Queensland Government
Environmental Protection Agency
Queensland Parks and Wildlife Service

Technical Guidelines

Management guidelines for golden-shouldered parrot conservation

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1. Introduction

Golden-shouldered parrots

The golden-shouldered parrot is a symbol of Cape York Peninsula. The turquoise male, with its black crown and bright yellow wings, is most commonly seen sitting atop his antbed nest, watching for predators as his mate attends a large clutch of chicks. Once these birds were found throughout the peninsula, with large jewelled flocks collecting near waterholes at the end of the dry season. Now visitors to the peninsula are lucky to catch a glimpse of a few birds at one of their remnant haunts.

Golden-shouldered parrots are only found in far north Queensland, and once occurred throughout Cape York Peninsula. The contraction of their distribution, which started in the 19th century, continued to the end of the 20th century. Golden-shouldered parrots are now restricted to two small areas, covering less than 2,000 km^2. Fewer than 2,500 parrots remain at the start of each breeding season.

Their closest relative, the paradise parrot of southeast Queensland, is now extinct. The more distantly related hooded parrot[1] of the Northern Territory is still secure, but its range has also contracted.

Small parrots the size of a budgerigar, golden-shouldered parrots live on seeds that are abundant in the grassy woodlands of the peninsula. They are endangered because of changes in land management over the last 120 years, which have affected both nesting and feeding habitat.

The golden-shouldered parrot is recognised as endangered by both the Queensland[2] and Australian governments. This protects them from trapping and from some threatening land uses. International trade[3] is also severely restricted. Designation as an endangered species has led to studies being undertaken to identify threats and implement solutions to the species' decline.

Current aims of golden-shouldered parrot conservation

- To improve the conservation status of the golden-shouldered parrot from endangered to vulnerable
- To develop and implement land management strategies that restore grassland and grassy woodlands to the benefit of dependent fauna and in sympathy with co-existing land values
- To assist recolonisation of known former golden-shouldered parrot habitat
- To operate the recovery program efficiently, cost-effectively, and with high levels of community participation.

On the road to recovery

Golden-shouldered parrots on Cape York Peninsula have been studied in detail for 13 years[4]. During that time, land management through sections of the parrots' range, particularly fire management, has been adjusted to suit both the parrot's ecological requirements and to restore pastoral productivity. The parrot's distribution, which was still contracting between 1992 and 1998, may now have stabilized.

Although several peripheral nesting areas were abandoned between 1992 and 1998, no losses have occurred since. If this trend continues, it is possible to conclude that threats to the golden-shouldered parrots have been significantly reduced. The species could then be considered as vulnerable rather than endangered.

The plight of the golden-shouldered parrot will be reconsidered in 2007. If the species continues to maintain its current population and distribution, QPWS may then consider reclassifying the species as vulnerable[5], and make a submission to the Federal Government to do the same.

Downlisting of the golden-shouldered parrot in 2007 will reward 15 years of effort of landholders and researchers. It will indicate that land management on Cape York Peninsula has become more ecologically sensitive and sustainable.

Management guidelines

To many people, golden-shouldered parrots would seem to occur in remote habitats largely independent of human activities: Cape York Peninsula has been described as wilderness[6]. However, Aboriginal people have occupied and managed Cape York Peninsula for many thousands of years, and most golden-shouldered parrots live on land that has been managed for cattle for over 100 years[7]. Only a small proportion of the golden-shouldered parrot's distribution is on Staaten River National Park, which is also the traditional land of the Ukele people. This means that any decisions made to conserve golden-shouldered parrots could affect pastoral leaseholders and traditional owners.

Parrots co-existed with Aboriginal people throughout the savannas of Cape York Peninsula, and are presently found on the lands of Kuku Thaypan, Olkolo and Uwoykand, as well as Ukele lands. Reintroduction of golden-shouldered parrots to traditional land of Kandju people on Mungkan Kandju National Park is also planned.

Parrots persist in conjunction with pastoral enterprises on Artemis, Bulimba, Dixie, Kalinga, Killarney and Mary Valley. While undoubtedly some aspects of pastoralism have contributed to the disappearance of golden-shouldered parrots, others have not. Implementing land management that is sympathetic to the parrots need not mean disadvantaging other interests on Cape York Peninsula. Other uses of land within the parrot's distribution include mining on Imooya, and tourism throughout the peninsula.

Appropriate land management appears to be the key to recovery of the golden-shouldered parrot, as well as to the maintenance of many other species and ecological systems on Cape York Peninsula. This booklet contains guidelines that will assist in the maintenance of healthy native vegetation on Cape York Peninsula, to the benefit of both nature conservation and pastoral values of native grasslands.

The guidelines in this booklet are part of the recovery process for the golden-shouldered parrot[5]. Management to address known threats in addition to other ongoing work on the parrots includes research to refine our knowledge of the species, to identify new threats, and to enable the development of new management methods.

Aims of management guidelines of golden-shouldered parrots

To manage habitat for golden-shouldered parrots.

To maintain the parrot population at the receding edge of their distribution

To increase the number of wild populations of golden-shouldered parrots

2. Conservation and legal status

Golden-shouldered parrots are considered to be endangered because they have a restricted distribution[8] are found in only two areas (B1a), and there is an ongoing decline (B1b) in their extent of occurrence (i), area of occupancy (ii), quality of habitat (iii) and number of mature birds (v), and are therefore at risk of extinction[9].

The Golden-shouldered Parrot is listed as Endangered in Queensland[10]. This listing offers protection to the species with respect to actions undertaken in Queensland. The intention of the Queensland legislation is that management of golden-shouldered parrots should aim to ensure the preservation or re-introduction of viable populations in the wild; identify and mitigate threatening processes; identify and conserve critical habitat; develop and implement a recovery plan or conservation plan for the species and its habitat, and seek funding in order to do so[11]. Other stated intended actions regarding endangered species include recording information, establishing state-federal communications, developing community and land manager education programs, undertaking regular monitoring; reviewing of the status of endangered wildlife and its habitat; encouraging scientific research and inventory programs; and ensuring that environmental impact assessment procedures adequately assess impacts on endangered wildlife and developing effective mitigation measures. The legislation also requires that any use of endangered species is ecologically sustainable.

Queensland legislation makes it an offence to pursue, injure, kill or trap golden-shouldered parrots, or otherwise try to take them from the wild[12]. Hybrids or mutations of golden-shouldered parrots must not be deliberately bred, abandoned or released to the wild[13]. Permission must be obtained before releasing any captive-bred animal to the wild[14]. Breaches of these restrictions may attract fines and/or imprisonment. Restrictions regarding golden-shouldered parrots can be over-ruled by a conservation plan covering the golden-shouldered parrots, or by amendments to the regulations. There are currently no plans to write a conservation plan for this species.

Aborigines and Torres Strait Islanders are permitted to take, use or keep golden-shouldered parrots where this is consistent with traditional customs, unless specifically prohibited under a conservation plan. At present, no such customs have been identified or proscribed under any conservation plan.

The Golden-shouldered Parrot is also listed as a restricted bird in Queensland[15]. Under this listing, recreational wildlife (specialist) licences can be granted for the keeping of golden-shouldered parrots in captivity where the applicant can be shown to possess adequate knowledge, experience and facilities[16]. Such licences cannot be granted in the local government areas of Aurukun, Burke, Carpentaria, Cook, Croydon, Etheridge, Herberton, Mareeba or Torres[17]. These areas overlap with the natural distribution of the parrots. Birds that escape from aviaries may spread disease to wild birds, or interbreed with wild birds. The

conditions relating to recreational wildlife (specialist) licences for keeping golden-shouldered parrots for the purpose of sale are the same as they are for all other native birds. Such licences can be granted where they are unlikely to adversely affect the ecological sustainability of golden-shouldered parrots in the wild, and where the birds have been lawfully taken, kept or used[18]. Licences to harvest golden-shouldered parrots from the wild for commercial or recreational purposes cannot be granted, as this has not been approved under a conservation plan[19]. Golden-shouldered parrots cannot be kept on a commercial wildlife licence[20].

Under Queensland legislation, conservation work that includes studying, trapping and taking golden-shouldered parrots into captivity undertaken for the purpose of implementing the golden-shouldered recovery plan is permitted[21].

The Golden-shouldered Parrot is also listed nationally as Endangered[22]. This listing protects the species from any actions that have, will or are likely to have a significant impact on golden-shouldered parrots without approval from the Commonwealth[23]. If undertaken in absence of approval, such actions are punishable by fines.

Commonwealth legislation also allows for state-federal agreements that assist in the conservation of threatened species[24], for the production and implementation of recovery plans[25], and for federal funding of conservation work that involves research, monitoring and development of management techniques. It also allows for the identification, registration and protection of critical habitat[26]. It identifies killing, injuring, taking, trading, keeping or moving golden-shouldered parrots, or damaging critical habitat within a Commonwealth area as offences punishable by imprisonment or fines[27].

Under Commonwealth legislation, the export of golden-shouldered parrots, which are listed under Appendix I of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)[28], is an offence punishable by imprisonment or fine[29].

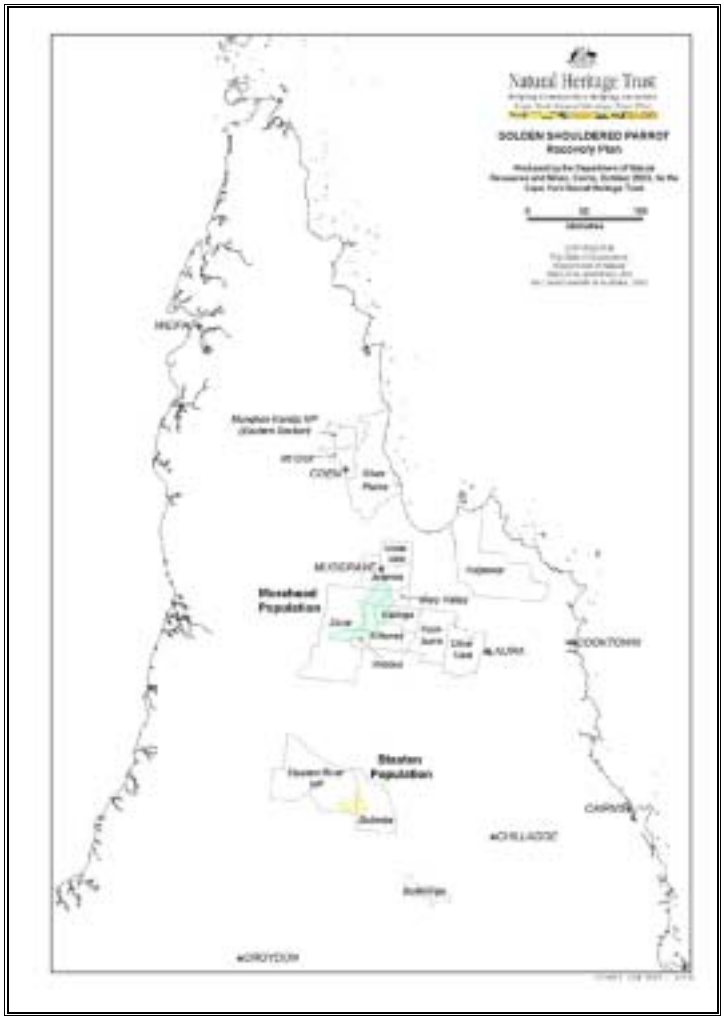
Conservation of golden-shouldered parrots is enshrined in a conservation agreement covering 2120 ha on Artemis station, Nature Refuge 8010.

3. Distribution and population

Golden-shouldered parrots once occurred throughout Cape York Peninsula from Croydon in the southwest to near Weipa in the north. The distribution was probably fragmented in patches of suitable habitat, radiating out from focal areas along the ranges and rocky river banks, where the parrots could feed through the early wet season to areas where patterns of rainfall and fire history allowed the parrots to persist for short periods. It is not clear to what extent the birds could move between these focal areas, or if there were several separate populations. At present, two distinct sub populations are known, and there are plans to re-establish a third.

Population statistics				
	1992 – 1998		1999 – 2002	
Parameter	**Estimate**	**Reliability**	**Estimate**	**Reliability**
Extent of occurrence	3,000 km^2	medium	3,000 km^2	medium
trend	decreasing	high	stable	medium
Area of occupancy	1,780 km^2	medium	1,740 km^2	medium
trend	decreasing	high	stable	medium
No. of breeding birds	4,000	medium	3,900	medium
trend	decreasing	high	stable	medium
No. of sub-populations	2	medium	2	medium
Largest sub-population	3,000	medium	2,900	medium

The total breeding population is estimated to be total approximately 3,900 individuals in two populations. This estimate is calculated by estimating the number of nest attempts/ha in each habitat type for the intensively studied Morehead population and extrapolating to the entire area of occupancy across both populations. In the non-breeding season, based on an average productivity of 1.7 fledglings/nest attempt, the population is thought to swell to about 6,600.



Current distribution of golden-shouldered parrots

Morehead population

The Morehead population occurs in the headwaters of the Morehead River and nearby westward flowing streams, on Artemis, Dixie, Mary Valley, Imooya, Kalinga and Killarney stations. It has been know to occur in this area since at least the 1950s.

There were also nesting records from further east on Kalinga, Olive Vale and Kalpowar station, and south on Koolburra station in the 1960s and 1970s and the species was recorded nesting at Violetvale station from 1927[30] through to at least 1974[31]. By 1992, the most north-easterly nest was 14 km southeast of the last recorded nesting on Four Mile Flat at Violetvale. By 1998, nesting habitat had contracted southeast a further 6 km, with the desertion of 40 km^2 of habitat.

Morehead population statistics

(15°15' S 143°30' E)	1992 – 1998		1999 – 2002	
Parameter	**Estimate**	**Reliability**	**Estimate**	**Reliability**
Area of occupancy	1,380 km^2	medium	1,340 km^2	medium
trend	decreasing	high	stable	medium
No. of breeding birds	3,900	medium	3,800	medium
trend	decreasing	high	stable	medium

Staaten population

The Staaten population occurs west of the Lynd River, west of Chillagoe. Its distribution covers at least 400 km^2, extending through the upper tributaries of Staaten River, in the headwaters of Cockburn and Back creeks on Bulimba station and the Staaten River National Park[32a]. A further 1,600 km^2 to the south may also support the species, but may also be too cool and dry.

This population also appears to have contracted in range. Golden-shouldered parrots bred on Bulleringa Station to the southeast in the 1960s, but there was no evidence of their presence by the 1990s. There were also reports from Dorunda station, west of Staaten River National Park in the 1960s[33], but recent visits to the area had found no evidence[34]. However, there is no evidence of more recent contraction.

Staaten population statistics

(16°50' S 143°20' E)	1992 – 1998		1999 – 2002	
Parameter	**Estimate**	**Reliability**	**Estimate**	**Reliability**
Area of occupancy	400 km^2	low	400 km^2	medium
trend	stable	medium	stable	medium
No. of breeding birds	1,000	medium	1,000	medium
trend	stable	medium	stable	medium

Coen population

A third group of breeding birds was known from the Coen area, extending north to Mt Croll Station and Mungkan Kandju National Park and east to Silver Plains station. Breeding was

[a] This figure has been adjusted down after a survey of previously unexplored habitat west of the known range in March 2004 was found not to contain evidence of parrot nesting.

last definitively known north of Coen in 1922[35] and on Silver Plains in 1927 but individuals were seen on Silver Plains in the 1950s and a young bird was caught north of Coen in 1970. While there have been reports of birds away from these areas in the last decade, particularly to the north[36], no nesting has been confirmed.

Re-establishment of the Coen population is planned over the coming decade. Management guidelines provided in this booklet should facilitate this reintroduction.

Population fluctuations through the year

Golden-shouldered parrots pair-up in the early wet season, and breed when nutritious food supplies become reliable (see *Food*). Four to six eggs are laid and up to half of these successfully hatch and produce fledglings. Parrot families remain together into the middle of the dry season, usually with two or more family parties grouping together. Late in the dry season, paired adults leave the groups of young birds and unpaired adults. Many of young birds appear to die during the wet season, when they must learn to find and feed on new foods. Hence, the population is at its lowest early in the breeding season. At this time it consists of breeding pairs with an additional 5% being a floating population of unpaired males.

4. Natural history

A tropical species

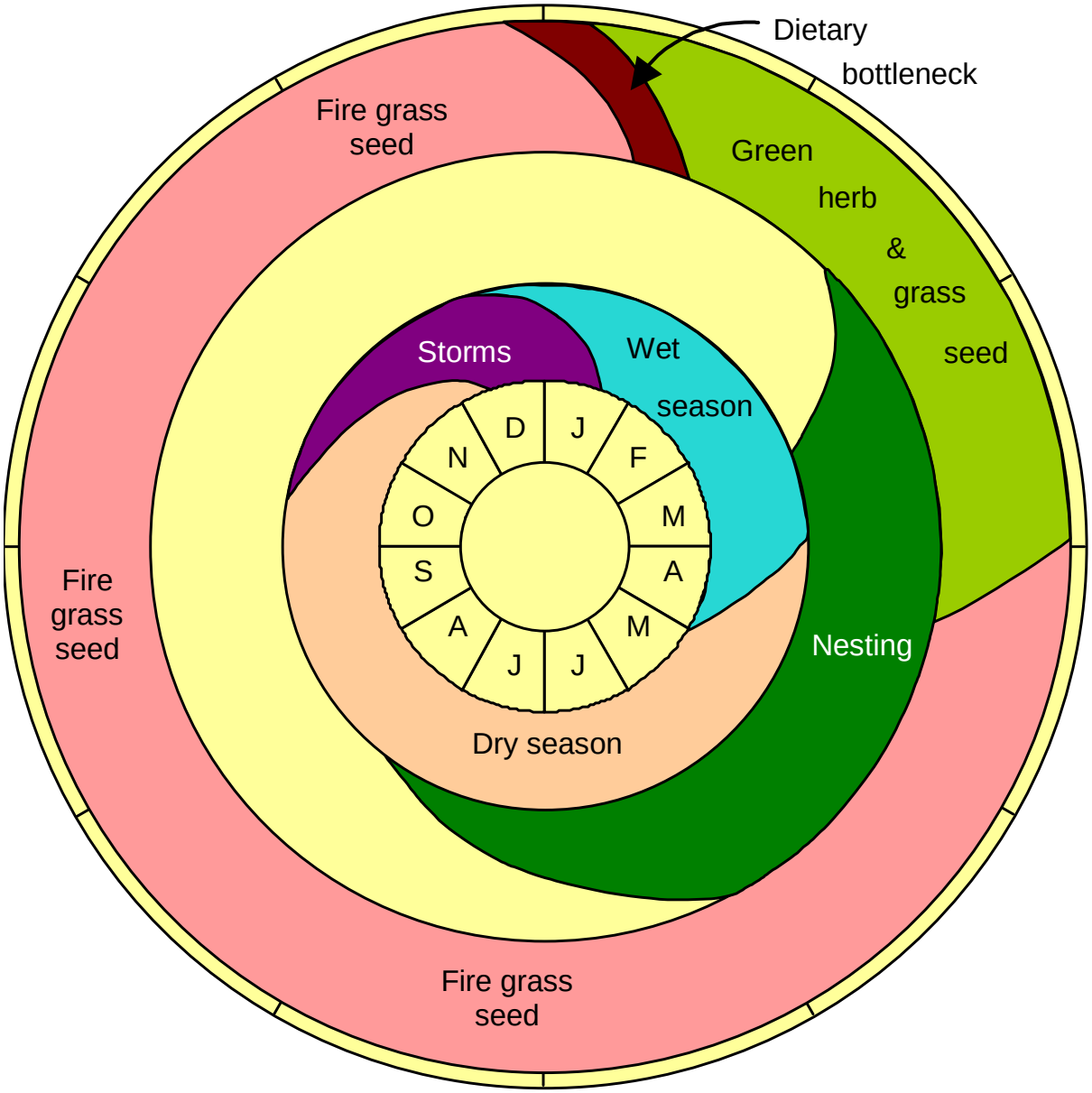
The golden-shouldered parrot is a specialized tropical species. The chicks are left alone in the nest when they are three to four days old; so need a warm climate to survive. When the mother first leaves the nest overnight temperatures are probably critical. Minimum temperatures through the parrot's distribution between March and August rarely fall below 10°C, and are more usually above 15°C[a]. Night-time temperatures are much lower just to the south of the parrot's known distribution. Nesting in termite mounds also helps to insulate the nestlings on cold nights[37]. The conical and magnetic antbeds[b] most commonly used by golden-shouldered parrots of the Morehead population for nesting are found only on Cape York Peninsula, while the third type used by the Staaten population is more widespread through the tropical and subtropical savannas.

