State of the environment in Queensland 1990

A Queensland Government publication

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A report by the Department of Environment and Heritage, Queensland

Index

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Foreword

The 1980s will be remembered as the decade of environmental consciousness. The prophecies of global climatic warming and the terms 'greenhouse effect' and 'ozone depletion' have become familiar to the community, reminders of the potentially disastrous consequences of abusing the environment in which we live.

While the accuracy of such prophecies remains to be seen, the evidence of a changing environment has brought about the realisation that ultimately we will all pay the price for environmental neglect. Whereas some people may choose to isolate themselves from the possible consequences of rainforest destruction in the Amazon, no-one can ignore the prospect of global climatic change.

Concern over air and water pollution, wildlife conservation and forest protection has been expressed the world over by a sympathetic minority for many years. As the problems associated with our neglect and mismanagement mount, the absolute necessity of living in harmony with our environment is becoming increasingly apparent to all.

The term 'Gaia'*, meaning the biosphere or living environment taken together with its interacting atmospheric environment, was coined to describe the living planet as a single ecosystem. People are but one component of that ecosystem. If our species is to survive, we must preserve the delicate balance existing between the many and diverse components. (* The mythological Greek goddess of earth. Used in James Lovelock's Ages of Gaia, Oxford University Press (1988).)

European settlement of Australia has been characterised by the exploitation of the continent's natural resources to the point where now we must take stock and question the wisdom of such actions. The degradation of once productive farmland, the depletion of fish stocks, water pollution and the rarity of once abundant species, clearly testify to over exploitation and non-sustainable development.

While any modern society will put demands on the natural environment, if quality of life is to be maintained in the long term these demands must not exceed what is ecologically sustainable. Accordingly, the biosphere must be managed responsibly and sympathetically if the needs of modern society are to continue to be met. The environment of Queensland is no exception.

In view of the unpredictable and frequently harsh nature of the Queensland climate, our environment is in some ways highly sensitive to the impact of humans. The intensity of tropical

storms and the severity of drought may quickly degrade a landscape cleared of its protective natural vegetation. This sensitivity highlights a particular need for informed and careful management.

The World Conservation Strategy objectives encompass maintenance of essential ecological processes and life support systems, preservation of genetic diversity, and sustainable utilisation of species and ecosystems. As we approach the 21st century, the status of the Queensland environment deserves detailing.

The purpose of this report is to provide a brief summary of the state of the environment in Queensland. It represents a preliminary overview based on the most current data readily available. The compilation of this material is the first step towards the preparation of a Queensland Conservation Strategy and regular State of the Environment reports.

We have not attempted to cover every aspect of what today is considered to be `the environment'; rather we are pointing to the `hot spots'. By reviewing the status of the environment in broad terms, the needs and objectives of a conservation strategy can be better identified.

A revised National Conservation Strategy is due for release in mid 1990. A draft Queensland Conservation Strategy will follow – the first for Queensland.

The strategy will examine options, policies and a new approach to Queensland's environmental problems as we move towards a new century. Public input to that strategy at all stages will be essential. I hope information presented here will encourage many groups and individuals to make preliminary submissions in this preparatrion stage.

Following a period for public comment, the Queensland Conservation Strategy should be completed in 1991.

I invite all Queenslanders to think very seriously about the environmental problems which we face and to suggest solutions for the benefit of ourselves, our lifestyle and our planet.

Pat Comben
Minister for Environment and Heritage
February 1990

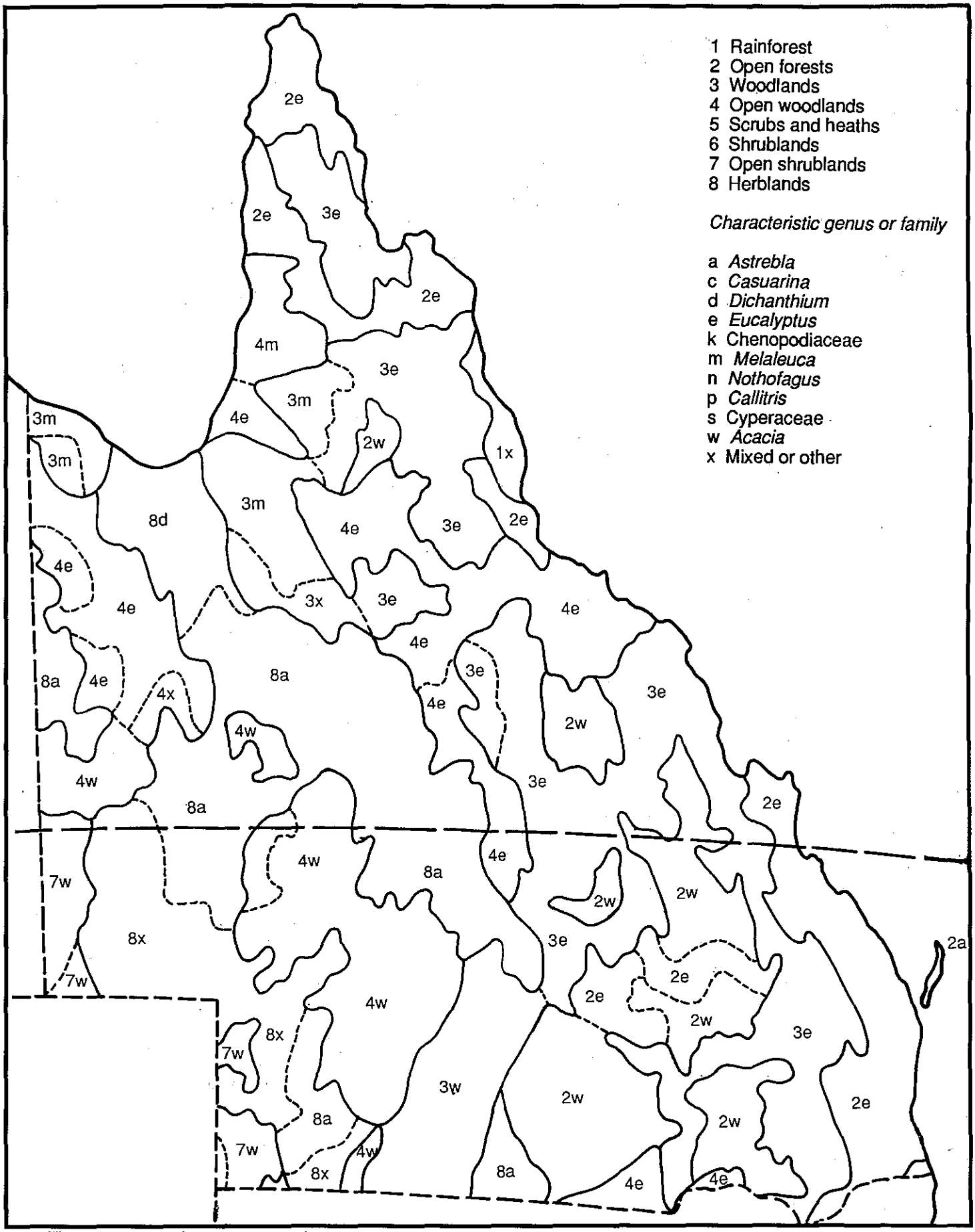


Figure 1. Natural vegetation of Queensland after Carnahan. Note the scale of this map means rainforest areas of Eungella and from Miriam Vale south to Lamington do not show.

Land degradation

Land degradation is the decline in the condition or quality of land as a consequence of misuse or overuse. This can occur whenever the natural balances in the landscape are disturbed by developments that are beyond the capability of the land. It reduces the affected land's productive capacity and can have significant off-site effects. Common forms of land degradation in Queensland are soil erosion in cropping and grazing lands, pasture degradation, woody shrub invasion, and scalding. Also significant are induced salinity, induced soil acidity, soil structure decline, and mass movement.

Soil erosion

Cropping lands: Soil erosion can occur as gullying and as sheet and rill erosion. Gullying occurs where topsoil is removed along channels generally deeper than 0.3m. Sheet and rill erosion is characterised by the removal of the surface layer with some minor channelling where water flow is concentrated. Water and wind cause sheet erosion in some arid grazing lands. Water is the principal erosive agent in the cropping and more humid grazing lands.

Approximately 3.3 million hectares in Queensland are cropped. Of this, about 2.9 million hectares is used for extensive grain cropping and 0.4 million hectares for intensive horticulture and sugar-cane. Of the 3.3 million hectares, 2.8 million hectares has suffered some erosion or is at risk from erosion if not protected by soil conservation measures including conservation cropping practices. About 2.0 million hectares require contour banks at specified intervals together with conservation cropping practices. Another 800 000 hectares require conservation cropping practices plus measures such as strip cropping or strategic earthworks.

Conservation cropping practices involve management of crop residues and tillage operations. These practices ensure maximum protection for the soil surface.

More than 1.14 million hectares of Queensland's cropping lands are now protected by soil conservation measures. About 940 000 hectares have contour banks and associated erosion control measures while 200 000 hectares have required less intensive measures, primarily strip cropping. More than 12 600 farmers are actively involved in these conservation measures.

Soil erosion is a serious concern on the remaining 1.66 million hectares of cropping land requiring protection. However, conservation cropping practices are used on a large proportion of this area resulting in a significant reduction in soil erosion when compared with bare fallow cropping. Accurate statistics on the area involved are not available.

Grazing lands: Queensland has about 154.7 million hectares of grazing land with approximately 83 million hectares of this being in the arid lands and 71.7 million hectares in more humid areas. An overview of soil erosion in these areas was gained through the Commonwealth/ State Collaborative Study published in 1975. The study showed that 43.9 million hectares, or 53 percent of the grazing land in arid areas, suffered soil erosion together with vegetation degradation. Erosion was classed as severe on 8 million hectares (10 percent) of the arid lands. There is every indication the position may have worsened since the 1975 study.

The study found 16.1 million hectares or 22.4 percent of the grazing land in non-arid areas had suffered erosion with 7.3 million hectares sheet eroded, 5.7 million hectares sheet and gully eroded, and 3 million hectares gully eroded. About 55 000 hectares were extremely eroded.

Land resource surveys of the arid lands (less than approximately 450mm mean annual rainfall) undertaken in the 1970s found that mulga lands and alluvial frontage country were particularly prone to or affected by land degradation.

Vegetation communities dominated by mulga (*Acacia aneura*) occupy about 15 million hectares or 18 percent of the arid lands. A recent survey has examined degradation on properties occupying 3 million hectares of mulga land. Erosion was classed as negligible on properties occupying 2.61 million hectares (87 percent), minor on properties occupying 120 000 hectares (4 percent) and severe on properties occupying 270 000 hectares (9 percent).

Other vegetation types occupying significant areas of the arid lands are the Mitchell grass (*Astrebla* spp.) and the spinifex (*Trioda* spp.) grasslands as well as open woodlands of eucalypts. Erosion of clay soils of the Mitchell grass is generally low, but severe erosion may occur when heavy rains follow drought-induced reduction in grass cover. Soils of the spinifex areas are generally erodible but they are usually protected by grass cover because the grasses have low grazing value.

The most extensive native pasture community in the non-arid area is that dominated by black spear grass (*Heteropogon contortus*). Here soils are frequently erodible. Sheet and gully erosion is common where overgrazing leaves the soil exposed to intense summer rains. As such, erosion is recognised as a significant problem in the northern black spear grass areas.

Aristida/Bothriochloa pastures grow on a wide range of soils, many of which are prone to erosion. The clearing of steep slopes, and the exposure of extremely erodable subsoils by mechanical clearing have also contributed to erosion.

Pasture degradation

Pasture degradation occurs when overuse or mismanagement causes the balance of species present to change so that less productive species, species providing less ground cover or species providing reduced periods of ground cover dominate the pasture. In Queensland, the change in species occurring usually takes the form of reduced proportions of palatable perennial grasses (or occasionally shrubs) and increased proportions of less palatable annual grasses, ephemeral species and weeds.

Pasture degradation is recognised as a significant problem in parts of:

- the northern black spear grass lands where weed invasion is occurring;
- the mulga lands where perennial grass cover has decreased;
- the *Aristida/Bothriochloa* areas where the proportion of wire grass (*Aristida* spp.) has increased; and
- the Mitchell grass lands where the proportion of roly-poly (*Salsola kali*) has increased.

Pasture degradation is frequently reversible when grazing pressure is reduced. However, insufficient information is available for the various ecosystems to be able to determine when degradation becomes irreversible.

Woody shrub invasion

Woody shrub (weed) invasion occurs when the density of undesirable native or introduced species increases to the extent that it reduces pasture production and carrying capacity. The occurrence and severity of the problem is very dependent on past pasture management with well managed pastures generally showing little or no degradation. The regrowth of native trees and shrubs that can occur after clearing is not considered as a form of degradation here.

Woody shrub invasion is a problem in parts of a number of native pasture communities including:

- Mitchell grass, where prickly acacia (*Acacia nilotica*), wattles (*Acacia* spp.) and Parkinsonia (*Parkinsonia aculeata*) invade large areas and are increasing in density;
- mulga pastures, where a number of species including green turkey bush (*Eremophila gilesii*), wattles, currant bush (*Cassia ovata*) and false sandalwood (*Eremophila mitchellii*) are increasing in density;
- black spear grass, where wattles and eucalyptus species cause problems throughout;
- in the north Chinese apple (*Ziziphus mauritiana*) and rubber vine (*Cryptostegia grandiflora*) invade and are increasing in density; and
- *Aristida/Bothriochloa* pastures, where wattles, eucalyptus species, currant bush and false sandalwood are causing problems in some localities.

The recent survey of 3 million hectares of mulga land showed that woody shrubs reduced productivity over 44 percent of the area with a potential problem on another 21 percent of the area. The instability of this biogeographic region is reflected in its continuous unidirectional change towards woody weed invasion. Over grazing, associated with mulga and other acacias providing valuable fodder, and high stocking rates during drought can affect the subsequent recovery after rain.

Prickly acacia, an introduced species, has infested about 6.6 million hectares of the estimated 29.5 million hectares of Mitchell grass. By the time shrub canopy cover reaches 20 percent, grass production has been reduced by 50 percent.

Scalding

Scalds are bare areas where vegetation has been removed by overgrazing, and/or fire and/or drought, and the topsoil eroded by wind and water to expose dispersible clay subsoils. These subsoils are characterised by a smooth, impermeable surface crust of fine sand and silt cemented together with clay. Features which inhibit plant growth are:

- high surface temperatures,
- high wind speeds which remove seeds and sandblast seedlings,
- poor moisture penetration below the crust, and
- high salinity levels beneath the crust.

Scalds are most common on the alluvial frontage country of the arid zone. An estimated 590 000 hectares are affected. This represents only 7 percent of the land considered susceptible. The potential for this form of degradation to increase with land mismanagement is enormous.

Salinity

Induced salinity occurs when changes in the level of the water table bring salts to the soil surface where they are concentrated by evaporation. Salinisation results when salt concentrations reach levels where only salt-tolerant species grow, or when no plant species survive.

The changes in water table levels that result in salinity are usually caused by irrigation, excessive tree clearing, or inappropriately sited or poorly constructed above-ground water storages.

New outbreaks occur continually because up to 20 years may elapse between initial clearing and seepage salting. The extent of the area affected fluctuates seasonally, being greatest after wet years.

