FERAL PERIL:

Queensland's Introduced Plants and Animals

BACKGROUND INFORMATION BRIEF NO 28

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ABSTRACT

Australia has been an isolated island continent for the last 38 million years. During this time, ocean barriers protected its plant and animal inhabitants from invasion by foreign species. The isolation was not total. Dingoes are thought to have been introduced around 4000 years ago. But most feral animals and plants causing environmental concern were introduced after European settlement began two centuries ago.

The inappropriate introduction of plants and animals to Australia has been a major factor in the loss of certain species in this country. Since the arrival of Europeans there has been a sharp increase in the rate of species reduction and extinction. Introduced rabbits, goats, pigs, rats, horses, bees, foxes, cats, dogs, buffalo, camels, cane toads and carp have become wild in Australia. This has changed competitive relationships between animals to the detriment of the native species. Introduced plants have the dual effect of displacing native plants and removing the natural habitats which are food and shelter for native species. Introduced plant and animal diseases place native species further at risk.

1. INTRODUCTION AND BACKGROUND

1.1 Introduction

Australia has natural ocean barriers which have largely prevented invasion by foreign plant and animal species since the continent was formed. Occasional introductions (eg, dingoes) have occurred, probably through trading contacts. But large numbers of non-native animals and plants have been introduced since the start of European settlement two centuries ago. Of these, many species have become established in the wild and have caused significant environmental damage. These are termed `feral' - domestic introductions and their descendants that have become wild. The ongoing costs of control measures and lost agricultural production are enormous.

At least twenty-five exotic mammalian species have become established since they were introduced either deliberately or accidentally. Many are major pests, especially rabbits, foxes, feral horses, cats, pigs and goats. "Australia has more non-native animals than any other country, and they are breeding in the millions. Introducing them was easy - getting rid of them is nigh impossible"[1]. Successful feral animal colonisation is at the expense of the indigenous flora and fauna. Each feral animal and plant species alters the landscape in some manner.

It is estimated that about half of the 1900 plant species introduced since white settlement are now regarded as weeds. They include 220 which have been proclaimed noxious weeds[2]. About 50% of the noxious weeds were deliberate introductions. In fact the number of naturalised exotic species in eastern Australia has increased at a rate of fifty-eight species every decade for the last 150 years[3].

Invasion by introduced animals and plants is becoming an increasingly significant form of land degradation. Introduced plants have the dual effect of displacing native plants and removing the natural habitats which are food and shelter for native animals. Both aquatic and land habitats may be rendered inaccessible through the mass of exotic vegetation. Fish become trapped in the root systems, and even feral pigs are unable to push their way through the dense thickets[4]. It is estimated that woody weeds alone (eg exotics like boxthorn, mesquite and prickly acacia, and natives such as budda, punty bush

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[1] David Porter, `The Feral Peril', *Good Weekend*, 30 January 1988, pp.12-16.

[2] Trevor Johnston, `Weed Invasion: A $3 Billion Dilemma,' *Australian Farm Journal*, vol.2 no.12, February 1993, p.12-14.

[3] S. McIntyre, `Invasion of a Nation: Our Role in the Management of Exotic Plants in Australia', *Australian Biologist* vol.3 no.2, May 1990, pp.65-74.

[4] Dennis Schulz, `The Bad Seed', *The Bulletin*, vol.114 no.5819, 12 May 1992, p.47.

and turpentine) infest some 500 000 square kilometres of western Queensland and New South Wales and significantly contribute to land degradation and loss of productivity, especially in the sheep lands[5].

Feral animals contribute to land degradation by overgrazing, which leads to erosion, or by trampling the banks of streams and waterholes or creating wallows. Diseases carried by introduced plants and animals may also be passed on to native species.

This continent has 20 000 plant species, 18 000 of which are unique to Australia. There are 850 species of birds, 600 unique to Australia; 700 species of reptiles, with 600 unique species. Also, Australia has half the world's marsupials, two of only three egg laying species of mammals and altogether 276 unique land mammals[6].

"Through destruction of habitat and introduced predators we have wiped out a large section of Australia's fauna: 63 species of mammals, 36 species of birds, 20 reptiles, 13 species of fish and 9 species of frogs are extinct, endangered or vulnerable"[7]. Among those affected are bettongs (rat-kangaroos), numbats (banded anteaters) and bilbies (bandicoots). Australia accounts for two-thirds of the world's extinct mammals[8].

The inappropriate introduction of plants and animals to Australia has been a major factor in the loss of certain species. Since the arrival of Europeans there has been a sharp increase in the rate of species reduction and extinction[9]. Introduced rabbits, goats, pigs, rats, horses, bees, foxes, cats, dogs, buffalo, camels, cane toads and carp have become wild in Australia. This has changed competitive relationships between animals to the detriment of the native species.

Although only 2% of native plant extinctions are thought to have been caused by competition from exotic plants, around fifty native plant species, or 27% of those considered threatened, are regarded as endangered owing to competition from introduced weeds[10] [11].

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[5] Johnston, p.13.

[6] Chris Gallus, Speech to the Young Liberal Conference on Environmental Issues, Sydney, 5 January 1994, *Significant Speeches*, 1 March 1994, pp.19-21.

[7] Gallus, p.19.

[8] Anthony Hoy, `Outfoxing the Predators', *The Australian*, 17 May 1989, p.11.

[9] Greg Barns and Kate Brown, *Biodiversity: A Survey of the Law*, Occasional Paper No.B18, December 1992, Tasman Institute, Melbourne, p.16.

[10] P. Harris, `Environmental Impact of Weed-control Insects,' *Bioscience*, vol.38 No.8, September 1988, p.543.

[11] J. Leigh, R Boden and J. Briggs, *Extinct and Endangered Plants of Australia*, Macmillan, 1984, p.47.

A fuller picture of the uniqueness and vulnerability of Australian flora and fauna is given in Table 1.1.

Table 1.1 Key Features of Australia's Flora and Fauna

- 20 000 species of higher plants of which more than 90 percent occur naturally only in Australia;
- 850 species of birds of which 70 percent occur naturally only in Australia;
- 146 (52 percent) of the world's 280 marsupials, two of the world's three monotremes;
- 276 native land mammals, some 6 percent of the world's total, plus those that have been introduced in recent times;
- 700 species of reptiles of which 88 percent occur nowhere else; the reptile fauna of Australian deserts is the richest in the world;
- 54 000 known species of insects with at least as many still to be identified; many other invertebrates poorly known;
- 94 percent of our frog species occur nowhere else;
- 3600 species of fish and tens of thousands of species of molluscs; the flora and fauna of Australian coastal waters is one of the most diverse in the world;
- In the last 200 years, about 100 species of higher plants have become extinct;
- at least 209 higher plant species are endangered with a further 784 being vulnerable. This compares unfavourably with only 27 extinct species in Europe and 74 in the USA;
- about 20 species of mammals have been lost, most in the past 40-50 years; 38 species of mammals endangered or vulnerable;
- one mainland bird - the Paradise Parrot extinct; five birds from Norfolk Island, the Kangaroo Island, Emu and the King Island Emu extinct; 15 bird species endangered or vulnerable; and
- 88 species of invertebrates extinct.

Source: CSIRO and ANPWS, *Australasian Science*, Winter Issue, 1994, p.35.

1.2 Historical Context

The problem of feral animals and plants is linked to the cultural history of Australia over the past 200 years. Many intentional and well meaning animal introductions were the work of Acclimatisation Societies. Between 1850 and 1880 every State formed an Acclimatisation Society for the "introduction, acclimatisation and domestication of all innoxious animals, birds, insects and

vegetables whether useful or ornamental"[12]. The aim was to spread "over the length and breadth of the land inestimable acquisitions to the wealth and comfort of the people"[13]. European plants were deliberately introduced, as were many animals for food and sport. The possibility of developing export markets was one motivation. In other instances, European birds were introduced for purely aesthetic reasons. These included songbirds such as blackbirds, sparrows, starlings, skylarks and gold finches. The common factor is they were all introduced without full consideration for the long term impact on the indigenous ecosystem.

By 1870 complaints were occurring. Starlings and sparrows were preferring fruit and vegetables to the caterpillars and aphids they were supposed to be eating. Hares were ringbarking fruit trees. When the damage caused by rabbits was realised, foxes and cats were released in an attempt to control them. Invariably, attempts at control were either too late or merely added a greater problem.

Many other introductions were unintentional, but no less damaging. Among these were blowflies which arrived with sheep, rats and mice which escaped from ships, and horses, goats, donkeys, camels and pigs which escaped from domestic herds. Prickly pear escaped from gardens. Bathurst Burr was probably introduced to Australia in the tails of horses imported from Chile in the 1840's.

Mesquite species are native to North and South America. These were introduced to Australia as ornamentals in station homesteads or town gardens, and used in mine dumps and other soil stabilisation programs. Over time, mesquite spread along waterways and floodplains, along roadsides, and in horse-paddocks near homesteads.

Today, acclimatisation of exotic species would be seen as irresponsible and bizarre, inconsistent with current attitudes on the environment. Once introduced animals were seen as a valuable reminder of "home". Now they are seen as having no place in Australia's natural landscapes and are targeted for removal.

However the problem is massive. If a census of Australia's feral inhabitants was taken today, they would outnumber people[14]. Asked how many feral animals there are, Doug Grant, of Queensland's Rural Lands Protection Board, answers: "How long is a piece of string?". Another authority says, "It would be easier to count the number of trees because at least they stand still."[15] It is estimated introduced species constitute approximately 10% of Australia's

[12] E.C. Rolls, *They All Ran Wild*, Angus & Robertson, Sydney, 1969, p.215.

[13] Rolls, p.217.

[14] Porter, p.15.

[15] Porter, p.15.

terrestrial mammal species[16].

1.3 Principles of Pest Management and Control

The ideal solution to a problem caused by an introduced pest is to eradicate the pest. Unfortunately this is rarely if ever possible, except on a local scale and at a high cost. The pest species that have become prominent have usually either spread over a broad area or are causing extensive damage, or both. The primary requirement for eradication is that the pest must be killed at a rate faster than replacement rate at all densities[17]. As the density declines, locating and removing the last individuals becomes progressively harder. In the case of weeds, surveillance and control must continue until the seed depository in the soil is exhausted.

There are several other significant requirements for successful eradication:

- a zero re-establishment rate from adjacent areas,
- the availability of a control technique to which all individuals are vulnerable,
- adequate monitoring, and
- a suitable socio-political environment - that is, no major objections from animal welfare groups or those with economic or sporting interests in the animal or plant concerned[18].

There have been several missed opportunities. Small patches of both giant sensitive plant and nodding thistle were either ignored or underestimated when they were first observed[19]. There have also been successes, such as the eradication of rabbits from Phillip Island and of all feral species from various fenced reserves. But these examples illustrate that eradication of pests is only likely to be practical on small islands or in areas that can be fenced or isolated in other ways. Further, there is always the possibility that another pest will quickly take the place of the one removed, or that the removal of one component of a predation relationship (eg, rabbit and fox) will have harmful consequences for native fauna and flora.

Management and control of pests then becomes a matter of assessing the risks of damage and the costs and benefits of control measures. While the principles apply generally, assessments must be made for individual pests because they depend on the behaviour and biology of each species, and on management practices which may vary between properties, or between public and private

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[16] Peter O'Brien, `Managing Australian Wildlife', *Search*, vol.21 no.1, 1 January 1990, pp.24-27.

[17] Mike Braysher, *Managing Vertebrate Pests: Principles and Strategies*, Bureau of Resource Sciences, Canberra, AGPS, 1993.

[18] Braysher, p.31.

[19] Department of Primary Industries and Energy, *Towards a National Weeds Strategy*, Canberra, November 1992, p.10.

lands.

If eradication is discounted, the approach to control will be either:

- one-off,
- sustained,
- sporadic, or
- none;

and the method will be one or more of:

- mechanical,
- chemical,
- biological,
- suppression of reproduction, or
- commercial exploitation.

The release of a predator or parasite is a typical example of a one-off control technique. If the organism is virulent and persistent, control may be dramatically successful, as was the case initially with myxomatosis. More typically, a balance develops between pest and predator or resistance develops to a parasite or disease.

Mechanical techniques such as trapping, shooting, cultivation and fire have the limitations discussed above for eradication techniques. They may be successful over limited areas but must either be sustained or be applied in conjunction with some means of preventing recolonisation. Similarly, chemical control such as baiting and herbicide application may have short-term relevance but will generally have to be sustained, and is too expensive to be applied on a sufficiently broad scale to be a long-term solution. Chemical usage has other limitations such as environmental contamination, human health risks, and development of resistance in the target species.

Many animal pests are hunted for commercial or recreational purposes, with financial benefits to rural communities and to the nation through export earnings. These industries may play an important role in the management of pest populations, but in order to sustain their operations, sufficient numbers of animals must always be left to provide breeding stock for future years.

These approaches to control will be discussed in detail for plants in Chapter 2 and animals in Chapter 3, with examples provided of some of the most serious pests in each category. The best approach for each pest will almost always involve detailed analysis of options, costs, and benefits, multiple control methods, and, ideally, national coordination. The rationale for and progress towards a national approach is discussed in Chapter 4, along with details of legislation in each jurisdiction. Where common names for plant and animal species are available, they are used in the text in preference to scientific (latin) names. A full list of scientific names of those plants and animals declared in Queensland is provided in Appendices A and B. The scientific names of other species mentioned in the text, if known, are listed in Appendix C.

2. FERAL PLANTS - PROBLEMS AND CONTROLS

2.1 Introduction and Definitions

Defining a weed can be a complicated process, but in simple terms it is a plant growing in the wrong place. The Macquarie Dictionary says "a plant growing wild, especially in cultivated ground to the exclusion or injury of the desired crop, or any useless, troublesome or noxious plant, especially one that grows profusely". The Draft National Weeds Strategy defines a weed as "any plant that is objectionable or interferes with the activities of man"[20].

The Macquarie Dictionary defines `noxious' as "harmful or injurious", or "declared harmful by statute law for compulsory eradication". The definition of noxious weeds varies between States, and weeds that are proclaimed noxious in one State may be sold in an adjoining State[21]. Basically a noxious weed, which may be called a `noxious plant', a `pest plant' or a `declared plant', is one that is considered a serious enough pest to warrant the enactment of legislation to enforce its control.

Weeds may be categorised in several ways[22], for example by:

- lifespan - annual, biennial or perennial
- method of reproduction - seed, runner, rhizome, sucker, tuber or bulb
- method of distribution - physical agents (water, wind), birds and animals, or people
- origin - garden escape, accidental introduction (in seed), agricultural plant, or native plant
- botanical feature - woody or herbaceous
- habitat - water or upland
- impact - agricultural, environmental or social

Together they are estimated to cost Australia around $3 billion a year[23].
The impact of weeds on agriculture is primarily through the costs associated

[20] Department of Primary Industries and Energy, *Towards a National Weeds Strategy*, DPIE, Canberra, 1992, p.9.

[21] Tim Woodburn, `Biological Control of Weeds', *Australian Rural Science*, Annual 1990/91, p.53.

[22] J.N. Whittet, *Weeds*, NSW Government Printer, 1968.

[23] Trevor Johnston, `Weed Invasion: A $3 Billion Dilemma', *Australian Farm Journal*, vol.2 no.12, February 1993, p.12-14.

with control measures and lost production. For example, parthenium weed and rubber vine alone have been estimated to cost $16.5 million and $10 million respectively in lost agricultural production each year in Queensland[24]. Annual ragweed, on the other hand, has a major social impact, especially in south-east Queensland, where its pollen is a major cause of hay fever. A good example of weeds whose main effects are environmental are thunbergia vine and bitou bush. The former is very destructive on rainforest margins and the latter smothers and replaces native coastal dune vegetation, particularly in foreshore areas[25].

The distinction between water and land weeds is not absolute, as some like the giant sensitive plant and some of the grasses are happy in either environment. Water weeds may be described as plants which interfere with the use of water by humans, increase the damage caused by flood, or increase the incidence of disease. They exist in five basic forms :-

1) free floating (water hyacinth)
2) bottom rooted but with floating leaves (water lilies)
3) suspended (algae)
4) emergent with leaves held above the water surface (reeds, rushes)
5) rooted and completely submerged (hydrilla, water milfoils).

Some water weeds such as blue-green algae can cause serious stock poisoning and have deleterious effects on water sources used for human consumption. Others, by absorbing nutrients and trapping silt which would otherwise flow through the system, may clog up waterways and turn open water into swamp[26].

Not all water weeds are necessarily bad, however, and some filter out undesirable nutrients and stabilise banks. Sewage treatment ponds at Mount Isa and Maroochydore, for example, use salvinia weed to absorb undesirable material.[27]

2.2 Problems Caused by Feral Plants

2.2.1 Health Problems

More than 900 plants have been identified as poisonous, many of them are capable of poisoning animals. The Rhus tree causes skin disorders in most people who come in contact with it, while parthenium weed causes dermatitis in both humans and animals. Other weeds such as ragweed, capeweed,

[24] Queensland Department of Lands, *Rural Lands Protection Act Reform in Queensland*, Discussion Paper, Brisbane, February 1994, p.5.

[25] Queensland Department of Lands, p.5.

