consistent with these findings.

Following the significant reduction in numbers of singing males in the Lakes population in 1988, fox control was instigated within the Two Peoples Bay Nature Reserve. A further sudden drop in numbers occurred in 1991 and the decline has continued despite a reduction in fox numbers, suggesting that foxes are not implicated in these population declines. However, numbers of Southern Brown Bandicoots (*Isodon obesulus*) in the reserve appear to have increased significantly since 1988, consistent with results of fox control elsewhere (Kinnear *et al.* 1988, King and Kinnear 1991). Fox control has been intensified on the nature reserve since the rediscovery there of Gilbert's Potoroo (*Potorous tridactylus gilbertii*) in November 1994.

Birds released into unfamiliar habitat are likely to face higher levels of predation and exposure. Predation by the fox, although not considered to have impacted on the scrub-bird population living in dense habitat at Two Peoples Bay, may have been a factor in the failure of scrub-birds to survive at Nuyts and Quarram. It's also possible that the availability of invertebrate prey may be lower in these areas than at Mt Gardner.

Information about the behaviour of scrub-birds immediately after release in a new area may be important in understanding why some translocations are more successful than others. Radio-tracking of two of the males released at Mt Taylor in 1990 showed that, although both displayed an initial attachment to their release site, they differed significantly in behaviour. One bird, tracked for two days after release, stayed close to the release site moving no more than 200 m but was not heard to sing. The second sang frequently from 10 minutes after his release, interacted noisily with the resident territorial males and showed daily movements of up to 800 m from his roost area. By the fifth day he had settled in an area 400 m from the point of release. This pilot study showed that radio-telemetry techniques can provide previously unobtainable information about the post-release behaviour of Noisy Scrub-birds. As such it is an extremely valuable tool for increasing our understanding of the translocation process and may allow improvements to be made in the strategies currently used. Radio-tracking studies on both males and females released at the Mt Taylor and Mermaid sites have continued (A. Danks, J. Rolfe & A.H. Burbidge unpublished).

2.5.3 Resources for translocation

Since 1985, translocation and the monitoring of release areas has been the most intensive activity in the Noisy Scrub-bird management program. Release site selection, organising and preparing for translocation projects, capture and release of birds, and monitoring of an expanding number of release areas and of the parent populations require about eight months full-time work each year. Although valuable assistance has been provided from other CALM staff and volunteers, this work has largely been carried out by one person, who also has other duties associated with the management of Two Peoples Bay Nature Reserve.

Management of the Two Peoples Bay Nature Reserve as well as an increasing population of scrub-birds and an expanding management program is now beyond the capacity of one person and there is a requirement for an additional staff member to assist with the program. Noisy Scrub-birds are difficult and time-consuming to capture. Obtaining sufficient numbers for translocation each year requires considerable preparation and the operation of a small team of experienced people for several months. The translocation of the relatively large numbers since 1983 would not have been possible without the assistance of over 30 voluntary workers who gave their time and enthusiasm to this task.

2.6 Population monitoring

To determine the success or otherwise of each translocation requires regular monitoring of the release sites. A count of singing males immediately after release, and again at the beginning of the next breeding season, will show whether males are establishing territories in the area. Once breeding is occurring, indicated by an increase in the number of singing males above the number released, an annual census can provide information on the growth of the new population.

Keeping track of the growth and expansion of the scrub-bird population in the Oyster Harbour - Cheyne Beach area requires regular counts of singing males in the five population concentrations, as well as searching of nearby areas for new singing males. Until 1987 only the Mt Gardner, Lakes and Mt Manypeaks areas were censused. Wider searching and annual counts of the additional subpopulations within this management zone have become routine since then.

The regular removal of breeding birds from Mt Gardner has the potential to affect the growth of the parent population. Replacement of translocated males from within the population is monitored by regular checking of territories from which birds have been removed. These data and the annual census of singing males have shown that removals for translocation at current rates have so far had no effect on the parent population (Danks and Smith in prep.).

2.7 Review of 1986 management program

Two strategies were proposed in the 1986 Management Program (Burbidge *et al.* 1986): habitat management at Two Peoples Bay Nature Reserve and translocation to establish new populations. The aim of the translocation program was "to establish additional populations of the Noisy Scrub-bird, so that there are at least four reproducing populations at any one time" (p. 21). The program anticipated that some populations would be wiped out or seriously depleted by fire from time to time and that these would need re-establishment after the habitat had regenerated. It suggested that it would be "necessary to establish perhaps six to eight populations in order to ensure that there are at least four viable populations at any one time" (p. 22).

In 1991, a shortage of funds and the failure of translocations west of Albany led CALM to postpone translocation for that year and conduct a review of the 1986 management program. As part of the review CALM arranged for Don Merton of the New Zealand Department of Conservation to visit Two Peoples Bay and the translocation sites and review CALM's procedures in the light of his considerable experience in the conservation of threatened birds world-wide. In May 1991, at the conclusion of the visit, a workshop was held and the recommendations developed at and after the workshop were considered by CALM's Corporate Executive later in the year. The review resulted in additional funds being allocated to the South Coast Region specifically for scrub-bird management, the setting up of a Recovery Team, the preparation of this Recovery Plan, the re-commencement of the Two Peoples Bay Nature Reserve Management Plan and a decision to seek external funds to pay for the implementation of some parts of the Recovery Plan.