Queensland has an estimated 8400 hectares of salinised land. Occurrences are scattered throughout areas receiving more than 600mm annual rainfall and south of Port Douglas. Salinised areas are erosion prone and aesthetically ugly, but the area affected in Queensland is low by comparison with other mainland states.

Silver turkeybush has invaded extensive areas of previous open mulga sandplain in the Thargomindah district.

Induced soil acidity

Induced soil acidity occurs when fertilizer and management regimes are such that acid-producing chemical reactions predominate in the soil and alkaline products and waste products are removed by leaching. By causing nutrient toxicity and imbalances, it can reduce crop and pasture growth. These problems usually occur when soil pH is reduced to below 5.0.

Induced soil acidity is most common in highly leached soils such as those on the Wet Tropical Coast. It also occurs in highly fertilized pasture soils in other coastal areas and is likely in the granite/ traprock areas of south-east Queensland. No reliable statistics are available on its occurrence in Queensland, but at least 150 000 hectares are believed affected.

Though soils of significant areas of the Wet Tropical Coast have been acidified, the problem does not appear to be causing significant reductions in sugar-cane yields. Sugar-cane is very tolerant to soil acidity. Fertilizer regimes are changed also as soils become more acid to ensure adequate nutrient supplies. The problem increases production costs through increased fertilizer inputs and reduces the suitability of the land for other uses.

Soil structure decline

Soil structure refers to the arrangement of soil particles and the spaces between them. Soil structure decline occurs when soil is pulverised and compacted by tillage machinery or stock. Dense layers known as `plough pans' may form just below the level of cultivation and soil surfaces can become hard and compacted. Reduction in soil organic matter through burning stubble, frequent cultivation or removal of forage can increase structure degradation also.

Soil structure decline is known to be a serious problem in many cropping areas where it causes decreased yields and increased cultivation costs. Reliable information on its occurrence in Queensland is not available.

Limited investigations in soils used for cotton indicate that it is a more serious and more extensive problem than was originally supposed. Data for Australia suggest this is the most costly form of degradation in cropping lands.

Mass movement

Mass movement is the down-slope movement of soil or rock material under the force of gravity and includes soil creep, earthflow, slumping, landslips, landslides and rock avalanches. It usually occurs on steeper slopes where the binding effect of tree roots has been removed by clearing and is most common after heavy rain when water lubricates soil or rock particles and adds mass to the system. Mass movement is common in steeper parts of eastern Queensland but no complete data is available. No more than 400 to 500 hectares are likely to be affected annually. In some areas such as the Lockyer Valley, it can be associated with specific rock types and/or contacts between rock types.

Summary

In summary, the effect of land degradation is to reduce the area of arable land, a finite resource and one diminishing alarmingly.The inputs of severe degradation extend beyond the affected land and the immediate catchment. Rivers and water resources far downstream may be degraded as a result. Examples are salinity in the Murray-Darling Rivers system with thousands of kilometres of waterways affected and the siltation of rivers, harbours, and biologically productive estuaries. Degraded landscapes and watercourses inevitably result in loss of natural diversity and habitats for wildlife.

Mass movement of soil following heavy rain caused by clearing vegetation to the waters edge.

Water and the coastal zone

Beach erosion

Queensland's 1 727 000 sq.km has about 7400 kilometres of coastline, about one-fifth of Australia's coastline. About half of the state's coastline is backed by sand dunes or beach ridges. The other half is backed by alluvium, mud, tertiary (lateritic) sediments, or rock. Beaches and estuaries are evolving natural systems, constantly changing and adapting to the prevailing environmental conditions. With proper planning and management they act as a natural buffer against extreme weather conditions, providing protection and then recovering their former condition. The value of such buffers may become apparent if climatic and sea level changes resulting from the 'greenhouse effect' cause coastal realignment and inundation of low lying areas.

Parts of the coastal sand dunes and beach ridges are devoid of vegetation and subject to wind erosion (Table 1). These figures, from CSIRO's Inventory of Coastal Lands (1981), exclude offshore islands including the sand islands of Moreton Bay and Fraser Island, and consequently represent an underestimation of the coast occupied by sand dunes.

Recession of the sand shoreline occurs when sand is blown landward from the beach proper or from an unstable frontal sand dune. In trials on South Stradbroke Island, the average weekly volume of sand blown off the beach and trapped by sand drift fences, brush matting and vegetation was between 0.18 and 0.92 cubic metres per metre length of beach.

Applying these figures to the 360km of bare mainland coastal sand dunes detailed in Table 1, the annual, permanent, and cumulative loss of sand from the beach/dune system by wind action is calculated to be in the range of 3.4 to 17.2 million cubic metres. Over the next 50 years, wind blown sand losses could be as high as 170 to 860 million cubic metres.

Changes to unstable beach and estuarine systems can affect areas well away from the site of the original works. Developments occurring within eroding or erosion-prone sections of coastline are common in Queensland. Some date from the turn of the century but others are more recent. Where adequate buffer zones do not exist, restoration of buffer zones by beach nourishment or resumption of private property is expensive. If the need for such works is to be avoided, a high value must be placed on the preservation of natural coastal buffers.

Erosion of the southern Gold Coast beaches is primarily a result of the impact of the Tweed River training walls. Major beach nourishment was first carried out in 1974; the present Surfers Paradise beach is a result of this nourishment. Approximately 4 million cubic metres of sand taken from outside the active beach system has been placed on Gold Coast beaches up until 1988. The current southern Gold Coast beach nourishment project (Stage 1) involves an additional 2.4 million cubic metres.

Amity Point on North Stradbroke Island is eroding as a result of realignment of a major tidal channel. This realignment was triggered by natural changes to the South Passage entrance.

Beaches in the Hervey Bay City (Urangan to Point Vernon) area have been eroding as a result of natural processes. Several sections of the esplanade have been protected by rock wall construction. About 300 000 cubic metres of sand is required for minimum beach nourishment.

Yeppoon Beach is in poor condition at present with virtually no usable beach at high tide. A sea wall has been constructed along most of the beach to protect the esplanade from cyclonic wave attack. Beach condition has become worse over the years as the beach level in front of the sea wall has been reduced. The sea wall has been damaged repeatedly during cyclones and a continuing maintenance commitment is required.

Localised erosion at the southern end of Holloways Beach (Mulgrave Shire) is directly threatening more than 15 beachfront residences. The provision of a rock wall will guarantee the loss of the beach in the same way as adjoining Machans Beach has been degraded. Beach nourishment with a minimum of 100 000 cubic metres of sand is recommended for this beach. Annual losses of between 5000 and 7000 cubic metres are anticipated, necessitating ongoing maintenance. Restoration of this beach has been implemented as a Beach Protection Authority project. Restoration work is incomplete.

Table 1. Lengths of coastline with dunal development (km)

Type	Vegetated	Bare	Total
Small parabolic dunes	390	160	550
Large parabolic dunes	20	0	20
Sand cliffs	40	10	50
Transverse dunes	230	60	290
Irregular dunes	50	30	80
Beach ridges	1930	100	2030
Total	2660	360	3020

Coastal development

Development of the Queensland coast has proceeded at an exceptional rate over the past decade. While much of the development has been justifiable economically, there has been an associated cost to the environment. As a result of the rate and extent of development, concern has been expressed over the loss of the coastal zone's finite biological resources, such as mangrove forests and seagrass meadows, and the effect of such losses on fisheries production and the ecology of near-shore waters. Tourist development is continuing, with 'several hundred' projects planned or under way along the entire Queensland coast.

Expansion of mineral sand extraction is proposed for the Shoalwater Bay-Agnes Water area. Sandmining continues on North Stradbroke Island. In the Gladstone region there are proposals for a steel mill, a titanium metal production plant, expansion of the existing aluminium refinery and smelter, reclamation of tidal

lands for expansion of port facilities and a naval base. Work has commenced on the building of two sodium cyanide manufacturing plants.

Many more proposals are being considered for the coast in the Brisbane area and the Sunshine Coast and Gold Coast regions including large integrated tourism resort and urban development projects.

Offshore islands

Some 230 offshore islands have been declared national parks and are managed under the provisions of the National Parks and Wildlife Act 1975-89. On 10 of these, including North Stradbroke, Moreton, Bribie, Fraser, Heron and Green Islands, only part of the island has national park status.

Seventeen islands declared environmental parks under the Land Act are managed by the Queensland National Parks and Wildlife Service. Two islands, Maclennan and Pandora Cays, have been set aside as scientific purposes reserves. Five islands – Bell Cay, Wild Cattle, Raine, Magnetic (part), Moreton (part) – have been gazetted as department and official purposes reserves.

All islands off the coast of Queensland are fauna sanctuaries. Raine Island, the most important seabird and green turtle nesting island, has been gazetted as a fauna refuge under the provisions of the Fauna Conservation Act 1974-89.

The National Parks and Wildlife Act allows for the specialised management of national parks. Three island parks (Masthead, Hoskyn and Fairfax) have been zoned as scientific areas in recognition of significant seabird populations which breed on the islands.

In addition, Hoskyn, Fairfax, Wreck and Peak Island National Parks are restricted access areas. In the case of Wreck, this complements the Marine Park Preservation Zone which surrounds it, and recognises the island's international status as a major loggerhead turtle rookery. Peak Island is similarly important as a flatback turtle nesting island.

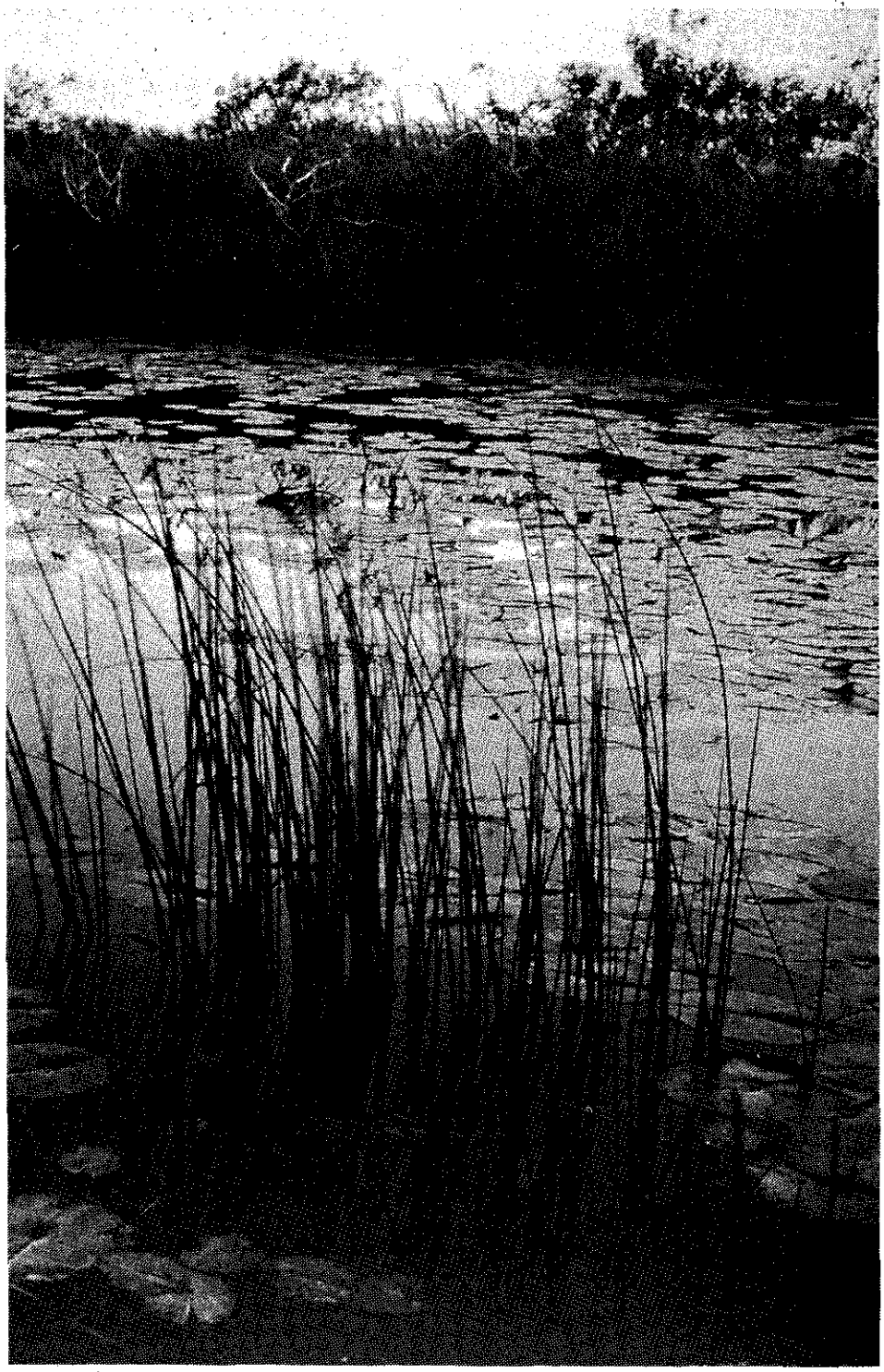
St Helena Island National Park, site of the historic penal settlement ruins, has been declared an historic area under the National Parks and Wildlife Act.

The major sand islands (Fraser, Moreton, Stradbroke, and Bribie) have been subject to considerable attention over the past few years. Almost 90 percent of Moreton Island is presently national park. This will be enlarged when existing mining leases become available.

Presently only a small portion of North Stradbroke Island is national park (Blue Lake - 501ha). Negotiations are continuing for half the island or 14 000 hectares to become national park.

South Stradbroke Island is subject to negotiations designed to establish a major environmental park (2430 hectares) which, in conjunction with 110 hectares of park and recreation reserves, will occupy 94 percent of the island.

Fraser Island is primarily national park (52 400 hectares) and state forest (105 000 hectares). The majority of the island is gazetted under the Recreation Areas Management Act 1988 as the Fraser Island Recreation Area. This



Wetlands occupy extensive areas of North Stradbroke Island, near Brisbane.

encompasses 168 100 hectares and extends to low water mark.

On-going extensions are planned to the Bribie Island Environmental Park and the Pumicestone National Park to protect the coastline of the island and provide protection to the Pumicestone Passage estuary (a marine park).

Wetlands

Wetlands may be broadly defined as vegetated areas which are permanently or seasonally flooded; the term therefore describes inland and coastal tidal swamps and marshes.

Wetlands are complex and highly productive ecosystems important to endemic and migratory waterbirds and to many species of fish and crustaceans which spend at least part of their life cycles in wetland environments.

Wetlands also perform important roles in water conservation, flood control, absorption of sediments and nutrients, and bank and shore stabilisation.

One hundred and forty-two major wetland aggregations have been identified in Queensland, representing about 90 percent of the total natural wetland surface area of the state.

Significant areas of wetland are found in the Gulf Country, on Cape York Peninsula, in the Townsville region, on Fraser, Moreton and Stradbroke Islands, and along the lower reaches of waterways in the Channel Country. The wetlands vary widely in type and occurrence within the biogeographic regions in accord with climatic factors, land forms, soils and proximity to the coast.

No estimate of the extent of wetland loss in Queensland is available due to deficiencies in our knowledge of the wetland resources. Wetlands have nevertheless been altered and destroyed as a result of increasing development.