The parrots are also attuned to the monsoonal climate cycle. Many grasses of the monsoonal tropics produce innumerable seeds that lie on the soil surface through the long dry season, waiting for the first wet season rain. These seeds feed the parrots for most of the year. While the parrots suffer a dietary bottleneck when these seeds germinate, the wet season soon provides a flush of seed from short-lived and early seeding grasses. The parrots are stimulated to breed with the return of reliable supplies of fresh grass and legume seeds

Fire is a feature of the monsoonal tropics, and the parrots are a fire dependent species. Their habitat is maintained by fire, and the availability of essential foods is enhanced by fire.

[a] www.bom.gov.au

[b] Mounds of grass feeding termites



Seasonal patterns affecting the life-cycle of golden-shouldered parrots

Food

Plants in the monsoonal tropics grow vigorously through the wet season, and then become dormant through the dry season. Annual grasses, such as fire grass and snake grass, survive only as seeds through the dry season, and it is the vast supplies of these seeds that allow the parrots and many other species to become seed-eating specialists.

Throughout the dry season, golden-shouldered parrots feed on the fallen seeds of annual grasses, particularly fire grass. The parrots may spend many months feeding in small areas where seeds are abundant, and prefer open ground created by dry season fires where the seed is most accessible. They optimise their feeding time by moving to areas where there are not just many seeds, but where most seeds contain sound kernels. As the dry season progresses, frequented areas are depleted of seeds[38], and the birds become more mobile, searching for areas of higher seed availability.

Dependence on seeds for food creates problems when the seeds start germinating at the start of the wet season. The first rain events influence access to food, even if they are short-lived, while repeated or extended rainfall causes changes in the abundance of food. On the morning after the first heavy thunderstorm of the wet season the parrots switch from taking fire grass to taking glimmer grass on *Glimmer grass flats*, which doubles the time required to procure enough food. In subsequent dry periods the parrots gradually return to fire grass, as the seeds that have not germinated dry out again. After successive storms, however, with an increasing proportion of fire grass seeds germinating, the parrots shift to the seed of species that require more rain to cause germination — grannies' bonnets, fisherman grass, snake grass and sedges. Eventually these seeds also germinate and the parrots switch to taking partially burnt seed, ungerminated seed lying on rocks, the growth buds and flowers of broad-leaved ti-tree and new leaves of Cooktown ironwood. On *Gravel slopes*, where soils are well drained, many seeds do not become sufficiently saturated to germinate until there have been extended periods of rain, so provide food well after most seed has germinated on flatter ground. *Rocky hills* also provide pockets of ungerminated seeds into the wet season. Among the seeds used by the parrots at this time are the seeds of itch grass and the introduced weed Hyptis that have fallen on to rocks, so although they become wet, do not germinate.

Exceptionally heavy falls at the start of the wet season present particular difficulties for the parrots because most seed will germinate before newly formed seed is available[39]. At this time the parrots appear to rely heavily on flowers and the growth buds of trees. The parrots do not feed in heavy rain but sit quietly in trees. Several days of continuous heavy rain, as is often associated with cyclones, is likely to prevent the birds from meeting their food requirements and may cause heavy mortality.

Six to eight weeks into the wet season (January–February), very little old fallen seed remains and the parrots eat flowers or new seed of herbs and early-seeding annual and perennial grasses. Judging from the time the parrots spend feeding, flowers do not appear to yield much nutritional value. The seed of herbs and early-seeding annual grasses is also time-consuming for the birds to obtain, because it is small, occurs at low density, or is physically difficult to extract from its husk. It is likely that some of the foods taken by the parrots, such as the spurges and the buds of Cooktown ironwood, are toxic. When they are taking these foods, the parrots also feed on clay from termite mounds. Such behaviour is known to be a way of counteracting the toxic effects of poisonous foods[40]. Availability of these seeds tends to be ephemeral, so the birds need to switch between food sources frequently. Young birds appear to be less efficient than adults at feeding on these food sources, and it is likely that deaths of young birds is particularly high at this time.

Among the early-seeding grasses is cockatoo grass, a perennial species that first produces seed about six weeks after the first heavy rainfall. Seed production of cockatoo grass is currently most abundant on *Gravel slopes* and *Sand ridges and low hills*. Although it produces large seed in a prominent inflorescence, many inflorescences contain nothing but sterile spikelets, so the parrots must be able to identify productive inflorescences. Seed production of cockatoo grass appears to be highest in the first wet season after a fire, regardless of season of burn, probably because of fertilization by ash and reduced demands for nutrients from the larger co-occurring perennial grass, plume sorghum.

Fire grass seeds are the parrots' main dry food, but germinate rapidly with the first wet season rain.

Cockatoo grass is one of the first perennial grasses to flower at the start of the wet season.

Seeding by cockatoo grass is both delayed and enhanced by storm-burning[a], possibly by synchronizing flower initiation, but also through ash fertilization. Hence availability of cockatoo grass seed is greatest where both storms and storm-burns have bee patchy, and the parrots can move between patches of seeds as they become available. In the absence of storm-burning, seed supply continues to be unreliable and patchy well into the wet season, until the seeding of plume sorghum, and soon after, of fire grass. In years of poor cockatoo grass seed production, the small seeds of early wanderrie grass may become important. The availability of cockatoo grass seed in storm-burnt areas appears to allow early breeding by the parrots. Another trigger for breeding may be the seeding of small native legumes, whose seeds the parrots feed to their chicks in the nest, along with those of introduced verano.

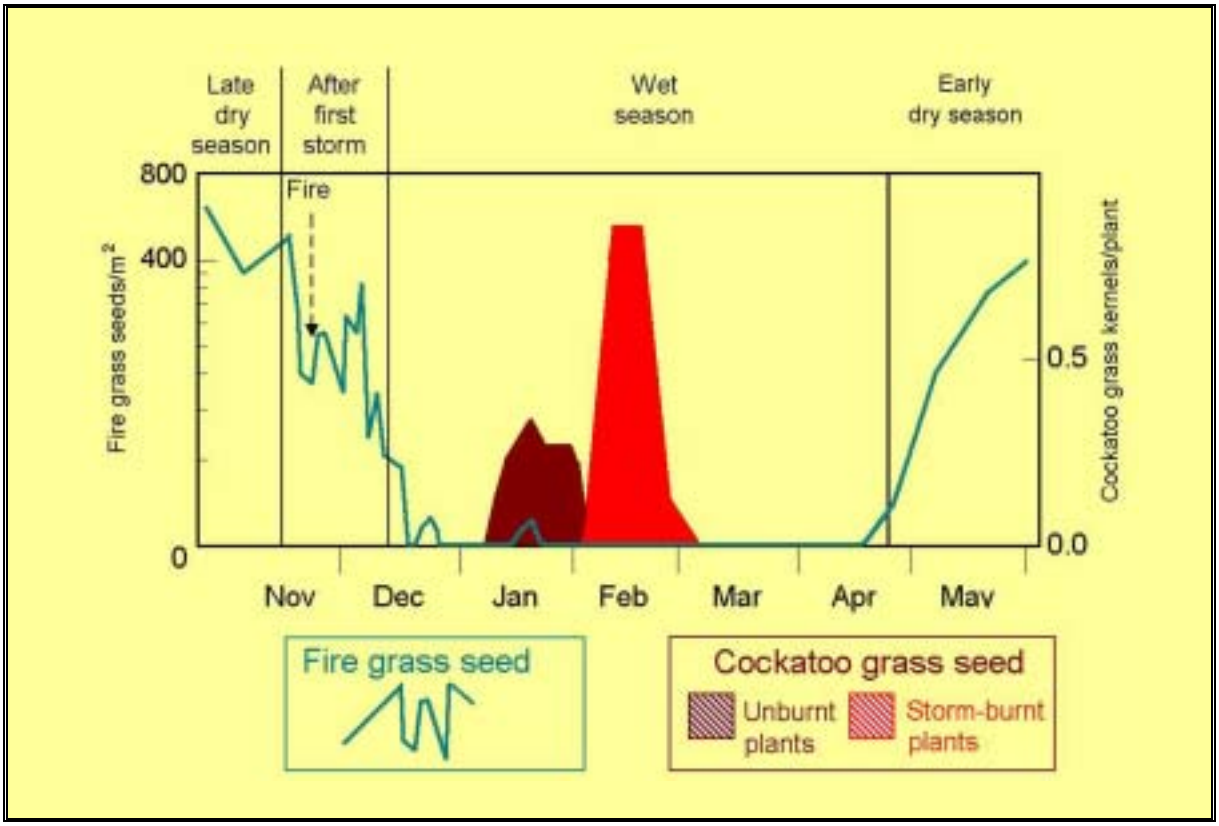
If storms have been patchy in both time and space, as usually happens at the start of the wet season, the availability of remnant fallen seeds overlaps with the production of seed of cockatoo grass and seeds of annual grasses and ephemeral herbs. Storm-burning extends the time seed is available to the parrots by removing rampantly growing ground layer vegetation, exposing ungerminated seed and killing seed that is just starting to germinate. It

[a] Burning within the first week following of the first heavy rains (≥ 50 mm over 72 hours) of the wet season, timing depending on extent and duration of rainfall.

also increases density of seeding herbs, increasing feeding efficiency of the parrots, and delays cockatoo grass flowering, increasing the length of time its seed is available[41], as well as the amount of seed produced.

Spade flower (left) and heliotrope (right) are two of the food plants that produce seed in the early wet season and are particularly abundant in storm-burnt areas.

By the time the chicks fledge, fire grass seed is once again abundant, so the young birds emerge to abundant food supplies. Through the rest of the dry season, they have little difficulty finding food.



Cockatoo grass plants provide seed at a time when fallen fire grass seed is scarce. Storm-burning patches of cockatoo grass extends availability of seed.

Breeding

Golden-shouldered parrots nest in antbeds[a]. In the area around Artemis, most nests are built in conical antbeds, although magnetic antbeds, and, occasionally, bulbous antbeds are also used. Parrots on Bulimba Station and Staaten River National Park mostly nest in domed antbeds. While antbeds of a suitable size for nesting are abundant through the parrot's present and former distribution, factors affecting antbed suitability are still unclear. Mounds are rarely occupied more than once, possibly because of the persistence of nest parasites, such as lice, or because antbeds repaired by termites are difficult to excavate. In some areas, most antbeds of a suitable size have already been used. Conical and magnetic antbeds grow remarkably slowly. Mounds are likely to be at least 30 years old when they are first suitable for nesting, and most antbeds with nests are at least 50 years old. Factors that affect growth rates, and hence nest site availability, are likely to include number of termites in a colony, length and intensity of the wet season, fire regime, grazing pressure and damage by pigs and cattle.

After the first storms, parrots begin displaying and making short scrapes in termite mounds. These scrapes may form part of the display. Scraping of mounds then stops when wet season rain sets in, resuming in late February. In some areas excavation almost invariably continues until a nest chamber has been created. In other areas many scrapes are terminated before a chamber is started. Some scrapes stop because the parrots encounter the remains of an old nest in the same mound. The nest is excavated in an antbed, largely by the female, between March and June. Disturbance of the parrots during excavation can cause abandonment of the chamber if it occurs before the first egg is laid. Predation of adults also occurs as they can not see predators coming while they are digging. Initiation of egg laying appears to be a consequence of nest antbed suitability and the availability of green seed. The entrances to chambers excavated too early in the wet season are sometimes covered over by termites. Termites also sometimes kill early eggs by cementing them to the floor of the chamber. Termites stop building when the rain stops, after which no nest chambers are covered over. The increase in amino acids containing sulphur, which is associated with newly formed seed, is also thought to be necessary for egg-formation, as with other grass seed-eating birds. First breeding for the year is sometimes associated with the flush of cockatoo grass seed on storm-burnt areas but these efforts sometimes fail if other seed is not available, particularly the seed of later-seeding plume sorghum. Food during the remainder of the breeding season largely consists of annual sorghum and fire grass, supplemented with that of legumes and annual herbs, such as Hyptis and the legume Desmodium. Egg laying ceases when green grass seed is no longer available.

[a] Terrestrial mounds of grass-feeding termites.

An average of 5 to 6 eggs is laid at two-day intervals. Of these 76% hatch after about 3 weeks. The female broods the young for less than a week after hatching, and then only returns to feed them. Of the birds that hatch, 66% fledge about five weeks after hatching. The principal reason for nest failure is predation, particularly in late April and early May. The principal predator of eggs and young in the nest is thought to be reptiles, particularly small goannas. Predation of nestlings and newly fledged young by pied butcherbirds is also thought to be high, particularly at the moment of fledging. Re-nesting has only been observed after the failure or desertion of nests early in the breeding season, with two out of three known cases being by birds that had nested in storm-burnt areas.

Dispersal

By the mid dry season (July–August) most nestlings have fledged. Young birds stay with their parents within about 2 km of the nest for the first six weeks after fledging, often in a flock with other birds. Some chicks then disperse, young males generally moving further from the nest than young females. Young birds then join flocks at a number of traditional locations. These flocks contain unpaired adult males, subadult males from the previous breeding season and some adult pairs. Other adult pairs apparently remain independent of the flock. By July most of these flocks are feeding on areas that have been burnt early in the dry season. Flocks with a choice of burnt and non-burnt areas appear to choose the burnt areas where the seed is easy to find and where it is easy to see predators. Pairing appears to occur in these flocks.

Many of the traditional sites where flocks gather through the dry season are areas occupied by *Black-faced woodswallows*. Through the late dry season (September–October) flocks move to sites where woodswallows traditionally breed. Again some adults are in these flocks but others remain independent. The flocks remain with the woodswallows until well after the wet season has begun. Parrots leave woodswallow flocks and disperse as the early wet season proceeds and the woodswallows finish breeding and become more mobile. Increased access to food means that they stay longer in areas that have been storm-burnt, provided those areas had not been burnt the previous year. In addition, some birds move from unburnt areas to storm-burnt areas. The accessibility of seed in storm-burnt areas and on gravel slopes during the early wet season appears to enhance rates of survival, particularly among young, inexperienced birds, suggesting that food supply and/or accessibility is inadequate to support the parrots in the remainder of the landscape. Parrots radiate out from these wet season feeding areas to re-occupy nest sites. Contraction of parrots from the east of the Great Dividing Range suggests that sites closest to the hills are occupied first.

Habitat restoration recommended for golden-shouldered parrot recovery entails the reversal of invasion by broad-leaved ti-tree of grasslands on drainage depressions. Communities dominated by broad-leaved ti-tree cover 14.2% of Cape York Peninsula, whereas the threatened grassland communities occupy less than 0.2%[42]. Recovery of this habitat will therefore not impact adversely on broad-leaved ti-tree, habitats dominated by broad-leaved ti-tree, or dependent fauna.

Research findings arising from earlier golden-shouldered parrot recovery plans[43] particularly the roles of, and threats to, cockatoo grass, have contributed to the understanding of processes affecting the endangered gouldian finch and northern bettong. Planned actions during the current recovery plan include further assessing threats to cockatoo grass, notably grazing by pigs and cattle. These actions will be undertaken in cooperation with the recovery plan for the northern bettong, and information gained will contribute to the recovery of all three species.

Golden-shouldered parrot nests are the only known habitat of the antbed parrot moth. The decline of the parrot thus implies that the antbed parrot moth is also endangered, although no direct assessment of the species status has been made. Plans to re-introduce golden-shouldered parrots to Mungkan Kandju National Park will also involve re-introduction of this species.

Black-faced woodswallows

The presence of black-faced woodswallow nests is important for the parrots' survival through the early wet season. Through most of Australia, Black-faced woodswallows are associated with open woodlands and grasslands[44]. On Cape York Peninsula, the habitat they use is uncharacteristically heavily wooded, though nesting sites tend to be near open areas[45]. Typically Woodswallows nest on *Gravel slopes* and *Glimmer grass flats*, where there are open areas over which to feed. The woodswallows frequently feed on the ground, or take large insects caught in the air down to the ground to dismember. Woodswallow nests are dispersed regularly across the landscape, with the same areas being occupied each year. When young are present in the nest, the parents defend the area around the nest from predators. Hawks, butcherbirds and kookaburras are largely kept away, and the woodswallows make alarm calls when they approach. During the woodswallows' breeding season, from October to January, most young parrots feed close to woodswallow nests. Predatory birds rarely disturb these parrots. Young parrots feeding in other parts of the landscape at this time are frequently harried by butcherbirds. Colour-banded parrots not seen with woodswallow flocks through the wet season were not seen again.