[26] P.M. Room, `Water Weeds Biological Control', *Water Talk*, April 1988, p.2.

[27] Room, p.2.

Paterson's Curse, ryegrass and pellitory are associated with asthma, hayfever and other allergies. Annual ragweed, which is prevalent in the highly populated areas of south-east Queensland, contains an allergen which is a major cause of hay fever The seeds of the castor oil plant and the leaves of oleander are poisonous when eaten.

At least 150 of the above plants are capable of poisoning animals. They may be either native or introduced, and include grasses, shrubs, trees, fungus, ferns, or algae. Poisoning of livestock by toxic plants cost the industry millions of dollars each year. Fireweed poisons many cattle along Australia's east coast, *Pimelea* poisoning costs the Queensland beef industry $10 million each year, and a native plant, Georgina gidgea, kills thousands more[28].

2.2.2 Agriculture

Weeds cause losses to our agricultural industries in various ways. They limit crop and pasture growth, poison stock, make land inaccessible, contaminate products such as grains and wool, and impose direct costs of control techniques.

The following figures illustrate the various ways that woody weeds cost the wool industry in Australia:[29]

Table 2.1 Effects of Woody Weeds on the Australian Wool Industry

Woody weed infestation	Lambing percentage	Flock mortality (percentage)	Adult wool cut (kg per sheep)	Mustering time (hrs per 1000 ha)
Nil	75%	5%	5.5	3.75
Minor	72%	5.5%	5.3	4.25
Moderate	61%	7%	4.8	4.75
Severe	45%	10%	4.0	6.0

African Boxthorn can be an aggressive invader of pastures, roadsides and reserves forming impenetrable, sharp-spined thickets which reduce the movements of stock. Large thickets thus reduce the useability of pasture land and provide an excellent haven for rabbits. Seed is dispersed when the fruit is ingested by birds and animals which subsequently excrete the viable seed.

Bathurst Burr has a major impact on the wool industry in Eastern Australia.

[28] Johnston, p.12.

[29] Wayne Ralph, `Fire For Woody Weed Control', *Rural Research,* no.150, Autumn 1991, p.15.

The burrs tangle readily in wool and are costly to remove, significantly reducing returns to wool growers. It can also be a problem in summer crops particularly in irrigated situations.

Mesquite, once a favoured shade tree around homesteads, forms dense impenetrable thickets. Many infestations are along waterways, both natural and manmade. Even in rangeland it is an aggressive competitor. Mesquite thickets can shade out other vegetation, interfere with mustering and block access to watering places. The sharp spines can injure animals and puncture vehicle tyres. Mesquite is a hard plant to kill. Seeds can lay dormant for years, and mesquite seedlings can therefore reappear in areas that had been previously cleared.

Parthenium weed infests about 170 000 square kilometres of central Queensland. It is a vigorous species which colonises weak pastures with low ground cover. It will readily colonise disturbed, bare areas along roadsides and heavily stocked areas around yards and watering points. Parthenium weed can also colonise brigalow, gidgee and blackwood scrub country. Its presence reduces the reliability of improved pasture establishment and delays its production potential.

Rubber vine infests about 350 000 square kilometres of north Queensland, and has been identified as the single most damaging weed in Australia. Rubber vine is a vigorous climber introduced from Madagascar in the 1870s which produces long, upright unbranched shoots 3-7 m long. It can grow as an unsupported many stemmed shrub 1-2 m high or scramble into the tree, eventually smothering them and other vegetation that it entangles[30].

Rubber vine invades creek and river systems where it forms dense, impenetrable thickets, and then spreads through pastures which results in loss of grazing area, restriction of access to water and mustering difficulties. It is poisonous to stock and, although not very palatable, occasionally causes deaths among cattle at times when other feed is scarce.

Some weeds are considered valuable to some industries. This perceived value can sometimes lead to conflicts of interest as in the case of Paterson's Curse, which was introduced from a nursery in England and has spread throughout much of eastern Australia including most of New South Wales and southern Queensland. It is estimated that Paterson's Curse costs the agricultural industry around $30 million annually, but there was great resistance to its control by beekeepers because of its great benefit to the honey industry[31].

2.3 Methods of Prevention and Control

[30] `Environmental Weeds - a Massive Problem', *Ecos*, no.74, Summer 1992/93, p.6.

[31] Jane Ford, `Beekeepers Stung by Release of Moths', *New Scientist*, vol.119 no.1627, 25 August 1988, p.26.

The prevention and control of Australia's massive and rapidly expanding weed problem calls for the development of integrated approaches involving federal, state and local governments, and the forestry, agricultural, horticultural, and tourism industries. Academia and the general public must also become involved, with task forces required to address problems on an issue-by-issue or species-by-species basis[32].

Australia's plant import legislation is out of date and must be revamped to reflect current awareness of the environmental and economic disasters that can result from random plant introductions[33].

Weeds may be controlled by five main methods - mechanical, chemical, biological, fire, or grazing - or by any combination of the five.

2.3.1 Mechanical

Removal of declared weeds by mechanical means, whereby they are cut down, bulldozed, ploughed in or burnt is at best a temporary solution which requires repeated application. Apart from its use in cultivated crops, it is expensive, time consuming and, in the case of many weed species, actually assists their spread and germination.

2.3.2 Chemical

Chemical control is also very expensive and time consuming and often has to be repeated several times to control the more persistent weed species.

There are several drawbacks in the continual use of herbicides to control declared weeds:

> 1) Chemical control of weeds on uncultivated land is almost always detrimental to the native flora[34].
>
> 2) Although many herbicides [apart from such things as diquat, paraquat, DNOC (nitrated cresol), 2, 4, 5-T, 2, 4-D and arsenical compounds] have relatively low toxicity, some of them can cause irritation, and contact with the skin must be avoided[35].
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> 3) Over time, there is the possibility of soil contamination and seepage of herbicides into the groundwater or watercourses. There have been no instances in Australia of groundwater contamination

[32] `Environmental Weeds - a Massive Problem', p.8.

[33] `Environmental Weeds - a Massive Problem', p.8.

[34] P. Harris, `Environmental Impact of Weed-control Insects', *Bioscience*, vol.38 no.8, September 1988, p.243.

[35] `Pesticides Toxic Effects', *Farm*, vol.10 no.4, April 1989, p.44.

by herbicides, but surface water especially in irrigation areas needs to be monitored as it is subject to contamination[36].

4) The problem of the accumulation of these chemicals in food plants has not yet been fully assessed. There is also widespread public concern about the hazards associated with the use of pesticides especially the possibility of residues in food[37].

5) Over time weeds may develop immunity to certain weedicides resulting in much greater control problems. Continued heavy applications of herbicides opens the possibility of the development of `super weeds' as herbicide resistance in weeds has become a major problem for Australian agriculture which can only be solved by a change in strategy by farmers, scientists, and the agrochemical industry. Several species of important weeds have now developed multiple resistance to a wide range of herbicides that are chemically dissimilar and act in different ways. These include wild oats which cost the Australian wheat industry over $40 million each year, and other common agricultural weeds such as annual ryegrass, barley grass and capeweed[38].

2.3.3 Biological

Biological agents are chosen for their ability to attack selected weeds, leaving crops and other plants unharmed (including plants which may be related to the target weeds)[39].

Australia has a long history of weed biocontrol beginning with the successful control of prickly pear by a moth imported from South America *(Cactoblastis cactorum).* A rust fungus imported by the CSIRO has been very successful in controlling the narrow-leaf form of skeleton weed, a serious pest of the agricultural regions of south east Australia. In Queensland control of salvinia using a weevil (*Cyrtobagous salviniae*) has been very successful.

[36]Department of Primary Industries and Energy, p.41.

[37]Department of Primary Industries and Energy, p.41.

[38]Department of Primary Industries and Energy, p.41.

[39]Gary Strobel, `Biological Control of Weeds', *Scientific American,* vol.265 no.1, 1 July 1991, p.5.

In 1988 New South Wales and Victoria released a moth *(Dialectica scalariella)* to control Paterson's Curse, after the Industries Assistance Commission concluded that the harm caused by this weed exceeded the benefits by a ratio of 10:1[40]. In 1989 a weevil *(Ceutorhynchus larvatus)* was released to help in the fight against this weed, and there are plans to release a flea beetle *(Longitarsus aeneus)* to attack Paterson's Curse in the future[41].

A leaf-eating beetle and a stem-galling moth have been introduced into Queensland and have reduced the size and vigour of annual ragweed. Despite limited biological control, annual ragweed is still a significant problem and other control methods are necessary.

The moth *Epiblema strenuana* (introduced from Mexico) is having limited success in reducing the vigour of parthenium weed infestations. The moth's larvae feed inside the stem forming galls which stunt the plant's growth and reduce seed production and competitiveness. *Epiblema* is established in all parthenium weed areas. Further research into other insects is continuing.

However, insects are not the only biological agents being used in the battle against weeds. They range from goats which effectively control blackberries and various other weeds[42], to fungi. They include weevils, nematodes, mites, viruses and bacteria. A rust has been released for parthenium but it is to early to evaluate its success due to drought conditions.

Mycoherbicides should soon take position on the front line of the agricultural weeds war. They are developed by finding natural diseases for major crop weeds, "taming" them in the laboratory, and breeding them up to spray (in much the same way as traditional chemicals) on weeds[43].

When a weed has been targeted for biocontrol, field trials are conducted in the weed's native habitat to establish what are its natural enemies, and which ones are specific to the particular weed. Upon importation to Australia, the agent must undergo at least one generation in quarantine to ensure it is free of its own natural enemies so that it can increase rapidly upon release[44].

Currently there are over forty biocontrol programs operating in Australia including:-[45]

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[40] Robert Lehane, `Biological Control of Paterson's Curse: Prospects Look Good', *Rural Research*, no.151, Winter 1991, p.8.

[41] Lehane, p.10.

[42] `Goats Effective in Weed Control', *New South Wales Farmer and Grazier*, September 1990, pp.2-3.

[43] Andrew Cooke, `Sex, Flies and Sticky Tape', *Australian Rural Times*, no.32, May 31-June 6 1990, p.17.

[44] Woodburn, p.53.

[45] Woodburn, p.53.

- Giant sensitive tree
- Skeleton weed
- Water hyacinth
- Paterson's Curse
- Blackberry
- Bitou bush
- St John's wort
- Common heliotrope

Biological approaches may not replace the use of chemical herbicides entirely, but they should greatly limit their use. They may also make it possible to control the weeds that cannot be managed by standard herbicides.

2.3.4 Fire

For thousands of years, regular burning by Aborigines suppressed woody shrubs and favoured native grasses upon which kangaroos, their main prey, grazed. When European settlers arrived, they suppressed outbreaks of fire, which eventually resulted in the current woody weeds problem.

The CSIRO has collaborated with various State Departments to examine the effects of fire as a control measure for woody shrubs on Australia's rangelands[46].

Fire may be the only economically realistic option for much of the degraded pasture lands, and has the attraction of being relatively cheap (estimated at around 50 cents per hectare). The added benefits of potentially increased financial returns from the re-establishment of native grasses once the woody shrubs have been thinned out makes burning off a reasonably attractive proposition. However, it is essential to try to time a major burn-off while woody shrubs are still young and when there is a high fuel load. This will ensure maximum mortality especially among intractable species like turpentine bush and budda which have a tendency to resprout rapidly after fire[47].

2.3.5 Grazing

Goats are being used more and more for weed control in Australia as they have proved to be very effective in helping to control thickets of vines and woody shrubs in other parts of the world such as the United States and Africa[48].

Goats tend to eat a wider range of vegetation than sheep which, like cattle, avoid thickets. The constant pruning by goats encourages the growth of

[46] Ralph, p.13.

[47] Ralph, p.14.

[48] John Pearce, `Using Goats to Control Weeds', *W.A. Journal of Agriculture*, vol.32 no.3, 1991, p.83.

grasses, thus making more feed available for sheep and cattle[49]. They are particularly fond of blackberries and thistle flower heads and control them very effectively[50]. In New Zealand where gorse is a major problem, they are used to graze the seedlings which promotes an increase in grasses and clovers[51].

The advantages and disadvantages of using goats to control noxious weeds are summarised in Table 2.2[52], and a list of weed species preferred by goats appears in Table 2.3.

Table 2.2 Advantages and disadvantages of weed control by goats.

ADVANTAGES	DISADVANTAGES
• Most weeds have a staggered or delayed germination so grazing by goats can provide continuous control. Some of the weeds goats prefer to eat are listed in the table. • Goats prefer not to eat clovers. While other weed species are being grazed the clovers can build up to provide feed for sheep and cattle. • Goats can be used to graze over difficult terrain where vehicular or boomspray access is impossible or limited. Fencing must be adequate.	• Goats would graze the least palatable species last, and so their impact on other palatable vegetation would be severe. • Very high stocking rates would be needed to remove undesirable species quickly with grazing. This would cause problems with animal production, and would require more expensive good quality fencing to retain the stock. • The problem species of vegetation are not evenly distributed over an entire paddock, but usually in pockets, which would require additional fencing.

Table 2.3 Weed species preferred by goats

[49] Pearce, p.83.

[50] `Goats Effective in Weed Control', pp.2-3.

[51] Pearce, p.84.

[52] Pearce, p.87.

Annual ryegrass*	Barley grass*	Blackberry
Brome grasses	Dock	Doublegees
Horehound	Native sarsparilla	Paddy & Afghan melons
Paterson's curse**	Saffron thistle**	Skeleton weed**
Storksbill**	Wild mustard**	Wild turnip*
Variegated thistle	Yellow-Burr weed	

* Highly palatable
** Mainly at flowering

2.4 Information on Specific Feral Plants

Information on ten of the most serious weeds in Queensland is presented in Table 2.4. For each weed, a map indicates its distribution in Queensland. A list of declared plants in Queensland is presented in Appendix A.

Table 2.4 is presented on the following ten pages.

AFRICAN BOXTHORN

African Boxthorn is a perennial shrub up to 2.5 metres in height with a deep and extensive root system. The main branches are drooped, widely-spreading and carry divergent branches. The flowers are white to pale mauve and occur singly or in pairs in the forks of leaves on the short shoots. Smooth green berries ripen to a bright orange to red colour and contain numerous light-brown, oval, flattened seeds.

The plant can be an aggressive invader of pastures, roadsides and reserves forming impenetrable, sharp-spined thickets which reduce the movements of stock. Large thickets thus reduce the useability of pasture land and provide an excellent haven for rabbits. Seed is dispersed when the fruit is eaten by birds and animals and subsequently excreted.

Seeds may germinate at any time of the year and an extensive root system can be developed in the first few months of growth. Plants are at least two years old when they first bear flowers and although this generally occurs in summer, some flowering and fruiting may occur at all times of the year, depending on the type of season.

African Boxthorn is a native of Southern Africa, occurring mainly in south-eastern Queensland but has been recorded from as far afield as Hughenden and Charleville. It is an aggressive weed on some of the better soils of the Maranoa and Darling Downs districts.

Large stands can be cleared by bulldozing, or blade-ploughing but treatment of regrowth by herbicide is essential. Cultivation is effective in dealing with seedlings. Herbicides may be applied by foliar spray, if plants are actively growing, or to the base of the trunk, or by root application (to the soil, preferably when the soil is wet or rain is expected).

Source: Queensland Rural Lands Protection Board, *African Boxthorn and its Control*, Pestfact No. P008/89A, July 1989.

ANNUAL RAGWEED

Annual Ragweed is an erect annual plant, one to two metres high with slightly rough fern-like leaves. Flowers are small and greenish, but flower spikes appear yellow when mature because of pollen production. The seeds are black, small, top-shaped and rough.

Annual ragweed is a fast-growing, introduced plant which can invade and suppress poorly managed pastures. It often colonises bare areas on roadsides and banks of watercourses, and may invade pasture from these areas. Infestations can become particularly dense in overgrazed pastures. It is potentially a serious human health hazard as its pollen contains highly potent allergens which cause respiratory allergies such as hay fever and can aggravate asthma.

Plants normally germinate from spring through to summer but can germinate at other times of the year if conditions are suitable. Flowering usually occurs around mid-late March, after which plants die. Late-germinating plants, however, may over-winter and survive until the following autumn.

Annual ragweed is a native of eastern North America and is now naturalised in south-eastern Queensland and northern New South Wales. Infestations also occur near Stanthorpe, Inglewood, Gympie, Gin Gin and Atherton.

The main prevention is to maintain thick, healthy pastures in order to suppress ragweed germination and growth. Plants may be slashed or mown prior to them setting seed (ie, at the early flowering stage or immediately prior to flowering). Herbicide control of young plants is possible. A leaf-eating beetle and a stem-galling moth have been introduced into Queensland and have reduced the size and vigour of annual ragweed. Despite limited biological control, annual ragweed is still a significant problem and other control methods are necessary.

Source: Queensland Rural Lands Protection Board, *Annual Ragweed*, Pestfact No. P007/93E/993P.

BATHURST BURR

Bathurst Burr is a robust annual plant with a branching stem. It is usually 30-60cm tall but may reach a height of 1m. Flowering begins in January and continues through Autumn. Burrs are formed as the plant matures. One of the two seeds in each burr normally germinates in the following Spring. The second seed usually does not germinate for two or three years and some seeds may remain dormant for up to eight years.