Major threats to the survival of wetland systems include flood mitigation and flow improvement, reclamation for industrial, commercial, and residential developments, mining, grazing, sedimentation, water pollution, and the establishment of introduced animals and plants.

To varying degrees, wetlands may be afforded protection under the Queensland reserve system. National parks, environmental parks and marine parks may include areas of wetland.

Of the 142 major wetland areas, identified reserves have been gazetted over all or portions of 39. Many of these reserves cover only a small portion of the total wetland, and in some cases the wetland is threatened by activities beyond the reserve boundary.

Wetland areas are included in some 30 national parks established in the Wet Tropical Rainforest and South-east Queensland biogeographic regions. The major wetlands of inland Queensland are unprotected. There are no reserves covering wetland areas on the Mitchell Grass Downs, in the Mulga Lands, on the Einasleigh and Desert Uplands, or in the interior areas of the Brigalow Belt.

The extensive ephemeral wetlands of the Channel Country complex are also unprotected, as are the important tidal wetlands of the Gulf Plains.

Reserves established specifically for the purpose of protecting wetlands are restricted almost entirely to the coastal fringe, where reserves have been declared under the Fisheries Act 1976-1989 for the protection of fisheries resources.

Fifty fish habitat reserves protecting a total of 1 781 043 hectares of tidal lands, 29 wetland reserves totalling 52 865 hectares and six fish sanctuaries totalling 3343 hectares of tidal lands have been declared.

About 460 200 hectares of mangrove forest occur along the coast of Queensland, comprising 39.8 percent of the national resource.

Mangrove destruction has been extensive near coastal cities. Between 1974 and 1987, approximately 20 percent of mangroves in Moreton Bay were destroyed.

Mangrove forests more remote from population centres remain largely intact. An estimated 60 020 hectares, 13 percent of the total cover, is included in reservations.

All mangroves are protected under the Fisheries Act which prohibits the destruction of mangroves without authorisation. In the past, authorisation has been obtained relatively easily.

The conservation of wetlands in Queensland is complicated and hampered by the fragmented administrative responsibility for wetlands.

A number of government agencies may exercise control over land use activities which may directly or indirectly affect wetlands. In the absence of a State policy on wetland conservation and in the absence of a centralised administration, the wetland resource is inadequately protected.

River decline

Changes in catchment land use and the alteration of natural drainage paths and flow regimes have a profound effect on the ecology of rivers, lakes and wetlands. The pattern of river discharge is known to exert a major influence on fish and invertebrate communities. The occurrence of high flows associated with the onset of the wet season is responsible for triggering spawning migrations in some species of fishes. Floodplain inundation is also important in the life cycle of some species.

Accordingly, the regulation of flows through construction of dams and barrages may change the population structure of endemic fish species significantly. Regulatory structures may also interfere with the free passage of fish. Flow regulation may also affect thermal, sedimentation and light regimes, nutrient cycling, flow velocity and other physical characteristics which ultimately impact on aquatic life. Changes in velocity and sedimentation may cause changes in substrate characteristics and therefore the availability of different habitat types.

Although such changes are known to occur, the effects of river regulation on aquatic systems in Queensland are largely unknown. With an increasing number of watercourses subject to flow regulation the inevitable impact on aquatic ecosystems is a matter of concern.

A deterioration in water quality may be caused by the clearing of natural vegetation, land degradation and agricultural practices due to increases in sedimentation, nutrient enrichment and salinity. Increased siltation may fill lakes and wetlands; nutrient enrichment may promote prolific plant growth.

The loss of riparian vegetation represents a loss of habitat important to insects which have aquatic and terrestrial life stages. Thus the insect fauna of the stream may be reduced by clearing. Moreover, the loss of vegetation along watercourses may significantly increase bank erosion and therefore add to siltation problems.

In urban areas, flood mitigation and

drainage works may significantly alter natural watercourses. Clearing the vegetation and canalisation obviously cause major changes in habitat type with resultant changes in stream ecology. Many urban creeks are affected in this way.

Preservation of riparian vegetation and habitats associated with all wetlands and the vegetation along rivers, creeks and watercourses is of critical concern to protect natural diversity and wildlife habitat. Enforcement of conditions attaching to leasehold tenures and provisions of the Land Act is a first step to protect riparian vegetation.

Water pollution

Pollutants can be categorised broadly as originating from point sources or diffuse sources. Point sources include sewage and industrial effluents. Diffuse sources include urban stormwater runoff and rural runoff contaminated with sediment, nutrients, organic material and farm chemicals such as pesticides and herbicides.

In Queensland, the first major legislation which provided for control of water pollution and water quality management was the Clean Waters Act 1971 which aimed to preserve, restore and enhance the quality of the state's waters. The Act sought to control water pollution by two principal means -- by licensing whereby the quality and quantity of effluent discharged are stipulated, and by the 'duty of special care' provision whereby premises must ensure that water pollution does not occur. Specific provision in the Act for controlling diffuse source pollution is minimal. At present, there are about 590 discharges licensed under the Clean Waters Act.

The effectiveness of setting standards for effluent quality is limited by the availability of information relating to the impact of effluent constituents on aquatic ecosystems.

To date, few studies have attempted to determine such impacts in respect of Queensland's aquatic systems. As a result, criteria for water quality currently applied are based largely on those derived elsewhere. In many instances, whether such criteria are appropriate to the waters of Queensland has not been determined.

Despite major reductions in water pollution since the Act was introduced, water quality problems attributable to such discharges persist in many areas.

A significant deterioration in the quality of some waterbodies occurs as a result of the discharge of organic wastes. Such discharges may cause a severe deterioration in the dissolved oxygen content of the water making conditions intolerable to most aquatic life. In many such cases, practicable opportunities for improving effluent quality or for alternative disposal are unavailable.

Sewage and some industrial effluents contain substantial concentrations of nitrogen and phosphorus which, in excess, can promote the growth of algae and other aquatic plants to the extent that a considerable loss in amenity results. A number of rivers and creeks suffer problems arising from excessive nutrient inputs, particularly small urban creeks.

As populations grow an increasing number of watercourses are under threat in this way. In an effort to develop appropriate wastewater disposal strategies, studies have been conducted on many rivers receiving domestic wastes including the Logan, Albert, Maroochy, Mary and Burnett Rivers.

Nutrient enrichment of coastal waters is also a potential problem near some major population centres. Moreton Bay is increasingly subject to nutrient input from several sewage treatment plants.

The increased nutrient concentrations may be one of a number of factors responsible for the development of algae blooms ('red tides') in Bramble Bay and Deception Bay. Conversely, major ocean discharges of treated sewage effluent also occur off Kawana on the Sunshine Coast and off the Gold Coast apparrently without significant adverse effects.

Nutrient concentrations can be reduced through advanced treatment, but to date nutrient limits have been included in only relatively few licences. The number is

Section of Barambah Creek in the South Burnett district, a tree-lined pollution-free waterway.

likely to increase as more information supporting the need for limits becomes available.

The effectiveness of existing regulatory procedures is limited in those situations where pollution results from a specific activity, such as mining and dredging, without any readily identifiable discharge of wastes. These activities may cause a severe deterioration in water quality without being subject to quality control restrictions.

For example, the muddy appearance of Oxley Creek in Brisbane is attributed largely to past sand extraction in its catchment. Alluvial gold mining, tin mining or sand mining adversely affect the water quality of a number of rivers, including the South Pine River and Herbert River.

Mining has also generated other water quality problems, in some cases as a legacy of long-past operations. Stock deaths have resulted from the escape of process water contaminated with cyanide from gold mines. Seepage from old tailings heaps at the Mt Morgan gold mine has resulted in contamination of the upper reaches of the Dee River with toxic heavy metals like copper, zinc and lead.

Although point source discharges have been the focus of water pollution control strategies to date, pollutants originating from diffuse sources are responsible for significant water quality problems.

Pesticide contamination of creeks and rivers in agricultural areas is considerable problem. Each year a number of 'fish kills' caused by pesticide poisoning, particularly endosulphan, are recorded. Usually these eventuate when rainfall follows crop treatment.

Sediments and nutrients washed from catchment soils are the most significant diffuse source pollutants. Vast quantities of both are washed into rivers during storm events. An estimated 9400 tonnes of phosphorus is washed into the Cairns Section of the Great Barrier Reef Marine Park each year from mainland runoff.

Considerable concern has been expressed over the magnitude of such inputs to coastal waters. Although there is no historical data for comparison, such inputs may have increased significantly since European settlement.

Clearing of large areas of coastal river catchments may have increased annual sediment and nutrient inputs substantially. The impact of these changes on estuarine and coastal ecosystems is not known.

Of particular concern is the potential impact of the changing nutrient status of the waters of the Great Barrier Reef on the reef ecosystem.

Study of the impacts of diffuse source pollution in Queensland has been limited, but has provided an insight into the range of problems which might exist. The extent and magnitude of such problems remain largely unknown.

Pollution caused by the discharge of poorly-treated domestic wastes.

Prolific growth of the aquatic weed *Azolla* caused by high levels of nutrients resulting from the discharge of sewage effluent to the creek.

Flora

Threatened flora

The Queensland flora comprises approximately 7200 named species of vascular plants, of which 920 are introduced, with perhaps a further 1000 species awaiting description. The indigenous species occupy a diversity of habitats from semi-arid grasslands to tropical rainforests and swamps. The vegetation communities in Queensland, the most diverse in Australia, are shown in figure 1. Queensland can be divided into 13 biogeographic regions on the basis of vegetation type and land form (figure 2).

During the years of European settlement there has been widespread modification of plant habitats ranging from total clearing for intensive agriculture through various degrees of partial clearing for broad scale low-intensity grazing. All of these processes have contributed to the decline in many of our native plant species. Selective exploitation has also occurred, such as the logging of open forest and rainforest tree species and the collection for sale of ferns, orchids and other species of horticultural value.

A 1989 review of the status of the Queensland flora identified 1201 vascular plant species as rare and/or threatened. They represent 558 genera within 151 families. There are 82 species of ferns, eight gymnosperms and 1111 angiosperms. The list includes 223 as yet undescribed species. The largest three groups of rare or threatened species are the Myrtaceae (eucalypts, eugenias)(126 species), Orchidaceae (orchids)(93 species) and Mimosaceae (acacias)(58 species). Approximately half (610 species) of these species have a range of 100 kilometres or less while 210 have distributions extending beyond the Australian continent.

One species, *Euphorbia carissoides*, known only from the Herberton district and last collected in 1908, is presumed extinct. *Marsdenia caranata* and *Triunia robusta* were presumed extinct until collected recently. *Dioscorea pentaphylla* has been recorded only from Thursday Island.

A further 52 species are regarded as endangered and 231 as vulnerable, making a total 287 species which are definitely under threat in Queensland. Another 650 species have restricted but relatively secure distributions. A further 264 species are poorly known and therefore may or may not warrant rare or threatened status. Of the 35 species known only from their type collection, most may also be extinct since they have not been collected in the past 50 years.

The wet tropics of north-eastern Queensland contain the greatest concentration of rare or threatened species. The major rainforest areas of the Bellenden Ker Range, Boonjee-Mt Bartle Frere, the Hugh Nelson Range and the sclerophyll forests and woodlands of the Herberton-Irvinebank area, contain 315 listed species. Other rainforest areas, including Mt Lewis, Mt Spurgeon, Thornton Park, the McDowall Range, the Daintree valley and the Alexandra Bay - Cape Tribulation area contain 278 species.

Of the 1201 rare or threatened species, 607 have been recorded from nature conservation reserves in Queensland. A further six have been recorded from conservation reserves elsewhere in Australia. The majority of the rare species (434 out of 650) occur in nature conservation reserves whereas only 115 of the 287 threatened species are known from reserves.

The Department of Environment and Heritage is responsible for carrying out the functions of The Native Plants Protection Act of 1930. Under this, special protection is given to 73 species of palms, orchids, ferns and other plants including some wildflowers. This Act requires urgent amendment to provide meaningful protection to rare and nominated species on all land.

The major threat to the survival of the endemic flora of Queensland is habitat destruction. Those habitats which are not totally protected are susceptible to the pressures of commercial, industrial, agricultural and urban expansion. The

Table 2. Forest areas by ownership category for each major forest type group ('000 hectares)

Forest type	Ownership Category				
	Public 1	Public 2	Public 3	Private	Total
Rainforest	696*	147	313	81	1237
Eucalypt (tall forest)	163	4	16	22	205
Eucalypt (open forest)	1563	1724	175	1128	4590
Cypress pine	696	773	6	211	1686
Total	3118	2648	510	1442	7718

Public 1. Forests managed for multiple use including wood production.
Public 2. Crown land vacant or occupied under lease on which wood harvesting is carried out under Government control.
Public 3. Crown land e.g. national parks on which wood production is excluded.
Source: Australian Forest Resources, February, 1989.

* Approximately 621 000 hectares occurring in the Wet Tropics is now part of the World Heritage Area and no longer available for extensive logging.

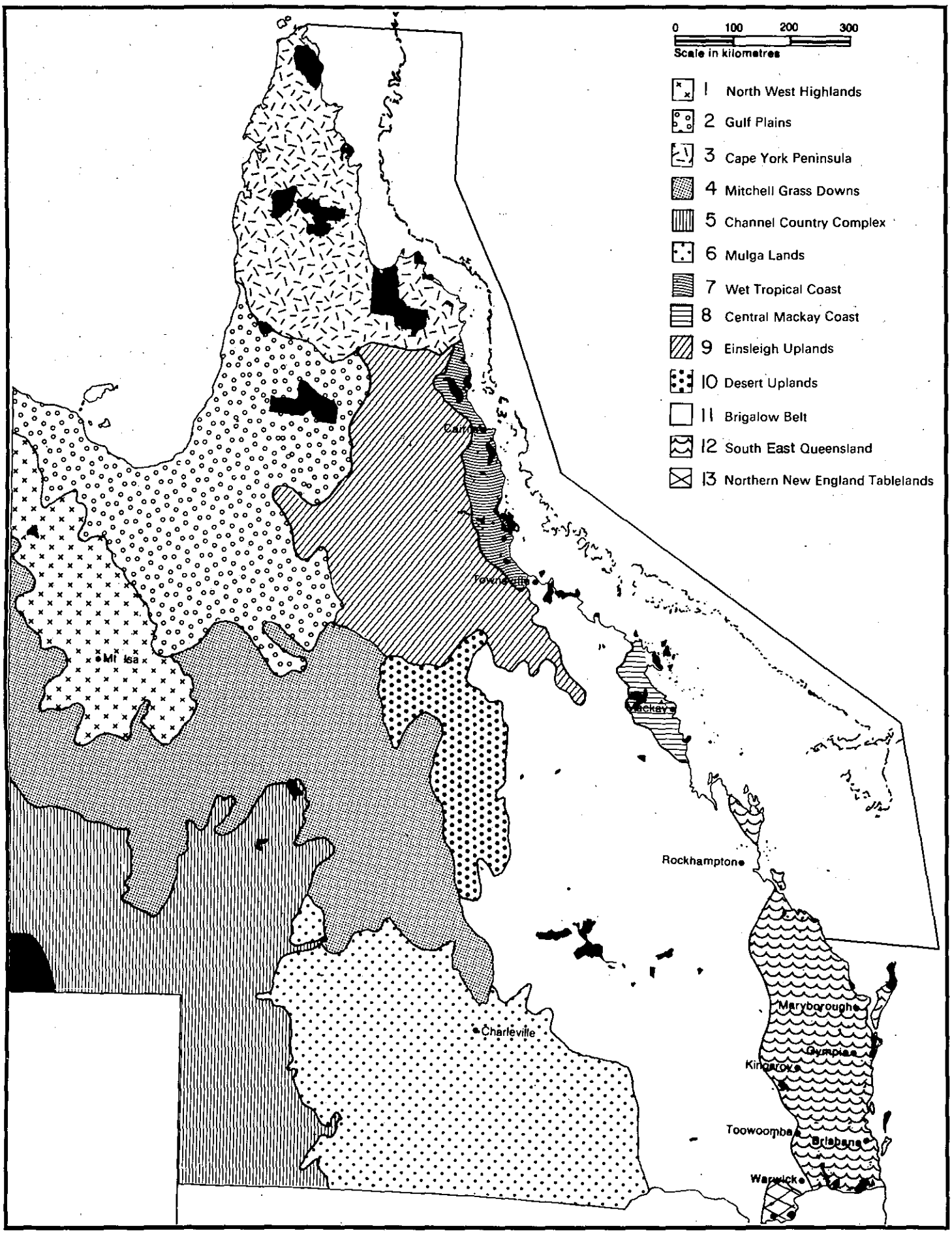


Figure 2. Distribution of national parks within the biogeographic regions of Queensland. The objective of our national parks is the representation of natural diversity across all biogeographic regions.

habitats of a significant number of both rare and threatened plant species are not protected in existing conservation reserves.