Black-faced woodswallows nest in open areas in the late dry season and early wet season.

Nesting habitat of black-faced woodswallows on a gravel slope.

A habitat maintained by fire

The antbeds used by golden-shouldered parrots are usually associated with open, grassy drainage lines. The right fire regime is needed to keep this habitat open. There are two ways in which the fire regime has been investigated. The first has been to examine the fire regimes under which golden-shouldered parrots evolved and flourished. The second has been to examine the effects of different fire regimes on both the habitat and the parrots.

Historical fire regimes

Before Aboriginal people arrived, lightning was the sole cause of fires on Cape York Peninsula. Lightning still starts many fires in northern Australia each year. Most lightning is associated with early wet season storms[46]. At the start of the wet season, when fuel is dry and flammable, lightning is likely to start fires. In some years, dry storms start fires that are hot and burn thousands of square kilometres before being extinguished at the coast or by rain. In other years, the wet may begin with few lightning strikes, or fires that start are immediately put out by rain. In most years, though, there would be many small fires at storm-time, which burn only until heavy rains come.

Spectacular lighting displays are a feature of the northern wet season.

Late dry season fires and storm-burns keep the country open.

Historically, the hottest storm fires were probably always along the drainage lines and flood plains, where lingering moisture would maintain grass cover and heavy fuel loads to the end of the dry season. Aboriginal people also lit fires through the dry season. Progressive lighting of fires through the year led to a fine mosaic that impeded the spread of late dry season fires. Such fire mosaics are still created around some Aboriginal communities on Cape York Peninsula.

Golden-shouldered parrots evolved before Aboriginal people arrived but persisted through the period of exclusive Aboriginal land management. Given that the parrot's distribution in the mid- to late 19th century covered most of the available climatic range, it is likely that Aboriginal fire regimes were as beneficial to the parrots as the pre-Aboriginal fire regime.

The parrot's distribution contracted under European management, which included a reduction in intentional fires and a shift away from late dry season fires and storm-burning[47]. Native pastures are too important for cattle forage for large areas to be burnt intentionally through the dry season. Some areas may escape fires for many years. However, there are still many fires through the dry season that are not lit deliberately by land managers, whether from dropped cigarettes, or by hunters in pursuit of pigs. Because grazing by cattle reduces fuel loads, these fires are unlikely to burn as fiercely as they would have in the past. However, where there is no network of earlier fires, these unintentional fires often cover vast areas. As a result, fewer fires lit may be by lightning. Roads and grazed paddocks also reduce the spread of such fires. This less controlled fire regime has been associated with a contraction of parrot numbers and distribution. Over the last decade, and particularly since 1998, there has been both a return to storm-burning in the parrot's habitat[48] and an apparent stabilization of the parrot's distribution.

Effects of fire on parrot habitat

Fires in golden-shouldered parrot habitat help keep the grasslands open and promote wet season food availability. However, not all fires are beneficial. Early dry season fires, necessary because they help to control the spread of fires later in the year, promote vegetation thickening, and may weaken perennial grasses. The grass layer is often full of broad-leaved ti-tree suckers, kept below grass height by heavy competition by vigorous grass growth. If burnt in the dry season, broad-leaved ti-trees begin to recover immediately because they can draw on ground water. Grasses do not completely recover until the following wet season. By the time the rains come, many broad-leaved ti-tree suckers have escaped the grass layer to a height where they can grow rapidly in the absence of competition. As a result, the woody vegetation may be far thicker after an early dry season fire than if not burnt at all.

As the dry season progresses, fires become more extensive and more intense. This can have both undesirable and useful environmental effects. Undesirable effects of late dry season fires include soil erosion when the rains arrive, loss of refuge areas for fire-sensitive species, possible high rates of tree death[a], and, where livestock are grazed, loss of cattle forage. However, late dry season fires are effective at reducing the number of sapling-sized trees, and restoring the open structure of golden-shouldered parrot habitat[49].

Mid- to late dry season fires expose the soil surface to erosion.

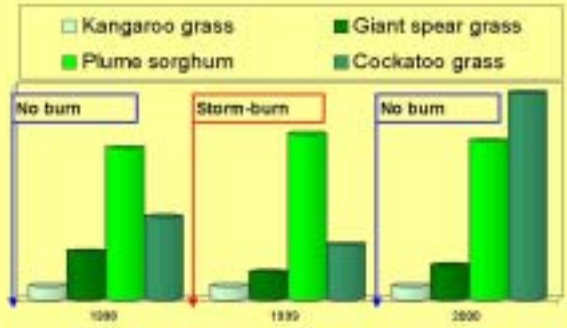
Open habitat gradually restored by a series of storm-burns.

Pastoralists recognize that both late dry season fires and storm-burns effectively maintain open grasslands and grassy woodlands[50]. However, storm-burns have few of the unwanted effects of late dry season fires. Because plant recovery is rapid, soil erosion is likely to be less severe. Because they are characteristically restricted in extent and patchy, fire-sensitive

[a] This is less of a problem on Cape York peninsula than in the top end of the Northern Territory or the Kimberly of Western Australia, where lower humidities and higher fuel loads create intense fires and extensive tree death (Stanton 1992; Crowley 1995).

animals can find refuge until essential features of their habitat recover. Storm-burning does not appear to eliminate any of the major woody or ground layer plants that are characteristic of golden-shouldered parrot habitat. They also appear to promote seed production in cockatoo grass, even though the plants may not to reach maximum extent or seed production for 2 years. If the first storms of the wet season are not be followed by heavy rain for several weeks, the effects of storm-burns may be similar to those of late dry season fires. To avoid this storm-burns should only be lit after reasonably heavy rain (>50 mm), and late enough in that year that follow-up rain is predictable (late November onwards).

Seedlings of ephemeral food plants are more abundant on storm-burnt areas than in unburnt areas.



Perennial grasses persist under storm-burning, with cockatoo grass being most abundant in the second year after a storm-burn

Burning trials in golden-shouldered parrot habitat[51] have shown that open parrot habitat containing broad-leaved ti-tree can be completely lost in around 20 years if left unburnt. Storm-burns are effective at maintaining the structure of grasslands, but the frequency needed varies across landscape settings. Biennial to triennial storm-burns are adequate to maintain grasslands on flats dominated by a range of ti-tree species. Hill sites dominated by broad-leaved ti-tree may require up to annual storm-burning.

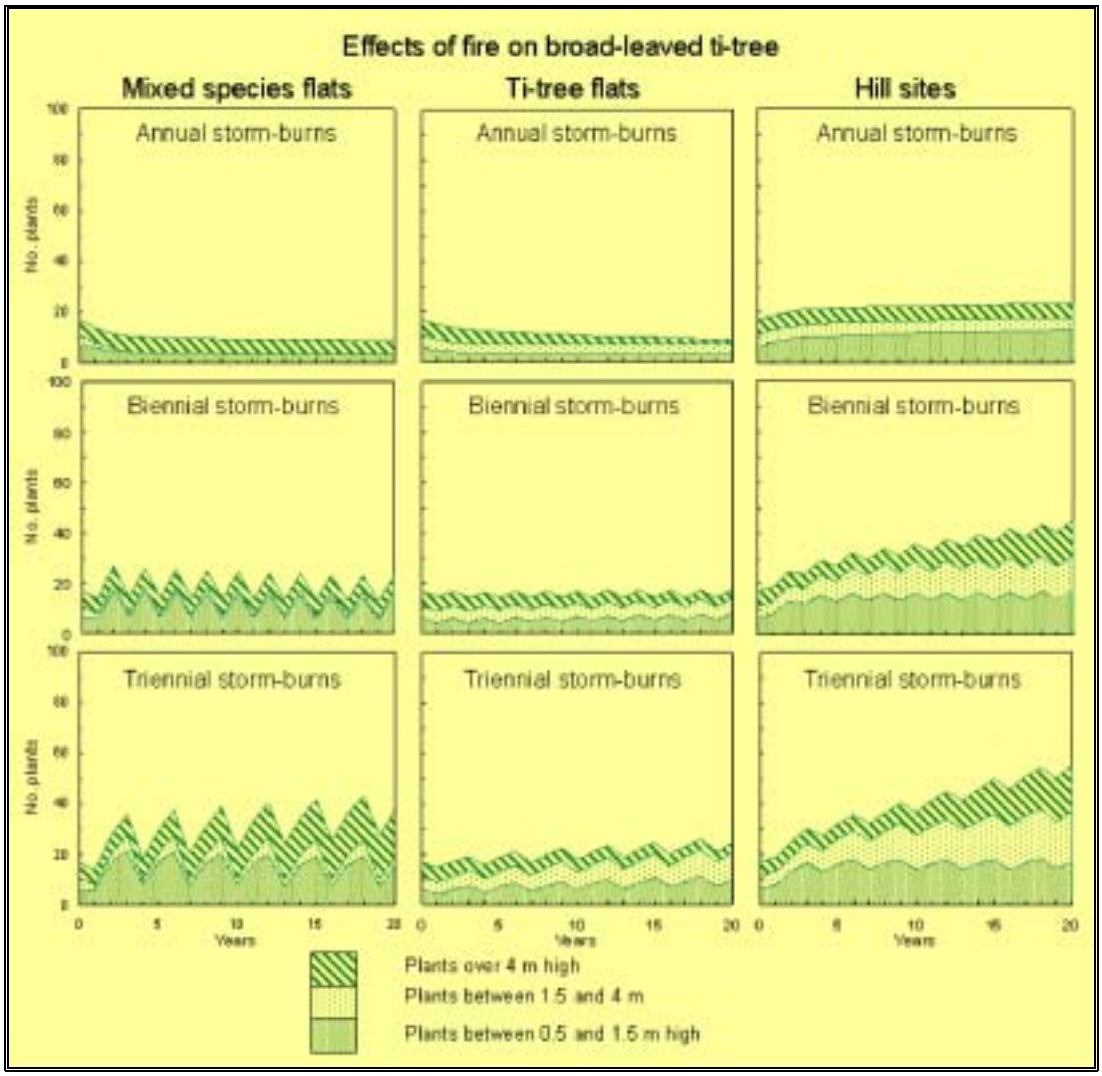
Storm-burning also reduces the impact of wet season food shortages. Ungerminated and partially germinated seed is killed by storm-burns, and the vegetation cover removed, making such seeds easier to find. A number of ephemeral plants are more abundant on storm-burnt areas than on adjacent, unburnt areas, including heliotrope and spade flower. Cockatoo grass seeding is extended by patchy storm-burning, with storm-burnt areas starting to produce seed as nearby unburnt areas become depleted.

Fire characteristics	Early dry season	Mid-dry season	Late dry season	Storm-burns
Management regime				
Lightning			+	++
Aboriginal	+	+	+	+
Pastoral	++			+
Spread	restricted	extensive	extensive	restricted
constrained by	streams, roads, tracks/ dozed fence lines	rivers, earlier burns	some rivers, some earlier burns	earlier burns, rivers, tracks/dozed fence lines
Intensity	mild	moderate	intense	variable
Canopy scorch	limited	moderate	extensive	variable
constrained by	soil/plant moisture, evening dew, mild weather, grazed fuel	mild weather, grazed fuel	grazed fuel	rain, soil moisture, mild weather, grazed fuel
Erosion	limited	moderate-extreme	extreme	limited
constrained by	incomplete burning of ground layer, green pick recovery	incomplete burning of ground layer	-	incomplete burning of ground layer, rapid grass layer recovery
Promote	woody plants	woody plants	grasses	perennial grasses and ephemeral plants
influenced by	green pick recovery followed by selective grazing	delayed grass layer recovery	delayed grass layer recovery	rapid grass layer recovery
Frequently burn	road/track sides	eucalypt/bloodwood woodland	all	ridge-tops, iron-stone country
Rarely burn	riverine vegetation, drainage depressions	riverine vegetation, drainage depressions	-	-

Effects on parrot habitat	No fire	Early dry season fire	Mid-dry season fire	Late dry season fire	Storm-burns
Influence on grassland habitat	promotes woody thickening	promotes woody thickening	promotes woody thickening	maintains open structure	maintains open structure
Influence on dry season foods	reduces seed availability	reduces seed availability, exposes fallen seeds	exposes fallen seeds	exposes fallen seeds	exposes and extends availability of fallen seeds, reduce annual grass seed availability in subsequent year
Influence on wet season foods	reduces access to and density of external hubs	may reduce seeding by weakening perennial grasses	-	-	extends seeding period of cockatoo grass, promotes increases in herb density
Influence on parrot survival	predation risk increased by vegetation thickening	predation risk increased by vegetation thickening – fires around active nests unaffected by heat	predation risk increased by vegetation thickening	predation risk reduced by open structure	predation risk reduced by open structure and increased wet season food availability

Hence fire regimes based on patchy storm-burning conserve plant cover and fuel loads, promote food plants and keep parrot habitat open. These factors are associated with high parrot survival and nesting success. In conclusion, regular storm-burning is considered the most suitable fire regime for maintaining golden-shouldered habitat because it;

- is the natural regime under which the parrots evolved;
- maintains open habitat structure (so limits predation);
- promotes production of wet season food supplies;
- minimises impact on the habitat of fire-sensitive species;
- minimises impact on cattle forage; and
- minimises soil erosion.



Storm-burning maintains vegetation structure. Mixed species flats need annual storm-burning. Ti-tree flats need biennial to triennial storm-burning. Hills sites need annual fires.

5. Habitats

Critical times for the parrot are the early wet season, when the parrots must feed for long periods and are exposed to predators, and the breeding season, when they are vulnerable to predation at nests. Ideal wet season feeding habitat is either well drained and gravely, retarding the germination of fallen seeds, or has been storm-burnt, exposing patches of roasted seeds that cannot germinate. It is also open-structured, to enable the parrots to be vigilant of butcherbirds, has a black-faced woodswallow nest, as woodswallows' alarm calls at the approach of predators also assist the parrots.

For nesting, the parrots require antbeds, particularly conical antbeds in the Morehead population and domed antbeds in the Staaten population. Again open structure is important to enable predator vigilance and maximise nest success.

In the dry season, habitat choice appears to be based on the availability of annual grass seed. Seed is abundant in many different habitat types, so none can be considered critical.

Gravel slopes

Gravel slopes support many seed-producing grasses and herbs in the wet season. Through the dry season, these die back, leaving grass seed on the ground. The parrots collect here in the early wet season, as the well-drained soils are slow to saturate, and seed slow to germinate. Particularly important are the slopes of quartzite gravel that occur in association with metamorphic rocks and granites. These areas are used as refuges early in the wet season.

The accessibility of seed in storm-burnt areas and on gravel slopes during the early wet season appears to enhance the survival of parrots through the wet season, particularly assisting young, inexperienced birds. This suggests that food supply and/or accessibility is often inadequate to support the parrots in the remainder of the landscape. Parrots radiate out from these wet season feeding areas to re-occupy nest sites.

Broad-leaved and lemon-scented ti-trees slowly invade gravel slopes, and are difficult to control because of low fuel loads. Annual storm-burning may be required to maintain this critical habitat, and if possible grazing pressure by cattle and pigs should be reduced in the months leading up to a planned fire.

Habitat	**Gravel slopes**
Critical habitat for:	Wet season feeding Breeding
Also used for:	Dry season feeding, roosting
Structural type	Low open lemon-scented ti-tree/broad-leaved ti-tree woodland
Dominant species	Lemon-scented ti-tree, scale-leaved ti-tree, broad-leaved ti-tree, hairy quinine, Clarkson's bloodwood and/or flying-fox ti-tree
Habitat characteristics	Gravel and rocks that retain ungerminated seeds through the early wet season; seeds of cockatoo grass, early wanderrie grass, spade flower, aneilema, heliotrope & sedges for wet season feeding; fire grass for feeding through the year, conical antbeds for nesting, black-faced woodswallow nesting habitat.
Properties	Artemis, Mary Valley, Dixie, Kalinga, Killarney & Bulimba
Regional ecosystems	Similar to 3.3.47 & 3.3.50, but found in seepage areas on hills

Gravel slopes support many seed-producing grasses in the wet season (above). By the end of the dry season (below), these die back, leaving grass seed on the ground.

Glimmer grass flats

When fire grass seed is wet by even brief periods of rain, the parrots have difficulty splitting the seed to extract the kernels inside. Therefore, following most early wet season showers, the parrots collect on glimmer grass flats in the lowlands to feed on glimmer grass, whose kernels, though smaller and more time-consuming to extract than those of fire grass, are still accessible. Glimmer grass flats form a short-term feeding stopgap, until glimmer grass seed also begins to germinate. Glimmer grass flats are also one of the first habitats in which new season seed is produced. Characteristic early seeding plants include parrot daisy and aneilema. Though used for short periods, glimmer grass flats are critical to parrot survival through periods of food scarcity.

Despite their open structure, glimmer grass flats can be invaded by lemon-scented ti-tree. Regular storm-burning is required to maintain an open structure.

Habitat	**Glimmer grass flats**
Critical habitat for:	Wet season feeding
Also used for:	Dry season feeding
Structural type	Low open lemon-scented ti-tree woodland
Dominant species	Lemon-scented ti-tree, scale-leaved ti-tree and/or broad-leaved ti-tree and/or flying-fox ti-tree
Habitat characteristics	Gaps in woody vegetation dominated by fire grass, glimmer grass, aneilema, parrot daisy and/or legumes, black-faced woodswallow nesting habitat.
Properties	Artemis, Mary Valley, Dixie, Kalinga, Killarney
Regional ecosystems	3.3.47

When fire grass seeds become soggy after the first rains, golden-shouldered parrots switch to fallen glimmer grass seeds (above) that are found on glimmer grass flats (left). Parrots may also nest in magnetic mounds in this habitat.

Broad flats

Broad flats are generally covered in open vegetation, with grasslands dominated by wanderrie grass and sorghum. Treed vegetation, primarily dominated by broad-leaved ti-trees, is most likely to occur along the flat edges. These flat may be invaded by ti-tree, but are frequently devoid of suckers in the grass layer (see *Narrow flats*). Of all nesting habitat, they are least likely to be invaded, but they still should be storm-burnt to ensure an open structure.

A few parrot nests are found on broad flats. Because these habitats are characteristically open, they have a high level of nesting success.