Bathurst Burr has a major impact on the wool industry in Eastern Australia. The burrs tangle readily in wool and are costly to remove, significantly reducing returns to wool growers. It can also be a problem in summer crops particularly in irrigated situations. It is claimed to be poisonous to stock but is usually avoided because of its sharp spines. It is spread mainly by its hooked burrs which cling firmly to the wool, fur, tails and manes of animals and to bags, wool packs and clothing. It may also be spread through the sale of fodder.

Bathurst Burr is a native of South America but is now widespread through the world. It was probably introduced to Australia in the tails of horses imported from Chile in the 1840's. The plant will grow on most soil types and heavy infestations occur where the ground has been disturbed, eg. roadsides, headlands, fallow cultivation, firebreaks and around stockyards.

Like many of the robust weeds, Bathurst Burr should be treated early in its growth cycle to achieve good control. Older plants are more difficult to kill and once the plants have flowered and set mature burrs, treatment with herbicides will not prevent more seed being added to soil seed reserves.

Bathurst Burr can readily be controlled on arable land by cultivation. Hand pulling and chipping are also effective but are practical only in small and isolated situations. A range of herbicides is available to treat Bathurst Burr in pastures, in non-crop areas, on non-agricultural land and along roadsides. No successful biocontrol agents have ever been located. However, authorities in New South Wales are carrying out research into a myco-herbicide, a herbicide whose active agent is a plant pathogen, for use on Bathurst Burr.

Source: Queensland Rural Lands Protection Board, *Bathurst Burr and its Control*, Pestfact, (unnumbered), January 1989.

CHINEE APPLE

Chinee apple (or Indian jujube) is a large shrub or small spreading tree up to 8 metres high and 10m in diameter. It is densely branched, and forms thorny thickets. Flowers are small and inconspicuous, greenish-white, and emit an unpleasant smell. The edible fruits are similar in size and structure to a cherry, but pale yellow or orange when ripe.

Dense infestations create impenetrable thickets which seriously hamper stock management and reduce pasture production and accessibility. Mature trees produce large quantities of fruit which are readily eaten by birds and stock, assisting the spread of the seed.

Chinee apple is native to Southern Asia and Eastern Africa. It was first recorded from the Torres Straits in 1863 and from Townsville in 1916.

The species is widespread in North Queensland, mainly in the areas surrounding towns associated with mining early this century. The largest areas of dense Chinee apple are around Charters Towers, Mingela and Ravenswood, but the plant also occurs around many of the towns in the drier parts of North Queensland.

Effective control of Chinee apple can be achieved by a combination of mechanical and herbicide controls or by herbicide controls alone.

Source: Queensland Rural Lands Protection Board, *Chinee Apple and its Control*, Pestfact, (unnumbered), 1992.

FIREWEED

Fireweed is an annual or short-lived perennial, daisy-like bush. In harsh conditions it will be short and sparse, but in good conditions will grow to 50cm with multiple branches. The flowers are bright yellow, daisy-like, and produce up to 100 seeds each. Most seedlings appear between March and June then grow quickly to produce their first flowers in 6 - 10 weeks.

Fireweed can dominate pasture and is toxic, particularly to cattle and horses. Heavy infestations of fireweed result from either lack of good ground cover from overgrazing or drought, or poorly timed cultivation for pasture improvement. Unless fireweed poisoning is severe it can be difficult to detect because the symptoms - reduced weight gain and/or low milk production - could have a variety of causes. Sheep and goats are less susceptible to fireweed poisoning and can graze in fireweed infested paddocks for at least one season.

Fireweed is native to Madagascar and southern Africa and was first recorded in Australia in the Hunter Valley in 1918. It is not known how it was introduced but it could have been brought in privately as a garden plant. It spread slowly at first but in the last 30 years it has rapidly increased its range, most likely aided by modern transport and rural practices.

Fireweed is currently established in beef and dairy pastures along the entire New South Wales coast and north to Brisbane. Fireweed is spreading northward and has the potential to infest the valuable pastures north of Brisbane. Substantial infestations have been found near Caboolture and single plants as far north as Gympie. Climate and land use models indicate that fireweed could be a serious pest as far north as Rockhampton. Seeds are light and are carried by the wind.

An integrated control program involving careful control of stocking levels, fertiliser application, pasture upgrading and well timed herbicide application is the best approach to fireweed control. The first step is to prevent it establishing by ensuring that there is a dense cover of pasture in autumn and winter. Isolated plants should be pulled up, bagged and burnt. The effectiveness of slashing is doubtful as it may lead to increased stock poisoning. A number of organisms can be found attacking fireweed but their effect is temporary and isolated. An orange rust is common and affects fireweed in lower country. The blue stem borer moth is also common but the larvae usually develop too slowly to have an impact.

Source: Queensland Rural Lands Protection Board, *Fireweed*, Pestfact.

MESQUITE

The various mesquite species are also known as algaroba, Cloncurry prickle bush, or Quilpie algaroba. These thorny trees grow to 15m, usually with a main single stem and spreading canopy.

Mesquite, once a favoured shade tree around homesteads, has spread significantly in Queensland and unless checked, will continue. Although sparse stands of mesquite trees may provide shade and some fodder for stock, dense impenetrable thickets of mesquite can often form. Many infestations are along waterways, both natural and manmade. Even in rangeland it is an aggressive competitor. Mesquite thickets can shade out other vegetation, interfere with mustering and block access to watering places. The sharp spines can injure animals and puncture vehicle tyres. Mesquite is a hard plant to kill. Seeds can lay dormant for years, and mesquite seedlings can therefore reappear in areas that had been previously cleared.

Mesquite species are native to North and South America. These were introduced to Australia as ornamentals in station homesteads or town gardens, and used in mine dumps and other soil stabilisation programs. Over time, mesquite has spread along waterways and floodplains, along roadsides, and in horse-paddocks near homesteads. Seeds are spread by floodwaters and also in the dung of horses and cattle.

Mesquite may be grubbed out using grubber attachments on dozers and tractors. Best results are achieved when soil moisture is sufficient to allow machinery to work with minimum strain, but soil is dry enough so the root system desiccates (late autumn/winter for a normal wet season).

Fire has been effective against one species of mesquite (*Prosopis limensis*) in and around Hughenden, when there is sufficient fuel for the fire. The problem is that there is seldom sufficient grass and debris to fuel a fire where mesquite is a problem.

Source: Queensland Rural Lands Protection Board, *Mesquite*, Pestfact.

PARTHENIUM WEED

Parthenium is one of Queensland's most serious weeds and infests about 170 000 sq. km. of central Queensland. Parthenium is an annual herb with a deep tap root and an erect stem which becomes woody with age and may reach a height of 2 metres. Flower heads are creamy white and are borne at the tips of the branches. Seeds are black, 2 mm long with two thin, white spoon shaped appendages.

Parthenium weed is a vigorous species which colonises weak pastures with low ground cover. It will readily colonise disturbed, bare areas along roadsides and heavily stocked areas around yards and watering points. Parthenium weed can also colonise brigalow, gidgee and blackwood scrub country. Its presence reduces the reliability of improved pasture establishment and delays its production potential.

Parthenium weed is also a health problem as it can cause serious allergic reactions such as dermatitis and hay fever.

Parthenium normally germinates in spring and early summer, produces flowers and seed throughout its life and dies around late autumn. However if suitable conditions prevail, parthenium can grow at any time of the year. In summer plants can flower and set seed within 6 weeks of germination even if the plants are stressed and small.

Parthenium is capable of growing in most soil types but prefers alkaline, clay loam soils. Parthenium is a native of sub-tropical South and North America and was initially recorded at Toogoolawah in 1955 followed by a second introduction north of Clermont in 1966. Unfortunately its early establishment was ignored. The plant is now well established in central Queensland and present in isolated infestations west to Longreach and in southern Queensland.

Source: Queensland Rural Lands Protection Board, *Parthenium Weed*, Pestfact No. P002/93E/993P.

PRICKLY ACACIA

Prickly acacia infests about 70 000 square kilometres of north west Queensland. Prickly Acacia is a thorny shrub or small tree growing 4-5m high, occasionally to 10m. The umbrella shape of the tree and pods are characteristic. Pods are 10-15 cm long, flat, and grey.

Prickly acacia is a native of Pakistan. It was introduced into Queensland for shade and fodder early this century. Scattered trees occur all over the state, with widespread infestations in northwest Queensland. Once established along bore drains, trees spread into adjacent pasture. The thorny thickets interfere with mustering, movement of stock and access to water. Trees along bore drains use valuable water, increase maintenance cost of bore drains and provide seed to increase the spread of prickly acacia. Pasture decreases as tree size increases because little grows under the canopy.

A 1975 survey of nine western Queensland shires indicated nearly 30% of these shires were infested with prickly acacia to some degree; 50% of one shire was infested. About 5 million ha have low density infestations, 1¼ million ha medium density, and nearly half a million ha are heavily infested.

Herbicide may be applied as foliar (leaf and stem) spray or basal bark spray. The best time for treatment is during autumn when plants are actively growing and soil moisture is good. Cut stumps may be swabbed with a herbicide mixture.

Prickly acacia is readily attacked by certain native insects associated with Australian native acacias and other native plants. Generally, leaf-feeding, sap-sucking, root, pod and seed feeding insects attack actively growing prickly acacia. Bark and wood-feeding insects attack stressed and dying plants.

The native seed-feeding beetle *Caryedon serratus* attacks seeds of prickly acacia and other woody weeds including honey mesquite, Parkinsonia and mimosa bush. The seed-feeding beetle *Bruchidius sahibergi* is well established. The level of control exerted by *Bruchidius* can vary from 0% to 80% and depends on the availability of mature seed pods. However, the impact of this beetle on seed production is minimal. Up to 70kg of pods or 300 000 seeds per tree along bore drains have been recorded.

Source: Queensland Rural Lands Protection Board, *Prickly Acacia*, Pestfact No. POO9/93E/793P.

TOBACCO WEED

Tobacco weed is a perennial broad-leaved plant, generally 30 to 120cm high and somewhat woody at the base. Its stem is more or less erect, sparsely branched and covered with white hairs which may cause skin irritation when brushed against.

The small white flowers are clustered in heads at the tips of the stems and side shoots. After flowering, a large number of 3mm long greyish-black seeds are released, each with bristle-like hairs on the top.

Tobacco weed is not palatable to cattle and can suppress useful pasture species in a few years. Control is difficult because the plant is a prolific seeder and seed banks develop in the soil. Sprays must be repeated a number of times to exhaust soil borne seeds.

Seeds probably germinate any time of the year, given sufficient moisture. Flowering also may occur all year. In other tropical regions flowering is reduced or stopped by prolonged dry spells. Germination to reproduction time and the time ungerminated seeds remain viable is not known.

A native of the tropical Americas, tobacco weed has spread to many other tropical regions. In Queensland it is found in the Millaa Millaa area on the southern Atherton Tableland and at Sarina, near Mackay.

A closely related species (*Elephantopus scaber*) is found from the northern Tableland to Cape York. Flowers are usually blue and stem leaves are either absent or few and much reduced in size. Currently it is not considered as great a threat to production as tobacco weed.

Source: Queensland Rural Lands Protection Board, *Tobacco Weed*, Pestfact No. P032/E0194/P0294.

RUBBER VINE

Rubber vine infests about 350 000 sq. km. of north Queensland, and has been identified as the single most damaging weed in Australia. Rubber vine is a vigorous climber introduced from Madagascar in the 1870s which produces long, upright unbranched shoots 3-7m long. It can grow as an unsupported many stemmed shrub 1-2m high or scramble into the tree, eventually smothering them and other vegetation that it entangles.

When cut or broken a milky sap oozes from stems, leaves and seed pods. The leaves are dark green, semi-glossy and about 6-10cm by 3-5cm. The flowers are large, showy and funnel-shaped, and range from white to pale purple. The seed pods are 10-12cm long and the abundant seeds are easily dispersed by wind and water. If sufficient moisture is available rubber vine seeds will sprout throughout spring and summer. In ideal conditions it may flower throughout the year, though mid to late summer is the main flowering period.

Rubber vine invades creek and river systems where it forms dense, impenetrable thickets, and then spreads through pastures which results in loss of grazing area, restriction of access to water and mustering difficulties. It is poisonous to stock and, although not very palatable, occasionally causes deaths among cattle at times when other feed is scarce.

Rubber vine seems to have been introduced into North Queensland as an ornamental where it was popular in mining settlements due to its hardiness. By the turn of the century infestations were recorded around Charters Towers. Since then it has spread throughout the river systems of southern Cape York Peninsula and the Gulf of Carpentaria. It has also moved along the coast as far south as the Burnett River, with isolated pockets as far south as Gatton and as far west as the Northern Territory border. Other infestations are common in Central Queensland west to the Great Dividing Range, and around Mt Isa, Longreach, Aramac, Blackall, and Charleville.

Several chemicals are effective for foliar, basal bark or cut stump treatment. Biological controls have not yet been established in Australia, though there are two which may prove effective. The moth *Euclasta whalleyi* whose larvae are leaf-eaters is not yet established in the field, and a rust *Maravalia cryptosteiiae* from Madagascar is undergoing trials in the UK.

Source: Queensland Rural Lands Protection Board, *Rubber Vine*, Pestfact No. P011/93E/793P, 1992.

3. FERAL ANIMALS - PROBLEMS AND CONTROLS

3.1 Introduction

There are good reasons for controlling feral animals. "Feral animal groups pose one of the largest single threats to the whole nation, to the landscape and to the conservation of the more vulnerable Australian native species of flora and fauna."[53] The damage caused by feral animals includes environmental degradation, losses to agricultural industries, and the spread and potential spread of diseases.

3.2 Environmental Degradation

Many feral animals are herbivores that remove vegetation which provides food and cover for native species, resulting in their disappearance. This therefore limits Australia's potential biodiversity. Some of the changes caused by feral animals are more subtle but with the same effect. The removal of vegetation by feral animals means there are fewer fires to control the invasion of scrub. Australia's current flora and fauna have evolved with natural and Aboriginal induced fires. This can have a major effect on reserves established to preserve native plants and animals.

Land degradation can also result from feral animal damage. Soil erosion is a consequence of overgrazing by feral animals, or from direct damage from trampling, rooting and wallowing. The most serious damage is caused by rabbits, goats, horses, donkeys and pigs.

Feral animals cause major losses to agriculture. Farmers incur costs for control programs. They compete with domestic stock for food, damage crops, prey on sheep, and damage fences and water supplies. Estimates of the cost of damage are difficult to obtain. Some of the published figures for the cost of lost agricultural production are $90 million from rabbits[54] and $80 million from pigs[55].

Because feral animals are similar to domestic animals, they are potential carriers of disease. Preventing the entry of economically important diseases such as foot and mouth disease, rabies and swine fever, as well as parasites

[53] Evidence presented by RSPCA Australia at Senate Select Committee on Animal Welfare, *Culling of Large Feral Animals in the Northern Territory*, June 1991, AGPS, Canberra, p.242.

[54] *On the Brink*, Newsletter of the Endangered Species Program, Australian Nature Conservation Agency, December 1993.

[55] Roger Beckmann and Steve Davidson, `The Pig Problem', *Ecos*, no.65, Spring 1990, pp.20-22.

such as screwworm fly is of paramount importance. An outbreak of foot and mouth disease would have an immediate and disastrous impact on the entire Australian economy. The potential of feral animals to act as a reservoir for exotic diseases makes control difficult. The only natural control of feral animals in Australia is drought.

Feral animals also have a major impact on native animals, either through competition for food (rabbits, goats, horses and pigs) or through predation (cats, dogs, foxes and pigs).

Table 3.1 summarises the environmental damage caused by Australia's major feral animals.

Table 3.1 Environmental Degradation by Feral Animals

Types of Degradation	Feral pig	Rabbit	Fox	Cat	Cane Toad	Goat	Dingo	Water Buffalo	horse	Donkey	Cattle	Camel	mouse
Direct Competition with native species	–	–	–	–	–	–	–	–	–	–	–	–	–
Land degradation	–	–				–		–	–	–	–	–	–
Damage native environment	–	–	–	–	–	–	–	–	–	–	–	–	–
Predation	–		–	–	–		–						
Potential disease carriers	–	–	–	–		–	–	–	–	–	–	–	–
Significant economic impact on agriculture	–	–				–	–	–	–	–	–		–
Potential commercial use	–	–			–	–	–	–	–	–	–	–	

3.3 Diseases and Health

Feral animals have the potential to harbour diseases and pass them on to domestic livestock. Pests can also spread diseases that affect people - referred to as zoonoses. The actual level of such diseases currently present in feral animals in Australia is low, but the risk of disease is high, as Australia is free from many exotic animal diseases.

Feral animals are recognised as potential entry points and reservoirs for major exotic diseases. Feral cattle, buffalo and pigs in coastal regions provide potential entry points for such diseases as foot and mouth disease, screw-worm fly and swine fever. Foxes, living in urban areas, could spread the fatal exotic disease rabies to pets and people. Quantifying the likelihood and economic impact of exotic diseases establishing in feral populations is difficult. But the

potential impact has been described as "devastating" on Australia's economy and export trade[56].