Forests and woodlands

Immediately before European settlement, less than 10 percent of the Australian continent was covered by forest. Since settlement, extensive areas of the original forest have been cleared or severely modified. Before European settlement, forest covered an estimated 35 544 000 hectares (21 percent) of Queensland. By 1984 this had been reduced by nearly half to between 17-20 million hectares. Woodland originally covered approximately 28 percent of the state but has now been reduced to 19-21 percent, a loss of some 11-15 million hectares.

The remaining area of Queensland forests dominated by large trees potentially capable of commercial timber production is currently 7 718 000 hectares. Hardwood covers 4 795 000 hectares, cypress pine 1 686 000 hectares, and rainforest 1 237 000 hectares. Approximately 6.6 percent (510 000 hectares) of this is on Crown land such as national park which excludes timber production. Composition and ownership categories of these forests are detailed in Table 2.

The Crown forest estate consists of 3 984 000 hectares of state forest and 529 000 hectares of timber reserve. In addition to native forests, the state forest includes an area of 169 304 hectares of plantations of native and introduced species. Native conifers (mostly hoop pine) cover 44 932 hectares, introduced conifers 122 600 hectares, and broadleaf species (native hardwoods) 1772 hectares. Of the total Crown estate, approximately 2 million hectares of state forest have been set aside for future timber production. The remainder will not be logged, but will be retained for other multiple use values including catchment protection, stock grazing, wildlife habitat protection, honey production and recreation.

State forests are managed with the aim of sustaining production of forest products and services within a multiple use management system. Recent milling timber removals are given in Table 3.

About 80 percent of wood cut from the state's forests is used in construction and furniture manufacture. The remainder is chipped or used in bulk as railway sleepers or bridge piles.

With increasing awareness of the value of trees in protecting land and water resources from degradation and their role in maintaining air quality and climatic stability, the planting and preservation of trees has been encouraged. The interest on the part of the rural landholder and the city dweller in growing trees is reflected in tree sales from the Department of Forestry amenity nurseries. In 1988/89 total sales amounted to 487 670 seedlings.

In 1989, the One Billion Trees Program was launched by the Commonwealth with the aim of having one billion more trees around Australia by the year 2000. This will entail a community tree planting program to plant 400 million trees, and a natural regeneration and direct seeding program to establish over 600 million trees. The Save the Bush program was also launched. This program aims to protect remnant areas of forest, woodlands, heaths, grasslands and wetlands which lie outside existing reserves.

Major initiatives are required in order to reverse to any appreciable extent the progressive decline in tree cover experienced since European settlement.

Vegetation conservation

Rainforests: Rainforests are renowned for their intrinsic beauty, but more importantly for the diversity and abundance of plant and animal life and the genetic resources contained therein. The patches of rainforest extending along the east coast of Australia are believed to be remnants of the type of vegetation which once covered most of the continent. The rainforests of north Queensland are of significance in having the highest number of relic genera of any region in Australia and the highest concentration of primitive angiosperms of any locality in the world. The area also supports many narrowly endemic species.

Less than one half, some 1 237 000 hectares, of the original rainforest in Queensland remains. This represents approximately 54 percent of Australia's remaining rainforests. Within the Wet Tropics rainforest region between Townsville and Cooktown 727 443 hectares remain. Of this, 621 566 hectares (85.4 percent) is within the World Heritage Area. Before listing as a World Heritage area, only 19.6 percent of the rainforest was in national parks. As a result of World Heritage listing, rainforest timber production from Crown land declined from 60 274 cubic metres in 1987-88 to 8733 cubic metres in 1988-89.

Administrative arrangements and management plans for the World Heritage area are currently being prepared by State and Commonwealth agencies.

Rainforests can be classified into a number of types including:

Complex notophyll forests – Complex notophyll forests occur in north and south Queensland on high and medium fertility soils in high rainfall areas. The remaining forests are largely protected in national parks, namely Eungella National Park in the Mackay district, and Lamington National Park in the Moreton district. Exceptions include the Bulburin-Granite Creek area near Miriam Vale, which is state forest.

Notophyll-microphyll forests – These forests, dominated by hoop pine (*Araucaria cunninghamii*), are widespread on the coastal and subcoastal ranges in central and southern Queensland. These forests are poorly conserved in formal conservation reserves, although well represented on Crown lands, mostly in state forests.

An estimated 100 000 hectares remain on the ranges between the Brisbane Valley and the Boyne Valley, though much of this is logged. In terms of conservation value, the type deserves equal status to

Table 3. Milling timber removals from Crown and private lands 1988-89 (gross cubic metres)

Wood type	Crown land	Private land	Total
Rainforest timber	8 733	35 617	44 350
Forest hardwoods	252 479	208 823	461 302
Native forest conifers	154 731	53 272	208 003
Plantation species	555 560	55 133	610 693

wet tropical rainforest.

Semi-evergreen vine thicket – Vine thicket and vine forest occur in inland central and southern Queensland on high fertility soils or fire-protected locations. The type is poorly represented on Crown lands, and has been extensively cleared for agriculture. The conservation value of remnant areas on freehold and leasehold land requires addressing, with protection of remnants wherever possible.

Tall open forests – Tall open forests of the wet sclerophyll type, characterised by an understorey or developing understorey of rainforest species, are restricted to high rainfall areas of south-east Queensland, with outliers in south-east Queensland and along the western side of the rainforest 'massif' in the wet tropics.

While some areas have been cleared for dairying (Springbrook and Mt Mee), extensive areas are retained within state forest and to a far lesser extent in national parks. Major issues relating to status of the type include the role of fire and logging. Fire is an important factor in maintenance of the type; irregular fires (50-150 years) are required for the regeneration of eucalyptus. Land use in some areas precludes the use of high intensity fire and the vegetation is changing to a type of simple rainforest. Logging promotes maintenance of the type, at the expense of 'old growth' expression of the forest.

Open forests: Open forests are widespread in south-east Queensland on the ranges on the central coast and the sandstone ranges in the central highlands. A large number of broad forest community types can be classified on the basis of geological substrate.

Open forests of the 'dry sclerophyll' type are still well represented in the landscape as much of this forest type is contained within state forest or on hillsides too steep to clear. Major exceptions are the communities on sandstone on the coastal lowlands of the south-east Moreton district. These have been subject to clearing for rural residential subdivision. Important remnants include the Greenbank Army Training Centre and Karawatha on the southern outskirts of Brisbane. Elsewhere, clearing of open forest containing commercial species for pasture should be recognised as an important land use conflict given the diminishing nature of the hardwood resource overall.

An important factor to be considered is the regrowth potential of some major species, in particular spotted gum, because of a special woody structure called a lignotuber in seedlings. Lignotubers often persist in cleared country and 'shoot' when suitable conditions prevail. This means that a bulldozed spotted gum forest can quickly regrow, even after several years' grazing and fire.

Brigalow open forests and shrublands present a unique case because of the scale of clearing at a time when other legitimate land uses, including conservation, were barely considered. Approximately six million hectares of brigalow (*Acacia harpophylla*) dominated communities have been cleared in the past three decades with areas protected on national parks and state forests representing less than 1 per cent of the original occurrence. A number of brigalow communities are not covered or only poorly so.

Woodlands: Woodlands presently face more widespread and complete clearing than open forests because there are few perceived tangible economic benefits accruing from their retention. Exceptions are the widespread cypress pine communities of the central and southern inland. The woodlands on flat to gently undulating country are most at risk.

The poplar box woodlands, which cover a vast area of central Queensland and northern NSW, are one of the largest uncleared areas of woodland in Australia. A recent CSIRO report has drawn attention to the potential to clear 30-50 percent of the 100 million hectares in Queensland through the application of an arboricide, Graslan. If clearing proceeds, 5 billion trees could be lost. The cost would be $2-4 billion, justified by its proponents by gains in productivity; an estimated additional 1-2 million head of cattle could be grazed in the region. There is considerable concern at the risk of widespread land degradation resulting from soil loss and dryland salinity, and massive loss of wildlife should Graslan be used on such a scale.

Other vegetation types: The conservation status and needs of other plant communities must also be addressed. Wildflower heaths of south-east Queensland have been reduced mainly through spreading of urban and other development. The teatree (*Melaleuca* spp.) forested wetlands of central and southern Queensland have been impacted through all types of coastal development. Many minor communities in specialised geological, climatic and topographic niches have to be considered.

Noxious plants

A noxious plant is a plant considered a serious enough pest to warrant its control being enforced under the Rural Lands Protection Act (1985-1988). The term 'declared plant' is used to describe a plant declared under the Act. The prolific growth of one particular plant in an area may have significant environmental and/or economic consequences. Complex native plant communities which offer a range of habitat types and support a diversity of plant and animal life may be replaced by a single plant species. Infestation of farm lands may result in a significant reduction in productivity and an increase in running costs. Rivers and lakes may also be affected. Lakes may become covered by dense mats of vegetation and rivers choked.

Declared plants are categorised according to the threat they pose and the measures required for control. Thirty seven plants are declared under the Rural Lands Protection Act. All are introduced species, the spread of which is not controlled by natural mechanisms such as insect pests, diseases and competition with other species. The management of the control of major pest plants and animals is the responsibility of the Rural Lands Protection Board.

Bitou bush, a native of southern Africa, poses a serious threat to coastal dune vegetation as it is capable of eliminating virtually all native plant species. First identified in Queensland in 1979 at Rainbow Beach it is now subject to a total eradication program. Annual ragweed is widespread in the south-east of Queensland with isolated heavy infestations near Stanthorpe, Gympie and Gin Gin; it is continuing to spread. Parthenium weed infests an area of 12 million hectares in the Central Highlands, with major infestations in other areas.

In the wet tropical north, giant sensitive plant poses a significant threat to natural plant communities and to commercial crops such as sugar cane. It climbs over other vegetation eventually eliminating all other species. Seed longevity is of the order of 50 years. Rubber vine, a native of Madagascar, is one of Queensland's worst weeds. The plant chokes out watercourses and is impenetrable to livestock and very competitive with native flora. control agent. Water hyacinth and salvinia, native to South America, colonise slow-flowing and still waters. They grow quickly and can rapidly cover entire lakes. Groundsel bush, a native of North America, has been an expensive weed in terms of control measures in south-east Queensland over many years.

Fauna

Queensland has 180 native mammals (approximately 70 percent of the national total), 581 species of birds (80 percent), 396 reptiles (50 percent) and 114 frogs (60 percent). Species that are endangered, or have become extinct in Queensland in the past 200 years are shown in Table 4. A list of species is presented in Appendix 1.

Determining which native animal species are threatened with extinction is difficult because of the paucity of information about many of the more elusive species. Some are endangered, some threatened, and some rare but common in their restricted habitats. The status of others has not been accurately determined. There can be major difficulties in determining whether a species is in fact rare or just rarely seen.

Mammals

Of those species listed as endangered in Appendix 1, the Queensland National Parks and Wildlife Service is conducting research on the northern hairy-nosed wombat, Proserpine rock wallaby, bridled nailtail wallaby and greater bilby. The habitat of the Proserpine rock wallaby is protected in the Dryander and Conway National Parks, and that of the bridled nailtail wallaby in a central Queensland scientific purposes reserve/fauna refuge.

In addition to those species listed as endangered, other species of concern include the ghost bat, orange horseshoe bat, tube-nosed insectivorous bat, golden-tipped bat and the Hastings River rat. Habitat destruction poses a significant threat to the survival of several of these species.

Mining was responsible for the destruction of part of the Mt Etna cave complex, a known habitat of the Ghost Bat, in 1989. A conservation strategy for caves systems and associated bat species across Queensland is needed.

The tube-nosed insectivorous bat (*Murina florium*) was captured for the first time in Australia in 1981 in the Atherton Tableland. It is the rarest mammal recorded alive in Australia. Its distribution is restricted to the mountainous tropical rainforests of north Queensland. The only record of the orange horseshoe bat (*Rhinonicteris aurantius*) in Queensland is from Camooweal. However, the species does occur in limited numbers in the Kimberley region and in the Northern Territory. The golden-tipped bat (*Phoniscus papuensis*) is extremely rare and was thought to be extinct in Australia until it was rediscovered in 1981 in the Cairns region.

The Hastings River rat (*Pseudomys oralis*) is known in Queensland only from near Warwick, although bones have been found in owl pellets near Maleny, 100km north of Brisbane.

Other species are rare but there is insufficient data on populations to determine whether they are threatened.

The northern population of the yellow-bellied glider (*Petaurus australis*) may be threatened as a result of removal of red mahogany, the only tree used by this species as a source of sap. The Atherton antechinus (*Antechinus godmani*) has a restricted distribution extending from the Topaz region to Yamanie Falls National Park. The species does occur in state forest, but little of its habitat has national park status.

Only seven specimens of the Thornton Peak melomys (*Melomys hadrourus*) are known to science. The species is confined to the uplands of Thornton Peak to the north of the Daintree River and has a range of about 200sq.km. The prehensile-tailed rat (*Pogonomys mollipilosus*) was first recorded from Australia in 1974 at Lake Barrine, Atherton Tableland. Further specimens have since been recorded, all from areas of tropical rainforest.

The Lakeland Downs mouse (*Leggadina lakedownesis*) is known only from four specimens taken near Cooktown. The population of this species apparently fluctuates widely in response to changing environmental conditions.

Following the decimation of the world's whale population in the late 1800s and early 1900s, numbers are now increasing. The population of humpback whales off the Queensland coast is estimated at 1100, with an annual increase of about 10 percent.

Birds

The paradise parrot (*Psephotus pulcherrimus*) has not been sighted in Queensland since 1922 and is presumed extinct.

A number of species of birds are rare or threatened. The golden shouldered parrot (*Psephotus chrysopterygius*) which nests in termite mounds is an endangered species from tropical north Queensland.