Habitat	**Broad flats**
Used for:	Breeding season feeding, wet season feeding, nocturnal roosting, breeding
Structural type	Low open broad-leaved ti-tree woodlands, plume sorghum grassland and grass flats
Dominant species	Broad-leaved ti-tree, smooth quinine, plume sorghum, annual kangaroo grass, wanderrie grass, wire grass, love grass, sedges
Habitat characteristics	Conical & magnetic antbeds for nesting; cockatoo grass, storm-burnt fray grass for wet season feeding; fray grass, summer grass, ditch millet, legumes, barnyard grass, *Ischaemum decumbens*
Properties	Artemis, Mary Valley, Kalinga, Dixie, Staaten River NP, Bulimba
Regional ecosystems	2.3.28, 3.3.49, 3.3.56 & 3.3.59

Broad flats provide both nest sites (above) and food through the wet season (below).

Narrow flats

The vegetation on most flats in the parrot's habitat was grassland or grassy woodland, with a sparse canopy, primarily of bloodwood and broad-leaved ti-tree. This vegetation structure is maintained by fire, particularly storm-burns and late dry season fires that favour grasses over trees. There are usually many ti-tree suckers in the grass layer. If flats are left unburnt for more than a couple of years, or if burnt too early in the dry season, these suckers grow rapidly and escape to the canopy. After about 5 years of inadequate burning, they are too tall to be damaged except by very hot fires, and the dense vegetation has shaded out most grasses. After several years, the vegetation may thicken to such an extent that the colonies of grass-feeding termites can no longer survive, and the antbeds degrade and disappear. The vegetation at a site near Coen, at which parrot nests were once abundant[52], is now so dense that no antbeds can be found. Invasion of mixed-species flats is fastest, but, because fuel loads are moderately heavy, can be retarded by biennial to triennial storm-burning.

Parrots often nest in termite mounds on narrow flats, but their chance of success is lower when flats are invaded by ti-tree. They also feed on them in the wet season, as long as suitable seeds can be found, but prefer more open areas. Dense vegetation in Narrow flats provides suitable day time roost sites.

Habitat	**Narrow flats**
Critical habitat for:	Breeding
Also used for:	Wet season feeding, dry season feeding, roosting
Structural type	Low broad-leaved ti-tree woodland and low open lemon-scented ti-tree/broad-leaved ti-tree woodlands
Dominant species	Broad-leaved ti-tree, wattles, orange-flowered ti-tree, lemon-scented ti-tree, scale-leaved ti-tree, quinine, Clarkson's bloodwood and/or other ti-trees
Habitat characteristics	Conical and magnetic antbeds for nesting
Properties	Artemis, Mary Valley, Dixie, Kalinga, Killarney, Imooya, Bulimba & Staaten River NP
Regional ecosystems	2.3.28, 3.3.33, 3.3.42, 3.3.47, 3.3.50, 3.5.14 & 3.5.17

Narrow flats are used for breeding even though the breeding success is lower than on open flats (above). However, eventually the vegetation becomes too dense to support antbeds, and important nesting areas, such as this invaded flat at Coen (below), can no longer support antbeds.

Flat edges

A distinctive vegetation community is found at the boundary between the drainage flats and the sand ridges. Here the vegetation is often more dense than through most of the parrots habitat. Grevilleas, wattles and myrtaceous shrubs dominate, and there are patches of Cape York red gum. There is often a sparse overstorey of bloodwood, broad-leaved carbeen and ghost gum. Often there is little ground cover. Otherwise, sedges predominate in damper areas, and fire grass and snake grass in the drier areas. Magnetic and conical antbeds are common. The extent of this vegetation type is determined by fire history. Storm-burning opens this dense vegetation without eliminating any species, but the dense structure is recovered within a few years.

Parrots often nest in conical antbeds on flat edges, though nests are likely to fail where the vegetation is dense. They will also feed on flat edges in the middle of the dry season, taking seeds of annual grasses, but prefer more open areas. The dense vegetation may be used for roost sites.

Habitat	**Flat edges**
Critical habitat for:	Breeding
Also used for:	Dry season feeding, roosting
Structural type	Cape York red gum woodland and scrubby thryptomene woodland
Dominant species	Cape York red gum, thryptomene, broad-leaved ti-tree, wattle, golden parrot tree and/or yellow ti-tree
Habitat characteristics	Conical and magnetic antbeds for nesting; fire grass, snake grass for dry season feeding
Properties	Artemis, Mary Valley, Dixie, Kalinga, Killarney & Imooya
Regional ecosystems	3.3.33 & 3.3.15

Nests are often built in antbeds on flat edges.

Bare areas

In their search for seed in the wet season, golden-shouldered parrots are frequently seen along roadsides, on patches of bare ground close to dams or in stream beds. These areas support a suite of ephemeral weeds, some of them introduced. The short-lived plants of these habitats often provide food for parrots, and include awnless barnyard grass, summer grass, parrot daisy and glimmer grass.

Bare areas also have many similarities to burnt areas in which parrots prefer to feed in the dry season. Verano, common along the roadsides, is also used in the breeding season. Seeds of surrounding vegetation, such as fire grass and plume sorghum, also blow onto bare areas, where they are easy picking for the parrots. Bare areas do not require any specific management, but should not be considered wasteland.

Habitat	**Bare areas**
Used for:	Wet season feeding, dry season feeding
Structural type	Stream beds, roads, scalds and pavements at the base of magnetic termite mounds
Dominant species	-
Habitat characteristics	-
Properties	Artemis, Mary Valley, Dixie, Kalinga, Killarney, Imooya, Bulimba & Staaten River NP
Regional ecosystems	-

Bare areas are an important source of seed in the early wet season, especially of ephemeral plants such as awnless barnyard grass (above).

Box flats

Box flats occur on alluvial plains and undulating clay plains. They have a very sparse canopy of shiny-leaved box, and an open understorey that includes broad-leaved ti-tree. Magnetic termite mounds are scattered across the flats and may be used for nesting. These flats rarely have many suckers in the grass layer, so do not tend to be invaded by ti-trees. A good body of grass is produced annually, ensuring hot fires. Biennial to triennial storm burns are sufficient to keep box flats open. Box flats provide many food plants through the breeding season, notably plume sorghum.

Habitat	**Box flats**
Used for:	Nesting, dry season feeding, breeding season feeding
Structural type	Shiny-leaved box open-woodland
Dominant species	Shiny-leaved box
Habitat characteristics	Plume sorghum, giant spear grass, black spear grass for breeding season and dry season feeding, magnetic mounds for nesting
Properties	Artemis, Mary Valley, Dixie, Kalinga, Killarney, Imooya, Bulimba & Staaten River NP
Regional ecosystems	3.3.36, 3.9.2, 2.3.10

Box flats provide food through the wet season; particularly plume sorghum and giant spear grass seeds.

Riparian forest and swamp edges

Dense vegetation associated with riparian forest and swamp edges is used by the parrots for day-time roosting. The parrots also feed on fisherman grass, found under orange-flowered ti-trees on flat edges, in the late wet to early dry season.

Habitat	**Riparian forest**
Used for:	Roosting
Structural type	Paperbark open forests
Dominant species	Silver-crowned and/or weeping paperbark
Habitat characteristics	Dense foliage
Properties	Artemis, Mary Valley, Dixie, Kalinga, Killarney & Imooya
Regional ecosystems	3.3.10

Habitat	**Swamp edges**
Used for:	Late wet season and early dry season feeding. Roosting
Structural type	Paperbark and orange-flowered ti-tree swamp woodland
Dominant species	Paperbark, broad-leaved ti-tree, orange-flowered tree and/or other ti-trees
Habitat characteristics	Dense foliage, fisherman grass
Properties	Present at less than mappable scale on Artemis, Mary Valley, Dixie, Kalinga, Killarney, Imooya, Bulimba & Staaten River NP
Regional ecosystems	2.3.28, 3.3.14

Parrots roost in riparian woodland.

Parrots roost in swamp edges.

Rocky hills

The tops of the hills and eastern flank of the Great Dividing range are clothed in heavy soils interspersed with granite boulders. Bulbous antbeds are common. Mixed deciduous woodland covers these slopes. Ironbark and ghost gum dominate the vegetation, with scattered bloodwood. Kapok trees and horse bush are particularly common, and the ground is covered in dense tall perennial grasses (plume sorghum, giant spear and black spear).

During the early wet season, golden-shouldered parrots search the boulders on fringes of this habitat for ungerminated hyptis seed, and the new seeds of aneilema.

Habitat	**Rocky hills**
Used for	Wet season feeding
Structural type	Ironbark, ghost gum and bloodwood woodlands
Dominant species	Cullen's ironbark, Clarkson's bloodwood, shiny-leaved box, broad-leaved carbeen
Habitat characteristics	Boulders or storm burnt areas with seed of Hyptis and/or *Aneilema siliculosum* for wet season feeding
Properties	Artemis, Mary Valley, Dixie, Kalinga, Killarney & Imooya
Regional ecosystems	3.11.7, 3.11.8, 3.12.10

Seeds on rocks remain ungerminated long into the wet season, so provide food when other seed is scarce.

Sand ridges and low hills

About half of the area within the parrots' distribution is composed of sand ridges and low hills. These areas have sandy topsoil, underlain by heavy red earth. While the soils saturate rapidly, they also drain quickly. Bulbous antbeds are common; conical and magnetic antbeds only occur in poorly drained areas. Bloodwood and messmate dominate the vegetation, with scattered ironbark, ironwood and ghost gum. Nonda plum and other softwood species are found in small patches, particularly at high points in the landscape. The understorey is a mixture of perennial (early wanderrie grass, cockatoo grass, plume sorghum, giant spear, love grass, panic grass) and annual (fire grass, snake grass) grasses. Annual grasses can produce over a thousand seed per square metre. Small annual grasses and herbs (summer grass, common native couch, brachiaria, native spurges) grow in sandy areas under nonda plums. Hyptis is common and perennial grasses are suppressed in the more heavily grazed areas.

Parrots feed on sand ridges in the late wet when plume sorghum seed matures . They feed on fire grass seeds from the time these become available at the beginning of the dry season until the start of the wet season. They usually congregate on recently burnt areas, where seeds are easy to find, but can also feed in amongst sparse standing grass. The dense-foliaged nonda plums are favoured as roosting sites. If the sand ridges are storm-burnt, parrots may continue to use them into the early wet season, taking roasted seeds that cannot germinate. Later in the wet season, the parrots return to feed on the seeds of annual grasses and herbs associated with nonda plums on ridge tops.

Habitat	**Sand ridges and low hills**
Used for	Wet season feeding, dry season feeding, breeding season feeding, roosting, nesting
Structural type	Messmate and bloodwood woodlands
Dominant species	Clarkson's bloodwood, Cooktown ironwood, broad-leaved ti-tree, Molloy box, messmate, woolly-butt, nonda plum, gum-topped bloodwood, rough-leaved bloodwood and/or Melville Island bloodwood
Habitat characteristics	Early wanderrie grass, cockatoo grass, plume sorghum, giant spear grass, love grass, panic grass, fire grass, snake grass, summer grass, native couch grass, signal grass, and/or native spurges
Properties	Artemis, Mary Valley, Dixie, Kalinga, Killarney, Imooya, Bulimba & Staaten River NP
Regional ecosystems	2.5.5, 3.3.20, 3.5.7, 3.5.9, 3.5.10 & 3.5.12

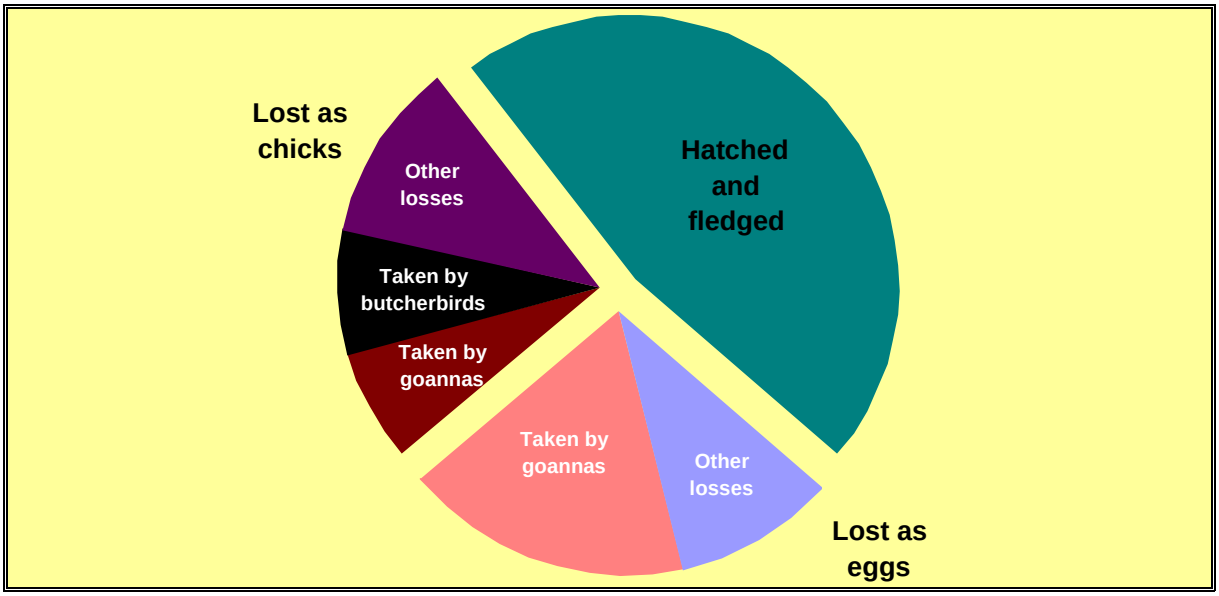
During the dry season, the parrots spend much time camouflaged in shady trees of riparian forest, swamp edges or eucalypt/bloodwood woodland (bottom right).

6. Threats

The golden-shouldered parrot occurs in tropical savanna woodland and feeds on seeds from a range of annual and perennial grasses. A natural shortage of food occurs annually in the early wet season. This can be made worse by a lack of burning and intense cattle and pig grazing. Altered fire regimes, in association with grazing by cattle and feral pigs, have also resulted in an increase in the density of woody shrubs, which appears to increase the vulnerability of the parrots to predators. In the early wet season, when parrots have to feed for long periods, they gather around the nests of black-faced woodswallows. These birds alert the parrots to the presence of predators. The number of woodswallow nesting territories has declined within the parrot's distribution, possibly as a result of vegetation thickening. This may have resulted in increased predation rates. The parrots nest in termite mounds, and damage to mounds by pigs and cattle may be reducing the availability of nest sites. While trapping, predation by feral cats and habitat clearance are potential threats, these are not operating at a significant level within the parrot's habitat.

Predation

Bright birds are particularly prone to predation[53], and golden-shouldered parrots are no exception. Predation of golden-shouldered parrots appears to be the immediate cause of the species' decline. Pied butcherbirds are thought to be a major predator of young golden-shouldered parrots, particularly immediately before and after fledging when they have already survived predation from other sources. About 48% of eggs laid produce chicks that leave the nests. Although 2.8 chicks fledge per nest where clutches are completed, this is reduced to only 1.7 fledglings/nest attempt when earlier failures are included. Goannas are by far the most significant predators, taking both eggs and chicks. A small number of chicks are taken at the nest by butcherbirds. This level of nest success should be enough to sustain the parrot population, but high losses of adults cannot be sustained. Most adult deaths occur in dense vegetation and appear to be caused by predation by butcherbirds. Many young birds appear to be taken either just after they leave the nest. Again butcherbirds are the most likely predators. Openness of vegetation is likely to be important for their survival.



Fate of eggs laid by golden-shouldered parrots.

Golden-shouldered parrots entering and leaving the nest (above left) are vulnerable to predators, particularly pied butcherbirds (above right). Evidence of predation by butcherbird, such as tail feathers of carcasses (below left), is found at many nests. Because of butcherbird predation, few nests in dense vegetation (below right) succeed.

Direct threat A. Predation	
Populations threatened	
Morehead	Current
Staaten	Unknown
Habitats threatened	
Not habitat specific, but predation by butcherbirds appears to be greater in habitats with a dense sapling layer	
Management actions	
Current/ongoing	Maintain open vegetation structure (Fire management)

Predation rates are affected by both *Vegetation thickening* and *Shortage of wet season foods*. Both threats have come about as a result of *Inappropriate fire regimes*, particularly in combination with overgrazing by *Pigs and cattle*. Pied butcherbirds are thought to be a major predator of young golden-shouldered parrots, particularly immediately before and after fledging when they have already survived predation from other sources. Predation rates are also likely to be inflated in the early wet season when the parrots must spend many hours a day feeding because of a *Shortage of wet season foods*,[54] as a result of overgrazing by Pigs and cattle and *Inappropriate fire regimes*. Predation in the early wet season may also have increased as a result of the *Loss of black-faced woodswallows*.

Shortage of wet season foods

Because of the lag between germination of annual grass seeds and the production of cockatoo grass seeds, the early wet season has probably always been a period of high mortality for tropical granivores, particularly for inexperienced immature birds[55]. The parrots rely on the seeds from a variety of ephemeral plants through this time, including parrot daisy, aneilema, cartonema, spurges, bloodroot and blue trumpet.

Shortage of wet season food can be exacerbated by *Inappropriate fire regimes*. Storm-burning improves feeding efficiency by removing vegetation cover and exposing the sparse seeds. It also kills many ungerminated and partially germinated seeds, so extends the period over which the parrots can take fire grass seeds. Many ephemeral plants that provide seeds in the interim between the depletion of fire grass seed and production of cockatoo grass seed are more abundant on storm-burns. Storm-burning is needed to extend the period that cockatoo grass is available. Where there are no storm-burnt areas, the parrots may gain insufficient food, reducing their chances of survival. This period of low food availability is extended if seed production by cockatoo grass is reduced by *Loss of perennial grasses* as a result of overgrazing by Pigs and cattle [56]. Other early seeding perennial grasses may also be adversely affected.

Storm-burning briefly removes vegetation cover, exposing sparse seed supplies.

Direct threat B. Shortage of wet season foods		
Populations threatened		**Exacerbates**
Morehead	Current	Predation
Staaten	Current	
Habitats threatened		
Wet season feeding	Significant	
Breeding season feeding	Significant	
Management actions		
Current/ongoing	Supplementary feeding (Morehead)	
	Cattle management	
Future	Feral pig control	

Nest site shortage

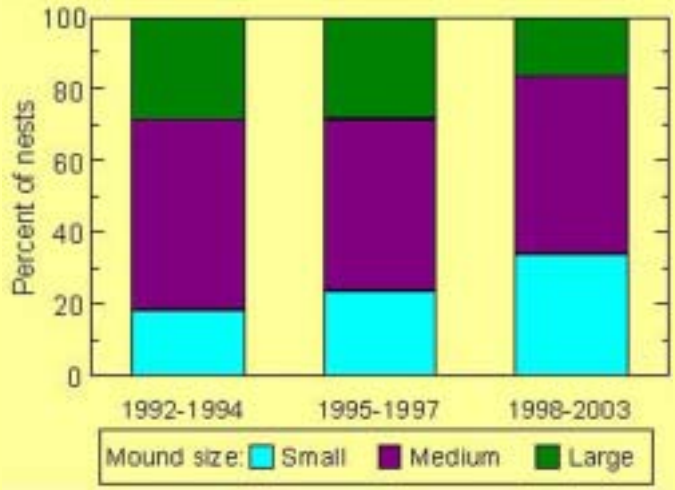
Availability of antbeds suitable for nesting is decreasing, at least for the Morehead population. Most antbeds are only used once, and, in some areas, most suitable mounds have already been used. Antbeds grow slowly, and can be damaged by pigs and cattle. Early results suggest that new antbeds may establish faster than old antbeds are lost only in areas from which pigs and cattle have been excluded.