An outbreak of foot and mouth disease could cost Australia $9 billion a year[57] in lost exports and between $0.3 and 3.7 billion a year in on-going management costs, depending on whether parts or all of the country were affected[58]. There are also the less tangible aspects of a disease outbreak. Exporters have aggressively marketed Australia's image as a clean producer of agricultural products. One result of disease would be Australia's "Clean Food" image being severely tarnished.

The major diseases of concern that are already present in feral animals are bovine tuberculosis, toxoplasmosis and echinococcosis[59]. Bovine tuberculosis spreads between domestic cattle and feral cattle and buffaloes. Cats are responsible for the transmission of toxoplasmosis and sarcosporidiosis, parasitic protozoans, which are often fatal for marsupials. These diseases effect agricultural productivity through causing abortion in ewes and cysts in muscle tissue, downgrading carcases. They may also cause illness in humans, particularly pregnant women, but have no effects on the cats.

Echinococcosis (hydatids) can infect domestic and feral dogs, dingoes, cattle, sheep, kangaroos and feral pigs. Pigs also spread endemic parasites such as leptospirosis and sparganosis. Cane toads readily eat animal and human faecal material and in areas of poor hygiene, they have been known to transmit diseases such as salmonella[60].

Table 3.2 provides a list of diseases that could potentially be harboured or spread by feral animals.

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[56] Evidence presented by Mr A. Bryce, Northern Territory Department of Primary Industries and Fisheries at the Select Committee on Animal Welfare, *Culling of Large Feral Animals in the Northern Territory*, June 1991, AGPS, Canberra.

[57] Bureau of Resource Sciences, *Strategic Vertebrate Pest Management: A National Approach to Major Pest Animals*, BRS, December 1992.

[58] Steve Davidson, `Foot and Mouth Disease: the Feral Pig Factor', *Rural Research*, no.148, Spring 1990, pp. 20-26.

[59] M.G. Garner and P.H. O'Brien, `Wildlife Disease Status In Australia', *Rev. Sci. Tesc. Off. Int. Epiz.*, vol.7 no.4, 1988, pp.823-841.

[60] Queensland Department of Lands, *The Cane Toad*, Pestfact Information Bulletin A021/91A, 1992.

Table 3.2 Exotic Diseases and Parasites that Feral Animals Could Carry

DISEASE	SPECIES
Foot and mouth disease	ruminants, pigs and other cloven-hoof animals
Vesicular stomatitis	ruminants, pigs, horses, man
Vesicular exanthema	pigs
Swine vesicular disease	pigs
Rinderpest	cattle
Swine fever	pigs
African swine fever	pigs
Rabies	man and other warm-blooded animals
Newcastle disease	birds
Virulent avian influenza	birds
Bluetongue	sheep, cattle
Screwworm fly	many animal species
Anthrax	man and other mammals
Brucellosis	man, cattle, pigs
Vibrionic enteritis	man, birds, cattle, sheep, dogs, cats, rodents
Leptosirosis (Weil's disease)	cattle, pigs, dogs, rats, man
Tuberculosis	mammals, including man
Cowpox	rodents, cats, cattle, man
Murine Typhus	rats, man
Angiostrongyliasis	rats, man
Balantidiasis	pigs, non-human primates and man
Sparganosis	pigs, rabbits, rodents, frogs, snakes, man
Rotaviruses	man, calves, piglets, foals, lambs, monkeys, mice and rabbits.

Sources: Scott-Orr, H. and Mylrea, P.J., *New South Wales Exotic Animal Disease Control Manual*, New South Wales Department of Agriculture, Sydney, 1987; and Stevenson, W. and Hughes, K., *Synopsis of Zoonoses in Australia*, second edition, AGPS, Canberra 1988.

To put the problem into perspective, eradicating all feral animals would not eliminate the risk of exotic disease entry into Australia. The presence of exotic disease in feral animals would however increase the difficulty of detection, control and eradication.

3.4 Methods of Prevention and Control

Most introduced pests are highly mobile and do not have natural predators or diseases that can control their numbers. Therefore, feral animals are controlled in a number of other ways. Harvesting and culling of feral animals is common, particularly for animals which have commercial uses, such as goats, horses and buffaloes. Chemical measures are mainly used for pigs, particularly in difficult terrains. Fertility control is emerging as the control mechanism of the future. It has the potential to be quite specific in its target population and once introduced would involve little continuing control input. But, this mechanism is still in the developmental stages and has a number of problems to overcome before being able to used on a large scale. Diseases have been used to control rabbit populations, but the effectiveness of this method has declined with time. Other control mechanisms, including mechanical measures, permits, bounties and registration, have limited application but are used in certain specific circumstances.

In contrast to the case for controlling feral animals, it has to be noted that not everyone wants to see the feral populations decimated. Sporting shooters, an estimated 100 000, use feral animals as a recreational resource. Feral animals are also utilised commercially, which will be discussed in section 3.5.

3.4.1 Harvesting and Culling

In 1990, the Bureau of Rural Resources estimated Australia could earn $100 million annually from the commercial harvesting of feral animals[61]. Dr George Wilson, assistant director of the Bureau, said potential revenue from feral animals was wasted. He said game meat contains less fat and cholesterol, wild animals are not treated with pesticides, growth promotants or medications, and are disease free in Australia. Wild animal meats which are sought after include the horse, buffalo, donkey and pig. Some exports of feral pig meat are already occurring.

Commercial use of feral animals encourages harvesting methods of control. Some animals are mustered and trapped for domestication. Some feral horses (brumbies) are used as stock horses. Feral goats are often captured for interbreeding with commercial flocks, to improve their genetic base. Most feral animals, however, are mustered, yarded and transported to abattoirs for slaughter, processing and sale. Meat may be used for domestic consumption, export or for pet food. Some goats are exported live for slaughter in the Middle East. Sometimes the feral animal hides are sold. Feral cat pelts were exported in small numbers until 1988, but not since[62], because of reduced demand. Commercial use is viable when animals are abundant and readily accessible. Feral animals utilised in this way include goats, horses, buffalo and pigs.

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[61] `Time to Cash in on Camels, Roos and Cane Toads', *Australian Financial Review*, 13 July 1990, p.35.

[62] Chris Dickman, `Raiders of the Last Ark: Cats in Island Australia', *Australian Natural History*, vol.24 no.5, Winter 1993, pp.44-52.

Commercial use of feral animals is not always possible. For example, the low numbers of animals may make the operation uneconomic, the terrain may be too rough or inaccessible to capture them, or toxins may be present in the animals' tissues[63]. In these circumstances, lethal methods of control are applied. Lethal methods include shooting or poisoning. Shooting can be undertaken from the ground or from helicopters. Department of Primary Industries and Energy information papers recognise ground shooting as the most humane method of culling[64]. The shooting of feral animals from helicopters is a very contentious issue, due to animal welfare considerations. However shooting from helicopters can be quick, effective, and a relatively humane method of controlling large feral animals[65]. Helicopters can approach feral animals closely, facilitating a clearer and more accurate shot than may be possible from the ground. Helicopters also allow a quicker follow-up and kill when animals are wounded.

Most animal welfare and conservation organisations advocate the culling of feral animals. The RSPCA Australia strongly favours the destruction and culling of feral animals. The society gave the following reasons for its view in evidence before the Senate Select Committee on Animal Welfare:

> "Not only is it important to cull feral species from the point of view of preserving uniquely Australian species, it is also important from the point of view of preserving the broader genetic heterogeneity. Another important reason for culling feral animals is to preserve a lifestyle in Australia for the human species".[66]

Most other organisations agreed. However, methods of culling are often criticised. Shooting from helicopters has been perceived by animal welfare and conservation groups as cruel and inhumane, particularly by overseas organisations. The animal welfare organisation, Australians for Animals, took the case against helicopter shooting of feral buffalo and horses to the International Court of Justice for Animal Rights[67].

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[63]The Senate Committee hearing was advised feral horses from central Australia cannot be used for pet meat. A toxin from indigofera plants growing in the area and eaten by feral horses, accumulates in horse meat and is poisonous to dogs. (p.40).

[64]Correspondence to the Senate Select Committee on Animal Welfare, *Culling of Large Feral Animals in the Northern Territory*, by the Department of Primary Industries and Energy, 8 January 1991, p. 9.

[65]Evidence presented at Senate Select Committee on Animal Welfare, *Culling of Large Feral Animals in the Northern Territory* by Northern Territory Government, p.48.

[66]Select Committee on Animal Welfare, *Culling of Large Feral Animals in the Northern Territory*, June 1991, AGPS, Canberra, p.33.

[67]Established in Geneva by Franz Weber, Europe's best known ecologist and conservationist, the self-styled tribunal has drawn international attention to a number of environmental issues. These include the killing of baby seals, bullfights in Spain, elephant slaughter in Africa and the mass killing of migratory birds in Italy. see David Hancock, `Licensed to Kill', *Geo*, vol.11 no.4, December 1989, pp.88-101.

The Federal and Northern Territory Governments were found guilty of "striving to exterminate Australia's native (*sic*) horses and tolerating torture of animals using barbaric killing methods". Problems identified with helicopter shooting include training, accreditation and supervision of shooters, coordination and planning of culling operations, use of inappropriate firearms and ammunition, and wounding of animals. However the Senate Select Committee on Animal Welfare concluded that in rugged and inaccessible terrain, "shooting from helicopters is the only practical method of control ... (and) represents the most humane method of controlling feral animals in inaccessible locations"[68].

3.4.2 Mechanical Control Measures

In the past, mechanical means of control were used widely. This involved the setting of steel-jawed traps. These have now been banned in Australia in response to demands by animal welfare organisation. Cats, pigs, foxes, dingoes and feral dogs are still trapped by more humane methods. However mechanical control has become less common due to the cost of labour and animal welfare issues. As mentioned earlier, some ripping of rabbit warrens does still occur, but it is rare. One important mechanical control measure still widely used in Queensland is the dingo fence. Fencing can be used as an effective control measure for a number of feral animals, including pigs, horses and donkeys. It has been used for defined areas (eg, the 1200 ha Yookamurra reserve in South Australia, which cost $200 000), but without government assistance the cost is prohibitive for large areas[69].

3.4.3 Chemical Control

Chemical control of feral animals is primarily achieved through baiting. Exercises in regions with known feral pig problems suggest shooting will remove about 80 percent of the animals. However in some places, this method of control is not possible, and poisoning is used as an alternative. Baits of preferred foodstuffs are impregnated with a poison, most commonly 1080 (sodium monofluoroacetate) or strychnine.

Baiting as a control mechanism has many problems. First, it is difficult to place baits in remote and inaccessible terrain. Non-target species may eat the baits or the poisonous remains. During spring and summer when food is abundant, pigs may ignore baits. Some pigs still survive after eating baits, so resistance develops. Finally, pigs may develop bait shyness over time, markedly reducing the long-term effectiveness of the method.

Warfarin, a rat poison, is also effective against pigs. It is less likely to cause bait shyness and has an antidote, unlike strychnine and 1080. In one campaign warfarin baits were dropped in a wooded area. The baits achieved an 84 percent reduction in pig numbers. Once again, these figures show control is possible,

[68] Select Committee on Animal Welfare, p.52.

[69] Martin Warneminde, `City Kitty Killers', *Bulletin*, 12 November 1991, pp.48-49.

but eradication is not. Remaining pigs would repopulate the area and new animals may move in from surrounding areas[70].

Warfarin and 1080 can be utilised on other terrestrial vertebrate pests such as cats and foxes. The same problems though are encountered.

The cane toad has never been a declared animal in Queensland, and control remains the discretion of the individual. Historically control has been by physical methods. Freezing has been suggested as the most humane form of treatment, as the cold initiates dormancy. A commercial chemical spray is available, Toadex[71].

Economic and environmental damage from mice plagues is estimated at between $50 and $100 million[72]. There is little farmers can do to control mice during a plague. There are no chemicals registered for broadacre baiting to protect crops, because of the potential residue problems and risk to wildlife. Damage to stored produce, buildings and equipment can be reduced by strategic baiting in order to limit mice numbers before a plague can develop. Baiting is most effective if it is carried out in conjunction with management techniques to reduce food and refuge areas around farm buildings.

3.4.4 Biological Control

Since the 1880s, when the effects of rabbits were first realised, almost every conceivable method of controlling them has been tried. Direct techniques such as fumigation, warren ripping and poisoning are useful. However, they are labour intensive, sometimes dangerous, inhumane and expensive. The most powerful control mechanism was the introduced disease myxomatosis. This was first released near Albury in 1950. Initially it had a mortality rate of 99%. Within 2 years of introduction, myxomatosis reduced Australia's rabbit population from an estimated 600 million to less than 100 million. However, over time the virus has declined in strength and the animals have built up resistance. Myxomatosis mortality is now only around 40 percent. Also, the insects which spread myxomatosis, the European Rabbit Flea and some mosquitoes, do not persist in the arid zone, where annual rainfall is less than 200-250mm. This leaves about half of the rabbit infected areas of Australia without reliable vectors to spread the disease[73].

New methods of rabbit control are being investigated. The Spanish Rabbit Flea is adapted to arid regions and is a promising candidate for the distribution of myxomatosis throughout the arid zone. A further control is a virus, rabbit

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[70] Beckmann and Davidson, p.21.

[71] Queensland Department of Lands, *The Cane Toad*.

[72] Grains Research and Development Corporation, `Mouse Plague Threat Continues to Build', *Alert*, GRDC, 1993.

[73] Graeme O'Neill, `Australia's Most Wanted', *Time Australia*, vol.9 no.14, 4 April 1994, pp.48-53.

haemorrhagic disease (RHD), which has decimated farmed and wild rabbit populations in other parts of the world. The CSIRO is currently investigating the potential of this virus for rabbit control. Unlike myxomatosis, RHD is transmitted by direct contact, so no vector is needed. Observations overseas suggest the virus persists even with low rabbit densities and virulence does not reduce in the wild even after three years. The disease kills adult rabbits within about 30 hours, much faster than myxomatosis. Although promising, the RHD virus will take many years of testing before it can be utilised in the field[74].

The main problem with techniques that control rabbits by killing them is that their impact diminishes in the long term. Rabbits' extremely high reproductive capacity ensures that killed individuals are quickly replaced. The diseases mentioned kill rabbits as sub-adults, after they have already contributed to vegetation loss, species reduction and land degradation. A more effective method of biological control would be to focus on the rabbit's birth rate rather than death rate. If rabbits were rendered infertile, it would not eliminate rabbits but it would severely limit their numbers forever. One important aspect of fertility control is the inter-relationship between feral animal numbers. If rabbit numbers alone are reduced, foxes and cats will increase their predation on native animals. If fox and cat numbers are controlled, rabbit numbers will rapidly increase. Techniques created may need to be applied to a number of feral animal species simultaneously[75].

Currently there are investigations into the use of a parasitic worm to control mice plagues. These plagues occur regularly causing large amount of damage to agriculture. Crops and stored grains are affected as are native animals through competition for food and shelter, disease and increased predation. The roundworm (*Capillaria hepatica*) is a naturally occurring liver parasite of mice. The parasite suppresses rodent numbers by making females skip alternate breeding cycles. Scientists are investigating the use of baits containing the parasite[76].

One disadvantage of using biological control mechanisms is that the disease or parasite may affect the domestic population more than the feral. A non-specific virus developed to control foxes may threaten the dingo and domestic dog. Two diseases which could be used to control the feral cat population would be feline enteritis and cat influenza, but this would require vaccination of all the domestic population. Similar situations arise for horses, cattle, donkeys, pigs, goats, deer, camels and rabbits.

Some native animals are able to control feral species, although examples are rare. Researchers suggests the native keelback snake can eat cane toads without ill effects, and may be a potential control mechanism[77]. The keelback is

[74]Robin Taylor (ed), `Rabbit Control: The 90's Approach', *Rural Research*, no.162, Autumn 1994, pp.4-8.

[75]O'Neill, p.50.

[76]`Worm May Control Mice', *Courier Mail*, 11 July 1992, p.3.

[77]Matthew Franklin,`Slaughter of Harmless Toads Cruel: Scientist', *Courier-Mail*, 4 January 1994, p.1.

harmless to humans, can eat cane toads up to 5cm long and is found in Queensland, New South Wales, and the Northern Territory.

New biological techniques for rabbits and foxes show promise for widespread control, but they are not yet proven and are a long way off.

3.4.5 Fertility Control

Current methods of feral animal control address the symptom rather than the source of the feral animal problem. A more long-term and sustainable control measure would involve fertility manipulation. "Control of the source, rather than the symptom of the problem, will result in humane and sustained management of feral animals"[78]. However, current technology is not sufficiently advanced to control particular species, or the technique is not yet feasible in either application or cost. Fertility control will only become an option for feral animal control when a fertility agent is developed which is species-specific, harmless to humans, sufficiently long-acting, easily administered and cost-effective.