2.8 Biodiversity benefits of conserving the Noisy Scrub-bird

Protection and management of Noisy Scrub-bird habitat and adjacent areas within Two Peoples Bay Nature Reserve conserves a wide variety of ecological communities and taxa, typical of the wetter parts of the south coast of Western Australia. Information on the reserve's biota has been summarised in Hopkins and Smith (in prep.).

Aside from the Noisy Scrub-bird many other taxa are of special interest. These include the Western Ringtail Possum *Pseudocheirus occidentalis*, Southern Brown Bandicoot *Isodon obesulus*, Western Bristlebird *Dasyornis longirostris*, Western Whipbird *Psophodes nigrogularis*, Australasian Bittern *Botaurus poiciloptilus*, Red-eared Firetail *Stagonopleura oculatum*, Peregrine Falcon *Falco peregrinus*, Carnaby's Black Cockatoo *Calyptorhynchus funereus latirostris* and the Carpet Python *Morelia spilota*, all of which are declared rare or in need of special protection under Section 14(2)(ba) of the Western Australian Wildlife Conservation Act. The Action Plan for Australian Birds (Garnett 1992b) lists the Western Bristlebird and the western heath subspecies of the Western Whipbird as Endangered and Carnaby's Black-Cockatoo as Vulnerable. The reserve also contains *Banksia verticillata*, *Adenanthos cunninghamii*, *Stylidium plantagineum*, and the moss *Pleurophascum occidentale* (which is only known from the Two Peoples Bay Nature Reserve) all of which have been declared under Section 23F(2) of the Act. The population of the Quokka *Setonix brachyurus* is one of the few mainland populations of this species.

In late 1994 Gilbert's Potoroo *Potorous tridactylus gilbertii*, which had been presumed to be extinct, was rediscovered in the Mt Gardner area of the reserve (Sinclair *et al.* in press). This animal, collected only from the King George Sound area last century, had not been recorded for over 100 years. It presumably survived at Mt Gardner for similar reasons to the scrub-bird (see section 1.6). Fox control and management of Two Peoples Bay Nature Reserve for the Noisy Scrub-bird has probably contributed to its survival in recent years.

Management for the Noisy Scrub-bird has also benefited at least two of the other threatened species present. The population of the Western Bristlebird within the reserve appears to have increased since the early 1970s. Between 1976 and 1983 Smith (1985d) noted an increase from 86 pairs to about 100 pairs and attributed this increase to the exclusion of fire. In 1991 mapping of Bristlebird calling locations indicated 245 occupied territories (Danks, unpublished data). Similarly, an increase from 87 pairs to about 100 pairs was noted for the Western Whipbird (Smith 1985d). An incomplete count in Two Peoples Bay Nature Reserve in 1991 indicated at least 110 pairs (A. Danks, unpublished).

The long post-fire age of many areas on Mt Gardner, which is a direct result of habitat management for the Scrub-bird, also may have contributed to the unusual richness and species diversity of fungi. Recent collecting at Two Peoples Bay Nature Reserve has shown the presence of over 400 species of higher fungi, some of them new to science (K. Syme¹ personal communication).

Many of the above threatened taxa are also found in smaller numbers in other localities within the Oyster Harbour - Cheyne Beach area. Several rare plant species including *Corybas limpidus*, *Adenanthos cunninghamii*, *Banksia verticillata* and *Stylidium plantagineum* are found in the Gull Rock National Park where Noisy Scrub-birds and Western Whipbirds are also present. Goodga River and Boulder Hill Reserves are important for their populations of the critically endangered *Andersonia* sp (Two Peoples Bay). Waychinicup National Park (Mt Manypeaks area) contains the declared rare plants *Banksia verticillata*, *B. brownii*, the fern *Asplenium obtusatum* and populations of the Western Bristlebird and the Western Whipbird. Numbers of these two bird species have increased since a survey in 1985 (McNee 1986, A. Danks, unpublished). The area also has historic records for the endangered Ground Parrot (Watkins 1985). Sightings and calls have recently shown the Ground Parrot to be present in several areas of the eastern part of this area (Danks unpublished data). Garnett (1992a) considers the Two Peoples Bay - Mt Manypeaks area to be the most important area in mainland Australia for endangered birds. Habitat management designed primarily to conserve

¹ Katrina Syme, RMB 1020, South Coast Highway, Denmark, W.A. 6333

the Noisy Scrub-bird population concentrations in this area will inevitably benefit other threatened species, as has occurred at Two Peoples Bay Nature Reserve.

