Commercial Use of Wild Animals

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Department of Primary Industries and Energy
Bureau of Resource Sciences

Commercial use of wild animals in Australia

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The Bureau of Resource Sciences is a professionally independent Bureau in the Department of Primary Industries and Energy. It was formed in October 1992 from the existing Bureau of Rural Resources and the resource assessment branches of the former Bureau of Mineral Resources.

The Bureau's role is to support the sustainable development of Australia's agricultural, mineral, petroleum, forestry and fisheries industries by providing scientific and technical advice to government, industry and the community.

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Agricultural man spread himself about the globe dragging with him a small handful of species and a set pattern of husbandry, carrying them beyond their natural boundaries. Thus, he forced exotic species and practices upon strange and often fragile environments—overgrazing, destroying natural ground cover with his plough, creating dust bowls, and driving out the native species. Often it was a history of early success that was prelude to defeat by an exhausted and desiccated earth. The flow of life had been interrupted...

To achieve an agriculture that is as gentle as possible with nature, man will need to domesticate many of the inviting species native to a given region and utilise them within that natural environment with which they are in harmony and best able to cope.

John J. Teal

The late John Teal was involved in saving the declining musk oxen populations in Alaska by successfully domesticating the species. This quote was taken from a paper by Bostid (1991), which was given at the Second International Wildlife Ranching Symposium in Edmonton, Canada. Teal's point about fitting the animal to the environment is a significant one, and emphasises the need for a fundamental change in attitude if a more sustainable agriculture is to be achieved in Australia and throughout the world.

FOREWORD

The trade in wild animals and their products is small compared with the scale of Australia's mainstream animal industries. Nonetheless, industries based on wild animals have been expanding in recent years and there are good prospects for continued growth. Provided these animals can be harvested humanely and, in the case of native animals, sustainably, wild animals are potentially profitable supplements and alternatives to domestic animal production. Their harvest can also make a valuable contribution to achieving conservation and pest management goals.

However, there are virtually no published data describing the activities of wild animal industries and their operating environment. Data on the number of wild animals harvested, the regions harvested, the characteristics and trends in domestic or export markets, or the value of products and trade are sparse and incomplete. Further, little is known of the capacity of these industries to gather market intelligence, monitor markets, distribute information and coordinate promotion.

Fundamental trade data are needed to determine the status, performance and potential of industries based on non-traditional livestock. There are accurate data on the volume of trade in native animals because it is carefully monitored by conservation authorities, but data on the trade in introduced wild animals are scarce.

This report was produced as the major output of a research project at the Bureau of Resource Sciences to examine ways of increasing the value of wild animal exports. The work was funded by the Rural Industries Research and Development Corporation, the Bureau of Resource Sciences Vertebrate Pests Program and the Australian Game Meat Producers Association.

The Bureau of Resource Sciences anticipates that the information presented in this report will provide the basis for more informed discussion of the opportunities and impediments for development of wild animal industries, and for wildlife management generally.

Neil Williams
Executive Director
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Overview and findings

1 INTRODUCTION

Humans have always used wild animals as a source of food, clothing, fibre and medicines. Wildlife is still important to human welfare in many parts of the world, but its use has been largely supplanted by modern agriculture, particularly in developed countries. Domesticated species will continue to be the primary source of food and fibre for humans, but compelling economic, social and environmental arguments are emerging in support of a reappraisal of the potential for using wildlife. Wild animals can be used to diversify and enhance the productivity of farming systems, particularly on lands that are marginal for conventional agriculture.

The world trade in wild animals and their products is already a multi-billion dollar industry (Fitzgerald 1989; Hoffman 1991). Australia has a small share of this trade, but has an abundance of wild native and introduced animals with commercial potential. This document explores the prospects and opportunities for Australia to develop a profitable, sustainable trade in wild animals and their products.

The economically efficient farming systems of the 1990s are based on a few highly selected species, and many natural ecosystems have been removed or extensively modified to accommodate these favoured species. The adverse environmental impacts of modern farming systems are now attracting increasing public concern, due to their negative impact on biological diversity and soil and water quality.

Incorporating indigenous animals into agricultural production systems makes good economic and environmental sense. Native animals are superbly adapted to their natural environment. They have the capacity to survive local environmental extremes such as drought, are resistant to indigenous diseases and parasites, and can yield unique products for lucrative niche markets. Developing industries based on indigenous species is one strategy for building the competitive advantage of a nation's rural and associated manufacturing industries.

Besides the obvious commercial incentives for developing the trade in wild animals, there are many environmental benefits. Farming and sustainable harvesting of native species are now recognised in international fora and within Australia as potentially powerful tools for ensuring the conservation of species and habitats. This approach involves a transition away from specialisation with a single species, towards multi-species grazing systems that make the best use of the available natural foods. A feature of such a transition is that it offers the potential for productivity improvements without large increases in inputs. It also offers the prospect of rehabilitating degraded habitats through the adoption of farming systems that are more in tune with the natural environment.

Australia's opportunities in developing industries based on wild animals are not restricted to native species. Many introduced wild and domestic animals have established large populations, and have significant commercial potential. These introduced species are regarded as pests and can cause extensive agricultural and environmental damage. Landowners and government agencies expend considerable resources to reduce the abundance and distribution of introduced vertebrate pests. Commercial harvesting of these species can make a valuable contribution to more cost-effective pest management.

Commercial use of wild animals is innovative and controversial, but is not a recent development in Australia. Wild animals have been harvested for profit in Australia for roughly two centuries. Early European settlers killed millions of native animals, including kangaroos, wallabies, possums, fur seals and koalas for their skins, and muttonbirds for meat, oil and feathers (Thompson et al. 1987). Koalas and fur seals are now fully protected, but controlled harvests of other native animals still occur.

In focussing on developing industries based on introduced domestic species, Australia has not taken full advantage of its wild animals and plants. In illustrating this failure, Spierre (1992) pointed out that other

countries have been quick to recognise and exploit the potential of Australia's genetic resources.

- The largest producer of (and the first nation to domesticate) the Australian native nut, the macadamia, is the United States.
- The world's largest producer of eucalyptus oil is Portugal.
- The world's largest producer of woodlot eucalyptus timber is Brazil, followed by China.
- The first nation to take out a worldwide patent on the waratah was New Zealand. It was named the 'Kiwi Rose'.
- The world's largest producers of Australian native wildflowers (kangaroo paw and boronia) are Holland and Israel.
- The first nation to farm the barramundi and mud crab was Thailand, which is still the largest producer.
- The world's largest desert revegetation programs using Australian native arid-adapted plants are in Israel and South Africa.
- The world's main breeding programs for Australian native arid-adapted plants occur in Israel, the US, China and South Africa. (Australian farmers are now importing species such as the Australian saltbush to revegetate degraded land.)

While other nations have recognised and exploited our natural resources, Australians have placed great emphasis on pest control rather than recognising that wild animals can have a resource value and managing them accordingly. The goal has been to foster industries based on introduced domestic species rather than to seize new opportunities. Each year millions of wild, introduced and native animals are shot, poisoned, trapped and rounded up for the primary purpose of pest control. Commercial harvesting has a role in this pest management, but the size of the industries involved could be greatly expanded, and there is scope for increasing profitability by further processing and developing exports.

Perhaps the biggest challenge facing the development of wild animal industries in Australia is that of changing past attitudes and recognising that wild animals are potentially profitable supplements and alternatives to domestic animal production. Legislative impediments are also a major issue to be addressed before wild animal industries can reach their potential.

Australian laws and attitudes have begun to change over the past decade in favour of better management and use of our wild indigenous and introduced genetic resources. For example:

- Following a recommendation by the (then) Council of Nature Conservation Ministers in 1989, kangaroo management plans were amended in 1992 in Queensland, New South Wales and Western Australia to include an objective to manage kangaroos as a renewable resource, providing this does not compromise conservation of species or habitats.
- An emu farming industry has been developing since 1987, and in 1990–91 Australia surpassed the USA as the world's largest producer of emus.
- Farming of Australian freshwater and saltwater crocodiles for meat and skins has developed rapidly since 1986.
- Australia entered the wild boar game meat export trade in 1980, and now rivals Poland as the world's largest exporter. Australian wild boar meat exports are now worth around $20m annually.
- Feral goats have formed the basis of a profitable, export-oriented fibre and meat industry. During the 1980s Australia became the world's largest exporter of goat meat.
- Wild rabbit meat exports recommenced in 1989 and have since expanded rapidly, although the industry has been constrained by supply problems because rabbit populations crashed following the widespread drought in western New South Wales and south-west Queensland in 1991–92.

1.1 Background to this study

Wild animals in Australia are the subject of a wide range of cultural values and attitudes which can present a management dilemma for government agencies (Wilson 1987) and complicate the operation and development of industries using wild animals. Introduced wild animals are managed as pests of agriculture and the environment, and as potential vectors for exotic diseases. However, these species can simultaneously have a value for recreational and commercial hunting. Similarly, native animals such as kangaroos are agricultural pests, a national symbol, and the basis for a substantial commercial industry. However, management of wild animals with commercial potential has tended to retain an overwhelming emphasis on pest control rather than adopting a more flexible approach to multiple use.

Those studies that have explored the options for more flexible management of wild animals with commercial potential have tended to focus on a single species (e.g. Tisdell 1982; O'Brien 1987). Most studies have been limited by the lack of accurate quantitative and qualitative data on the operations of wild animal industries. The Bureau of Resource Sciences identified a need to draw together information on the use of a variety of species to provide a national perspective on the opportunities and impediments for wild animal industries.

The Bureau was successful in receiving funding from the Rural Industries R&D Corporation and the Australian Game Meat Producers Association for this study into ways of increasing the value of wild animal exports.

1.2 Objectives and scope

Krostitz (1985) and Luxmoore (1989) observed that accurate quantitative information on the volume, value and patterns of international and domestic trade in wild animal products is lacking. It is undeniable that wild animals make an economic contribution, but the scale and stability of the trade remain obscure in the absence of data. Detailed information is essential for wise resource management and for the formulation of policies and strategies to develop sustainable, profitable wild animal industries. The objectives of this report are to:

- provide a detailed quantitative outline of the variety, number and value of wild animals that are now used commercially in Australia. This includes a description of the methods used and products traded;
- identify the potential for and impediments to increasing the export value of wild animals. This includes an outline of the marketing and wildlife management implications for the industries concerned; and
- discuss options and strategies for facilitating the development of wild animal industries in Australia and expanding their contribution to export earnings.

Wild animals are killed or captured for many reasons, including pest control, recreation, subsistence, and for research. But the emphasis of this report is on species that are killed or captured for commercial reasons. In addition, the focus of the report is on animals that are taken from free-ranging wild populations rather than on species that are farmed. Nonetheless, wild stock have formed the basis of new farming industries such as the goat fibre, buffalo, emu and crocodile industries.

Sport hunting is beyond the scope of this report. Most wild animals that are shot for sport in Australia are not taken in game parks or hunted under commercial arrangements such as guided safari hunts. Nonetheless, with declining access to hunting resources in Australia and overseas and a growing demand for these resources, there are prospects for sport hunting to be put on a more commercial footing.

1.3 Methods

The information presented in this report was prepared from an extensive literature review, numerous interviews with participants from wild animal industries and government officials in Australia and overseas, and from international trade statistics held by the Australian Bureau of Statistics and equivalent overseas agencies. Values presented in foreign trade statistics were converted to Australian dollars using the exchange rates listed in the Reserve Bank of Australia Bulletin.

Import statistics provided by overseas agencies were often difficult to acquit against Australian export statistics. This could be due to several factors, such as the delay between shipment and receipt of goods and different reporting conventions. For example, financial years may end on 30 June or on 31 December; the units of quantity can vary and may be recorded by number, weight or, in the case of skins and hides, be measured in square metres; or commodities may be broken down in detail, such as 'frozen unboned hams, shoulders and cuts thereof of non-domestic swine' or lumped in a general category such as 'game meat'.

It is important to realise that the destination nominated in export statistics may not necessarily be the country of consumption. Products or animals may pass through several countries before consumption, or be processed to a further stage before re-export.

Australian Bureau of Statistics data on exports of various products are extracted from specific Australian Harmonised Export Commodity Classification (AHECC) codes. The AHECC codes have been in place since January 1988. A list of these current codes, which were used in this report, is in the Appendix. Previous codes used in this report are taken from the Australian Export Commodity Classification, which ceased to be used in December 1987.

There are two other important sources of information on trade in Australian wild animal products. These are the Australian Nature Conservation Agency (formerly the Australian National Parks and Wildlife Service) which monitors the harvest and export of native animal products, and the Australian Quarantine and Inspection Service which provides inspection and certification services for all animal products and livestock exported. However, neither of these agencies can provide information on the value of products traded.

All values shown are current Australian dollars, unless stated otherwise.

2 CONCEPTS AND PRINCIPLES

Commercial use of wild animals is controversial (Wilson 1987; Ramsay & O'Brien 1991). Some groups are philosophically opposed to the use of wildlife or killing of animals for moral reasons. Others are concerned that harvesting might compromise the conservation of native species or be carried out in a manner which is unacceptable from an animal welfare viewpoint. There is also conflict in Australia between pest control authorities, landowners and commercial industries over the use of introduced wild animals which are being managed as pests (Ramsay & O'Brien 1991). In addition, wild animal industries are anxious to ensure a sustainable supply of animals for trade, and will lobby government for a legislative framework that will allow efficient operation of their enterprises. Finally, Aboriginal attitudes to killing wild animals vary depending on the region and species of animal, but most regard wild animals as a resource and abhor the waste associated with pest control campaigns (Wilson, McNee & Platts 1992).

Community attitudes to the use of wild terrestrial animals vary markedly from those toward commercial fisheries. Wilson, McNee and Platts (1992) observed that it seems widely acceptable to harvest abundant populations of fish and crustaceans, but at the same time there is community reticence to make full use of abundant populations of wild terrestrial animals. Similarly, the authors noted the fundamental divergence in attitudes between killing introduced domestic stock and killing wild species that evolved in Australia.

Although there are divergent attitudes within the Australian community towards the use of wild animals, there are basic principles and concepts which provide a framework for rational development of profitable wild animal industries that can generate benefits for individuals and for society. These principles and concepts are discussed below. But firstly, an overview of the legislative framework provides a useful insight into the environment within which wild animal industries operate.

2.1 The legal framework governing trade in wild animals

There are several levels and types of legal controls over the trade in wild animals and their products. The main types of legislation are:

- international agreements, which are open to all countries, and aim to regulate and monitor trade in wildlife;
- legislation by individual countries to restrict imports of wildlife species which they determine are threatened by commercial use;
- legislation by individual countries to set minimum standards for import of products such as meat for human consumption;
- legislation within individual countries to conserve or protect native species and to control introduced species; and
- legislation within individual countries to ensure minimum standards are met for the processing of wild animal products such as meat for domestic and export markets.

Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)

The major international agreement governing trade in wildlife is the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). CITES has been in effect since 1975, when Australia and 69 other countries became signatories. By 1992, 103 countries were party to the CITES agreement (Broad et al. 1992).

CITES aims to establish worldwide control over trade in endangered species and their products. This is in recognition that wild animal populations and plant communities can be overexploited by unrestricted trade.

Wildlife is a renewable resource, but only if the management program in place does not permit an unsustainable rate of harvesting. However, CITES also firmly recognises that when the rate of harvesting is sustainable, commercial trade may be beneficial to the conservation of species and ecosystems (Broad et al. 1992).

CITES classifies endangered species into three categories:

Appendix 1: Species threatened by extinction. International trade in these species (for example, giant pandas) is not permitted, except for scientific purposes.

Appendix 2: Species that may become threatened with extinction unless trade is regulated. International trade in these species is permitted only with proper documentation.

Appendix 3: Species that individual countries wish to protect and for which they seek the cooperation of others.

Trade restrictions by importing countries

Countries with a large consumer market for wild animal products can introduce import restrictions on particular products or species, and have a major impact on the trade. The type of restrictions range from a total ban on imports to a ready trade if certain conditions are met. These conditions typically relate to conservation and/or animal welfare concerns.

The European Community (EC) and the USA are major world markets for wildlife products, particularly furs, skins and game meats. Both the EC and the USA have enacted legislation to regulate the import of particular wildlife products. One of the most well-known examples was when the Council of the European Community issued a directive banning the import of raw, tanned or dressed skins of pups of harp seals and hood seals in 1983. The Royal Commission of Seals and the Sealing Industry in Canada (1986) found that the ban reflected public concern over the killing of baby seals rather than scientific evidence regarding the survival of the seal stocks and the humaneness of the method of killing. However, the impact of the market collapse on the viability of the trade was profound and immediate.

In the USA, importation of particular wildlife species can be prevented through the *Endangered Species Act 1973*, which is administered by the US Fish and Wildlife Service (USFWS). For example, a ban on the commercial importation of products derived from red, eastern grey and western grey kangaroos was imposed by the Fish and Wildlife Service from 30 December 1974, because the Service at that time believed that continued killing would endanger those species (Senate Select Committee on Animal Welfare 1988). The three species were listed as 'threatened species' under the *Endangered Species Act 1973*.

The ban on importation of products from red, eastern and western grey kangaroos remained in place between 1974 and 1983. The USA was a major buyer of kangaroo skins, and the ban damaged the Australian kangaroo skin industry. The local skin industry reacted to this ban by developing the necessary skills and technology to tan kangaroo skins to a high standard, and developed a substantial domestic trade in kangaroo skin products, including footwear.

Since 1981, the Australian Nature Conservation Agency have argued that the species should be delisted. At the beginning of 1990, the US Fish and Wildlife Service initiated a review of the status of the red, eastern grey and western grey kangaroos. In January 1993, the USFWS published a notice of a proposed rule to remove these species as threatened species.

Product standards set by importing countries

All countries have legislation to protect public and animal health. This type of legislation can specify the minimum construction standards of the processing establishment; the required farming, handling, slaughter, processing, packing and labelling procedures; minimum levels for chemical residue and bacterial

contamination; and declaration/s of a country's freedom from particular diseases (such as foot-and-mouth disease). Legislation specifying the veterinary and public health requirements of importing countries can impede or prevent the trade in some species of wild animals.

Australia is free of all major animal diseases (Garner & O'Brien 1988), which provides Australian meat and livestock exporters with good access to overseas markets. However, other veterinary requirements vary considerably depending on the particular species and the importing country.

International trade in traditional livestock and their products is well established, but controls over trade in wild animals and their products vary widely between countries. For example, some countries, such as Germany and France, allow import of meat from many species of field-shot wild animals (game meat). Other countries, such as Canada, require that all imported meat products be subject to ante-mortem and post-mortem inspection, which usually means that the animals must be slaughtered at an abattoir. It is not practical to transport live wild animals such as rabbits or kangaroos to an abattoir, which means that the import requirement for ante-mortem inspection effectively prevents trade. Import requirements also vary by species. For example, field-shot rabbit and kangaroo meat can be exported to the USA, but field-shot wild pig meat cannot.

To the uninitiated, it may seem puzzling that inspection requirements, which should be able to be specified quite objectively (e.g. meat is either fit for human consumption or it is not), should vary so much between countries and by species. However, the variability in requirements merely reflects the complex social, political and economic factors that underpin international trade. In effect, stricter inspection requirements are being increasingly used to deny access to many markets and, as such, act as a non-tariff trade barrier.

Domestic legislation to conserve native species

Within Australia, the most powerful Commonwealth legislation regulating the harvesting and trade in wildlife is the *Wildlife Protection (Regulation of Exports and Imports) Act 1982*. The Wildlife Protection Act is administered by the Australian Nature Conservation Agency, and by controlling the export and import of wildlife and their products, can exert a powerful influence over the conservation legislation in each State and Territory.

The Wildlife Protection Act aims to protect wildlife by improving safeguards on exports and imports to ensure that:

- species agreed internationally to be threatened by extinction are not further threatened by trade;
- species do not become threatened by continued unregulated trade;
- Australian wildlife does not enter international trade unless it has been established that such trade will not have an adverse effect on the species;
- the Australian environment is adequately protected from the adverse influence of further introductions of exotic animals and plants; and
- other wildlife receives special protection when needed.

Domestic standards for production and sale of food

Each State and Territory in Australia has legislation in place to control the production and sale of animal products for the local market. This legislation is administered by the State agencies responsible for agriculture and, if the product is for human consumption, by health authorities. Construction standards and processing, handling, packing and labelling requirements vary between States and by species.

Development of new animal industries which produce novel food products such as game meats are particularly affected by the lack of uniformity in legislation for the domestic trade in food products. The

Canberra-based National Food Authority was established in 1991 to develop national standards for food products, for subsequent adoption into the legislation of all States and Territories. The National Food Authority is developing a national standard for game meat, which should be in place by the end of 1993.

The Australian Quarantine and Inspection Service (AQIS) is responsible for inspection and certification of all meat and livestock exported from Australia, and also provides a meat inspection service in most States. These services extend to control over the processing and export of meat from wild animals, whether killed in the field or at an abattoir. Wild animals which are processed at an abattoir, such as feral goats, horses or buffalo, are processed in the same manner as domesticated livestock. However, wild animals which are shot in the field to produce game meat are subject to different requirements.

The requirements for the export of game meat are specified in the *Export Control Act 1982*. A large range of species are suitable for inclusion as game animals, but in practice, kangaroos, pigs and goats are the main species used. Specific requirements may vary depending on the conditions specified by the importing country, but key requirements are:

- game meat must be derived from a game animal, which is defined as a wild animal, other than a bird or rabbit, that has been killed in its habitat by a shot from a firearm;
- after shooting, the animals are bled and partially eviscerated by removal of abdominal and urogenital tracts except the kidneys. The lungs, heart, liver and spleen are also left attached to the carcase for inspection purposes;
- the carcases of game animals are to be transported promptly to either a game processing establishment or to an approved depot chiller, which may be mobile or fixed, where they are placed under refrigeration;
- transport from depot chiller to the game processing establishment is to be as a hanging load;
- the standards of sanitation and hygiene of the game processing establishments and depot chillers are the same as those applying to conventional export establishments;
- at game processing establishments, AQIS inspectors carry out post-mortem inspection; and
- AQIS provides documentation allowing game meat to clear Australian Customs. Animal/public health certification is also issued by AQIS veterinarians.

2.2 Using wildlife for conservation—A philosophical framework

Long-term conservation of native plants and animals ultimately depends on the preservation of natural habitats. The traditional approach to wildlife conservation in developed countries has been to set aside land as national parks or conservation reserves. However, the supply of suitable land is limited and the costs of acquiring the land and managing it can be high. There is also some doubt that the areas already set aside for conservation are large enough to sustain some species and habitats (Grossman et al. 1992). On the other hand, a huge variety and quantity of indigenous genetic resources are held on private lands outside of national parks. An emerging challenge in conservation policy is to ensure the conservation of wildlife and natural habitats outside reserves.

The retention and maintenance of natural habitat on agricultural and pastoral land is dependent on the attitudes and land use practices of individual landowners. Most land is used for agricultural purposes. The international trade in farm products is very competitive, and farmers are under enormous economic pressure to increase productivity. Widespread land clearing and intensive cropping and stocking practices over the past two centuries have caused serious degradation of land and water resources and

loss of biological diversity in many parts of Australia (Chartres et al. 1992; Beattie et al. 1992).

The need to involve landowners in the conservation and management of a nation's natural biological diversity is now recognised in international conservation fora. Most importantly, sustainable use of wildlife is now widely acknowledged as a key strategy to encourage landowners to consider the environmental implications of their management decisions. The International Union for the Conservation of Nature and Natural Resources (IUCN) has had an important role in the development of policy for sustainable use of wildlife.

The IUCN is an international organisation with a membership that includes many government and non-government agencies from over 115 countries. The World Conservation Strategy was prepared by the IUCN with the support of the United Nations Environment Program, the World Wildlife Fund, the Food and Agriculture Organisation of the United Nations and the United Nations Educational Scientific and Cultural Organisation.

The World Conservation Strategy defines conservation as 'the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations'. The Strategy recognises that sustainable use of species is compatible with conservation, and sets out three explicit objectives in resource conservation:

- to maintain essential ecological processes and life support systems on which human survival and development depend;
- to preserve genetic diversity; and
- to ensure the sustainable utilisation of species and ecosystems.

These objectives have been adopted into Australia's National Conservation Strategy.

Integrating native plants and animals into the farm production system is an important way of diversifying the economic base in an ecologically sustainable way. In the longer term, it could also provide an incentive for farmers to protect and re-establish natural habitats.

Only a few species of wildlife are likely to have attributes that make them attractive to use commercially, although use of some species can benefit other species which share the same habitat. In Australia, the large kangaroos are a good example of species with commercial potential (Grigg 1988; Wilson 1988). Kangaroo populations are abundant and widespread over many habitats, have a high rate of increase when conditions are favourable, are well adapted to the harsh and variable environment of inland Australia, and produce unique high quality meat and skin products. Developing the commercial use of kangaroos has the potential to generate significant conservation benefits over a vast area of Australia.

The positive conservation implications associated with managing kangaroos as a renewable resource were formally acknowledged in September 1990 by the (then) Council of Nature Conservation Ministers. The Council endorsed the following as a third objective to the National Guidelines for Kangaroo Management: 'Where possible, to manage kangaroo species as a renewable natural resource providing the conservation of the species is not compromised'. In 1992, this new objective was implemented into kangaroo management programs in Queensland, New South Wales and Western Australia.

The importance of sustainable use of kangaroos to conservation was recognised at the highest level when the Council of Australian Governments endorsed the National Strategy for Ecologically Sustainable Development on December 1992. Objective 1.4 of the Strategy is 'to improve kangaroo management at the national level, including the removal of impediments to a sustainable commercial kangaroo industry'. In achieving this goal, it was agreed that governments will 'work towards an integrated, and coordinated kangaroo management strategy which is based on development of national guidelines for kangaroo management, the use of market mechanisms such as individual tradeable

quotas and the early finalisation of National Game Meat Standards'. These policy directions offer exciting prospects for conservation off reserves and an incentive to foster the development of new industries based on the sustainable use of native species.

2.3 Population management

Caughley (1977) observed that there are only three management options for populations of game animals:

- conservation, to increase the density of a small or declining population;
- sustained yield harvesting, which includes commercial harvesting for profit and recreational hunting; and
- control, where the aim is to reduce the density of a population.

The focus of this report is on sustained yield commercial harvesting, but as many native and introduced wild animals are also regarded as pests, there is considerable overlap and potential for integration between managing for sustained yield and managing for control.

2.3.1 Maximum Sustainable Yield

The theory of harvesting dynamics predicts two possible outcomes when a population of wild animals is culled for any purpose (Caughley 1985):

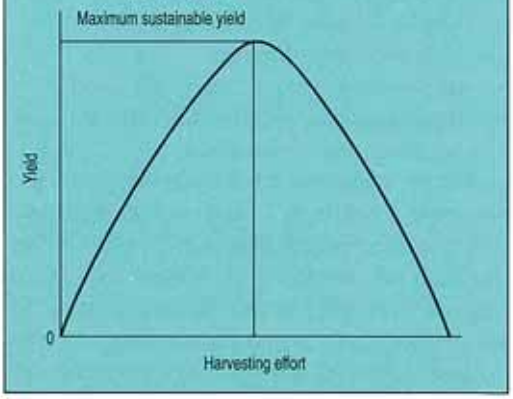
1. If some animals are taken out of a population, the fortunes of the others will be enhanced, and their fecundity and survival will rise to compensate for the removals.
2. If the rate of removal is too high, the population will be unable to compensate and will slide to extinction.

When the rate of harvest is below that which will cause the ultimate extinction of a population, a sustainable harvest exists (figure 2.1). The point where the sustainable yield reaches a maximum is referred to as the Maximum Sustainable Yield, or MSY.

Commercial harvesting and pest control have not caused the extinction of any introduced animals in Australia and are thus sustainable harvests—certainly for mainland populations of wild boar, rabbits, foxes and goats (Ramsay & O'Brien 1991). In the case of commercial harvesting of a native species, a key management objective is to ensure that the rate of harvesting does not exceed the MSY and threaten the viability of the species. Narrow economic interests could favour action to deplete a population to levels well below that producing MSY, possibly even to extinction (May 1976; Caughley 1977). Some factors which can contribute to high, unsustainable use of a resource include:

- the common property characteristic of free-ranging wild animals, where market participants are unable to capture all the benefits of private management, leading to competitive rather than cooperative use;
- the economic discount rate, which can provide incentive to harvest all the animals now, rather than have a sustained harvest;
- 'prey switching' in multi-species harvest, where the availability of another species permits harvest of a rarer species well beyond the optimum

Figure 2.1: Relationship between harvest effort and yield. Both pest control and commercial use function as sustainable yield harvest in Australia



for a single species. An example is professional kangaroo shooters harvesting wild boar from a region with few pigs, because the acquisition cost is subsidised by the value of kangaroos shot; and

- low costs of harvesting and low rates of population growth.

In these circumstances, better returns may flow from a large immediate harvest (the proceeds of which earn interest) than from a possible larger harvest to be taken some time in the future.

Using the MSY as a management objective has disadvantages and is now generally rejected as a management option (Larkin 1977). If, for example, the stock abundance varies because of environmental changes, attempts to take exactly the MSY each year can lead to dangerous instability. A further limitation of the MSY model is that it attempts to describe the exploitation of single species populations and as such does not account for confounding interactions among species (that is, predators, prey and competitors). Therefore, if a species is being managed as a resource, it is wise to adopt a more conservative approach to setting harvest rates and aim to achieve an Optimum Sustainable Yield (OSY) that maximises revenue or social benefits (Caughley 1977). The OSY approach incorporates a safety factor to compensate for imperfections in the MSY model.

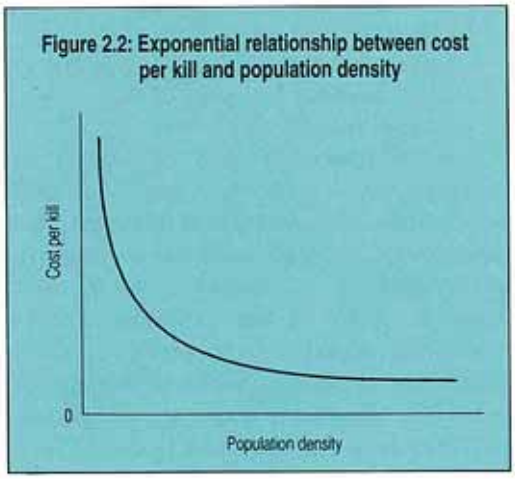
If a species is being managed as a pest (e.g. feral animals such as goats and horses), overexploitation may be of little concern. In practice, if a pest species gains sufficient value, landowners will ranch or capture and domesticate stock for production, as occurred with feral deer in New Zealand (Fennessy & Taylor 1989). In the case of native species, wildlife management agencies monitor the harvest and the abundance and distribution of the species and, if necessary, will limit the activities of the harvesting industry.

2.3.2 Control or eradication?

Many species have been driven to extinction by changes to the animals' habitat, or in some cases by overexploitation (Caughley 1977; May 1976). In contrast, no abundant and widespread population has been extinguished by a premeditated control campaign. However, successful eradication campaigns have been held for feral goats on some islands (Parkes 1990a) and for a small population of coypus, which were introduced to Britain for fur farming but escaped to run wild (Gosling & Baker 1987).

The reason for the failure of eradication campaigns is that species are more vulnerable to a manipulation of their environment than a manipulation of their numbers. As population density declines—due either to commercial take, pest control, or fluctuating seasonal conditions—the cost per kill increases (figure 2.2). The population density at which costs exceed benefits is likely to differ for pest control and commercial hunting, depending on the market value of the products and on the cost of damage caused by the pests. While 'getting the last' rabbit, fox or goat would bankrupt a commercial operator, it would certainly do the same to a land manager or pest control agency.

Figure 2.2: Exponential relationship between cost per kill and population density



Therefore, culling for pest control is in reality a harvesting program that takes a sustainable yield, and only differs from commercial or recreational hunting in terms of the objectives sought. Sustainable harvesting accurately describes what has been happening to pest species in Australia since pest control operations first commenced.

A key objective of pest control is to reduce damage by lowering density. Similarly, although profit is the objective, an effect of commercial harvesting is to reduce population density. Although the objectives differ, the effects are the same if equivalent numbers of animals are removed. In some situations, harvesting pressure from commercial use greatly exceeds control pressure, whereas in others, commercial use is negligible. However, the two management options have tended to be viewed as mutually exclusive (certainly for introduced vertebrate pests).

Bomford and O'Brien (1992) pointed out that the issue of eradication of vertebrate pests is important from a management and policy perspective because:

(a) there is strong intuitive support for an approach which is generally ineffective;
(b) eradication attempts are very expensive and failed eradication attempts are wasteful; and
(c) decisions to embark on eradication in preference to ongoing control need to be based on an analysis that ensures that the program is feasible and in the best interests of the problem owners.

Nonetheless, the idea of action to permanently remove pest animal populations is appealing and has been tried repeatedly. There is a perception in government pest control agencies and some sections of the community that eradication could be achieved if sufficient funds were available. However, eradication is not possible for most introduced species, and therefore the goal has been to have 'as few as possible'. Parkes (1990b) observed that this goal appeals to some managers and conservation groups because it is always achieved. As many pests as possible are killed with the available resources, but managers are not obliged to decide whether the real goal—managing the damage caused by introduced pests—has been achieved. Reducing the cost per kill has been a major focus of pest control, but the application of cost–benefit analyses that take into account the relationship between damage, pest density and control are lacking.

Recent work by the Bureau of Resource Sciences (Bomford & O'Brien 1992) showed that vertebrate pest eradication is the preferred option only when:

- there is no immigration;
- all animals are a risk;
- the rate of removal exceeds the rate of increase at all densities;
- discounted cost–benefit analysis favours eradication; and
- there is a favourable sociopolitical environment.

It is almost impossible to meet these criteria for any species of abundant vertebrate pest in Australia. When this fact is considered, along with the increasing public concern about techniques used in pest control, particularly biological control such as myxomatosis, shooting from helicopters and the use of poisons, it is evident that the goals and activities of pest control must become more accountable to the community.

2.3.3 Pest or resource?

As mentioned previously, a distinctive feature of wild animal management in Australia is the strong, historical focus on pest control. Native animals such as kangaroos, introduced wild animals (for example, the red fox and the European rabbit), and domestic animals which ran wild (for example, feral donkeys, horses and goats) are managed as pests of agriculture and (except in the case of kangaroos) the environment.

Despite the best efforts of landowners and government agencies, introduced pests remain widespread and abundant in Australia. Following the failure of pest control activities to remove introduced pests from Australia, a significant trade in these wild animals has developed and has been expanding in recent years. Because these animals are sufficiently numerous for commercial harvest, it is valid to regard them

Table 2.1: Attitudes and comments on conflict between commercial use and pest control of introduced wild animals

Criticisms of commercial use	Comments
(a) Aims for sustainable yield only and will not eradicate	Both commercial harvest and pest control behave as a sustainable harvest in Australia.
(b) Does not stop damage	Likely to be true of control and use, and the challenge is to identify and implement policies that optimise the impact of use on damage reduction.
(c) Does not provide sustained effort	Markets for wild animal products are volatile and this is often true, and a compelling reason for integrating use and control.
(d) Will oppose new control methods	This usually refers to proposals for biological control. The *Biological Control Act 1984* ensures that introduction of novel biological control agent is in the long-term national interest.
(e) Will expand pest distribution	It is questionable whether any suitable and uncolonised habitat remains. When pest value increases, there is incentive to ranch or farm.
(f) Will change attitudes to pests	At some value, pests will be considered a resource.
(g) Is illegal	Legislation in many States requires that introduced pests be eradicated, although this is unachievable in most cases.
(h) Exotic disease risk	Commercial harvesting could facilitate exotic disease management by providing opportunity for routine disease surveillance; reducing density of potential vectors; increasing knowledge of animal distribution; and increasing expertise available to control potential vectors.
(i) Contrary to conservation goals	Commercial use may have a significant, unexplored role in achieving conservation goals.
Criticisms of pest control	
(a) Not cost-effective	Pest control is expensive and there is doubt about its cost-effectiveness in some areas. Use is inherently cost-effective, and can generate income for the land manager.
(b) Wastes a resource	Society is likely to view control as a waste of a resource — this was a widespread attitude to the feral buffalo cull of the Brucellosis and Tuberculosis Campaign.
(c) Less humane than commercial use	Society will increasingly view techniques such as poisoning and biological control as less humane than commercial shooting.
(d) Poisoning not species specific	Poisoning is less specific than shooting and non-target native and introduced animals can be at risk.
(e) Reduces scope for use	Control operations can compete with the commercial harvest, thus reducing commercial efficiency and increasing control costs.

as a resource, as well as a pest. However, to do so challenges the attitudes instilled by past generations. Pest control agencies and some land managers are still focussed on eradication, and assigning a resource value to a target species is regarded as a threat to eradication campaigns. Some of the issues that surround the pest versus resource debate are outlined in table 2.1.

Landowners ultimately own both the problem and the resource (the wild animal). Unless landowners receive income from the commercial harvest of pest species, they are likely to consider them as pests. Conversely, hunters will continue to view wild animals as a resource while demand exists for their products.

Clear objectives in pest management are needed. A key objective should be to ensure that pest management becomes an integral part of land management strategies that recognise the impact of total grazing pressure on the long-term sustainability of ecosystems (Mills 1986; Wilson & Hodgkinson 1991). Pest management must also be cost-effective and humane, otherwise government agencies risk being charged with expending public money in the application of increasingly unpopular techniques to pursue unquantified and often unachievable goals.

2.4 Commercial incentive for using wild animals

Wild animal products often have special qualities and attributes that enhance their value.

Meat

In general, game meats contain less total fat and associated visible fat than meats from domestic species such as sheep and cattle (Sinclair 1988; O'Dea 1988). Further, wild animals are not treated with pesticides, substances which promote growth, or medications, which removes the major sources for residues in the meat. Health-conscious consumers in Australia and in developed overseas markets are now demanding that meat products be lean and 'clean'. One such market is the European Community, which in 1989 banned the use of hormonal growth substances in meat production.

Skins and fur

Leather from wild animals often has a tensile strength comparatively greater than that of traditional livestock. For example, kangaroo leather is recognised as being by weight one of the strongest available leathers (Stephens 1987). Wild furs have also long been recognised for their durability. The Australian red fox fur has remained competitive with farmed furs on world markets because the high fur strength and low production cost make it suitable for manufacture into durable garments. Australian wild rabbit fur is also regarded as being superior to farmed rabbit fur for the manufacture of felt hats.

By-products

Products from some exotic and wild animals are valuable for traditional medicines in many cultures. Oriental cultures have used deer by-products, including the velvet from the antlers, for medicinal purposes for thousands of years (Wong 1991). Today, these products are still in demand, and pharmaceutical companies are scrutinising wild animals as a potential source of useful compounds. For example, the brains from Australian wild rabbits are used for extraction of thromboplastin, a valuable compound used in medical tests.

Genetic material

Wild stock can bolster genetic material available to domestic livestock industries (McNeely 1989). Most Australian cashmere and mohair goats have been derived from wild goats.

Besides being available in commercial quantities, Australia's wild animal populations are free of all serious animal diseases, such as rinderpest and foot-and-mouth disease (Garner & O'Brien 1988). This enhances the value of wild animals and their products on world markets, and has given Australia an edge over its competitors in those overseas markets with strict animal health import requirements.

Australia is well placed to supply a large variety and volume of high quality wild animal meats, furs and skins at competitive prices to traditional markets in Europe and North America, and to nearby high growth markets in Asia.

3 THE FINDINGS

Wildlife use in Australia has developed with minimal government involvement, and has been largely driven by economic considerations. Although a wide variety of species are used, there are many linkages between the industries concerned, and industries often share opportunities and impediments to development. Australia's wild animal industries already generate significant economic, social and environmental benefits and there are opportunities for expansion to exploit niche markets in Australia and overseas.