Fertility is the ability to reproduce and fecundity is a measure of the number of offspring produced. Fertility control is defined as any technique that reduces offspring and includes a reduction in fertility or fecundity. Fertility control of animals may involve the following mechanisms:

- Chemosterilants are chemicals which cause permanent or temporary sterility, reduce the number of offspring or alter the fertility of offspring produced;

- Immunocontraception raises the antibodies against sperm, ova or reproductive hormones in order to inhibit reproduction. The method involves stimulating the immune system to block production of hormones necessary for the completion of the reproductive cycle. This method of control is being successfully used on horses in America. Mares are vaccinated against their own eggs. It is proving to be more than 95 percent effective as a contraceptive[79];

- Genetic engineering uses specific recombinant viruses to deliver foreign genes that disrupt reproduction; and

- Hormone antagonists, which inhibit the release of reproductive hormones.

Gordon Feeney,`Snake to Tackle Cane Toad Invasion', *Search*, vol.2, no.7, August 1994, p.209.

[78]Evidence presented by the Australian and New Zealand Federation of Animal Societies to the Senate Select Committee on Animal Welfare, *Culling of Large Feral Animals in the Northern Territory*, p.69.

[79]Jay Kirkpatrick, `Contraception: The Humane Choice for Control of Overpopulated Species', *Animal Liberation Magazine*, no.40, April-June 1992, pp.7-9.

Fertility control is perceived as being more humane and morally acceptable than current lethal control methods. This is because fertility control acts to reduce birth rates rather than increase mortality.

The practical application of fertility control techniques to the management of animal pests in Australia is assessed against the following criteria:

- availability of drug or technique that will temporarily or permanently sterilise target animals;
- a delivery mechanism allowing an adequate proportion of the target population to be treated including widespread and abundant animals in areas with poor access;
- a treatment effect on the target population that is of sufficient magnitude, rapidity and duration to achieve the objective of damage control;
- no undesirable side effects on the target species, such as welfare problems caused by toxicity or behavioural changes;
- the drug, technique, delivery system or handling process are target-specific, so that non-target species, or people handling the drug are affected;
- no build-up of environmental or food-chain residues that are toxic or polluting, nor release of genetically engineered organisms that upset the environmental balance; and
- the program is cost-effective in terms of cost of treatment versus savings in damage, or in relation to the cost of alternative conventional control programs.[80]

After considering these matters, Dr Bomford concludes that antifertility agents will not be a panacea. The best use of fertility control as a population management tool may be to use it to slow population recovery or stabilise numbers after conventional methods have been used to reduce numbers. The overall conclusion of the review is that the present role of fertility control is extremely limited.

A practical, long-term mechanism of fertility control would be the ideal means of managing feral animal populations. The reality, however, is that such a mechanism does not exist. For some time to come, conventional methods based on harvesting and lethal control will continue to play a significant role in feral animal management. Evidence indicates fertility control would be more

[80] Mary Bomford, *A Role for Fertility Control in Wildlife Management?*, Bureau of Rural Resources, Canberra, 1991.

effective on populations already reduced by other means. Research into fertility control mechanisms is important, though, for long-term, humane and non-lethal control.

3.4.6 Registration and Desexing

As some of the feral animals are domestic animals, such as cats, rabbits and dogs, other control measures are available. Most local councils require registration of dogs. Often financial incentives are provided to owners who desex their animals and provide obedience training. Currently 80 percent of the domestic cat population are desexed. It is estimated this figure needs to rise to 97 percent before there is a significant impact on the cat population. More recently, there have been moves for cats to also be registered. Gladstone was one of the first regional centres in Australia to require the compulsory registration of cats and to impose night curfews with a fine of up to $5000 incurred. Two Victorian municipalities, Coburg and Sherbrooke, have already introduced compulsory cat registration, desexing and curfews[81].

There is no proven link between the number of domestic cats and the number of feral cats. The RSPCA firmly believes stray cats "replenish" feral cat numbers. No empirical evidence exists. Conservation groups often suggest pet cats be made to wear bells, enabling animals to be warned of an impeding attack. But bells only make a difference in one out of three cat attacks on wildlife[82].

Another problem is the way cats are viewed in common law. Traditionally cats have been regarded as a person's "chattels". Authorities are often loathe to act against cats for fear of a law suit. New laws are required reclassifying cats as animals which may or may not have owners, similar to the way dogs are currently treated[83]. Giving cats a legal status would allow owners to be prosecuted and cats to be impounded and destroyed[84].

Earlier this year, Queensland's Minister for Environment and Heritage, Hon. Molly Robson MLA, proposed a 10-point plan for the control of domestic cats. The Local Government Association and Australian Veterinary Association rejected the proposals because of the cost and effectiveness of such a scheme. However the National Consultative Committee on Animal Welfare, representing state animal welfare ministers, later adopted much of the plan. The committee recommended the imposing of night curfews, desexing, compulsory cat registration and culling of homeless cats, and these are expected to be adopted in Victoria before the end of the year[85]. But animal welfare groups are sceptical about whether unwieldy legislation will solve the cat problem.

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[81] Michelle Nijk, `Feral Cat Control', *Australasian Science*, Winter 1994, pp.30-32.

[82] Dickman, p.48.

[83] Ian Anderson, `Should the Cat Take the Rap', *New Scientist*, vol.142 no.1926, pp.13-14.

[84] Megan Turner,`Cat Wars', *Courier Mail*, 26 April 1994, p.9.

[85] Turner, p.9.

3.4.7 Permits

In Queensland the keeping of rabbits requires a permit from the Department of Lands. No other state bans domestic rabbits. Queensland's policy was reviewed last year. Even though it was found pet rabbits did not pose a significant threat to agriculture or the environment, the policy was maintained. It was considered that freed domestic rabbits may survive and inter-breed with wild rabbits[86]. The keeping of dingoes is also prohibited in most states, except by permit.

3.4.8 Community Education

One other and quite significant aspect of the feral animal problem, is the human element. Irresponsible pet owners may be largely to blame. Dr Diane Sheehan, president of the Queensland branch of the Australian Veterinary Association, says the cat problem stems from a lack of understanding of feline behaviour, and that community education is the only way to address the problem. A survey conducted by the Australian Museum last year showed most cat owners supported legal controls to stop their pets killing native animals. Seventy-two percent of cat owners surveyed believed cats were a problem in the wild, while 85 percent of non-cat owners agreed. There seems to be opposing views when discussing cat control. One view is that every cat should be shot on sight. The opposing view of ailurophiles - cat lovers - is that cats are ethereal spirits unable to be controlled. This polarisation of opinion hinders the implementation of effective control mechanisms. Education campaigns would alleviate this problem[87].

3.4.9 Bounties

Bounties have been offered for the culling of pest animals in the past. A $10 bounty for dingoes currently applies in Queensland. In 1992, it was suggested a bounty be imposed on cats in Queensland. The suggestion received some support, but has since been dismissed. Bounties are generally regarded as an inefficient means of controlling pest animals and have been discontinued elsewhere in Australia[88]. The program was considered too costly to administer and would achieve little because of the high reproductive capacity of cats. There was also concern pet cats would be culled by unscrupulous hunters.

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[86] Rory Medcalf,`State a Bunny over Pet Ban', *Sunday Mail*, 19 December 1993, p.19.

[87] Turner, p.9.

[88] Queensland Department of Lands, *Rural Lands Protection Act Reform in Queensland*, Discussion Paper, February 1994.

3.4.10 Control Organisations

Commonwealth

The Commonwealth Government is involved in a range of initiatives aimed at reducing the impact of feral animals on agricultural production, and the native flora, fauna and ecosystems. These initiatives are being implemented through Commonwealth programs in both resource management and conservation-orientated agencies, including the Bureau of Resource Sciences, the CSIRO and the Australian National Parks and Wildlife Service. The Cooperative Research Centre for Biological Control of Vertebrate Pest populations is an important initiative in this area.

The Commonwealth Government began a special Feral Pests Program in 1992/93, with funding of $15 million over four years. The Feral Pests Program aims to reduce the impact of feral animals on the natural environment, particularly in areas of importance for endangered species recovery. Two million dollars were allocated in 1993/94 of which 90% was directed to four major pest animals - foxes, cats, goats and rabbits. These animals have been identified as key threats under the *Endangered Species Protection Act 1992*[89].

The Australian National Parks and Wildlife Service (ANPWS) is involved with programs to protect Australia's native wildlife as well as having responsibility for the management of Commonwealth parks and reserves. It administers, in cooperation with the States and Territories, the Endangered Species and Feral Pests Programs.

The National Landcare Program provides funding to facilitate cooperative action on the part of landholders and local groups. It is directed at sustainable land use and the control of land degradation. One of the ANPWS sponsored Landcare projects is the development of farm management plans enabling farmers to conserve native plants and animals on their land.

State and Territory resource and conservation agencies are integrally involved in these research and management initiatives. The Commonwealth Government also encourages community and landholder involvement in feral pest control. Tax concessions are available to landholders for pest control activities and the National Landcare Program funds community pest control activities.

Queensland

In Queensland, the Land Protection Branch of the Department of Lands is responsible for the "strategic allocation and sustainable use of land for economic development, public purposes and environmental conservation". Controlling the impact of problem plants and animals is integral to the fulfilment of this responsibility. The Branch's Management Plan has as one of

[89] *On the Brink*, December 1993.

its "desired outcomes" the "exclusion of new exotic pest plants and animals, the containment of target pest plants, the reduction of established pest animals (dingoes, feral pigs, rabbits) and the suppression of the plague potential of reproductively dynamic pest animals (locusts, rodents)".

3.5 Commercial Usage of Feral Animals

The commercial use of pest animals is worth more than $100 million a year, largely through export[90]. For example, the commercial use of goats is a primary goat management technique earning $22 million a year.

Many of the feral pest species have value as recreational resources for hunters, export commodities as game meat and genetic resources. Australian sporting shooters rate the feral pig as their favourite quarry[91]. It is a paradox that the eradication of feral pigs is legally required of landholders in New South Wales and Queensland, while at the same time 270 000 carcases with a value exceeding $15 million are exported annually to game meat markets in Europe from these two States[92].

Optimising the pest and resource values of these species involves the development and implementation of appropriate multi-use management plans. The diversity of values of interested parties involved in the control of feral animals - landholders, commercial harvesters, sporting shooters, pest and disease control authorities and conservation agencies - is a recipe for conflict. Some attempt to reconcile the interests of all concerned parties is made in legislation, although there has been no concerted effort to enact uniform legislation throughout Australia. This leads to a piecemeal approach to the problem. Feral animals do not recognise State and Territory borders.

3.6 Information on Specific Feral Animals

Table 3.3 lists information on the environmental effects and control measures for 13 of Australia's most serious feral animal pests, together with brief information on several others. The map with each of the major pest species indicates their current distribution. Appendix B lists the animal species currently declared in Queensland.

Table 3.3 is presented on the following ten pages.

[90] Bureau of Resource Sciences, p.4.

[91] C.A. Tisdell, *Wild Pigs: Environmental Pest or Economic Resource?*, Pergamon, Sydney, 1982.

[92] Peter O'Brien, `Managing Australian Wildlife', *Search*, vol.21 no.1, January 1990, pp.24-27.

FERAL PIGS

Australia is the only continent without a native pig population. However following their introduction as a source of food by the early European settlers, feral pig populations became established in most climatic regions of Australia. Significant numbers of feral pigs are now found in western Victoria, New South Wales, Queensland and across northern Australia, from Cape York to the Kimberleys. The number of feral pigs in Australia has not been determined but it is thought to be in the millions. Estimates range from 4 to 20 million. They easily outnumber the 2.6 million domestic pigs.

Feral pigs damage both the natural environment and crops and pastures, kill lambs, and have the potential to spread exotic diseases, such as foot and mouth disease. Their cost to agricultural production has been estimated at about $80 million a year. Feral pigs take 40% of lambs born in some areas. There is also some evidence feral pigs spread the fungal spores of the root-rot fungus (*Phytophthora cinnamomi*). Outbreaks of the disease and plant death are associated with feral pig disturbance.

They pose a major threat to national parks, where their damage is not able to be easily assessed. They cause physical damage such as wallows, compacting of soil on trails, ploughing up of the soil surface and disturbances along creek banks, presumably made in search of food. They can turn surface soil in areas up to half a hectare. This disturbance can grossly affect the establishment and growth of seedlings and leave the soil susceptible to erosion. This has important implications for the future species composition of the area. Permanent open clearings could be produced within a few decades if pig damage continues. Pigs compete directly for food with native ground-feeding animals and destroy the understorey habitats necessary for nesting and shelter.

The export of feral pig meat to European countries is valued at $10 million annually. The meat is known as "wild boar" or "sanglier", and is a popular winter dish.

Sources:
1. Senate Select Committee on Animal Welfare, *Culling of Large Feral Animals in the Northern Territory*, June 1991, AGPS: Canberra, p. 6.
2. Beckmann, Roger and Davidson, Steve, `The Pig Problem', *Ecos*, no.65, pp.20-22.

RABBITS

An early entrepreneur, Mr Thomas Austin, introduced 24 English wild rabbits onto his farm near Geelong, Victoria in 1859. Within 50 years, they had invaded more than two-thirds of the country. Rabbits contribute to the extinction and reduction in habitat of many native Australian mammals by competing with them for food and burrow space. They can even displace large mammals and birds, especially during drought, because of the rabbit's ability to eat most of the vegetation. Rabbits can remove vegetation cover leading to soil erosion and loss of habitat for native animals. In rangelands, especially during drought, they can strip and ringbark native plants. Even at very low densities rabbits can prevent regeneration of long-lived species such as mulga.

Indirectly rabbit numbers sustain large fox and cat populations that prey heavily on many native species. The interrelationship between the rabbit, fox and cat creates problems in determining which of the three species is targeted first for control.

In direct loss, rabbits are estimated to cost the Australian economy $90-100 million a year from lost agricultural production. However the damage they cause through soil erosion and extinction in native species, plants and animals, costs much more. Studies have shown that removing rabbits substantially improves wool and meat production, wool quality, and lambing rates, by increasing pasture availability and quality. Fifteen rabbits eat as much as one sheep. Rabbit numbers are estimated at between 200 and 300 million.

Australia has quite a significant rabbit-farming industry for fibre and meat. They are also sought after as pets. The Bureau of Rural Resources estimates the potential overseas market for rabbit meat could be valued at $100 million annually. Rabbit farmers are concerned at the research into rabbit haemorrhagic virus, due to its potential impact on the industry.

Sources:
1. Taylor, Robin, `Rabbit Control: The '90s Approach', *Australian Farm Journal*, vol.4 no.4, June 1994, pp.86-90.
2. Williams, Brian, `Virus to Sterilise Rabbits', *Courier Mail*, 14 October 1992, p.17.
3. O'Neill, Graeme, `Australia's Most Wanted', *Time*, 4 April 1994, pp.49-53.
4. *Strategic Vertebrate Pest Management: A National Approach to Major Pest Animals*, Bureau of Resource Sciences, December 1992.
5. Quiddington, Peter, `Virus Plan has Rabbit Farmers Hopping Mad', *Sydney Morning Herald*, 4 November 1989, p.9.

FOXES AND DINGOES

The European red fox was introduced into Australia for recreational hunting, and was successfully established in the 1870's in Victoria. Foxes are found throughout southern Australia with the exception of Tasmania and Kangaroo Island. Foxes are estimated to number around 5 million.

CSIRO wildlife ecologist Dr Alan Newsome notes a close congruence in rabbit and fox ranges across Australia, and the disappearance of almost the entire suite of small native animals. Western Australian researchers, Dr Andrew Burbidge and Norm McKenzie, coined the term "critical weight range" to describe how introduced predators seem to have targeted native mammals weighing between 35 grams and 5.5 kilograms. Says Newsome: "It really points the finger at the fox as the culprit".

The relative contributions of foxes and feral cats to the demise of native species are uncertain. Because foxes are nocturnal and shy, many Australians tend to regard feral cats as the most destructive alien predator. There is little empirical evidence which supports this view. Burbidge recounts anecdotal evidence from Aboriginal oral history which suggests cats were present prior to European settlement. Many Aborigines considered cats part of the native fauna. The most damning evidence against foxes comes from Tasmania and Kangaroo Island. On those islands foxes are not present yet feral cats are present. Not one single small mammal has become extinct despite the presence of feral cats.

The dingo is thought to have arrived about 4000 years ago with asian seafarers. As it was present prior to European settlement, the dingo is often thought of as native. This is a debateable point. Regardless of its classification, the dingo's impact on the environment is similar to that of a feral animal. Feral animals compete with and consume native wildlife, spread disease, interfere with the country's biological diversity and disrupt ecosystems. The dingo is credited with making the Tasmanian Tiger extinct.

Source:
1. O'Neill, Graeme, `Australia's Most Wanted', *Time*, 4 April 1994, pp.49-53.

FOXES DINGOES

FERAL CATS

Cats were introduced as pets and were actually released to control rabbits and mice. The cat survives in almost all of Australia's habitat, except dense forest. It is essentially a desert species, surviving without needing to drink water, so Australia's dry climate is not restrictive.

Cats have become public enemy number one in Australia. They have received the most attention from the media of all of the feral animals. Biologists say feral cats pose the most serious threat to wildlife in Australia, where native carnivorous animals are rare and the human population is relatively small and concentrated in urban areas. They are accused of hunting some of the countries most endangered animals, such as the bilby, golden bandicoot and burrowing bettong.