Protection of the lakes and streams of the Two Peoples Bay Nature Reserve has helped maintain an extremely rich and distinctive aquatic invertebrate fauna. Recent surveys have found 247 taxa. At least two undescribed species of rotifer were collected with two other species being recorded in Australia for the first time. At least five undescribed species of cladoceran were collected and a further five were recorded in Western Australia for the first time. Among the larval chironomids, four taxa had not previously been collected, although the adults may have been described. It seems likely that maintenance of water quality and habitat structure as a result of reservation are the primary reasons for this diverse fauna persisting while changes are occurring in community composition of most other Western Australian wetlands (Storey *et al.* 1993; Coy *et al.* b in prep.).

2.9 Noisy Scrub-bird Recovery Team

The Noisy Scrub-bird Recovery Team first met in February 1992 and then consisted of Dr Andrew Burbidge (Chair) and Dr Allan Burbidge (CALM Science and Information Division), Kelly Gillen and Alan Danks (CALM Albany District), Gordon Wyre (CALM Wildlife Branch) and Dr Graeme Smith (CSIRO Division of Wildlife and Ecology). It decided to co-opt additional members representative of the volunteers who have worked on the translocation program, the Shire of Albany and the Australian Nature Conservation Agency's Endangered Species Program. Peter Cale, representing the volunteers, Bruce Male (ANCA) and Richard Rathbone (Shire of Albany) joined the team in April 1992. Alan Danks became Chairman in 1994.

3. RECOVERY OBJECTIVES, STRATEGY AND CRITERIA

3.1 Objectives

The long term objective of Noisy Scrub-bird management is to increase the number of subpopulations and individuals of the Noisy Scrub-bird until it can be removed from threatened species lists, and intensive management is no longer necessary for its survival.

To allow upgrading from Endangered to Vulnerable two of the following Mace and Lande (1991) criteria would have to be met:

- a) total effective population N_e more than 500 (or total N more than 2500);
- b) population fragmented with at least 5 subpopulations with N_e greater than 100 (N greater than 500) with immigration rates greater than 1 per generation;
- c) population not subject to catastrophic crashes (in the Noisy Scrub-bird this would primarily be due to wildfire).

The Albany Management Zone does not contain enough habitat to support a scrub-bird population large enough and with sufficient subpopulations to meet the criteria for Vulnerable. Current (1994) numbers in this zone are estimated to be about 1100, with only two subpopulations exceeding 100 singing males. Upgrading the species' listing to Vulnerable under the Mace-Lande criteria therefore requires the establishment of additional large populations. Noisy Scrub-birds will always be prone to catastrophic crashes due to the effects of wildfire; however, the existence of several subpopulations will reduce the effect of fire on the populations as a whole.

The objectives of this Recovery Plan are therefore:

1. In the Albany Management Zone to achieve and maintain a population size indicated by more than 300 singing males, and
2. To commence the establishment of populations in a western management zone.

It is important to note that a major wildfire in either of the Mt Gardner or Mt Manypeaks areas would reduce the number of birds considerably (see Table 1). Since wildfires in these areas are highly likely to occur from time to time, the Recovery Plan is based on the assumption that there will be a significant wildfire in one, but not both, of these areas over the next ten years.

3.2 Strategy for recovery

This Recovery Plan will run for a term of ten years from 1993 to 2002 inclusive. Four primary strategies will be implemented concurrently during this period and are presented below.

- 1) In the Albany Management Zone:
 - a) develop and maintain a census size of at least 300 singing males by translocation, habitat management and protection of corridors,
 - b) regularly monitor the scrub-bird population at all sites where it occurs including those to which translocations have occurred,

- c) ensure that existing genetic variability of Noisy Scrub-birds is maintained, by obtaining information on the genetic variability of the original Mt Gardner population and of populations derived from it. If translocated populations show significant loss of genetic variability, develop procedures to minimise or prevent such loss,
 - d) complete and implement a Management Plan for Two Peoples Bay Reserve. The highest priority goal in the Two Peoples Bay Management Plan is to conserve the Noisy Scrub-bird, Western Bristlebird, Western Whipbird and Gilbert's Potoroo. The Reserve will be managed to maintain the existing suitable Noisy Scrub-bird habitat and provide scrub-birds for the translocation program. It will also be a focus for presenting information to the public about the Noisy Scrub-bird and this Recovery Plan.
 - e) on other public lands managed by CALM, ensure the maintenance of areas of suitable scrub-bird habitat and maintain and improve areas of natural vegetation that are or have the potential to be corridors allowing the movement of birds between areas of population concentration, and
 - f) for scrub-bird populations on other lands, encourage, assist and provide advice to relevant land owners or managers to enable them to maintain scrub-bird habitat. Encourage the maintenance or development of appropriate scrub-bird corridors on private land and other public lands.
- 2) To develop a new management zone (or zones) west of Albany preferably with a long term capacity of at least 300 singing males by:
- a) finding and preparing at least two separate areas each suitable for developing new population concentrations. Within these areas it should ideally be possible to establish subpopulations which are in close proximity to each other and connected by corridors of habitat which facilitate movement of scrub-birds between them, while at the same time being separated sufficiently by distance or management actions to minimise the chance of a single wildfire affecting more than one area.
 - b) translocating scrub-birds into these areas from the Two Peoples Bay population.
 - c) monitoring the release areas by censusing singing males.
- 3) To improve the availability of information and educational material about the Noisy Scrub-bird. In particular, develop and maintain information displays and other educational projects at Two Peoples Bay Nature Reserve.
- 4) To continue to raise funds for Noisy Scrub-bird conservation.