Few Australians are aware of the scale, nature and opportunities for wild animal industries. They are surprised to hear that the wild boar industry generates more export income than the domestic pork industry, and that the kangaroo industry employs over 1600 shooters, plus hundreds of people in meat and skin processing factories in rural and urban centres. Further, the annual wholesale value of Australian wild animal products is conservatively estimated here at $132–156m (see table 3.1), but people are unaware that these industries have but a small portion of the total world trade in wild animal products. There are many opportunities to expand Australia's wild animal industries.

There is limited quantitative information describing the trade in wild animals and their products, and the values shown in table 3.1 are conservative estimates. For most industries, the value of trade within the domestic market is unknown. For example, what is the value of the kangaroo leather and manufacturing trade within Australia, and what is the scale and value of goat meat consumption in Australia? Anecdotal evidence suggests that the domestic trade in these products is increasing. Similarly, the scale of the local donkey and horse pet meat trade has not been quantified.

The trend in the growth of the key industries listed in table 3.1 indicate that the kangaroo and wild boar, goat and rabbit industries are expanding. These trends should continue over the next few years, with increases in the scale of harvests (within conservation limits for kangaroos) and with product and market development. The feral horse meat industry is static, and limited by supply of good quality horses. Substantial increases in the volume of the horse meat trade are unlikely, but there are opportunities for increasing returns by developing exports of prime cuts to growth markets in Europe. The red fox fur industry has been in decline since the mid-1980s due to a slump in demand for fur products on the world markets.

Many of the wild animals used are also pests that cause damage to agricultural production and the environment. There is no doubt that commercial harvesting is making an important contribution to pest management in many regions. However, the conservation benefits and the productivity gains to agriculture which flow from the commercial harvest of vertebrate pests have not been quantified. When these flow-on benefits to landowners and society are considered along with the obvious economic and social benefits of trade in wild animals and their products, the value of these industries to the national economy becomes substantial.

Table 3.1: Estimated annual wholesale value of trade in wild animals and their products

Animal	Value ($m)	Growth trend
Kangaroos & wallabies	50–60	Increasing
Goats[1,2]	27–28	Increasing
Horses[1]	22–25	Static
Wild boar	15–20	Increasing
Wild rabbits	8–9	Increasing
Feral buffalo	15–6	Decreasing
Crocodiles	2–3	Increasing
Red fox	1–2	Decreasing
Others[3]	2–3	–
Total	**132–156**	

1: Includes wild and domestic animals
2: Does not include value of fibre trade
3: Includes brushtail possum, hare, toad, deer, and feral camel, cat, and donkey

3.1 The best prospects

Wild animal industries with the best prospects for substantial gains, particularly in export markets, are those based on abundant wild animal populations. These include commercial harvests of kangaroos, wallabies, wild boar, goats, rabbits and foxes. Such industries are typically market-limited rather than supply-limited. Therefore, the challenge is to access and develop profitable markets for the products of these species. Gains will then be possible through increasing the scale of the harvests (within conservation limits for native species) and by adding value to products.

3.1.1 Market success factors

Industries based on harvests of the wild animals mentioned above are potentially very profitable:

- Populations are abundant and widespread with high reproductive rates, and the capital input required to harvest animals is low.
- There is an established international trade in game meats, furs and exotic leather in which Australian companies can compete. This world trade is almost free of distortions such as tariffs, duties and government subsidies, and Australia's wild animal export industries could build a sustainable comparative advantage. There is already some evidence of this competitive edge in the strong performance of the wild boar meat export trade over the past decade.
- The products of wild animals have attributes, such as low fat content in game meats, that can appeal to consumers and be capitalised on when marketing the products.
- Development of industries based on abundant populations of wild animals is also consistent with wider policy objectives to protect biological diversity and establish ecologically sustainable development. Removal of impediments to a sustainable kangaroo harvesting industry is an objective of the National Strategy for Ecologically Sustainable Development which was announced in December 1992. This is in recognition that commercial use of kangaroos is compatible with long-term conservation of kangaroos and their habitat. Conservation of kangaroo habitat will also benefit less common native species.
- Australia is free of all major livestock diseases, which enhances the value of wild animals and their products on world markets and has given Australia an edge over its competitors in those overseas markets with strict animal health import requirements.
- Australia's environment has low levels of contamination with chemical residues, nuclear radiation and other pollutants, compared with many countries. The image of Australia as a source of 'clean' agricultural products is an advantage that many rural industries already use when promoting their products. Wild animals are not treated with pesticides, substances which promote growth or medications, which eliminates the major causes for residues in the meat. This is an important market success factor when supplying increasingly health-conscious consumer markets.
- Commercial use is an innovative and cost-effective way of managing introduced vertebrate pests. Increasing harvesting levels will complement other initiatives to protect native habitats and improve agricultural productivity.

Development of commercial industries based on the key species which are already abundant will not occur in isolation from the development of industries based on farming of stock derived from the wild. As the wild harvesting industries develop, this will provide a catalyst for related industries based on non-traditional livestock.

Emerging industries with growth potential include farming of emus, crocodiles, goats, buffalo, deer and camels. These industries are primarily limited by lack of adequate breeding stock, and the challenge will be to capitalise on opportunities as this situation changes.

3.2 Key issues and impediments influencing the development of wild animal industries

3.2.1 Attitudes

The perception of wild animals as pests is much more than just a contemporary attitude—it is a widely accepted doctrine that is held by many primary producers and government officials at all levels. The idea that wild animals could be a resource is considered flippant and not to be taken too seriously. For example, who would actually want to eat a pest? For too long, Australians have perceived abundant wild animals as vermin to be eradicated or controlled, without recognising that wild animals can also be managed as a resource to supply profitable markets in Australia and overseas.

Parochial attitudes and the doctrine of pest control underpin most of the impediments to the development of profitable industries using wild animals. Australians find it difficult to believe that a German diner pays a premium for a meal of the same wild boar that New South Wales landholders shoot to rot in their paddocks. They are vaguely repulsed by other cultures' enthusiasm for our feral horse meat, and are surprised that rabbits, the bane of rural Australia, are the basis of a thriving international meat trade worth over $200m annually, of which Australia supplies about 1 per cent (Ramsay 1991).

There is a strong case for industry organisations to prepare and implement communication and awareness strategies to ensure that the general public has access to balanced information on industry activities and product attributes. This is likely to require some market research to establish the current perceptions about the particular industry and its products. Such research would be particularly important for the kangaroo industry.

3.2.2 Administrative and legislative structures

Australian attitudes to wild animals are reflected in laws and administrative arrangements for management of wild animals and trade in their products. For example, there is a well-established infrastructure in place to coordinate and promote pest control activities at the State and national level through the Vertebrate Pests Committee of the Standing Committee on Agriculture and Resource Management. By comparison, there is little or no infrastructure in place in State and Commonwealth agencies to foster industries based on wild animals. Therefore, at the highest levels in the bureaucracy, any discussions on wild animal management tend to focus on pest control. The existing structures are leading to a lack of balance, with pest control issues able to overshadow industry development issues.

In general, government agencies have allocated few (if any) resources to the development of industries based on wild animals. In contrast, millions of dollars are allocated for pest control activities and research. Commercial harvesting already forms a major (though largely unrecognised) role in the management of some pest animals. There is a strong case for agencies responsible for primary industries to examine the adequacy of their existing infrastructure to facilitate the development of new animal industries, including those based on wild animals.

In practical terms, this could mean assigning a discrete area within each agency with specific responsibility for developing new animal industries. Some State agencies have already done this, although others, at both the State and federal level, have tended to manage new animal industries on an ad hoc basis, with the main involvement being regulatory (for example, meat inspection).

The rationale for government agencies to put resources into a discrete area responsible for development of new animal industries is simply that the industries have much in common, and there are cost-savings. This

approach would also ensure that there is a readily identifiable point of contact for industry, the public, and other government agencies. Some State Government agencies have made considerable efforts to foster the development of new animal industries based on farming non-traditional livestock, such as emus, but there is little coordinated effort at a national level.

There are opportunities for increased cooperation between agriculture agencies at the State and federal level to ensure the rapid development of orderly and profitable new animal industries that supply local and international markets. It would also be beneficial to forge closer cooperation between agriculture and conservation agencies at all levels on the issue of commercial use of wild animals. Conservation agencies have an interest in management of feral animals and also have prime responsibility for ensuring the conservation of native animals subject to commercial harvesting.

Some government assistance measures are available for new animal industries. For example, these industries can seek funding for research through the Rural Industries Research and Development Corporation (RIRDC). In 1992, the RIRDC created a specific new animal products program and appointed a program coordinator, in recognition of the need to address research and development issues for these industries. State and Commonwealth agencies also offer a variety of business and marketing programs that can be relevant to wild animal industries. A good example is the Innovative Agricultural Marketing Program, which is jointly administered by the Department of Primary Industries and Energy and Austrade.

Each State and Territory has legislation controlling all aspects of commercial activities which service domestic markets. Standards and regulations often vary across State borders. For example, in 1992 the sale of kangaroo meat for human consumption (game meat) was permitted in all States and Territories except Queensland and Victoria. Amendments to allow the trade in kangaroo game meat in New South Wales and Western Australia were made towards the end of 1992, although the regulations were not in place to allow production until 1993. However, national standards for the production and sale of game meat have yet to be agreed. Such legislative differences between States have fostered industry fragmentation and delayed the development of a cohesive national kangaroo industry. The National Food Authority is currently developing a national standard for game meat, but this process began in 1988.

3.2.3 Variable operating environment

Australian wild animal industries are export-oriented, and trade into competitive, price-sensitive and often protectionist markets. The markets are volatile and Australian suppliers need to develop strategies to operate profitably in a risky marketing environment. For example, one strategy would be to spread the risk by diversifying into new markets, including development of the domestic market.

The export orientation of wild animal industries exposes industry participants to risk from volatile exchange rates. Short-term volatility of exchange rates makes international trade more risky, and makes planning, controlling and monitoring a firm's international operations more difficult and expensive. A survey by the Bureau of Industry Economics (1991) found that very small firms (with 20 employees or less) tended to be much more exposed to exchange rate risk than larger firms.

Besides the risk of operating in a variable marketplace, wild animal industries also face considerable production risk. Australia is a dry continent and rainfall is variable and unpredictable. The amount and timing of rainfall influences pasture biomass and hence agricultural production levels and the abundance of wild animal populations (Caughley 1987). Wild animal populations increase rapidly when food and water is plentiful, and crash during drought. Variable environmental conditions can have a major impact on the potential supply of wild animals for commercial harvesting.

Primary producers in Australia have access to mechanisms such as the Income Equalisation Deposits (IED) scheme, to smooth their income in the variable operating environment. There is a good case for participants of wild animal industries to also have access to mechanisms such as IEDs for risk management. Effective risk management is essential in these industries if their infrastructure is to remain intact following periods of supply restrictions and/or deterioration in market conditions.

For example, if kangaroo abundance falls due to a drought, conservation agencies may curtail or cease commercial harvesting in some areas. However, if industry participants have sufficient cash reserves held aside, the industry infrastructure can be sustained and harvesting can resume when kangaroo abundance increases. Alternatively, the industry can be expected to call for the harvest to continue at some level in order to preserve industry infrastructure when populations recover.

The risk of flow-on to other industries would need to be investigated before allowing wild animal industries to have access to IEDs. Nonetheless, fluctuating incomes and the need for careful risk management are a characteristic of these industries.

3.2.4 Current product values

Commercial use of wild native and introduced animals is not viewed by land managers as a viable option for land use because most products currently have a low value. Therefore, commercial harvesting operates at low and fluctuating levels. However, given creative promotion and marketing, commercial use could expand and provide an incentive for mixed species grazing management.

3.2.5 Small size

The small size of wild animal industries limits their capacity to gather trade intelligence, undertake research and development, and promote products. Even the larger sectors of the game industry, such as the kangaroo industry, have a poorly developed infrastructure for research, development and marketing. The small size of emerging industries, such as deer and emu farming, limits the capacity of these industries to supply the quantities of product required by buyers. For example, industry participants may have to use a cooperative approach to bid for large export orders.

3.2.6 Lack of information

There is a lack of quantitative information describing the trade in wild animal products in Australia and overseas. The export trade in Australian native animal products is well documented, but information on the domestic trade in native and introduced wild animals and their products is difficult to collate. This lack of information complicates any efforts by industries to monitor trade characteristics, trends and opportunities. Government agencies also require reliable statistics on industry performance when developing policy and managing industry development.

Local and overseas buyers are often unaware or misinformed of the variety, quantity and quality of products available from Australia. Potential buyers also have difficulty in identifying potential suppliers. There is scope for better information transfer within and between industries, between government agencies and industries, and between suppliers and buyers on emerging trade opportunities and threats.

The wild boar meat export industry is a good example of the need for information collection and transfer. This industry has experienced many difficulties maintaining access to increasingly protectionist markets in the European Community. If the industry and government are to argue the case for continued market access effectively, accurate and up-to-date information is needed on the operation of the industry and on the quantity, destination and value of exports. At present, it is not possible to extract reports on the export of wild boar products from the Australian Harmonised Export Commodity Classification system, which is managed by the Australian Bureau of Statistics. Therefore, the industry and government must rely on

the import statistics held by the European Community. A lack of reliable trade data is a threat to existing and future negotiations on market access and to industry development generally.

Government agencies responsible for trade could have a greater role in monitoring and reporting on emerging threats and opportunities for the products of wild animal industries.

3.2.7 Pest control

In all States, or specified regions within States, some introduced animals are proclaimed as pests by legislation and landowners can be required to control their numbers. There is an inherent risk associated with basing an industry on species that are also managed as agricultural and environmental pests. However, this risk may be reduced if a more flexible approach to pest management is developed, to integrate the commercial industry with pest management programs.

Conservative attitudes in government pest control agencies are impeding the expansion of industries based on wild animals that are also regarded as pests. Some staff in pest control agencies have difficulty coming to terms with the idea that commercial harvesting could fulfil pest management objectives in particular areas. They tend to see commercial harvesting as a threat to pest management, or at best a way of cost-effectively reducing population density to a certain level before other techniques are used. These attitudes are partly due to past management strategies that aimed for the costly and futile goal of eradication, rather than aiming to manage pest damage. The possibility of a pest species being managed as a resource, as is the case with feral deer in New Zealand, is still an abstract concept for many staff in pest control agencies in Australia.

The Bureau of Resource Sciences is now preparing national guidelines for managing the damage caused by major vertebrate pests, under the guidance of the Vertebrate Pest Committee of the Standing Committee on Agriculture and Resource Management. Staff from State pest control agencies are taking a major role in the drafting of these guidelines. The guidelines will give some attention to the scope for integrating commercial harvesting with other pest management techniques. However, in formulating the national guidelines, the role of commercial harvesting is necessarily being assessed within existing institutional frameworks and levels of industry activity. The role of commercial harvesting in pest management will need to be periodically reappraised to take account of the changing market and operating environment for wild animal industries.

Do commercial harvesters understand pest control issues?

Many participants of wild animal industries acknowledge that pest control is necessary. In particular, members of the fox fur and the rabbit industries seem to be aware of the need to control the abundance and distribution of these pests. The main concern of industry participants is that the resource value of pest animals is not fully considered in the development of pest management policies. Nonetheless, it is doubtful that all participants of these industries fully appreciate pest management issues.

Are pest control agencies able to properly assess commercial harvesting?

It is difficult to know the proportion of staff in pest control agencies with commercial experience or business qualifications. Staff with little or no commercial experience or training do have a major input to pest management policy and in the assessment of current and future prospects for commercial harvesting of pest animals. It would be unrealistic to expect that a wildlife biologist with many years' experience in pest control and no business qualifications or commercial experience can provide a balanced and accurate assessment of the potential for a commercial industry based on wild animals.

There would seem to be scope for compromise and cooperation between pest control agencies, nature conservation agencies and commercial harvesting industries.

3.2.8 Animal welfare

There is considerable opposition to the commercial use of wildlife, particularly by animal rights groups, some of which are morally and philosophically opposed to the killing of animals. Nonetheless, domestic and wild animals will continue to be killed while there is a consumer demand for the products. Therefore, the important issue is that humane techniques are used in the handling and killing of these animals. Most animal industries in Australia have developed a Code of Practice for humane handling and slaughter of the particular species used. This includes the kangaroo and game meat industries. Shooting by commercial hunters has been found to be a most humane way of killing wild animals such as kangaroos (RSPCA 1985; Senate Select Committee on Animal Welfare 1988). However, commercial use by live capture and transport of wild animals to abattoirs could compromise animal welfare if husbandry is not of a high standard (Pilkington & Wilson 1990). The largest industries that capture and transport wild animals are the feral goat, buffalo and horse industries.

Animal welfare must also be taken into account where wild animals are killed for pest control. Some techniques now used for pest control could be expected to attract increasing criticism from animal welfare groups and the community. For example, the use of steel-jawed leghold traps to kill rabbits, foxes and wild dogs for pest control is still permitted in many jurisdictions around Australia. The use of steel-jawed leghold traps by the fur industry in the Northern Hemisphere has drawn much criticism from animal welfare and community groups around the world. The depth of concern about this technique was reflected in a recent decision by the European Community to enact legislation that prohibits the use of leghold traps in its 12 member States and bans the import of fur products from certain species caught in leghold traps. Groups concerned about animal welfare issues have also called for the banning of the steel-jawed leghold trap in Australia (Anon. 1992). Retention of such pest control techniques as steel-jawed leghold traps has the potential to undermine not only exports of rabbit and fox furs, but of other wild animal products such as from kangaroos.

A New Zealand study (Sheppard & Urquhart 1991) found that there is considerable public concern about pest control methods such as poisoning and biological control. The attitude of the Australian public is likely to be similar, and these techniques can be expected to become less popular. For example, the use of the poison sodium monofluoroacetate (known as 1080) to kill wallabies in Tasmania has been criticised (Senate Select Committee on Animal Welfare 1988).

Even seemingly responsible pest control techniques such as electric fencing can have animal welfare implications. A good example is the use of the Finlayson trough (Norbury & Norbury 1992), a form of electric fencing to deny kangaroos access to water while allowing access to domestic stock such as sheep. Kangaroos are forced to move to alternative watering points, or die of thirst. The use of the Finlayson trough is currently being facilitated by some State agencies responsible for pest control.

4 FUTURE DIRECTIONS

4.1 Options for industry development

Wild animal industries have significant growth potential. However, the development of these industries will depend on the capacity and commitment of industry and government to both pursue existing and emerging opportunities and address the impediments outlined in the previous chapter. Governments in Australia are tending to move away from industry strategies that rely on a high degree of government intervention. Many primary industries are being deregulated, and a high degree of government intervention is not an option for new animal industries. Therefore, two options are possible: do nothing, or adopt a market-led approach with some government intervention.

4.1.1 Do nothing

The passive approach would be to allow market forces to drive the development of wild animal industries, with individuals tackling the various problems in the production–marketing chain. There are several problems with this approach.

Firstly, development of wild animal industries has been frustrated by industry fragmentation. The industries are small, have limited resources and lack cohesion and direction. Transfer of information on industry opportunities and threats is poor. A passive approach is unlikely to resolve the problem of fragmentation and lack of direction.

Secondly, there is the related problem of 'free riders'. This refers to the situation where individuals can benefit from the actions of others without contributing. This is a particular problem in the areas of marketing and research and development, and is quite evident in some wild animal industries. For example, there are many participants in the kangaroo industry, but a small number of the larger companies are meeting research and development and marketing costs which have benefits for the wider industry. However, these firms are not investing in some research and marketing areas, because they cannot capture enough of the benefits. For example, there are no nationally accepted product specifications for kangaroo meat for human consumption. The pace of industry development is therefore limited by the activities of a few.

There are many production and marketing linkages between wild animal industries, and the 'free rider' effect can also occur between industries. For example, there have been situations where businesses in one game meat industry have collaboratively invested considerable time and financial resources to gain access to new export markets, to the benefit of related industries which did not (and would not) contribute.

There is a case for encouraging collaboration between and within industries on issues such as research and development, processing, product development and marketing.

Thirdly, to maintain and increase the international competitiveness of rural industries in the long term, it will be necessary to diversify the agricultural base, increase productivity and encourage ecologically sustainable development. These broad goals underpin the explicit objective in the National ESD Strategy to remove impediments to a sustainable kangaroo industry. Rural industry and conservation policy objectives are unlikely to be met if a passive approach is taken by industry and government.

4.1.2 A market-led approach with some government intervention

The market-led approach draws on the lessons learnt from the successes and failures of the more traditional primary industries. This approach also recognises that government intervention and regulation can have both positive and negative effects. The key elements of the market-led approach are:

- Industry self-regulation is encouraged. This helps to ensure a market orientation to industry development, rather than a production orientation, and relies on strong industry initiative to resolve development problems. It also encourages individual firms to compete

aggressively for a share of the market.

- The role of government is essentially one of ensuring that the operating environment of businesses using wild animals is conducive to industry development. In the case of commercial use of native species, government intervention is justified to ensure that the resource base is not overexploited. The government also has important roles in facilitation, coordination and strategy development.

This approach is the preferred option for ensuring the development of new animal industries in Australia. The key industry issues are:

(a) What degree of 'pump priming' is required to stimulate growth and economically sustainable development for wild animal industries?

(b) How can the existing barriers to industry development be overcome to create more orderly and profitable wild animal industries?

4.2 A strategy for the development of wild animal exports

Several trends and characteristics of the existing wild animal industries can provide a pointer to the likely form of a broad development strategy. In particular:

- Wild animal industries are small individually, but collectively they are significant.
- The kangaroo industry is the largest wild animal industry in Australia, and has the potential to expand into a significant primary industry during the 1990s.
- Governments have made a commitment in the National Strategy for Ecologically Sustainable Development (1992) to develop a sustainable kangaroo industry.
- There are strong existing and potential links in production, processing and marketing of the various wild animal products.

These factors suggest that the development of individual industries cannot be viewed in isolation from the development of related industries. There is clearly scope to build on the existing linkages and gain the benefits of scale and consequent cost-savings. It also seems that expansion of the kangaroo industry could provide the inertia for development of other new animal industries. Therefore, the logical conclusion is that a broad strategy is needed in which the kangaroo industry assumes a central role within a group of industries based on wild animals or farming of non-traditional livestock.

However, a key policy principle for this approach is that individual industries should also prepare and pursue their own development strategies. The rationale here is that although there are obvious benefits for closer interaction between industries, these industries also compete with each other. For example, the buffalo, rabbit, kangaroo, wild pig, venison, crocodile, camel and emu meat industries all compete to supply food service industries in Australia and overseas. Similarly, exotic leathers such as emu and crocodile leather compete for a share of the fashion garment and accessory markets.

Nonetheless, the benefits associated with closer ties between industries will more than offset the negative effects of competition. Some of the existing and prospective areas for cooperation between industries are outlined below.

4.2.1 Production

There are two broad areas of common interest for production of new animal products. Firstly, industries based on harvesting wild animals such as kangaroos, wild pigs, goats, rabbits and foxes frequently overlap in their geographic areas of operation, and often share the same group of hunters. The closest interaction is probably that between the kangaroo and wild boar harvesting operations in eastern Australia, although kangaroo shooters will also opportunistically shoot foxes, rabbits and hares when prices are favourable.

Secondly, establishing an enterprise based on farming non-traditional livestock can be capital-intensive and there are opportunities for producers to have multi-species grazing systems. For example, deer, emu, ostrich and camels

could be farmed on the one property. The obvious extension to this would be the development of new farming systems that integrated non-traditional and traditional livestock production.

4.2.2 Processing

Processing is an area with many opportunities for cooperation between industries. For example, constructing, operating and maintaining an export standard meat processing plant is very costly, and plants that can process several species could bring substantial cost-savings for individual industries and the operator of the export establishment. Some businesses in the game meat (i.e. field-shot wild animals) industry already process several species through their establishment, such as kangaroos, wild boar and goats. Similarly, multi-species abattoirs could process farmed animals such as goats, deer, emu, rabbits and ostrich.

Skin-processing establishments that prepare exotic leathers from species such as emu, crocodile, kangaroo and ostrich would also generate cost-savings for the industry and the operator of the establishment.

4.2.3 Marketing

It is in the field of marketing that stronger linkages between industries will really bring benefits to producers and processors of new animal products; for example, gaining and maintaining access to domestic and export markets, gathering market intelligence, doing market analysis and research, and monitoring overseas competitors.

Coordination of marketing activities could also extend to ensuring that local buyers and importers can purchase the full range and quantity of products they require. For example, some importers position themselves as suppliers of Australian produce. These meat importers may buy Australian lamb, buffalo, kangaroo, deer venison and wild rabbit—they are seeking a basket of goods, but often have difficulty finding suppliers. There is a clear opportunity for a cross-industry marketing infrastructure that can offer a package of Australian wild animal products to importers.

4.2.4 Research and development

Few wild animal industries have the resources or infrastructure in place to fund research and development. Most industries have ongoing need for research into ways of increasing production efficiency, market research, packing, grading and quality assurance. There is some overlap in the research and development needs of individual industries. One example is in the area of market research, but in most instances research programs need to be tailored to suit the needs of individual industries.

4.2.5 Relationship with mainstream primary industries

Wild animal industries need to be integrated with traditional agricultural production systems. For example, government policies such as the National Drought Policy recognise that pest management strategies should be part of the property management plan prepared by individual landowners. Commercial harvesting is a cost-effective way of reducing pest density and impact, and these industries could work more closely with landowners to achieve land management goals. Further, many farmers are looking for opportunities to diversify their enterprise, and new animal industries such as kangaroo harvesting and emu, deer, buffalo, or goat farming could offer profitable opportunities.

4.3 Strategy development and implementation

Industries will have to take the initiative in preparing development strategies. However, governments can facilitate this process. Some industries, including those farming deer, goats and emus, have already made considerable progress in preparing and implementing industry development strategies. On the other hand, industries such as kangaroo and rabbit harvesting have made virtually no progress on the issue of industry development.

There are two critical steps involved in preparing and implementing a broad strategy for the development of new animal industries in Australia. Firstly, the kangaroo industry should prepare an industry development strategy. In the past, the kangaroo industry was the target of campaigns by animal welfare and conservation groups opposed to the harvest. Further, governments regarded the kangaroo industry as a tool of management—kangaroo management objectives were limited to conservation and pest management until 1992 (when management as a renewable resource was included as a new objective). In this environment, the kangaroo industry has tended to adopt a risk management strategy of keeping a low profile. This had the effect of fostering fragmentation of the industry.

However, the positive conservation, animal welfare, economic and social benefits associated with the development of a sustainable kangaroo industry have led to major legislative and policy changes by governments aimed at facilitating industry development. For example, kangaroo game meat should be available to consumers throughout Australia during 1994. It is therefore timely for the industry to review the implications of these changes, and to position itself to take advantage of new opportunities.

The kangaroo industry is now entering a critical phase of its development. The industry needs to communicate the positive attributes of both the industry and of kangaroo products to the public in Australia and overseas. Past experience has shown that inaccurate media reports and statements by groups opposed to the use of kangaroos have a negative influence on public perception of the industry (Dee 1990). The kangaroo industry will need to be active in providing information to the public in Australia and overseas (for example, by providing information packages to overseas posts), otherwise the growth and crash of exports experienced in the early 1980s could be repeated.

An industry development strategy would include an analysis of strengths, weaknesses, opportunities and threats for industry development. It would also identify appropriate structures for industry representation and explore options for funding research and marketing at a national level.

At present, the national kangaroo harvest is around 3 million animals per year and a levy of, say, 50 cents per animal, would raise $1.5m. In addition, if the appropriate industry infrastructure is in place, the industry can receive matching funds from the Commonwealth Government for any expenditure on research and development (including market research and product development). This also would require discussions between the industry and an organisation such as the Rural Industries Research and Development Corporation.

Secondly, there will need to be a forum for representatives of the various industries to debate the opportunities for and impediments to forming a closer alignment between industries. A workshop for industry representatives would be an appropriate mechanism, and the Australian Game Meat Producers Association could have an active role in seeking interest from other industry bodies.

The outcome of such a workshop could include the structure, function, funding and membership of an umbrella industry body. For example, an industry body could be established and be responsible for marketing and research and development issues affecting wild animal industries and emerging industries based on farming non-traditional livestock. Such a body would assume an important role in liaising with governments in Australia and overseas on industry development issues. This approach ensures that industry 'owns' and directs the development strategy.

4.4 Conclusion

Australia's wild animal industries have much potential. Development of these industries will generate significant economic, social and environmental benefits for the rural sector and the nation. The challenge is for industry to take the initiative and work with government to overcome impediments to industry growth and capitalise on emerging opportunities.

APPENDIX

Australian Harmonised Export Commodity Classification codes

(used in compiling this report)

Code	Description
0104.20.90	Live goats (excluding angora)
0204.50.00	Meat of goats, fresh, chilled or frozen
0205.00.00	Meat of horses, asses, mules or hinnies, fresh, chilled or frozen
0208.10.00	Meat and edible meat offal of rabbits or hares, fresh, chilled or frozen
0208.90.10	Kangaroo meat, fresh, chilled or frozen
0503.00.00	Horse hair and horse hair waste
0511.99.20	Kangaroo and wallaby meat, unfit for human consumption
4101.40.00	Hides and skins of equine animals, fresh, or salted, dried, limed, pickled or otherwise preserved but not further prepared
4103.10.00	Goat or kid hides and skins, fresh, salted, dried, limed, pickled or otherwise preserved, but not further prepared
4103.90.61	Kangaroo, *Macropus rufus* sp, raw hides and skins, fresh, salted, dried, limed, pickled or otherwise preserved but not further prepared
4103.90.62	Kangaroo, *Macropus giganteus* sp, raw hides and skins, fresh, salted, dried, limed, pickled or otherwise preserved, but not further prepared
4103.90.63	Kangaroo, *Macropus fuliginosus* sp, raw hides and skins, fresh, salted, dried, limed, pickled or otherwise preserved, but not further prepared
4103.90.64	Kangaroo, *Macropus robustus* sp, raw hides and skins, fresh, salted, dried, limed, pickled or otherwise preserved, but not further prepared
4103.90.65	Wallaby, *Macropus parryi* sp, raw hides and skins, fresh, salted, dried, limed, pickled or otherwise preserved, but not further prepared
4103.90.66	Wallaby, *Macropus ruforgriseus* sp, raw hides and skins, fresh, salted, dried, limed, pickled or otherwise preserved, but not further prepared
4103.90.67	Wallaby, *Thyogale billardierii* sp, raw hides and skins, fresh, salted, dried, limed, pickled or otherwise preserved, but not further prepared
4103.90.68	Kangaroo raw hides and skins, fresh, salted, dried, limed, pickled or otherwise preserved, but not further prepared (excluding *Macropus rufus, Macropus giganteus, Macropus fuliginosus, Macropus robustus, Macropus parryi, Macropus rufogriseus and Thylogale billardieri*)
4106.11.00	Goat or kid skin leather, without hair on (excluding leather of 4108 or 4109), vegetable pre-tanned
4106.12.00	Goat or kid skin leather, without hair on (excluding leather of 4108 or 4109), otherwise pre-tanned
4106.19.00	Goat or kid skin leather, without hair on (excluding leather of 4108 or 4109), other
4106.20.00	Goat or kid skin leather, without hair on (excluding leather of 4108 or 4109), parchment dressed or prepared after tannin
4107.90.12	Leather of kangaroo, without hair on (excluding leather of 4108 or 4109)
4301.20.00	Raw, whole furskins of rabbit or hare
4301.60.00	Raw, whole furskins of fox
4301.80.10	Raw, whole furskins of kangaroo and wallaby
4301.80.20	Raw, whole furskins of opossum
4301.80.30	Raw, whole furskins of cat
4302.12.00	Tanned or dressed, whole furskins of rabbit or hare, not assembled

PART B

WILD ANIMAL INDUSTRIES

Native animals

5 KANGAROOS AND WALLABIES

Distribution and abundance

Kangaroos and wallabies are a group of marsupials belonging to the Family Macropodidae, which are indigenous to Australia. Wallabies are smaller than kangaroos, weighing between 3 and 20 kilograms (Strahan 1983), while kangaroos can weigh up to 90 kilograms.

Before European settlement, kangaroos and wallabies were an important source of food and fibre for Aboriginals and were also incorporated into many aspects of their culture. Some Aboriginals still hunt kangaroos and wallabies for food, but they also have the option of selling the carcase and skin to the commercial kangaroo industry (Wilson, McNee & Platts 1992). The commercial kangaroo harvest offers an opportunity for employment and income in non-metropolitan Australia, where employment prospects are limited.

The large species of kangaroos and wallabies have generally adapted well to changes since European colonisation. Several species, particularly the red, eastern grey and western grey kangaroos, have thrived and their abundance and natural ranges may have been enhanced by an altered fire regimen, improved pastures, increased watering points (Anon. 1988), and reduced predation by dingoes (Caughley et al. 1980). By comparison, many of the smaller species have suffered due to loss of habitat, predation from introduced species such as the red fox (Kinnear 1988) and competition with introduced species such goats (Dawson & Ellis 1979) and rabbits.

Kangaroos and wallabies were a welcome source of food for early European settlers, but once agricultural enterprises expanded, they were perceived as a threat to production because they compete for fodder. The management of kangaroos as pests has since become an integral part of Australian agricultural history. At times, control efforts have been extreme. Thousands of kangaroos and wallabies were killed in drives or 'battues' where animals were driven into groups and shot or clubbed (Poole 1984). A government bounty was also paid in some States. Between 1877 and 1917 about $2m was collected through government subsidies and bounties for 26 million kangaroo scalps (Poole 1984) in the State of Queensland alone.

Table 5.1: Occurrence and status of common kangaroos and wallabies in Australia

Species included in Commonwealth approved management programs	ACT	NSW	NT	QLD	SA	TAS	VIC	WA
Red kangaroo	-	*	+	*	*	-	+	*
Eastern grey kangaroo	+	*	-	*	#	#	+	-
Western grey kangaroo	-	*	-	+	*	-	+	*
Wallaroo or euro	+	*	+	*	*	-	+	*
Whiptail wallaby	-	+	-	*	-	-	-	-
Species harvested for domestic market only								
Bennett's wallaby[1]	+	+	-	+	+	*	+	-
Rufous wallaby[1]	-	-	-	-	-	*	-	-

* Abundant, commercial harvests
\+ Common, non-commercial killing only
\# Limited, local distribution
\- Absent
1 Species harvested commercially only in Tasmania. No Commonwealth approved management plan since 1986.

Table 5.2 Population estimates for red, western and eastern grey kangaroos in Australia in 1981, 1984, 1987 and 1990

Species	*State*	1981	1984	1987	1990
Red	QLD	1 361 000	1 333 000	1 466 000	1 820 000
	NSW	3 837 000	1 663 000	2 770 000	4 500 000
	SA	1 138 000	745 000	963 000	1 950 000
	WA	1 004 000	1 993 000	2 329 000	2 178 100
	TOTAL	**7 340 000**	**5 734 000**	**7 528 000**	**10 448 100**
Western grey	QLD	104 000	55 000	76 000	58 000
	NSW	876 000	242 000	806 000	1 300 000
	SA	198 000	91 000	208 000	193 900
	WA	424 000	666 000	652 000	1 070 200
	TOTAL	**1 602 000**	**1 054 000**	**1 742 000**	**2 622 100**
Eastern grey	QLD	2 468 000	2 040 000	2 863 000	2 172 400
	NSW	2 010 000	929 000	1 824 000	2 750 000
	SA	-	-	-	-
	WA	-	-	-	-
	TOTAL	**4 478 000**	**2 969 000**	**4 687 000**	**4 922 400**
TOTAL		**13 420 000**	**9 757 000**	**13 957 000**	**17 992 600**

Source: Fletcher et al. 1990; plus unpublished data supplied by the Australian Nature Conservation Agency

The change in attitudes towards kangaroos may also have resulted when the European settlers perceived it as socially desirable to move from a dependency on wild animals for food towards the use of domestic stock.

Nevertheless, the large kangaroos and several species of wallabies have survived and may have increased their abundance in some regions (tables 5.1 and 5.2). These abundant populations of kangaroos and wallabies are subject to commercial and non-commercial harvesting in many parts of Australia.

Management

The legislative responsibility for conservation of all species of kangaroos and wallabies lies primarily with the State and Territory Governments. Where kangaroo populations are abundant and causing agricultural damage, the State conservation authority may prepare and administer a kangaroo management program. These programs can allow commercial and/or non-commercial harvesting of kangaroos and wallabies. Non-commercial harvesting is usually undertaken by landowners (or their agent) to control agricultural damage caused by kangaroos on their land. The commercial kangaroo industry is used by State conservation agencies as a tool of management to control kangaroo numbers.

Anyone wishing to kill kangaroos must have a permit from the State or Territory conservation agency. Products from species killed by non-commercial hunters cannot be sold.

Kangaroos and wallabies are harvested in five States: Queensland, New South Wales, South Australia, Western Australia and Tasmania (table 5.1). Products from these harvests can be sold throughout Australia. However, kangaroo products cannot be exported unless the State kangaroo management program is approved by the Commonwealth Minister responsible for the environment. The legislative basis for this is laid out under the Commonwealth *Wildlife Protection (Regulation of Exports and Imports) Act 1982*.

The management program for the commercial wallaby harvest in Tasmania has not been approved by the Commonwealth Minister responsible for the environment since 1986. Therefore, all products from the Tasmanian wallaby harvest can only be sold on the domestic market. In 1992, discussions were underway between the conservation authorities in Tasmania and the Australian Nature Conservation Agency (ANCA) in Canberra to develop a management program that complies with the Commonwealth *Wildlife Protection (Regulation of Exports and Imports) Act 1982*.

The determination of the maximum number, or quota, of each species of kangaroo that can be killed by commercial harvesters is specified in the management program approved by the Commonwealth Minister for the environment. The quota is determined annually by consultations between each State conservation agency and the Australian Nature Conservation Agency, and based on the status of the kangaroo populations. Without access to export markets, the kangaroo industry would operate at a much lower scale. Therefore, via control of exports, the ANCA can exert a major influence on the setting of quotas.

The details of the management programs vary between States, but all essentially aim to:

- ensure the survival of viable populations of all harvested species over their natural ranges;
- contain the deleterious effects of kangaroos on agricultural and pastoral production; and
- manage the species as a renewable resource, provided that the conservation of the species and their habitats are not compromised (this objective does not apply, as yet, in South Australia).

Management as a renewable resource is a new objective adopted in 1992 into management plans operating in Queensland, New South Wales and Western Australia, following a recommendation in 1990 by the (then) Council of Nature Conservation Ministers.

Commercial use of kangaroos is considered compatible with the long-term conservation of kangaroo populations. The National Strategy for Ecologically Sustainable Development was endorsed by the Council of Australian Governments (1992) on 7 December 1992. Objective 1.4 of the Strategy is 'to improve kangaroo management at the national level, including the removal of impediments to a sustainable commercial kangaroo industry'. To achieve this goal, governments will 'work towards an integrated and coordinated kangaroo management strategy which is based on development of national guidelines for kangaroo management, the use of market mechanisms such as individual tradable quotas and the early finalisation of National Game Meat Standards'. The positive conservation implications of the commercial kangaroo harvest have underpinned this major policy decision.

Kangaroo populations that are harvested commercially are monitored directly in each State by aerial and/or ground surveys. These surveys are variously carried out by State conservation authorities and the ANCA. Kangaroo population estimates in each State in 1981, 1984, 1987 and 1990 are shown in table 5.2. These figures show that kangaroo populations numbered at least 17.9 million in 1990. However, the values for grey kangaroos are underestimates because the correction factors used have since been shown to be too low (Short & Bayliss 1985; Short & Hone 1989; Fletcher et al. 1990). The decline in populations of the red kangaroo, western grey kangaroo and eastern grey kangaroo between 1981 and 1984 was a response to the severe drought in 1982–83.