Some scientists agree the case against the cat is not proven. They argue other creatures such as foxes are more to blame for the dwindling numbers of native species, along with the destruction of habitat, especially by rabbits. Others vigorously argue that feral cats "wreak havoc". David Paton, a zoologist at the University of Adelaide, estimates there are 3.8 million feral cats in Australia, which kill about 3.8 billion native animals a year. Other researchers estimate the number of feral cats at around 12 million animals, with 1.5 million in Queensland, which would mean around 12 billion natives killed annually. Paton says cats prey on 186 species of native mammals, 100 bird species, 97 species of reptiles and amphibians and numerous insects. A domestic cat's average weight is 3kg, while ferals can weigh up to 9kg. Cats need to consume around five to eight percent of their body weight daily, around 300-490 grams of meat a day. Zoology Technical Officer Luke Hogan calculates this to be equivalent to 1-2 rabbits, half a ringtail possum, 2-3 sugar gliders or 21-35 feathertail gliders.

Cats are not declared pests in Queensland. Declaring them imposes a legal obligation to implement control measures. Difficulties arise in determining the difference between domestic and feral animals. The deliberate killing of a domestic animal incurs legal problems.

Sources:

1. Anderson, Ian, `Should the Cat Take the Rap?', *New Scientist*, vol.142 no.1926, pp.13-14.
2. Single, Ann, `Going Wild: Feral Animals Threatening the State's Protected Areas', *Between the Leaves*, Winter 1993, pp.18-19.
3. Wamsley, John, `A Cat in the Hand', *Far Eastern Economic Review*, vol.157, no.17, 28 April 1994, p.86.

CANE TOADS

Cane toads were introduced into Queensland in 1935 from Hawaii to control Frenchi and Greyback beetles, economically significant pests of sugar cane. However, within six years it became apparent the cane toad was not effectively controlling the beetles. It failed because the toad has a wide-ranging and indiscriminate diet, and is not solely dependent on its intended beetle prey. There are also basic behavioural differences between the cane toad and the beetles. The Greyback beetle is rarely in contact with the ground, while Frenchi beetles invade cane at a stage where cane toads are not present because of a lack of shelter.

Because of its omnivorous diet and the existence of a suitable environment for reproduction, the toad spread. Cane toads are now found in all of coastal Queensland, plus parts of New South Wales and the Northern Territory. The cane toad population increases by an estimated eight percent annually and cane toads are now the most common small vertebrate in eastern Queensland. They live for fifteen years and a female produces 40 000 eggs in a season.

The environmental effects of the cane toad are serious. It produces a toxin, which if ingested will kill most domestic and native animals. The toxin pervades the skin and muscle tissue of the toad, therefore ingestion of toad tissue or the toxic secretion is harmful. Very few of Australia's predatory species can prey upon the toad without obvious effects. As well as poisoning native animals, toads consume a wide variety of native insects, frogs, small reptiles, mammals and even birds. The only limiting factor is the size of the prey relative to the toad's mouth. Cane toad competition for food and breeding sites may be responsible for the reduction in native frog populations. The cane toad is also not a declared pest in Queensland. Again declaration as a pest would require land owners to implement control measures. This would severely disadvantage some landholders. The Department of Lands recognises the cane toad as a pest and encourages population control.

Cane toad venom may become a valuable export industry. Chinese doctors believe the venom has curative powers and is used in traditional medicines. Their skins are also used, in some instances as credit-card wallets.

Sources:

1. `Cane Toad Venom has Queensland Hopping', *Australian Financial Review*, 22 August 1990, p.41.
2. Franklin, Matthew, `Slaughter of Harmless Toads Cruel: Scientist', *Courier Mail*, 4 January 1994, p.1.
3. `Toads on the High Road to China', *Courier Mail*, 13 April 1994, p.7.

GOATS AND CAMELS

European settlers introduced domestic goats in the late eighteenth century. They were used as a source of meat and milk. In 1861, cashmere and angora goats were introduced for fibre production. Many flocks were abandoned with a downturn in the industry. Feral goats occur in all States and Territories except the Northern Territory. Aerial surveys estimate there are close to one million goats in eastern Australia, with a minimum of 600 000 in Western Australia. The Department of Primary Industries estimates there are 50 000 feral goats in Queensland. They damage rangelands, reduce the viability of the pastoral industry, reduce carrying capacity, consume and damage water supplies and nullify attempts to rehabilitate damaged rangeland.

The commercial goat industry generated $20 million in export income in 1992, and has the potential to double to $40 million within five years. In 1993, a meat exporting company bought 4000 feral goats from Queensland Farmers, paying the rural community up to $52 000 a week. Feral goats may also assist in the control of introduced weeds such as blackberries, thistles and serrated tussock grass.

Camels were imported into Australia in the middle of the nineteenth century and used extensively in the exploration and development of the arid interior. Following the mechanisation of transport in the 1920s, the use of camels declined. Camels escaped or were abandoned. Australia is now the only country in the world with wild camels. Wild camels destroy fences, denude trees and degrade waterholes. Their effect is less serious than other feral animals, mainly because they have a hard, cloven hoof. About 40 000 camels are thought to roam the outback. Camels are used in the tourism trade for safaris. Some are exported to the Middle East to improve racing stock in Arab countries. It is not uncommon for a camel to sell for more than $300 000. The incidence of feral camels is low in Queensland.

Sources:
1. Dibben, Kay, `Costly Cutting in Goat Kill', *Sunday Mail*, 30 May 1993, p.19.
2. Johnston, Trevor, `New Feral Goat Action Plan', *Australian Farm Journal*, vol.2 no.10, December 1992, pp.22-23.
3. Queensland Department of Lands, *Feral Goats and their Control in Queensland*, Pestfact No. A018/89A, 1991.
4. Senate Select Committee on Animal Welfare, *Culling of Large Feral Animals in the Northern Territory*, AGPS, Canberra, June 1991, p.5.

FERAL GOATS

HORSES AND DONKEYS

Horses arrived in Australia just over two hundred years ago with first European settlement on the east coast of the continent. Domestic horses that escaped or were released became established in the wild. By the 1830s "bush horses" were plentiful in the hills around Sydney. The number of uncontrolled horses increased as pastoral development spread. In addition to these animals, many more horses were released following their use in the First World War. The wild descendants of these animals are viewed by some as an integral part of Australia's heritage. It has been estimated there could be 400 000 to 800 000 feral horses in Australia. Australia's feral horse population is significantly greater than that of any other continent, the next largest population existing in North America.

Horse grazing removes soil cover when they eat grasses back to the roots, exposing the country to erosion. They also compete with cattle for food and water, damage waterholes, fences and displace and compete with native wildlife.

In the 1860s, donkeys were imported into Australia for use in teams of freight haulage and as pack animals. They were used in areas where poisonous plants restricted horse use. Improved roads and mechanisation resulted in less need for donkeys. Donkeys thrive in areas unsuitable for horses. They eat a wide range of vegetation and graze further away from water. Donkeys cause similar environmental damage to horses. Their incidence is low in Queensland.

Sources:
1. Hancock, David, `Free and Feral', *Good Weekend*, 7 August 1993, p.27.

FERAL HORSES

CATTLE AND BUFFALOES

The European (*Bos taurus*) and Zebu (*Bos indicus*) cattle were introduced into Australia for beef production. Some of these cattle have become feral while others are unmanaged because of economic constraints on mustering. The Banteng (*Bos javanicus*) were imported from Java over 150 years ago. They have not spread far from where they were liberated. There are about 3000 found on the Cobourg Peninsula of the Northern Territory. Trophy hunting and use as food for the traditional Aboriginal landowners controls the Banteng population.

Water buffalo were introduced into the Northern Territory in 1825 as beasts of burden and food sources. Soon after, they went wild and their numbers increased. Buffalo numbers, however, were contained through hunting for buffalo hides. Following the collapse of this market in the 1950s, the population again increased rapidly. In 1985, the number of buffalo in the Northern Territory were estimated at 340 000. Because of the Brucellosis and Tuberculosis Eradication Scheme (BTEC), numbers have declined rapidly in the last three years, with at least 100 000 killed. A valuable game meat market has grown up around the animals, valued at $10 million.

Sources:

1. Hancock, David, `Licensed to Kill', *Geo*, vol.11 no.4, February 1990, pp.88-101.
2. Senate Select Committee on Animal Welfare, *Culling of Large Feral Animals in the Northern Territory*, AGPS, Canberra, June 1991, p.5.

HOUSE MICE

The house mouse was first introduced to Australia in 1904 and is currently found Australia wide. House mice compete with native animals, support predators and spread disease. They cause most of their economically significant damage when in plague proportions. The Darling Downs is the agricultural area in Queensland experiencing the most regular and serious plagues. Major outbreaks of mice have occurred in 1917, 1925, 1959 and 1970.

Since 1970, farmers have experienced significant annual crop losses due to mice. This is because of a change to minimum tillage and intensive broadacre farming, which has increased the number and variety of food sources. Mice are prolific breeders. Pregnancy is usually only 19-20 days, with litter sizes of 5-6. Young can be independent 18 days after birth and reach sexual maturity at 8 weeks of age.

Mice are a health threat to animals and humans. They carry diseases such as food poisoning and life-threatening meningitis.

Source:

1. Queensland Department of Lands, *House Mice: Their Biology and Identification,* Pestfact No. A017/91A, 1991.

NON-MAMMAL PESTS

While mammalian pests are the most widely recognised, other animals such as insects, fish and reptiles are just as damaging to the environment. Pest insects eat crops and native vegetation, spread disease and cause death or illness in livestock and humans. For example, the red-legged earth mite wipes out clover pasture costing an estimated $200 million a year. Screwworm fly infects the skin of animals. It poses a $430 million threat to Australia's livestock industry. In South Australia there is an exotic snail which is eating crops and affecting stored grain.

Introduced fish species are rarely recognised as feral animals, but some of their environmental effects are enormous. At least five species of carp have been introduced to Australia. They are able to breed at a rate far in excess of most other fish. The exotic tropical fish Tilapia is an enormous problem in Queensland. A possible solution to stem the spread of introduced fish species is the commercial harvesting of the animals, converting them into high value fish meal. Piggeries utilise large amounts of fish meal, which is often imported. The fish could also be used as a high value organic fertiliser.

Pests are introduced in a number of ways. Discharge of ballast water from foreign ships in Australian waters is blamed for the introduction of the North Pacific Seastar from Japan, which is affecting Tasmania's scallop industry. Common insect pests such as the Mediterranean fruit fly and the sheep blowfly probably arrived late last century along with plants and animals they feed on. Unlike animals, insects can be imported unknowingly. They can be part of a crop cargo, seeds in travellers clothing, stowaways in planes or even in the faeces of migrating birds. Pests from Papua New Guinea are of most concern. Last year the spiralling white fly and the oriental fruit fly moved from Papua New Guinea to the Torres Strait. The Torres Strait is considered a high-risk area for the introduction of unwanted species in Australia because of the ancient sea trade which persists between Islanders and Papua New Guinea.

The screwworm fly is a serious threat to Australia's livestock industry. It is a parasite of warm-blooded animals including humans, cattle, sheep and wildlife. It is an important pest in Papua New Guinea, but has not successfully established in Australia. On one occasion, dead screwworm flies were found on a livestock-carrying vessel at Darwin. An Australian tourist returning from South America in April 1992 was treated for screwworm fly infection. The fly infects open wounds, larvae emerge and damage body tissue. In agriculture, this leads to loss of production, reduced growth rates and often death if wounds are untreated. The Queensland DPI estimates a screwworm fly invasion would cost producers about $280 million dollars, with the biggest losses incurred in the beef cattle industry.

1. *Good Weekend*
2. *Queensland Country Life*
3. Seastar: Australia's Most Damaging *Search*
4. Simon, ` *Queensland Country Life* p.18.

4. LEGISLATION AND NATIONAL CO-ORDINATION

4.1 Introduction

Legislative power in relation to the environment is divided between the various levels of government in Australia. State and Territory Governments have legislative and administrative responsibility for land management, which includes the control of weeds and animal pests, and for the prevention of cruelty to animals. The Commonwealth has responsibility for environmental management in areas under its control, but under the Constitution it has no explicit environmental protection powers[93].

However the Commonwealth has established considerable authority in environmental matters through the application of its external affairs powers. In 1972 the Commonwealth ratified the United Nations Convention for the Protection of the World Cultural and Natural Heritage, which came into force in 1975. The Commonwealth's authority to legislate on the basis of the Convention and, in particular, to nominate and protect World Heritage areas, was confirmed by the High Court in 1983 and 1989. These were the well-known Tasmanian Dams Case and Queensland Wet Tropics World Heritage Area Case respectively[94].

There is both State and Commonwealth legislation that is directed at pests and noxious weeds and exotic animal diseases. Traditionally, the thrust of the legislation is the protection of agricultural processes and animal stock rather than the protection of species or their habitat.

Although each State and Territory has the constitutional right to its own legislation and procedures for managing pests, there is a need for a more consistent approach. Currently, agriculture and natural resource management in some jurisdictions is spread between several agencies.

Problems sometimes arise where plants declared as noxious weeds in one State are not necessarily so in another State. For example, honey locust is a declared plant in Queensland but not in New South Wales or Victoria[95]. Also, differences occur in relation to the sale and transport of weeds and weed-contaminated stockfeed and produce. Most exotic weeds were introduced unintentionally in agricultural seed or produce, though some were deliberately introduced, often for their agricultural or horticultural value[96].

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[93] Section 51 details the areas the Commonwealth may regulate. Environmental protection or species preservation is not explicitly included.

[94] P.H. Lane, *A Digest of Australian Constitutional Cases*, 4th ed, Law Book Company, Sydney, 1992, pp.131-139.

[95] Queensland Department of Lands, *Rural Lands Protection Act Reform in Queensland*, Discussion Paper, Brisbane, February 1994, p.14.

[96] Queensland Department of Lands, p.14.

4.2 International and National Initiatives

The Commonwealth and the States signed the *Intergovernmental Agreement on the Environment* in February 1992. The Agreement governs relations between the Federal Government, the State, Territory and Local governments on issues affecting the environment. It has no force in law and is essentially a political document designed to alleviate conflicts. The fundamental premise of the Agreement is that the development of a national environmental policy is, where possible, highly desirable[97].

In June 1992, Australia signed the *Convention on Biological Diversity* at the United Nations Conference on Environment and Development. The Convention requires the protection of native flora and fauna, ensuring biodiversity. The signing of this Convention will boost the ability of the Commonwealth to influence the direction of environmental legislation and strategies, especially those concerning native flora and fauna.

The *National Strategy for Ecologically Sustainable Development (NSESD)* was released by the Commonwealth in December 1992. It includes an objective on the need to reduce and manage effectively the impact of pest plant and animal species on Australia's agricultural areas.

The NSESD requires that Governments:

- give priority to rapid completion and implementation of national and regional strategic plans for the management of pests and weeds, in particular the *National Strategy on the Management of Vertebrate Pests* and the *National Weeds Strategy;*

- continue to work through the Intergovernmental Agreement on the Environment to co-ordinate effectively a national approach to the control of introduced animals and plants which pose a threat to the natural environment and farming; and

- review legislation for the control of pests.[98]

[97] See for example, clause 2.3.4: "The States have an interest and responsibility to participate in the development of national environmental policies and standards".

[98] Queensland Department of Lands, p.3.

National Strategy on the Management of Vertebrate Pests

The national strategy for vertebrate pests was published in 1993[99]. The strategy contains national guidelines and principles for the management of vertebrate pests. In summary, the principles are as follows:

- consistency with the principles of Ecologically Sustainable Development,
- adoption of beneficiary-pays,
- managing the inherent variability of land management systems,
- defining the role of various policy instruments to ensure desired management goals are met,
- involving all major interest groups in ownership of pest problems, and in planning and implementing management programs,
- managing total grazing pressure, and
- considering animal welfare.[100]

National Weeds Strategy

The final version of the National Weeds Strategy is expected to be available early in 1995. To facilitate national coordination in controlling weeds, the draft strategy proposes the establishment of a national weeds management coordinator who will act as permanent secretary to the Australian Weeds Committee and be responsible for:[101]

- developing an operating plan to implement the National Weeds Strategy;
- developing the new plant introduction legislation [Commonwealth] in liaison with the Australian Quarantine and Inspection Service (AQIS) and the Australian National Parks and Wildlife Service (ANPWS);
- developing with the Commonwealth, States and Territories a

[99] Mike Braysher, *Managing Vertebrate Pests: Principles and Strategies*, Bureau of Resource Sciences, Canberra, AGPS, 1993.

[100] Braysher, p.19.

[101] Department of Primary Industries and Energy, *Towards a National Weeds Strategy*, DPIE, Canberra, 1992, pp.5-6.

model plan for handling weed outbreak emergencies;

- identifying management directions that can provide an effective basis for regional and local action;

- promoting integrated management of weeds in accordance with sustainable land use and conservation principles;

- acting as convener of the working parties proposed in Recommendation 4 and driving Recommendations 5 and 6.

4.3 Queensland Legislation

The principal Queensland legislation is the *Rural Lands Protection Act 1985*. This Act replaced four existing Acts; namely the *Stock Routes and Rural Lands Protection Act 1944*, the *Barrier Fences Act 1954*, the *Rabbit Act 1964*, and the *Grasshopper Extermination Act 1937*[102].