Captive breeding was carried out by CSIRO from 1975 to 1981. This project had limited success and showed that captive breeding, while possible, would be difficult and a very expensive operation to produce the numbers necessary for translocation. While there are sufficient animals in the wild populations for translocation, captive breeding is not necessary for recovery.

3.3 Criteria

The criteria for successfully achieving the objectives are:

1. Within the Albany Management Zone:
 - a) the achievement and maintenance of the total number of singing males at above 300,
 - b) the presence of corridors which allow migration and gene flow between all the subpopulations within the management zone, and
 - c) wildfires do not significantly affect both the Mt Gardner and Mt Manypeaks subpopulations within the period of this Recovery Plan.
2. Establishment of at least two subpopulations within a new management zone west of Albany, each with at least 20 singing males and with sufficient habitat for them to increase to at least 40 singing males.
3. Completion and implementation of a Management Plan for the Two Peoples Bay Reserve that provides for the protection and maintenance of extensive areas of habitat suitable for Noisy Scrub-birds.
4. For CALM-managed public lands outside the Two Peoples Bay Reserve on which other subpopulations exist or are established, ensuring that areas of potential or occupied habitat are protected through the preparation and implementation of Interim Guidelines for Necessary Operations or Area Management Plans.
5. Implementation of a program that encourages, assists and provides advice to relevant owners and managers of other lands where scrub-birds occur, to enable them to maintain scrub-bird habitat and/or corridors.
6. The identification, mapping and protection of corridors of native vegetation which allow scrub-birds to move between subpopulations in each management area, including corridors between the Angove and Manypeaks subpopulation concentrations and the Lakes and Mt Taylor subpopulations.
7. Implementation and finalisation of research into site suitability to assist the selection of translocation sites and increase the chances of successful translocations. This will include research into food availability in relation to habitat and radio-tracking of translocated birds.
8. Measurement of genetic variability for the Mt Gardner and Lakes area subpopulations in the Two Peoples Bay Reserve and for the translocated subpopulation at Mt Manypeaks.
9. Implementation of a program to continue to disseminate and improve the quality of information on Noisy Scrub-bird biology and conservation.

4. RECOVERY ACTIONS

The Noisy Scrub-bird Recovery Team described in Section 2.9 above will continue to meet regularly to coordinate, review and revise if necessary the implementation of this Recovery Plan. The recovery actions presented below have been costed at 1992 prices. Unless otherwise stated CALM contributions include salaries. Amounts identified as "ESP" are those that are being provided by the Australian Nature Conservation Agency through the National Endangered Species Program.

The Recovery team will report annually on the implementation of the plan to CALM's Corporate Executive and funding agencies.

4.1 Prepare and implement a Management Plan for Two Peoples Bay Nature Reserve

4.1.1 Preparation of Management Plan

A new Management Plan for the Two Peoples Bay Nature Reserve was partly drafted in 1989, but was not finalised because of staff changes and because of changing priorities. Work was re-commenced in 1992 and the Plan was released for public comment in June 1993 CALM (1993). The final Plan was accepted by the National Parks and Nature Conservation Authority late in 1994 and approved by the Minister for the Environment in 1995. The term of the plan is ten years, with annual review.

Responsibility: CALM Planning Branch and CALM South Coast Region.

Cost: 1993

CALM 33500

Total Cost 33500

4.1.2 Implementation of Management Plan

Once approved, the Management Plan must be implemented. The primary management aim for the Two Peoples Bay Nature Reserve is to conserve the Noisy Scrub-bird and other threatened species. Whilst the Reserve has other values (including the conservation of additional threatened species) it is difficult to separate out costs associated only with these other values, and so they are all included below.

The Management Plan proposes the construction of a visitor information and education facility to inform visitors to the Reserve about the conservation of the Noisy Scrub-bird and other threatened animals that occur there. The facility is estimated to cost about \$240 000. A sponsor will be sought to meet the costs of construction.

Responsibility: CALM Albany District, South Coast Region.

Cost:	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CALM	82000	139000	83000	74000	74000	74000	74000	74000	74000	74000
ESP	2000	2000	4500	2000	4500	2400	4900	2400	2400	2400
Total Cost	84000	141000	87500	76000	78500	76400	76900	76400	76400	76400

4.1.3 Review of Management Plan

It is a requirement of the plan that its implementation be reviewed annually. The review will identify the extent to which the recommendations have been implemented and objectives achieved. It will identify new information which affects the management of the reserve and determine how management should be modified based on such information, and propose amendments to the plan as necessary. Implementation of the Management Plan will be monitored by the National Parks and Nature Conservation Authority.

Responsibility: CALM Albany District.