The commercial harvest statistics provide a means of indirectly monitoring the status of kangaroo populations. Data supplied by commercial operators can reveal trends in the sex ratio and average weight of kangaroos taken in particular regions. Monitoring provides information to the management authority to enable timely action to limit the harvest, if there are indications that populations are being placed at risk of overharvesting.

The commercial harvest can have a significant impact on kangaroo populations in some regions, but the abundance of kangaroos is primarily influenced by the level of food supply. In turn, pasture biomass varies with the level of rainfall and the abundance of other herbivores such as sheep (Bayliss 1987). Therefore, kangaroo populations thrive when food availability is increased after seasons of high rainfall, but mortality can be high when drought conditions occur.

A study of the dynamics of kangaroo populations in and around Kinchega National Park in western New South Wales (Bayliss 1987) quantified the relationship between rainfall, pasture biomass and kangaroo numbers. It was found that the rate of increase of kangaroo numbers was negative below 217 mm and 198 mm of rainfall per annum for western grey and red kangaroos respectively, and at pasture biomass of 111 kg/ha for greys and 157 kg/ha for reds. This study has not been expanded to cover all areas in which the two species occur. During the drought of 1982–83, the populations of red and western grey kangaroos declined in the study area in western New South Wales by an average of 53 per cent.

In the long term, the greatest threat to the viability of kangaroo populations is loss of habitat. In a study of western grey kangaroo populations in Western Australia (Arnold 1990) it was found that clearing of land for wheat production in some regions is having serious adverse effects on kangaroo populations.

Commercial use

The commercial kangaroo harvest has been the topic of intense public controversy in Australia and overseas in recent years. A variety of social, cultural, economic, biological and management issues associated with the commercial harvest have been debated at length on a national and international level (Shepherd & Caughley 1987; Wilson 1987; Arnold 1988; Rawlinson 1988). Kangaroos living off reserves have continued to be harvested because they cause economic losses for primary producers. However, these kangaroos also represent an economic resource for the commercial kangaroo industry and, in the longer term, a potential source of income for landowners.

Five species of macropods were harvested in Australia in 1993 under management programs approved by the Commonwealth Minister for the Environment. They were the red kangaroo *(Macropus rufus)*, eastern grey kangaroo *(Macropus giganteus)*, western grey kangaroo *(Macropus fuliginosus)*, wallaroo or euro *(Macropus robustus)* and the whiptail wallaby *(Macropus parryi)*. Products from these animals can be traded domestically and for export. The abundant red, eastern grey and western grey kangaroos are by far the most valuable species harvested commercially because of their abundance and size. Over 1600 licensed shooters were employed by the kangaroo industry in 1991.

An additional two species have been harvested in recent years under State management plans that have not been approved by the Australian Nature Conservation Agency. These species were the Bennett's wallaby *(Macropus rufogriseus)* and the Tasmanian pademelon or rufous wallaby *(Thylogale billardierii)*. Products from these species cannot be exported, but they can be traded within and between States. These species are of little commercial importance and the level of harvesting is small. The lack of commercial interest in these species is posing a management dilemma for the State authorities charged with control of vertebrate pests, because alternative control methods must be identified and funded.

Method of harvest

A Code of Practice for the shooting of kangaroos, which was endorsed by the (then) Council of Nature Conservation Ministers (now the Australian and New Zealand Environment and Conservation Council), has been incorporated into the kangaroo management plans in Queensland, New South Wales, South Australia and Western Australia. The code specifies the

standards of humane conduct which are the minimum required of people shooting kangaroos.

All kangaroos and wallabies harvested commercially must be killed by field shooting. Shooters must be licensed by the State conservation authority and have permission from the landowner.

The kangaroos are shot at night using a spotlight and a rifle fitted with a telescopic sight. The Code of Practice identifies minimum specifications for firearms and ammunition to ensure a sudden and painless death for the target animals. A rifle used for shooting kangaroos must have a centre-fire case capacity of at least .222 Remington. Shooters must immediately take every reasonable effort to locate and kill a wounded animal before targeting another animal.

It has been proven that head shooting is the most humane method of killing kangaroos (RSPCA 1985; Senate Select Committee on Animal Welfare 1988). This is particularly true for production of meat for human consumption, because carcase buyers stipulate head shooting to minimise spoilage of the meat.

The number of kangaroos killed by the commercial industry is primarily limited by the demand for kangaroo products, with an upper limit set by the commercial quota (maximum number available). When demand is poor, the commercial harvest can fall well below the quota. Alternatively, when demand is high the harvests are likely to be close to the specified quota.

Harvesting of kangaroos

Since 1984, the quota for the commercial harvest of the four large species (wallaroos and the red, eastern grey and western grey kangaroos) has shown a consistent increase on a national scale, and reached 5.18 million in 1992 (see table 5.3 and figure 5.1). In 1993, the national quota was 4.8 million. The quota is not intended to be a target for the commercial harvest to reach, but reflects the number of animals that could be harvested without compromising the conservation of the species.

In 1985, the national commercial harvest exceeded the quota by about 70 000 animals when it reached 1.76 million (table 5.4). Since then, the national commercial harvest has tended to lag well below the quota (figure 5.1). The national harvest in 1992 was 2.8 million, or 54 per cent of the quota of 5.2 million.

Figure 5.1: National quotas and harvests for red, eastern and western grey kangaroos

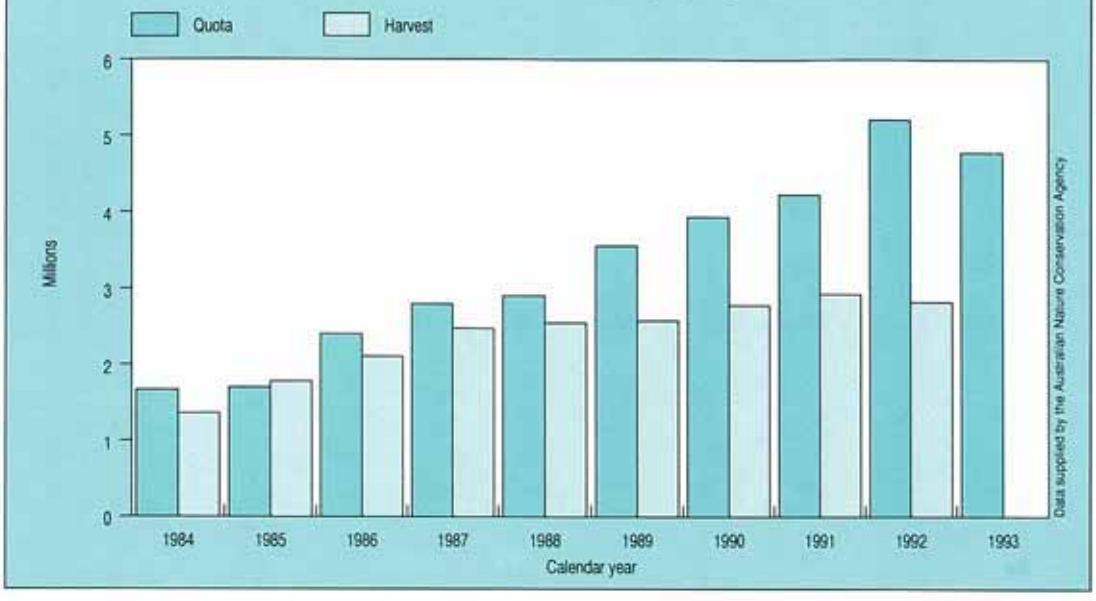


Table 5.3: Commercial harvest quotas for the large kangaroos in each State of Australia

SPECIES	*STATE*	NUMBER OF ANIMALS ('000s) BY CALENDAR YEAR									
		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
RED	NSW	399.0	190.0	313.0	313.0	354.0	487.0	626.0	706.0	956.0	598.8
KANGAROO	QLD	250.0	250.0	300.0	375.0	320.0	480.0	480.0	480.0	600.0	600.0
	SA	115.0	117.4	180.0	180.0	146.6	260.4	276.3	408.6	317.7	290.4
	WA	140.0	160.0	180.0	200.0	230.0	290.0	290.0	290.0	350.0	350.0
	TOTAL	**904.0**	**717.4**	**973.0**	**1 068.0**	**1 050.6**	**1 517.4**	**1 672.3**	**1 884.6**	**2 223.7**	**1 839.2**
EASTERN	NSW	100.0	110.0	264.0	189.0	271.0	222.0	394.0	584.0	790.3	757.0
GREY KANGAROO	QLD	500.0	720.0	970.0	1 300.0	1 300.0	1 500.0	1 500.0	1 300.0	1 500.0	1 500.0
	TOTAL	***600**	***830**	***1 234**	**1 489.0**	**1 571.0**	**1 722.0**	**1 894.0**	**1 884.0**	**2 290.3**	**2 257.0**
WESTERN	NSW	-	-	-	75.0	105.0	95.0	152.0	220.0	327.7	307.8
GREY	SA	22.0	9.0	34.6	30.9	31.7	33.0	36.9	31.7	35.5	48.6
KANGAROO	WA	50.0	50.0	50.0	45.0	45.0	45.0	45.0	45.0	65.0	65.0
	TOTAL	**-**	**-**	**-**	**150.9**	**181.7**	**173.0**	**233.9**	**296.7**	**428.2**	**421.4**
WALLAROO	NSW	1.0	1.0	0.0	0.0	0.0	1.0	10.0	10.0	22.0	23.0
OR EURO	QLD	60.0	70.0	70.0	70.0	70.0	100.0	80.0	100.0	180.0	200.0
	SA	6.0	8.6	12.0	16.5	16.5	16.5	16.5	28.5	28.5	28.5
	WA	10.0	10.0	10.0	0.0	10.0	10.0	10.0	10.0	10.0	10.0
	TOTAL	**77.0**	**89.6**	**92.0**	**86.5**	**96.5**	**127.5**	**116.5**	**148.5**	**240.5**	**261.5**
ALL	NSW	500.0	301.0	577.0	577.0	730.0	805.0	1 182.0	1 520.0	2 096.0	1 686.6
SPECIES	QLD	810.0	1 040.0	1 340.0	1 745.0	1 690.0	2 080.0	2 060.0	1 880.0	2 280.0	2 300.0
	SA	143.0	135.0	226.6	227.4	194.8	309.9	329.7	468.8	381.7	367.5
	WA	200.0	220.0	240.0	245.0	285.0	345.0	345.0	345.0	425.0	425.0
	TOTAL	**1 653.0**	**1 696.0**	**2 383.6**	**2 794.4**	**2 899.8**	**3 539.9**	**3 916.7**	**4 213.8**	**5 182.7**	**4 779.1**

* Eastern grey and western grey figures combined. Data supplied by the Australian Nature Conservation Agency

NSW = New South Wales; QLD = Queensland; SA = South Australia; WA = Western Australia

Table 5.4: Commercial harvests of the large kangaroos in each State of Australia

SPECIES	STATE	CALENDAR YEAR								
		1984	1985	1986	1987	1988	1989	1990	1991	1992
RED KANGAROO	NSW	157 629	213 297	263 046	270 467	218 086	297 029	377 155	495 986	412 189
	QLD	226 212	297 496	289 526	365 138	359 985	473 985	476 636	471 643	570 885
	SA	83 469	98 557	112 789	100 507	118 232	124 173	172 793	213 628	219 338
	WA	138 320	162 161	154 034	150 462	216 834	173 663	223 801	184 117	106 960
	TOTAL	**605 630**	**771 511**	**819 395**	**886 574**	**913 137**	**1 068 850**	**1 250 385**	**1 365 374**	**1 309 372**
EASTERN GREY KANGAROO	NSW	*63 754	*111 968	*181 463	140 061	130 335	136 073	170 766	253 791	264 447
	QLD	543 430	744 966	957 621	1 231 889	1 292 196	1 143 314	1 097 890	1 017 086	919 234
	TOTAL	*	*	*	**1 371 950**	**1 422 531**	**1 279 387**	**1 268 656**	**1 270 877**	**1 183 681**
WESTERN GREY KANGAROO	NSW	*	*	*	62 926	72 786	67 253	83 708	106 629	117 994
	SA	9 898	9 043	9 987	14 849	13 778	11 546	18 593	14 533	18 999
	WA	36 984	41 655	37 019	40 092	29 061	23 912	36 800	37 847	46 194
	TOTAL	*	*	*	**117 867**	**115 625**	**102 711**	**139 101**	**159 009**	**183 187**
WALLAROO OR EURO	NSW	632	763	0	0	0	97	1 967	1 378	1 377
	QLD	77 595	72 927	69 919	65 441	67 048	93 452	76 745	98 052	122 967
	SA	5907	7 043	6 147	9 167	8 892	5 756	7 014	8 966	11 252
	WA	5 606	6 646	3 940	0	819	4 164	5 191	5 399	4 437
	TOTAL	**89 740**	**87 379**	**80 006**	**74 608**	**76 759**	**103 469**	**90 917**	**113 795**	**140 033**
ALL SPECIES	NSW	222 015	326 028	444 509	473 454	421 207	500 452	633 596	857 784	796 007
	QLD	847 237	1 115 389	1 317 066	1 662 468	1 719 229	1 710 751	1 651 271	1 586 781	1 613 086
	SA	99 274	114 643	128 923	124 523	140 902	141 475	198 400	237 127	249 589
	WA	180 910	210 462	194 993	190 554	246 714	201 739	265 792	227 363	157 591
	TOTAL	**1 349 436**	**1 766 522**	**2 085 491**	**2 450 999**	**2 528 052**	**2 554 417**	**2 749 059**	**2 909 055**	**2 816 273**

* Separate harvest data for eastern grey and western grey kangaroos were not recorded prior to 1986 as the taxonomic status of these two species was not clarified until the 1980s. Data supplied by Australian Nature Conservation Agency

Table 5.5: Commercial quotas and harvests of wallabies (number of animals) included in approved management programs

SPECIES	STATE	ITEM	CALENDAR YEAR 1984	1985	1986	1987	1988	1989	1990	1991
WHIPTAIL WALLABY	QLD	QUOTA	35 000	40 000	40 000	10 000	50 000	50 000	50 000	25 000
		HARVEST	12 707	10 727	26 445	9 498	24 296	13 456	14 954	4 226
BENNETT'S WALLABY*	TAS	QUOTA	175 000	140 000	140 000	0	0	0	0	0
		HARVEST	71 000	55 000	33 000	-	-	-	-	-
RUFOUS WALLABY*	TAS	QUOTA	125 000	110 000	110 000	0	0	0	0	0
		HARVEST	47 000	37 000	27 000	-	-	-	-	-

* Data rounded to the nearest 1 000 and these species not harvested under a management program approved by the Commonwealth Minister for the Environment since 1986

The overall increase in quotas and harvests relate to eastern grey and red kangaroo populations in Queensland and New South Wales which have shown general increases since 1984 (note tables 5.3 and 5.4). The quotas for the large kangaroos have tended to increase in each State, but only in Queensland has the commercial harvest risen to match the State quota. The commercial industry is more responsive in Queensland because skin-only hunting is widely permitted and there are a large number of licensed shooters.

Harvesting of wallabies

The quotas and number of wallabies killed under management programs approved under Commonwealth legislation are listed in table 5.5. In 1986, the quotas for wallabies totalled 290 000 animals, but only 86 445 were shot.

Commercial harvests of the Bennett's wallaby and the rufous wallaby were significantly less than the quotas between 1984 and 1986. The overall harvest for these species also exhibited a steady decline regardless of the quota. By comparison, the harvests of whiptail wallabies in Queensland have fluctuated markedly. Since 1984, the whiptail harvest has varied from 26 445 in 1986, to 2071 in 1992.

The different patterns of harvesting for the whiptail wallaby, compared with the species harvested in Tasmania, could be because the products are sold to different consumer markets. Furs from the Tasmanian animals were primarily exported, whilst those from the whiptail wallaby are primarily sold on the domestic market.

In Tasmania, the Bennett's wallaby and the rufous wallaby have not been included in a management program approved by the Commonwealth since 1986. Poor demand for wallaby products overseas has made exports unprofitable and approvals from the Commonwealth unnecessary. However, a management program was submitted to the ANCA in 1992 and, if approved, Tasmanian companies may again seek export markets for wallaby products.

Table 5.6 Royalties paid on wallaby* furs in Tasmania							
YEAR	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91
NUMBER OF ROYALTIES	38 778	20 668	6 144	4 574	3 504	1 271	2 736

* Includes Bennett's wallaby and rufous wallaby. Data supplied by the Tasmanian Department of Parks, Wildlife and Heritage

A small commercial harvest of wallabies operates in Tasmania to supply the domestic market for game meat. The scale of this harvest is reflected in the number of royalties paid on wallaby skins in Tasmania (table 5.6). Royalties were paid on about 39 000 skins in 1984–85, but the harvest declined to only 2736 in 1990–91. These figures include both species and refer to financial years rather than calendar years; they therefore cannot be directly compared with harvests shown in table 5.5.

In the Northern Territory, agile wallabies are unprotected in the areas north of the fifteenth parallel of south latitude and outside of the boundaries of the Arnhem Land Aboriginal Reserve. There is no information on any harvests of these animals.

In Queensland, the red-necked wallaby, black-striped wallaby, swamp wallaby and agile wallaby were harvested in small numbers for their fur up until 1987, when they were fully protected. Annual harvest figures show that in 1983 the numbers taken were red-necked wallaby 91, black-striped wallaby 19, swamp wallaby 109, and agile wallaby nil (Kirkpatrick & Amos 1985).

The kangaroo meat industry

Kangaroo meat is a traditional food item for Aboriginals. The kangaroo meat industry began in 1959 in response to interest from European buyers wishing to import the meat for distribution to the local game meat market. At that time there were no government regulations controlling the killing and processing of kangaroos. Unfortunately, this export venture failed due to inadequate attention to hygiene during meat processing and packing (Corrigan 1988; Dee 1990). Kangaroo processors then began to develop a domestic trade in kangaroo meat for pet food, which now represents the main end use for kangaroo meat.

The product

Kangaroo meat is a very lean red meat with a slightly game flavour. It has a very low total fat content and a high proportion of polyunsaturated fatty acids compared with meat from traditional livestock species such as cattle and sheep (Sinclair 1988).

Studies in Aboriginals (Naughton et al. 1986) and Australians of European origin have shown that low fat diets rich in kangaroo meat are associated with a reduction in important risk factors for cardiovascular diseases (O'Dea 1988; Creevey 1989). More specifically, a diet of kangaroo meat can produce a rapid fall in cholesterol levels, and may also provide protection against thrombosis (O'Dea 1988).

Besides having positive health attributes, kangaroo meat should appeal to the tastes of many consumers. A taste panel assessment of kangaroo meat in Western Australia (Marshall & McIntyre 1989) found that it compared very favourably with beef in terms of tenderness, flavour and acceptability. Meat from young animals was found to be more tender than that from older animals. However, the authors concluded that meat derived from both female and male animals of a wide range of ages will be acceptable to consumers.

Meat production from kangaroos

Kangaroos that are shot for their meat are eviscerated in the field and transported either directly to the processing facility or to a field chiller to await transport. Industry

records indicate that the average whole dressed carcase weight for red and grey kangaroos is about 20 kilograms. The approximate yield from a 20-kilogram dressed carcase (i.e. skin on and the viscera, head and tail removed) is shown in table 5.7.

Table 5.7: Product yield from a 'typical' 20-kilogram dressed kangaroo carcase

Product	% Yield	Kilograms
Boneless forequarter meat	13	2.6
Boneless hindquarter meat	47	9.4
Bone	23	4.6
Skin	16	3.2
Trim	1	0.2

Note: These figures relate to processing of a mixture of species, particularly red and eastern grey kangaroos.

The average yield of boneless meat from a large kangaroo is about 12 kilograms (table 5.7). Therefore, the potential yield of boneless meat from the national commercial harvest of 2 554 417 kangaroos in 1989 was about 30 000 tonnes. However, a total of 1 054 600 animals were shot for the skin only in Queensland during 1989 (13 000 tonnes), and further, the majority of kangaroos shot in South Australia (141 475 animals in 1989) have the forequarter removed and left in the field (about 400 tonnes). This means that a total of about 13 400 tonnes of boneless kangaroo meat was left in the field in Australia in 1989.

The ANCA export permit records show that about 264 tonnes of meat from the 1989 cull was exported. Therefore, the apparent net domestic consumption of kangaroo meat in Australia in 1989 was roughly 17 000 tonnes.

The wholesale value of kangaroo meat varies between States and also depends on the end use (whether sold as pet food or game meat). The overwhelming end use is as pet food, and a very conservative estimate of the average wholesale value of all kangaroo meat sold would be $1.00 per kilogram. Therefore, the wholesale value of all kangaroo meat sold on the domestic market is roughly $20m per annum.

Meat production from wallabies

Wallabies are usually culled by commercial hunters for the fur, because the meat yield is small compared with that from large kangaroos. All whiptail wallabies harvested in Queensland in 1989 (13 456 animals) were probably taken only for the fur. However, the commercial harvests of Bennett's and rufous wallabies in Tasmania during the 1989 calendar year would have also been used as a source of meat for the local game meat and pet meat markets.

The total amount of wallaby meat, including pet meat and game meat, produced in Tasmania in 1989 is unknown. However, the Tasmanian Department of Primary Industry monitors the quantity of wallaby game meat produced at licensed premises. Production of wallaby game meat in Tasmania was 26.1 tonnes in 1988 and 15.5 tonnes in 1989.

Pet meat

The domestic trade

Most kangaroos killed by commercial hunters are shot to supply the domestic pet meat trade. The method of dressing the carcases is similar in most States. The head, tail, forearms and viscera are removed in the field, and the carcases are hung to cool on a rack on the rear of the shooting vehicle and delivered to a field chiller in the morning. The main exception to this method is in South Australia, where the forequarter is left in the field and only the hindquarter is retained for boning. The South Australian industry uses this technique because it saves on transport and boning costs.

Kangaroo pet meat is sold in all States and Territories of Australia. The domestic market for pet meat is relatively stable, but supply usually exceeds demand and competition can be intense. In most cases, the market preference is for fresh meat.

The largest market is in Sydney (80–120 tonnes/week), followed by Melbourne (30–40 tonnes/week), Brisbane, Adelaide

and Perth (Morris & Young 1985). Interstate movement of kangaroo pet meat can occur on a large scale, particularly between Queensland (the largest source of kangaroos) and New South Wales (the largest market for kangaroo pet meat).

Demand for kangaroo pet meat is influenced by a number of factors. The quantity of meat sold declines when the price increases, or when cheaper substitutes, such as mutton or beef, are available. However, a component of the demand is relatively price-insensitive, because some purchasers prefer kangaroo meat for their pets and will continue to buy it when prices increase (Morris & Young 1985). Although the short-term demand for kangaroo pet meat is relatively elastic, with sales volume dropping when price increases, it appears that in the long term demand is less elastic and the sales volume will recover after price increases.

The distribution channels for kangaroo pet meat are primarily controlled by State or Territory legislation. For example, kangaroo pet meat can be sold in supermarkets in South Australia and Western Australia, but not in other States. Limitations on the distribution channels for pet meat influence the ability of the kangaroo industry to develop markets for their products. There is a need to develop consistent national standards for treatment and packaging of kangaroo meat.

Kangaroo meat is not used in canned pet foods today, but it was once used in large quantities. The product used was crushed bone, which was prepared and packed after the meat was removed from the carcase. This trade yielded little profit for processors, but represented a means of reducing waste. Campaigns by groups opposed to the commercial use of kangaroos resulted in manufacturers ceasing to use kangaroo products. Most bones are now discarded, except in a few situations where processing occurs near to a rendering plant and the bones are sold for 3–6 cents per kilogram to produce meatmeal or fertiliser.

The export trade

Most kangaroo meat exported since 1983 has been pet food. The regular buyers have been Hong Kong, Japan and the United Kingdom, but South-East Asian buyers are becoming important (table 5.8). In general, pet food sales and imports to Asian countries, particularly Japan, have grown recently (McNeill 1989).

The total quantity of kangaroo pet meat exported over the past decade has fluctuated between 200–700 tonnes annually (figure 5.2). The potential supply of kangaroo pet meat far exceeds the demand for the product, so a small increase in the price paid overseas leads to a large increase in

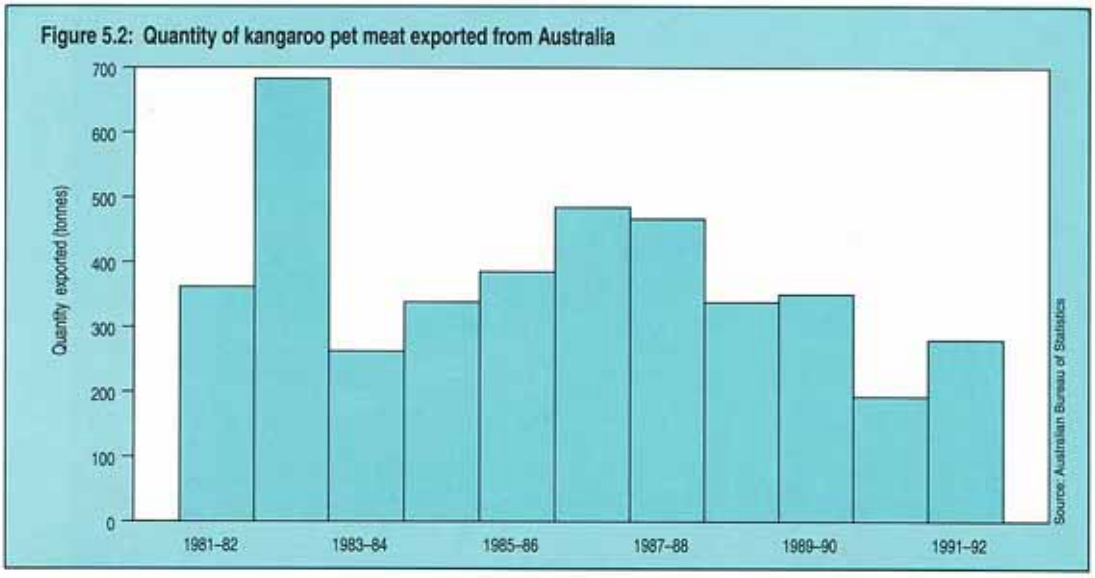


Table 5.8: Quantity, value and destination of kangaroo pet meat exported from Australia (all values are in Australian dollars)

DESTINATION	*ITEM*	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91	1991–92
GERMANY	Quantity (kg)	0	0	12 237	13 268	0	0	0	1 500
	Value ($)	0	0	5 788	9 483	0	0	0	6 773
HONG KONG	Quantity (kg)	213 570	228 825	213 570	183 060	446	0	15 800	15 984
	Value ($)	129 276	132 931	132 211	117 240	824	0	13 132	14 718
INDONESIA	Quantity (kg)	0	0	46 575	47 441	45 051	94 952	112 152	112 118
	Value ($)	0	0	39 362	30 637	30 730	67 806	76 931	75 400
JAPAN	Quantity (kg)	103 087	69 141	80 047	140 235	19 995	27 725	16 026	0
	Value ($)	67 835	43 859	55 074	130 502	14 802	27 339	10 738	0
MACAU	Quantity (kg)	0	0	0	15 984	204 475	178 152	31 968	112 920
	Value ($)	0	0	0	10 697	142 571	133 604	32 063	94 920
MALAYSIA	Quantity (kg)	0	0	15 417	31 968	16 483	0	0	14 000
	Value ($)	0	0	12 538	25 361	12 864	0	0	10 507
UNITED KINGDOM	Quantity (kg)	17 010	82 740	98 150	33 853	49 993	0	0	0
	Value ($)	13 823	75 292	111 419	24 151	29 832	0	0	0
UNITED STATES OF AMERICA	Quantity (kg)	0	0	0	920	0	1 500	0	0
	Value ($)	0	0	0	2 091	0	657	0	0
OTHER	Quantity (kg)	0	0	15 255	0	0	47 558*	16 384	19 549
	Value ($)	0	0	17 788	0	0	34 333	13 142	17 754
TOTAL ALL COUNTRIES	**Quantity (kg)**	**333 667**	**380 706**	**481 251**	**466 729**	**336 443**	**349 887**	**192 330**	**276 071**
	Value ($)	**210 934**	**252 082**	**374 180**	**350 162**	**231 623**	**263 739**	**146 006**	**220 072**
	Price ($/kg)	**0.63**	**0.66**	**0.78**	**0.75**	**0.69**	**0.75**	**0.76**	**0.80**

Source: Australian Bureau of Statistics (all values in current dollars) * Includes shipment to unidentified country

the quantity sold. The average price paid for kangaroo pet meat has varied between $0.60–0.80 per kilogram over the past decade. Exports have declined since 1986, and only 276 tonnes worth $220 000 were exported in 1991–92.

Game meat

The domestic trade

Kangaroo game meat (i.e. for human consumption) has been processed in South Australia and Tasmania for the domestic market for many years. Processors can sell kangaroo game meat within and between States. However, State legislation has prevented most Australians from buying the product. Up until mid-1992, kangaroo game meat could be legally sold only in the Northern Territory, the Australian Capital Territory, Tasmania, and South Australia. However, in the latter part of 1992, legislation was passed in New South Wales (in November) and in Western Australia (in December).

Tasmanians have traditionally dined on wallaby meat, but it was not formally incorporated into legislation controlling meat production and standards until 1985. Otherwise, the first State in recent history to implement legislative changes to allow production of kangaroo meat for human consumption was South Australia in 1980.

Sales of kangaroo game meat expanded rapidly in South Australia in the early 1980s, but marketing became difficult once the novelty of the product waned. The restaurant trade in South Australia is the main buyer of kangaroo game meat. In 1992, the retail value of kangaroo game meat varied from $4.50 per kilogram for mince to $9.00 per kilogram for prime cuts.

The total volume of domestic sales of kangaroo game meat in Australia is estimated to be less than 1000 tonnes per annum (Dee 1990).

The export trade

After the collapse of the export trade in kangaroo game meat in the 1960s, trade resumed in the 1980s when the Commonwealth Export Meat Orders (1985) were developed and implemented. These regulations provide stringent standards for harvesting, processing and inspection of game meats. The Australian Quarantine and Inspection Service (AQIS) is responsible for inspection and certification of all game meats exported. The standards for processing kangaroo game meat equal or exceed those for processing domestic stock, and all carcases receive post-mortem inspection by an AQIS officer.

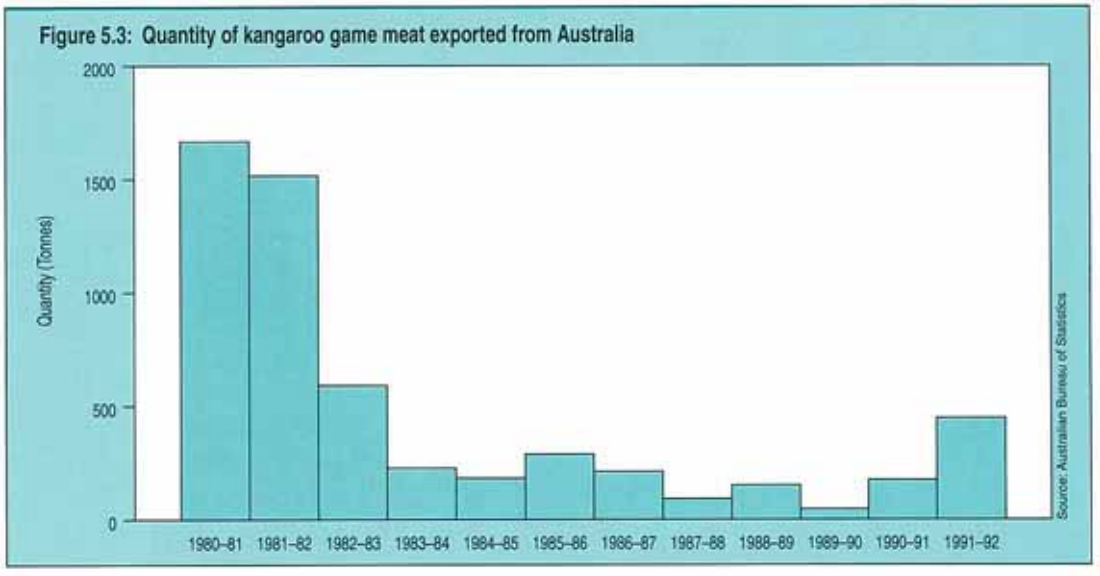


Table 5.9: Quantity, value and destination of kangaroo game meat exported from Australia (all values are in Australian dollars)

DESTINATION	*ITEM*	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91	1991–92
GERMANY	Quantity (kg)	50 177	3 528	39 655	2 780	11 539	0	0	0
	Value ($)	59 836	17 146	83 232	3 854	24 391	0	0	0
JAPAN	Quantity (kg)	15 189	65 206	35 111	50 260	0	15 856	67 272	312 988
	Value ($)	20 274	85 498	48 107	54 281	0	24 624	66 890	242 222
NETHERLANDS	Quantity (kg)	0	0	0	0	67 697	14 040	0	0
	Value ($)	0	0	0	0	102 569	82 172	0	0
NORWAY	Quantity (kg)	0	0	0	16 800	0	0	0	0
	Value ($)	0	0	0	28 605	0	0	0	0
PAPUA NEW GUINEA	Quantity (kg)	20 881	120 213	0	17 054	39 661	0	408	0
	Value ($)	26 677	161 406	0	23 336	57 059	0	1 060	0
REUNION ISLAND	Quantity (kg)	67 249	36 547	80 331	0	0	0	0	0
	Value ($)	70 873	57 489	105 516	0	0	0	0	0
UNITED STATES OF AMERICA	Quantity (kg)	0	774	3 465	2 823	0	0	2 893	2 682
	Value ($)	0	1 200	8 551	8 707	0	0	12 537	11 127
OTHER COUNTRIES	Quantity (kg)	29 594	65 260	51 406	0	31 896	18 180	104 832	129 150
	Value ($)	48 188	73 523	64 014	0	21 562	31 967	90 330	245 604
TOTAL ALL COUNTRIES	**Quantity (kg)**	**183 090**	**291 528**	**209 968**	**89 717**	**150 793**	**48 076**	**175 405**	**444 820**
	Value ($)	**225 848**	**396 262**	**309 420**	**118 783**	**205 581**	**138 763**	**170 817**	**498 953**
	Price ($/kg)	**1.23**	**1.36**	**1.47**	**1.32**	**1.36**	**2.89**	**0.97**	**1.12**

Source: Australian Bureau of Statistics (all values are in current dollars)

Several game meat processing establishments in New South Wales and Queensland began processing kangaroos to export the meat in 1980. The quantity of kangaroo game meat exported rose quickly to peak at 1671 tonnes in 1981, but sales have since declined (table 5.9 and figure 5.3).

The slump in kangaroo game meat exports followed successful campaigns by animal rights and animal welfare groups in Europe to dissuade importers from buying. The most effective argument raised by groups opposed to the trade was that kangaroo meat is primarily a pet food in Australia, where the animals are regarded as vermin. The European market deteriorated further when a German importer was found to be substituting kangaroo game meat for venison. In 1991, only 1800 of the 2.9 million kangaroos taken in the commercial harvest were processed for the export game meat market. Processing for export increased in the 1992 calendar year, when about 11 200 kangaroos went through licensed game meat processing establishments.

The kangaroo game meat industry is limited by market factors, rather than by supply considerations. The potential supply of kangaroo game meat far exceeds demand and the quantity of exports has remained small while prices are low. Since 1984–85, the total quantity exported has ranged between about 50–450 tonnes per annum, and the average value has ranged from $1.20–$2.90 per kilogram (table 5.9).

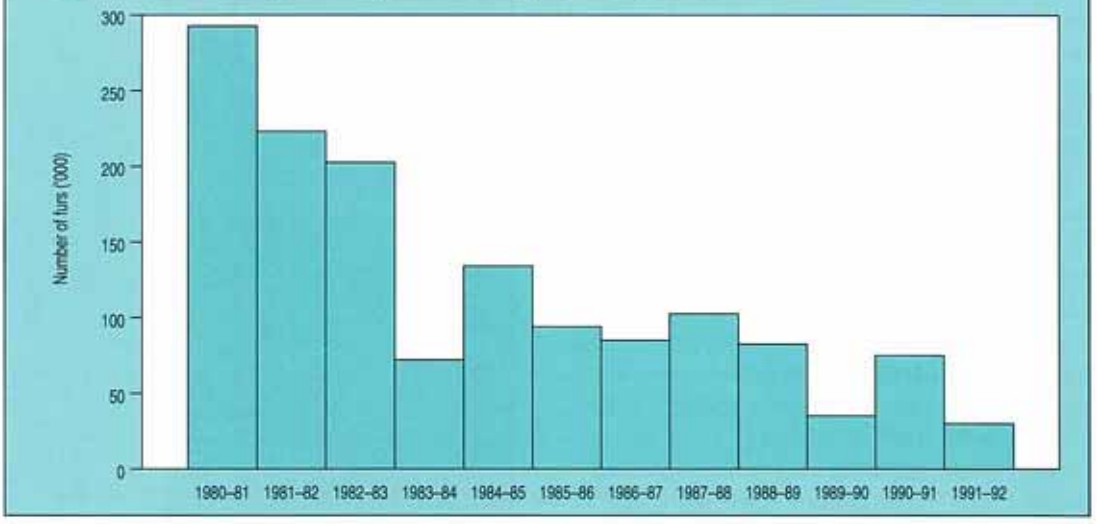
Japan seems to be the most regular buyer of kangaroo game meat, importing 15–65 tonnes per year. Otherwise, the destinations of exports have been highly variable. The outlook for the kangaroo game meat export industry is likely to remain poor until the domestic trade is developed nationally.

The kangaroo skin industry

Kangaroo skins enter commercial trade through the meat industry or directly from skin shooters. Shooters who supply the meat industry must deliver the skin-on carcase to a field chiller or processing works. The skin is removed in the meat processing works. Shooters who supply the skin industry remove the skin in the field, and the meat cannot be used. Skin shooters preserve the skins taken each night by treating them with salt. Once salted, the skins can be stored for several weeks before sale to a licensed dealer.

When each kangaroo is shot, a numbered tag from the State conservation authority must be fixed to the skin immediately. The tag signifies that the kangaroo has been shot as part of the State kangaroo management program. This enables conservation

Figure 5.4: Number of raw, whole kangaroo and wallaby fur skins exported from Australia



authorities to monitor the harvest and track the skins as they move through the commercial trade.

The product

Kangaroo skins can be used to make high strength, low weight specialty leathers of exceptional quality. The leather has a high tensile strength, which makes it ideal for the manufacture of athletic shoes (Stephens 1987). Most skins produced by the commercial harvest of large kangaroos are exported and used by the footwear manufacturing industry.

Kangaroo skins are graded on the basis of size and quality. The sizes used are small (0.27 to 0.45 m^2), medium (0.45 to 0.63 m^2) and large (over 0.63 m^2). The quality of skins used for leather production is initially affected by the habitat of the animal. For example, large kangaroos living in closely settled agricultural regions may have scarring of the hide due to scratches from wire fences. Kangaroos living in areas where the cattle tick is common may have damaged hides due to high tick infestation.

Trade in kangaroo and wallaby skins is divided here into sales of raw fur skins, semi-processed (pickled) skins and fully tanned skins.

Raw fur skins

Most wallabies taken by commercial industry are shot for their fur, whereas few kangaroo skins are used in the fur trade. The export trade in wallaby fur is currently limited to furs from the whiptail wallaby. Furs from the Bennett's and the rufous wallaby are traded in small quantities within Australia, but demand and prices are low.

Wallaby furs are usually sold as air-dried skins, but most kangaroo furs are traded as salted skins. The furs are exported to garment manufacturers or used by domestic manufacturers to produce toys and souvenirs. Some of the raw fur skins exported may ultimately be used as leather.