The size of antbeds used for nesting has decreased over the eleven years from 1992 to 2003. Over the same period, average height of the nest entrance above the ground has decreased by 12%, from 69 cm to 61 cm. In an area where recruitment, growth and death

of all antbeds has been monitored, the total number of antbeds decreased by 42%, while there has been a decrease of 28% in the number of mounds of a nestable size.

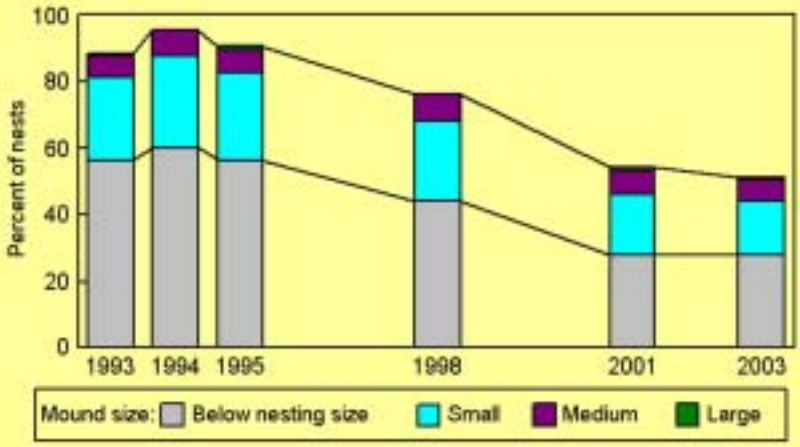
Small antbeds are particularly vulnerable to trampling by Pigs and cattle, which may prevent recruitment of new antbeds. Larger antbeds can be damaged or knocked over. As the antbeds used for nesting are built by grass and detritus-feeding termites[57], changes in fire and grazing regimes may influence the health of termite colonies. This may mean that antbeds grow more slowly when the grass is grazed or burnt early in the dry season. Antbeds disappear in areas where there has been *Vegetation thickening* as a result of Inappropriate fire regimes, possibly because of shading and loss of foods for termites.

Once a parrot has used the largest mounds in its territory, it may be several years before younger mounds become suitable for nesting.



Over the twelve years between 1992 and 2003, the parrots have nested in fewer large mounds and more small mounds[a].

[a] Size classes based on distribution of all nesting mounds used between 1992 and 2003. Small: smallest 25% of mounds (girth ≥ 98 cm and < 128 cm); Medium: middle 50% of mounds (girth ≥ 128 and < 159 cm); Large: largest 25% of mounds (girth ≥ 159 cm). Sample sizes 1992-1994: 98; 1995-1997: 188; 1998-2003; 112.



At one site where all termite mounds were measured over an eleven-year period, the total number of termite mounds decreased by 42%, and the number of a nestable size decreased by 28%.

Direct threat C. Nest site shortage (antbeds)	
Populations threatened	
Morehead	Current
Staaten	Potential
Habitats threatened	
Breeding	Significant
Management actions	
Current/ongoing	Cattle management, Antbed replacement
Future	Feral pig control
	Further actions contingent on monitoring results

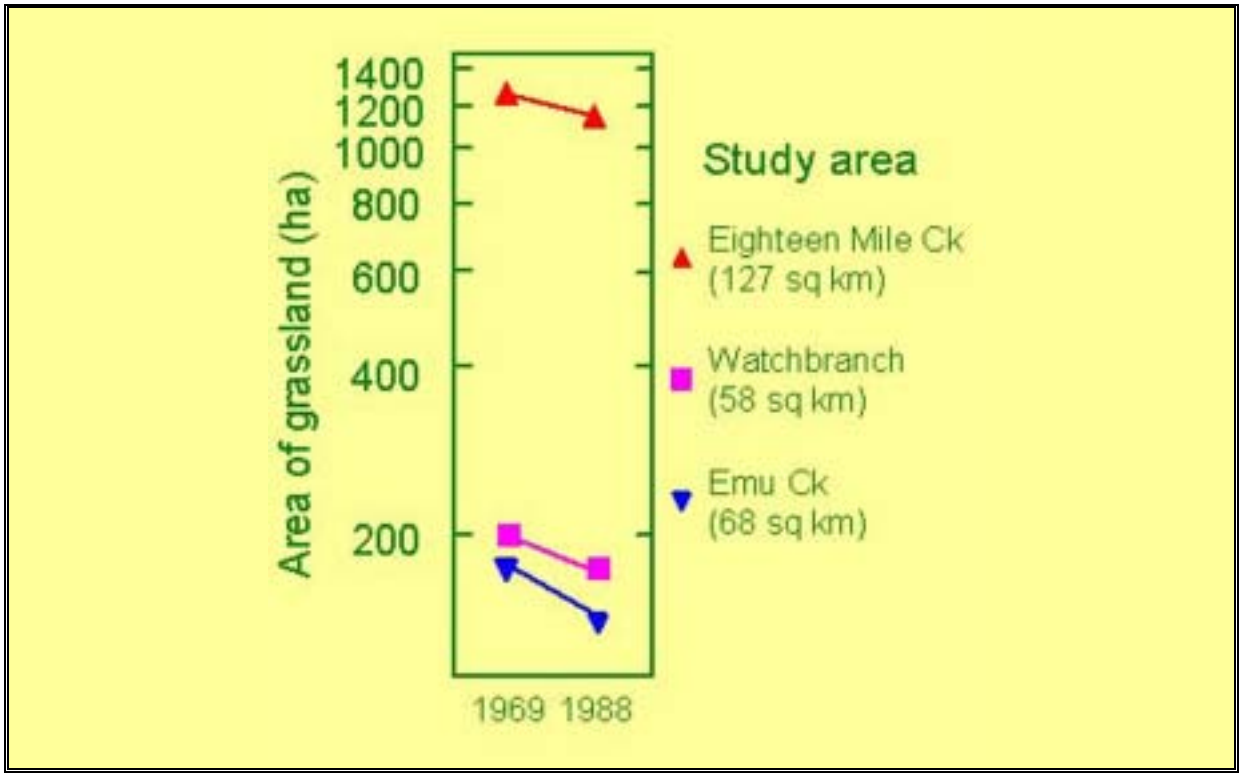
Vegetation thickening

Across northern Australia, grasslands have been disappearing and grassy woodlands have been getting thicker[58]. Golden-shouldered parrot habitat is also affected by these changes[59]. Invasion by broad-leaved ti-trees is resulting in the loss of grasslands throughout Cape York Peninsula, with an estimated loss of about 5% per decade. Disappearance of golden-shouldered parrots from Lakefield National Parks in the 1970s to 1980s has been attributed to loss of grasslands and thickening of grassy woodlands associated with inappropriate fire regimes[60]. Similar loss of habitat as a result of inappropriate fire regimes has also occurred on Mungkan Kandju National Park[61], where golden-shouldered parrot nesting was last recorded nesting in the 1920s. The main woody plant to invade grasslands on Cape York Peninsula is broad-leaved ti-tree. In the parrots habitat, lemon-scented ti-tree is also invasive.

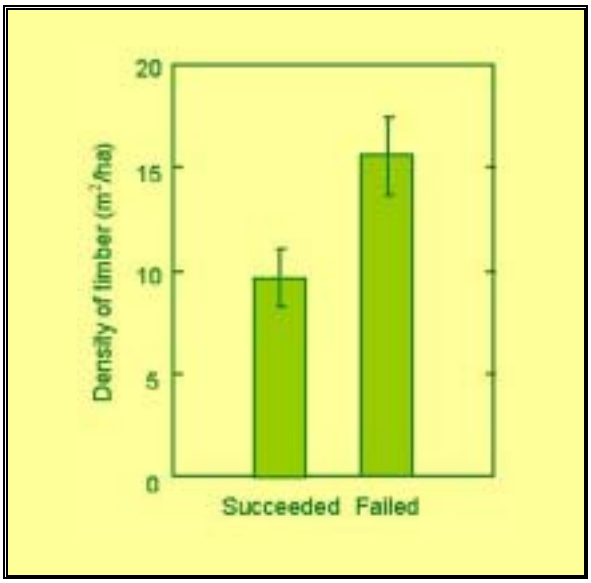
As vegetation gets thicker, *Predation* rates increase, so nests are more likely to fail in dense vegetation. We think this is because butcherbirds and other predators perch in low trees and wait for the nestlings to emerge. Adults building nests and attending young are also vulnerable to predators in dense vegetation. Nests in dense vegetation[a] are more

[a] As determined by Bitterlich measure (Open: Bitterlich ≤ 5; Closed: Bitterlich > 5).

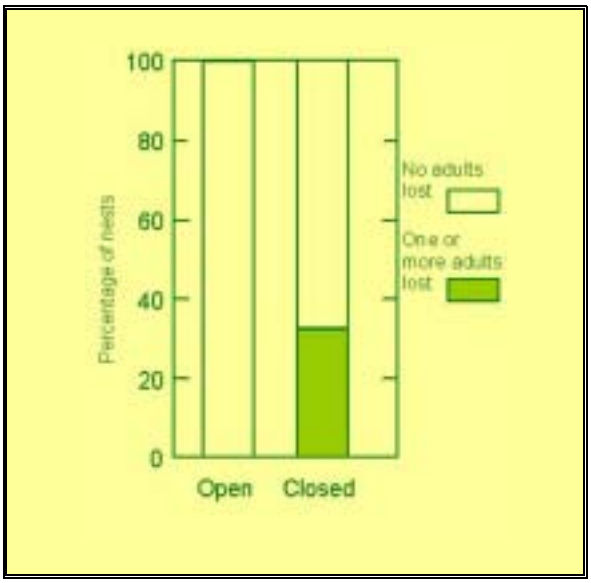
likely to lose at least one adult than nests in open vegetation. Vegetation thickening may also exacerbate *Predation* by causing the *Loss of black-faced woodswallows*, and *Nest site shortage* by shading antbeds and reducing food of termites.



Areas of grassland within golden-shouldered parrot habitat decreased at about 5% a decade



Success of nests is significantly lower in dense vegetation



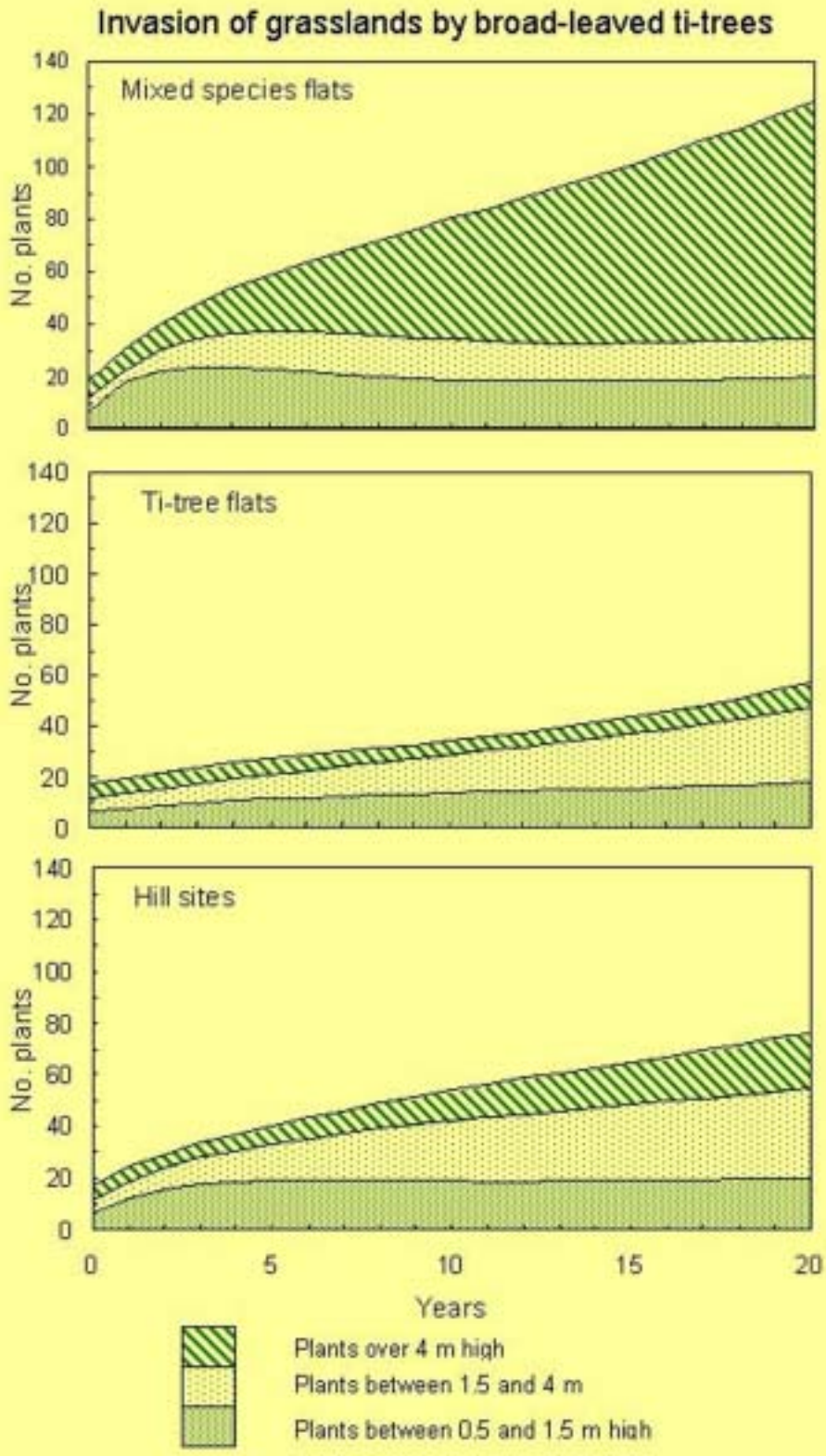
Risk of loss of adults at nests is higher in dense vegetation

Indirect threat a. Vegetation thickening		
Populations threatened		**Exacerbates**
Morehead	Current	Predation
Staaten	Current	Nest site shortage
Habitats threatened		
Wet season feeding	Significant	
Breeding	Significant	
Management actions		
Current/ongoing	Fire management	
	Cattle management	
Future	Feral pig control	

Inappropriate fire regimes

Fire regimes that once maintained golden-shouldered parrot habitat have been altered both intentionally and unintentionally. The need for forage for cattle means that pastoralists are reluctant to burn beyond the first months of the season[62]. As a result, country can remain unburnt year after year. However, lack of breaks in the fuel load mean that any fires starting from September onwards are able to spread across vast areas. These fires may not be hot enough to maintain grasslands. They also remove the grass that competes with broad-leaved ti-trees, which begin resprouting as soon as the fire passes. If grasslands are not burnt, then density of broad-leaved ti-tree above the grass layer can increase two- to seven-fold over a 20-year period. Fire intensity is also likely to be reduced as a result of grazing by pigs and cattle, which reduces fuel loads, so not all fires will be hot enough to maintain grasslands. Inappropriate fire regimes can lead to *Shortage of wet season foods,* and, through *Vegetation thickening*, *Loss of black-faced woodswallows, Nest site shortage* and *Predation*.

Open vegetation that is not burnt correctly can become too thick to walk through within a few years.



Without fire a two- to seven-fold increase in density of broad-leaved ti-trees is projected from current growth rates.

Indirect threat b. Inappropriate fire regimes		
Populations threatened		**Exacerbates**
Morehead	Current	Shortage of wet season foods
Staaten	Current	Vegetation thickening
Habitats threatened		Nest site shortage
Wet season feeding	Significant	
Breeding	Significant	
Breeding season feeding	Significant	
Management actions		
Current/ongoing	Cattle management	
	Fire management	

Loss of black-faced woodswallows

Parrots feeding near woodswallow nests during the early wet season benefit from alarm calls made by the woodswallows whenever predators are nearby, so are less likely to be killed. Like the parrots, woodswallows have disappeared from several areas on Cape York Peninsula. They no longer occur near Coen or on Silver Plains, where they bred in the early 20th century, and three of 12 known woodswallow traditional nesting sites on Artemis station have been abandoned between 1993 and 1995. Further losses from Artemis have not been recorded since storm-burning was incorporated into property-wide management, producing a more open vegetation structure. Storm-burning is therefore thought essential for the persistence of black-faced woodswallow habitat.

Loss of woodswallows appears to have occurred because of *Vegetation thickening* as a result of *Inappropriate fire regimes*, and has contributed to *Predation* of golden-shouldered parrots.

Golden-shouldered parrots associate with black-faced woodswallows in the late dry and early wet seasons.

Although some areas used by black-faced woodswallows may be densely wooded, nest are usually associated with areas of bare ground.

Indirect threat c. Loss of woodswallows		
Populations threatened		**Exacerbates**
Morehead	Current	Predation
Staaten	Potential	
Habitats threatened		
Not habitat specific, but predation by butcherbirds appears to be greater in habitats with a dense sapling layer		
Management actions		
Current/ongoing	Maintain open vegetation structure (Fire management)	

Loss of perennial grasses

Perennial grasses important to the parrots' survival include cockatoo grass and plume sorghum. Cockatoo grass is essential in the early wet season, and plume sorghum in the late wet season. Availability of these grasses triggers breeding by the parrots.

Abundance of these grasses fluctuates according to climatic conditions[63], but is also affected by fire and grazing. Plume sorghum does not produce seed until the end of the second wet season after a fire. Cockatoo grass seeds strongly after fire, but its period of seeding is delayed by storm-burning. A patchy fire mosaic that includes storm-burns will ensure maximum seed availability across the landscape and through the wet season. Both cockatoo grass and plume sorghum are sensitive to over-grazing[64], and cockatoo grass actively selected by pigs digging for food. Therefore *Inappropriate fire regimes* and *Pigs and cattle* need to be managed to ensure persistence of perennial grasses and adequate wet season food supplies for the parrots.