Cost:	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CALM	1000	2500	2500	2500	2500	2500	2500	2500	2500	2500
Total Cost	1000	2500	2500	2500	2500	2500	2500	2500	2500	2500

4.2 Management of other lands with scrub-bird populations

Management of other lands with Noisy Scrub-bird subpopulations and of corridors between subpopulations is required to maintain scrub-bird numbers, promote dispersal of birds (and hence gene-flow) between subpopulations and prevent the introduction or spread of the dieback disease. Movement between areas will be difficult to detect. If natural dispersal can not be proved, translocations between subpopulations will be required in order to ensure gene flow.

The management of Noisy Scrub-birds will be taken into account in the preparation and revision of management plans or interim guidelines for CALM-managed areas that either currently support scrub-birds or are identified by the Recovery Team as translocation sites. The involvement of CALM districts other than Albany District will be necessary as new translocation sites are identified.

4.2.1 CALM-managed public lands in the Albany District

Responsibility: CALM Albany District

Cost:	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CALM	65000	65000	65000	65000	65000	65000	65000	65000	65000	65000
Total Cost	65000	65000	65000	65000	65000	65000	65000	65000	65000	65000

4.2.2 Other public lands

Liaison with managers of other public lands where scrub-birds occur (such as the Angove water reserve and Boulder Hill), or may be found in future, will be the responsibility of CALM Albany District staff.

Responsibility: CALM Albany District

Cost:	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CALM	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500
Total Cost	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500

4.2.3 Private property

Liaison with private landowners where scrub-birds occur or which are existing or potential corridors for scrub-bird movement between subpopulations will be the responsibility of CALM Albany District staff.

Costs covered under 4.2.2

4.3 Translocations

Within the Albany Management Zone, apart from possible releases to top up or re-establish populations, no further translocations will be conducted during the period of this plan. If new release sites are available to the west of Albany translocations to these sites can begin in 1995.

It is envisaged that most birds will be taken from the Mt Gardner population concentration within Two Peoples Bay Nature Reserve. This area has the highest number of scrub-birds and has been shown to be able to withstand current cropping rates. If numbers of singing males are reduced significantly in this subpopulation birds will be taken from the Mt Manypeaks area. Ideally, translocations will be carried out by initially transferring between five and ten males to a site followed by a similar number of females if the males persist at that site for 12 months.

4.3.1 Research into release area selection

Current methods for selecting release sites require a subjective assessment of habitat suitability based on familiarity with scrub-bird habitat, since there are no data on scrub-bird habitat parameters which would allow measurable comparisons between occupied and potential sites. This approach has not been reliable in areas distant from Two Peoples Bay.

In 1992, a student from Murdoch University made further studies on the diet of Two Peoples Bay birds, utilising birds captured for translocation, via faecal analysis, feeding behaviour and studies of litter invertebrates within scrub-bird territories (Welbon 1993). Further research will be conducted to investigate whether habitat parameters, eg, leaf litter quantity, litter invertebrate species diversity and biomass, can be correlated with scrub-bird use and breeding. The aim will be to provide a quantitative method of evaluating possible translocation sites. In the meantime the present approach will be continued and improved with experience.

Radio-tracking of translocated birds is aimed at increasing understanding of scrub-bird behaviour in new sites. It will also assist in determining which micro-habitats are preferred by scrub-birds. Data from radio-tracking can be used to determine whether translocation methods can be improved.

Responsibility: CALM Albany District, CALM Science and Information Division and CSIRO Division of Wildlife and Ecology.

Cost:	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
<i>a) habitat/food parameters</i>										
CALM										
Albany	1600	1600	1600	1600	1600	-	-	-	-	-
ESP	2900	2900	2900	2900	2900	-	-	-	-	-
<i>b) radio-tracking</i>										
CALM										
Woodvale	5900	5900	5900	5900	5900	5900	-	-	-	-
Albany	2500	2500	2700	2700	2700	2700	-	-	-	-
ESP	2600	2600	2800	2800	2800	2800	-	-	-	-
Total Cost	15500	15500	15900	15900	15900	11400	-	-	-	-

4.3.2 Release area selection

In the area west of Albany, release areas will be sought which are capable of supporting subpopulations of at least 40 singing males and of being connected by corridors within a single management zone. The aim will be to find a management zone with a minimum of four sites; if this is not possible the aim will be to find one with three sites, then two sites. If areas are not found that are deemed capable of maintaining a subpopulation of 40 singing males, areas will be sought that can support at least 20 singing males.

The search for translocation sites will be developed in stages. First the area west and north of Albany will be examined, then the area between Walpole and the Blackwood River and then the west coast, including the Leeuwin-Naturaliste National Park, where sites will be sought similar to those where scrub-birds were recorded in the Drakesbrook - Mt William area last century.

Selection of release areas west of Albany will be the priority for the first two years of this plan.

Responsibility: CALM Albany District.

Cost:	1993	1994	1995	1996	1997	1998
CALM	8000	8000	8000	8000	8000	8000
ESP	10000	12700	12700	12700	12700	12700
Total	18000	20700	20700	20700	20700	20700

4.3.3 Carrying out translocations

Translocations will be subject to approval as laid down in CALM Policy Statement No 29. Translocations of scrub-birds to sites initiated in 1992 will be completed by 1994. Beginning in 1995, or earlier if a suitable site is decided upon, scrub-birds will be translocated to new areas west of Albany. Translocations of scrub-birds will take place during June and July each year. Ideally, five to ten males will be released at each site followed by a similar number of females in the next breeding season if the males survive. Given adequate resources it should be possible to translocate to two sites in most years.