The main importers of kangaroo and wallaby furs up to January 1988 were Italy,

Table 5.10: Number and value of raw, whole kangaroo and wallaby fur skins exported 1980–81 – 1991–92 (all values are in Australian dollars)

	1980–81	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91	1991–92
Number	282 294	214 682	194 529	68 917	129 246	90 730	82 135	98 454	79 057	33 367	71 807	27 961
Value ($)	1 404 000	1 161 388	1 275 000	475 383	1 003 578	817 507	674 909	853 118	562 153	434 571	770 594	402 056
Price ($/each)	4.97	5.41	6.55	6.90	7.76	9.01	8.22	8.67	7.11	13.02	10.73	14.38

Source: Australian Bureau of Statistics. Australian Export Commodity Classification 212.09.01 covers period to and including December 1988
Australian Harmonised Export Commodity Classification 43018010 covers the period from and including January 1989. All values in current dollars
Exports before and including 1986–87 may include Bennett's and rufous wallaby from Tasmania.

Japan, and the Federal Republic of Germany. Export statistics after January 1988 do not specify the importing country. Nonetheless, the total quantity and value of fur skin exports are available (table 5.10).

The number of raw kangaroo and wallaby fur skins exported has declined over the past decade (table 5.10 and figure 5.4). Most furs were exported in 1980–81, when 282 294 furs worth $1.4m were shipped. The average unit value of furs has since fallen as low as $5.00 each. A total of 27 961 furs worth $0.4m were exported in 1991–92 (table 5.10).

The slump in the volume of exports of raw furs over the past decade is partly because wallaby furs have not been exported from Tasmania since 1986 (the last year in which a management program was approved under Commonwealth legislation). Nonetheless, a major influence on the composition of the export trade is that the demand for kangaroo skins for use in leather production in Australia and overseas has been increasing.

The scale of the domestic trade in kangaroo and wallaby fur is unknown, but likely to be very small compared with the trade in skins for leather production.

Figure 5.5: Variations in the total number of pickled kangaroo skins exported

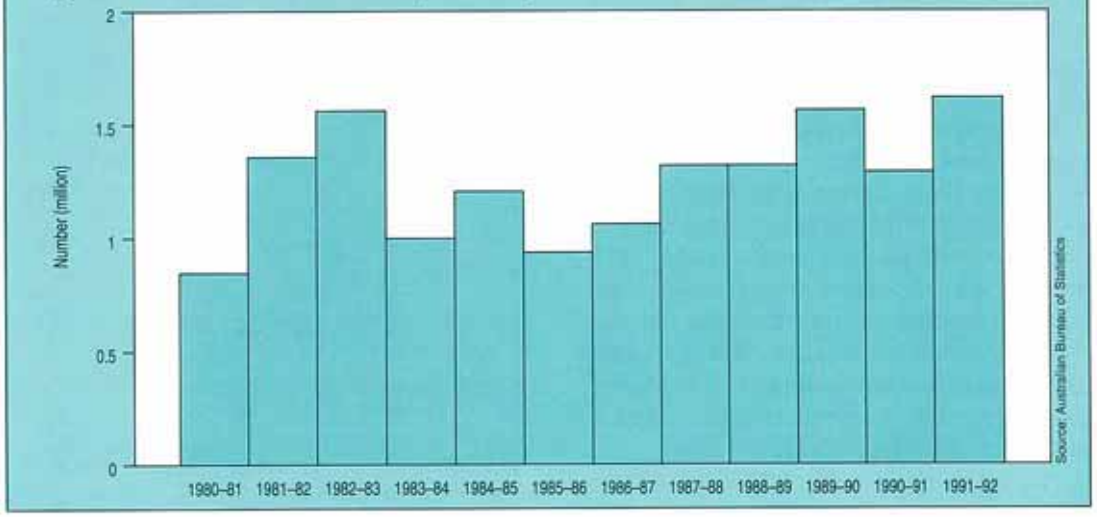


Figure 5.6: Variations in the average export value of pickled kangaroo skins

Pickled skins

Hides that are cured by salting are susceptible to deterioration when stored for long periods or transported over long distances in hot climates. They are also costly to transport because the salt increases the weight of the skin. Therefore, most kangaroo skins are now processed one stage beyond curing by pickling the skin. Pickling involves removing the fur by applying lime and treating the skin with a solution of sulphuric acid and salt.

Pickled hides can be held in storage for long periods. This can be an advantage when prices are low, because the skins can be stored until prices improve. Pickled kangaroo hides have proven the most economically important kangaroo export commodity over the past decade.

The destination of pickled kangaroo skin exports has not been published since December 1987. Before 1988, Italy was the major buyer of pickled kangaroo skins, taking about 75 per cent of all exports. Italy remains an important buyer today, but export markets have become more diversified and the relative importance of Italian imports is decreasing. For example, Japan and Germany also import large quantities of pickled kangaroo skins.

The total number of pickled kangaroo skins exported has varied between 0.84–1.56 million over the past decade (table 5.11 and figures 5.5 and 5.6). Most exports were in 1982–83 (1.55 million skins) and 1991–92 (1.62 million skins). The drop in the quantity of skins exported between 1983–84 and 1986–87 was partly due to a crash in the market and a reduction in supply following a widespread drought in 1982 and 1983. Kangaroo populations dropped significantly during the drought (Fletcher et al. 1990) and lower quotas were imposed to limit the operations of the industry.

Although pickled skins generate the most export earnings of all kangaroo products, there has been a trend for an increasing proportion of skin exports to be as finished leather.

Table 5.11: Number and value of pickled kangaroo skins exported from Australia, 1980–81 – 1991–92 (all values are in Australian dollars)

	1980–81	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91	1991–92
Number	843 896	1 352 925	1 554 398	993 598	1 199 883	929 540	1 056 976	1 310 931	1 310 692	1 558 936	1 283 770	1 617 474
Value ($)	3 334 000	6 703 423	8 344 000	5 687 447	10 911 206	8 998 083	7 926 654	9 147 104	9 623 000	13 658 477	14 114 824	15 527 522
Price ($ each)	3.95	4.95	5.37	5.72	9.09	9.68	7.50	6.98	7.34	8.76	10.99	9.60

Source: Australian Bureau of Statistics. Data up to and including December 1988 is from Australian Export Commodity Classification code number 211.99.05

Data from and including January 1989 is from a summation of Australian Harmonised Export Commodity Classification numbers 4103.90.61 - 4103.90.68 All values in current dollars

Exports before and including 1986/87 may include Bennett's and rufous wallaby from Tasmania.

Leather

Substantial quantities of finished kangaroo leather are now produced in Australia and sold on domestic and export markets. Most of this leather is exported, particularly to Japan and Germany (figure 5.7) where it is primarily used in the footwear manufacturing industry. France, Korea, Taiwan and the USA also import large quantities of kangaroo leather.

It is difficult to analyse the trade in kangaroo leather exports over the past decade, because the destinations are not published in many years. In addition, the unit of quantity used by the Australian Bureau of Statistics in its trade reporting changed from square metres to number of skins in January 1989.

The quantities of kangaroo leather exported since 1984–85 are shown in table 5.12. The quantity shipped in 1984–85 was quite small (26 270 square metres), but the average value was $33.40 per square metre. Exports were higher between 1985–86 and 1987–88, but the average value varied between $21.00 and $22.00 per square metre. Since 1989, the average value of skins exported has been around $19–21 each. In 1991–92, 545 000 tanned kangaroo skins worth $11.8m were shipped overseas.

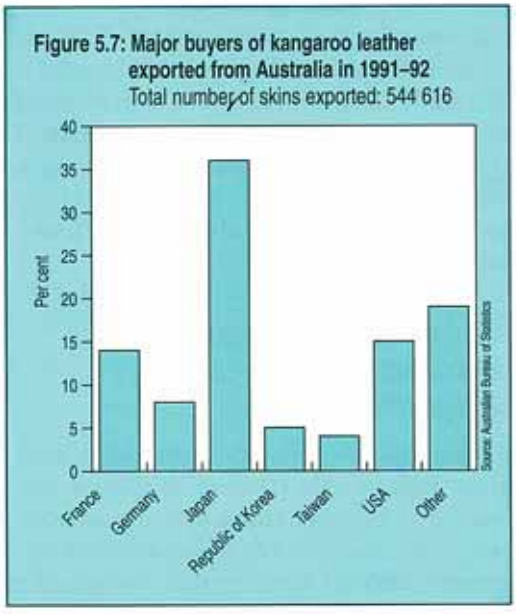
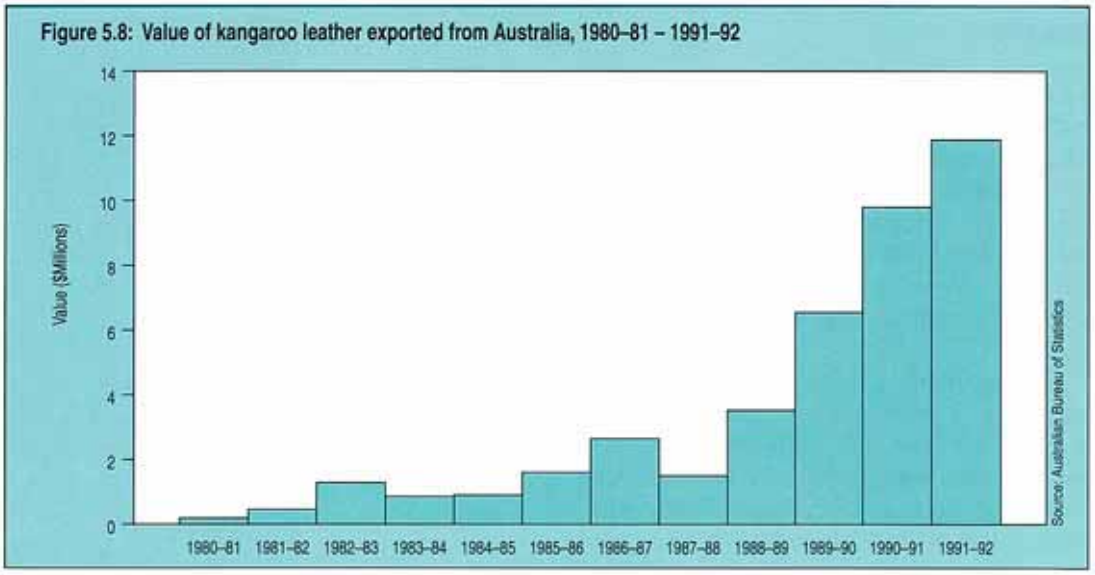


Table 5.12: Quantity and value of kangaroo leather exported from Australia, 1984–85 – 1991–92 (all values in Australian dollars)

DESCRIPTION		1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91	1991–92
QUANTITY*	Square Metres	26 270	72 108	122 566	69 200	50 279	-	-	-
	Number	-	-	-	-	122 082	344 534	478 827	544 616
VALUE ($)		877 867	1 584 096	2 587 873	1 497 087	3 456 686	6 498 154	9 714 475	11 761 790

Source: Australian Bureau of Statistics (all values in current dollars) * Number of skins recorded since January 1989



The value of kangaroo leather exports has increased significantly over the past decade (table 5.12 and figure 5.8). Many factors underpin this growth in trade:

- The local production capacity, efficiency and quality has increased, making the Australian product more competitive on world markets.
- The superior qualities of kangaroo leather for manufacture of some products, particularly athletic shoes, is becoming widely recognised.
- Export markets have become more diverse, with a total of 21 countries importing kangaroo leather during 1991–92.

Small kangaroo skins produce a thin leather that is used to manufacture products such as fine leather shoes or leather gloves. Most small skins are exported as pickled skins. In contrast, most medium and large skins are used to manufacture footwear, particularly sports shoes such as soccer boots.

Over the past decade, footwear manufacturers in Australia have started to use more kangaroo leather in their products. Melbourne is the main centre for footwear manufacturing in Australia, followed by Sydney. Medium and large skins are preferred and the quantity demanded is sensitive to competition from alternative leathers (primarily from goats and, to a lesser extent, calves).

Competition from substitute products becomes important when retail sales of footwear are depressed. High quality shoes made of kangaroo leather are often lined with leather, which increases the cost of production. Manufacturers can opt to cut production costs by using a leather which is thicker than that produced from kangaroo skins. This makes it unnecessary to line the shoe, and reduces the demand for kangaroo leather.

Patterns of trade in skin products, whether on domestic or export markets, are complex and difficult to interpret. Competition from substitutes, changes in consumer preference, and variations in the number of skins available combine to make analysis of the skin trade difficult. However, the demand for kangaroo skins seems strong, which is leading to a positive effect on skin prices and encouraging the development of domestic tanning and leather manufacturing industries.

Factors influencing commercial harvest of kangaroos

Many economic, biological and legislative factors influence the commercial harvest, and hence the number taken and the regions harvested. As with all consumer products, demand tends to fluctuate with the price of

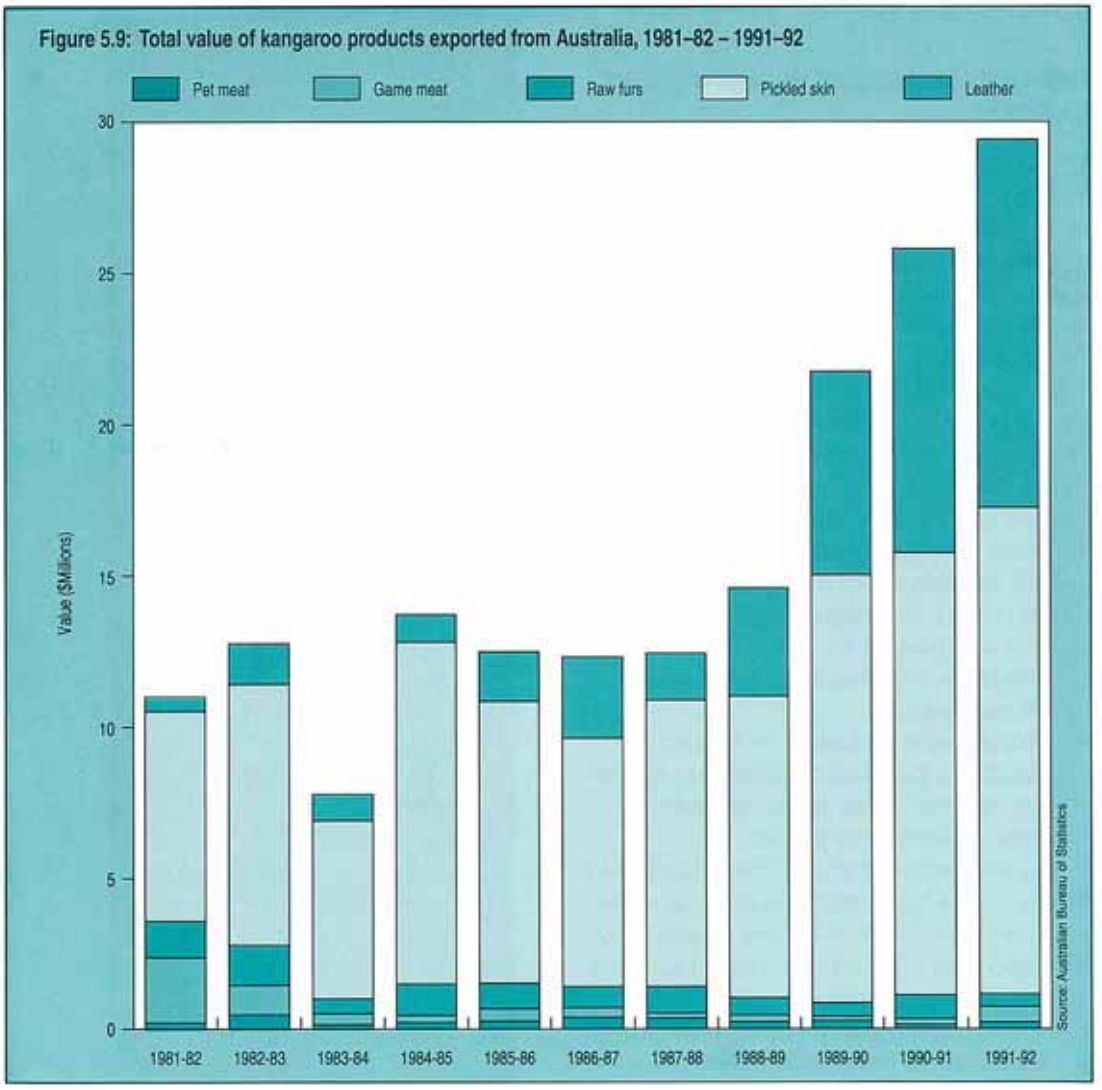
substitute products and consumer preferences.

Commercial hunters concentrate on populations that are the most economical supply, which is determined primarily by population density and proximity to markets. They extend their activities to lower-yielding regions only when higher prices justify increased costs. If the optimal density for damage control is lower than the profitable harvest density, the kangaroo industry may still be making an important contribution by reducing overall population densities to levels less than they might otherwise be.

A major influence on supply of kangaroo products is the variable patterns of local and regional rainfall. Drought can assist hunters, because the kangaroos must concentrate around watering points. It is most cost-effective to harvest kangaroo populations that are at a high density. On the other hand, rainfall disperses populations, making it difficult for hunters to have access for vehicles and increasing the time spent hunting.

Most pet meat distributors manage variable supply by stockpiling frozen meat. The larger distributors also have access to supply from interstate, to manage during periods of limited local production due to widespread environmental events such as drought and extensive rainfall which adversely affect supply.

Figure 5.9: Total value of kangaroo products exported from Australia, 1981–82 – 1991–92



Increased costs associated with supplying the market for kangaroo products reduces the capacity of the industry to harvest kangaroos. For example, as the kangaroo industry is based in rural areas, far from the major markets for its products, rising fuel and transport costs can significantly reduce the profitability of the industry. Further, export markets offer good prospects for kangaroo products, but the costs of establishing and maintaining export facilities are high. Many companies have not invested in export markets due to both the high cost and the high risk.

The kangaroo industry is also susceptible to worldwide campaigns by animal rights groups which are philosophically opposed to the killing of animals.

Value of the kangaroo and wallaby industry

There is much information on the value of kangaroo products exported, but the value of the domestic trade is difficult to establish. Interstate movement of kangaroo products is extensive, which complicates analysis of the quantities consumed in each State and Territory.

It is not possible to estimate the value of all skin products absorbed into the local market without undertaking a detailed survey of the industry. However, two factors that suggest the domestic trade is substantial are:

- Most finished kangaroo fur products are manufactured and sold in Australia. Overseas visitors are likely to be important buyers of these products, resulting in indirect export of the products.
- Manufacture of kangaroo leather products, particularly footwear, is now an important part of the domestic trade in kangaroo goods.

The total value of all exports of kangaroo products has been stable over most of the past decade (table 5.13 and figure 5.9). However, the total export value has been increasing since 1989, reaching $28m in 1991–92. The increase in the total export value reflects an increase in the demand for

Table 5.13: Total value of kangaroo products exported from Australia, 1981–82 – 1990–91 (all values in Australian dollars)

Product	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91	1991–92
Pet meat	205 508	456 000	145 076	210 934	252 082	374 180	350 162	231 623	263 739	146 006	220 072
Game meat	2 081 107	942 000	347 827	225 848	393 562	309 420	150 819	205 581	138 763	170 817	498 953
Raw fur skin	1 161 388	1 275 000	475 383	1 003 578	817 507	674 909	853 118	562 153	434 571	770 594	402 056
Pickled skin	6 703 423	8 344 000	5 687 447	10 911 206	8 998 083	7 926 654	9 147 104	9 623 000	13 658 477	14 114 824	15 527 522
Leather	458 742	1 288 000	841 618	877 867	1 584 096	2 587 873	1 497 087	3 456 686	6 498 154	9 714 475	11 761 790
TOTAL	10 610 168	12 305 000	7 497 351	13 229 433	12 045 330	11 873 036	11 998 290	14 079 043	20 993 704	24 916 716	28 410 393

Source: Australian Bureau of Statistics (all values in current dollars)

kangaroo skins, particularly kangaroo leather. However, it is also due to an expansion in the number of skins that receive further processing in Australia. Exports of raw skins have decreased and exports of pickled and tanned skins have increased significantly.

The trade in kangaroo meat products has been poor in comparison with the skin trade. Total meat exports have declined due to poor demand and a lack of access to domestic and export markets for kangaroo game meat. Most kangaroo game meat exported in recent years is used in meat processing.

The wholesale value of all kangaroo meats sold within Australia appears to be well in excess of $20m. The total wholesale value of the domestic and export trade in all kangaroo products is worth in the vicinity of $50–60m annually.

Non-commercial

Kangaroos cause losses to agricultural production by competing with domestic livestock for fodder (Wilson 1991) and damaging fences and watering points (Sloane Cook & King Pty Ltd 1989). A national survey of landowners (Gibson & Young 1988) found that the perceived losses due to kangaroos amounted to about $113m in 1987. In some regions, the commercial harvest is nonexistent, or inadequate to meet the pest mitigation needs of landowners, and an alternative control mechanism is required.

Conservation authorities in each State can issue a permit for landowners to kill kangaroos on their land. The permit is often referred to as a non-commercial or damage mitigation permit, and it specifies the number of kangaroos that can be killed. However,

Table 5.14: Number of kangaroos permitted to be killed for damage mitigation, other than by commercial harvesting

		CALENDAR YEAR				
STATE	*SPECIES*	1985	1986	1987	1988	1989
ACT	E. GREY	332	-	-	-	-
NSW	GREY*	15 314	17 582	37 747	29 087	1 761
	RED	-	-	2 219	915	50
	WALLAROO	855	60	2 380	3 873	225
NT	RED	6	-	-	-	-
QLD	GREY*	12 280	80 111	6 286	11 206	4 392
	RED	556	3 486	630	8 226	2 508
	WALLAROO	490	3 233	816	2 534	1 142
SA	E. GREY	-	29	-	-	35
	W. GREY	1 436	11 679	10 059	9 996	6 946
	RED	-	1 393	1 128	1 143	1 202
	WALLAROO	-	365	175	240	242
VIC	GREY*	9 725	-	-	-	-
WA	W. GREY	486	256	106	118	89
AUSTRALIA	GREY*	39 573	109 657	54 198	50 407	13 223
	RED	562	4 879	3 977	10 284	3 760
	WALLAROO	1 345	3 658	3 371	6 647	1 609
	TOTAL	**41 480**	**118 194**	**61 546**	**67 338**	**18 592**

* Figures for eastern and western grey combined

Source: Australian National Parks and Wildlife Service

the number of kangaroos killed under these permits is unknown, as most States do not require the landowner to report the number of animals that are killed. Even if landowners were required to make such a report, it is almost impossible to verify the number killed. The products from animals killed under non-commercial permits cannot be used for commercial purposes.

The method of killing kangaroos for damage mitigation is by shooting in all States and Territories, excepting Tasmania and Victoria, which also allow poisoning—using the chemical sodium monofluoroacetate, or 1080. New techniques for managing kangaroo and wallaby populations, such as the use of fertility control and electric fencing, are attracting some interest from landowners and from groups opposed to killing animals. However, there are concerns amongst some conservationists that the risks to species from the development of low-cost exclusion or killing methods have not been considered.

Shooting

Most non-commercial permits are issued to kill grey kangaroos, particularly eastern greys (table 5.14). Large populations of grey kangaroos are distributed in the more productive high rainfall regions (Caughley 1987; Fletcher et al. 1990). Red kangaroos are common in semi-arid pastoral regions, but few non-commercial permits are issued to kill them.

Since 1984, the largest number of kangaroos permitted to be killed annually in Australia under non-commercial permits was 118 194 in 1986. By comparison, the commercial cull was 2 085 491 in the same year. If the legal non-commercial kill was indeed 118 194 kangaroos, which is unknown, this would have increased the total number killed by about 1 per cent to 2 203 685.

An extension of the issue of the inability to accurately confirm the number of kangaroos killed under non-commercial

Table 5.15: Wallabies killed in Australia for pest mitigation other than under commercial harvest quotas

		CALENDAR YEAR				
STATE	*SPECIES*	1985	1986	1987	1988	1989
NSW	RED NECKED	171	35	295	225	10
	SWAMP	82	79	29	285	20
	TOTAL	**253**	**114**	**324**	**510**	**30**
QLD	WHIPTAIL	-	-	60	83	255
	ALL SPECIES	1 542	13 808	-	-	-
	TOTAL	**1 542**	**13 808**	**60**	**83**	**255**
SA	TAMMAR	12 660	8 760	-	-	4 649
TAS*	BENNETT'S	299 104	349 000	-	-	-
	RUFOUS	247 421	352 000	-	-	-
	TOTAL	**546 525**	**701 000**	**-**	**-**	**-**
VIC	RED NECKED	55	-	-	-	-
	SWAMP	157	-	-	-	-
	TOTAL	**212**	**-**	**-**	**-**	**-**
AUSTRALIA	**ALL SPECIES**	**561 192**	**723 682**	**384**	**593**	**4 934**

* Estimates from shooter questionnaires. Not provided after 1986

Source: Australian National Parks and Wildlife Service

Table 5.16: Quantity of 1080 poison used in baits for wallaby control in Tasmania							
FINANCIAL YEAR	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89
QUANTITY OF 1080 (kg)	7.81	7.15	9.03	8.25	11.64	15.23	8.59
Source: Tasmania Department of Primary Industry							

permits is the question of illegal kills. The incidence of landowners killing kangaroos and wallabies without first applying to conservation authorities for a permit is unknown. The number of kangaroos killed illegally by recreational shooters is also unknown.

The largest non-commercial cull of kangaroos or wallabies in Australia occurs in Tasmania (table 5.15). Here, the Bennett's and rufous wallaby are killed by recreational hunters, as well as by landowners and the State Department of Primary Industry.

Recreational hunters shoot wallabies for sport, and for meat for personal consumption or for pet food. This hunting has drawn criticism from animal welfare groups (RSPCA 1987) due to concerns over wounding of animals from using shotguns and .22 calibre rimfire rifles. It is illegal to use these weapons to kill kangaroos and wallabies in any mainland State or Territory.

A questionnaire survey of hunters carried out by the Tasmanian Department of Parks, Wildlife and Heritage in 1986 found that an estimated 349 000 Bennett's wallabies and 352 000 rufous wallabies were killed. The number of animals killed since 1986 is unknown.

Poisoning

The second most important method of killing wallabies in Tasmania is by poisoning under a crop protection permit. The Tasmanian Department of Primary Industry is responsible for inspecting properties seeking wallaby control and for carrying out poisoning activities. The method used involves laying baits, which are usually carrots impregnated with 1080 (Statham 1989).

The number of wallabies killed is unknown, but substantial quantities of poison are used (table 5.16). Use of 1080 poison to kill wallabies was condemned by the RSPCA (1987) as 'cruel and unacceptable'. The costs of the wallaby poisoning operations to the Tasmanian Department of Primary Industries amounted to $118 000 in 1987–88.

Non-commercial killing of wallabies in other States is negligible in comparison to that in Tasmania (table 5.15). The poorly developed commercial wallaby industry in Tasmania does not presently represent a viable means of controlling wallabies. Unless this changes, non-commercial methods of killing wallabies will continue to be employed on a large scale in Tasmania to mitigate damage caused to agriculture and forestry.

Fertility control

There has been increasing interest in the use of fertility control as an alternative method of controlling kangaroo and wallaby populations (Stelmaziak & Van Mourik 1987; Tyndale-Biscoe et al. 1990). However, a review of the potential for using fertility control in wildlife management (Bomford 1990) concluded that, at present, the role for this technique is extremely limited.

The main barrier to the use of fertility control to manage wild mammal populations is the lack of techniques to deliver drugs to widespread and abundant animals (Bomford 1990). Further, the costs of such broadscale fertility control would be prohibitive. Nonetheless, fertility control measures could be effective for small populations of kangaroos enclosed in parks or zoos.

Electric fencing

An electrified (or Finlayson) trough is a low-lying electrified wire that surrounds a watering trough. The device allows sheep access to water, while denying it to kangaroos (Norbury & Norbury 1992). It is cheap, costing approximately $200–250 to install, including the energiser, car battery and solar panel power source. Investigations by the WA Agricultural Protection Board indicate that the device excludes 99 per cent of kangaroos that attempt to drink. The animal welfare and conservation implications of this device are profound. Once installed, government agencies have no control over the use of the device. Widespread adoption of the Finlayson trough by landowners has the potential to reduce kangaroo populations from large areas which do not have natural waters.

Discussion

The commercial harvest of kangaroos and wallabies is worth at least $50–60m annually. However, there are many opportunities for further development of the kangaroo industry. Besides the obvious potential to gain economic and social benefits, there are also compelling environmental reasons for encouraging the development of a sustainable kangaroo industry.

Kangaroos are well adapted to the harsh and variable environment of inland Australia, the populations can increase rapidly in response to good seasonal conditions, and the capital costs of harvesting are low. Further, they could be a more appropriate production animal in rangelands that are becoming increasingly degraded due to the presence of hard-hoofed sheep and cattle (Grigg 1988). Moving to boost kangaroo production could help conserve native habitat for other less common native animals. Governments have made a commitment in the National Strategy for Ecologically Sustainable Development to remove impediments to a sustainable kangaroo industry (Council of Australian Governments 1992).

There are many linkages throughout the production–marketing chain between the kangaroo industry and other wild animal industries. For example, some participants in the kangaroo industry have diversified their operations to include harvesting of feral goats and wild boar for the export trade. The enhanced infrastructure associated with a more developed kangaroo industry could provide a catalyst for increased harvesting of feral animals that cause agricultural and environmental damage.

Several important observations in relation to wildlife management can be drawn from kangaroo harvesting:

- Data on the number, sex, species and geographic location of kangaroos killed are readily available from the commercial industry. By comparison, the impact of non-commercial killing is poorly documented. This is also true for other native and introduced species killed for commercial and non-commercial purposes. Nonetheless, direct monitoring of populations will provide data on population fluctuations resulting from all forms of mortality.
- Commercial harvest statistics provide a means of indirectly monitoring the status and distribution of kangaroo populations. This is an important adjunct to direct monitoring by aerial and ground surveys.
- In the long term, a large domestic market for kangaroo products will reduce the influence of the Commonwealth *Wildlife Protection (Regulation of Exports and Imports) Act (WPA) 1982* on kangaroo management. The WPA has direct control only over imports and exports.
- It could be argued that a more efficient kangaroo industry would reduce agricultural damage caused by kangaroos and lead to a reduction in illegal killing of kangaroos.
- When the commercial harvest is too small to mitigate damage, such as the present case with wallabies in Tasmania, the alternative methods available raise serious animal welfare and conservation concerns.

There is clearly a strong case for government conservation agencies to carefully monitor trends in the composition and value of trade in kangaroo products. At present, the relationship between prices, harvesting patterns and harvesting effort is poorly understood. This is an area where further research would seem appropriate.

One of the concerns about commercial harvesting of kangaroos and wallabies is the possibility of overharvesting. At present, quotas are set at a level which would prevent further population increase if fully taken. Quotas are therefore seen as a 'safety net' to prevent overharvesting. With continuing poor demand and limited market opportunities for kangaroo meat, it is unlikely that quotas will be met or exceeded in the near future. Quotas may therefore continue to increase in response to good rainfall and inadequate damage mitigation by the commercial industry. This raises the question of where the best prospects lie for development of the kangaroo industry.

Historically, most kangaroo skins produced have been exported as pickled skins. However, there has been a consistent trend over the past five years for an increasing proportion of the commercial take to be tanned in Australia to produce finished leather. Further, shoe manufacturers in Australia are increasing their use of kangaroo leather. In summary, developments in the kangaroo skin industry have been favourable in terms of improved value-adding. Therefore, the best prospects for further increasing the value of the kangaroo industry seem to lie with developing markets for kangaroo meat.

Most meat produced from the commercial kangaroo harvest is sold at low returns in the domestic pet food industry. Expansion of the pet meat trade seems unlikely, partly due to legal restrictions on distribution in some States (in particular, Queensland, New South Wales and Victoria) where kangaroo pet meat cannot be sold in supermarkets. This restriction extends to cooked, hermetically sealed sausage products, which are produced in Western Australia. Therefore, State legislation impedes distribution of kangaroo pet meat to consumers and also discourages the industry from developing new products to suit changing consumer requirements.

Production of kangaroo meat for human consumption offers the highest return for kangaroo meat and hence the best prospect for enhancing industry performance. However, at the beginning of 1993, State legislation prevented sale of kangaroo game meat in the important markets of Queensland and Victoria. The Queensland Government has indicated that legislative changes will be made to enable the sale of kangaroo game meat in the State. A national standard on game meats, including kangaroo game meat, is currently being prepared by the National Food Authority, although the decision to incorporate the standard into domestic legislation ultimately rests with individual States.

Consumers in developed countries are increasingly health conscious (Overton 1990) and the healthy attributes of kangaroo meat could help in promoting the product. However, the image of kangaroo meat as pet food within Australia severely undermines any efforts to promote the product overseas as a high quality meat. A strategy to develop a stable domestic market for kangaroo game meat would complement efforts to promote the product internationally.

The national quota of kangaroos in 1992 was 5.18 million, which represented a potential yield of more than 60 000 tonnes of boneless meat. If markets had been available and willing to pay an average value of, say, $3 per kilogram, production of kangaroo meat in 1992 could have returned about $180m. With careful market development and promotion, it is conceivable that the gross value of production for the kangaroo industry could reach several hundred million dollars annually.

Realising the potential value of the kangaroo industry will require many changes in laws and attitudes to develop markets for the products. It will require a shift from the philosophy that kangaroos are pests whose populations should be minimised towards

an attitude that kangaroos are a resource that should be highly valued, protected and incorporated into our future agricultural production systems. This means that kangaroos would be managed to maintain high population densities to maximise productivity in line with ecological sustainability principles.

Conclusions

There is significant potential to increase the value of the kangaroo industry in Australia by developing the market for game meat, and expanding further processing and manufacturing of the leather within the country. This means making better use of the animals now permitted to be killed.

Public education that kangaroo slaughtering and management practices are in accordance with animal welfare and conservation concerns is necessary if the products are to be marketed effectively. Improved markets for kangaroo products, particularly for game meat, will increase the value of kangaroos, and could provide incentive to landowners to manage populations and protect their habitat, rather than simply view kangaroos as vermin. This approach is consistent with broader initiatives in agriculture to develop a more diversified and resilient farm sector.

Non-commercial techniques for killing kangaroos and wallabies, such as the use of poisons and denying access to water using an electrified (Finlayson) trough, raise significant animal welfare and conservation issues. Such approaches are based on the assumption that kangaroo populations are a drain on economic production, rather than a valued resource.

Increasing the value of kangaroos will enhance the capacity of the industry to mitigate damage caused by kangaroos. Increasing the value of kangaroos is consistent with the objective of harvesting kangaroos as a renewable resource. The current management framework provides a sound basis to move towards treating kangaroos as a renewable resource, although some aspects, such as monitoring and assessment procedures, may need to be refined to ensure the sustainability of production.

Achieving the conservation goals associated with sustainable use of kangaroos will require that landowners receive direct benefits (money) for the animals taken from their land. These returns could be provided through payments from the kangaroo industry for access to the property, or on the basis of offtake. Either of these mechanisms would be effective. However, there is a risk that they would disconnect the landowner from the markets for kangaroo products and encourage a production-driven, rather than a market-led enterprise. With kangaroos, as with traditional production systems, primary producers need to have the opportunity to invest throughout the production–marketing chain.

At present, market access and development are the main barriers to the growth of the kangaroo industry. However, once a legislative framework permitting the sale of kangaroo game meat throughout Australia is in place, the kangaroo industry will be in a position to promote kangaroo meat effectively. The market will then decide the fortunes of the industry, within the constraints imposed by conservation authorities.

6 BRUSHTAIL POSSUM

Distribution and abundance

The brushtail possum *(Trichosurus vulpecula)* is the most abundant of all Australian possums. It has an extensive range, occupying forest habitats from tropical Cape York Peninsula in north Queensland, through to the cool temperate climate of Tasmania (How 1983). Population densities vary from 0.4 to 1.4 individuals per hectare on mainland Australia (How 1983), but can be as high as 8.0 per hectare in Tasmania (Johnson 1977). At least 60 per cent of rural Tasmania is suitable brushtail possum habitat, and they are only uncommon in areas of extensive agricultural land or rainforest.

Europeans have harvested brushtail possums for meat and furs since settlement (Lunney & Leary 1988; Thomson et al. 1987). Although this species remains locally abundant on the mainland, it is now only harvested commercially in Tasmania, where government regulation has controlled the harvest since 1918.

A brushtail possum management plan is prepared and administered by the Tasmanian Department of Parks, Wildlife and Heritage (DPWH). Under the management plan, special permits can be issued to allow commercial harvesting during a limited season, and also to allow non-commercial killing for crop protection. Harvesting of brushtail possums, for any reason, is regulated and enforced by DPWH.

Annual spotlight surveys have been carried out by DPWH staff since 1976 to monitor brushtail possum abundance. Results have indicated no significant changes.

The Commonwealth Minister responsible for the environment controls the export of native animal products through the *Wildlife Protection (Regulation of Exports and Imports) Act 1982*, which is administered by the Australian Nature Conservation Agency. Under this legislation, the State conservation authority must have the management plan for the species being harvested approved before products can be exported. Therefore, the DPWH submits the annual brushtail possum management plan for the forthcoming year to the Commonwealth Minister responsible for the environment for approval, to allow the export of brushtail products.

Status

Brushtail possums are fully protected throughout Australia, except in Tasmania, where they are legally defined as partly protected under the Wildlife Regulations 1971 of the *National Parks and Wildlife Act 1970*. Brushtail possums are regarded as a pest in forestry (Statham 1983) and agriculture.

Commercial use

Brushtail possums are harvested commercially on land used for grazing, farming and forestry. Harvesting is allowed under special permit for a specified period (July to September in 1990). A quota, or the maximum number permitted to be killed, is specified in the management plan. The quota has stood at 250 000 for several years.

The brushtail possum has proven to be a successful coloniser, and the populations are able to withstand a high level of culling. The Tasmanian brushtail possum population has sustained commercial harvests of over 200 000 per year when fur prices were high in the late 1970s, reaching almost 292 000 in 1979.

The most common method of killing brushtail possums is by shooting at night with the aid of a spotlight. However, live capture using a cage trap is also permitted.

Fur

Once the skin is removed from the possum, it is stretched, air dried and sold to a licensed fauna dealer. Not all skins taken are marketable and many are discarded by hunters. The total number of brushtail possums killed is estimated from hunters' returns (table 6.1). A record is kept of all skins sold to licensed dealers, who may discard further skins that are unsuitable for

Table 6.1: Trade figures for the brushtail possum industry in Australia (all values are in Australian dollars)

ITEM	CALENDAR YEAR					
	1985	1986	1987	1988	1989	1990
Estimated number killed	115 234	106 734	252 086	177 808	59 731	63 643
Number entering trade	59 922	61 839	153 104	93 255	34 047	18 800
Apparent rejects (%)	48.0	42.1	39.3	47.6	43.0	70.5
Average export value	5	6	8	6	5	
Number of permit holders	745	717	1 320	1 422	635	493
Average number killed per hunter	155	148	190	125	94	129
Number permitted to be exported by ANCA	89 306	89 111	172 184	111 618	42 538	NA

Data supplied by the Australian Nature Conservation Agency (ANCA), the Tasmanian Department of Parks, Heritage and Wildlife, and Australian Bureau of Statistics. NA = Not available

trade. All skins retained by dealers for trade must be presented to an officer from DPWH for branding within 28 days of purchase. A royalty (30 cents in 1990) is payable by the dealer to the DPWH on each skin that is branded.

The main reason for rejecting skins is poor fur quality—termed 'rumpiness' by the local traders—which is caused by scratching or rubbing. Many furs are also downgraded due to poor preparation. About 40 per cent of the estimated harvest is discarded due to poor quality.

There is much variation in fur colour, which can make it difficult to match skins used in the manufacture of garments. New Zealand entrepreneurs have tried to overcome the variable colour and quality of wild furs by farming brushtail possums, under controlled conditions and diet (Dellow & Harris 1985; Statham 1985). However, possum farming is only economical when fur prices are high (Statham 1985).