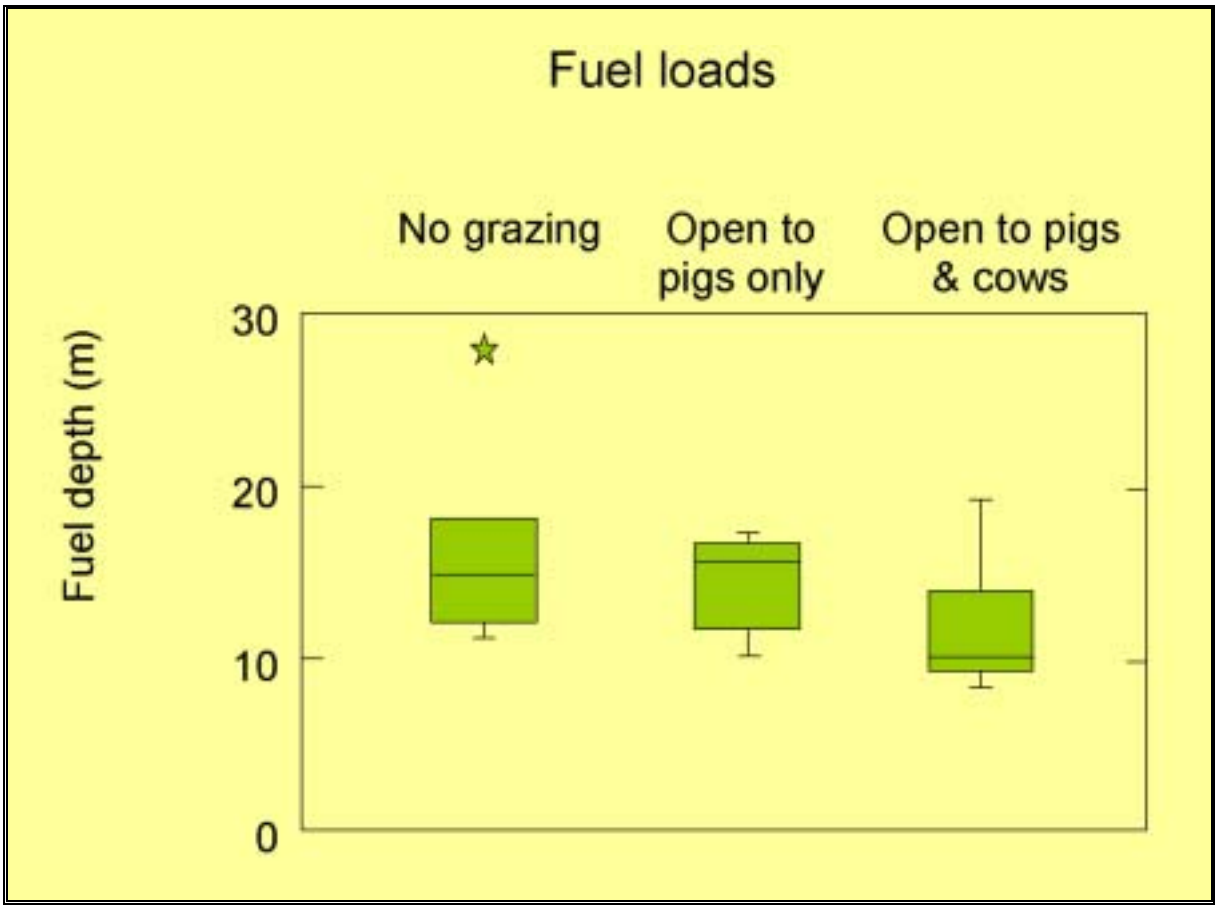
Indirect threat d. Loss of perennial grasses		
Populations threatened		**Exacerbates**
Morehead	Current	Shortage of wet season foods
Staaten	Current	
Habitats threatened		
Wet season feeding	Significant	
Breeding season feeding	Significant	
Management actions		
Current/ongoing	Cattle management	
	Fire management	
Future	Feral pig control	

Pigs and cattle

Cattle graze at low density through much of the parrots' habitat. However, lack of fencing has made control of grazing pressure difficult. Cattle congregate on hills and levees in the wet season, are widespread through the early dry season, and become increasingly concentrated on drainage flats late as the dry season progresses. Cattle movements are also influenced by availability of water and lick. Greatest impact is found around dams and lick sheds. Grazing pressure is likely to have increased with improvements in cattle husbandry that mean greater survivorship of animals through the dry season[65] and an increased appetite for dry grass.

Introduced to Australia in the 18th century[66], pigs are common and widespread on Cape York Peninsula[67]. Their numbers fluctuate with climatic conditions, peaking after a run of wet years.

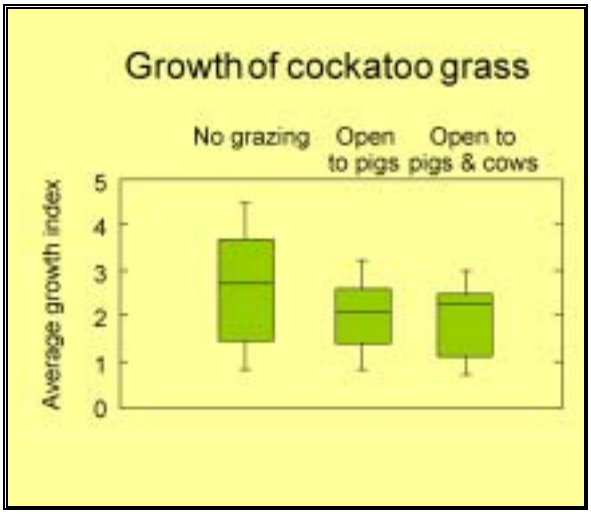
Grazing by pigs and cattle reduces fuel loads, thus is likely to contribute to *Inappropriate fire regimes* by reducing fire intensity.



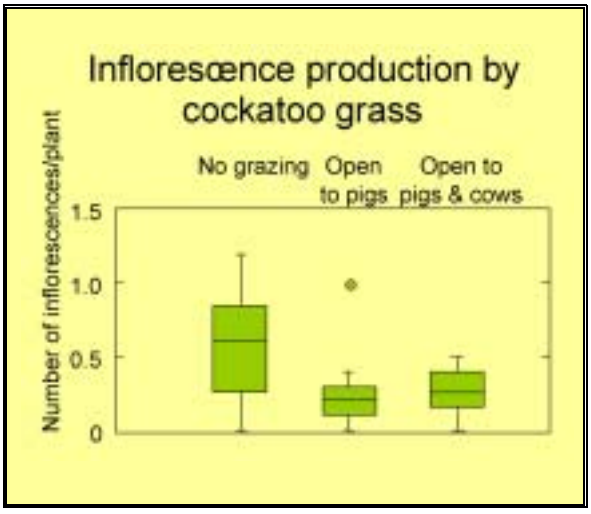
Fuel loads are highest in fenced areas.

Seed production by cockatoo grass is reduced by defoliation consistent with moderate cattle grazing[68]. Pigs may be even more destructive, as they actively uproot cockatoo grass in their search for food. As grazing by pigs and cattle reduces plant size, it affects seed production for at least two seasons. The period of food scarcity in the early wet season is therefore likely to be longer and more severe where seed production by cockatoo grass is reduced by pigs or cattle. Other early seeding plants may also be similarly affected. Hence, overgrazing by pigs and cattle contributes to *Shortage of wet season foods* by causing *Loss of perennial grasses*.

Pigs selectively graze and uproot cockatoo grass.

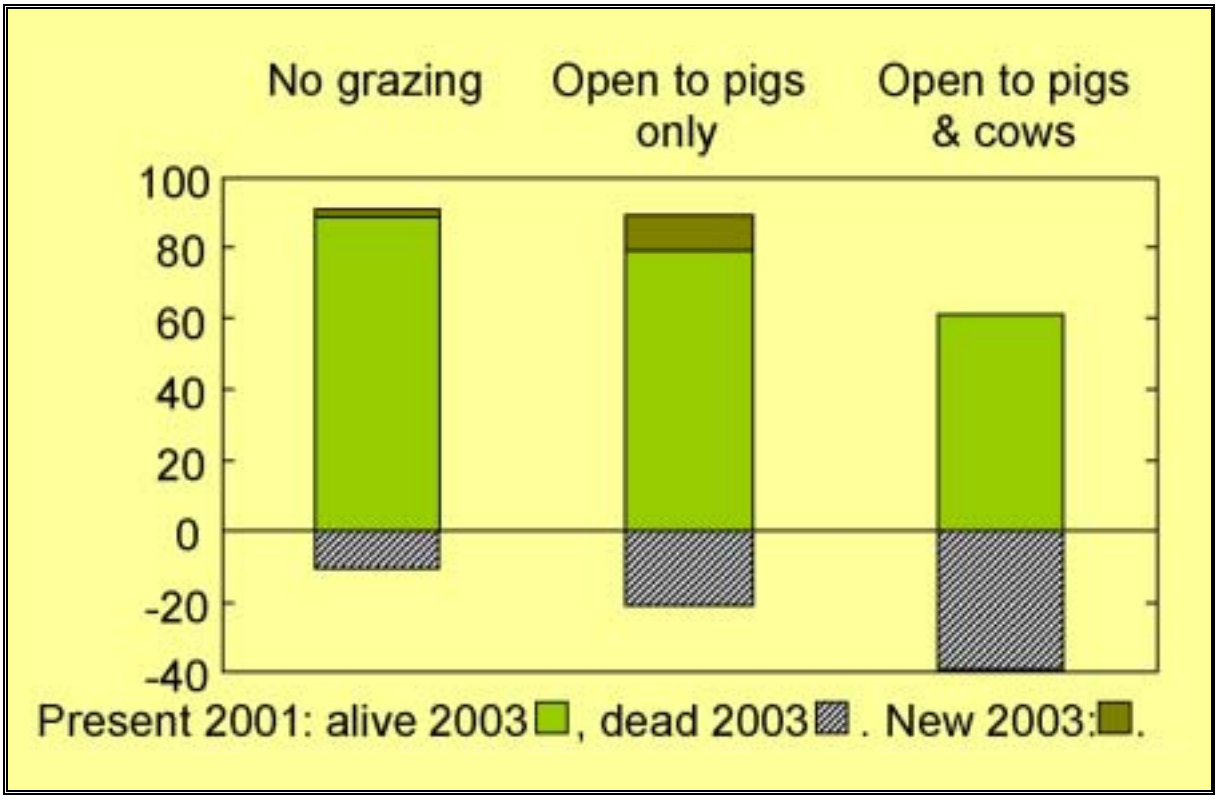


Grazing by pigs and cattle reduces growth of cockatoo grass.



Pigs and cattle reduce flowering and seed production by cockatoo grass.

Pigs and cattle also appear to influence *Nest site* . Preliminary work indicates that new conical antbeds are far less likely to develop in areas open to both pigs and cattle than they are in fenced areas. Survival of existing antbeds is also highest in fenced areas. This may explain the reduction in numbers of large antbeds being used as nests through the parrot's habitat.



Survival and recruitment of conical antbeds is highest in fenced areas.

Indirect threat e. Overgrazing by cattle		
Populations threatened		**Exacerbates**
Morehead	Current	Shortage of wet season foods
Staaten	Current	Inappropriate fire regimes
Habitats threatened		Vegetation thickening
Wet season feeding	Significant	Nest site shortage
Breeding season feeding	Significant	
Management actions		
Current/ongoing	Cattle management	

Indirect threat f. Feral pigs		
Populations threatened		**Exacerbates**
Morehead	Current	Shortage of wet season foods
Staaten	Current	Inappropriate fire regimes
Habitats threatened		Vegetation thickening
Wet season feeding	Significant	Nest site shortage
Breeding	Significant	
Breeding season feeding	Significant	
Management actions		
Future	Feral pig control	

Land clearance

Less than 1% of the woody vegetation on Cape York Peninsula has been cleared, and very little clearance has occurred within the parrot's habitat[69]. Land clearance is not listed as a threatening process for any of the regional ecosystems used by the parrots[70]. Most of the country used by the parrots is unsuitable for clearance, because of high suckering rates of the dominant woody species[71]. Clearance of fence lines to enable improved cattle and fire management is unlikely to have an adverse effect on the parrots, but should avoid critical habitat wherever possible.

Minor threats i. Land clearance	
Populations threatened	
Morehead	Potential
Staaten	Potential
Habitats threatened	
Wet season feeding	Potential
Breeding	Potential
Breeding season feeding	Potential
Dry season feeding	Potential
Roosting	Potential

Diseases and parasites

While disease has been raised as a potential threat[72], there are no indications of disease threatening wild populations of golden-shouldered parrots[73]. Parrot corpses examined had no sign of disease[74]. Regulations restricting the holding of golden-shouldered parrots in captivity

within their natural distribution minimises the likelihood of diseases entering the wild population. Hygienic captive breeding techniques will be essential for the handling of birds bred for release on Cape York Peninsula.

Minor threats ii.	Diseases and parasites
Populations threatened	
Morehead	Potential
Staaten	Potential
Habitats threatened	
Effect not habitat specific	

Trapping and trade

Golden-shouldered parrots were actively trapped through the 1950s to 1970s[75]. However, large numbers in captivity, and development of successful breeding techniques has reduced any financial incentives to trap wild parrots[76]. At present trapping and trade are not considered threats to the wild population.

Minor threats iii.	Trapping and trade
Populations threatened	
Morehead	Potential/ historical
Staaten	Potential/ historical
Habitats threatened	
Effect not habitat specific	

Feral cats

While feral cats have been raised as a potential threat[77], cat numbers are low in golden-shouldered parrot habitat and nest losses to cats are currently less than 0.5%[78]. Feral cats are therefore not currently considered a significant threat to golden-shouldered parrots.

Minor threats iv.	Feral cats
Populations threatened	
Morehead	Potential
Staaten	Potential
Habitats threatened	
Effect not habitat specific	

7. Management guidelines

Maintenance of existing habitat

Just as the decline of golden-shouldered parrots has followed changes in land management, changes in land management practices hold the key to the parrot's recovery. Little of the habitat has been cleared, or altered too profoundly, so recovery of habitat is still possible.

Where the parrot persists in good numbers through the wet season, habitat must still be in good condition, and management practices are assumed to be largely sympathetic to parrot requirements. There are still enough parrots to spread out to the nesting areas.

Disappearance of parrots from nesting areas is more complex, as this may indicate either few parrots have survived the wet season, or that nesting sites are no longer suitable.

However in both nesting and wet season feeding habitats, the aim is to reduce the likelihood of predation. This is done by maintaining an open vegetation structure that has few suckers.

Critical habitat of golden-shouldered parrot should be managed to maintain an open grassland/grassy woodland structure, to protect antbeds suitable for nesting and maintain seeding populations of perennial grasses (particularly cockatoo grass and plume sorghum). Maintenance of open vegetation structure, particularly of grassland nesting habitat and wet season feeding areas, is considered essential to the persistence of golden-shouldered parrots.

Nesting sites are characterised conical antbeds on drainage flats (left). When left unburnt for a number of years, these sites are invaded by broad-leaved ti-tree (right), increasing the risk of predation.

Critical habitat should not be cleared. Clearance elsewhere in the parrot's distribution is unlikely to have adverse effects, as long as substantial areas of eucalypt/bloodwood woodland with fire grass remain (>70% original cover on sand ridges, >50% other land forms). Critical habitat should be managed using low stocking rates (or destocking) and storm-burning every two to four years. In most habitats, two to three-yearly storm-burning is ideal. In dry years, three to four years between burns may be adequate. This should maximize fuel loads. Where stock are present, numbers should be reduced at least 6 months before burning, to maximize fuel loads, and up to six months after burning, to allow recovery of perennial grasses.

Critical habitat needs to be protected from unintentional fire through the dry season. The most effective method for doing this is to use early dry-season burning to create firebreaks around designated areas, especially between critical habitat and public roads.

Pig numbers should also be controlled in critical habitat, through the use of baiting, fencing and hunting.

Nesting habitat also needs protection from pigs and cattle to ensure survival and recruitment of termite mounds.

Management practices essential to the maintenance of critical habitat
moderate stocking rates or destocking,
effective pig control,
regular storm-burning,
effective firebreak networks.

Signs of habitat degradation
golden-shouldered parrots no longer present,
golden-shouldered desert traditional nesting areas,
black-faced woodswallows desert traditional nesting areas,
dense suckering of broad-leaved ti-tree and/or lemon-scented ti-tree,
cockatoo grass population declines, or its seed production reduced,
plume sorghum population declines,
increase in annual grass at the expense of perennial grass,
loss of antbeds

Management practices most likely to degrade critical habitat
inappropriate fire regime (frequent dry season fires or inter-fire intervals of five or more years).
inadequate pig control,
overstocking,
clearance

Cattle management

Parrots and cattle can co-exist, but only where cattle movement and density are controlled. Both cattle and parrots are favoured by open landscapes with healthy perennial grasses, so management for parrots should improve the productivity and sustainability of pastoral properties. Any control of cattle numbers will require fencing. In National Parks, cattle should be completely removed and excluded by fencing and closing off any artificial watering points.

Key areas of cockatoo grass should be protected from overgrazing in the early wet season, when perennial grasses are most vulnerable. The most important areas are gravel slopes in the hills. Even a few hectares protected from grazing should provide food for the parrots through the critical period of the early wet season.

To maintain and restore an open vegetation structure, grazing pressure needs to be minimised before a planned storm-burn. This will ensure fuel loads are large enough to produce a high intensity fire. If it is not possible to remove cattle for an entire year, then cattle should be removed or reduced in number in the early to mid-dry season, before they begin to congregate on drainage areas. Cattle should not be returned until perennial grasses have re-established. Again rotation of stock will depend on adequate fencing.

Cattle may need to be excluded for longer periods from areas where availability of nests is limiting. A fenced area of one hectare should be enough to ensure availability of nests for at least ten years. Areas critically short of antbeds can be supplemented by replacement from areas where the parrots are absent (see *Antbed replacement*)

Maintaining parrot habitat helps to maintain the productivity and sustainability of pastoral operations.

Fencing is an integral part of controlling grazing pressure.

Feral pig control

Feral pigs should be kept at minimum levels to minimise loss of cockatoo grass and other perennial grasses, and damage to termite mounds. Feral pig numbers vary with climatic conditions, with numbers increasing in wet years, and decreasing in dry years. Control measures undertaken when populations are low may restrict the increases in wet years. As pigs are fast breeders, continual effort is required to keep pigs at a minimal level.