Table 3.
Tentative translocation program by year, 1993 to 2002

Site	Translocation									
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
<i>E of Albany</i>										
1. Bald Island	+	?	?							
2. Mermaid	+	?	?							
<i>W of Albany</i>										
1. New Site a		+	+	?	?					
2. New Site b			+	+	?	?				
3. New Site c				?	+	+	?	?		
4. New Site d				?	+	+	?	?		
5. New Site e						?	+	+	?	?
6. New Site f						?	+	+	?	?

Responsibility: CALM Albany District.

Cost:	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CALM	33100	33100	33100	36100	36100	36100	36100	36100	36100	36100
ESP	25300	12300	12300	12300	12300	12300	12300	12300	9500	9500
Total	58400	45400	45400	48400	48400	48400	48400	48400	45600	45600

CALM costs include salaries and wages of CALM staff, vehicle costs and \$6 000 per year for equipment, plant and expenses associated with the volunteers program. "Other" costs are wages/salary for an assistant, upgrading of the accommodation for volunteers and other infrastructure costs.

4.3.4 Genetic assessment

In order to properly manage translocations, information on the genetic variability within the original Mt Gardner population and populations derived from it, should be known. The Lakes population was derived from the natural movement of birds from Mt Gardner, while the Manypeaks population was established by translocation. Genetic information on these three populations would enable assessment of the background variation and any changes in the derived populations.

Examination of hypervariable DNA (eg Jeffreys *et al.* 1985) will allow determination of genetic variation within and between populations and has been used in studies of birds. Small quantities of blood (100 microlitres) have been taken from birds as small as fairy-wrens (about 10 g) without any evident harm to them (I. Rowley² and M. Brooker² personal communication), and no problems are foreseen with scrub-birds. It may also be possible to utilise the new and rapidly evolving techniques based on extracting DNA from feathers. Feathers have been retained from many of the birds translocated in the last ten years. Birds from the Mt Gardner subpopulation can be sampled during routine captures for translocations. Birds from Manypeaks and the Lakes areas will need to be captured as a special operation, programmed for 1996.

All translocated birds will be sampled for 1-2 feathers and, if it can be done safely, for blood so that genetic variation and any founder effects can be measured. DNA analyses would be

² Mr I. Rowley and Mr M. Brooker, CSIRO Division of Wildlife and Ecology, LMB No. 4, Midland, W.A. 6056

carried out from stored samples once a minimum of 20 samples is available. Because techniques in this area are evolving rapidly, precise techniques to be used will be decided on when sufficient samples are to hand.

Responsibility: CALM Albany District.

Cost:	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CALM	-	-	-	-	-	-	-	-	-	-
ESP	500	500	500	10500	500	500	500	500	500	500
Total Cost	500	500	500	10500	500	500	500	500	500	500

4.4 Monitoring Noisy Scrub-bird numbers

Numbers of singing males will be counted and their positions plotted on maps every year in Two Peoples Bay Nature Reserve. A total count of singing males will be performed every alternate year in the Albany Management Zone and every alternate year in all other populations (Table 4). This will provide data on trends in populations established by translocation and in subpopulations that have been used as sources for translocations. Any significant unexplained decrease in numbers in any area will be highlighted in the Annual Report and the Recovery Team will then decide on appropriate action.

4.4.1 Post release monitoring

Information on the movements and interactions of released scrub-birds may be obtained using radio-telemetry. The presence of singing males in a release area will be monitored shortly after the initial transfer of scrub-birds and at the beginning of the following breeding season. Monitoring at the latter time is particularly important since it will determine the persistence of males in the area and hence its suitability for the release of females. Each release area must be monitored for several years after releases to determine whether scrub-birds remain in the area and, later, whether breeding is occurring.

Table 4.
Tentative monitoring schedule, 1993 to 2002

Population concentration	Monitoring year									
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
<i>East of Albany</i>										
1. Mt Gardner	+	+	+	+	+	+	+	+	+	+
2. Lakes area	+	+	+	+	+	+	+	+	+	+
3. Mt Manypeaks	+	+	?	+	?	+	?	+	?	+
4. Mt Taylor	+	+	+	+	+	+	?	+	?	+
5. Angove - Normans	+	+	+	+	+	+	?	+	?	+
6. Bald Is	+	+	+	+	+	+	?	+	?	+
7. Mermaid	+	+	+	+	+	+	?	+	?	+
<i>West of Albany</i>										
8. Quarram	?	?	+	?	+	?	?	?	?	?
9. Nuyts	?	?	+	?	+	?	?	?	?	?
10. New site a			+	+	+	+	+	+	?	?
11. New site b			?	+	+	+	?	+	?	?
12. New Site c					?	+	+	+	?	?
14. New Site e							?	+	+	+
+ monitoring										
? monitoring if warranted										

4.4.2 Parent population monitoring

For the period of this plan, it is envisaged that all scrub-birds for translocation will be captured from the Mt Gardner area. Annual singing male censuses of this area will monitor

the effects of regular removal of breeding birds and reveal any declines, resulting from excessive removal or other causes, which might preclude further removals or lead to a modification of plans. Monitoring females is difficult, but is desirable in areas where females are removed for translocation. This will be carried out when searching for nesting females for capture in successive years.