Fur dealers have found that the storage life of dried furs is about 12–18 months. Over a period of time, dealers have found that about 5 per cent of brushtail furs make first grade, 15 per cent are second grade, 50 per cent third grade, and 30 per cent fourth grade or badly damaged. Prices paid to hunters vary with the size and quality of the fur skin. In the 1990 season, the price varied from 50 cents per fur skin to a maximum of $6.00 for a large first grade fur skin.

Brushtail possum fur skins are ultimately used in the manufacture of garments, frequently as a lining for collars and cuffs. Alternatively, the fur is cut from the skin and woven with synthetic material and then used in garment manufacture or by the textile industry to line shuttles. Roughly 50 per cent of Tasmanian brushtail possum fur skins are used overseas as cut fur rather than as a fashion fur for garments.

The number of possum fur skins exported is controlled and monitored by the Australian Nature Conservation Agency (ANCA). The ANCA export figures shown in table 6.1 are consistently higher than the number of furs entering the trade, as recorded by the Tasmanian Department of Parks, Wildlife and Heritage. This discrepancy could be caused either by dealers storing furs from the previous year, by statistical errors, or from illegal trade where dealers fail to advise the DPWH of the correct number of furs entering trade. Nonetheless, the number of furs exported is consistently less than the number of animals that are estimated to be killed each year.

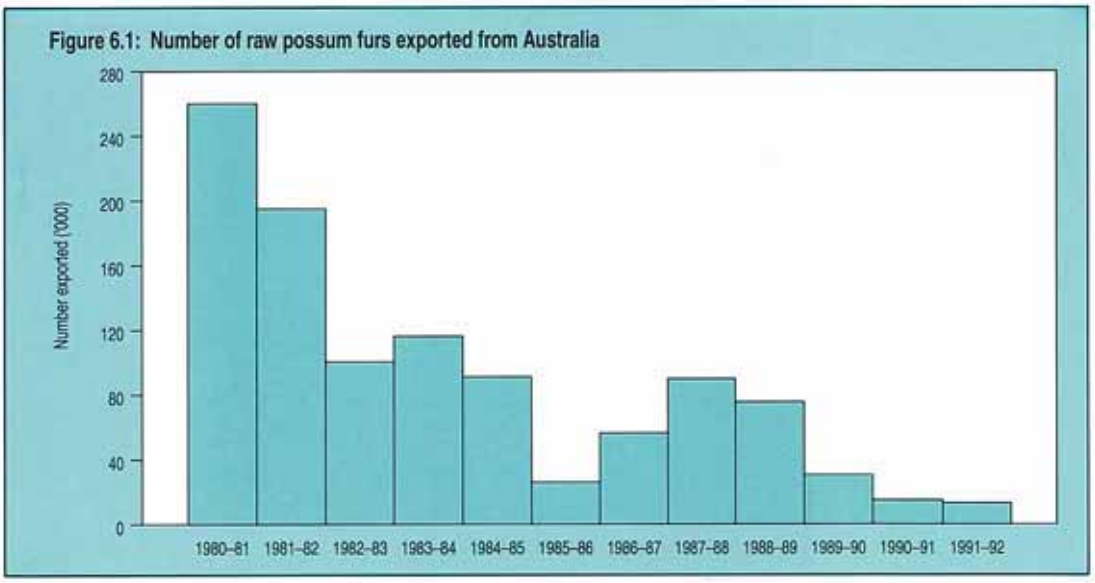
There is a strong relationship between market prices and the size of the harvest, as shown in records of the possum harvest (table 6.1). As the fur price increases, the number of permit holders (hunters) increases, as does the number of brushtail possums taken per hunter. The net result is increased harvest levels at higher prices. In addition, more furs may enter the trade when prices are high

Table 6.2: Destination, number and value of raw possum fur skins exported from Australia (all values in Australian dollars)

Destination		1980–81	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91	1991–92
Italy	Number	119 489	39 696	18 289	14 684	5 450	11 180	5 500	7 100	4 390	0	0	0
	Value ($)	1 293 000	318 573	125 000	81 000	35 808	80 232	61 199	98 700	56 980	0	0	0
Japan	Number	19 900	26 245	6 030	7 475	4 600	6 038	1 200	2 870	0	18 058	8 205	2 872
	Value ($)	48 000	143 326	16 000	21 000	15 000	14 800	4 600	10 000	0	81 454	23 565	8 284
New Zealand	Number	0	38	0	0	0	0	1 060	36 855	22 749	5 079	0	0
	Value ($)	0	400	0	0	0	0	3 000	257 985	156 886	25 902	0	0
Republic of	Number	0	0	16 805	13 770	32 420	2 378	31 477	27 214	28 134	0	0	0
Korea	Value ($)	0	0	71 000	54 000	146 000	14 099	182 000	243 090	153 000	0	0	0
United Kingdom	Number	40 070	103 770	34 993	73 119	11 582	0	18 140	17 332	17 844	0	0	2 293
	Value ($)	346 000	569 787	198 000	514 000	56 828	0	90 700	115 026	100 000	0	0	19 833
United States	Number	55 634	24 200	25 230	8 020	29 725	6 000	0	0	3 200	7 421	2 910	2 905
of America	Value ($)	275 000	103 525	137 000	27 000	121 880	42 395	0	0	13 600	34 014	7 300	13 248
Other	Number	28 057	2 350	0	0	8 557	500	300	0	130	466	3 785	4 500
	Value ($)	224 000	11 750	0	0	56 988	5 450	2 170	0	1 400	7 097	8 706	25 214
Total all	**Number**	**263 150**	**196 299**	**101 347**	**117 068**	**92 334**	**26 096**	**57 677**	**91 371**	**76 447**	**31 024**	**14 900**	**12 570**
countries	**Value ($)**	**2 186 000**	**1 147 361**	**547 000**	**697 000**	**432 504**	**156 976**	**343 669**	**724 801**	**481 866**	**148 467**	**39 571**	**66 579**
	Price $/ea	**8.31**	**5.84**	**5.4**	**5.95**	**4.68**	**6.02**	**5.96**	**7.93**	**6.3**	**4.79**	**2.66**	**5.3**

Source: Australian Bureau of Statistics (all values in current dollars). Note: 1991–92 data includes 6 793 foreign fur skins worth $45 047, which were re-exported.

Figure 6.1: Number of raw possum furs exported from Australia



because lower grade furs will have some commercial value.

Most furs are exported (table 6.2), and hunting effort in Tasmania is therefore primarily influenced by offshore prices for fur products. The market value of brushtail possum furs has been declining over the past decade (figure 6.1), and the harvest has declined concurrently. In 1980–81, 263 150 furs worth a total of $2.2m ($8.31 each) were exported. By 1990–91, the export trade had fallen to only 14 900 furs worth a total of $39 000 ($2.66 each). The 1991–92 export figures were lower again, with 12 570 skins exported, but roughly half of these were re-exports of foreign possum furs (possibly originating from New Zealand).

Italy, the United Kingdom, Japan and the USA have been traditional buyers of brushtail possum furs over the past decade (table 6.2). However, many furs may be re-exported by the primary importer to supply consumer markets in Western Europe. For example, the Republic of Korea has recently begun importing Australian brushtail possum fur to manufacture into garments for re-export to Europe.

There is little further processing of possum fur in Australia, and most furs are exported raw. By comparison, the New Zealand possum industry is involved in dressing and manufacturing possum furs for local and export markets. New Zealand companies now import brushtail possum fur skins from Australia for processing and re-export.

The brushtail possum is an introduced pest in New Zealand and a vector for bovine tuberculosis, thought to be responsible for frequent outbreaks in farmed deer and cattle (Coleman 1988). Eradication of tuberculosis from the New Zealand brushtail possum population has proven impossible.

Table 6.3: Comparison of the scale and value of the Australian and New Zealand possum fur export industries (all values in Australian dollars)

	NEW ZEALAND			AUSTRALIA		
YEAR	NUMBER ('000)	VALUE ('000)	UNIT VALUE	NUMBER ('000)	VALUE ('000)	UNIT VALUE
1986–87	2 478	15 186	6.13	58	344	5.96
1987–88	2 408	15 803	6.56	91	725	7.93
1988–89	1 358	5 959	4.39	76	482	6.3

Sources: Australian Bureau of Statistics, NZ Department of Statistics (all values in current dollars). Numbers and values rounded

Populations have flourished despite extensive poisoning campaigns and the development of a substantial commercial trade in raw and finished fur skins over the past century. The New Zealand possum industry is much larger than that in Australia. In 1988–89, New Zealand exporters shipped over 1.3 million raw fur skins valued at $5.9m (table 6.3). In years when the international fur prices were high, New Zealand has exported up to 3 million brushtail possum furs annually, which is about ten times the volume of trade from Australia during good seasons.

Meat

Both the Tasmanian *Meat Hygiene Act 1985* and the brushtail possum management plan allow production of possum meat for human consumption for the domestic trade, although none has been produced so far. Brushtail possum meat is sold legally in Tasmania as a pet food, and retails for about $1.50 per kilogram. There is no information on the numbers of animals or quantity of meat involved in this pet food trade.

New Zealand possum farmers pioneered a possum meat export industry during the early 1980s—the meat was marketed as 'Kiwi bear'. Meat production from farmed possums became unprofitable when fur prices declined, causing the export trade to collapse.

Non-commercial use

Crop protection permits are issued by the Department of Parks, Wildlife and Heritage (DPWH) to landowners wishing to control brushtail possum outside of the period set aside for commercial harvesting.

Methods of control specified in these permits include shooting, live capture and release, or in exceptional circumstances, poisoning with sodium monofluroacetate or 1080.

Very few crop protection permits are issued (table 6.4) and the DPWH have found that about 60 brushtail possums are killed annually under each shooting permit. In the case of poisoning, 1080 is impregnated into bait material, such as an apple, and left for the possum. It is difficult to establish the numbers of brushtail possum killed by poisoning, but this technique is rarely used.

Products from brushtail possums killed under crop protection permits cannot be used commercially.

A comparison of the effectiveness of hunting and aerial 1080 baiting for the control of brushtail possums in New Zealand found that commercial hunters were a more cost-effective option (Morgan & Warburton 1987). The scale of the harvest depended primarily on the target population density and the prevailing incentive (market price) for commercial harvesting.

Discussion

Most brushtail possums killed in Tasmania are taken by commercial harvesting. Conservation authorities fix the maximum commercial cull, but economic considerations otherwise control harvest levels. When fur prices are high, more hunters are active and more possums are killed by each hunter. When the commercial industry is active, it reduces the need for alternative

Table 6.4: Crop protection permits issued for control of brushtail possums in Tasmania

	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90
SHOOTING	46	44	109	153	109	171
POISONING	5	7	2	3	9	7
ACTUAL POISONINGS	1	4	0	0	1	NA
QUANTITY OF 1080 USED (GRAMS)	3	36	0	0	7.5	NA

Data supplied by Tasmanian Department of Primary Industries and Tasmanian Department of Parks, Wildlife and Heritage NA = Not available

pest control methods, such as poisoning, which are less target-specific and less acceptable to the community (Sheppard & Urquhart 1991).

Europe is the premium market for the fur trade and patterns of demand are influenced by a number of factors including prevailing fashions and severity of the winter. The Australian fur industry has no influence on world prices. Patterns of harvesting will therefore continue to reflect changes in overseas demand within the quota fixed by conservation authorities.

Substantial quantities of skins are discarded due to poor fur quality. When the economic outlook for fur is positive, these discarded furs could be of some value as cut fur for the textile industry.

The brushtail possum carcase is usually discarded after the fur skin is removed, and the meat is not used. A small but unquantified amount of possum meat is sold as pet food in Tasmania. Trade in possum meat for human consumption is not new—New Zealand businesses established a small export trade a decade ago. There is now some interest in Tasmania for exporting brushtail possum meat for human consumption. However, the market prospects and strategy for developing an Australian export trade in brushtail possum meat have not been fully explored.

7 SHORT-TAILED SHEARWATER (MUTTONBIRD)

Distribution and abundance

The short-tailed shearwater *(Puffinus tenuirostris)* or Tasmanian muttonbird is a migratory seabird that visits coastal islands and shorelines of south-eastern Australia between September and April every year to breed. Southern New South Wales, Victoria, South Australia and Western Australia support muttonbird breeding colonies. However, most rookeries are in the Tasmanian region, where at least 167 colonies occupy an area of 1522 hectares and support a population of about 9.3 million breeding pairs (Skira 1987). Adult muttonbirds lay a single egg and rear the young in a burrow (Serventy 1974).

Muttonbirds have a mean lifespan of about 21 years (Serventy 1974) and a remarkably predictable migration and breeding cycle. A controlled sustainable harvest is possible due to these factors.

Commercial exploitation of muttonbirds occurred soon after the arrival of European settlers in 1803 and developed to become an integral part of the economy of islands in Bass Strait. The annual harvest often exceeded one million birds, yet no colonies have been destroyed by commercial harvesters. However, non-commercial harvesting has damaged some colonies.

Various legislation has been enacted since 1891 to protect muttonbirds. Several legal, social, and economic factors have led to a marked decline in the size of this industry over the past 60 years. Aboriginals have historically been involved in the muttonbird industry, and now represent most participants, with the annual season being of high social and economic importance (Skira 1987).

Status

Short-tailed shearwaters are fully protected in all Australian States except Tasmania, where they are defined as 'partly protected' under the Wildlife Regulations 1971 of the *National Parks and Wildlife Act 1970.* These regulations permit annual open seasons and define conditions under which harvesting and trading may occur.

The Tasmanian Department of Parks, Wildlife and Heritage is responsible for management of short-tailed shearwaters. They monitor the population abundance annually to establish harvesting levels and ensure rookeries are not overexploited. Muttonbird products cannot be exported unless a plan of management has been approved by the Commonwealth Minister for the Environment, as required under the Commonwealth *Wildlife Protection (Regulation of Exports and Imports) Act 1982.*

There are two primary objectives for the management of muttonbirds in Tasmania: conservation of the existing populations over the present range of colonies, and harvesting of chicks on specific colonies on a sustainable yield basis. Licenses can be issued to allow the harvesting of chicks for commercial or non-commercial purposes during a limited season.

Commercial use

Adult muttonbirds are fully protected and only the chicks can be taken. The commercial harvesting season extends from 27 March to 30 April each year. Chicks may be taken on specified rookeries by holders of a commercial muttonbird catchers licence or a commercial muttonbird operators licence, which is issued by the Department of Parks, Wildlife and Heritage.

Commercial harvesting is now essentially restricted to the Furneaux and Hunter groups of islands in Bass Strait. There is no bag limit for licensed catchers. The maximum sustainable yield has been estimated at 37 per cent (Skira et al. 1986), which equates to about 1.63 million chicks. However, the annual harvest does not usually exceed 450 000 (table 7.1).

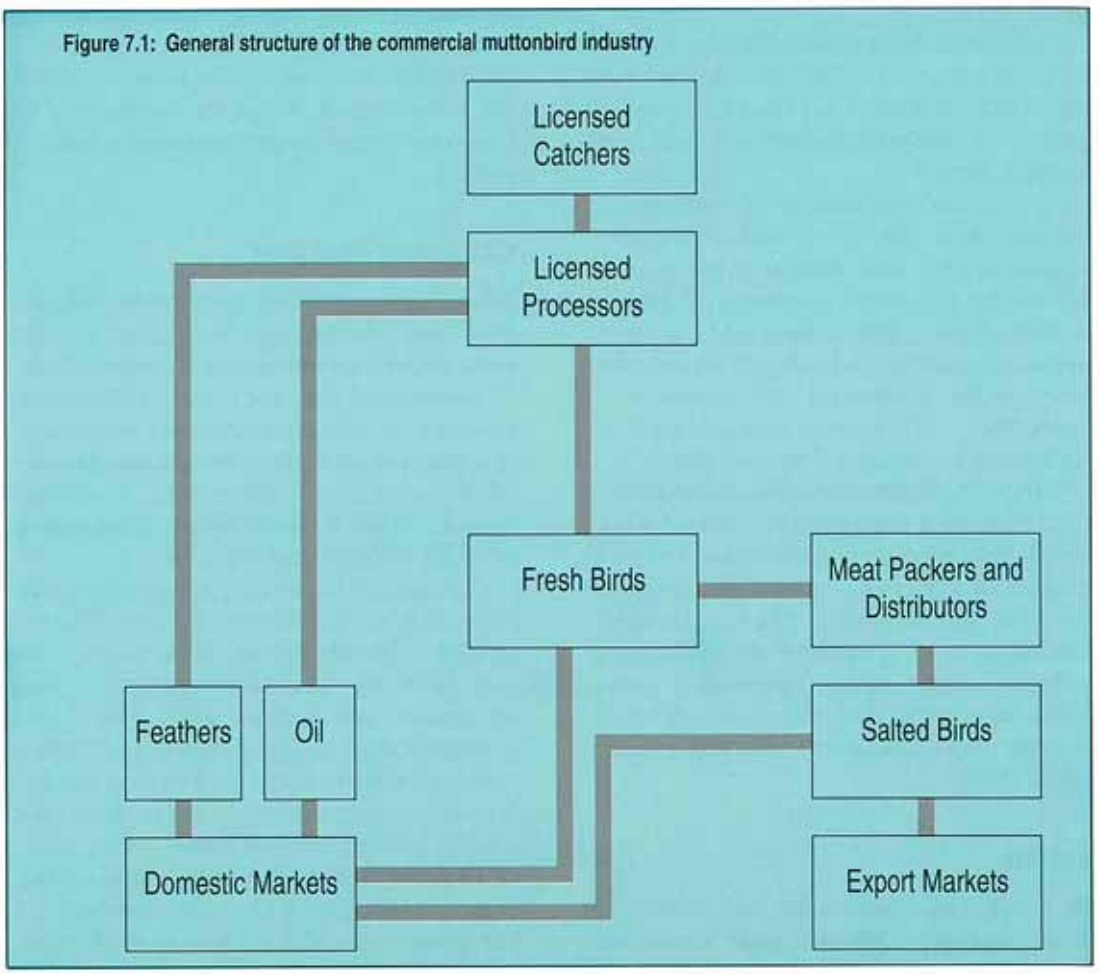
The muttonbird industry has a simple structure (figure 7.1). The method of harvesting has remained largely unchanged

Table 7.1: Commercial harvesting of muttonbirds in Tasmania, 1980–1990

CALENDAR YEAR	Number caught	Number exported	Per cent exported	Oil produced (litres)	Feathers produced (kg)	Number of catchers
1980	335 744	140 604	41.9	4 021	5 238	61
1981	369 085	183 025	49.6	4 654	4 968	69
1982	359 305	186 120	51.8	4 842	7 344	64
1983	412 645	229 159	55.5	4 781	6 102	70
1984	367 219	163 590	44.5	4 805	5 535	69
1985	324 579	116 985	36	2 945	5 233	64
1986	249 014	123 865	49.7	3 255	4 212	50
1987	235 890	79 500	33.7	1 210	3 276	41
1988	310 336	93 280	30.1	2 351	5 523	43
1989	217 638	57 660	26.5	4 112	4 104	54
1990	202 824	68 284	33.7	2 430	3 543	42

Source: Tasmania Department of Wildlife, Heritage and Parks

Figure 7.1: General structure of the commercial muttonbird industry



over the past century. Catchers remove the chick from the burrow by hand and break its neck. It is then threaded by the bottom beak onto a spit and carried to the operators' shed for processing. Most islands supporting large colonies of muttonbirds have processing sheds on site. These premises are subject to annual inspection and approval by the Tasmanian Health Department.

Once delivered to the processors shed, the proventricular oil is drained into a drum and the birds are plucked and stacked on racks to cool. The feathers and oil are sold on the domestic market after the season.

The daily catch is eviscerated and transported to meat-packing facilities, where the birds are preserved in a salt brine and later distributed to domestic and export markets.

Meat

The long history of this industry in Tasmania has been due to a stable demand for muttonbird meat within Tasmania and in New Zealand. A few muttonbirds are sold through specialist meat distributors in mainland Australia, but most birds are sold at retail outlets in Tasmania as a fresh, salted or cooked (roasted whole) product. The meat is very oily and has a strong flavour that appeals to some consumers, although it is certainly an acquired taste.

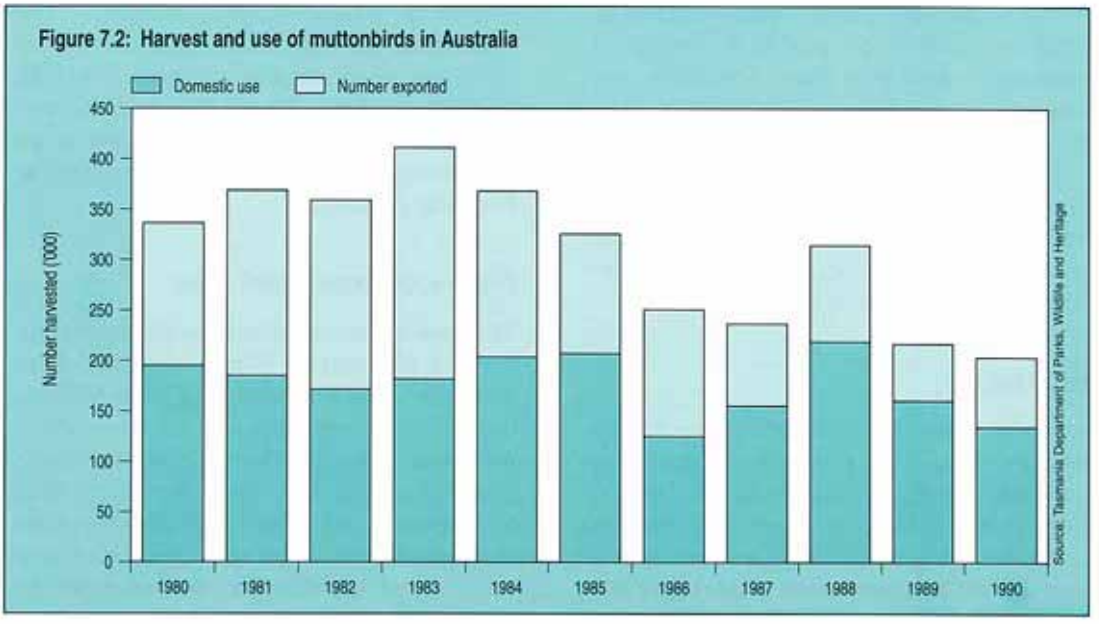
There is a lack of knowledge about consumers of muttonbird meat. Meat distributors identify Aboriginals and people from older age groups as the main end users. Muttonbirds are not sold as a gourmet meat—it has a down-market image, which is reflected by low prices.

Whole muttonbirds have been canned in aspic, or prepared as a dried meat in the past. However, these products have not proven commercially successful.

There is a small harvest of muttonbirds on Stuart Island in New Zealand to supply a local demand for the meat. New Zealand importers have purchased all Australia's exports of muttonbirds since 1984 (table 7.1) to meet the shortfall in local supply. The proportion of the Tasmanian catch of muttonbirds that is exported has declined with the commercial catch over the past decade (figure 7.2).

Muttonbirds have a low unit value. Therefore, to keep the costs of supplying the export market to a minimum, refrigerated shipping containers must be filled to capacity. A shipping container holds 35 000–40 000 birds: a quantity that is becoming more difficult to supply as the commercial harvest declines.

Figure 7.2: Harvest and use of muttonbirds in Australia



Limited access to refrigeration and high freight costs are two major problems associated with harvesting and processing muttonbirds on islands in Bass Strait. These limitations, combined with the brief harvesting season, make it difficult for the industry to develop markets. Expansion of sales outside traditional markets is further limited by poor consumer acceptance of the product. Education in preferred cooking methods may help in developing trade in the meat.

During the 1990 season, licensed processors received about $1.20 per bird from meat distributors. A total of 202 824 birds were harvested, equating to a gross income of $243 000.

Oil

Proventricular oil is collected in drums and purified by filtering. Most of the oil is purchased by the racehorse industry for use as a food additive to improve the coat. Muttonbird oil is also especially good for softening and waterproofing leather. The horse and leather industries in Tasmania use fish oil as a substitute product when the supply of muttonbird oil is depleted. Small quantities of muttonbird oil are sold to use as an ingredient in pharmaceutical lotions.

The wholesale value of muttonbird oil in 1990 was about $5 per litre and total production was 2430 litres. Therefore, the value of oil produced in 1990 equated to $12 000.

Distribution and sale of muttonbird oil is poorly coordinated. Some processors have difficulty selling all the muttonbird oil produced each season, while at the same time buyers report shortages.

Feathers

Feathers from the muttonbird chicks are retained and sold for manufacture into bedding items, particularly feather quilts. During the 1990 season, processors received $1.50 per kilogram for raw feathers and a total of 3543 kilograms were produced (table 7.1), which equates to a total value of about $5300.

The composition of muttonbird feathers (by weight) is roughly 75 per cent small feathers and 25 per cent down. The down is the premium product because it is softer, lighter and warmer. Down is primarily used in feather quilts, while the small feathers are used in feather pillows.

Feather quilts and pillows are usually stuffed with duck feathers. Raw duck feathers are produced locally, or imported from Taiwan, and are worth about $8 per kilogram. Although duck feathers are worth much more than muttonbird feathers, the small muttonbird feathers are of similar quality. However, muttonbird down is prone to rolling up into balls during manufacturing and is inferior to duck down.

The small quantity of feathers produced and the brevity of the season mean that the supply of muttonbird feathers is of minor significance to manufacturers. The total production of muttonbird feathers during a season is only sufficient to supply a single factory for one week of manufacturing. Therefore, muttonbird processors are price-takers when selling feathers, and have little scope to negotiate prices.

Total income derived from sale of meat, feathers and oil was estimated at $328 000 in 1985 (Skira 1987), which equals an average return of about $1.00 per bird. The commercial harvest declined substantially by 1990, and gross income was only $260 000, or $1.28 per bird. The increase in the unit value of muttonbirds is insignificant given the increased costs due to inflation over the five-year period.

Non-commercial use

The non-commercial season extends from the last Saturday in March until mid-April each year. The Department of Parks, Wildlife and Heritage can issue a licence to harvest muttonbird chicks, at a cost of about $10.00. A daily bag limit of 50 birds per day on Bass Strait islands and 15 birds per day elsewhere is imposed. Holders of a licence to take muttonbird chicks for non-commercial

Table 7.2: Annual sales of licences for the non-commercial harvest of muttonbirds

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Number	4 644	4 790	4 326	3 882	2 269	3 039	2 865	918	1 157	1 053	470

Source: Tasmania Department of Wildlife, Heritage and Parks

purposes can consume the meat, but no products can be sold.

Non-commercial harvesters are not required to provide details of the numbers taken. However, it has been estimated from the number of licenses issued and bag limits that about 300 000 birds are harvested annually by amateur catchers (Skira 1987). The number of licenses issued has declined over the past decade (table 7.2) due to a reduction in the bag limit from 25 to 15 in 1984 and the closure of many colonies in 1987. Colonies on the West Coast and Bass Strait islands can still be harvested by non-commercial catchers, but the remainder are closed.

Studies of population abundance indicate that amateur muttonbirders have a greater impact on rookeries than commercial catchers—up to 90 per cent of chicks are taken (Skira & Wapstra 1980). The hunting pressure from non-commercial catchers is greater because people work until they capture the bag limit.

Problems including overharvesting, damage to habitat, alleged cruelty towards birds, litter, poaching, anti-social behaviour and general abuse of regulations have led to closure of many non-commercial colonies and calls for an end to amateur muttonbirding (Skira 1987).

Discussion

Muttonbirds have been managed as a renewable resource for many decades. An indication of the positive conservation implications for sustainable use of muttonbirds (and perhaps other native species) is evidenced by the lack of 'improvement' of lands where shearwater colonies exist. Recognition of the economic value of muttonbirds by landowners has undoubtedly played a role in conserving colonies.

There is little waste of chicks taken by commercial operators—only the legs, head, and viscera are discarded. However, changing consumer tastes, low returns for the products, increasing overheads, and the demanding nature of the work has resulted in low recruitment of workers into the muttonbird industry. Further, the logistical difficulties associated with harvesting and freighting products out of Bass Strait are significant. Hence, the muttonbird industry is in gradual decline and the annual harvest is well below the maximum sustainable yield.

Similar numbers of chicks are taken by commercial and non-commercial harvesting. However, the impact of amateur catchers on muttonbird rookeries is much greater than that of the commercial industry. It appears likely that amateur muttonbirding will cease before much longer, and only limited commercial harvesting will occur.

The future of the commercial muttonbird industry will depend on broadening domestic and export markets for the meat and improving distribution and marketing of by-products. Muttonbird meat is a product that is unique to Australia and New Zealand, and there should be prospects for expanding the volume of trade within these markets. Further, there could be niche markets for muttonbird meat in many Pacific island nations and within Asian countries such as the Republic of Korea and Japan.

Although higher value niche markets could be available in Asia, the muttonbird industry does not have the infrastructure

or the skills base to identify and develop these markets. Therefore, the short-term strategy for the muttonbird industry should be to stabilise trade and supply for the New Zealand and domestic markets. Once this is done, it will then be possible to develop plans for new export markets.

At present, the muttonbird industry is poorly coordinated and many participants are involved for social reasons rather than for profit. The social and economic value of this industry must be viewed in relation to the isolation of communities involved and the tradition of participation.

8 CROCODILES

There are two species of crocodile in the wild in Australia: the estuarine or saltwater crocodile *Crocodylus porosus*, and the freshwater or Johnston River crocodile *Crocodylus johnstoni*. The saltwater crocodile occurs along the northern Australian coastline and most coastal rivers, creeks and swamps. Freshwater crocodiles are more restricted to northern river systems.

Populations of both species were depleted by the early skin trade, and between 1945 and 1972, 270 000–330 000 crocodiles where shot for skins (Webb et al. 1984) However, crocodile populations now appear to be recovering since full protection was granted in Western Australia in 1962, in the Northern Territory in 1964, and in Queensland in 1974 (Webb et al. 1984).

When wild populations expanded, the Australian population of *Crocodylus porosus* was relisted by the Convention on International Trade in Endangered Species (CITES) from appendix 1 to appendix 2 in 1986 (under the provisions of appendix 1, no products from these animals could be traded internationally). This relisting of *Crocodylus porosus* was the beginning of the Australian crocodile farming industry. The industry has been able to establish and expand under Australian legislation, including the Commonwealth *Wildlife Protection (Regulation of Exports and Imports) Act 1982*, and the various State/Territory conservation laws.

The crocodile industry

In 1991 there were 14 crocodile 'farms' in Australia, with a total stock of 30 000 saltwater and 19 000 freshwater crocodiles (Onions 1991). The five farms in Queensland are 'farms' by the CITES definition, as all the livestock are bred in captivity. A further six farms in the Northern Territory are technically crocodile ranches, where saltwater crocodile eggs and freshwater crocodile hatchlings are collected from the wild each year under a management plan that is administered by the Northern Territory Conservation Commission. About 9200 saltwater crocodile eggs were collected from the wild in 1990–91, and 2725 freshwater crocodile hatchlings were taken in 1990 (Onions 1991). The Northern Territory farms also have captive breeding programs for saltwater crocodiles.

The remaining farms in Western Australia are primarily captive breeding enterprises, but a limited number of both species of crocodile are collected from the wild.

There are two main products of crocodile farming in Australia other than tourism. These are the skin and the meat. Skulls and teeth are also sold to tourists. Crocodile skins are the major product and source of income for the industry.

Skins

The world market for quality or 'classic' crocodile (which includes *Crocodylus porosus*) is estimated at 150 000 skins per year (Webb et al. 1987). Australia is a small producer of saltwater crocodile skins, and therefore has no significant influence on market prices. On the international market, Australian skins face competition from alligator and crocodile skins produced in Papua New Guinea, Africa, Asia and North America. The lower-valued sector of the market is supplied largely by caiman skins produced in South America. Australian crocodile skins also compete with other exotic skins such as snake, shark, emu and fish skins.

Raising crocodile hatchlings for market takes three to four years, when saltwater crocodiles reach about 1.5 m and freshwater crocodiles reach about 1.2 m. Skin prices obviously vary with species, size and quality. The saltwater crocodile skin is the most valuable and worth about US$9/cm (which is measured across the belly). There are firm markets for saltwater crocodile skins in the 34–35 cm belly skin range, and for large skins over 40 cm in width. High production of smaller crocodilian skins in other parts of the world is reducing the value of small skins (Onions 1991).

In contrast, *Crocodylus johnstoni* skins are not regarded as a classic crocodilian skin,

returning only US$5/cm. This is mainly due to the osteoderms (bones) in the belly scutes which make it difficult to tan and manufacture.

Over 90 per cent of crocodile skins are exported, which means that the crocodile industry is quite exposed to exchange rate variability. Some stockpiling of skins may occur as producers try to smooth out exchange rate problems, but the need to maintain a steady cash flow would limit this option. Most crocodile skins are exported raw and tanned overseas. The major buyers are in Japan and France, although Korea has emerged as an important buyer in recent years. Tanned crocodile skin is used in designer label products such as shoes, handbags, wallets and briefcases.

Tanning and manufacture of crocodile skins is occurring on a small scale within Australia. However, Onions (1991) considers that Australia presently lacks the tanning and manufacturing expertise to produce any volume of high quality crocodile product. Current production is largely restricted to using second and third grade skins to produce wallets, keyholders and similar items for local retail outlets servicing the tourist industry. Nonetheless, high quality crocodile skin products are extremely valuable at the retail level, and the tanning and manufacturing potential of the crocodile industry could be considerable for Australia. There are obvious opportunities for an Australian crocodile skin tanning and manufacturing industry to also tap into the supply of raw skins available from neighbouring countries, such as Papua New Guinea.

Meat

Crocodile meat can be produced safely for human consumption if high standards are maintained in the construction of processing premises and in processing (Rickard 1991). Small quantities of crocodile meat are being produced and exported under the *Export Control Act 1992*. Sales of crocodile meat to the restaurant trade in Australia have flourished since the late 1980s. Crocodile meat sells for $16–20/kg, yielding $130–160 and $60–80/kg for *Crocodylus porosus* and *Crocodylus johnstoni* respectively. This is a novelty product, and demand and prices had declined by 1990 and could fall further until prices are around that for other exotic meats such as deer venison or kangaroo meat, which sell for about $10/kg.

Industry value

Until recently, there was only one crocodile farm in Queensland, at Edward River, that produced significant quantities of crocodile products. Unpublished data from the Conservation Commission of the Northern Territory show that production in 1989–90 included slaughter of 1336 saltwater crocodiles and 1101 freshwater crocodiles. The value of production for the Australian crocodile industry in 1989–90 was $1.5m (McKelvie & Treadwell 1991). However, the industry is expanding, and Onions (1991) estimated that the total production of the crocodile industry in the Northern Territory alone in 1991 could be 5000 animals, worth $2.5m in exports plus $0.5m for meat and by-products on the domestic market.

Discussion

Crocodile farming is essentially long term, export-oriented and capital-intensive. It can take several years to build assets before significant returns can be made.

McKelvie and Treadwell (1991) analysed the economics of crocodile farming in Australia and found that the profitability of crocodile farming would be improved if production were concentrated on saltwater crocodiles. Further, the economic model used by the authors indicated that captive breeding enterprises receive lower returns than those that capture stock from the wild. However, the prospects for increasing saltwater stocks are much better for farms with captive breeding programs than for farms reliant on wild supplies, which can be variable.

At the marketing end of the industry, the skin and meat products are competing for

high value niche markets. These markets are susceptible to changes in fashion, in the case of skins, and to fads for other novelty or exotic foods, in the case of meat products. The markets for both the skin and meat products are likely to be sensitive to declines in economic conditions.

In summary, the crocodile farming industry in Australia is expanding, and largely limited by a shortage of suitable breeding stock. Income from tourism supplements cash flow. The husbandry and management of crocodiles in captivity is improving, and future research will aim to improve reproduction and nutrition. The industry is likely to continue to shift towards farming of saltwater crocodiles. The development of a profitable industry based on tanning and manufacturing of crocodile skins in Australia would boost industry growth and stability.

9 EMU

Distribution and abundance

The emu (*Dromaius novaebollandiae*) is a flightless native bird reaching up to 2 m in height and 50 kg in weight. Emus are distributed throughout most of Australia, and the highest densities are in the sheep pastoral zones which provide adequate food and water during the critical stages in the breeding cycle—autumn and spring (Grice et al. 1985). The population density varies significantly between some regions, and Caughley and others (1980) suggested that the abrupt change in densities across the dingo fence in the north-west corner of New South Wales could reflect predation by dingoes.

Emus are highly mobile and may concentrate temporarily in other land-use zones in response to localised high rainfall or when food and water are scarce in the sheep pastoral areas (Grice et al. 1985).

Status

Emus are fully protected as native fauna in all States and Territories. However, in Western Australia emus are also recognised as an agricultural pest under the *Western Australia Agriculture and Related Resources Protection Act 1976*. This means that the Western Australian Government can authorise the killing of emus for pest control.

Commercial use

Wild emus are not used commercially in Australia, but farming is now permitted in some States. Emu farming was pioneered by the Ngangganawili Aboriginal community at Wiluna in Western Australia in 1976 using breeding stock initially captured from the wild (Smetana 1992). Commercial emu farming was authorised by the Western Australian Government in August 1987. All emu farms are licensed by State conservation agencies, and farm size, stocking densities, and fencing requirements are regulated.

Today there are 38 emu farms in operation in Western Australia, and farms have also been established in Tasmania and Queensland. The national flock numbers over 30 000 birds. The emu farming industry aims to supply meat, skins and by-products such as oil and feathers to consumer markets in Australia and overseas. Some farms are also generating revenue by allowing tourists to visit. To comply with the Commonwealth *Wildlife Protection (Regulation of Imports and Exports) Act 1982*, all emu products destined for export must be derived from animals bred in captivity or taken under an approved management program. At present, there are no approved management programs that permit harvesting of emus from the wild.

When Australian farmers began farming emus, there were no established markets in Australia or overseas for emu products. A guide to the range of emu products and market prices is shown in table 9.1. The gross return to the producer, on delivery to a processing works, has been estimated at $296 per emu (Acil Australia Pty Ltd 1992).

Table 9.1: Current prices for various emu products
(Smetana 1990; Acil Australia Pty Ltd 1992)

Product	Estimated yield per bird	Unit price ($ ex works)
Leather		
Body	0.80 m^2	15–20/ft^2
Legs	2	30
Meat		
Cuts	11 kg	15
Trim	4 kg	5
Liver	0.6 kg	5
Giblet	0.6 kg	5
Oil	6 kg	15
Feathers	0.7 kg	0
Eggs		
(plain and carved)		10–500

The demand for breeding stock in Western Australia was strong between 1987 and 1991, and slaughters of emus for

commercial production did not begin in earnest until 1991. About 13 500 birds were available for slaughter in 1992, and if numbers continue to expand as predicted by farmers, 85 000 birds will be available for slaughter in 1995 (Acil Australia Pty Ltd 1992).

The key export markets for emu products have been identified as the USA, Japan, France and South-East Asia for meat, leather and oil. There are also prospects in Switzerland (meat), Germany (meat and leather) and Spain (leather).

Meat

Emu meat is low in fat and cholesterol (Naughton et al. 1986), and has a slightly gamey taste. In-store tastings of fried emu meat were recently conducted in two Perth supermarkets by the Western Australian Department of Agriculture (Frapple & Hagan 1992) to establish basic information on consumer attitudes to emu meat. Of those who tasted the meat:

- 44 per cent considered that emu tasted like beef, while 40 per cent described the flavour as rich or tasty;
- 14 per cent found the meat slightly tough or tough;
- 98 per cent found the meat 'acceptable' or better;
- 91 per cent thought that the meat was as good as or better than the grilling steak they now buy;
- 80 per cent would buy the meat at least once per month;
- 66 per cent would pay $6–10/kg for the meat;
- about 15 per cent declined to taste the meat because it was from an emu.