Effective methods for controlling pigs include poison baiting, trapping and fencing. Use of poison baits is the most effective control method, and can reduce pig numbers by up to 90%[79].

Poison baits are the most effective, cheapest and least time-consuming method of pig control[80]. Guidelines for use of poison baits to control pigs are available from the Department of Natural Resources and Mines[81]. At present 1080 is recommended for pig control in Queensland, although other poisons are being trialled. Pigs that eat 0.3 milligram of 1080 per kilogram of body weight will be killed. Fermented grain is recommended over meat, as it is most effective, and can be buried so that non-target animals are not poisoned. However, meat, available from wild brumbies at little cost, is also effective, particularly in dry weather. If meat is left in large chunks, it is less likely to be taken by non-target animals. As 1080 is soluble in water, placing baits in areas that will flood in the wet season will ensure that all poison is removed from the environment[82]. The risk of animals being poisoned by drinking contaminated water is extremely low[83].

On-ground shooting and hunting with dogs have been found to be ineffective, and, by scattering pigs, may reduce the effectiveness of other control methods[84].

Example protocol for poisoning pigs

Undertake control during dry weather when pigs congregate around shrinking swamps and waterholes

Contact local government pest officer to arrange date for baiting

Collect bait. If using meat, cut into large chunks (about 1kg pieces)

If possible, establish a free-feeding routine with unpoisoned bait for several days

Erect warning signs and alert neighbours

Lock up dogs while poison baits are present to prevent their accidental poisoning

Get bait injected by pest officer and store in large drums

Distribute bait around swamps and water holes, below high water mark

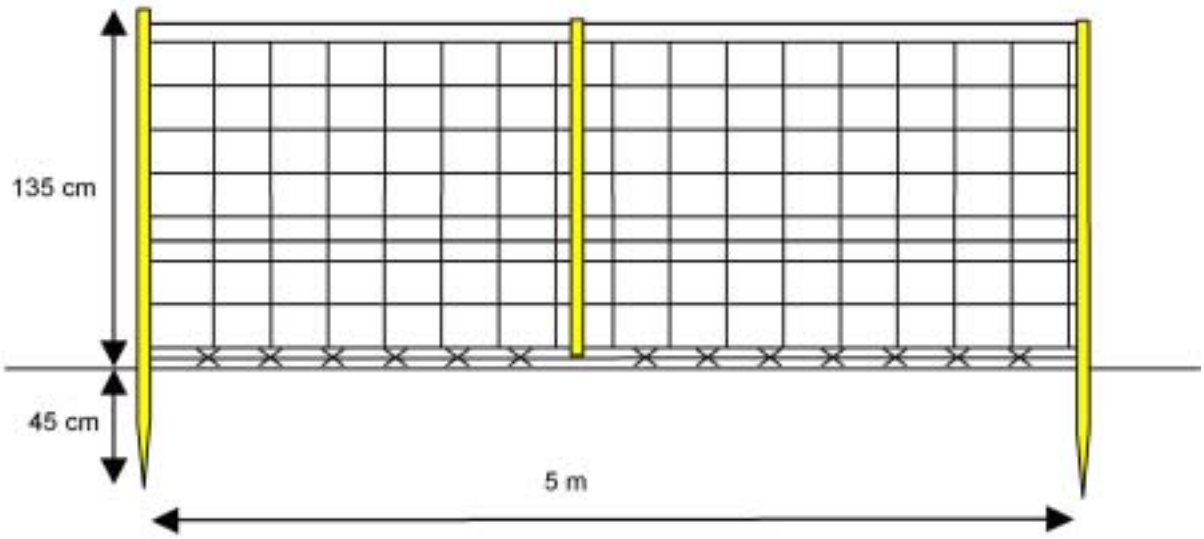
Monitor baits and remove any that have not be taken

Wash wheels of cars after entering baiting areas

Release dogs only after substantial rainfall in the affected area

Trapping can be effective when pig numbers are at low levels[85]. The Department of Natural Resources and Mines can provide specifications for building suitable traps[a].

Pigs can be fenced out from small areas, including rubbish dumps. Pig fences should be erected using wire mesh attached to star pickets at 5 m spacings. Every 100 m or so, a steel post should be concreted in to the ground. Barb wire strung at ground level wire prevents pigs from forcing their way under the fence. To the same purpose, concrete strips should be laid under any gates.



[a] Anon. 2003. Control of feral pigs. Pp. 1-4 NRM facts, vol. PA7. Queensland Department of Natural Resources and Mines, Brisbane.

Materials for pig fencing

Product	Approx. unit cost	Recommended units/km
1150 mm high dog wire (150 mm vertical spacing, 8 horizontal wires, 150-200 mm spacing) 100 m rolls	$133	11
180cm star posts	$7	200
2.5 gauge, heavy galvanised, barbed wire 500 m roll	$85	3
4mm plain wire 500 m roll	$92	7
117cm droppers (45/bundle)	$70	5
16 mm clips (500/bag)	$14	6
Steel strainer assembly	$143	6
Steel posts	$14	as required
Concrete	$11	18
Grid (away from gazetted roads)	$2,850	as required

Fire management

Fire management of golden-shouldered parrot habitat should aim to maintain or restore an open vegetation structure and minimise vegetation thickening. This is particularly important around potential nest sites (*Gravel slopes*, *Narrow flats*, *Flat edges* and *Box flats*) and in wet season feeding habitat (*Gravel slopes* and *Glimmer grass flats*). This is most effectively achieved by storm-burning or late dry season fires. It is also important to maintain habitat diversity, and to allow time for post-fire recovery of perennial grasses. Fire management of wet season feeding areas should be used to create a mosaic of open ground with fallen annual grass seed (storm-burnt), early seeding (unburnt for one dry season) cockatoo grass, later seeding (storm-burnt) cockatoo grass, and later seeding plume sorghum (unburnt for at least two wet seasons). Mosiac patch size should ideally be less than 1km^2, but with several patches to avoid overgrazing of green pick.

1999 – Before storm-burning

2000 – After storm-burning

Most burning should be at storm-time. While late dry season fires are also effective at maintaining open vegetation structure, storm-burns are desired because they minimise erosion, expose and kill seed, promote seed-producing ephemeral plants, extend the seeding of cockatoo grass and are usually less extensive than late dry season fires. The only reason for actively burning at other times of the year are to minimise the spread of wildfires, and to assist in the creation of a post-fire mosaic.

Creation of a mosaic is achieved with a combination of landscape features (network of streams, ridgelines, scalds and rocky areas), earthworks (graded fence lines, tracks and roads) and active burning (wild-fire scars, early dry season fires, storm-burns, back-burning). Some features become less effective as the dry season progresses. Dry season fires may prevent spread of fires until the following June or July. Storm-burnt areas, streams, creek lines and roads may stop the spread of fires until August or September the following year. By October, spread is only stopped at major rivers, on areas burnt in the current dry season that are at least one kilometre across, or by back-burning from roads and major watercourses. The most effective fire breaks at this time of the year are continuously burnt areas that are at least one kilometre wide and several kilometres long. They are most necessary along major access roads or around recognised ignition sources, such as campgrounds.

Effective fire breaks can generally be achieved by burning in June or July[86]. Ariel incendiaries can be used over extensive areas or in remote terrain, but on ground assessment of fuel conditions and logging of geographic co-ordinates of fire lines are essential[87]. As well as using this GPS information when following fire lines in an aircraft, it is important to have a passenger who can recognise landmarks in the landscape. Helicopter flying is flexible enough to allow for rapid correction if GPS readings are seen to be faulty, or repeat burning if a patch fails to ignite. Fixed wing aircraft are less flexible, but are more cost effective when covering extensive areas, especially following long straight roads or fence lines[88]. Follow-up of the extent of the fires, either on ground or by remote sensing[a] is also important. If fires from a single fire line are not extensive enough, second and third lines may be required. To prevent excessive spread it is desirable to burn towards roads or streamlines, rather than away from them.

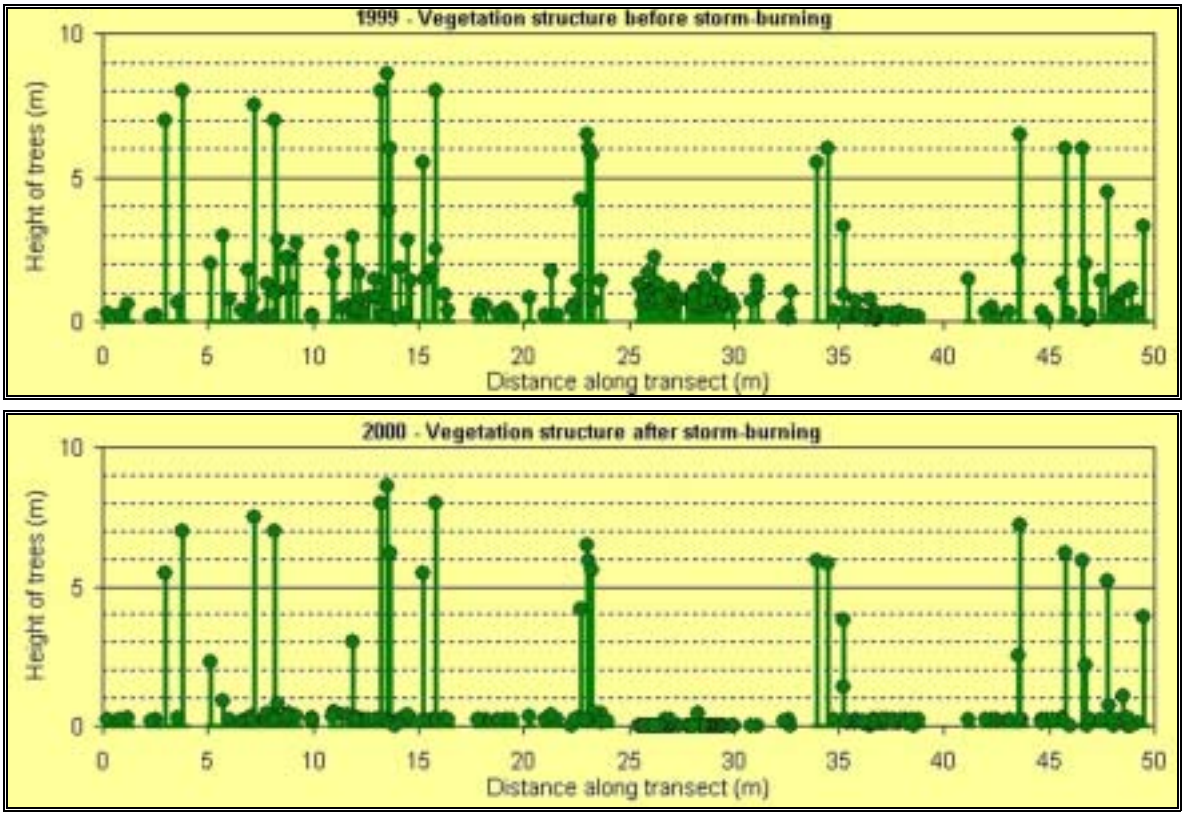
Areas selected for burning firebreaks should have ample fuel to ensure near complete ignition. Suitable areas are those that have remained unburnt for at least two growing seasons, or areas on rich soils or damp depressions that produce a heavy body of grass each year. It is best not to use the same areas each year, as this promotes overgrazing and weed invasion[89]. However, it may not be possible to use alternate areas each year, especially is it is necessary to burn along public access roads. Fuel should also be cured enough to carry fire, but there should be enough moisture in the fuel for fires to self extinguish overnight. Where possible, fires should usually be lit in the mid to late afternoon, when fuel is at its driest, and strong breezes will carry the fire, but air cooling and dew fall will prevent the fire spreading too far. Local experience is the greatest tool in determining the right time and place to burn. Inexperienced landholders should ask the advice of a neighbour. Information on the permits required and other obligations, including notification of neighbours, should be obtained from the Queensland Rural Fire Service[b].

Mosiacs that ensure about half the country remains unburnt[86] can also be created by burning through most of the year, as probably happened in pre-European times. Such a fire regime is

[a] http://firenorth.org.au/nafi/dbconnect.jsp

[b] http://www.ruralfire.qld.gov.au/

unlikely either to benefit or harm the parrots but is not compatible with pastoral production[90] and has other adverse effects, such as soil erosion[91].



Dense suckering of broad-leaved ti-tree (left) can be reduced by storm-burning to produce an open vegetation structure in golden-shouldered parrot habitat (right).

The main fires lit for management of golden-shouldered parrot habitat should be lit at storm-time. Storm-burns can occur as a result of lightning. For an effective storm-burn, grazing pressure should be reduced in the months before a designated burn, to ensure adequate fuel loads. To ensure storm-burns are limited in extent, areas designated for storm-burning should be isolated by early dry season burns and other appropriate breaks. Storm-burns should be lit after the first reasonably heavy rain (>50 mm), but late enough in the year that follow-up rain is predictable (late November onwards). The grass should be dry enough to carry fire. Ideal conditions are one to two days of heavy rain and two days of sunshine. There will be years when such conditions do not occur. If heavy and widespread rain falls more or less continuously for a week or more, seed germination and perennial grass recovery will be advanced, and storm-burning will result in bare scalded areas. Burning should certainly not be undertaken more than a few days after the first heavy rains.

As part of the purpose of storm-burning is to open up woody vegetation, the hotter the conditions the better. A mid to late afternoon burn on a hot day will ensure an effective burn. Landholders storm-burning should remember to apply for a permit and inform neighbours.

Summary

Management of existing habitat	
Pasture management	**Measure of success**
Maintain cockatoo grass in key wet season feeding areas	Cockatoo grass present in >25% of 20 randomly-spaced 25 x 25 cm plots in hill and sand ridge sites
Maintain sorghum in key wet season feeding areas	Plume sorghum present in >10% of 20 randomly-spaced 25 x 25 cm plots in sand ridge sites
Cattle management	
Fence pastoral properties to enable stock control	Sound fencing present that allows management of cattle movements across existing habitat
Identify sacrifice areas where high stocking rates cannot be avoided	Sacrifice areas not to include key nesting or wet season feeding areas
Destock key nesting areas on pastoral properties	Cattle completely excluded from at least ten 1 ha nesting territories with unused antbeds of at least 75 cm girth
Completely fence out cattle from existing habitat on National Parks	No cattle on existing wet season feeding or nesting habitat on national Parks
Feral pig management	
Annual baiting of pigs at end of dry season	Pig rooting in key nesting and wet season habitat covers less than 10% each year
Exclude pigs from key nesting areas	Pigs completely excluded from at least ten 600 m^2 potential nesting territories
Exclude pigs from key wet season feeding areas	Pigs completely excluded from at least ten 600 m^2 areas of gravel slope
Fire management	
Prevent extensive dry season fires by establishing adequate fire breaks (network of streams, ridgelines, scalds and rocky areas, early dry season burns, graded fence lines and tracks)	No more than 30% of nesting or feeding habitat burnt during dry season
Storm-burn wet season feeding habitat	20 to 30% of wet season feeding habitat storm-burnt each year, no more than five years between storm burns in any location
Storm-burn nesting habitat	20 to 30% of nesting habitat storm-burnt each year, no more than five years between storm burns in any location

Restoration of deserted habitat

Deserted habitat close to persistent populations should be restored to allow the natural recolonisation of parrots from existing populations. Further afield, habitat restoration should be undertaken before the parrots are actively re-introduced. Restoration of habitat should also benefit other grassland dependent taxa, such as buff-breasted button-quail.

Habitat suitability should be assessed for features that are critical to parrot survival. These include availability of antbeds suitable for nesting, perennial grasses, gravel or rocky slopes that provide reserves of ungerminated seed into the wet season. Vegetation should be open, and breeding territories of black-faced woodswallows are desirable. Once these features are identified, cattle, feral pigs and fire should be managed as for existing habitat.

Summary

Restoration of deserted habitat

Action	Criteria
Nest site availability	
Assess antbed availability	At least 10 conical mounds of girth > 1 m/km^2 in areas of impeded drainage lines
Food availability	
Assess abundance of cockatoo grass	Cockatoo grass present in >25% of 20 randomly-spaced 25 x 25 cm plots in hill and sand ridge sites
Assess abundance of plume sorghum	Plume sorghum present in >10% of 20 randomly-spaced 25 x 25 cm plots in sand ridge sites
Access to gravel slopes or rocky hills	Presence of at least 5 ha rocky hills or gravel slopes
Predation risk	
Assess vegetation openness in potential nesting areas	Bitterlich values ≤ 5
Search for black-faced woodswallow nesting territories	Presence highly desirable
Cattle management	
Fence to enable stock control	Sound fencing present that allows management of cattle movements across an area of at least 25 km^2
De-stock key nesting areas	Cattle completely excluded from at least ten 1 km^2 potential nesting territories
Destock key wet season feeding areas	Cattle completely excluded from at least 10 km^2 gravel slopes
Reduce cattle numbers or destock in other areas	Stock density does not exceed 50 head per hectare over an additional 15 km^2 critical habitat
Feral pig management	
Annual baiting of pigs at end of dry season	Pig rooting in key nesting and wet season habitat covers less than 10% each year
Exclude pigs from key nesting areas	Pigs completely excluded from at least ten 600 m^2 potential nesting territories
Exclude pigs from key wet season feeding areas	Pigs completely excluded from at least ten 600 m^2 areas of gravel slope
Fire management	
Prevent extensive dry season fires by establishing adequate fire breaks	No more than 30% of nesting or feeding habitat burnt during dry season
Storm-burn wet season feeding habitat	20 to 30% of wet season feeding habitat storm-burnt each year, no more than five years between storm burns in any location
Storm-burn nesting habitat	20 to 30% of nesting habitat storm-burnt each year, no more than five years between storm burns in any location

Intensive management

Intensive management of parrots is appropriate in areas where the parrot distribution is rapidly contracting, or when parrots are being re-introduced to deserted habitat. Captive

breeding and release may be used to re-establish golden-shouldered parrots. Supplementary feeding will help the transition from captivity to the wild, as well as assisting in retaining existing populations as local habitat is restored.

Re-establishing parrots populations in the wild

Much planning and organization is required before the parrots can be returned to the wild. It is necessary to assess habitat suitability, to restore habitat, and to make sure land management of the area will maintain the parrot's habitat (see *Restoration of deserted habitat*).