Other rare species include the red goshawk (*Erythrotriorchis radiatus*), black-breasted button quail (*Turnix melanogaster*) and the Eungella honey-eater (*Lichenostomus hindwoodi*). The black-breasted button quail has been recorded only from the Nanango, Bunya Mountains and Lamington areas, although recent observations in hoop pine plantations and lantana stands indicate that numbers may be increasing in these habitats. The Eungella honey-eater has the most localised distribution of any species in Queensland being found only in Eungella National Park.

The Queensland National Parks and Wildlife Service is involved in a number of studies on birds. A major study on the rare ground parrot (*Pezoporus wallicus*) has recently been completed. Centred on Cooloola National Park, the study looked particularly at food and breeding requirements. It was found that these were related to the fire history of the area. Conclusions were drawn as to the appropriate controlled burn fire regime needed to ensure survival of the population.

A study of the distribution and habitat requirements of the eastern bristle-bird (*Dasyornis brachypterus*) is currently under way. Monitoring of seabird breeding sites throughout the Great Barrier Reef is continuing, particular attention being given to the little tern (*Sterna albifrons*).

Table 4. Numbers of Queensland endangered or extinct species

	Total species	Endangered	Extinct
Mammals	80	8 (4.4%)	5 (2.8%)
Birds	581	9 (1.5%)	1 (0.2%)
Reptiles, amphibians	510	5 (1.0%)	0

Very little is known about most of these species in Queensland. Species with highly localised distributions may be quite common within their specific habitat, but as a result of their limited distribution are especially vulnerable to adverse habitat modification. In the almost total absence of data on populations, to identify those species which are gravely threatened or rare is difficult.

Research on the feeding ecology of fruit pigeons in south-east Queensland rainforests has been published recently. A study involving waterbird habitat mapping in the Gulf region is being planned.

Reptiles and amphibians

Approximately 400 non-marine reptile species occur in Queensland. Of these, 99 species are restricted to Queensland and a further 56 species are regarded as essentially Queensland species geographically. Thus, of the total 400 species, 155 are endemic or largely restricted to this state.

Several species are rare or threatened, and a number have very restricted distributions. The Bartle Frere skink (*Leiolopisma jigurru*) occurs only on Mt Bartle Frere. Other rare skinks include *Calyptotis thorntonensis*, which is found only on Thornton Peak, north Queensland, and *Sphenomorphus mjobergi*, which has been recorded only between Mt Bartle Frere and Ravenshoe.

Several species of frogs are also very rare: *Litoria lorica* has been found only at about 650 metres on Thornton Peak; *Cophixalus neglectus* is recorded only from the Bellenden Ker Range; and *Taudactylus rheophilus* occurs only between altitudes of 1150 and 1400 metres on Mt Bellenden Ker and Thornton Peak. The gastric brooding frog (*Rheobatrachus silus*), first discovered in 1973, is now believed to be extremely rare. It is confined to a small area of the Blackall and Conondale Ranges in south-east Queensland. Much of its habitat is not protected in reserves.

A number of rare species occur in habitat types which lie outside the protection of parks or reserves and which are threatened by development. The habitat of the lizard *Ctenotus rawlisoni* from Cape Bedford, north Queensland, is threatened by mining activities. Urban development in Brisbane and clearing in other areas represent a threat to the skink *Delma torquata*. Similarly, clearing of the brigalow in central Queensland has probably contributed to the rarity of the elapid snake *Glyphodon dunmalli*. Habitat destruction has probably also contributed to the declining populations of red-bellied black snakes and death adders.

On Cape York Peninsula, six rare species of frogs and 22 rare reptile species are recorded. Of these, one gecko, five skinks and one elapid snake were not found in national parks, state forests or timber reserves (as of 1982).

Other reptile and amphibian species may be at risk or declining but there is a paucity of data on the central Queensland brigalow belt, north-west Queensland, and the Gulf drainage system and the Mitchell grasslands.

Insects

Queensland has a large and diverse insect fauna with many species undescribed or poorly known. As a result of the scant resources available, the inaccessibility of many habitats and the enormous diversity of insects in some ecosystems many important areas of the state remain totally or relatively unsurveyed.

The enormity of the task of describing the insect fauna is best illustrated by the diversity in tropical rainforests. In 1981, an intensive three week survey by the Queensland Museum and Earthwatch of five sites extending from the Russell River to the summit of the Bellenden Ker Range yielded over 5000 species of insects and over 300 species of spiders. It was estimated that this small area contained about 7 percent of the total Australian insect fauna. Despite the high diversity the population of many species was low, with 612 species of beetles being represented by only one specimen. The vast majority of species collected were undescribed and this survey did not include the rainforest canopy.

A recent survey of rainforest canopy insects in the sub-tropical rainforest of Mt Glorious also revealed enormous diversity, with over 900 species recorded from one rainforest tree and only 380 species able to be identified to genus.

Australia was once part of the cool, wet, 'Antarctic' supercontinent Gondwanaland which began to break up about 150 million years ago. The summits of some of Queensland's mountains experience a climatic regime similar to that of ancient Gondwanaland. Here some ancient forms of animals and plants have survived relatively unchanged for 100 million years. In surveys of mountain tops undertaken particularly in the last 10 years, many new species of insects have been found with nearest relatives now surviving on mountains in New Zealand, New Caledonia and South America.

Many rainforest insects are flightless and restricted to a small area, particularly the relict ancient forms. Some quite large and beautiful beetles are restricted to one rainforest locality. They are therefore particularly vulnerable to habitat destruction. Considering how little is known of our vast insect fauna and the extent of rainforest clearing to date almost certainly many species of insects have become extinct without our ever having been aware of their existence.

Few intensive surveys of insects in drier areas of Queensland have been undertaken. One at Lake Broadwater near Dalby revealed 1231 species of moths and many species of other insects, including a new genus of Christmas beetle (*Wambo puticasus*) represented by just two specimens after a year's trapping.

The main danger to insects is habitat destruction, not collection. Legislative protection from collectors without protection of the species' habitat does little to ensure its survival.

The butterflies thus protected in Queensland, the birdwing butterflies, *Ornithoptera* spp., and the Ulysses butterfly, *Papilio ulysses joesa*, are scarce only where the rainforest has been destroyed and this has been somewhat allayed by the planting of foodplants.

The butterflies are the only group of insects whose distribution is fairly well known throughout the state. The following species are considered to be endangered or vulnerable:

- *Hypochrysops piceatus* from the Leyburn and Millmerran districts is most endangered.
- *Hypochrysops theon creatus*, known only from coastal riverine rainforest on the Rocky River in the McIlwraith Range area, is under immediate threat from alluvial gold mining.
- *Lexias aeropa* is known in Australia only from a few square kilometres of unprotected rainforest at Heathlands near Shelburne Bay on Cape York Peninsula.
- *Philaris diana diana*, from the Atherton Tableland, is only known to have been collected once in the past 40 years and the New Guinea subspecies are only known to occur in primary rainforest, which is disappearing due to logging.
- *Acrodipsas illidgei*, a mangrove species from Moreton Bay and

recently collected near Maryborough, is threatened by coastal development.

Several species of Acrodipsas have extremely restricted distribution patterns and may be endangered. Many other species are almost certainly under pressure but even with this well known group of insects it is often difficult to make definite statements about their status.

Many other Queensland insects are extremely rare, and due to restricted distributions, may be endangered. They are certainly vulnerable unless their habitat is protected. Some species of dragonfly are known to have extremely restricted distribution from the lakes of the great sand islands of Stradbroke and Fraser. Many large flower feeding beetles are extremely rare and it is believed that they may be declining due to competition from introduced bees. Similarly, the introduced cane toad probably affects insect and reptile populations within its range.

Queensland boasts the largest moth and largest cockroach in the world. The stag beetle, *Phalacrognathus muelleri*, from north Queensland, is the most sought after Australian beetle. New species and new genera are being discovered and described constantly. In 1980, the 'Cooloola monster', a very special and bizarre burrowing cricket from the sand masses of Cooloola and Fraser Island, was described as a new family.

Introduced animals

Eighteen introduced species of mammal are now established in the wild in Queensland. These are: black rat, brown rat, house mouse, hare, rabbit, cat, dog, fox, horse, donkey, pig, camel, water buffalo, goat, and four species of deer. Only the rats and the house mouse were introduced accidentally. The dingo was brought to Australia not less than 6000 years ago by Aborigines.

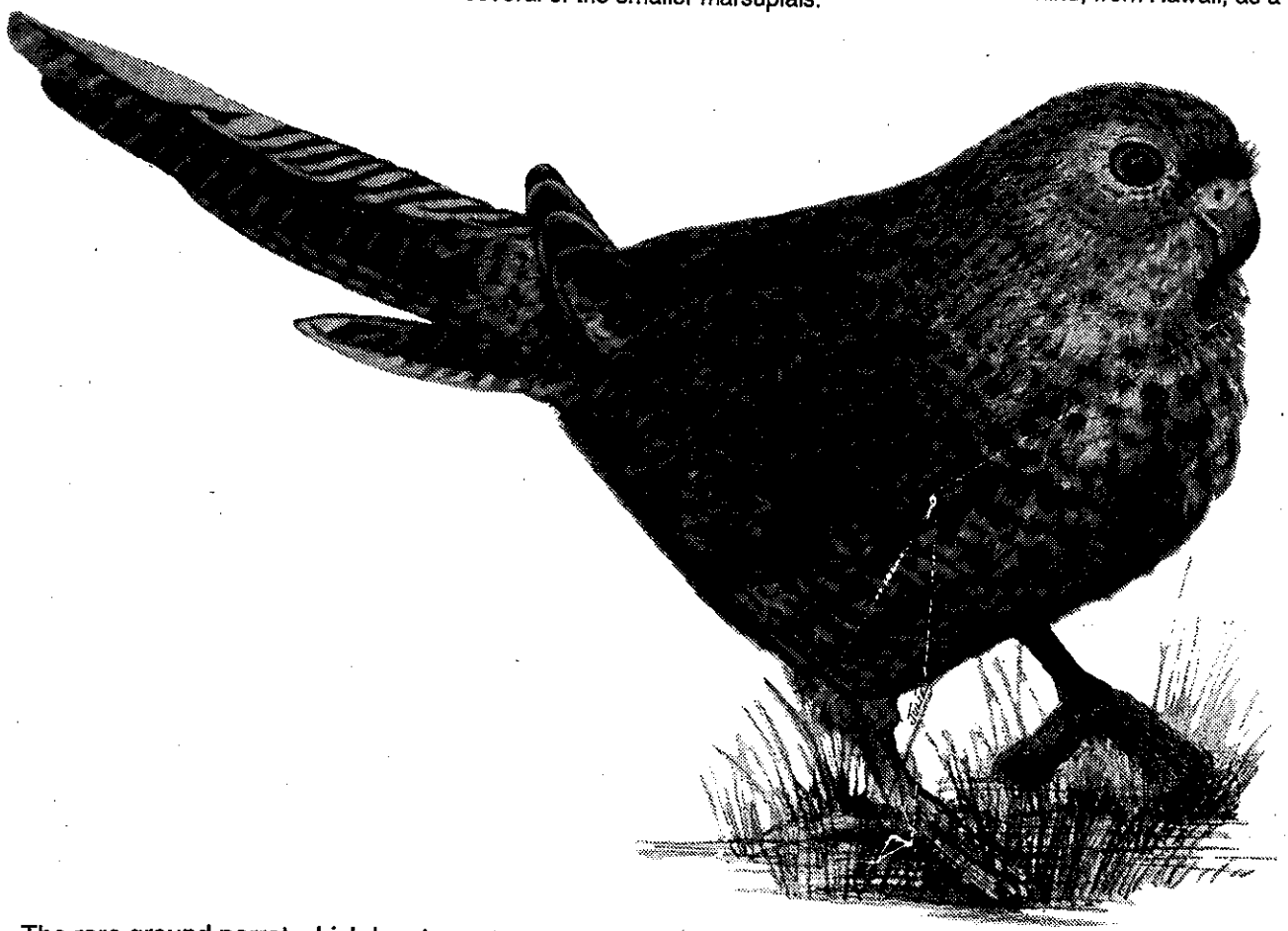
The introduction of animals to a land in which conditions were suitable for colonisation and in which there were no natural predators or other population control agents has proved disastrous. Introduced animals have contributed either directly or indirectly to the decline of some native marsupials and the degradation of a variety of habitats. The cat and fox, highly efficient predators, may have contributed to the rarity of several of the smaller marsupials.

Rabbit plagues before the introduction of the Myxoma virus were responsible for significant land degradation, particularly in semi-arid areas. Rabbits are widespread in southern inland border areas with smaller infestations elsewhere in the southern half of the state. Chemical control is actively used in support of regular releases of the Myxoma virus.

Feral pigs are distributed throughout the state with highest densities in isolated wetter areas. They are responsible for severe damage to pastures and native plant communities and predation on native animals and livestock. Their impact has been reduced significantly in recent years through poisoning, trapping and commercial harvesting.

Feral horses and goats are a significant problem only in localised areas. Control measures may be necessary in some instances to protect the natural environment.

Several other animals of significance have also been introduced to Queensland. The cane toad, *Bufo marinus*, was introduced in 1935 to the sugar cane fields of Gordonvale, north Queensland, from Hawaii, as a biological



The rare ground parrot which has been found to require a particular fire regime to ensure the species' survival.

control agent for the greyback and frenchi beetles. It established very quickly due to its ability to adapt to a variety of environments, its high breeding potential and the virtual lack of predators. However, by 1941 it was apparent that the toad was having little impact on beetle numbers. The cane toad is now distributed across the Gulf Country and along the eastern seaboard into northern New South Wales. Populations appear to be limited by the controlling factors of available food, water, cover and temperature. It is unlikely that the toad has reached its potential limits of distribution in Australia. There is evidence to suggest that direct predation by *B. marinus* has caused a decline in native frog populations.

Queensland's inland waters have been successfully colonised by nine freshwater fish species introduced to the continent. These include five poeciliids (live-bearing fishes), two cichlids and two cyprinids. The species are regarded as ecological pests in Australia and are especially problematic in sub-tropical and tropical Queensland. These fishes are generally most abundant and successful in disturbed habitats such as polluted drains and degraded urban streams and waterways with regulated flow.

The poeciliid species of most concern in Queensland are the mosquitofish, *Gambusia affinis*, the guppy, *Poecilia reticulata*, and swordtail, *Xiphophorus helleri*. *Gambusia affinis* is the most widely distributed species with a relatively long history of deliberate introductions dating back to the 1920s for mosquito control. It is particularly abundant in modified and/or polluted urban and suburban creeks and in more degraded creeks may comprise over 90 percent of the total fish population. However, it has also become established in environments that are almost pristine, including Eighteen-Mile Swamp on North Stradbroke Island and freshwater creeks on Fraser Island.

Poecilia reticulata is widespread in eastern Queensland in urban and suburban creeks and drains around Cairns, Innisfail, Ingham, Mackay, Rockhampton and Gladstone. Further south the guppy is more patchily distributed, occurring in clear, freshwater springs flowing into Barambah Creek, a tributary of the Burnett River, and in a few Brisbane creeks.