These findings show the importance of giving consumers the opportunity to try the new product. Establishing the product in the domestic market should be a high priority for the industry. Samples of emu meat have been shipped to many countries and, in the long term, export markets are likely to absorb most emu meat produced in Australia.

Skins

The skin of an emu is characterised by a raised area around the feather follicle. This feature gives the tanned body skin a distinctive patterned surface and is the reason for the current relatively high prices (Frapple & Hagan 1992).

Samples of emu skin and leather have been forwarded to exotic leather manufacturers in Australia and overseas. The leather is used in a variety of products including high fashion clothing, watch bands, wallets and other accessory items.

Oil

Emu fat is rendered to produce an oil, which is used in cosmetics, and is reputed to be effective in the treatment of muscle and joint pain (Frapple & Hagan 1992). These claims have not been proven scientifically, but raw emu oil is being sold in bulk at prices of about $14.50/litre.

Non-commercial harvesting

Emus cause damage to agriculture mainly by trampling wheat and lupin crops, eating ripening grain and damaging fences (Agricultural Protection Board 1992). In the past, many thousands of emus were shot as vermin to protect grain crops. Today, landowners in Western Australia must have a damage licence from the Department of Conservation and Land Management before they can legally kill emus.

Landowners with a damage licence can kill emus by shooting or, if there are large numbers of emus, they can arrange for the Agriculture Protection Board to carry out a strychnine poisoning program (Agricultural Protection Board 1992). The number of birds killed by poisoning and shooting under damage permits is unknown.

Products from animals killed under damage permits cannot be used.

Exclusion fencing is also used to prevent emus moving into the grain-growing areas of Western Australia. A State Barrier Fence

stretches over 1200 kilometres from the Zuytdorp Cliffs north of Kalbarri to the Johnston Lakes in the Dundas Shire.

Discussion

There has been much publicity about the emerging emu industry, and this has stimulated the interest of potential buyers of emu products in Australia and many overseas countries. This interest has boosted the expectations of Australian emu farmers. Until recently, the emu industry has been unable to respond to the apparent high demand, because most animals were sold as breeding stock. However, this situation is now changing in Western Australia, and small quantities of products are now being offered to consumer markets. The strong expressions of interest in buying emu products have not been translated to orders, and several Western Australian farms had excess stock available for slaughter in 1992.

The emu industry in Western Australia is now entering a critical phase where it can no longer rely on income from livestock sales, and has to establish and develop a profitable trade in emu products. There is scope for improving production and processing efficiency, but market development is now a high priority for the emu farming industry.

While the supply of emu products is still quite limited, the products can be marketed at low volume/high value markets. For example, prime cuts of emu meat can be sold through the up-market food service industries and the leather used for manufacture of fashion items. However, as supply increases and these high value markets become saturated, prices are certain to fall and producers will have to turn to high volume/low price markets such as the major retail stores. This development pattern is typical of new agricultural industries such as crocodile, deer, ostrich and buffalo farming.

There are a few emu farms in Queensland and Tasmania and interest in developing an emu farming industry has been expressed in South Australia, New South Wales and Victoria. Western Australian emu farmers are far ahead of other States and will dominate the Australian emu industry for several years. Producers in Western Australia should be able to subsidise their transition from a livestock-based trade to a product-based trade by selling livestock to other States.

Unfortunately, Australia does not have a monopoly on the supply of emu products. Emus are also farmed in New Zealand, France, and the United States of America. In 1991, the US industry bred 88 000 chicks from 4000 breeder pairs, with an expected growth to a total of 750 000 birds by 1994 (Acil Australia Pty Ltd 1992). Overseas producers, particularly those in the US, are confident of matching or exceeding the performance of the Australian emu industry. The basis of this claim is that Australian producers are burdened with the bureaucracy associated with trading in a native animal, while overseas farms have few restrictions (Guilliatt 1992).

Emu products also have to compete with substitute products, and the most likely direct competitor is ostrich products. An ostrich farming industry is now developing in Australia, partly because there are fewer restrictions for ostrich farming compared with emu farming, and partly because there are good returns on investments in livestock. The Australian ostrich industry is still very small and unlikely to produce substantial quantities of ostrich products for several years. However, there is a significant international trade in ostrich meat and skins, which is almost exclusively supplied from South Africa.

Ostriches have been farmed in South Africa since 1865 (Conroy & Gaigher 1982) and, at first, the farms supplied feathers to the fashion industry, but a meat industry has been operating since 1965. It is very difficult to obtain reliable information on the scale and value of the South African industry. Only 50 000 birds were killed in 1980 (Conroy & Gaigher 1982), and meat prices are now around $6.50/kg. This information suggests that after being in

place for over a century, the African ostrich industry has not met with a huge demand for its products. As with the emu industry, the wider consumer market for ostrich products remains untested.

Wilson, McNee and Platts (1992) observed that wild emus that are killed for pest control, or which congregate along vermin fences and die in large numbers, could represent a resource. At present, all emus killed under damage permits must be left in the field and the products are wasted. There would seem to be a case for making legislative changes to allow a controlled harvest of wild emus in some regions. Wild harvesting for export would require the approval of a management program under the *Wildlife Protection (Regulation of Exports and Imports) Act 1982*. The decision to allow a wild harvest lies with the State/Territory conservation agencies.

The emu farming industry will go through some major changes over the next few years. Nonetheless, if production and processing costs can be lowered, and a more coordinated and targeted marketing effort implemented, the industry outlook is very optimistic.

PART C

WILD ANIMAL INDUSTRIES

Introduced animals

10 WILD BOAR

Distribution and abundance

The wild pigs or boar *(Sus scrofa)* of Australia share many characteristics of the Eurasian wild boar. Physical similarities include a large head with protruding tusks; large forequarters and small hindquarters; a black coat with a mane; a straight tail; and in some regions, agouti coloured adults and striped young are common (Giles 1980; Groves & Giles 1989). In addition, the ecology of Australian wild boar includes similar habitat preferences, behaviour, and food habits as those reported for the European wild boar (Sludskii 1956; Giles 1980; Spitz 1986).

Wild boar are omnivores, but their diet consists primarily of green herbaceous material obtained by grazing, and roots, fruits and seeds (Giles 1980). Cultivated plants are not an important part of the diet of most wild boar populations in Australia because they live in remote regions where crops are not grown. The primary diet of the European wild boar is also plant material (Sludskii 1956), accounting for up to 91 per cent of intake (Genov 1981). However, cultivated plants are a very important part of the European wild boar's diet, representing up to 71 per cent of the plant material eaten (Genov 1981). The ready access to cultivated crops is a key factor that has enabled European wild boar populations to increase over the past 3–4 decades, although food conditions in natural habitats have declined in Western and Central Europe.

The origin of the Australian wild boar population is not known with certainty. There is a possibility that wild boar were present in Australia before European settlement. Cassels (1983) speculated that wild boar may have migrated to northern Australia from Papua New Guinea in prehistoric times. Another potential route of introduction was via the extensive trade between indigenous peoples of northern Australia and the Papua New Guinea region. Pullar (1950) regarded such an introduction as improbable, but pig-like animals are depicted in prehistoric rock art found in north-eastern Australia (Clegg & Fethney 1988).

There were many introductions of wild animals such as rabbits and red foxes to Australia by acclimatisation societies after European settlement (Rolls 1969). However, records of deliberate introductions of wild boar have not been found. Domestic pigs have escaped and formed feral populations in Australia, as has happened in many parts of the world, including Europe, Asia and North America (Tisdell 1982; Mayer 1983).

The origins and bloodlines of the domestic pigs introduced to Australia at the time of European settlement are largely unknown. English domestic pig breeds were improved by crossing with pigs imported from Thailand during the eighteenth century, and it is likely that Chinese immigrants brought pigs with them during the gold rush of the 1800s (Tisdell 1982). Further, Asian pigs were introduced from Timor and Kisar to the Northern Territory from as early as 1826 (Letts 1962).

Historical records show that by 1795, escaped pigs were a problem in Sydney Cove and orders were issued that they could be shot if they trespassed on private land (Pullar 1953). Domestic pigs that were released or escaped formed feral populations in New South Wales by the mid-1800s (Rolls 1969; Pullar 1953). Populations of feral pigs also established in the Northern Territory following release or escape from captivity. Despite their uncertain origins, these animals are known locally as wild pigs or boar (certainly by sport hunters and commercial harvesters, who regard them as a resource).

Today, the largest populations of wild boar are distributed through New South Wales, Queensland and the northern portion of the Northern Territory. Isolated populations also occur in Victoria, Kangaroo Island in South Australia, Western Australia and on Flinders Island off the north-east coast of Tasmania (Wilson, Dexter, O'Brien & Bomford 1992).

The total number of wild boar living in Australia is unknown and difficult to establish due to their cryptic habits—they are more active at night and prefer habitats with sufficient vegetation to provide cover (Saunders & Kay 1991). Further, population density can vary significantly between habitats and seasons in response to availability of food and water (Hone 1990). Therefore, estimates of population size have varied from 1 to 12 million (Tisdell 1982). The Australian Game Meat Producers Association consider that the actual population is close to the lower end of this range. This conclusion is based on anecdotal evidence including the low catch per unit effort for harvesting boar, compared with harvests of kangaroo populations of a known size.

There are at least 800 000 wild boar in 20 European countries, with most living in Russia and the Ukraine, France, Germany, Poland and Yugoslavia (Hoffman 1991).

Status

Wild boar are regarded as a major vertebrate pest in Australia (O'Brien 1987). They cause environmental and agricultural damage to native and introduced pasture by rooting (Hone 1980), predation on lambs (Pavlov et al. 1981), and consumption of crops (Tisdell 1982). They are also a potential reservoir for exotic diseases such as foot-and-mouth disease, and could complicate attempts to eradicate disease should an outbreak occur in Australia (Wilson & O'Brien 1989). Therefore, State and Territory legislation for vertebrate pest control requires landowners to suppress wild boar populations on their land. In practice, the mobility of wild boar complicates any attempts to control their numbers and impact (Auld & Tisdell 1986). Wild boar in Europe act as a reservoir of serious animal diseases such as classical and African Swine Fever (Paul Vitolovich, Australian Quarantine and Inspection Service, personal communication).

Wild boar are unprotected in Australia, and may be hunted year-round.

Commercial use

Wild boar are a popular quarry for hunters in many parts of the world. The largest harvests are in Europe, where up to 525 000 are harvested annually (Hoffman 1991), and Australia, where the annual commercial harvest has been as high as 270 000.

The product

Two types of wild boar meat are traded on the world market—game meat and meat of farmed wild-type pigs. The most important type is game meat, which is from wild boar that are shot while living in a wild state. Game pig meat has a strong and distinct flavour and fetches higher prices than domestic pork. European consumers will pay more for game pig meat because of its flavour, and because of the long cultural tradition of eating wild boar that are killed by hunting. Most wild boar meat entering commercial trade is game meat, but hunting resources are limited and wild boar populations are under increasing pressure.

A growing number of the wild boar shot in Europe are killed in closely managed hunting reserves or game ranches (Hoffman 1991). The animals in these reserves are confined in an enclosure of at least 300–400 hectares, provided with supplementary feed, and selectively culled to enhance offtake (Hoffman 1991). Although most wild boar harvested in Europe are killed outside game ranches, wild populations are carefully managed and supplementary food is provided during winter (Andrzejewski & Jezierski 1978). These management practices might explain the very high offtake indicated by Hoffman (1991), where he suggests that the European wild boar population is at least 800 000, while the annual cull is up to 525 000. There is no ranching of wild boar in Australia, and no management to increase population size and distribution.

Some European buyers perceive that wild boar meat from Eastern Europe is superior to that from Australia, partly because countries such as Poland are traditional

Table 10.1: Composition of trade in fresh and frozen wild boar meat for selected markets (all values are in Australian dollars)

IMPORTING COUNTRY	TONNES OF MEAT IMPORTED AND (% FROM AUSTRALIA)									
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
GERMANY	3528 (3.9)	2592 (6.1)	2150 (14.2)	2967 (36.9)	3302 (39.8)	2536 (32.6)	2765 (33.9)	3705 (27.7)	3943 (34.7)	3966 (27.2)
FRANCE	870 (4)	871 (4.2)	1204 (13)	1504 (40.9)	1251 (33.9)	1907 (27.6)	2319 (31.2)	2272 (26.8)	2586 (38.6)	1878 (16.6)
ITALY	657 (0)	865 (0)	1051 (0)	1121 (0)	1683 (0)	1502 (0)	1616 (0)	2076 (0)	1802 (1.1)	1853 (3.5)
NETHERLANDS	182 (0)	140 (0)	105 (0)	143 (5.6)	131 (10.7)	311 (52.4)	244 (37.3)	288 (19.4)	152 (13.8)	344 (19.2)
BELGIUM/ LUXEMBOURG	230 (0)	95 (0)	111 (0)	80 (0)	124 (11.3)	106 (0.9)	174 (0)	355 (1.4)	323 (4.3)	724 (0)
OTHER EC COUNTRIES	54 (1.9)	63 (0)	77 (0)	57 (0)	14 (0)	121 (0)	560 (0)	571 (0)	1002 (1.5)	911 (1.6)
JAPAN	80 (50)	103 (79.6)	80 (56.3)	68 (69.1)	36 (66.6)	57 (56.1)	40 (47.5)	52 (46.7)	110 (74.5)	210 (84.9)
TOTAL QUANTITY	**5601**	**4729**	**4778**	**5940**	**6541**	**6540**	**7718**	**9319**	**9918**	**9886**
(% from Australia)	**(3.8)**	**(5.8)**	**(10.6)**	**(29.7)**	**(27.4)**	**(23.7)**	**(22.9)**	**(18.5)**	**(25.4)**	**(17.3)**
TOTAL VALUE ($M)	**12.2**	**15**	**21.7**	**38.5**	**50.6**	**27.7**	**24.1**	**30.5**	**46.6**	**40.4**

EC = European Community

Figures may not add to totals due to rounding. (all values in current dollars)

Source: Eurostat Foreign Trade Statistics; Japan Foreign Trade Statistics. All Commodity Codes for fresh or frozen meat from non-domestic swine are combined.

suppliers, while the Australian product is quite new in the marketplace. Therefore, wild boar meat from Poland fetches a premium over that from suppliers such as Australia. This perception is likely to fade with time, because the quality of the Australian product matches or exceeds that of wild boar meat produced in Bavaria, Poland and Hungary (Hofmann 1992).

The second type of wild boar meat that enters commercial trade is from farmed wild-type pigs that are slaughtered at an abattoir and subject to ante-mortem inspection. Wild boar are not farmed in Australia, but farming of wild boar is now common in several countries as more business people recognise the commercial opportunities. Most wild boar farms are in France and Belgium, and lesser numbers are farmed in the United Kingdom (Booth et al. 1988), Japan (Takahashi & Tisdell 1989) and Canada. The distinction between wild boar meat and domestic pork is becoming blurred in countries other than Australia, with the development of overseas farming enterprises based on wild-type pigs that are selectively bred and crossed with domestic pigs to increase productivity.

The international trade in wild boar meat

The total international trade in fresh and frozen wild boar meat amounts to at least 10 000 tonnes per annum, valued at up to $50m (table 10.1). Consumption and imports of wild boar meat are highest in countries in the European Community (EC). The trade is volatile, with imports to EC countries varying from less than 5000 tonnes, to almost 10 000 tonnes over the past decade. Several factors influence the demand and prices for wild boar meat, including the supply levels from Eastern Europe and the severity and length of the winter. It seems that consumption of wild boar increases when the northern winter is long and cold.

Germany is the world's largest importer of wild boar meat, purchasing a total of 3966 tonnes in 1990. Other major importers during 1990 were France (1878 tonnes), Italy (1853 tonnes), and Belgium/Luxembourg (724 tonnes). Several countries outside the European Community, such as Japan and Sweden, also import wild boar meat.

Before Australia's entry to the international trade in game pig meat in 1980, Eastern

Table 10.2: Major suppliers of wild boar meat (tonnes) to all countries in the European Community

CALENDAR YEAR	AUSTRALIA	POLAND	HUNGARY	GERMANY	OTHER	TOTAL
1981	175	1 971	922	319	2 134	5 521
1982	194	1 432	845	278	1 877	4 626
1983	463	1 131	1 215	323	1 566	4 698
1984	1 717	1 010	1 093	303	1 749	5 872
1985	1 767	1 170	1 401	447	1 720	6 505
1986	1 517	1 576	1 055	535	1 800	6 483
1987	1 750	1 641	1 183	576	2 528	7 678
1988	1 698	1 520	1 064	637	4 348	9 267
1989	2 437	1 594	887	764	4 126	9 808
1990	1 537	2 361	1 037	1 472	3 269	9 676

Source: Eurostat Trade Statistics

1981–1987 = Commodity Code 0201.54 (meat of non-domestic swine)

1988–1990 = Summation of Commodity Codes 0203.29-90 (frozen meat); 0203.21-90 (frozen carcases); 0203.22-90 (frozen unboned cuts); 0203.11-90 (chilled carcases); 0203.12-90 (chilled unboned cuts); and 0203.19-90 (chilled boneless meat) for non-domestic swine

European countries dominated supply (table 10.2). Poland and Hungary continue to supply a large amount of the wild boar meat imported by EC countries, but Australia now rivals Poland as the world's largest exporter of wild boar meat (figure 10.1). Australia supplies 20–30 per cent of the total international trade in wild boar meat.

The expansion of Australian exports during the 1980s had the effect of increasing the volume of wild boar meat available on the world market, but has not displaced production by existing suppliers. Therefore, Australian exports appear to be increasing the trade in, and consumption of, game pig meat.

The composition and value of wild boar commodities imported to EC countries are shown in table 10.3 and figure 10.2. This information shows that the international trade is based on frozen boneless meat, which represents about 70 per cent of sales. There is also a substantial trade in live wild boar within the EC and between the EC and Eastern Europe. These pigs are slaughtered or used for breeding in wild boar farms and game ranches. Value-added products, including salted, dried or smoked meats, represent the smallest volume (1–2 per cent) of trade.

Patterns of imports of wild boar meat by the world's largest buyers—Germany, France and Italy—over the past decade reveal some market trends (figure 10.3). Firstly, imports by the largest buyer, Germany, have cycled between 2000–4000 tonnes, illustrating the volatile nature of the market for wild boar meat. Secondly, France and Italy import similar quantities, and purchases have tended to grow. The sustained growth in wild boar

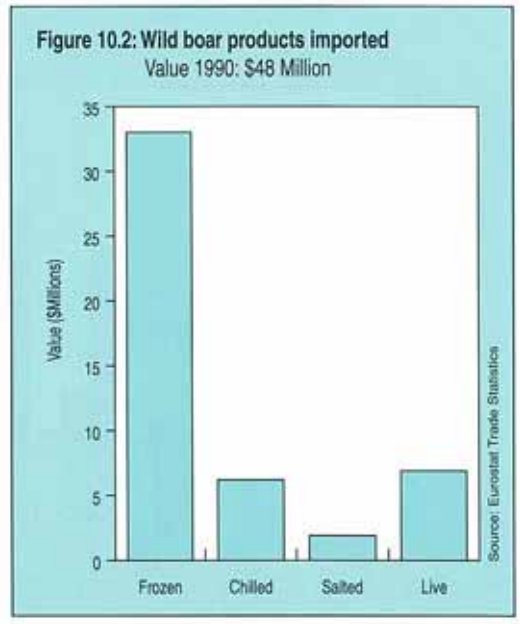
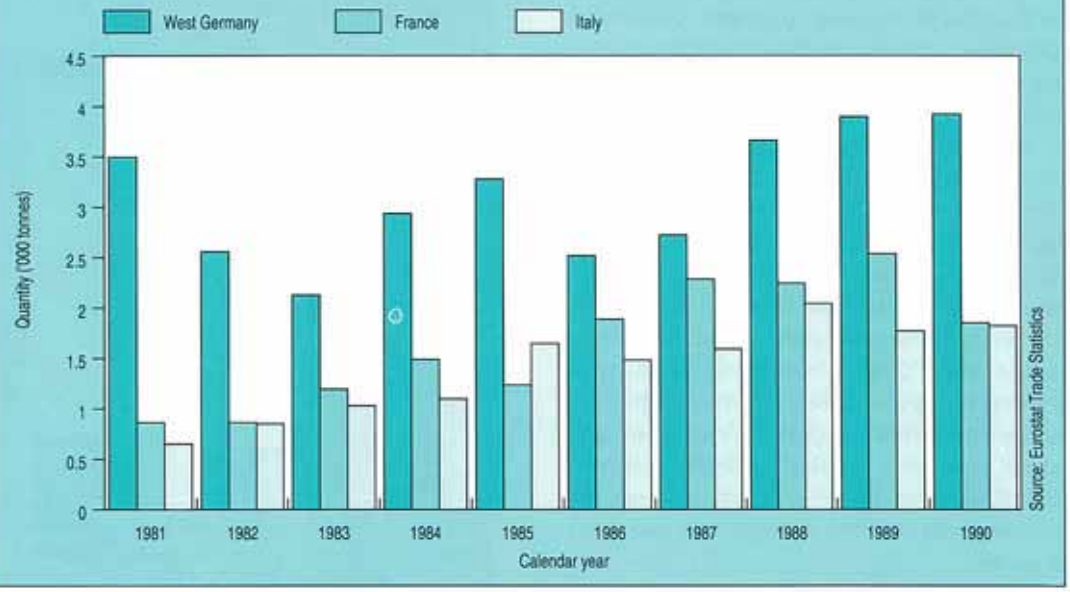


Table 10.3 : Quantity and value of wild boar commodities imported to the European Community from 1988 to 1990

ITEM	FORM	1988 QUANTITY (TONNES)	1988 VALUE (ECU)	1989 QUANTITY (TONNES)	1989 VALUE (ECU)	1990 QUANTITY (TONNES)	1990 VALUE (ECU)
FROZEN							
	BONELESS	4 151	15 097 000	4 482	20 995 000	4 209	16 257 000
	CARCASE	2 279	5 199 000	2 346	7 087 000	1 851	3 683 000
	PORTION	1 191	4 844 000	1 530	7 179 000	1 333	4 645 000
	SUB-TOTAL	7 621	25 140 000	8 358	35 261 000	7 393	24 585 000
CHILLED							
	BONELESS	284	891 000	245	1 323 000	582	1 784 000
	CARCASE	1 075	2 841 000	826	2 368 000	1 403	2 185 000
	PORTION	287	555 000	379	1 117 000	298	667 000
	SUB-TOTAL	1 646	4 287 000	1 450	4 808 000	2 283	4 636 000
SALTED, DRIED OR SMOKED							
	BONELESS	27	110 000	28	99 000	30	79 000
	BELLIES	44	90 000	30	33 000	13	36 000
	PORTION	56	291 000	104	365 000	250	1 320 000
	SUB-TOTAL	127	491 000	162	497 000	293	1 435 000
LIVE ANIMALS							
	UNDER 50KG	1 625	2 532 000	470	1 512 000	1 279	2 548 000
	OVER 50KG	1 258	1 408 000	858	1 364 000	2 008	2 588 000
	SUB-TOTAL	2 883	3 940 000	1 328	2 876 000	3 287	5 136 000
TOTAL ALL ITEMS		12 277	33 858 000	11 298	43 442 000	13 256	35 792 000

Source: Eurostat Trade Statistics All values in European Currency Units

Figure 10.3: Patterns of imports of wild boar meat by major buyers



meat imports to Italy and France make these markets an attractive prospect for exporters. A veterinary agreement between Australia and Italy was signed in March 1993, opening up the opportunity for exports to Italy.

Eastern European countries have preferential market access to the European Community (Anon. 1990b). Their proximity to major importing countries in Western Europe gives the East European suppliers of wild boar meat a significant market advantage over more distant suppliers such as Australia and New Zealand.

Production of wild boar meat in Eastern Europe increased in 1990 and 1991, which contributed to low prices that made trade from Australia unprofitable. The volume of exports from Australia dropped in 1990 and 1991. The supply of wild boar meat from Eastern Europe contracted in 1992 and prices are now increasing. The short-term outlook for Australian exports to the EC is very good, but the main threat is increasing protection.

The Australian game meat industry

Commercial harvesting and export of Australian wild boar for the game meat trade began in early 1980, after regulations were developed by Australian authorities with the assistance of the game meat industry. The legislative requirements are specified in the Game, Poultry and Rabbit Meat Orders 1985. The main requirements are that pigs living in the wild are killed by a shot from a firearm, partially eviscerated, and delivered to a licensed game meat processing establishment for post-mortem inspection and processing.

Structure and operation of the industry

The wild boar meat industry in Australia has a simple structure. It consists of shooters and chiller operators, who are based in rural townships, and game meat processors, who are now based in Sydney and Brisbane. The commercial harvest occurs in Queensland and New South Wales, but extended to the Northern Territory in 1989 when demand was strong.

Wild boar carcases are supplied to the game meat industry by part-time recreational hunters who shoot and sell boar opportunistically to defray hunting costs; by professional kangaroo shooters, who shoot boar to supplement their income; and by professional shooters, who hunt boar on a full-time basis.

Shooters usually begin hunting late in the afternoon, and use a spotlight at night (the boar are more active at dusk and during the night). Four-wheel drive utilities are a common shooting vehicle.

The Australian Game Meat Producers Association has prepared a Code of Practice for the Humane Shooting, Harvesting and Hygienic Handling of Game Animals. Key requirements are that hunters shoot from a stationary platform, use a centre-fire rifle fitted with a telescopic sight, aim for the brain or heart, and take all reasonable effort to locate and kill any animal that is thought to be alive after being shot.

The pig carcass is partly eviscerated, leaving the skin, head, feet, lungs, liver, spleen, heart and kidneys attached for hygiene and inspection purposes. The dressed carcases are hung on a rack on the rear of the vehicle to cool. Carcases must be delivered to a field chiller, which is usually located in rural townships, within two hours of being shot. If shot between sunset and sunrise, the carcase must be delivered within two hours of sunrise.

Chiller operators buy wild boar carcases from shooters, paying by the kilogram, with different rates for various weight classes (table 10.4). The number and average weight of wild boar taken by shooters can be manipulated by varying prices and weight classes. A low price is paid for weight classes under 30 kilograms to encourage shooters to target larger animals. It is uneconomic to process boar under 20 kilograms. Few wild boar weigh over 80 kilograms, but higher prices are paid in the largest weight class to encourage more shooters into the field.

A high number of boar were taken in 1989, when prices for carcases over 80 kilograms reached $1.50/kg (Dee 1990).

Similarly, the harvest was high in 1992 when prices were at comparable (or in some cases higher) levels. In 1992, a wild boar carcase was worth an average of $18–25 to a shooter.

Chiller operators are paid a commission of 8–10 cents per kilogram for the carcases they buy. In 1989, game meat companies paid at least $4–5m to shooters and chiller operators for wild boar. The wild boar industry provides significant employment and is an important part of the rural economy in parts of eastern Australia.

Table 10.4: Typical prices paid by Australian chiller operators for wild boar meat, 1987 and 1992

Year	Weight[a] of carcase (kg)	Price per kg ($)	Price per carcase ($)
1987[b]	22–30	0.40	8.80–12.00
	31–40	0.60	18.60–24.00
	41–61	0.70	28.70–42.00
	61+	0.80	48.80+
1992	23–30	0.30	6.90–9.00
	31–50	0.60	18.60–30.00
	51–80	0.70	35.70–56.00
	81+	1.00	81.00+

a = partly eviscerated
b = from Takahashi & Tisdell 1989

The wild boar carcases must be chilled to a deep muscle temperature of at least 7 degrees celsius within 15 hours of delivery to the field chiller. These requirements are more than adequately met, and carcases are typically stored at 0–2 degrees celsius. All carcases are transported by refrigerated vehicle from the field chillers to a licensed game meat processing establishment.

Meat production

Chiller operators are not paid for any carcases that are condemned at the processing establishment, which provides an incentive for self-regulation of product quality. Chiller operators advise shooters on correct hygiene, carcase dressing and handling procedures, and will not buy substandard carcases.

At the processing establishment, all carcases are individually inspected by AQIS staff. The main reason for condemnation of carcases is 'off condition' on arrival at the processing plant.

Most of the dressed wild boar carcases received at the processing establishment weigh 25–125 kilograms, depending on the region harvested and the prices offered. A carcase that weighs 45 kilograms includes the skin (8.5–9 kg), head (4.5–5 kg), feet (1–1.4 kg) and offal (1–1.4 kg). There are no markets for these products, therefore about 35 per cent of the carcase is discarded.

The prices received for wild boar meat vary depending on the cuts, the type of packaging required and size of the shipment. Frozen whole or half carcases will have a lower value than the leg and boneless saddle, which are premium cuts. However, contracts are usually negotiated on 'natural fall', which means that the buyer takes all the meat from each carcase.

Table 10.5: Composition of meat cuts from a wild boar carcase that produces 20 kilograms of saleable cuts

Product	Weight (kg)	Per cent
Bone-in legs	9.8–10	49–50
Boneless shoulder	4.0–5.0	20–25
Boneless meat	2.2–2.8	11–14
Boneless saddle	1.8–2.0	9–10
Boneless neck	1.0–1.4	5–7

The typical yield from a carcase that produces 20 kilograms of saleable cuts, including bone-in legs, is shown in table 10.5. Profitable markets for skins and by-products have not been identified.

Scale and value of the industry

The highest annual production of wild boar in Australia occurred in 1992, when 271 133 wild boar were processed through export game meat establishments. Previously, the highest production was in 1989, when 203 837 wild boar were processed.

Production was lower in 1990 (96 962) and 1991 (101 006) due to low demand and prices. The variable throughput between 1989 and 1992 highlights the volatility of this trade. The total value of all game boar meat exports has varied from $10–20m per annum over the last few years.

Factors influencing trade and harvesting

Veterinary issues

Special conditions apply when processing wild boar for some importing countries. For example, German, French and Italian authorities require that all carcases be tested for the nematode parasite *Trichinella spiralis*.

Trichinella spiralis is infectious to humans if raw or poorly cooked infested meat is eaten (Geering & Forman 1987). The most important pathogenic effects occur when larvae infect the muscles and, if untreated, may cause death through paralysis of the respiratory muscles.

Outbreaks of trichinellosis have occurred in Europe due to consumption of infected European wild boar meat (World Health Organisation 1988). *Trichinella spiralis* has never been detected in domestic livestock or wildlife in Australia and there is no evidence of any indigenous trichinosis in man or animals in Australia (Geering & Forman 1987). The requirement to test all animals for *Trichinella spiralis* is unwarranted in the Australian context and increases production costs when packing for Germany, France and Italy.

Factors influencing supply

The wild boar harvesting industry must have very flexible field operations to maintain an adequate supply of high quality wild boar carcases. Wild boar are common in Australia, but factors such as short-term environmental variability can reduce access for hunters (e.g. due to flooding) and long-term environmental conditions, such a drought, can influence wild boar abundance and distribution. Therefore, the wild boar industry has mobile field operations that extend over a wide area of eastern Australia to ensure constant supply.

Other factors that influence supply are the price of wild boar meat, the availability of shooters and the number of chillers operating. More shooters enter the industry when prices are high, thus increasing harvesting pressure. Further, it becomes possible to expand hunting activities to include remote regions when prices are high. Few shooters are available in remote regions and game meat processors sometimes deploy teams of professional hunters to harvest wild boar. There are now roughly 200 field chillers deployed throughout rural Queensland, New South Wales and the Northern Territory.

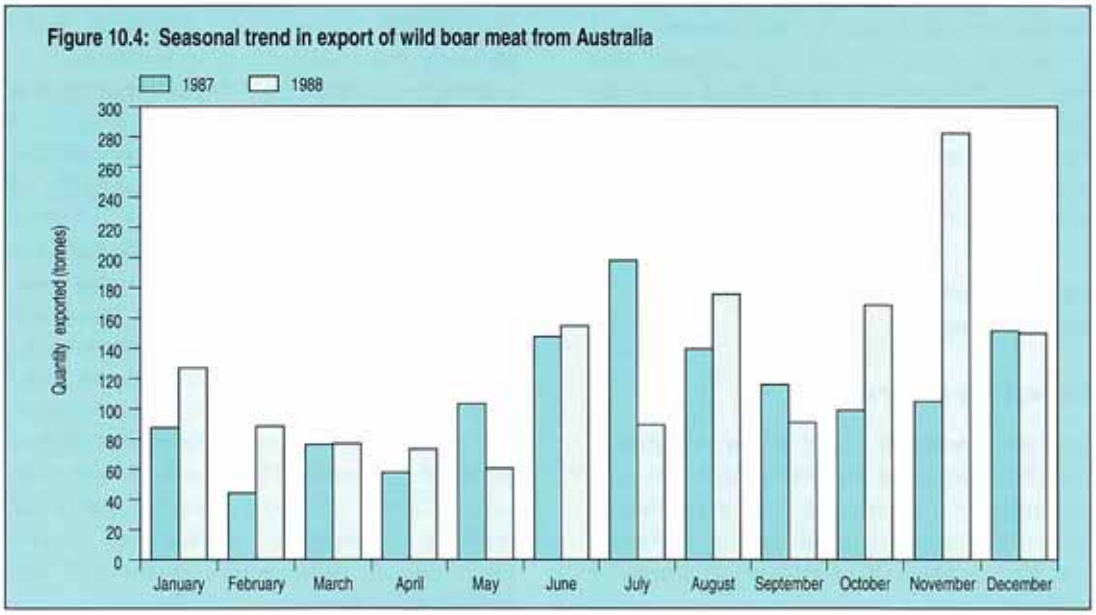
Factors influencing demand

Consumption of wild boar meat in Europe is highest during the northern winter. Therefore, most wild boar meat is exported from Australia between May and December to coincide with the seasonal demand (figure 10.4). The quantity and price of wild boar meat supplied by competitors such as Poland and Hungary influences the prospects for Australian exporters. For example, Australian exports decreased in 1990 due to high production and low prices in eastern Europe (table 10.2).

Product description issues

Wild boar meat receives a premium over domestic pork, and the origins of meat labelled as wild boar meat must be known to protect consumers from substitution. There are no analytical techniques that can reliably detect the difference between wild and domestic pig meat. Although useful experimental work continues on this subject (e.g. Vizzani et al. 1985), its application in the field remains a long-term possibility.

Genetic differences have been proposed as a means of differentiating wild and domestic pigs—European wild boar were thought to have a diploid chromosome



number of 36, while feral and domestic pigs have 37 or 38 (Henry 1969). However, it has since been proven that European wild boar are polymorphic, with a diploid chromosome number of 36, 37 or 38 (Bosma 1976; Arroyo Nombela et al. 1990). An assessment of genetic variability between isolated populations of European wild boar (Hartl & Csaikl 1987) indicated that the increasing artificial alteration of landscape and intensive wildlife management in Europe could underpin the genetic variations observed.

Due to the increasing competition from newly arrived Australian suppliers, some European competitors have questioned whether Australian wild boar can be labelled as wild boar, given the uncertain origins of the base population. This issue was first raised by Germany in 1985–86. The Australian Quarantine and Inspection Service was able to assure German authorities of the integrity of the wild boar harvesting, processing and certification system in Australia. Further, it was shown that Australian wild boar and Eurasian wild boar share many phenotypic and behavioural traits.

German authorities now require that the Australian product is labelled as Australian wild pig *(Australisches wildschweinfleish)*. The continued acceptance of the Australian product by German authorities and consumers endorses the quality and authenticity of Australian wild boar meat. The quality of the Australian product has been confirmed by a sensory analysis of the quality of Australian wild boar meat and meat from Poland, Bavaria and Hungary (Hofmann 1992). The study concluded that there was no quality differentiation in relation to the country of origin.

Nonetheless, the product description issue resurfaced in 1991 when EC officials proposed to reclassify meat of Australian wild boar as meat of domestic pigs for tariff purposes. This move was possibly associated with newly introduced practices in England and other EC countries of farming of wild pigs, to capture some of the market now dominated by wild boar hunters. Australian authorities were again able to provide the necessary technical information to address concerns about product description.

The question of product description is complicated by the existence of two systems of producing wild boar meat—as game meat or farmed meat. It is paradoxical that 'wild pigs' can be husbanded and selectively bred in Europe, including crossbreeding with domestic pigs to enhance production (Booth et al. 1988; Steel & Turff 1991), while the meat is sold as wild boar.

Australia is now one of the few places in the world where large quantities of wild boar meat can be produced from pigs that live in the wild.

Abattoir slaughter

In Queensland, wild boar can be captured live using enclosure traps or dogs, and transported to an abattoir for slaughter for domestic and export markets. These boar are processed in the same manner as domestic pigs, including ante-mortem inspection. It is illegal to transport live wild boar in New South Wales, which precludes this type of processing.

Game meat distributors estimate that about 5–10 tonnes of wild boar are sold annually on the domestic market. Wild boar meat is available at some specialty shops, but most is sold through the food service industry as a highly priced, gourmet meat. Restaurants buy the premium cuts—saddle ($10–18/kg) and leg ($5–9/kg)—but there is little demand for other cuts.

Export of abattoir-slaughtered wild boar meat has been negligible. It is not exported to Europe, and Japan and the United States of America have been the main buyers. The total quantity exported has declined from a high of about 47 tonnes in 1986, to no exports in 1990 (O'Brien & Meek 1992). The value of these exports is unknown.

Recreational/trophy hunting

Wild boar are a popular hunting resource for amateur hunters in Australia. It has been estimated that 100 000–200 000 Australians engage in wild boar hunting as an occasional recreational activity (Tisdell 1982). Recreational pig hunting can vary from opportunistic shooting, through to well-planned trophy hunts organised by professional safari outfitters.

Australian wild boar are recognised as a trophy animal in the hunting achievement awards of the Australian–South Pacific Chapter of Safari Club International, which is an international hunting organisation of some 25 000 members in 30 countries. Hunters from around the world, in particular from Europe, regularly visit Australia for its wild boar hunting. However, the scale and value of trophy hunting of Australian wild boar have not been quantified.

Non-commercial killing

Landowners and State and Territory pest control agencies kill many wild boar each year to reduce the agricultural and environmental damage they cause. The techniques employed include ground and helicopter shooting, trapping, poisoning and exclusion fencing. The products from these animals are not used. The total number of boar killed for pest control is unknown, but likely to be substantially less than the number killed in the commercial harvest.

There is also a large but unquantified consumption of wild boar meat by amateur hunters and people living in rural areas.

Discussion

Over the past decade, the wild boar game meat industry in Australia has been established as a wholly export-oriented industry. Competitive pricing and quality products have made Australia one of the world's leading suppliers of wild boar meat. However, there is scope for continued expansion of the export trade. There are several important markets that Australian exporters do not have access to, and opportunities for better penetration of existing markets.

In the short term, the biggest gains for the industry could be made by gaining access to new markets. The recent signing of a veterinary agreement between Australia and Italy provides an opportunity for Australian exporters to expand into this new and growing market for wild boar meat. However, Australia does not have access to markets in Canada, the USA and the Republic of Korea. Access to the North American and Korean markets is denied because the animals must be subjected to ante-mortem inspection. The internal market for game meat, including wild boar,

is well developed in North America. Australian exports could be increased substantially if existing barriers were removed.

World imports of wild boar meat are increasing, but markets are volatile due to competition between suppliers. Better penetration of key markets would provide greater stability for the Australian exporters. One way of increasing market penetration is to take advantage of emerging trends in consumer requirements in the food industry. For example, there is strong growth in demand for convenience packed meats in developed countries, including western Europe (Krieg 1990; Buckle 1990). One Australian company is already producing value-added packs that are shipped in a form ready for retail sale in French supermarkets (Dee 1990).

Another important trend is that consumers are becoming increasingly concerned about chemical residues in food products. For example, there has been considerable concern about the risk of radioactive contaminants in European wild boar meat following the Chernobyl disaster (Hofmann 1992). Australian wild boar live in a less modified environment than wild boar in many parts of the world and are at low risk of contamination with residues and radioactive material. Australian exporters should be positioning their product as a clean meat, which is derived from free-ranging wild boar.