Responsibility: CALM Albany District.

Cost:	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CALM	7400	11300	11500	14000	16000	15700	16000	14000	16000	11300
ESP	3900	6000	5200	7400	6600	7400	6600	7400	6600	6000
Total Cost	11300	17300	16700	21400	22600	23100	22600	21400	22600	17300

4.5 Education, publicity and sponsorship

In 1992, a draft of this Recovery Plan was submitted to the Australian Nature Conservation Agency for funding under the National Endangered Species Program. Funding was approved and the proportion of the cost of implementing actions being funded by ANCA is shown in the Plan as 'ESP'.

4.5.1 Education and publicity

The Recovery Plan described here is expensive in terms of both staff and finance and the support of the public is essential if the Noisy Scrub-bird is to be conserved.

The Department of Conservation and Land Management, in cooperation with other relevant organisations, will coordinate a public education program on the Noisy Scrub-bird and on the measures being undertaken to prevent its extinction.

Responsibility: CALM Corporate Relations Division, Noisy Scrub-bird Recovery Team

Cost:	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CALM	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Total Cost	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

4.5.2 Grants and sponsorships

Although this Recovery Plan is fully funded through the CALM budget and via a contract from ANCA to CALM under the National Endangered Species Program, extra money will need to be raised for special projects, such as helicopter charter to transport birds to translocation sites that are not easily assessable by vehicle.

The Recovery Team will endeavour to raise money from sponsorships as required.

Responsibility: *Noisy Scrub-bird Recovery Team, in conjunction with CALM's Sponsorship Coordinator.*

Cost:	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
<i>CALM</i>	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
<i>Total Cost</i>	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000

5. IMPLEMENTATION SCHEDULE

Task	Priority	Feasibility	Responsible party	Cost estimate (\$000s/year, 1992 dollars)											
				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Total	
1. MANAGEMENT PLAN															
1.1 Management Plan preparation	1	100%	CALM Albany	a*	33.5										33.5
1.2 Management Plan implementation	1	100%	CALM Albany	a b	82.0 2.0	139.0 2.0	83.0 4.5	74.0 2.0	74.0 4.5	74.0 2.4	74.0 4.9	74.0 2.4	74.0 2.4	74.0 2.4	822.0 29.5
1.3 Management Plan review	3	100%	CALM Albany	a	1.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	23.5
2. MANAGEMENT OF OTHER LANDS															
2.1 CALM-managed public lands	2	100%	CALM Albany	a	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	650.0
2.2 Other lands	3	75%	CALM Albany	a	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	45.0
3. TRANSLOCATIONS															
3.1 Research into release area selection	2	50% SID	CALM Albany/ a b	10.0 5.5	10.0 5.5	10.2 5.7	10.2 5.7	10.2 5.7	10.2 2.8					60.8 30.9	
3.2 Release Area Selection			b	a 10.0	8.0 12.7	8.0 12.7	8.0 12.7	8.0 12.7	8.0 12.7	8.0				73.5	48.0
3.3 Carrying out translocations	1	100%	CALM Albany b	a 25.3	33.1 12.3	33.1 12.3	33.1 12.3	36.1 12.3	36.1 12.3	36.1 12.3	36.1 12.3	36.1 9.5	36.1 9.5	36.1 130.4	352.0
3.4 Genetic assessment	3	100%	CALM Albany/ Curtin Uni b	0.5	0.5	0.5	10.5	0.5	0.5	0.5	0.5	0.5	0.5	15.0	
4. MONITORING OF NOISY SCRUB-BIRD NUMBERS															
4.1 Post Release Monitoring and															
4.2 Parent Population Monitoring	1	100%	CALM Albany b	a 3.9	7.4 6.0	11.3 5.2	11.5 7.4	14.0 6.6	16.0 7.4	15.7 6.6	16.0 7.4	14.0 6.6	16.0 6.0	11.3 63.1	133.2

Task	Priority	Feasibility	Responsible party	Cost estimate (\$000s/year, 1992 dollars)											
				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Total	
5. EDUCATION, PUBLICITY AND SPONSORSHIP															
5.1 Education and publicity	3	100%	CALM CR Div/ NSB Rec Team	a	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	10.0
5.2 Grants and Sponsorships	2	50%	NSB Rec Team	a	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	20.0
TOTAL COST OF															
SCRUB-BIRD RECOVERY		CALM commitment			247.5	276.4	220.8	217.3	219.3	219.0	201.1	199.1	201.1	196.4	2198.0
		ESP/other funds required			47.2	39.0	40.9	50.6	42.3	38.1	24.3	22.6	19.0	18.4	342.4
TOTAL					294.7	315.4	261.7	267.9	261.6	257.1	225.4	221.7	220.1	214.8	2540.4

*a CALM commitment

b ESP/other funds required

SID Science & Information Division

Visitor Centre (Sponsor to be sought)

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GLOSSARY

arthropods, any of the Arthropoda, the phylum of segmented invertebrates having jointed legs, such as insects, spiders, crustaceans, etc.