The Rural Lands Protection Act provides for the management, control, prohibition, and regulation of the introduction, spread and keeping of certain plants and animal pests. These are referred to as `declared' plants or animals. There are 64 declared plants and 44 declared animals in Queensland. The animals include 36 mammals, eight reptiles and 3 insects. Once plants and animals are declared under the Act, landowners are required to implement control programs. The local authority for the area may issue a notice on the occupier or owner (or both) requiring certain declared plants on that land to be controlled by a certain date.

Failure to comply by the specified date may result in the local authority arranging for the work to be carried out by other persons at the expense of the occupier or owner. Local authorities and government departments are also required to control declared plants on land under their control[103].

The Act specifies five categories of declared plants and eight categories of declared animals (section 70).

Categories of Declared Plants

Category P1 Plants whose **INTRODUCTION** into the State is **PROHIBITED.**

Category P2 Plants which are to be **DESTROYED** throughout the State or the relevant parts

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102 Queensland Department of Lands, p.2.

103 Queensland Rural Lands Protection Board, *The Declared Plants of Queensland*, Pestfact no. P001/90B, December 1990, p.1.

thereof.

Category P3 Plants whose **NUMBERS** and/or **DISTRIBUTION** are to be **REDUCED** throughout the State or the relevant parts thereof.

Category P4 Plants which are to be **PREVENTED FROM SPREADING** from the places in which they occur in the State or the relevant parts thereof.

Category P5 Plants which should be **CONTROLLED** only on land under the control of a Government Department or Local Authority.

A list of currently declared plants is provided in Appendix A.

Categories of Declared Animals

Category A1 Animals whose **INTRODUCTION** to an area is **PROHIBITED**.

Category A2 Animals that are not native to an area and should be **DESTROYED** in that area.

Category A3 Animals whose **KEEPING AND SALE** in an area is **PROHIBITED**.

Category A4 Animals whose **INTRODUCTION** to an area is **RESTRICTED**, subject to prescribed conditions.

Category A5 Animals whose **NUMBERS** in an area should be **REDUCED AND KEPT RESTRICTED**.

Category A6 Animals whose **KEEPING AND SALE** in an area is **RESTRICTED**, subject to prescribed conditions.

Category A7 Animals who are native to an area and for which a **MANAGEMENT PROGRAM** is to be implemented.

Category A8 Animals which are pests in an area and during **PLAGUES** quickly inflict severe damage to crops and pastures.

A list of currently declared animals is provided in Appendix B.

The Rural Lands Protection Act requires the Department of Lands to control plants and animals on land under its control (s.73). Private land owners are similarly required to control declared plants and animals on their land (s.80). Notices in writing can be issued to landowners requiring the implementation of control measures. Penalties can be incurred for non-compliance (s.82).

The Act established two statutory authorities, the Rural Lands Protection Board (RLPB) and the Darling Downs - Moreton Rabbit Board. Local governments contribute funds to the boards for budgeted expenditure. The Rural Lands Protection Board is the body responsible for minimising economic, environmental and social impact of Queensland's harmful plants and animals. The Board is comprised of industry, local government and departmental nominees.

Recently there has been criticism of the State government's financial support for the Board's programs. Local Government Association Executive Director Greg Hallam said the State government reduced the board's budget by $218 000 this year[104]. He stated that local government contributions to the board increased more than 90 percent in the last four years, while State government funding increased only 3 percent. The Queensland Farmers Federation suggests $2 million is required to restore the board's programs[105]. The Treasurer, Mr Keith De Lacy, announced an additional $700 000 funding for the Rural Lands Protection Board in the 1994/95 budget. The Minister for Lands, Mr Geoff Smith, described the funding increase as the "largest budget in it's (RLPB) history"[106].

Present legislation does not include provisions controlling pests or disease of livestock, crops and pasture. There are no State government management strategies for feral cats or cane toads, although some local councils have taken steps to control these pests. There are also no controls for potential pests such as exotic bird and fish species currently in captivity. The Department of Lands has concentrated its control efforts on the introduced pests of agriculture. Control strategies are fragmented, with a number of agencies, such as the Departments of Lands, Environment and Heritage, and Primary Industries, having roles in the control of different species.

Under the current legislation local governments have the primary responsibility for enforcing control of declared pests on private land. Some councils are reluctant to enforce provisions, resulting in poor pest control in some areas. It is proposed to develop and implement local government pest management plans to address this problem.

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104 Gordon Collie, `Bushland Vegetation in a Battle of Survival', *Courier Mail*, 30 March 1994, p.7.

105 Lex Buchanan, `QFF Raises Concern over Weeds Problem', *Queensland Country Life*, 14 April 1994, p.9.

106 Hon Geoff Smith, *Queensland Parliamentary Debates*, 15 June 1994, p.8346.

Review of the Rural Lands Protection Act

The government has decided that a review of the legislation is required to ensure that the government's role, and that of government departments, statutory authorities, and other relevant bodies, is appropriately defined. The Lands Department has identified a number of deficiencies in the Rural Lands Protection Act through consultation with various bodies including local authorities, during the nine years that it has been in force.

All legislation administered by the Minister for Lands including the Rural Lands Protection Act is currently being reviewed. This review will examine the existing Acts relating to land protection, and, if appropriate, direct parts to other legislation, and/or develop new provisions, modernise existing provisions, and delete redundant or unnecessary provisions[107].

Further justification for reviewing the legislation include the need to modernise existing provisions, eliminate duplication within the Act and between Acts, remove any unnecessary impediments to business, introduce sustainable land use principles, comply with fundamental legislative principles, and construct it in simple English.

The Queensland Department of Lands issued a Green Paper entitled *Discussion Paper on a Review of the Rural Lands Protection Act* in February 1994 with the objectives of:

- Informing other government departments, organisations, and the community at large of the issues involved in such a review.

- Canvassing comments from interested bodies on the various proposals to protect the land from feral pests.

- Generating ideas and concepts that may be included in new legislation.

- Identifying unnecessary or inappropriate provisions contained in the current legislation.

A number of internal documents prepared by the Department of Lands have identified the need for change to the current legislation in several areas, particularly in regard to plant and animal control, and ecologically sustainable issues. Such documents include the *Strategic Plan for the Stock Route Network in Queensland* and an *Evaluation of the Land Sustainability Program*[108].

The Queensland Government is proposing to develop a new Act which will draw together and consolidate sections of the current Rural Lands Protection Act

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[107] Queensland Department of Lands, p.2.

[108] Queensland Department of Lands, p.2.

which are presently fragmented and disjointed. The efficiency and effectiveness of the new Act will be strengthened by appropriate regulations. It is proposed to draft a Bill in simple English which sets out clearly the obligations to State and local governments and landholders[109].

Management and control techniques that are compatible with the environment will be used to help maintain the land for use by future generations.

It is considered that the new legislation with respect to pest plants and animals should augment and strengthen the existing provisions, and provide power to:

- prevent establishment of potential pests not currently present in the State;

- provide for eradication of newly introduced plants and animals with pest potential, whenever it is feasible to do so; and

- limit the spread of established infestations[110].

The legislation should provide for the power, or source of authority, to deal with pest plants and animals, and the State's stock route network. Further detail will be contained in regulations or defined in policy documents. The new legislation could bear a new title to reflect its full scope of activities in relation to land management in Queensland, and to remove confusion that only "rural" land is affected[111].

The Discussion Paper on the Rural Lands Protection Act has identified several issues which could be addressed in the new Act. These include:

- inclusion of pests whose impact is environmental or social, as well as those which have an economic impact,

- broader division of responsibility between landholders and local and state government agencies. (Under the current legislation landholders are solely responsible for controlling weed infestations on their properties, which in many cases is financially prohibitive. Considering that the whole community stands to gain from the effective control of the particular pest, it may be more efficient as well as more equitable to divide the responsibility between the landholder, the local authority and government departments).

- use of Pest Management Plans as a regulatory technique. (The present legislation vests local authorities with the primary task of enforcing declared plant control on private land. As some local

109 Queensland Department of Lands, p.4.

110 Queensland Department of Lands, p.4.

111 Queensland Department of Lands, p.4.

authorities are reluctant to enforce the provisions of the Act, absence of effective pest control occurs in some areas. Local Authority Pest Management Plans are a possible way of overcoming this problem.)

- greater control of baiting,

- use of quarantine-type provisions to prevent the spread of weed seed in fodder and on stock and equipment,

- incentives for early detection and notification of pest outbreaks,

- responsibility for plant control on watercourses,

- greater emphasis on exclusion of additional pest species (restrictions on the introduction into Queensland of species such as ornamental, garden and aquarium species that could become costly pests,

- state-wide prohibition of sale and distribution of species which have the potential to become pests if released;

- strategic control of well established pest species in order to reduce the rate of spread into new areas.

The Discussion Paper invited submissions by May 1994. From these the Department of Lands will prepare draft proposals for discussion with major stakeholders late in 1994, and the new legislation is expected to be developed early in 1995.

Other Queensland Legislation

Introduced fish species which pose a threat to native waterways and fisheries resources are controlled through the Department of Primary Industries. The *Fisheries Act 1976* categorises fish as noxious (eg. piranha, European carp), non-indigenous (eg. nile perch, sturgeon fish) and prescribed non-indigenous (eg. goldfish).

Various regulations under the *Health Act 1937* impact on pest control. The Vermin Control Regulations 1991 give local governments the responsibility for controlling rats and mice in urban areas. The Mosquito Prevention and Destruction Regulations 1982 require local authorities to control mosquitoes.

The *Biological Control Act 1987* regulates biological control programs and is part of a uniform national legislation scheme for such programs.

4.4 Current Legislation in the Commonwealth and Other States

Current legislation regulating pest animals and plants in the other Australian jurisdictions is summarised in Table 4.1, which is presented on the following five pages.

Table 4.1 Australian Pest Animal and Plant Legislation

(a) Commonwealth

LEGISLATION	EFFECTS
Quarantine Act 1908	This Act regulates the Australian importation of exotic animals to prevent the introduction of unwanted pests and diseases. The Act also provides national powers to control outbreaks of exotic diseases. The States and Territories have enacted complementary legislation to enable coordinated control of exotic disease outbreaks under the Australian Veterinary Emergency Plan.
Biological Control Act 1984	Although this Act regulates biological control of pest organisms in the ACT only, it is the model legislation for a uniform national scheme. Complementary legislation exists in each State and the Northern Territory.
Exotic Animal Disease Control Act 1989	This Act established the Exotic Animal Disease preparedness Consultative Council, whose role is to report on and make recommendations about the possibility, prevention and control of outbreaks of exotic animal diseases in Australia. Most provisions of the Act will cease to operate on 30 June 1995, the remainder on 31 December 1995.
Endangered Species Protection Act 1992	With the enactment of the *Endangered Species Protection Act 1992* the Commonwealth has directly legislated for the preservation of flora and fauna. The Act operates in respect of Commonwealth areas and activities which require the approval of Commonwealth agencies. The legislation provides for the listing of endangered, vulnerable, presumed extinct native species, ecological communities that are endangered and key threatening processes. Where a species or community is listed, the Commonwealth is obligated to prepare a recovery plan or a threat abatement plan in the case of a key threatening process. The Act provides for the making of various types of conservation orders. The purpose of such orders is to protect listed species and communities in the immediate and longer term.

(b) New South Wales

LEGISLATION	EFFECTS
Prickly Pear Act 1987	This Act gives authority to the Department of Agriculture for research on, and control and destruction of, Prickly Pear.
Non-Indigenous Animals Act 1987	The Act classifies animals that are not indigenous to Australia into categories, including animals which pose a threat to the health or safety of native fauna, or which need to be controlled to limit their pest potential.
Rural Lands Protection Act 1989	This Act is the principal one regulating vertebrate pest management. It established 57 autonomous Rural Lands Protection Boards which are responsible for ensuring pest management, including locust control, within their respective areas. The Department of Conservation and Land Management, which administers the *Crown Lands Act 1989* and the *Western Lands Act 1901*, has overall responsibility for leased Crown Land, approximately 40 percent of the State. Orders can be issued relating to destocking or pest animal control.
Commons Management Act 1989	Under this Act, the Trust of a Common is responsible for the control of declared animals and weeds on the Common.
Noxious Weeds Act 1993	This Act regulates the control of all declared noxious weeds except Prickly Pear. Various categories of control are specified, similar to those in the Queensland Rural Lands Protection Act.

(c) Victoria

LEGISLATION	EFFECTS
Vermin and Noxious Weeds Act 1958	In Victoria the various pieces of legislation relating to national parks also have the function of controlling pests, plants and animals in order to protect the integrity of plants. The *Vermin and Noxious Weeds Act 1958* provides for the control of noxious weeds and pests on private land. This Act is regulated by the Department of Conservation and Natural Resources. It establishes the Land Protection Council, which has as one of its functions, vertebrate pest management.
Catchment and Land Protection Act 1994	This newly enacted piece of legislation creates Regional Catchment and Land Protection Boards, and a Pest Animal Advisory Committee which will coordinate and monitor the control of pest animals in the State. Part 8 of the Act classifies prohibited weeds and pest animals, establishes control mechanisms and creates offences relating to the importing, keeping and trading of pest animals and plants.

(d) Western Australia

LEGISLATION	EFFECTS
Agriculture Protection Board Act 1950 *Agriculture and Related Resources Protection Act 1976*	The Agriculture Protection Board is constituted under the *Agriculture Protection Board Act 1950*. The *Agriculture and Related Resources Protection Act 1976* is the principal Act for pest and weed management, and is administered by the Agriculture Protection Board.
Wildlife Conservation Act 1950	The *Wildlife Conservation Act 1950* prohibits the release of animals in any part of the State where that species is not normally found in the wild. It also bans the importation or keeping of any animal with habits or a nature which might "become or threaten to become injurious to fauna" (section 17(2)(f).
Argentine Ant Act 1968	This Act regulates the control and destruction of Argentine Ants.

(e) South Australia

LEGISLATION	EFFECTS
Animal and Plant Control (Agricultural Protection and Other Purposes) Act 1986	In South Australia the *Animal and Plant Control (Agricultural Protection and Other Purposes) Act 1986* applies to noxious weeds and feral animals. It establishes the Animal and Plant Commission which reports to the Minister for Primary Industries. The Act requires land owners and occupiers to control pests proclaimed under the Act.
National Parks and Wildlife Act 1972	The *National Parks and Wildlife Act 1972* prohibits the release of protected or controlled species from captivity without a permit. This is used as a mechanism to prevent the release of pest species. It also regulates the use of poisons to deal with noxious weeds and pests.

(f) Tasmania

LEGISLATION	EFFECTS
Vermin Destruction Act 1950	The *Vermin Destruction Act 1950* regulates the management of declared vermin, currently only rabbits. It is administered through the Animal Health Branch of the Department of Primary Industry and Fisheries. Other major pests are native animals which are controlled through permits issued under the *National Parks and Wildlife Act 1970*.
Noxious Insects and Molluscs Act 1951	This Act provides for the control and management of Argentine Ants and other declared noxious insects, molluscs of the genus *Lymnea*, and other declared noxious molluscs.
Noxious Weeds Act 1964	This Act provides for the control and management of declared noxious weeds, under the authority of the Department of Agriculture.
National Parks and Wildlife Act 1970	There are provisions in the *National Parks and Wildlife Act 1970* which prohibit the import or release of certain noxious species including the dingo, fox, wolf and mink.

Plant Protection Bill 1994	If passed and proclaimed, the Plant Protection Act will replace the *Noxious Insects and Molluscs Act 1951* and the *Noxious Weeds Act 1964*.

(g) Australian Capital Territory

LEGISLATION	EFFECTS
Rabbit Destruction Act 1919	This Act regulates rabbit control in the ACT.
Nature Conservation Act 1980	In the ACT, plants and animals are protected under the *Nature Conservation Act 1980*. Specifically, there are provisions which prohibit the introduction of non-wildlife or noxious species into any reserve area. The licensing provisions in the Act prohibits the keeping of species without a permit providing a control mechanism in relation to introduced species. The Parks and Conservation Service has primary responsibility for vertebrate pest management in the national park and nature reserves that represent 40 percent of the ACT. Conservation officers have certain powers of entry onto private land and enforcement powers in relation to plant and animal protection, use of herbicides and poisons, and the treatment of diseased wildlife.

(h) Northern Territory

LEGISLATION	EFFECTS
Stock Disease Act 1954	Feral animals are controlled for disease reasons. This legislation provided the basis of buffalo and cattle control under the national Brucellosis and Tuberculosis Eradication Campaign (BTEC).
Soil Conservation and Land Utilisation Act 1969	The Government requires the removal of excess stock including feral animals if stocking rates result in degradation.
Territory Parks and Wildlife Conservation Act 1976	The *Territory Parks and Wildlife Conservation Act 1976* regulates the use of parks, reserves, sanctuaries and protected areas. If the Director of Territory Parks and Wildlife is satisfied that the existence of feral animal in an area threatens the survival of native animals or their habitat, the feral animal may be destroyed. There are provisions

	which create "prohibited entrants" which may not be imported into the Territory without proper authority. The Government can order a property owner to control feral animals provided the animal is a declared pest and the land involved is a declared pest control area.