Wild boar populations are coming under increasing pressure in many parts of the world as human populations expand and habitats are modified, and hunting pressure increases. Entrepreneurs in Europe, Japan and Canada are farming wild-type pigs to supply meat to consumer markets now supplied by the game meat industry. Farming and ranching of wild pigs could be expected to increase overseas, but is unlikely to occur (and in many cases is illegal) in Australia. Overseas producers of farmed wild pig meat could be expected to continue to lobby for restrictions on the trade in game pig meat. These activities underpin the most serious threat to the viability of the Australian industry, this being increased protectionism, particularly in the key EC market.

Wild game pig meat producers in Europe, Australia and other parts of the world will have an advantage in selling their product to traditional consumers of game meat. Producers of wild game pig meat also have a cost advantage over producers of farmed meat as the capital investment is much less than that required to husband and slaughter pigs. Australia is well placed to develop its exports of wild game pig meat—there are large populations of wild boar available and the product is well accepted by consumers in key markets. Australia is emerging as one of world's leading suppliers of wild game pig meat, and there is scope for exporters to expand sales and to position their products as meat from genuinely wild pigs living in a harsh environment.

Since the beginning of 1992, there has been a firm demand for Australian wild boar meat in Europe. This has led to a record harvest of some 270 000 wild boar in 1992, when the industry reported that it was supply-limited. The widespread drought through Queensland and New South Wales, combined with heavy hunting pressure, would have contributed to the reduced supply.

The wild boar industry has a number of positive attributes, besides providing much needed export income and employment in the rural sector. Commercial harvesting plays a major, but largely unrecognised, role in reducing wild boar population density and hence reducing the damage they cause. Commercial harvesting is likely to remove more wild boar than all other methods of control combined. In addition, the method of harvesting—head shooting from the ground—could be more acceptable from an animal welfare viewpoint than helicopter shooting (Senate Select Committee on Animal Welfare 1991) or the use of poisons.

Various authors have identified the prospects for multiple use management of wild boar (Tisdell 1982; O'Brien 1987;

O'Brien & Meek 1992), incorporating commercial use, recreational hunting and pest control. This approach recognises wild boar as both a pest and a resource. However, wild boar continue to be managed as a pest, with little consideration given to commercial needs. This has led to conflict between pest control authorities and the commercial wild boar industry (Takahashi & Tisdell 1989). Current legislation and management practices do not account for the resource value of wild boar and should be amended to assist the development of the game meat industry, where this does not conflict with other resource management goals.

11 FERAL GOAT

Distribution and abundance

Domestic goats, *Capra hircus*, were introduced to Australia from England with the First Fleet in 1788 as a source of meat, milk and fibre (Rolls 1969). The early stock were hardy and quickly adapted to the new environment. Before long, flocks of milking goats were kept at many properties and settlements in rural Australia. It was common practice to allow milking goats to forage during the day and return to holding yards each night. These goats lived in a semi-feral state, and could readily mingle with, or form wild populations. Feral goat populations expanded when angora and mohair fibre industries failed in the late 1800s, and domestic goats were abandoned (Long 1988).

Feral goats are now widely distributed in mainland Australia, with the largest populations occurring in the semi-arid pastoral areas of Western Australia, South Australia, New South Wales and Queensland (Wilson, Dexter, O'Brien & Bomford 1992). Feral goats also live on many coastal islands around Australia—a legacy of introductions by early mariners.

The Australian feral goat is a naturally fertile animal with an extended breeding season, early puberty, and a high ovulation rate (Holst 1981). They graze extensively when pasture quality is high (Harrington 1986), but are primarily selective browsers (Wilson et al. 1975; Standing Committee on Agriculture 1982), particularly during dry conditions. A high reproductive capacity and flexible diet have enabled feral goats to thrive in the harsh environment of arid and semi-arid Australia.

White is the primary coat colour of feral goats in Australia, although mixed colours and black are common in some regions (Holst 1981), reflecting the mixed origins of the original stock.

Feral goats can compete with native herbivores for food. A study of the diets of locally endangered yellow-footed rock wallabies, *Petrogale xanthopus*, and other herbivores in western New South Wales found that goats were the most important potential competitors with the rock wallabies (Dawson & Ellis 1979). During drought, the dietary overlap was 75 per cent in all plant categories. The New South Wales National Parks and Wildlife Service is actively involved in removing feral goats from the habitats of the yellow-footed rock wallaby.

The adverse effects of grazing by feral goats are likely to be small compared with that of sheep on mainland Australia (Standing Committee on Agriculture 1982). It is only uncontrolled grazing by large numbers of goats that causes degradation, in the same way that uncontrolled grazing by sheep can cause damage. However, island habitats are more susceptible to overgrazing. Letts et al. (1979) described severe degradation on North East Island off Groote Eylandt in the Northern Territory following overgrazing by goats and deer.

Nonetheless, it appears that sheep and goat diets are largely complementary, and there is little overlap when food is not limiting (Wilson et al. 1975). The available evidence suggests that competition between feral goats and other animals is likely to be an issue when the goats are at high density during times of drought.

The total number of goats living in the wild in Australia is unknown, and estimates vary from 280 000 to over 2 million (Standing Committee on Agriculture 1982). However, most feral goats occur in dry and semi-arid regions, where herbivore populations, such as kangaroos, can crash when pasture biomass is reduced following low rainfall (Caughley 1987). Consequently, estimates of feral goat population size or density will vary widely between regions and over time in response to harsh and unpredictable environmental conditions.

Feral goats live in a wide range of habitats, but are most common in rough, scrubby country, particularly in *Acacia* shrublands (Standing Committee on Agriculture 1982; Mahood 1983b). These habitats provide refuge from hunters and predators such as the dingo. There is anecdotal evidence that dingo distribution influences goat distribution —goats are most abundant in regions where

dingoes are excluded or controlled, or where vegetation can provide refuge (Wilson, Dexter, O'Brien & Bomford 1992). Another predator, the red fox *(Vulpes vulpes)*, is known to kill domestic goat kids (Long et al. 1988), but the role of foxes in limiting feral goat populations has not been established.

Australia's feral goats are now a valuable source of meat for domestic and export markets, and provide valuable genetic material to bolster domestic goat fibre industries. Access to large populations of feral goats has enabled rapid expansion of herds of domesticated goats, which can be a useful tool in range management. Selective grazing by goats has proven to be a practical alternative to chemicals for the control of weeds in pastoral areas and coastal regions (Davies 1982) when stocked at a sufficiently high rate (Wilson et al. 1975). Research in Australia (Peirce 1991) and New Zealand (Crouchley 1980) has shown that grazing by goats can control thistles, blackberries and briar.

Status

Feral goats are not protected, and can be hunted throughout the year. They are regarded as an important resource for the goat meat and fibre industries, and as pests of agriculture and the environment.

Commercial use

Commercial harvesters use three principal methods of capturing feral goats—trapping at watering points, mustering with dogs and vehicles, or field shooting to produce game meat for export. Trapping or mustering are the most common methods used, and it is usually landowners that capture and sell feral goats. Therefore, the feral goat harvest is simultaneously a means of suppressing feral goat populations and an opportunity for pastoralists to supplement their income. Most feral goats are sold to abattoirs in Australia and overseas for slaughter.

Meat

Goats are an important production animal in many parts of the world. In 1990, there were about 550 million domestic goats in the world, and about 2.5 million tonnes of goat meat were produced (FAO 1991). Developing countries in Africa and Asia produce approximately 90 per cent of the world supply of goat meat, but most of this meat is consumed domestically and only small quantities enter international trade.

Although many consumers in developed countries perceive goat meat as a down-

Figure 11.1: Quantity and destination of goat meat exported 1982–92

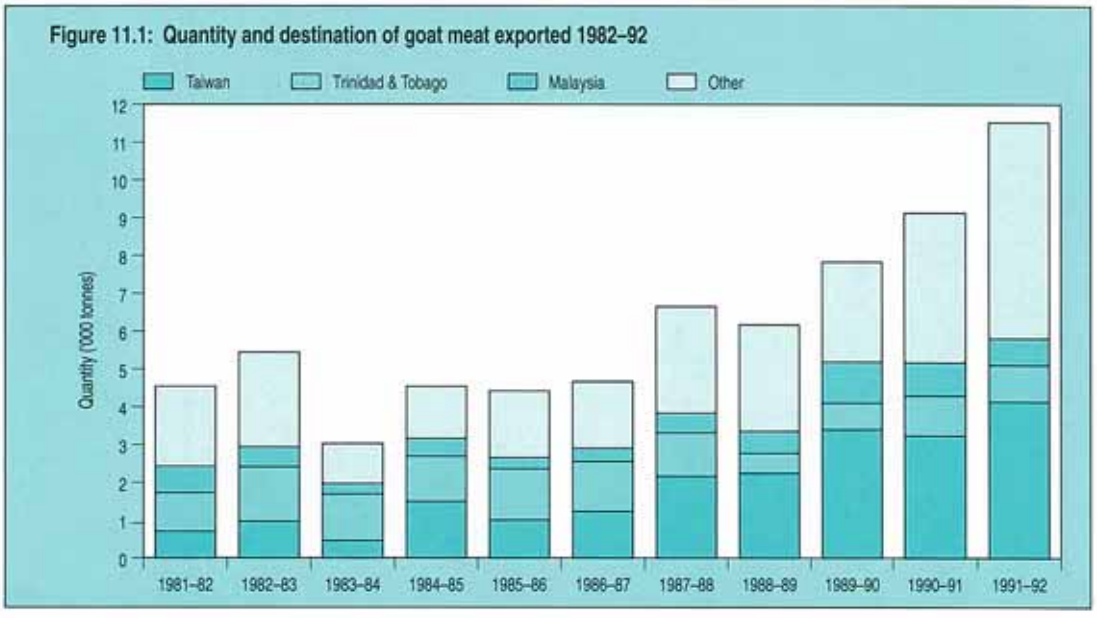


Table 11.1: Quantity, value and destination of goat meat exports 1981–82 – 1991–92 (all values are in Australian dollars)

DESTINATION	*QUANTITY VALUE*	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91	1991–92
MALAYSIA	kg	710 677	518 332	292 160	474 027	290 669	366 443	543 940	555 686	1 075 200	885 195	673 342
	$	964 201	690 000	505 847	751 404	509 124	741 165	980 847	921 695	1 493 247	1 337 706	1 065 417
PUERTO RICO	kg	0	13 472	0	0	26 503	32 737	242 317	705 677	437 915	514 272	281 228
	$	0	21 000	0	0	40 466	55 622	445 318	1 205 103	718 971	1 005 774	472 896
REPUBLIC OF KOREA	kg	0	0	0	0	0	50 142	0	0	34 779	489 441	1 184 097
	$	0	0	0	0	0	39 822	0	0	66 655	1 006 509	2 169 726
SINGAPORE	kg	888 384	630 307	180 485	292 855	168 371	190 751	587 298	553 025	316 738	287 433	398 450
	$	1 092 617	767 000	242 822	386 545	186 709	250 875	685 271	686 080	368 265	345 769	483 217
TAIWAN	kg	682 797	945 349	447 993	1 483 582	985 733	1 204 398	2 141 341	2 189 721	3 356 136	3 180 522	4 112 593
	$	939 203	1 308 000	779 022	1 654 934	1 535 095	1 761 489	3 522 408	3 836 631	5 942 413	5 052 973	8 188 631
TRINIDAD AND TOBAGO	kg	1 011 120	1 444 715	1 248 848	1 168 614	1 348 350	1 284 149	1 151 285	517 693	701 093	1 026 074	970 290
	$	1 447 303	2 098 000	2 315 254	2 320 158	2 283 053	2 140 045	1 865 924	749 990	1 026 461	1 771 639	1 408 144
UNITED STATES OF AMERICA	kg	0	134 765	16 329	178 583	227 136	135 079	336 822	389 416	907 789	1 140 699	1 476 953
	$	0	263 000	46 793	289 230	341 277	270 157	752 816	588 783	1 397 642	2 522 800	2 464 810
OTHER	kg	1 220 796	1 740 281	809 553	903 666	1 314 853	1 375 197	1 601 224	1 142 992	961 729	1 470 982	2 343 718
	$	1 710 525	2 750 000	1 754 085	1 773 240	2 577 591	2 951 792	3 186 787	1 965 656	1 602 766	2 584 042	4 101 024
TOTAL	**kg**	**4 513 774**	**5 427 221**	**2 995 368**	**4 501 327**	**4 361 615**	**4 638 896**	**6 604 227**	**6 054 210**	**7 791 379**	**8 994 618**	**11 440 671**
	$	**6 153 849**	**7 897 000**	**5 643 823**	**7 175 511**	**7 473 315**	**8 210 967**	**11 439 371**	**9 953 938**	**12 616 420**	**15 627 212**	**20 353 865**
	$/kg	**1.36**	**1.46**	**1.88**	**1.59**	**1.71**	**1.77**	**1.73**	**1.64**	**1.62**	**1.74**	**1.78**

Source: Australian Bureau of Statistics — Australian Harmonised Export Commodity Classification number 2045000: Meat of goats, fresh, chilled or frozen — All values are in current dollars

market product, it is often priced at a premium over beef in many countries of the developing world, such as Kenya, Iran and Indonesia (De Boer 1982). Goat meat is often associated with festivals, religious occasions and special dishes in developing countries. Therefore, some consumers are prepared to pay more for goat meat, because it is considered a delicacy.

Australia began exporting goat meat in 1952 (Standing Committee on Agriculture 1982), and the trade has developed to become an important export industry. Australia is now the world's largest supplier of chilled and frozen goat meat, and the main competitor is New Zealand (Goodwin 1980). Feral goats and their progeny are the mainstay of the Australian and New Zealand goat meat industries.

Growth and diversification of markets were a feature of the Australian goat meat industry over the past decade. Exports were highest in 1991–92, when 11 440 tonnes valued at $20.4m or $1.78 per kilogram were shipped (table 11.1 and figure 11.1). Taiwan, Trinidad and Tobago, and Malaysia are traditionally the largest markets for Australian goat meat, but Reunion Island, Mauritius, The Netherlands and French Antilles also buy large quantities.

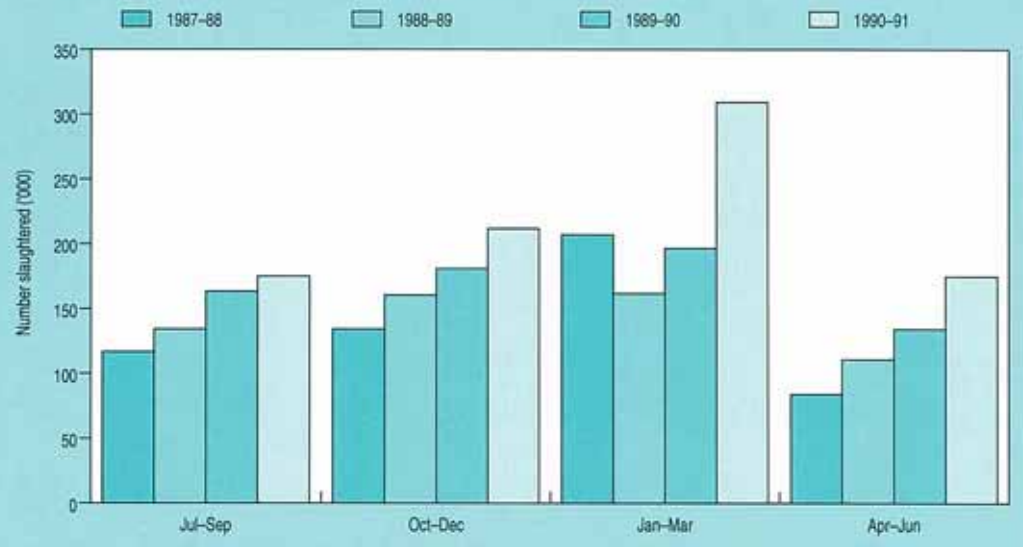
Growth in the Taiwan market has been a major factor in the continued expansion of Australia's goat meat exports. Taiwan imported about 15 per cent of all goat meat exported from Australia in 1981–82. However, by 1991–92, sales to Taiwan had increased to 36 per cent of exports.

Diversification into new markets also contributed to the expansion in goat meat exports over the last decade—in 1991–92, 33 countries imported Australian goat meat. The new growth markets are Puerto Rico and the Republic of Korea.

The characteristics of the major markets for goat meat vary considerably (Hughes 1987). For example:

- Demand in Taiwan is seasonal, with little or no trade between February and August. Consumption increases during festivals when goat meat is eaten as a delicacy. A premium is paid for lean skin-on carcases weighing 14–20 kilograms.
- Caribbean buyers prefer frozen, boneless meat from carcases weighing over 16 kilograms.

Figure 11.2: Seasonal variation in slaughter of goats in Australia



Source: Australian Quarantine and Inspection Service

Note: Data incomplete for goats slaughtered at domestic abattoirs in Qld, NSW and Vic.

Table 11.2: Number of goats slaughtered at domestic and export abattoirs in all States and Territories

YEAR	TAS		WA		QLD		SA		NT		NSW		VIC		LOCAL TOTAL	EXPORT TOTAL	GRAND TOTAL
	local	export	local	export	local	export	local	export	local	export	local	export	local	export			
1987–88																	
Jul–Sep	36	0	-	20 628	7 859	14 539	12	23 469	0	0	2 065	34 383	-	9 801	9 972	102 820	112 792
Oct–Dec	0	0	-	41 044	96	12 135	116	18 691	1	0	5 466	52 979	-	0	5 679	124 849	130 528
Jan–Mar	0	0	-	79 704	134	23 181	97	35 293	24	0	7 271	56 341	-	0	7 526	194 519	202 045
Apr–Jun	1 148	0	-	17 514	122	31 214	75	11 497	11	0	11 649	8 503	-	0	13 005	68 728	81 733
TOTAL	1 184	0	20 330	158 890	8 211	81 069	300	88 950	36	0	26 451	152 206	15 695	9 801	72 207	490 916	563 123
1988–89																	
Jul–Sep	377	0	-	28 691	78	25 875	83	19 617	0	0	10 160	42 664	4 075	0	14 773	116 847	131 620
Oct–Dec	79	0	-	37 478	166	31 626	172	21 880	0	0	10 875	50 798	4 462	0	15 754	141 782	157 536
Jan–Mar	95	0	-	60 617	66	31 304	5 387	27 584	0	0	9 827	14 672	8 046	0	23 421	134 177	157 598
Apr–Jun	212	0	-	24 411	104	33 039	2 173	5 611	0	0	12 613	21 957	8 009	0	23 111	85 018	108 129
TOTAL	763	0	25 840	151 197	414	121 844	7 815	74 692	0	0	43 475	130 091	24 592	0	102 899	477 824	580 723
1989–90																	
Jul–Sep	1 149	0	-	41 904	-	45 817	2 207	23 541	0	0	9 316	30 107	4 787	0	17 459	141 369	158 828
Oct–Dec	0	0	-	57 003	-	24 981	1 168	23 483	11	0	6 390	56 256	7 459	0	15 028	161 723	176 751
Jan–Mar	16	0	-	53 035	-	52 433	1 563	30 022	0	0	3 972	35 652	15 023	0	20 574	171 142	191 716
Apr–Jun	1 262	0	-	34 583	-	19 644	1 106	15 140	66	0	4 460	35 723	17 795	0	24 689	105 090	129 779
TOTAL	2 427	0	20 731	186 525	1 559	142 875	6 044	92 186	77	0	24 138	157 738	45 064	0	100 040	579 324	679 364
1990–91																	
Jul–Sep	319	0	-	48 957	-	40 034	683	20 094	0	0	914	44 465	14 931	0	16 847	153 550	170 397
Oct–Dec	0	0	-	58 927	-	43 943	1 311	29 917	0	0	1 777	60 817	9 683	0	12 771	193 604	206 375
Jan–Mar	2	0	-	91 380	-	37 937	948	55 883	0	0	1 903	99 050	12 884	21	15 737	284 271	300 008
Apr–Jun	347	0	-	13 202	-	43 600	1 106	51 115	0	0	2 088	53 945	4 635	0	8 176	161 862	170 038
TOTAL	668	0	15 703	212 466	750	165 514	4 048	157 009	0	0	6 682	258 277	42 133	21	69 984	793 287	863 271
1991–92																	
TOTAL	578	0	16 432	255 340	265	136 581	3 416	162 303	0	0	19 661	403 659	20 928	2 657	61 280	960 540	1 021 820

Source: Australian Quarantine and Inspection Service (unpublished data)

- Buyers in the Middle East prefer lean, uniform carcases in the weight range 8–12 kilograms. Halal slaughter is essential.
- Singapore, Malaysia and Brunei import frozen bone-in goat carcases weighing less than 18 kilograms. Demand is highest in November (Deepavali) and other religious festivals (Hari Raya Puasa and Hari Raya Haji). Halal slaughter is essential.
- Okinawa is a traditional market for Australian goat meat. Demand is for skin-on goat carcases. Goat meat is regarded as medicinal, and sliced raw goat meat is used as a diet for the ill.
- Importers in Italy, Greece and Cyprus require lightweight carcases weighing about 10 kilograms. Quota restrictions on goat meat imports to countries in the European Community limits the prospects for Australian exporters.

Most goats slaughtered for export are of feral origin, but animals from domestic herds are also processed. The domestic goat industry is primarily concerned with fibre production, and meat production is of lesser importance (Cribb 1991). Therefore, many domestic goats are sent to slaughter because they have poor fibre-producing characteristics, not because they have been produced to supply meat to a particular market. Nonetheless, there is growing interest, particularly in Western Australia, in producing meat from milk-fed kid goats for the 'top end' or high value segments of local and export markets (Nussey 1989; Cribb 1991).

Most of the large export markets for goat meat require a lean product (De Boer 1982; Hughes 1987). Feral goat meat has attributes that appeal to these consumers, and consequently, exports of Australian goat meat have continued to expand. As the domestic goat herd increases, it may become necessary to develop new markets that will accept meat with a higher fat content.

The total number of goats processed at export abattoirs in Australia reached a record level of over 960 000 in 1991–92 (table 11.2). Most of these animals were processed in New South Wales (42 per cent), Western Australia (27 per cent), South Australia (17 per cent) and Queensland (14 per cent). A further 60 000 goats were slaughtered at domestic abattoirs in 1991–92 (table 11.2), bringing the national goat slaughter to over 1 million animals. Most goats are slaughtered between October and March each year in response to seasonal demand and ease of supply during summer (figure 11.2).

There is little information on the size, value and characteristics of the domestic market for goat meat. Export abattoirs can sell produce on domestic markets, which makes it very difficult to quantify the number of goats slaughtered for domestic consumption. It is likely that many lower quality carcases or cuts are diverted to the local market for manufacturing meat. However, domestic abattoirs cannot export their products, and throughput represents the minimum quantity sold into the domestic market. Table 11.2 shows that 60 000–100 000 goats are slaughtered annually at domestic abattoirs, particularly in Victoria and Western Australia.

It appears that there are three distinct markets for goat meat in Australia. The two main markets are retail of fresh goat meat or 'chevon' through butcher shops and delicatessens, primarily to service demand from ethnic consumers; or wholesaling to the smallgoods industry for manufacturing. The smallgoods industry blends lean goat meat with fatty beef or mutton for use in pies, sausages, hamburger mince and pet food. Smallgoods products are not promoted as containing goat meat, and demand is very price-sensitive. For example, buyers will switch to mutton when mutton prices are low. Finally, there is a small market in the food service industry (restaurants, hotels) for goat meat.

The size and age of captured feral goats is highly variable. Consequently, the goats need to be graded carefully at the abattoir to ensure that product quality matches the buyer's requirements. Most abattoirs pay for goats 'over the hooks', which means that the seller is paid at a certain rate per kilogram of the hot carcase weight (viscera,

skin and head removed). Wide variations in goat breeds and habitats within Australia and overseas complicate any comparison of meat production characteristics (growth rates, carcase composition) of Australian feral goats and domestic goats (McGregor 1984).

Supply of the required quantity and quality of goats is influenced by factors such as the prices offered, abundance of feral goats, distance from abattoirs, and environmental factors such as flood and drought. Overlaying the uncertainties of supply are seasonal demand patterns and irregular processing by abattoirs. Most export abattoirs that process goats are primarily concerned with slaughtering sheep, and goats are purchased opportunistically. With so many variables influencing the trade, the goat meat industry can be a risky venture for all participants. Nonetheless, the Australian goat meat industry has continued to grow and prospects for further growth appear good.

Game meat

Besides abattoir slaughter of feral goats, several thousand wild goats are slaughtered in the field each year by hunters supplying the game meat industry. The game goat meat industry is small compared to the abattoir slaughter of goats, and all meat is exported, primarily to countries in the Caribbean. A total of 26 628 goats were processed for game meat in 1989. Production has been higher in 1990 (38 995), 1991 (38 354) and 1992 (39 731).

The method of harvesting and processing wild goats for game meat is virtually identical to that for wild pigs. Hunting takes place late in the afternoon or early morning, and the goats are shot using a rifle with a calibre of at least .222. Most wild goats are taken for game meat by professional kangaroo or wild pig shooters who hunt goats opportunistically when demand and prices are high.

After it has been shot, the goat is bled and partly eviscerated, leaving the head, skin, liver, spleen, heart, lungs and kidneys attached. The dressed carcases are hung on a rack on the shooting vehicle to cool, and delivered to a field chiller within two hours of daybreak.

Shooters are paid according to the weight of the carcases delivered. Assuming that an average field dressed goat carcase weighs about 25 kilograms, and the average price offered is $0.40 per kilogram, shooters can expect to receive about $10 per goat. Therefore, about $390 000 was paid to hunters in 1992, based on the annual harvest over 39 000 head.

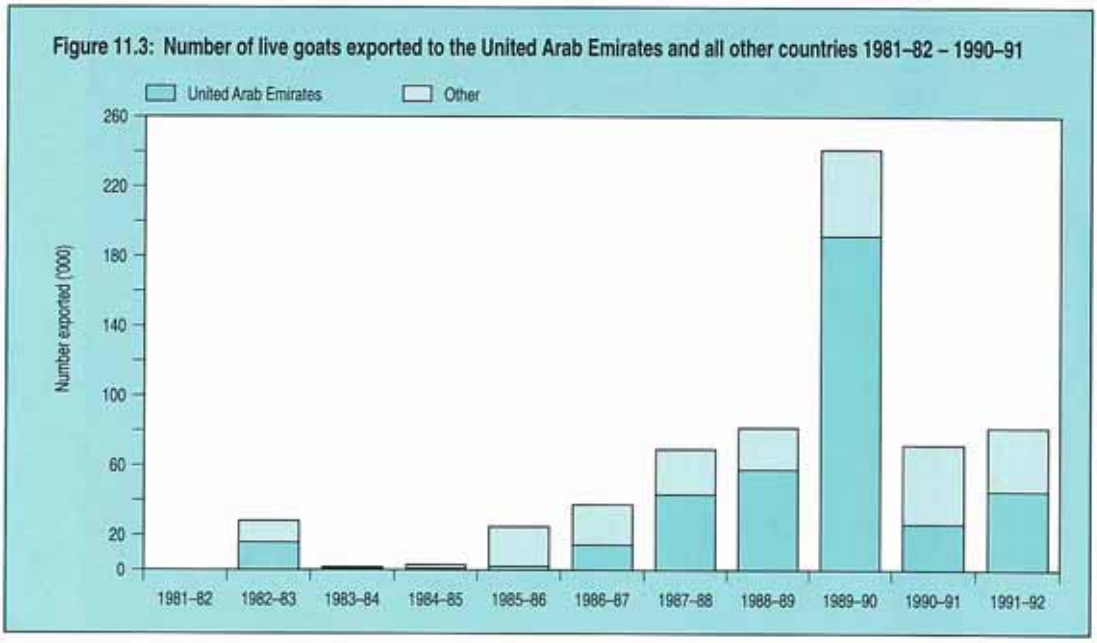
The goat carcases are collected regularly from field chillers and transported in a refrigerated vehicle to a game meat processing establishment. There are currently four such establishments based in Queensland and New South Wales. The carcases are inspected by officials from the Australian Quarantine and Inspection Service, and processed and packed to the customer's requirements.

Live goats

Many captured feral goats are used in breeding programs by domestic goat fibre industries to enhance production of cashmere and mohair. The scale and value of this genetic transfer have not been quantified.

There is a strong demand for goats as a carcase meat in countries with a large Indian population or countries with strong trading ties with the Indian subcontinent, such as the United Arab Emirates and Oman. Significant numbers of goats are imported into these countries from the Indian subcontinent, from the Syrian and Turkish regions, and recently, from Australia (Hughes 1987). These markets require live goats that are even in type and weight, producing carcase weights in the 16–22 kilogram range.

A few domestic goats are exported for breeding, but export of live feral goats for slaughter at overseas abattoirs represents the largest volume of trade in live goats from Australia. Export of live goats has flourished since the early 1980s (table 11.3



and figure 11.3), although there has been significant variations in demand within and between markets. Around 70 000–80 000 goats worth $2–4m are now shipped annually. Inclusion of domestic breeding goats in the trade statistics complicates interpretation of the unit value of goats exported.

The United Arab Emirates is the most important buyer of live goats (for slaughter) from Australia, although Oman, Bahrain and Malaysia are of growing importance. Live goats of the type and weight required can attract premium prices, and it is sometimes viable to send air shipments of quality goats for slaughter to markets in the Middle East and Asia. However, most feral goats are exported by ship.

Skins and leather

The goat skin and leather industry is a by-product of the goat meat industry. In 1990, world goat skin production amounted to 481 785 tonnes, with about 95 per cent of these skins being produced in developing countries (FAO 1991). Developed countries have traditionally purchased most goat skins traded on international markets (FAO 1970; De Boer 1982; Figueiredo et al. 1982). India, Pakistan and China are the major exporters of goat skins, and Italy, Spain, Sweden and Germany are important buyers of goat skins.

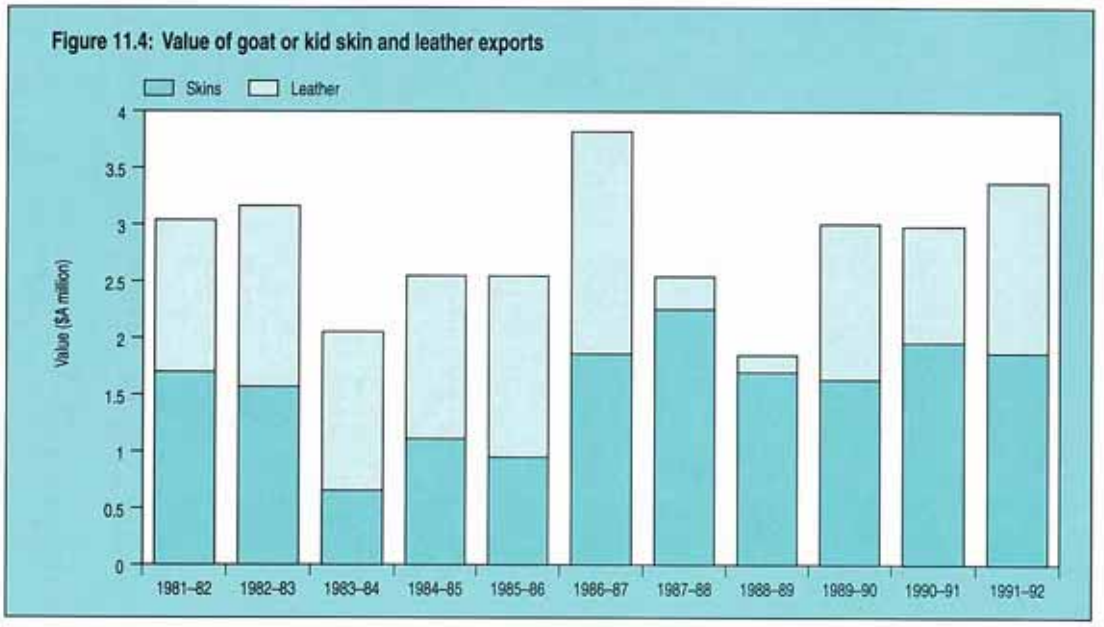
Most goat skins are used as leather, and the fibre on the skin is of no value. Roughly 60–70 per cent of tanned goat and kid skins are used as upper material for shoes (FAO 1970; De Boer 1982). In addition, extensive use is made of these leathers in the manufacture of fancy goods, bookbinding, clothing, and women's dress gloves. In developing countries, the skins are also used as water containers, tents or mats.

The supply of goat skins in Australia depends on the demand for meat, as is true in other parts of the world. If all skins were used after slaughter, production of goat skins in Australia could have reached over one million in the financial year 1991–92 (table 11.2). However, where abattoirs slaughter goats infrequently, it appears that most skins are dumped (Australian Meat and Livestock Industry Policy Council 1988). Further, defects in the skins lead to rejects and downgrading. The skin can be damaged during the life of the goat, and during flaying, preservation, transport and tanning

Table 11.3: Destination, number and value of live goats (excluding angora) exported from Australia (all values are in Australian dollars)

DESTINATION		1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91	1991–92
BAHRAIN	*NUMBER*	0	0	0	0	0	0	937	994	26 162	16 262	0
	VALUE ($)	0	0	0	0	0	0	25 135	24 611	409 655	195 177	0
MALAYSIA	*NUMBER*	0	1 339	151	820	32	5 115	1 557	988	4 893	6 083	10 898
	VALUE ($)	0	43 000	55 828	41 000	13 897	215 985	90 743	35 777	147 776	276 471	357 348
OMAN	*NUMBER*	0	4 500	0	0	420	7 937	18 433	18 704	8 216	17 075	500
	VALUE ($)	0	99 000	0	0	17 140	223 152	581 128	508 566	201 326	282 502	12 000
SAUDI ARABIA	*NUMBER*	400	0	0	0	21 755	5 528	1 950	2 010	0	0	0
	VALUE ($)	6 800	0	0	0	740 375	152 063	58 539	57 929	0	0	0
SINGAPORE	*NUMBER*	0	0	112	30	117	2 224	917	396	570	0	900
	VALUE ($)	0	0	2 937	810	3 911	54 079	46523	27 382	13703	0	34 141
UNITED ARAB EMIRATES	*NUMBER*	0	15 897	0	817	2 095	14 860	44 438	57 306	193 843	26 259	45 480
	VALUE ($)	0	441 000	0	20 698	68 059	476 349	1 809 898	2 864 657	2 249 414	723 467	950 677
OTHER	*NUMBER*	6	6 474	811	1 425	1 249	2 914	2 142	1 147	10 674	6 501	23 769
	VALUE ($)	900	475 000	82 621	73 787	1 231 098	2 696 988	418 618	316 266	352 440	674 177	2 391 456
TOTAL	***NUMBER***	**406**	**28 210**	**1 074**	**3 092**	**25 668**	**38 578**	**70 374**	**81 545**	**244 358**	**72 180**	**81 547**
	VALUE ($)	**7 700**	**1 058 000**	**141 386**	**136 295**	**2 074 480**	**3 818 616**	**3 030 584**	**3 835 188**	**3 374 314**	**2 151 794**	**3 745 622**

Source: Australian Bureau of Statistics (all values in current dollars) Australian Harmonised Commodity Classification 01042090 (Live goats, excluding angora)



(Standing Committee on Agriculture 1982; Figueiredo et al. 1982). The main causes of skin defects are:

- mechanical damage to live goats, such as wounds, scratches, brands and the action of ectoparasites such as ticks;
- skin diseases, either parasitic or fungoid in origin;
- damage at slaughter due to careless flaying. Skin wastage of 40 per cent occurs at some Australian abattoirs through excessive slash cuts (Australian Meat and Livestock Industry Policy Council 1988); and
- poor preservation and storage from slaughter to processing which leads to bacterial and insect damage.

There is no information on the size and value of the trade in goat leather within Australia. Most goat skins produced are exported as semi-processed (mostly pickled) skins or finished leather (Australian Meat and Livestock Industry Policy Council 1988). In 1991–92, exports of fresh, salted, dried, limed or pickled goat skins amounted to almost 1700 tonnes, valued at $1.9m or $1.13 per kilogram (table 11.4).

The value of goat leather exports varied between $1–2m per annum over the past decade (table 11.4 and figure 11.4), except in 1987–88 and 1988–89 when exports were worth less than $0.5m. Trade recovered in 1990–91, and 42 197 square metres of leather valued at $1.03m were exported. Exports continued to increase in 1991–92 when over 75 000 square metres of leather worth $1.5m were shipped. The cause of the apparent crash in Australia's exports of goat leather is unclear, but the crash coincides with a change of the statistical classification system used for commodity exports. This raises the possibility that the variation may be due to an anomaly in data collection.

Leather produced from Australian feral goat skins is comparable to that produced from domestic goat skins. The physical properties of the leather, such as tensile strength and elasticity, are of commercial standard (Holst et al. 1987). Similarly, leather from feral goat skins can have desirable aesthetic qualities, such as a fine grain appearance. Skins from young goats have a high follicle density and low fibre diameter, which means that they are aesthetically acceptable (Holst et al. 1989). Animals weighing less than 25 kilograms produce a fine grained skin, which attracts premium prices (Holst et al. 1987).

There are several trends that will influence the future viability and direction

Table 11.4: Quantity and value of goat and kid skin exports, including leather 1981–82 – 1991–92 (all values are in Australian dollars)

PRODUCT		1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91	1991–92
SKINS												
FRESH, SALTED, DRIED	kg	475 108	750 935	524 164	1 083 652	448 290	893 100	955 450	944 624	1 202 562	1 498 440	1 672 337
LIMED OR PICKLED	$	1 700 668	1 566 000	655 217	1 129 889	954 564	1 876 705	2 274 263	1 710 841	1 647 423	1 972 432	1 885 227
	$/kg	3.58	2.09	1.25	1.04	2.13	2.10	2.38	1.81	1.37	1.32	1.13
LEATHER												
KID AND SUBSTITUTES	SM	85 849	101 114	87 959	81 578	74 809	78 756	3 866	-	-	-	-
(a)	$	1 321 400	1 554 000	1 357 038	1 397 980	1 593 911	1 925 100	96 022	-	-	-	-
	$/SM	15.39	15.37	15.43	17.14	21.31	24.44	24.84	-	-	-	-
OTHER (INCLUDING	SM	2 352	2 438	12 458	12 703	253	6 390	250	-	-	-	
CRUST, ROUGH TANNED	$	24 429	33 000	32 202	36 314	1 265	39 043	3 000	-	-	-	
AND SUEDE) (a)	$/SM	10.39	13.54	2.58	2.86	5.00	6.11	12.00	-	-	-	
VEGETABLE	SM	-	-	-	-	-	-	1 507	51	10 581	744	2 066
PRE-TANNED (b)	$	-	-	-	-	-	-	55 320	1 350	158 269	15 292	69 156
	$/SM	-	-	-	-	-	-	36.71	26.47	14.96	20.55	33.47
OTHERWISE	SM	-	-	-	-	-	-	4 071	0	4 591	963	3 584
PRE-TANNED (b)	$	-	-	-	-	-	-	53 717	0	55 599	43 373	107 177
	$/SM	-	-	-	-	-	-	13.2	0	12.11	45.04	29.9
OTHER (b)	SM	-	-	-	-	-	-	2 373	5 209	16 056	12 090	31 305
	$	-	-	-	-	-	-	65 680	119 641	274 709	296 348	266 092
	$/SM	-	-	-	-	-	-	27.68	22.97	17.11	24.51	8.50
PARCHMENT DRESSED	SM	-	-	-	-	-	-	316	1 689	33 574	28 400	38 613
OR PREPARED AFTER	$	-	-	-	-	-	-	11 609	25 984	878 233	670 107	1 054 573
TANNING (b)	$/SM	-	-	-	-	-	-	36.74	15.38	26.16	23.60	27.31
TOTAL LEATHER	SM	88 201	103 552	100 417	94 281	75 062	85 146	12 383	6 949	64 802	42 197	75 568
PRODUCTION	$	1 345 829	1 587 000	1 389 240	1 434 294	1 595 176	1 964 143	285 348	146 975	1 366 810	1 025 120	1 496 998
	$/SM	15.26	15.33	13.83	15.21	21.25	23.07	23.04	21.15	21.09	24.29	19.81
TOTAL VALUE ALL PRODUCTS	$	**3 046 497**	**3 153 000**	**2 044 457**	**2 564 183**	**2 549 740**	**3 840 848**	**2 559 611**	**1 857 816**	**3 014 233**	**2 997 552**	**3 382 225**

Source: Australian Bureau of Statistics

(a) Export statistical items under Australian Export Commodity Classification number 611.61 — valid to and including December 1988

(b) Export statistical items under Australian Harmonised Export Commodity Classification number 4106 — valid from and including January 1988 (values in current dollars) SM = Square metres

of the Australian goat skin industry. These are:

- increasing competition from suppliers in developing countries, where labour costs are low;
- increasing competition from substitute materials including synthetics and other types of leather;
- continually changing fashions, which influence the quantity and type of leather demanded by consumers;
- growth in consumption of goat leather will continue to be associated with high income-earners living in developed countries; and
- increasingly stringent effluent discharge and air pollution regulations in Europe and the United States of America are causing supply countries to tan a greater proportion of goat skins before export.