The earliest records of the swordtail, *Xiphophorus helleri*, in Brisbane date from about 1966. Swordtails were recorded in 19 creeks around Brisbane in 1977-78 and most of these populations have persisted to the present. *X. helleri* is frequently found in the same habitats as *G. affinis* in Queensland waters, although some isolated populations exist around Brisbane.

Potential impacts of introduced fishes may involve habitat disruption, competition for space or food, predation and the introduction of exotic parasites and diseases. There is little firm evidence of the ecological impacts of introduced fishes in Australia. Information on the native fish fauna before the introduction of exotics is largely unavailable.

Resource competition for food seems a likely impact of *G. affinis* in many areas of introduction. There is considerable overlap in the diets of mosquitofish and guppies and representatives of several Australian fish families. Interference competition may also be important because the mosquitofish is an aggressive species. It has been called the 'fish destroyer' because it attacks the eggs and fry of important sport fishes, and it is well known that mosquitofish may be piscivorous.

Regardless of the mechanisms involved, there is good evidence from Australia that several endemic fish species have become less numerous in habitats where the swordtail and/or mosquitofish are abundant, e.g. melanotaeniids, eleotrids, ambassids, kuhlids, atherinids and a retropinnid. There is at least one Australian instance where *G. affinis* may have eliminated a native fish from a near pristine system. The rainbowfish, *Rhadinocentris ornatus*, is a common species in swamps and lakes on Queensland's dune islands but is very rare in Eighteen Mile Swamp on North Stradbroke Island; *G. affinis* is abundant in this swamp.

The cichlid of most concern in Queensland is the mozambique mouth-brooder, *Oreochromis mossambicus*, commonly called tilapia. Although species of tilapia were introduced throughout south-east Asia for cultivation as a food fish, tilapia has never been used for food in Australia and it appears that *O. mossambicus* was first introduced as an aquarium species. It is a prohibited import into Australia. There are a number of viable populations of tilapia in Queensland, although there appears to have been little natural range expansion with most spread resulting from human intervention. Populations are generally associated with urban areas, such as the Townsville drainage system. Its presence in tidal waters near Cairns and possibly Port Douglas is cause for concern since tilapia can breed in seawater. The ecological effects of tilapia in Queensland are poorly known, mainly because of the absence of a concerted research effort. Some research is being undertaken by Griffith University.

Nature reserves

In 1969, the International Union for the Conservation of Nature and National Resources (IUCN) recommended that the term 'national park' be reserved for areas answering the following characteristics:

- One or several ecosystems which are not materially altered by human exploitation and occupation, where plant and animal species geomorphological sites and habitats are of special scientific, educative and recreative interest or which contain a natural landscape of great beauty;
- the highest component authority of the country has taken steps to prevent or eliminate as soon as possible exploitation or occupation in the whole area and to enforce effectively the respect of ecological, geomorphological or aesthetic features which have led to its establishment; and
- visitors are allowed to enter, under special conditions, for inspirational, educative, cultural and recreative purposes.

The basic objectives of Queensland's national park system are:

- conservation of areas representative of natural diversity,
- conservation of unique, uncommon and threatened species, and
- protection of outstanding natural scenery and maintenance of opportunity for passive recreation, education and scientific and historic interest.

The question of how much land should be set aside for conservation reserves is difficult to answer. No uniform percentage of the total area of a country can be set (although 5 per cent is often mentioned) as the biodiversity and extent of the different endemic plant associations as a major indicator of biodiversity determines to a considerable extent the desirable area. As many of these associations as possible should be protected in areas large enough to be self-perpetuating. The critical question is what size area is sufficient to ensure self-perpetuation.

A total of 218 major vegetation types have been identified within the 13 biogeographic regions of Queensland (fig. 2) (Stanton and Morgan, 1977). This broad classification system has provided the biological foundation for selecting representative and important areas for national park status.

The percentage of each region that has been declared national park, and the percentage representation of the regions' major vegetation types are presented in Table 5 (based on Sattler, 1986). These vary significantly between regions, from good representation in the Central Mackay Coast and South-east Queensland regions to no representation in the Desert Uplands region. Overall, approximately 2.18 percent of the state lies within the national park estate. This encompasses less than 55 percent of the state's major vegetation types.

While the average size of national parks is 10 675 hectares, only 99 parks or aggregations like groups of islands have areas greater than 1000 hectares, considered to be a minimum for adequate conservation and efficient

Part of Lawn Hill Gorge, an integral part of Lawn Hill National Park, an unusual reserve in the North-west Highlands.

Table 5. Representation of plant communities in parks in each biogeographic region of Queensland as at 1 January 1988 *

Biogeographic Region	Regional area (ha)	% area Qld	No. parks >1000ha	Park area (ha)	% Area of region	% Representation Type	% Representation Subtype
1. North West Highlands	8 117 800	4.7	1	12 200	0.150	27	-
2. Gulf Country	17 272 000	10.0	1	470 000	2.721	17	-
3. Cape York Peninsula	10 881 400	6.3	12	1 368 024	12.572	81	-
4. Mitchell Grass Downs	25 735 300	14.9	1	13 800	0.050	40	-
5. Channel Country	21 762 700	12.6	3	613 500	2.819	29	-
6. Mulga Lands	20 726 400	12.0	1	27 300	0.132	25	17
7. Wet Tropical Coast	2 245 400	1.3	21	231 508	10.310	87	72
8. Central Mackay Coast	1 554 500	0.9	10	106 909	6.877	100	89
9. Ensleigh Uplands	13 126 700	7.6	4	39 571	0.300	47	-
10. Desert Uplands	6 217 900	3.6	0	0	0.000	0	0
11. Brigalow Belt	33 162 200	19.2	21	471 640	1.420	66	59
12. South East Queensland	11 399 500	6.6	17	201 393	1.770	95	89
13. New England Tablelands	518 200	0.3	2	23 706	4.570	57	67
TOTAL	172 720 000	100.0	94	3 579 551	2.072	58	52

1. Based on 218 major vegetation types over 13 regions.
2. Subtypes are derived from a finer ecological classification of diversity and the total is a weighted estimate. The conservation status of these plant communities is less than 52% due to inadequate representation of some types.
* As at November, 1989, a further five parks with areas > 1000 hectares have been added. These, in addition to extension to existing parks takes the park area to approximately 3.76 million hectares (2.18% of the state).

management purposes. Today's estate reflects pressures applied and withdrawn and opportunities taken and lost for reservation since Queensland's first national park, Witches Falls National Park, Tamborine, was declared on 28 March 1908. 'Fortunate accidents' might be an apt description of actions over the years as seen in hindsight applying the reservation criteria of recent times.

The National Parks and Wildlife Act requires that for a gazettal to be approved, the land or water must be vacant Crown land unencumbered in any way. In recent years, this has meant more than 50 actions might have to be taken before a recommendation by the Director of National Parks and Wildlife is put to the Governor in Council. Once declared, there is total protection of plants, animals and landscape. The Act states that the cardinal principle to be observed in the management of national parks shall be the permanent preservation, to the greatest possible extent of their natural condition. The Director of National Parks and Wildlife shall exercise powers under the Act in such manner as appears most appropriate to achieve this objective.

Consistent with the Act, the Director may construct, carry out, improve, maintain, operate, protect, control and otherwise manage any works or do any act or make any such provision as considered necessary or desirable for the preservation, proper management or public enjoyment of that national park. When sufficient information is available about a national park's flora, fauna and natural features and the potential value of the park in relation to uses to which it may be lawfully applied, the whole or part of a park may be declared a primitive area, a primitive and recreation area, a recreation area, a scientific area, or an historic area. Action is proceeding to have most of Hinchinbrook Island declared a 'primitive' zone. Revocation of a national park or part of a park requires consent of Parliament after notice. Lands may be excluded from a national park for tourist and road purposes.

Environmental parks

A 1973 Land Act amendment provided for declaration of lands in public (Crown) ownership as environmental parks. The Act does not define such a reserve but indicates protection for areas in their natural or near-natural state.

On a Queensland scale, these reserves, mananaged by the Queensland National Parks and Wildlife Service, sometimes with the assistance of trustees, are seen to have only moderate conservation and recreation values. At regional or local levels, particularly in the urban and highly modified lands of south-east Queensland, they have great importance as reminders of past landscapes and as benchmarks to encourage retention and proliferation of natural vegetation in nearby lands and as havens for wildlife. Of 178 environmental parks declared, only five exceed 1000 hectares. Most are between 5 and 20 hectares. Many small areas pose management problems.

Fauna refuges

Fauna refuges are declared under the Fauna Conservation Act over land of any tenure to conserve one or more species of fauna. Conditions and restrictions may be imposed on the use of the fauna refuge for purposes other than fauna conservation. Flora and fauna are protected.

Department and official purposes reserves

As the title indicates, these are declared under the Land Act for various purposes by Government departments.

The Environment and Heritage Department divides its reserves into resource reserves, primarily landscapes with legal impediments to national or environmental park declarations, and administration reserves of offices, accommodation and information centres.

Scientific purposes reserves

These reserves are declared under the Land Act for specific scientific studies relating to flora and fauna conservation.

Fauna sanctuaries

Land of any tenure may be declared a fauna sanctuary under the Fauna Conservation Act. This is an old form of fauna protection since the Act now protects most native species everywhere in Queensland.

All state forests, national parks and islands off the Queensland coast are automatically fauna sanctuaries.

Open season fauna cannot be taken in fauna sanctuaries.

Fauna reserves

The Fauna Conservation Act provides for the declaration of fauna reserves. None has been gazetted.

Recreation areas

These may be declared under the Recreation Areas Management Act over land and waters of any tenure by agreement of the landholders.

A Board answerable to an Authority is required to provide, co-ordinate, integrate and plan for the recreational development and management of such areas taking into account the recreation, education, conservation, commercial and production values, and the interests of landholders.

Most of Fraser Island is presently managed under the provisions of the Act to provide for nature-based recreation. Brisbane Forest Park is managed under similar legislation.

Details of Queensland's nature conservation estate and related reserves are given in Table 6.

Table 6. National parks and other reserves in Queensland as at 2 December 1989 (hectares)

Tenure	Number	Area
National parks	332	3 544 333
Environmental parks	178	50 650
Departmental and official purposes (resource reserves)	23	206 585
Scientific purpose reserves	8	64 655
Total		3 788 429
Other reserves		
Departmental and official purposes	34	789
Fauna refuges	5	6 473
Fauna sanctuaries	over 1 350	over 11 000 000

Queensland marine parks

Under the Marine Parks Act 1982-88, marine parks may be declared over tidal lands and tidal waters of Queensland. A marine park may protect a coral reef community, a mangrove forest, or an area of mudflats and seagrass important for birds, turtles or dugong. But mostly they are intended to provide a means for guiding use of our marine and estuarine areas. Their legal boundaries are Cartestian co-ordinates and geographical descriptions.

Hervey Bay Marine Park of about 200 000 hectares was gazetted on 16 September 1989. This park has one general use zone covering a whale management and monitoring area. Pumicestone Passage Marine Park, gazetted on 1 February 1986, is managed for the protection of fisheries resources. Mackay/Capricorn Marine Park, gazetted on 27 August 1988, incorporated the Capricorn-Bunker Marine Park, part of which was formerly the Heron-Wistari Marine Park. A zoning plan is in force. Townsville/Whitsunday Marine Park was gazetted on 3 October 1987. Cairns Marine Park, gazetted on 18 February 1989, incorporated Green Island Marine Park.

Public expressions of interest were sought in the declaration of a Woongarra Marine Park near Bundaberg. This proposal has not yet been approved. Another proposal for a northern Moreton Bay Marine Park has been held pending the outcome of the Moreton Bay Strategic Plan deliberations.

Great Barrier Reef Marine Park

The Great Barrier Reef Marine Park covers 344 000 sq.km and extends along 2300 kilometres of the Queensland coast from the tip of Cape York to just south of Lady Elliot Island.

This is by far the world's largest marine protected area. Within the area are 2900 individual reefs. More than 2100 reefs make up the main barrier, with a further 540 high continental islands closer inshore having significant fringing reefs. The reef is home to more than 1500 species of fishes, 330 species of hard corals, and 350 species of echinoderms (starfish, sea urchins and feather stars). Innumerable other species of a variety of life forms also inhabit the park waters. The islands are inhabited by or visited by more than 240 species of birds.

The Great Barrier Reef Marine Park Act was passed by Federal Parliament in 1975. In October 1979, the southern-most Capricornia section was declared. By 1983, the entire Great Barrier Reef had been declared. The Reef has been inscribed on the World Heritage List as a natural site.

The Great Barrier Reef Marine Park is a multiple-use protected natural area. Management is based on the concept of zoning whereby areas are designated suitable for particular activities. Zoning plans have been developed for all sections of the Marine Park, the last, the Mackay/Capricorn section, coming into effect on 1 August 1988.

The Queensland National Parks and Wildlife Service is the principal agency responsible for the park's day-to-day management on behalf of the Great Barrier Reef Marine Park Authority.

Staff resources have not increased in accord with the area requiring management. Vast areas receive little or no surface management, particularly in the north, because resources must be concentrated in areas of high intensity uses.

The rising population of coastal towns, mainland agricultural and industrial development, a growing tourist industry and an increase in accessibility of the reef inevitably pose some threat to the integrity of the Barrier Reef ecosystem. As a result of pressures for tourist development, strategies to manage such development are to be incorporated into zoning plans.

Concern has been expressed in recent years over the concentrations of the nutrients nitrogen and phosphorus in Reef waters. Research has shown that the concentrations in some inshore areas at times significantly exceed those which have been shown to cause mortality in corals. Such nutrients originate from wastewater discharges and from river runoff.

Nutrient inputs associated with discharges from resorts are relatively small (3-5 tonnes of phosphorus a year) and pose a potential threat only in highly localised areas in the immediate vicinity of discharges. Conversely, inputs associated with mainland runoff are measured in thousands of tonnes and are of greater concern considering the Reef ecosystem as a whole.

As a result of land clearing and agricultural development, such inputs may have increased significantly since European settlement, and may be continuing to increase. The magnitude of such increases and the effects of any resultant changes in the nutrient status of Reef waters are unknown. Studies have now been initiated by the Great Barrier Reef Marine Park Authority to address these issues.

The most contentious issue concerning the Great Barrier Reef is that of the crown of thorns starfish (*Acanthaster planci*). Are infestations natural or induced by human activity, and what can or should be done?

Major infestations occurred in the 1960s and again in the 1980s causing considerable damage to many reefs in the northern and central sections. As a result of a perceived need to understand the causes and consequences of such outbreaks more fully, the Authority established the Crown of Thorns Starfish Research Committee to advise on a research program. A comprehensive program addressing various aspects of the biology and ecology of the crown of thorns is well advanced.

In 1988-89, 35 projects were funded by the Authority at a cost of $632 000 following recommendations by the Committee. In the same year, related research expenditure by the Australian Institute of Marine Science was of the same order. For 1989-90, the corresponding amount budgeted by the Authority is approximately $800 000.

Rural nature conservation

The rural nature conservation program run by the Queensland National Parks and Wildlife Service considers the conservation of natural resources outside the system of national parks and other reserves.

More than 70 percent of Queensland is under some form of Crown leasehold tenure (principally pastoral leases). Another 22 percent is held as freehold tenure or is in the process of alienation.