5. CONCLUSION

> "With the exception of four animals; the kangaroo, koala, emu and platypus, Australians have been contemptuous of their wildlife and have been content to watch it disappear from their backyards, their farms and finally their wilderness"[112].

As many commentators[113] have observed, humans have been spectacularly successful in the unintentional extermination of some species and remarkably unsuccessful in attempts at eradicating pest species through direct population reduction.

> "Feral animals and invasive plants play a pivotal role in the long term health and sustainability of Australian society and environment. They destroy or compete with indigenous Australian flora and fauna in a variety of ways. They are damaging the regenerative capacity of the Australian environment and they affect the success of environmental restoration, revegetation and rehabilitation program.
>
> The problem of feral animals and invasive exotic plants has defied more than a century of legislation and is currently costing the community billions of dollars a year. Weeds are said to cost $3 billion per annum[114]. There are 848 species of `naturalised' alien plants in Western Australia, of which 458 are found in national parks and other conservation lands; around 40 of these are considered threats to indigenous ecosystems[115]. Although there is no definitive study of the costs of feral animals to agriculture, it is estimated by officers of the Bureau of Resource Sciences to be in the order of hundreds of millions of dollars. There are at least 25 species of introduced mammals in Australia that have established wild populations. An outbreak of exotic diseases such as foot and mouth disease could be spread by the feral pig and goat population, and it is estimated that it could cost Australia

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112 Chris Gallus, `Speech to the Young Liberal Conference on Environmental Issues', Sydney, 5 January 1994, *Significant Speeches*, 1 March 1994, pp.19-21.

113 See Caughley, G., *Analysis of Vertebrate Populations*, John Wiley and Sons, Chichester, 1975, and Gosling, M., `Extinction to Order', *New Scientist*, 4 March 1989, pp.44-49.

114 Department of Primary Industries and Energy, *Towards a National Weeds Strategy*, DPIE, Canberra, 1992.

115 G.J. Keighery, `Environmental Weeds of Western Australia', In *Kowari: Plant Invasion*, ed S. Humphries, Australian National Parks and Wildlife Service, Canberra, pp.180-182.

$9 billion annually were it to occur".[116]

The costs of weeds to agriculture in terms of post-production quality downgrading and herbicide expenditure are well documented, as are the costs of programs to control weeds on waterways. On the other hand, the costs of soil loss, land degradation and loss of biodiversity are largely unquantified. Human health costs associated with plant-induced allergy and asthma problems are also poorly quantified and understood. An appropriate analytical approach to determine the costs and benefits of weed control in wilderness areas and rangelands still needs to be developed[117].

There is no specific mention of the environment in the Australian *Constitution* and prime responsibility for environment and conservation matters rests with the States and Territories. Nevertheless, the Federal Government has power to enact laws affecting the environment, through the external affairs power. Moreover, Commonwealth legislation has supremacy over that of the States. As a consequence, responsibility for the environment is shared between the Federal, State and Territory governments. This creates complexities resulting in a lack of coordinated legislation for the management of the feral animal and plant problem. Legislation though is only one of the solutions.

The difficulties of management are exacerbated by the complicated procedures necessary to have a plant or animal declared as a pest, as well as the acceptance of financial responsibility for control measures and management. The demarcation problem between different parts of the bureaucratic system inhibit constructive management. Also management programs tend to differ between state borders - borders feral animals do not recognise. To solve this problem, Gary Burke of Murdoch University suggests a massive awareness campaign to enhance ecological awareness, along the lines of QUIT or AIDS campaigns[118].

Eradication of feral plants and animals from Australia's landscape appears almost impossible. Containment is within reach, but it involves a concerted effort and coordination of resources and programs.

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[116] Gary Burke, `Feral Animals and Invasive Plants: Who's Feral? Whose Ferals?', In *Facing the Future: Proceedings of the Ecopolitics VII Conference*, eds Barabara Jolly and Ian Holland, Griffith University, July 1993, pp.95-100.

[117] Department of Primary Industries and Energy, p.2.

[118] Burke, p.96.

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APPENDIX A

DECLARED PLANTS IN QUEENSLAND

(As at 1 September 1994)

PLANT	CATEGORY	PARTS OF THE STATE
Acacia species (all thorny species not indigenous to Australia, other than *A. nilotica*)	P1	Whole
African boxthorn (*Lycium ferocissimum*)	P3	Whole
Alligator weed (*Alternanthera philoxeroides*)	P1, P2	Whole
Anchored water hyacinth (*Eichhornia azurea*)	P1	Whole
Annual ragweed (*Ambrosia artemisiifolia*)	P3 P2	Local government areas of: Albert Beaudesert Logan Stanthorpe Remainder of the State
Austroeupatorium inulaefolium	P1	Whole
Badhara bush (*Gmelina asiatica*)	P2	Whole
Bathurst burr (*Xanthium spinosum*)	P3	Whole
Bitou bush (*Chrysanthemoides monolifera*)	P2	Whole
Blackberry, Florida (*Rubus argutus*) Syn: *R. penetrans*	P1	Whole
Blackberry (*Rubus fruticosis*)	P3	Local government area of: Stanthorpe
Cabomba (*Cabomba caroliniana*)	P2	Local government areas of: Atherton

		Eacham Johnstone Mulgrave
Chinee apple (*Ziziphus mauritiana*)	P3	Whole
Christ thorn (*Zizyphus spina-christi*)	P1	Whole
Crofton weed (*Eupatorium adenophorum*)	P3	Whole
Dwarf arrowhead (*Sagittaria pygmaea*)	P1	Whole
Eurasian watermilfoil (*Myriophyllum spicatum*)	P1	Whole
Fireweed (*Senecio madagascariensis*)	P3, P4 P2	Local government areas of: Albert Beaudesert Boonah Ipswich Logan Moreton Remainder of the State
Giant bramble (*Rubus alceifolius*)	P3	Local government areas of: Eacham Johnstone Mulgrave
Giant rats tail grass (*Sporobolus pyramidalis*)	P4	Whole
Giant sensitive plant (*Mimosa invisa*)	P2	Whole
Giant sensitive tree (*Mimosa pigra*)	P1, P2	Whole
Green cestrum (*Cestrum parqui*)	P3	Local government areas of: Beaudesert Boonah Caloundra Ipswich Laidley Moreton
Groundsel bush (*Baccharis halimifolia*)	P3, P4	Local government areas of: Albert

	P3	Brisbane Caboolture Caloundra Cooloola Gold Coast Ipswich Logan Maroochy Noosa Pine Rivers Redcliffe Redland Remainder of the State
Harrisia cactus (*Eriocereus* spp.)	P2 P3	Local government areas of: Banana Duaringa Emerald Fitzroy Jericho Livingstone Mt Morgan Rockhampton Remainder of the State
Hemlock (*Conium maculatum*)	P2	Whole
Honey locust tree (*Gleditsia triacanthos*)	P2	Whole
Horsetails (all *Equisetum* spp.)	P1	Whole
Kochia (*Kochia scoparia*)	P1	Whole
Koster's curse (*Clidemia hirta*)	P1	Whole
Madras thorn (*Pithecellobium dulce*) Syn: *Mimosa dulcis*	P1	Whole
Mesquites (*Prosopis* spp.) *P. glandulosa* and *P. limensis* *P. flexuosa* (Quilpie mesquite) All other *Prosopis* spp.	 P3 P2 P1, P2	 Whole Whole Whole
Mikania vine (all *Mikania* spp.)	P1	Whole
Milkweed	P3, P4	Local government areas

(*Euphorbia heterophylla*)	P4 P2	of: Atherton Bowen Burdekin Cairns Cardwell Cook Douglas Eacham Hinchinbrook Johnstone Mackay Mareeba Mulgrave Pioneer Sarina Thuringowa Townsville Whitsunday Local government areas of: Bundaberg Gooburrum Isis Kolan Woongarra Remainder of the State
Mistflower (*Eupatorium riparium*)	P3	Whole
Navua sedge (*Cyperus aromaticus*)	P3	Whole
Noogoora burr (*Xanthium pungens*)	P3	Whole
Oxygen weed (*Lagarosiphon major*) Syn: *Elodea crispa*	P1, P2	Whole
Parkinsonia (*Parkinsonia aculeata*)	P3 P2	Catchment areas of the: Fitzroy and Burdekin river systems; and Lake Eyre systems (other than Diamantina, Barcoo, Quilpie and Bulloo Shires); and Gulf rivers systems (other than Mareeba, Cook and Aurukun Shires)

		Remainder of the State
Parthenium weed (*Parthenium hysterophorus*)	P3, P4 P2	Local government areas of: Bauhinia Belyando Bowen Broadsound Dalrymple Duaringa Emerald Fitzroy Nebo Peak Downs Remainder of the State
Perennial ragweed (*Ambrosia psilostachya*)	P3	Whole
Peruvian primrose (*Ludwigia peruviana*)	P1	Whole
Prickly acacia (*Acacia nilotica*)	P3 P2	Local government areas of: Aramac Bowen Flinders McKinlay Richmond Remainder of the State
Prickly pears (*Opuntia* spp., other than *O. ficus-indica*)	P3	Whole
Red sesbania (*Sesbania punicea*)	P1	Whole
Romerillo (toxic groundsel) (*Baccharis coridifolia*)	P1	Whole
Rubber vine (*Cryptostegia grandiflora*)	P3	Local government areas of: Calliope Banana Duaringa Bauhinia Jericho Barcaldine Ilfracombe Longreach Winton Boulia and all local

	P2	government areas to the north of the line formed by the areas specified. Remainder of the State
Sacramento burr (*Triumfetta semitriloba*)	P1	Whole
Saffron thistle (*Carthamus lanatus*)	P3	Whole
Salvinia spp. (other than *S. molesta*)	P1	Whole
Salvinia (*Salvinia molesta*)	P2 P3	The Murray-Darling catchment area Remainder of the State
Senegal tea plant (*Gymnocoronis spilanthoides*)	P1	Whole
Siam weed (*Chromolaena odorata*)	P1, P2	Whole
Sicklepod (*Cassia obtusifolia*)	P3, P4 P2	Local government areas of: Bowen Burdekin Cairns Cardwell Cook Douglas Hinchinbrook Johnstone Mackay Mulgrave Pioneer Proserpine Sarina Thuringowa Townsville Remainder of the State
Spiny emex (*Emex australis*)	P2	Local government area of: Atherton
Thornapples (*Datura ferox, D. meteloides, D. stramonium, D. tatula*)	P3	Whole
Thunbergia (*Thunbergia grandiflora*)	P2	Local government areas of: Cairns

		Cardwell Cook Douglas Hinchinbrook Johnstone Mulgrave
Tobacco weed (*Elephantopus mollis*)	P2	Whole
Tropical pickerelweed (*Pontederia rotundifolia*)	P1	Whole
Water chestnuts (all *Trapa* spp.)	P1	Whole
Water hyacinth (*Eichhornia crassipes*)	P2 P3	The Murray-Darling catchment area Remainder of the State
Water lettuce (*Pistia stratiotes*)	P2 P3	The Murray-Darling catchment area Remainder of the State
Witchweeds (all *Striga* spp. not indigenous to Australia)	P1	Whole
Yellow burr-head (*Limnocharis flava*)	P1	Whole

Source: Rural Lands Protection Regulation 1989

APPENDIX B

DECLARED ANIMALS IN QUEENSLAND

(As at 1 September 1994)

PART 1 - MAMMALS

ANIMAL	CATEGORY	PARTS OF THE STATE
Alpaca (*Lama pacos*)	A4, A6	Whole
Agouti (*Dasyprocta myoprocta*)	A4, A6	Whole
Baboon: Olive (*Papio cynocephalus*) Sacred (*Papio hamadryas*)	A4, A6	Whole
Bali cattle (*Bos sondaicus*)	A4, A6	Whole
Bear: Himalayan (*Selenarctos thibetanus*) European (*Helarctos arctos argos*) Sun (*Helarctos malayanus*) Canadian Grizzly (*Ursus arctos*)	A4, A6	Whole
Cattle (*Bos* spp.)	A2	Inside the livestock buffer zone
Cricetinae (family): Hamsters of the genera *Mesocricetus* and *Cricetus* and gerbils and jirds of the genera *Gergillus, Tatera, Taterillus and Meriones*	A1, A2, A3	Whole
Deer: Chital (*Cervus axis*) Sambar (*Cervus unicolor*) Rusa (*Cervus timorensis*) Hog (*Cervus porcinus*) Red (*Cervus elaphus*) Fallow (*Cervus dama*) Wapiti (*Cervus canadensis*)	A4, A6	Whole

Dingo (*Canis familiaris dingo*)	A1, A3, A5	Whole
Dingo hybrids (*Canis familiaris*)	A1, A3, A5	Whole
Elephant, Asia (*Elephas maximus*)	A4, A6	Whole
Feral buffalo (*Bubalus bubalus*)	A1, A2, A6	Whole
Feral camel (*Camelus dromedarius*)	A2, A4, A6	Whole
Feral dog (*Canis familiaris*)	A1, A3, A5	Whole
Feral donkey (*Equus asinus*)	A2, A4, A6	Whole
Feral goat (*Capra hircus*)	A2, A4, A6	Whole
Feral horse (*Equus caballus*)	A2, A4, A6	Whole
Feral pig (*Sus scrofa*)	A1, A2, A6	Whole
Fox (*Vulpes vulpes*)	A1, A2, A3	Whole
Hare (*Lepus capensis*)	A1, A2, A3	Whole
Herpestinae (family): all genera	A1, A2, A3	Whole
Himalayan Tahr (*Hermitragus jemlahicus*)	A4, A6	Whole
Leopard (*Panthera pardus*)	A4, A6	Whole
Liger (*Panthera leo-tigris*)	A4, A6	Whole
Lion (*Panthera leo*)	A4, A6	Whole
Llama (*Lama glama*)	A4, A6	Whole
Monkey: Macaque (*Macaca* spp.) Marmoset (*Callithrix jacchus*) Rhesus (*Macaca mulatta*) Spider (*Ateles* spp.)	A4, A6	Whole

Mustelidae (family): Stoats, weasels and mink of the genus *Mustela* including domestic ferret, *M. furu*	A1, A2, A3	Whole
Panther (*Panthera pardus*)	A4, A6	Whole
Pig (*Sus scrofa*)	A2	Inside the livestock buffer zone
Puma (*Felis concolor*)	A4, A6	Whole
Rabbit (*Oryctolagus cuniculus*)	A1, A2, A3	Whole
Racoon (*Procyon lotor*)	A4, A6	Whole
Tiger (*Panthera tigris*)	A4, A6	Whole
Vicuna (*Vicugna vicugna*)	A4, A6	Whole
Mammals other than: (a) Those listed above (b) Those indigenous to Queensland (c) Black rat (*Rattus rattus*) Brown rat (*R norvegicus*) Cat (*Felis catus*) Cattle (*Bos taurus* and domesticated *B. indicus*) Donkey (*Equus asinus*) Goat (*Capra hircus*) Guinea pig (*Cavia porcellus*) Horse (*Equus caballus*) House mouse (*Mus musculus*) Pig (*Sus scrofa*) Sheep (*Ovis aries*) Marine mammals of the orders: *Cetacea* (whales) *Pinnipedia* (seals, walruses) *Sirenia* (dugongs,	A1, A2, A3	Whole

seacows)		

PART 2 -REPTILES

ANIMAL	CATEGORY	PARTS OF THE STATE
Alligator snapping tortoise (*Chelydra serpentina*)	A4, A6	Whole
American alligator (*Alligator mississipiensis*)	A4, A6	Whole
American cornsnake (*Elaphe guttata*)	A4, A6	Whole
Boa constrictor (*Boa constrictor*)	A4, A6	Whole
Burmese python (*Python molurus*)	A4, A6	Whole
Reticluated python (*Python reticulatus*)	A4, A6	Whole
All species indigenous to Australia but not indigenous to Queensland	A4, A6	Whole
All other species not indigenous to Australia	A1, A2, A3	Whole

PART 3 - INSECTS

ANIMAL	CATEGORY	PARTS OF THE STATE
Australian plague locust (*Chortoicetes terminifera*)	A8	Whole
Migratory locust (*Locusta migratoria*)	A8	Whole
Spur throated locust (*Austracris guttulosa*)	A8	Whole

Source: Rural Lands Protection Regulation 1989

APPENDIX C

SCIENTIFIC NAMES OF SPECIES NOT IN APPENDICES A OR B

This appendix lists scientific names of plants and animals mentioned in the text, that are not included in Appendices A or B.

Plants

Budda (*Eremophila mitchellii*)
Castor Oil plant (*Ricinus communis*)
Common heliotrope *(Heliotropium europeaum)*
Oleander (*Oleander* spp.)
Skeleton weed (narrow-leaf form) (*Chondrilla juncea*)
St John's wort *(Hypericum perforatum)*
Turpentine bush (*Eremophila sturtii*)

Animals

European rabbit flea (*Spilopsyllus caniculi*)
Keelback snake (*Tropidonophis mairii*)
North Pacific seastar (*Asterias amurensis*)
Screwworm fly (*Chrysomya bezziana*)
Spanish rabbit flea (*Xenopsylla cunicularis*)