Atrichornithidae, the family containing the Noisy and Rufous Scrub-birds.

ANZECC, The Australian and New Zealand Environment and Conservation Council; a decision-making body consisting of Australian Commonwealth, State and Territory Ministers for Environment and Conservation and the New Zealand Minister.

critical, a taxon classified as critical under the proposed IUCN categories has a 50% probability of becoming extinct within 5 years or two generations, whichever is longer.

CALM, The Western Australian Department of Conservation and Land Management.

CSIRO, The Commonwealth Scientific and Industrial Research Organization.

DNA, deoxy-ribo-nucleic acid; the molecules of which contain the genetic information in the genes.

endangered, a taxon classified as endangered under the proposed IUCN categories has a 20% probability of extinction within 20 years or 10 generations, whichever is longer.

fledge, develop feathers until able to fly or leave the nest.

genus (plural **genera**), a taxonomic group of related species; the genus name is the first part of a scientific name of a species.

IUCN, the World Conservation Union (formerly the International Union for the Conservation of Nature and Natural Resources).

limiting factor, something that limits the size of a population.

Menuridae, the lyre-bird family

Menuroidea, the super-family containing both lyre-birds and scrub-birds; some authors include other families as well.

monogeneric family, a family with only one genus.

N_e, effective population size; the reproductively-active part of a population.

Passeriformes, the taxonomic order containing all songbird families.

re-stocking, movement of animals with the intention of building up the number of individuals in an original habitat.

riparian, pertaining to the bank of a river.

taxon (plural **taxa**), any taxonomic category, such as sub-species, species, genus, family, etc.

translocation, moving an animal from one place to another.

vulnerable, a taxon classified as vulnerable under the proposed IUCN categories has a 10% probability of becoming extinct within 100 years.

Population data that could be used in a calculation of effective population size N_e , the Mt Gardner population

Census size: Numbers of singing males (those defending a territory) are given in Table 1. Important points are that the number of singing males dropped to a low of about 40 in the 1960s (and may have dropped as low as 20 to 30 in the 1940s (Smith 1985d) and the number has steadily increased since 1971. Rate of annual increase at Two Peoples Bay from 1970 to 1980 was 8.6% per year (range -2.2% to 18%) and from 1980 to 1991 was 6.4% per year (range -7.3% to 14.6%). At Mt Manypeaks the mean annual rate of increase from 1987 to 1991 was 54.3% (range 26.9% to 81.8%). The carrying capacities of Mt Gardner and Mt Manypeaks are not known, but the carrying capacity of the latter could be estimated from aerial photographs.

The relationship between the census size (number of singing males) and the actual population size (N) is not known. It is known, however, that sub-dominant males and females can exist within defended territories. In one area, after the dominant male was removed three males were successively removed in the same breeding season. However, in other territories where the dominant male was captured he was not replaced in that year. In the past we have assumed a conservative ratio of singing males to N of 2.5. In this Recovery Plan we assume that the minimum viable population size of the Noisy Scrub-bird equates to a census size of 40 singing males, provided that > 90% are in optimal breeding habitat.

Lifetime dispersal: Not known, but males are known to have moved up to 8 km (straight line map distance) from Lakes population to Mt Taylor and also from Lakes population to upper Angove River. Other data are Mt Gardner to Lakes: 3 km; translocated males at Mt Manypeaks up to 5 km from release site, but dispersal from established territories mostly less than 2 km. Evidence at Mt Gardner suggests that only a small proportion of non-territorial males disperse. A female banded as a nestling was recaptured at a nest 2 km away two years later. One female dispersed 500 m to her breeding site one year after fledging and another moved 1200 m.

Generation length: Females can breed at year 1. The oldest known breeding female was age 10 (although this animal spent virtually all of her known life in captivity). Captive data suggest age at first breeding for males is 2-3 years.

Reproductive output: The clutch size is one and females raise a maximum of one chick each year. A second (or even a third) nest is built if the first egg is lost. Lost chicks are not replaced.

Breeding system / Social System: Males are opportunistically polygamous. The dominant male defends a territory and has the opportunity to mate with females who have nesting areas that may overlap or be adjacent to his territory. Sub-dominant males may occur within male territories and may be capable of mating with females even though they are not defending a territory (based on a single sub-dominant male that died during capture which had active gonads).

Sex ratio: Not known to be significantly different to 1:1.

Life table: Parameters not known; the only indication of mortality is based on population increase rates of singing males at Mount Manypeaks (26.9 to 81.8% per annum, mean 54.3% per annum over the four years 1987-1991).

Appendix 2

Noisy Scrub-bird Recovery: Albany Management Zone