The program recognizes that unless nature conservation is practised on all lands, reserves like national parks can become mere curiosities.

Plants and animals do not recognise drawn boundaries. These must be flexible with safe corridors and viable communities that can re-establish populations destroyed in natural or man-made disasters.

The program sets out to integrate nature conservation with rural enterprise for the mutual benefit of the countryside and the community.

The Service acts as a catalyst to encourage co-operation of the rural community with input from interested landowners and managers, other Government departments, and producer organisations.

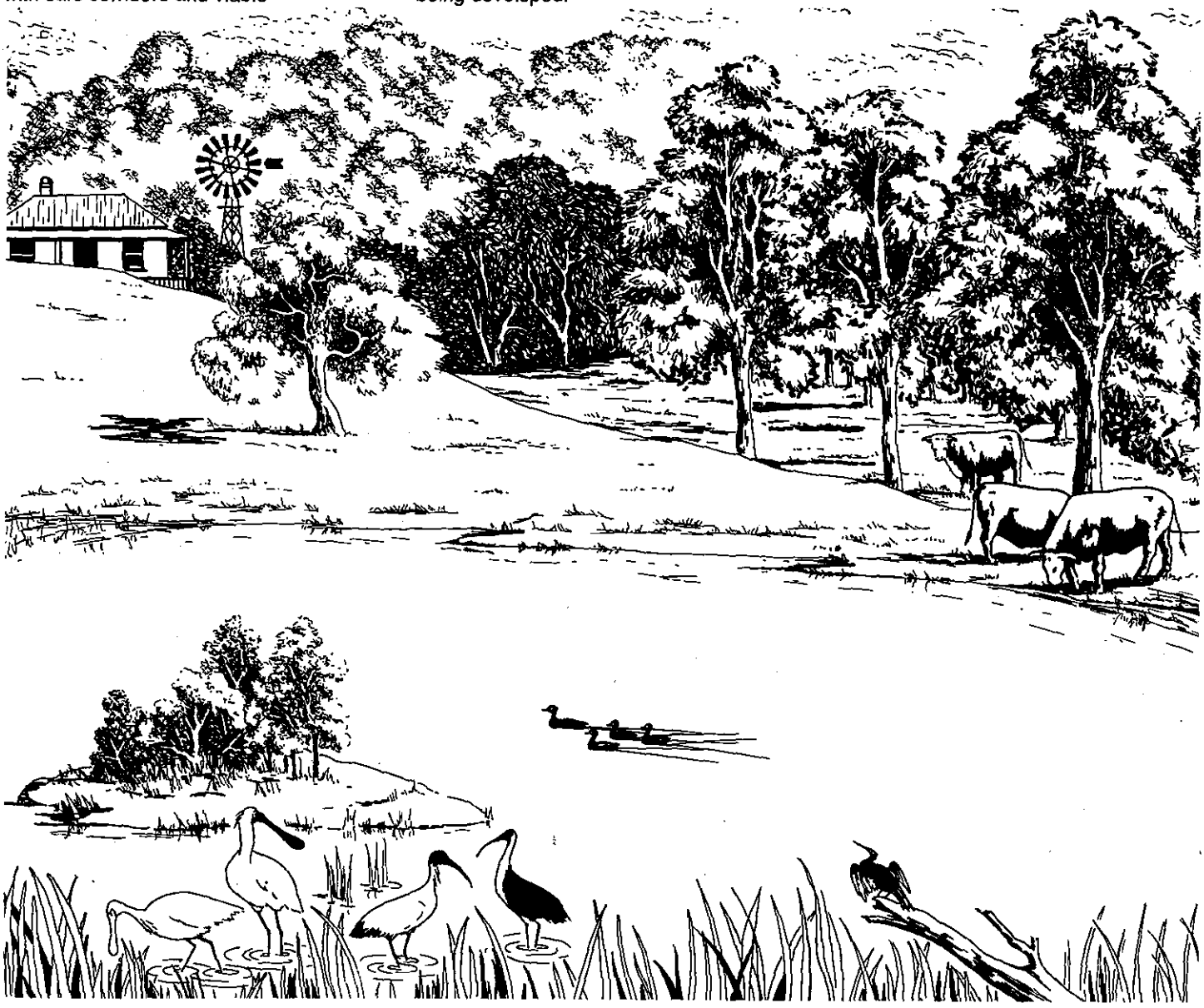
By drawing on the knowledge and practical experience of landholders and adding Service resources and expertise, practices appropriate for each area are being developed.

A pilot program on the Darling Downs proved the concept was feasible and much valuable data was gathered and disseminated.

The program includes techniques for restoring productive capacity such as vegetation retention and planting along streams and ridges and maintaining shade patches and windbreaks for stock and crops.

In turn, tree corridors and islands in farm dams provide not only habitats for wildlife but give a more pleasant outlook for property residents.

Effective promotion of rural nature conservation program principles has not been extended across the state.



Air pollution

The major air pollutants are carbon monoxide, sulphur dioxide, photochemical oxidants, suspended particulate matter and lead. Levels of these pollutants in Brisbane are low and, with few exceptions, comply with air quality goals recommended by the National Health and Medical Research Council (NHMRC).

Motor vehicles are major sources of carbon monoxide, nitrogen dioxide and lead, and are the most important contributor to air pollution in Brisbane. Air quality in Brisbane could deteriorate in the future with increasing urban development and reliance on petrol and diesel-powered motor vehicles for transport.

Significant concentrations of carbon monoxide occur only in areas of very high motor vehicle density. Levels have been decreasing over the last 10 years due to emission reductions achieved by the implementation of Australian Design Rules for new motor vehicles.

During 1988, the Division of Environment's continuous air monitoring program recorded only one value in excess of the NHMRC goal. Emissions of sulphur dioxide in Brisbane are low and there are no problems with sulphur dioxide pollution. Levels of nitrogen dioxide are well below the goals set by NHMRC.

Levels of suspended particulate matter in the respirable size range are well below standards set by the United States Environmental Protection Authority.

There are some localised problem areas where levels of total suspended particulate matter (includes particles larger than respirable size) exceed NHMRC goals.

Concentrations of lead in air exceed the NHMRC goal at sites where there is high motor vehicle density. Oil companies have been asked to lower the amount of lead used in Queensland's supergrade petrol to bring it into line with practice elsewhere in Australia.

There is evidence that ambient levels of lead have started to decline since the introduction of unleaded petrol and this trend should continue.

Photochemical smog is formed as a result of photochemical reactions between nitrogen oxides and hydrocarbon compounds. It builds up to relatively high levels (one-hour concentrations greater than 8.0 parts per hundred million ozone) on two or three days a year. These levels comply with the present NHMRC goal of 12.0 pphm. The NHMRC is expected to revise this goal and set a lower concentration. Current levels may not meet the new goals. There is also the possibility that ozone levels could increase because increases in motor vehicle use will result in higher total emissions of nitric oxide, one of the primary pollutants involved in photochemical smog production.

Visibility is not impaired frequently or seriously by air pollution in Brisbane. The noticeable discolouration observed over the city on most days is the result of sunlight shining on very small particles of carbon emitted by motor vehicles.

Visibility measurements over the past 10 years have shown an improvement despite a doubling in population.

A significant contribution to this improvement has been made by the banning of backyard burning by local authorities.

The forestry and agricultural practice of burning off unwanted vegetation can affect visibility. Under unfavourable meteorological conditions, the smoke from this practice can impact on Brisbane for several days.

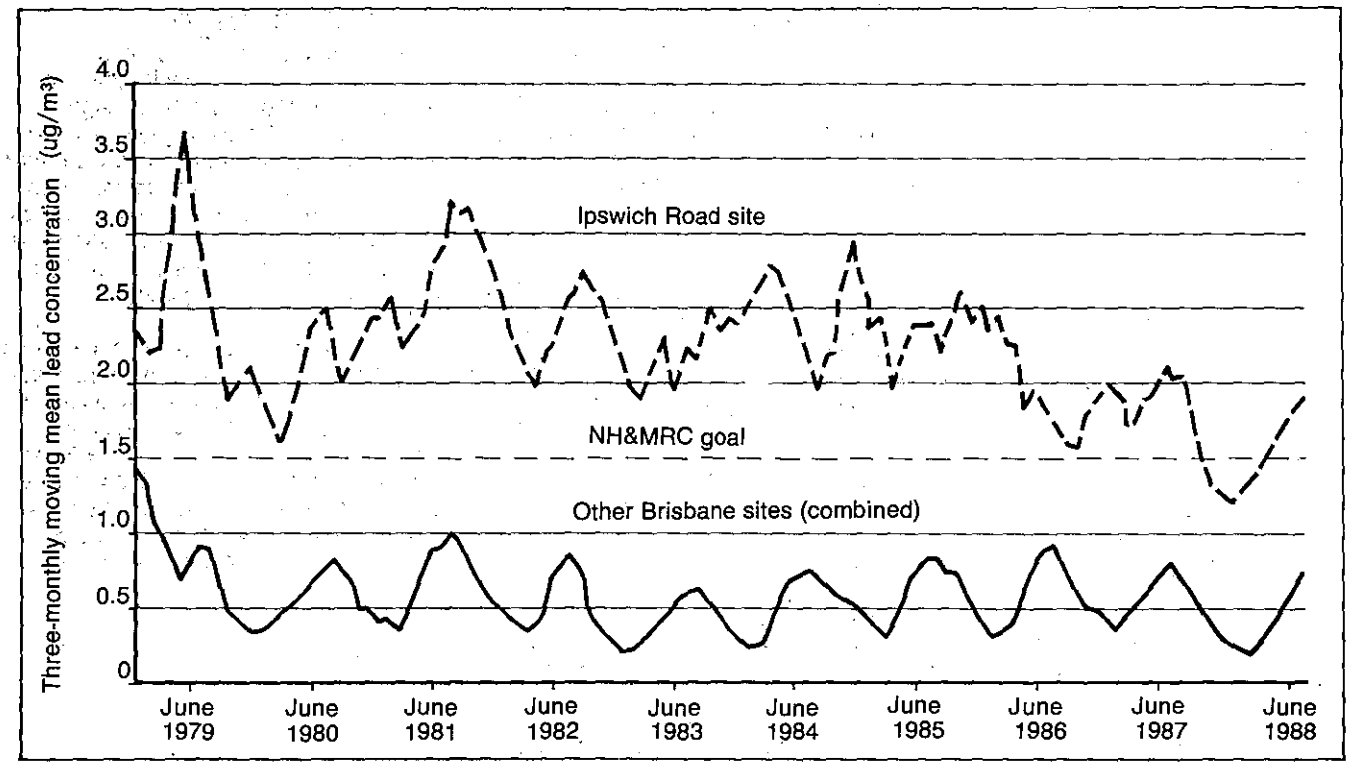


Figure 3. Lead concentrations in the air at a site adjacent to Ipswich Road and at other Brisbane sites 1979-1988.

The impact of industrial odours on urban communities is increasingly recognised as a major problem. Poor planning is almost always associated with these problems. A major problem exists in Brisbane's southside river mouth suburbs.

Major point source emissions

Major industrial point source emitters of air pollutants are generally situated outside the Brisbane area and are distributed throughout the state. In view of the volume of pollutants there are concerns over the environmental impact of many of these sources.

In 1988, Mt Isa exceeded the NHMRC goal for hourly average concentrations of sulphur dioxide on 25 occasions. Since monitoring commenced in 1979, violations of ambient air quality goals for sulphur dioxide have decreased. This is partly due to the high chimney stack now used for release of sulphur dioxide from the smelter and partly due to the control strategy used to reduce emissions during times when they impact directly on the city.

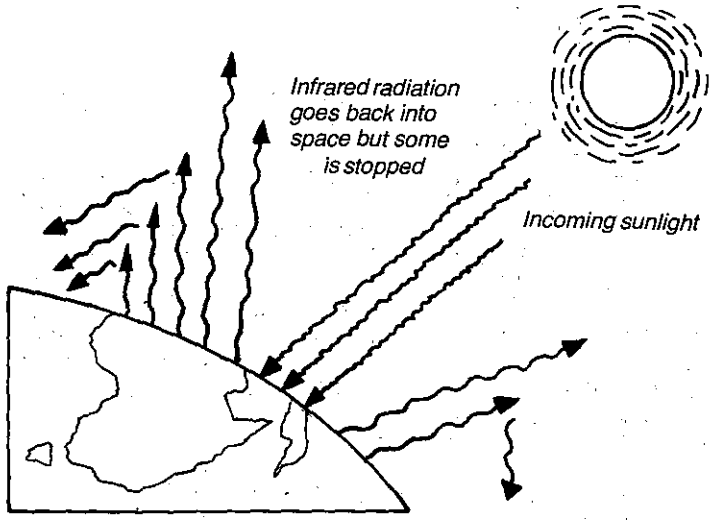
Extensive measurements have been made of the impact of industries in the Gladstone area for 10 years. This has included fluoride measurements in air and vegetation at Boyne Island, sulphur dioxide, nitrogen oxides and suspended particulate matter downwind of Queensland Alumina Ltd and the Queensland Electricity Commission power generation station. There is no cause for concern over the levels of sulphur dioxide, nitrogen oxides and suspended particulate matter in the Gladstone area at present.

There is no evidence of adverse impacts of fluoride emissions from the Boyne Island Smelter outside the designated buffer zone.

Ozone depletion

The stratospheric ozone layer which filters out harmful ultraviolet radiation is being depleted. A global network to measure stratospheric ozone commenced in the 1960s. In the area 64deg.N - 30deg.N, a loss of ozone in the order of 2.3 plus or minus 0.8 percent from 1969 to 1986 was found. This data has been used to calibrate satellite data collected since 1979, which shows a global ozone loss of 2.5 plus or minus 0.6 percent up to 1987.

At its most dramatic, an area of severe depletion (up to 50 percent) has occurred in spring each year over Antarctica. This has been referred to as a 'hole' in the ozone layer. In fact it is an area of severe seasonal depletion. Although the Antarctic 'hole' exhibits a two-year cycle of severe and mild depletion (with variations of up to 40 percent between consecutive years), it has been getting progressively worse since first observed in 1979.



The 'greeenhouse effect' arises because the earth's atmosphere tends to trap heat near the surface. Greenhouse gases are relatively transparent to the shorter light wavelengths that carry most of the energy fof sunlight, but they absorb the longer wavelengths emitted by the earth. Hence an increase in the levels of greenhouse gases tends to warm the surface by downward radiation.

Increasing levels of chlorine in the stratosphere are the cause of this depletion. Although there are some natural sources of chlorine, manufactured chemicals known as chlorofluorocarbons (CFCs) and halons and, to a lesser extent trichloroethane and carbon tetrachloride, currently account for some 75 percent of the chlorine in the stratosphere.

Although there is no evidence of biological damage resulting from the depletion, atmospheric modelling predicts that chlorine levels in the stratosphere will increase by several hundred percent if global measures are not introduced to limit the emission of ozone depleting substances. Reliable predictions of the resultant additional depletion and subsequent biological effects are unfortunately not yet possible.

The Montreal Protocol on Substances that Deplete the Ozone Layer, which Australia has signed, is an attempt to obtain international action to control the emission of ozone-depleting substances. Unfortunately, this protocol does not appear to go far enough, although amendments due for discussion in June 1990 may correct this situation. The Australian Environment Council (now Australian and New Zealand Environment Council), through its Strategy for Ozone Protection, has attempted to establish Australia as an example of what emission reductions are possible. If some measure of national conformity is to be developed, Queensland must enact legislation to implement the ANZEC strategy. Action to achieve this is in train.