Before golden-shouldered parrots can be moved to a new area in order to establish a new wild population it must be established
The species was once present in the area
The species is presently absent from the area
The habitat is adequately restored to support the species
The area is under secure tenure such as in a protected area or covered by a conservation agreement

There are currently enough golden-shouldered parrots remaining for birds to be taken from the wild without further endangering the existing population. Nestlings should be taken from nests, as they have the lowest survival rate and are least likely to contribute further to the existing population. Nests in dense areas should be targeted, as these have a low probability of success. At this stage, there is no need to seek the donation of captive bred stock. However, this may be necessary if the population declines further. Captive bred stock may be genetically compromised, may have lost some of their instinctive behaviours that enable survival in the wild and pose a risk of spreading disease to wild birds.

Birds could be directly transferred to restored areas, but the more birds that are released at one time, the greater the probability of a new population establishing successfully[92]. To increase the number of birds released, at least one generation of birds should be bred in captivity. Captive-bred birds will also be more likely to stay near the release site, making it possible to feed them during the wet season in their first inexperienced year (see *Supplementary feeding*), as well as to determine whether the release program has been successful. The capture, rearing and release of golden-shouldered parrots can only be undertaken if it complies with national and international protocols[93]. Before a captive-breeding program is established a thorough project proposal should be produced that covers (1) design of aviaries; (2) management of parrots in aviaries, including feeding (3) breeding of captive parrots and (4) translocation and release to the wild.

The following is a brief overview of the type of program that could be undertaken. Aviaries will be erected at both the capture site and the release site. Birds will be captured and reared to the second generation at the capture site. They will then be transferred to the aviary at the release site, with all birds being micro-chipped, genetically typed and banded. Captive parrots will be released when at least 50 birds are available. Release of birds during the breeding season will ensure that birds remain in the vicinity of the release site. Several releases will be undertaken. Birds numbers will be monitored at least until the new population is established.

Supplementary feeding

Supplementary feeding is required when there is a shortage of wet season foods or a high risk of predation in the early wet season because of vegetation thickening, or when captive-bred birds are first released to the wild. In the first two cases, feeding stations are supplied with commercial birdseed from the late dry season to the mid wet season. When captive-

bred birds are released, they may continue to be fed at feeding stations near the release site until the can feed independently, and again in the early wet season.

Feeding stations have a supply of seed, shelter from rainfall and wind, and protection from predators. Commercial birdseed can be used. A deep trough or bowl will prevent too much seed being split by gusts of wind or frenetic feeding birds. A roof over the feeder provides protection from rain. Enclosing the feeder in large mesh weld mesh ensures that parrots can escape from predators that may be attracted by the congregations of parrots and finches that attend the feeders. Ideally the feeder is placed at a traditional breeding site for black-faced woodswallows.

Golden-shouldered parrot (top right), masked finch (top left) and three double-barred finches attend a feeding station in the early wet season.

Antbed replacement

In places where a chronic shortage of antbeds seems likely on the basis of past use antbeds large enough for the parrots to use can be moved from areas that are no longer occupied. In a trial nine antbeds were moved during the 2004 wet season and, as of April 2004, all had re-established successfully at their new locations. It is not yet known whether the parrots will find them acceptable.

Antbeds can be moved successfully when the soil is saturated during the wet season. Initially they should be pushed over and placed gently onto padding in a small trailer or the back of a utility. The antbeds should then be transferred immediately to the site where there is an apparent shortage. Any breakages in transit can be repaired by fitting broken pieces back in their previous order and sealing with wet mud.

Sites lacking an adequate supply of antbeds should not be selected for translocation of parrots.

Mounds are fragile and need to be kept well-padded when being moved (above).

Mounds moved in the wet season put on at least as much new growth (dark areas on mound to right) as those that has remained in the same place. Grey plaster shows the site of successful mound repair.

Summary

Steps in reintroduction of golden-shouldered parrots
Action
Site identification
Assess criteria for habitat suitability (see Restoration of deserted habitat)
Site restoration
Manage site to restore and maintain habitat (see Maintenance of existing habitat and Restoration of deserted habitat)
Site security
Establish a protected area or conservation agreement over reintroduction area
Proposal preparation
Develop captive breeding and release program within national and international protocols
Apply for appropriate permits
Identify resource and personnel requirements
Population assessment
Use population viability analysis to assess whether removal of nestlings will threaten existing population
Aviary design and construction
Liaise with amateur bird keepers to develop aviary design
Capture of wild birds
Take nestlings from nests in dense vegetation
Management of captive birds
Rear birds in aviary at capture sites
Transfer birds to release aviaries
Release
Release groups of at least 50 birds at a time during breeding season
Provide supplementary food until the birds are feeding independently, as well as in the early wet season
Monitor population success
Monitor nests in the wild
Monitor wet season population

8. Conclusions

Golden-shouldered parrots require many characteristics of grasslands that existed before cattle grazing replaced Aboriginal management of Cape York Peninsula. These are open grassy plains and drainage depressions with healthy antbeds, and early-flowering perennial grasses. In open habitats used by black-faced woodswallows, and with a plethora of seeding grasses, predation is kept to a minimum. These features can be maintained by reinstating appropriate fire regimes that include regular storm-burning, and minimising the effects of pigs and cattle on important feeding and breeding areas. While some important areas are on National Parks, substantial parts of the parrot's populations are on grazing leases, and the co-operation of pastoralists has been, and will continue to be, essential for the persistence of golden-shouldered parrots.

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11. Appendix 1 Species names used in booklet

Common name	Scientific name
Birds	
black-faced woodswallow (Cape York Peninsula)	*Artamus cinereus normani*
buff-breasted button-quail	*Turnix olivii*
crimson finch (white-bellied)	*Neochmia phaeton evangelinae*
golden-shouldered parrot	*Psephotus chrysopterygius*
gouldian finch	*Erythrura gouldiae*
hooded parrot	*Psephotus dissimilis*
paradise parrot	*Psephotus pulcherrimus*
pied butcherbirds	*Cracticus nigrogularis*
star finch (Cape York Peninsula)	*Neochmia ruficauda clarescens*
double-barred finch	*Taeniopygia bichenovii*
masked finch	*Poephila personata*
Reptiles	
goannas	*Varanus* spp.
Mammals	
northern bettong	*Bettongia tropica*
Insects	
antbed parrot moth	*Trisyntopa scatophaga*
bulbous antbed termite	*Nasutitermes triodeae*
conical antbed termite	*Amitermes scopulus*
domed antbed termite	*Amitermes vitiosus*
magnetic antbed termite	*Amitermes laurensis*
Plants	
aneilema	*Aneilema siliculosum*
annual kangaroo grass	*Themeda arguens*
annual sorghum	*Sarga angustum*
awnless barnyard grass	*Echinochloa colona*
barnyard grass	*Echinochloa colona*
black spear grass	*Heteropogon contortus*
bloodroot	*Haemodorum brevicaule*
bloodwood	*Corymbia* spp.
blue trumpet	*Brunoniella acaulis*
brachiaria	*Brachiaria holosericea*
broad-leaved carbeen	*Corymbia confertiflora*
broad-leaved ti-tree	*Melaleuca viridiflora*
Cape York red gum	*Eucalyptus brassiana*

Common name	Scientific name
cartonema	*Cartonema spicatum*
Clarkson's bloodwood	*Corymbia clarksoniana*
cockatoo grass	*Alloteropsis semialata*
common native couch	*Brachyachne convergens*
Cooktown ironwood	*Erythrophleum chlorostachys*
Cullen's ironbark	*Eucalyptus cullenii*
ditch millet	*Paspalum scrobiculatum*
early wanderrie grass	*Eriachne obtusa*
eucalypt	*Eucalyptus* spp.
fire grass	*Schizachyrium* spp.
fisherman grass	*Ischaemum decumbens*
fray grass	*Ischaemum fragile*
ghost gum	*Corymbia dallachiana*
giant spear grass	*Heteropogon triticeus*
glimmer grass	*Planichloa nervilemma*
golden parrot tree	*Grevillea pteridifolia*
grannies' bonnets	*Mnesithea formosa*
gum-topped bloodwood	*Corymbia hylandii subsp. peninsularis*
hairy quinine tree	*Petalostigma pubescens*
heliotrope	*Heliotropium* spp.
hyptis	*Hyptis suaveolens*
ironbark	*Eucalyptus cullenii*
itch grass	*Rottboellia cochinchinensis*
kangaroo grass	*Themeda triandra*
legumes	*Desmodium* spp.
legumes	*Stylosanthes hamata*
legumes	*Stylosanthes* spp.
lemon scented ti-tree	*Melaleuca citrolens*
love grass	*Eragrostis* spp.
Melville island bloodwood	*Corymbia nesophila*
messmate	*Eucalyptus tetrodonta*
Molloy box	*Eucalyptus leptophleba*
native couch	*Brachyachne convergens*
native spurges	*Phyllanthus* spp.
nonda plum	*Parinari nonda*
orange-flowered ti-tree	*Asteromyrtus symphyocarpa*
panic grass	*Panicum* spp.
paperbark	*Melaleuca* spp.*, especially M. saligna*
parrot daisy	*Allopterigeron filifolius*
phyllanthus	*Phyllanthus virgatus, P. fuernrohrii*
plume sorghum	*Sarga plumosum*
rough-leaved bloodwood	*Corymbia setosa* subsp*. pedicillaris*
scale-leaved ti-tree	*Melaleuca foliolosa*
scale-leaved ti-tree	*Melaleuca foliolosa*
sedges	*Fimbristylis, Scleria*
shiny-leaved box	*Eucalyptus chlorophylla*
signal grass	*Brachiaria holosericea*
silver-crowned paperbark	*Melaleuca argentea*
silver-crowned paperbark	*Melaleuca fluviatilis*
smooth quinine tree	*Petalostigma banksii*
snake grass	*Thaumastochloa* spp.
spade flower	*Hybanthus enneaspermus*
summer grass	*Digitaria* spp.
thryptomene	*Thryptomene oligandra*
ti-tees	*Melaleuca* spp.
wanderrie grass	*Eriachne* spp.
wattles	*Acacia* spp.
weeping paperbark	*Melaleuca leucadendra*

Common name	Scientific name
wire grass	*Aristida* spp.
wooly-butt	*Eucalyptus chartaboma*
yellow ti-tree	*Neofabricia mjoebergii*

12. Appendix 2 Regional ecosystems (REs) referred to in this booklet

RE	Landscape setting	Vegetation description	Parrot habitat	Breeding	Feeding	Roosting	Status
Cape York Peninsula bioregion							
3.3.10	Fringes streams & creeks	*Melaleuca argentea* &/or *M. fluviatilis* ± *M. leucadendra* open forest	Riparian forest			+	
3.3.14	Swamps	*Melaleuca saligna* ± *M. viridiflora*, *Lophostemon suaveolens* woodland	Swamp edges			+	
3.3.15	Lowlands	*Melaleuca viridiflora*, *Asteromyrtus symphyocarpa* low woodland	Flat edges	Critical	+	+	Of concern
3.3.20	Plains	*Corymbia clarksoniana* ± *Erythrophleum chlorostachys* woodland	Sand ridges & low hills	+	+	+	
3.3.33	Lowlands	*Thryptomene oligandra*, *Melaleuca viridiflora* woodland on sides of depressions	Flat edges	Critical	+	+	
3.3.36	Lowlands	*Eucalyptus chlorophylla* open woodland on alluvial plains	Box flats	+	+	+	
3.3.42	Lowlands	*Melaleuca viridiflora* low woodland in drainage areas	Narrow flats	Critical	+	+	
3.3.47	Lowlands & Hills	*Melaleuca citrolens* ± *M. foliolosa* low open woodland along drainage lines	Gravel slopes Glimmer grass flats Narrow flats	Critical	Critical	+	
3.3.49	Lowlands	*Melaleuca viridiflora* ± *Petalostigma banksii* low open woodland on floodplains	Broad flats	Critical	+		
3.3.50	Lowlands	*Melaleuca viridiflora* ± *Petalostigma pubescens* low open woodland on low plains	Gravel slopes Narrow flats	Critical	Critical	+	
3.3.56	Lowlands	*Eriachne* spp. ± *Aristida* spp. closed tussock grassland in longitudinal drainage depressions	Broad flats	Critical	+		
3.3.59	Lowlands	*Sorghum plumosum*, *Themeda arguens* closed tussock grassland on erosional flood clay plains	Broad flats	Critical	+		Of concern
3.5.7	Sand ridges	*Eucalyptus tetrodonta* ± *Corymbia clarksoniana* woodland	Sand ridges & low hills	+	+	+	
3.5.9	Sand ridges	*Eucalyptus tetrodonta*, *Corymbia hylandii* subsp. *peninsularis* woodland	Sand ridges & low hills	+	+	+	
3.5.10	Sand ridges & low hills	*Eucalyptus tetrodonta*, *Corymbia nesophila* woodland	Sand ridges & low hills	+	+	+	
3.5.12	Sand ridges & low hills	*Eucalyptus tetrodonta* ± *Corymbia nesophila* ± *C. clarksoniana* woodland	Sand ridges & low hills	+	+	+	
3.5.14	Lowlands	*Melaleuca viridiflora* ± *Acacia* spp. ± *Asteromyrtus symphyocarpa* low woodland	Narrow flats	Critical	+	+	
3.5.17	Lowlands	*Melaleuca stenostachya* ± *M. viridiflora* low open woodland	Narrow flats	Critical	+	+	Of concern

RE	Landscape setting	Vegetation description	Parrot habitat	Breeding	Feeding	Roosting	Status
3.9.2	Plains	*Eucalyptus chlorophylla* open woodland	Box flats	+	+	+	
3.11.7	Hills	*Eucalyptus cullenii*, *Corymbia clarksoniana* woodland	Rocky hills		+		
3.11.8	Hills	*Eucalyptus cullenii* ± *Corymbia clarksoniana* woodland	Rocky hills		+		
3.12.10	Hills	*Eucalyptus cullenii* ± *Corymbia clarksoniana* woodland	Rocky hills		+		
			Bare areas		+		
Gulf Plains bioregion							
2.3.10	Lowlands	*Eucalyptus microtheca*, *Eucalyptus chlorophylla* low open woodland, & *Melaleuca viridiflora* woodlands & savannah	Box flats		+	+	
2.3.28	Lowlands	*Melaleuca* spp. woodland	Broad flats	Critical	+		
			Narrow flats				
			Swamp edges				
2.5.5	Sand ridges & low hills	*Eucalyptus tetrodonta* and *Corymbia polycarpa* open woodland	Sand ridges & low hills	+	+	+	
			Bare areas		+		

Endnotes

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[2] Schedule 3 Queensland's *Nature Conservation (Wildlife) Regulation 1994*

[3] Appendix I *Convention on International Trade in Endangered Species Wild Fauna and Flora* (www.cites.org)

[4] Garnett and Crowley 1995a; 1999; 2003

[5] Schedule 3 Queensland's *Nature Conservation (Wildlife) Regulation 1994*

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[7] Rigsby 1981; Crowley and Garnett 1998, 2000

[8] IUCN SSC 2001

[9] Garnett and Crowley 2000

[10] Schedule 2 Queensland's *Nature Conservation (Wildlife) Regulation 1994*

[11] Section 73 Queensland's *Nature Conservation Act 1992* and Section 16 Queensland's *Nature Conservation (Wildlife) Regulation 1994*

[12] Section 88 Queensland's *Nature Conservation Act 1992*

[13] Section 92 Queensland's *Nature Conservation Act 1992*

[14] Section 238 Queensland's *Nature Conservation Regulation 1994*

[15] Schedule 12 Queensland's *Nature Conservation Regulation 1994*

[16] Section 99 Queensland's *Nature Conservation Regulation 1994*

[17] Section 99 Queensland's *Nature Conservation Regulation 1994*

[18] Section 95 Queensland's *Nature Conservation Regulation 1994*

[19] Section 100 Queensland's *Nature Conservation Regulation 1994*

[20] Schedule 7 *Queensland's Nature Conservation Regulation 1994*

[21] Section 17 Queensland's *Nature Conservation (Wildlife) Regulation 1994*

[22] *Environment Protection and Biodiversity Conservation Act 1999*

[23] Section 18 *EPBC Act*

[24] Section 53 *EPBC Act*

[25] Sections 260, 269A, 270 *EPBC Act*

[26] Sections 207A, 207B and 207C *EPBC Act*

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[28] *Convention on International Trade in Endangered Species of Wild Fauna and Flora*

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[31] Weaver 1982

[32] Garnett and Crowley 1997, 1999

[33] H. Beste pers. comm.

[34] I. Fox pers. comm.

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[38] Crowley and Garnett 1998

[39] Crowley and Garnett 1999

[40] Gilardi *et al*. 1999

[41] Crowley and Garnett 2001

[42] Crowley and Garnett 1998; Neldner *et al.* 1997

[43] Garnett and Crowley 1995a, 1999

[44] Garnett and Crowley 2000

[45] Garnett and Crowley 2000

[46] Kuleshov *et* al. 2002

[47] Crowley and Garnett 2000

[48] Crowley *et al.* unpublished manuscript

[49] Crowley and Garnett 2000

[50] Crowley and Garnett 2000

[51] Crowley *et al.* unpublished manuscript

[52] McLennan 1922; White 1922

[53] Huhta *et al.* 2003

[54] Garnett and Crowley 1995b

[55] Garnett and Crowley 1994, 1995b

[56] Crowley and Garnett 2001

[57] Dawes-Gromadzki 2003

[58] Neldner *et al.* 1997; Crowley and Garnett 1998; Bowman *et al.* 2001; Burrows *et al.* 2002; Sharp and Whittaker 2003; Fensham and Fairfax 2003; Fensham *et al.* 2003

[59] Crowley *et al.* unpublished manuscript

[60] Crowley and Garnett 1998

[61] Neldner *et al.* 1997

[62] Crowley and Garnett 2000

[63] Crowley *et al*. unpublished manuscript

[64] Crowley and Garnett 1998, 2001

[65] Boorman 1991

[66] Choquenot *et al*. 1996

[67] Morgan 2000

[68] Crowley and Garnett 2001

[69] Wilson *et al*. 2002

[70] EPA 2003

[71] Anning 1980

[72] Garnett 1992

[73] Garnett and Crowley 1999

[74] John Norton (Queensland Department of Primary Industries) pers. comm. 1995

[75] Garnett 1992

[76] Garnett and Crowley 1999

[77] Garnett 1992

[78] Garnett and Crowley 1999

[79] Hone 2002; Anon. 2003b

[80] Anon., 2003a

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[85] Anon. 2003a

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[87] Lana Little (Queensland Parks and Wildlife) pers. comm. 2004

[88] Peter Thompson (Cape York Development Association) pers. comm. 2004

[89] Andrew 1986

[90] Crowley and Garnett 2000

[91] Townsend *et al*. 2000

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