Greenhouse induced climate change

There is concern as to the possible consequences for the environment of accelerated global climatic change induced by the increasing levels in the atmosphere of greenhouse gases (carbon dioxide, methane, nitrous oxide, CFCs, ozone). Scenarios for the future include coastal inundation, rainfall variation and, as a result, changes in the suitability of land for agricultural purposes.

Although there is good historical evidence that climate changes of similar magnitude have occurred previously, these changes have developed over many hundreds of years. The time in which the predicted climatic change is expected to occur is considerably shorter (approximately 50 years), making adaptation of natural systems to the changes much more difficult.

Noise pollution

In 1986, a national survey of 2332 people from all federal electoral divisions found that noise was the most serious type of environmental pollution affecting people in their homes. Forty percent of respondents reported disturbance to listening activities or to sleep because of some form of noise pollution.

Like residents in other states, Queenslanders listed the following nuisance noise sources: traffic, barking dogs, lawn mowers, noisy neighbours, trail bikes, and aircraft noise.

By comparison, commercial and industrial noise was of relatively minor importance. Construction noise was the most frequently mentioned source in the industrial and commercial area.

Although road traffic noise is the most significant and widespread noise problem in urban areas today, it has received little effective attention in Queensland.

Population exposure estimates have not been established for the state in terms of the Organisation for Economic Co-operation and Development (OECD) 'undesirable' and 'unacceptable' criteria. There are indications that large sections of the community are exposed to excessive road traffic noise.

Traffic noise control requires a range of different strategies. Vehicle source controls are important and, while new vehicles adequately meet existing criteria through the Australian Design Rules (ADRs), Queensland has not implemented in-service vehicle testing.

At present, the Transport Department conducts very limited testing on noisy vehicles following police referral.

The Commonwealth Government exercises control of aircraft noise at major airports through avenues such as noise certification of aircraft, flight path restrictions and curfews.

Current problems exist as a result of the redirection of flights at Brisbane Airport over areas previously little affected by aircraft noise. The introduction of 'quieter' jets will have only a small effect in terms of maximum noise levels.

Noise from smaller airports and landing facilities for helicopters is the responsibility of local authorities and is not yet the subject of uniform noise control guidelines. Specific items such as lawn mowers, air-conditioners and power tools are not yet subject to regulations controlling maximum noise emissions and noise labelling.

Queensland is benefiting from legislation in New South Wales, Victoria and Western Australia, but in the absence of controls there is a danger that Queensland could become a dumping ground for noisy equipment unsuitable for sale elsewhere.

Noise from commercial and industrial premises can and must be prevented at the planning stage of new developments. Prevention relates to the suitability of the location in terms of buffer distances and the transport requirements of the site, as well as engineering noise control.

Informal arrangements provided under the Noise Abatement Act whereby local authorities may refer proposals to the Division of Environment for advice were intended to achieve control at the planning stage. However, because they give the local authority discretion regarding referral, they have proved only partially effective.

Waste management

Solid and liquid waste disposal has the potential to pollute surface and ground waters and the atmosphere. Many such wastes are toxic and may be highly persistent in the environment. Careless disposal can result in unnecessary alienation of land through chemical contamination. Costly rehabilitation may be required in such instances.

Serious problems arising from urban hazardous waste disposal have been identified in the last 15 years in the Kingston residential area (acid oil sludge and suspected PCBs), Willawong waste disposal area (liquid industrial waste treatment and disposal) and Carina sub-divisional development (arsenic contamination from hide treatment). Significant problems at the Willawong facility have been overcome, although the site has only limited capacity for certain types of waste.

All these sites are in or around the Brisbane metropolitan area. Other examples will undoubtedly be identified in the future because of the lack of proper toxic waste disposal methods in Queensland in the past.

Environmental pollution can also result from fires or spills involving hazardous chemicals. Within the last 10 years, at least 10 such 'chemical fires' have occurred resulting in significant air and/or water pollution. Some of these also had the potential to adversely affect public health. Except for one in the Hughenden area, all incidents were confined to the Brisbane or nearby local authority areas.

Spills of hazardous chemicals resulting from traffic accidents, unsatisfactory storage practices or deliberate release occur relatively more frequently than chemical fires, and have similar potential in terms of public health and environmental impacts.

Legislative and practical arrangements for hazardous waste management have clearly become deficient in recent years.

With the exception of pathological wastes, refuse disposal in Queensland is currently by sanitary landfill, although the increasing scarcity of suitable sites in the Brisbane area is beginning to force consideration of alternatives.

Significant pollution problems with landfills in Queensland tend to be associated with poorly-sited or poorly-operated tips. Apart from methane gas emission, which is not collected at any site, air pollution from burning of refuse is confined to only a few provincial tips, and is a diminishing problem. Pollution of surface waters is caused from time to time by a few poorly-sited tips located within or adjoining tidal wetlands.

Minor leachate seepages occur from some disused tips, but the problem has not been studied in any depth. No on-site leachate treatment facilities have yet been installed at any Queensland tip, but leachate and contaminated drainage have been diverted to the sewerage system in at least one instance.

Many of these problems with refuse disposal are a legacy of past practices, particularly the siting of tips in mangrove areas. There has been a major improvement in the siting and

management of refuse tips over the last decade.

Hospital wastes of a pathological, cytotoxic or pharmaceutical nature are generally disposed of in hospital incinerators. Some of these facilities are unsatisfactory due to the inclusion of plastics and non-segregation of wastes prior to incineration. In addition, the design of some installations does not ensure the destruction of cytotoxic wastes. As a result not all wastes are destroyed.

The only radioactive wastes generated in Queensland on an ongoing basis are small quantities of radioisotopes and contaminated laboratory or process equipment originating from medical, scientific or industrial applications. Because of the small quantities involved, disposal by storage at appropriate locations is feasible on a long-term basis.

The current system of regulation of waste management in Queensland tends to reflect the relatively low environmental hazard presented and the generally low density of disposal sites which existed in the past when present arrangements evolved.

Resource conservation

Before 1989, efforts towards recycling in Queensland were mostly commercially driven.

While the environmental benefits of resource conservation through reuse, recycling and waste minimisation have long been recognised, until early 1989 little, if any, effort had been made at the State Government level to promote and encourage these practices.

Such practices are in the interest of reducing the environmental impact of our use of natural resources locally and abroad.

Estimated levels of recycling for some materials in Queensland are: glass 23 percent, paper (excluding cardboard) 15 percent, aluminium 56 percent, and plastic bottles (polyethelyne terephthalate or PET) less than 2 percent.

For some recycled materials, the recent upsurge in community interest in recycling has tended to destabilise what was previously a relatively stable though small market. The result is that levels of recycling for most of the above materials are likely to be in a state of flux for the foreseeable future.

Programs initiated by the Division of Environment in mid-1989 are aimed at facilitating local authority implementation of community recycling schemes, minimisation of waste generation by industry and the community generally, and the promotion of waste exchange programs.

Storage of tailings from mineral extraction to prevent contamination of water resources by salts and heavy metals represent a continuing challenge to the mining and process industries.

Queensland heritage

Limited heritage legislation has been in place in Queensland since 1967. The initial legislation dealt only with Aboriginal 'relics' (Aboriginal Relics Preservation Act 1967-75). European historical sites were not covered in this legislation.

In 1987, the Cultural Record (Landscapes Queensland and Queensland Estate) Act was introduced to incorporate protection for historical sites. Because of its broad level of definition, this legislation has been largely ineffective.

Aboriginal heritage

Archaeological (prehistoric) site records are held in computerised and hard copy form by the Heritage Section of the Department of Environment and Heritage.

Computerisation of archaeological sites began in 1986 and some 5000 records have been entered. Information held on prehistoric and historic sites represents only a fraction of the sites that exist throughout Queensland.

The Register of the Queensland Estate currently lists 13 'Aboriginal-Prehistoric' declared landscape areas. These are:

Far north Queensland-- Quinkans I and II (art and habitation), North-west– Granites (art), Stanbroke (art), Central and Central West Highlands– Black's Palace (art), Wallaroo (art and habitation), Morven (stone arrangement), South-east Queensland– Toorbul Point (bora ring), Gatton (art and habitation), Nanango (bora ring), Meringandan (stone arrangement, art and habitation), Burleigh Heads (bora ring), Nudgee (bora ring), Moggill (bora ring).

The Heritage Section of the Department administers the National Estate Grant and the Queensland Heritage Grant programs. Although much of the grant programs are conservation or restoration oriented, a proportion of primary research projects have been supported.

The Heritage Section has made a significant contribution to establishing the chronology of Aboriginal occupation through the provision of funding for radiocarbon dates to independent researchers.

To date, with a few exceptions, management of heritage sites has occurred on the basis of immediate need. Little forward planning has been possible and management has been restricted to signage and minor fencing.

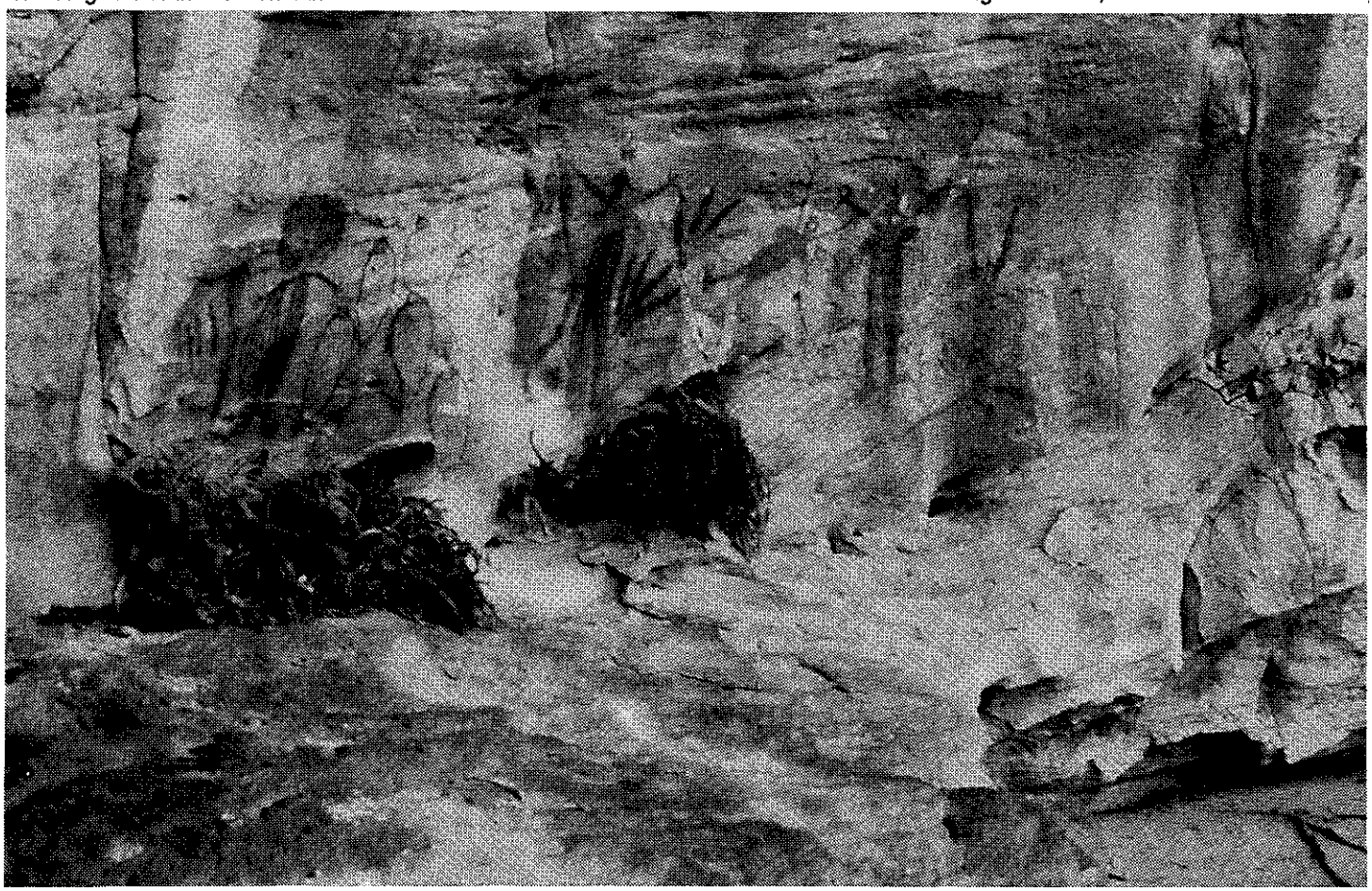
Nevertheless, there has been a growing concern by local councils and others to manage cultural resources.

Those areas already designated as declared landscape areas require the development of substantial management plans to maintain their significance and integrity.

Built environment

Records of approximately 2-3000 'historic building' sites are held in hard copy form.

The Register of the Queensland Estate currently lists one 'European-Historic' item, the Yungaba Migrant Centre, Kangaroo Point, Brisbane.



A fine example of monochrome animistic art detailing human and mythological figures -- from Cape York Peninsula.

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Appendix 1

Endangered and extinct* vertebrates of Queensland

Mammals

Darling Downs hopping-mouse *Notomys mordax* (extinct 1840)*
Eastern hare wallaby *Lagorchestes leporides* (extinct 1890)
White footed rabbit rat *Conilurus albipes* (extinct 1875)
Desert rat-kangaroo *Caloprymnus campestris* (extinct, 1935)
Lesser bilby *Macrotis leucura* (extinct, 1931)
Brush-tailed bettong *Bettongia pencillata*
Bridled nailtail wallaby *Onychogalea fraenata*
Proserpine rock wallaby *Petrogale persephone*
Northern hairy-nosed wombat *Lasiorhinus krefftii*
Greater bilby *Macrotis lagotis*
False water-rat *Xeromys myoides*
Dusky hopping-mouse *Notomys fuscus*
Kowari *Dasyuroides byrnei*
Northern hopping-mouse *Notomys aquilo* (no longer known in Queensland but persists elsewhere)

Birds

Paradise parrot *Psephotus pulcherrimus* (extinct, 1922)
Red goshawk *Erythrotriorchis radiatus*
Plains wanderer *Pedionomus torquatus*
Little tern *Sterna albifrons*
Golden-shouldered parrot *Psephotus chrysopterygius*
Ground parrot *Pezoporus wallicus*
Plumed frogmouth *Podargus ocellatus*
Purple-crowned fairy-wren *Malurus coronatus*
Eastern bristle-bird *Dasyornis brachypterus*
Carpentarian grass wren *Amytornis dorotheae*
Night parrot *Geopsittacus occidentalis gould*

Reptiles and amphibians

Gastric brooding frog *Rheobatrachus silus*
Long-nosed tree-frog *Litoria longirostris*
Elegant microhylid *Cophicalus concinnus*
Rock-dwelling microhylid *Cophicalus saxatalis*
Loggerhead turtle *Caretta caretta*

* Date of last record shown

Source: Council of Nature Conservation Ministers as updated by Queensland National Parks and Wildlife Service, 1990.

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