To remain competitive in this changing world market, the Australian industry must be flexible enough to respond and adapt to changing patterns of consumer demand.

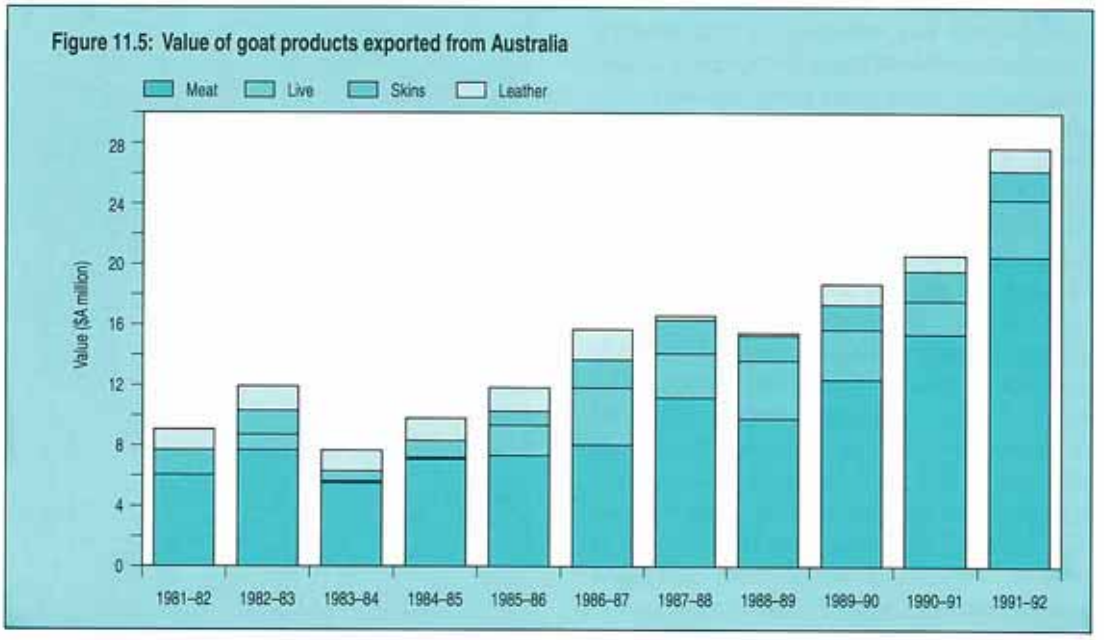
Fibre

Feral goats are an important genetic resource for Australia's goat fibre industries. However, goat fibre production is primarily associated with domesticated goats, and is not examined in detail here.

Feral does with potential for fibre production are purchased by goat breeders in Australia. The commercial potential of feral goats for fibre production varies between regions (Standing Committee on Agriculture 1982). A study in Western Australia (Johnson 1985) found that at least 30 per cent of feral goats could produce commercial quantities of cashmere. Restall (1982) found that 90 animals (72 per cent) from a herd of 125 unselected feral does from western New South Wales had commercially recoverable down.

Cashmere fibre is prized for its great softness, lightness and warmth, which result from its extremely fine fibre diameter. It is spun into very fine yarns used to produce luxury knitwear. The broadest fibre diameter acceptable as cashmere is 18.5 microns, and a premium is paid for average diameters less than 16.5 microns. In 1990, cashmere fibre less than 16.5 microns was valued at around $147 per kilogram (Cribb 1991). An analysis of the fleece characteristics of 418 unselected feral goats (does) from New South Wales found that the average diameter of cashmere down was 15.4 microns (Restall 1985).

Figure 11.5: Value of goat products exported from Australia



Cashmere exports from the world's largest producer, China, have tended to decline over the past two decades. Therefore, fibre processors in the United Kingdom, Italy and the United States of America have looked to Australia and New Zealand to supply fibre (Restall 1985). Australia's feral goats produce significant amounts of high quality cashmere, and were the foundation of this new industry.

The angora mohair industry has the highest value of production of all Australian goat industries, and mohair production reached about 1000 tonnes in 1989 (Cribb 1991). Feral goats were, and to a limited extent still are, used to provide the foundation stock for angora goat upgrading programs. Pure bred angora bucks are crossed with feral does, and the progeny are also crossed with pure bred angora to produce a three-quarter type. This process is continued until the fifth cross, which is regarded as a pure angora goat. Low numbers and high prices for pure bred stock were a stimulus for this process of 'breeding up' angoras from feral stock.

Value of feral goat industry

It is not possible to determine the precise value of production from commercial use of feral goats in Australia. Products from the extensive and expanding domestic goat herds are included in trade statistics, which complicates any estimate of the relative contribution of feral goats to total production. Nonetheless, feral goats predominate in the production of meat, skins, and export of livestock for slaughter. Further, Australia's goat fibre industries largely owe their existence to the genetic contributions of feral stock. The gross value of the goat fibre industries is difficult to estimate.

However, the quantity and value of exports of meat, skins, leather and livestock (excluding export of angoras) are available (table 11.5). The total export value of products has increased from $9.2m in 1981–82, to $27.5m in 1991–92. This growth is largely due to expansion in meat exports (figure 11.5), which amounted to $20.4m in 1991–92. There are prospects for continued growth in the export of these products.

Table 11.5: Value of goat products exported from Australia (all values are in Australian dollars)

YEAR	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91	1991–92
MEAT	6 153 849	7 897 000	5 643 823	7 175 511	7 473 315	8 210 967	11 439 371	9 953 938	12 616 420	15 627 212	20 353 865
LIVE*	7 700	1 058 000	141 386	136 295	2 074 480	3 818 616	3 030 584	3 835 188	3 374 314	2 151 794	3 745 622
SKIN	1 700 668	1 566 000	655 217	1 129 889	954 564	1 876 705	2 274 263	1 710 841	1 647 423	1 972 432	1 885 227
LEATHER	1 345 829	1 587 000	1 389 240	1 434 294	1 595 176	1 964 143	285 348	146 975	1 366 810	1 025 120	1 496 998
TOTAL	**9 208 046**	**12 108 000**	**7 829 666**	**9 875 989**	**12 097 535**	**15 870 431**	**17 029 566**	**15 646 942**	**19 004 967**	**20 776 558**	**27 481 712**

Source: Australian Bureau of Statistics (all values are in current dollars)

* Refers to live goats excluding angoras

Disease

An abattoir survey of feral goats in South Australia (Hein & Cargill 1981) showed a low incidence of disease, as compared to domestic livestock.

The most significant zoonosis of feral goats is a rickettsial disease, *Coxiella burnetii*, which causes Q fever. *Coxiella burnetii* is common in sheep, cattle and feral goats, and Q fever is an occupational disease, particularly in the meat industry (Stevenson & Hughes 1988).

Feral goats are susceptible to several exotic diseases that can infect domestic livestock, such as foot-and-mouth disease and bluetongue, and could act as a reservoir for these diseases (Murray et al. 1976; O'Brien 1989).

Pest control

Western Australia is the only State in Australia where feral goats are declared as pests. Landowners in all States and Territories are responsible for controlling feral goat populations on their land. Staff from State or Territory agencies responsible for pest management provide landowners with technical advice on control of feral goats. There are several methods of killing or capturing feral goats (King 1990; Parkes 1990b).

Three harvesting tactics are specifically associated with goat control, and animals killed are not used. Firstly, shooting from helicopters can be a very effective way of killing goats, but the costs are high (Parkes 1990b). Secondly, the 'Judas' goat technique involves using radio tracking equipment and goats to locate other feral goats (Taylor & Katahira 1988). Goats are fitted with a collar and radio transmitter and released. Within a few days, they join feral goat groups, which are then located and shot. This is a cost-effective way of locating remnant feral goats.

Finally, poisoning foliage using 1080 has been used to kill feral goats in New Zealand (Parkes 1990b). Poison is seldom used for goat control in Australia due to their large-scale movements and the hazard posed to non-target species (King 1990). There is little quantitative data on the number killed and the costs (or benefits) of control using these techniques. Eradication of widespread populations of feral goats is not a realistic management option, but it is feasible to attempt eradication of island populations (Parkes 1990a).

Feral goats are also removed in pest control campaigns by using ground-based shooters, and by trapping or mustering (King 1990). Ground shooting by recreational hunters and professional shooters supplying the game meat trade is significant, but the impact of recreational hunters is poorly quantified. Like commercial harvesters, pest control programs tend to target high density accessible goat populations. Therefore, there is potential for overlap in hunting effort in some regions, and pest control activities could increase the costs of supplying the market.

Constructing traps around water holes can be an effective way of capturing feral goats during periods of drought. Mustering in open country using dogs and motorbikes is also a very efficient way of capturing large numbers of feral goats. The benefit of trapping and mustering is that captured goats can be sold. Therefore, many farmers manage feral goats to harvest them each year and supplement farm income. The volatility of the markets for goats can complicate the use of this strategy to manage feral goat numbers.

The number of goats killed for pest control would vary widely between years, depending on the commercial value of goats, the size of goat populations, and on the resources available to pest control agencies and landowners.

Discussion

Australia's feral goats have provided the foundation for new and substantial industries based on sale of meat, fibre and skins. Feral goats are relatively free of disease; are well adapted to the Australian environment; have carcase, fibre and skin qualities that appeal to consumer markets; and the capital costs of harvesting goats are low compared with farming.

Goats are now proportionally the fastest growing extensive livestock industry in Australia, generating over $30m annually in exports, and offering a sound option for diversification in the rural sector (Cribb 1991). However, several factors are impeding the development of the feral goat industry.

(a) Irregular supply and demand

Unpredictable rainfall patterns cause difficulties in capturing the required number and type of feral goats. Catching operations are usually more cost-effective when feed and water become limited during the dry season, when goats tend to form larger herds.

The uncertain supply of goats can create problems in matching slaughterhouse capacity, shipping capacity and seasonal demand patterns. Many export markets for goat meat and live goats are highly seasonal.

(b) Variable type

Feral goats are unhusbanded, and it is difficult to supply animals of the age, type and condition required by the market. The catch is highly variable, and can include valuable does with potential for fibre production, aged bucks weighing 40 kilograms with little value, or kids under 8 kilograms with high value.

The difficulties are obvious when, for example, an abattoir or live goat dealer contracts to supply a large quantity of lean healthy goats that would dress between 14 and 20 kilograms. In supplying this order, many goats that did not meet the buyer's criteria would also be captured. This complicates efficient trade in feral goats.

(c) Slaughter capacity

As discussed previously, there are few specialised goat abattoirs in Australia. Many goats are slaughtered as a 'fill in', when the season on sheep and lamb meat closes. Opportunistic processing of goats is a mechanism to reduce variable costs of operating an abattoir. However, production capacity may not match market demand patterns, and at certain times of the year demand may not be met due to inadequate slaughter capacity.

(d) Pest control

The commercial harvest of feral goats has greater impact on feral goat numbers than any other form of control. Commercial harvesting is also inherently cost-effective, and generates useful income to landowners. However, the commercial harvest is not formally integrated with goat control programs, thus reducing options for more cost-effective management of goat populations.

Parkes (1990b) concluded in a paper on feral goat control in New Zealand that 'a general policy to eradicate all herds is futile'. Any attempt to eradicate feral goats from mainland Australia is also likely to be futile.

Many of these problems could be overcome by the development of goat farming industries with the explicit objective of supplying goat products to match consumer requirements. Nonetheless, goat meat and fibre industries will continue to depend on feral stock for products and to bolster genetic material.

Game meat from field-shot wild goats could attract lower tariffs in overseas markets than meat from goats slaughtered at an abattoir. Opportunities for developing the export of game meat from wild goats have not been fully exploited.

Attempts to eradicate feral goats are likely to be futile and counterproductive. There is a need for management strategies to boost goat control in environmentally sensitive regions, while stimulating demand for goat products and thereby expanding the scale and range of the commercial harvest. Better market intelligence, improved market penetration and diversification, and an expansion of (or more timely) slaughter capacity would all contribute to the development of a commercially attractive industry that offers the added benefit of cost-effective control of feral goat populations.

12 FERAL HORSE

Distribution and abundance

Domestic horses *(Equus caballus)* were introduced to Australia by the early European settlers. Horses were bred in large numbers for transport and draft, as well as for stock work and military and police use. Records of domestic horses being abandoned or escaping to the wild date from 1804 (Rolls 1969). However, herds of feral horses (known as brumbies) were not widely reported as pests until the late 1860s (Rolls 1969; Long 1988).

Today, feral horses are common and widely distributed in central and northern Australia. A small population also exists in the mountainous regions of southern New South Wales (Gooding 1983) and there are isolated mainland and island populations elsewhere, such as on Moreton and Fraser Islands, Queensland (Wilson, Dexter, O'Brien & Bomford 1992).

The number of feral horses in Australia is unknown, but the largest populations occur in the Northern Territory. An aerial survey in the Northern Territory in 1984 (Graham et al. 1986) estimated the feral horse population as 82 032 in the Alice Springs region and 30 100 in the gulf region. Feral horse numbers in the arid zone vary significantly with environmental conditions. Thousands of feral horses die when food and water diminish during prolonged droughts in Central Australia (Letts et al. 1979).

Feral horses make use of watering points provided for stock and compete with cattle for fodder (Berman & Jarman 1987). However, there is little quantitative data on environmental damage they cause. This is because it is difficult to separate damage caused by horses from that caused by cattle. Nonetheless, horses can travel further from watering points and graze hilly areas where cattle cannot traverse. In addition, their grazing pressure is not managed like that of cattle (Berman & Jarman 1988). As a result, feral horse populations are culled at varying levels across their range to control the damage they cause.

Status

Feral horses are not protected and landowners throughout Australia are responsible for controlling their numbers. Further, feral horses in national parks and reserves are regarded as environmental pests. Most State or Territory pest control agencies provide advice to land managers on how to reduce feral horse populations.

Commercial use of horses

Feral horses have been killed and used for commercial purposes since at least the 1860s; they were shot for hides and hair. In 1869, horse hides sold for 4 shillings and sixpence per pound (Rolls 1969). Today, commercial use of feral (and domestic) horses in Australia is for the production of pet meat, meat for human consumption, and hides and hair for domestic and export markets.

Pet meat—Domestic market

Horse meat can be sold as pet food in all States and Territories of Australia. The pet meat processors are licensed by the State or Territory authorities responsible for regulating the meat industry. Horse pet meat can be produced from field slaughtered animals, or from animals slaughtered at a licensed knackery. Legislation in individual States and Territories controls which method can be used.

Field slaughtering of feral horses is only permitted in Western Australia and the Northern Territory. Hunters must have the permission of the landowner, and all animals are killed by shooting with a large calibre rifle. Often, horse shooters are also involved in hunting buffalo, donkeys or camels for pet food.

The most common hunting technique is to shoot the horses as they come to water. The carcase is then boned out, and the meat is placed in a refrigerated box at the shooters camp and later transported to processing plants for packing and sale. Alternatively, the carcases are quartered in

the field and boned out at the processing plant. The average meat yield using these methods is roughly 110 kilograms per horse. Processors paid shooters about $0.85 cents per kilogram for boneless meat in 1991, yielding a gross return of about $95 per horse for shooters.

The Northern Territory Department of Primary Industry and Fisheries recorded that 1884 horses were slaughtered for pet meat in 1989. The number killed in Western Australia is unknown.

Domestic horses are slaughtered for pet meat at licensed knackeries in Queensland, New South Wales, Victoria, Western Australia and South Australia. A few feral horses are also processed in this way, particularly in Queensland. The animals are mustered into yards, or trapped using enclosures around watering points. Captured horses are transported by truck to the knackery for slaughter.

The number of horses slaughtered at knackeries in Victoria and South Australia is unknown, and records in Queensland and New South Wales are incomplete. The Queensland Department of Primary Industries recorded that 3728 horses were slaughtered in the State in 1988. In New South Wales, the Australian Quarantine and Inspection Service recorded that 5523 horses were killed in 1988 and 5790 were killed in 1989. The number killed for pet meat in Australia is likely to be more than 10 000 animals per year.

Horse meat is sold for pet food (in Australia) as a fresh or frozen product. The wholesale value varies between $1.10 and $2.00 per kilogram, depending on the quantity ordered and the packing required. Horse meat is not used by pet food canneries in Australia.

Pet meat—Export markets

Horse pet meat is exported almost exclusively to Japan where it is primarily used by animal parks to feed carnivores. The Northern Territory and Western Australia are the major exporters of horse pet meat. The volume of exports to Japan has declined in recent years as Australian exporters have lost market share to suppliers from Argentina, North America and China.

Australian exporters argue that the loss of market share for horse pet meat is not a function of price but of market preference. Under the *Export Control Act 1982*, which is administered and enforced by the Australian Quarantine and Inspection Service (AQIS), all exports of pet meat from Australia must be stained with brilliant blue dye. Japanese importers object to the blue dye. Only Australia and the United Kingdom require exporters to stain pet meat, resulting in a market advantage for competitors supplying markets such as Japan. However, AQIS have recently allowed the export of unstained pet food to heat processors (i.e. canneries) where the importing country approves this import.

The size of the export trade in horse pet meat has not been accurately quantified. However, trade sources have indicated that during the past five years exports peaked in 1988, when at least 600 tonnes of horse pet meat was shipped to Japan. This equates to about 5000–6000 horses. The average value of the meat exported, including costs and freight, was about $1.55 per kilogram. Therefore, horse pet meat exports were worth at least at least $0.8m in 1988.

Horses in the Tennant Creek and Alice Springs area of the Northern Territory are known to develop a neurological syndrome termed Birdsville horse disease. It occurs due to consumption of a native legume, *Indigofera linnaei*, which leads to a build-up of indospicine poison in the meat. Horse meat that is contaminated with indospicine causes fatal liver disease in dogs (Hegarty et al. 1988). Consequently, horses from areas where *Indigofera linnaei* is distributed cannot be used to produce pet meat.

The number of horses available to pet meat processors has declined over the past decade due to competition for stock from processors exporting for human consumption.

Table 12.1: International trade in horse meat — tonnes imported

YEAR	IMPORTING COUNTRY JAPAN	BELGIUM/ LUXEMB'G	FRANCE	NETHER- LANDS	ITALY	REST OF WORLD	TOTAL
1978	62 290	39 293	54 310	34 330	9 095	8 558	207 876
1979	64 503	36 209	57 462	34 886	9 797	10 330	213 187
1980	51 418	35 097	57 348	32 592	11 304	7 573	195 332
1981	52 887	31 238	55 103	30 654	9 195	6 398	185 475
1982	48 261	30 009	50 349	31 158	8 535	5 744	174 056
1983	42 120	30 113	46 606	26 535	8 994	4 425	158 793
1984	40 026	27 419	42 567	27 366	6 969	4 680	149 027
1985	39 040	28 625	37 280	23 533	9 992	4 946	143 416
1986	34 466	31 296	34 943	24 206	10 672	8 042	143 625
1987	32 387	35 794	45 304	25 672	12 751	9 392	161 300
1988	35 643	34 980	44 192	25 845	16 257	15 405	172 322

Source: FAO 1980, 1983, 1985, 1988

Meat for human consumption

World production of horse meat for human consumption amounted to about 463 000 tonnes in 1988 (FAO 1989), which equates to over 1 million horses. However, world imports of horse meat in 1988 amounted to only 172 322 tonnes, valued about $497m. The leading importer regarding quantity was France (44 192 tonnes), followed by Japan (35 643 tonnes), Belgium/Luxembourg (34 980 tonnes), the Netherlands (25 845 tonnes) and Italy (16 257 tonnes). These five countries absorb over 90 per cent of horse meat traded internationally (table 12.1 and figure 12.1).

International trade in fresh or frozen horse meat is segmented into either lower grade meat used for manufacturing or prime cuts for retail sale. Japan and the Netherlands

Figure 12.1: The international trade in horse meat — tonnes imported

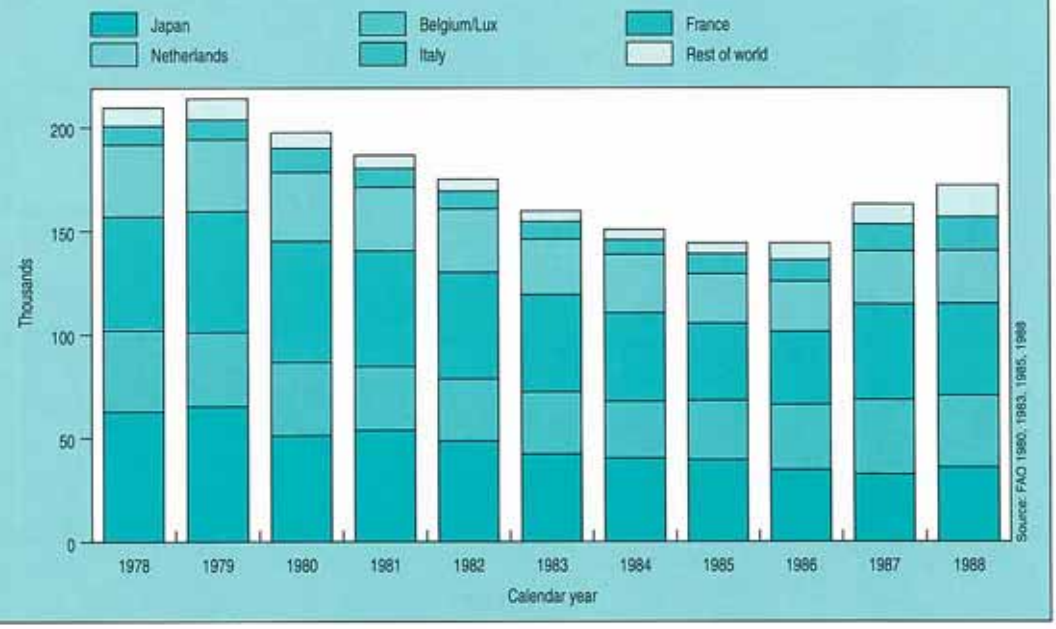


Table 12.2: International trade in horse meat — tonnes exported

CALENDAR YEAR	EXPORTING COUNTRY					
	AUSTRALIA	CANADA	ARGENTINA	USA	REST OF WORLD	TOTAL
1978	85	16 049	43 162	54 986	93 129	207 411
1979	55	16 429	44 196	54 182	86 041	200 903
1980	571	15 102	32 669	55 269	88 135	191 746
1981	7 777	13 802	32 420	42 498	84 067	180 564
1982	7 589	12 109	41 992	31 554	74 166	167 410
1983	8 344	9 250	43 438	23 221	70 323	154 576
1984	7 474	11 726	36 999	22 933	67 805	146 937
1985	8 021	12 594	33 895	19 804	60 342	134 656
1986	9 327	17 268	28 651	29 398	46 577	131 221
1987	9 306	20 172	29 180	41 119	42 222	141 999
1988	9 000	23 306	37 335	51 864	40 031	161 536

Source: FAO 1980, 1983, 1985, 1988

primarily import frozen manufacturing grade meat, which is used in preparing smoked meats, sausages and meatballs. France, Italy and Belgium/Luxembourg mostly import higher value fresh prime cuts (by air freight) for retail sale (Lopes-Bragga 1983).

The United States of America, Argentina and Canada are the major exporters of horse meat, although Poland and Australia also export significant quantities (table 12.2 and figure 12.2). There are marked differences in the composition of trade between major exporters and importers. Argentina and Australia primarily supply the lower value Japanese market for frozen manufacturing meat. By comparison, the USA and Canada primarily supply the higher value European market for fresh prime cuts.

Horse meat consumption is increasing in some countries, such as France and Italy, although retail prices are similar to that for beef (Staun et al. 1982). This suggests that

Figure 12.2: The international trade in horse meat — tonnes exported

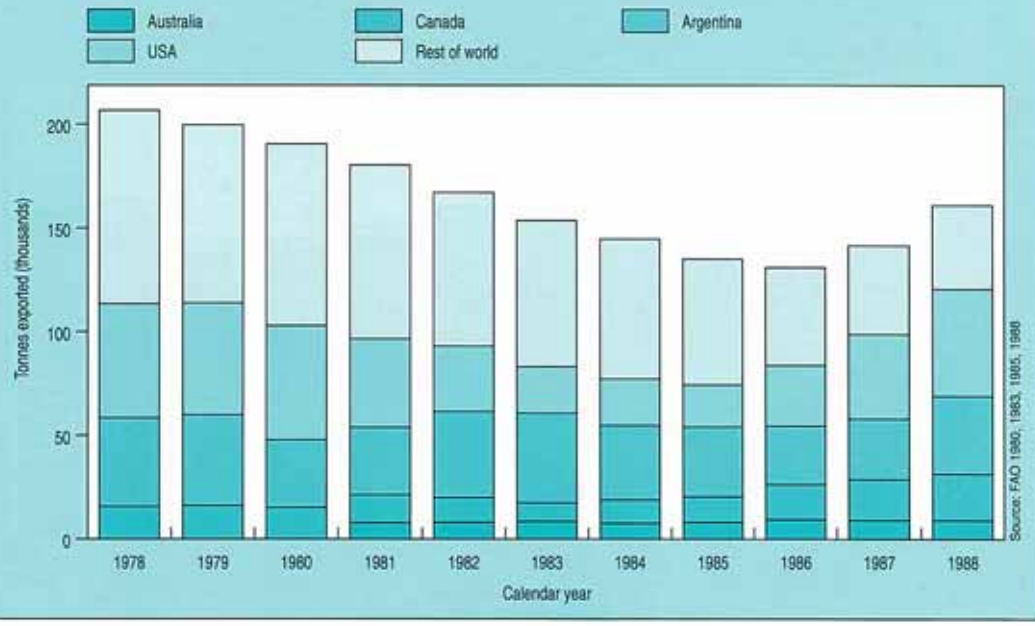


Table 12.3: Quantity and value of horse meat exported from Australia 1978–79 – 1990–91

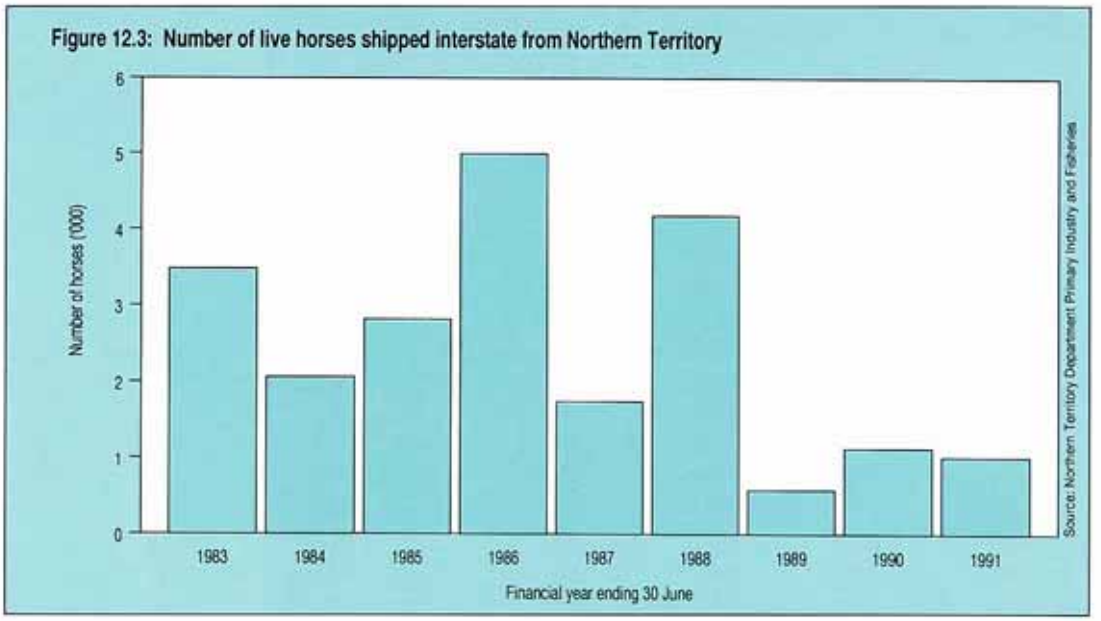
	QUANTITY (TONNES)	VALUE $	PRICE $/kg	NUMBER OF COUNTRIES	QTY (%) EXPORTED
1978–79	55.3	21 000	0.38	1	100
1979–80	571	1 028 000	1.8	4	57.8
1980–81	7 777	12 371 000	1.59	12	53.3
1981–82	7 589.5	11 809 448	1.56	6	74.6
1982–83	8 344.2	14 224 000	1.7	6	58
1983–84	7 473.6	12 319 790	1.65	7	68.6
1984–85	8 021.3	13 755 565	1.71	10	72.5
1985–86	9 326.8	17 900 286	1.92	9	71.8
1986–87	9 306.2	18 401 000	1.98	11	59.5
1987–88	7 912.6	16 683 466	2.11	13	54.9
1988–89	6 649	13 214 620	1.99	12	60
1989–90	7 531	18 045 674	2.4	13	60.5
1990–91	7 622.3	18 767 126	2.46	12	53.2
1991–92	8 849	23 754 509	2.68	12	45.8

Source: Australian Bureau of Statistics (all values in current dollars)

Table 12.4: Destination, quantity and value of horse meat exported from Australia (values in Australian dollars)

DESTINATION		1985–86	1986–87	1987–88	1988–89	1989–90	1990–91	1991–92
BELGIUM/ LUXEMB'G	kg	1 345 058	1 636 424	1 840 949	1 228 217	1 192 027	1 722 394	1 739 443
	$	3 754 849	4 224 951	5 110 953	3 441 116	4 138 260	6 575 824	6 876 138
	$/kg	2.79	2.58	2.78	2.80	3.47	3.82	3.95
FRANCE	kg	427 244	239 770	0	89 936	274 560	8 351	295 428
	$	1 229 179	711 050	0	274 907	1 232 450	66 522	1 591 036
	$/kg	2.88	2.97	0	3.06	4.49	7.97	5.39
ITALY	kg	21 878	245 054	331 877	234 407	0	37 357	93 043
	$	53 895	842 030	1 111 996	761 005	0	187 285	482 713
	$/kg	2.46	3.44	3.35	3.25	0	5.01	5.19
JAPAN	kg	6 700 785	5 536 305	4 346 514	3 991 460	4 559 418	4 053 131	5 463 936
	$	10 456 722	8 917 722	6 593 060	5 994 362	7 948 302	6 795 964	9 889 328
	$/kg	1.56	1.61	1.52	1.50	1.74	1.68	1.81
NETHERLANDS	kg	778 070	30 850	627 997	439 556	547 079	903 687	474 689
	$	2 253 522	92 830	1 506 839	702 498	1 022 412	1 521 967	827 022
	$/kg	2.90	3.01	2.40	1.60	1.87	1.68	1.74
OTHER	kg	53 726	1 617 784	765 290	665 412	957 918	897 354	782 786
	$	152 119	3 612 417	2 360 618	2 040 732	3 704 250	3 619 564	4 088 272
	$/kg	2.83	2.23	3.08	3.07	3.87	4.03	5.22
TOTAL	kg	9 326 761	9 306 187	7 912 627	6 648 988	7 531 002	7 622 274	8 849 325
	$	17 900 286	18 401 000	16 683 466	13 214 620	18 045 674	18 767 126	23 754 509
	$/kg	1.92	1.98	2.11	1.99	2.40	2.46	2.68

Source: Australian Bureau of Statistics (all values in current dollars)



some consumers prefer horse meat for its intrinsic qualities and will continue to buy it instead of substitute products such as beef.

Horse meat can only be sold for human consumption in Australia in the Northern Territory. However, none has been sold so far. The reasons for non-consumption in the Northern Territory are unclear. However, the reasons for non-consumption in France, a major consumer market for horse meat, include symbolism (i.e. friend of Man), individual taste preferences, legislative restrictions on distribution and inefficient distribution networks (Martin-Rosset 1987). Nonetheless, horse meat is low in fat—a product characteristic that could be used to advantage when promoting the meat to increasingly health-conscious consumers.

Exports of horse meat for human consumption from Australia began in the late 1970s (table 12.3) and developed rapidly to remain relatively stable at around 8000–9000 tonnes per annum. In 1991–92, a total of 8850 tonnes of horse meat worth $23.8m were exported from Australia.

Japan has been the major importer of the Australian product, taking 55–75 per cent annually of all horse meat produced for export. However, Australian exporters have penetrated other markets (table 12.4) and now service about 12 countries. Diversification into new markets helps the stability of the horse meat industry in Australia.

Since the inception of the horse meat export industry in Australia, several abattoirs have experimented with processing and exporting horse meat. However, in 1992 only two export abattoirs were processing horses on a regular basis—one in Queensland and one in South Australia. An abattoir in the Northern Territory processes horses on an ad hoc basis. The commercial viability of processing horses depends on a continuous supply of quality animals for slaughter. Supply has been a problem at times and one company has attempted to address this problem by getting a dual licence, which allows cattle to be processed when horses are unavailable.

The relative proportion of feral and domestic horses killed at export abattoirs is unknown. However, an indication of the scale of feral horse use can be gleaned from records held by the Northern Territory Department of Primary Industry and Fisheries, which monitors interstate transport of live horses. Since 1982–83, interstate shipments of horses from the Northern Territory have varied considerably (figure 12.3), peaking at 4968 in 1985–86 and falling as low as 574 in 1988–89. Note that these

Table 12.5: Number of horses slaughtered at all export abattoirs in Australia

TIME PERIOD	CALENDAR YEAR 1987	1988	1989	1990	1991	1992
JAN–MAR	13 498	12 020	8 637	-	-	-
APR–JUN	17 662	11 338	10 591	22 333*	-	-
JUL–SEP	15 037	10 088	10 793	-	-	-
OCT–DEC	13 724	12 031	11 217	24 580*	-	-
TOTAL	59 921	45 477	41 238	46 913	49 161	47 333

Data supplied by the Australian Quarantine and Inspection Service. *Six month total

figures could include some domestic horses and some animals which may not be destined for slaughter. Nonetheless, this supports estimates that less than 30 per cent of horses slaughtered at export abattoirs are feral (Senate Select Committee on Animal Welfare 1991).

The availability of feral horses from Central Australia is likely to be seasonal. Feral horses are more likely to be captured during the dry season (May to September) when populations congregate near scarce water and feed. High offtake from the readily accessible regions and drought can reduce the number of horses available. Superimposed on these factors is an increased availability of domestic horses from the racing and leisure horse industries. Therefore, domestic horses are likely to remain the most important source of animals for slaughter at export abattoirs.

Supply of feral horses is maintained by mustering using vehicles or helicopters, or by trapping at watering points. The average farm gate value of these horses was about $100–120 in 1991, excluding transport costs. Captured horses are transported to an export abattoir and then slaughtered under the supervision of inspectors from the Australian Quarantine and Inspection Service.

There are animal welfare and stock quality concerns associated with capturing (McCool 1981) and transporting feral horses (Pilkington & Wilson 1990; Senate Select Committee on Animal Welfare 1991). Care is needed when transporting domestic horses. Feral horses are wild animals and are especially susceptible to injury and stress during transport.

The total number of domestic and feral horses killed at export abattoirs has varied between 40 000–60 000 animals per year over the past four years (table 12.5). There is no marked seasonality in the slaughter of horses, although availability of feral horses improved during dry periods. The limited number of livestock available for slaughter means that abattoirs will operate all year to service the large export market.

Feral horses from the Central Australia region yield a hot carcase weight (i.e. whole dressed carcase before chilling) of 180–250 kilograms (Synnot 1984). Horses from areas south of Tennant Creek are consistently heavier. The yield of boneless meat from hot carcases is about 70 per cent (125–175 kilograms per animal). There are six prime cuts (table 12.6), which constitute about 46 per cent of the boneless meat produced.

The carcase characteristics of feral horses differ markedly from those of horses bred for human consumption in Europe. French farmers fatten horses for meat to

Table 12.6: Primary meat cuts from feral horses

Primal cut	Percentage	Weight (kg)
Knuckle	8	12
Outside	10	15
Inside	8	12
Rump	8	12
Striploin	9	14
Tenderloin	3	5
Total	**46**	**70**

Source: Derived from Synnot 1984. Figures rounded, and based on average yield of 150 kilograms of meat per horse.

complement beef and milk production (Martin-Rosset 1987). Horses which are reared indoors and fed on cereals are slaughtered when they yield a dressed carcase weight of at least 270–300 kilograms. Pasture grass is the least costly feed for horse meat production. Pasture-fed horses are slaughtered when carcase weight is at least 330–350 kilograms. Therefore, European consumers are accustomed to larger cuts of horse meat than are produced from feral horses in Australia.

Feral horses are not treated with substances which promote growth, medications such as antibiotics, or pesticides, and therefore yield a relatively 'clean' meat. Meat from domestic horses is more likely to contain residues. Australian exporters of feral horse meat have an advantage in markets with stringent requirements for residue levels, such as the European Community. Major competitors such as the USA depend on domestic horses as a source of livestock for slaughter.

The larvae of a nematode parasite, *Trichinella spiralis*, can be transmitted to humans through poorly cooked meat, particularly pork (Kazacos 1986). This parasite has not been recorded in Australian livestock or wildlife. However, it is a major zoonosis in countries such as the USA, where 150 000 to 300 000 people per year are treated after consumption of infected pork (Kazacos 1986). An outbreak of trichinosis occurred in France in 1985 after infected horse meat was imported from the USA and Germany (Ancelle et al. 1988). The European Community now requires that all meat from horses slaughtered in France and other countries, including Australia, is tested for Trichinella. This exotic parasite has not been detected in Australian horse meat.

Hides, hair and by-products

Hides

Feral horses are rarely hunted for the hide only, although a small number may be taken when hide prices are high. Further, hides from feral horses that are field-shot for pet meat are rarely used because the hides are

Table 12.7: Quantity and value of horse hides exported from Australia (all values in Australian dollars)

IMPORTING COUNTRY	1988–89 Quantity (kg)	Value $	Price $/kg	1989–90 Quantity (kg)	Value $	Price $/kg	1990–91 Quantity (kg)	Value $	Price $/kg	1991–92 Quantity (kg)	Value $	Price $/kg
GERMANY	0	0	0	32 372	77 624	2.40	0	0	0	0	0	0
JAPAN	1 039 852	2 336 616	2.25	630 185	1 511 715	2.40	676 088	1 401 264	2.07	915 697	1 120 365	1.22
TAIWAN	14 105	34 536	2.45	0	0	0	0	0	0	0	0	0
OTHER	937	8 000	8.54	800	1 876	2.35	105 995	218 834	2.06	1 247 405	422 069	0.34
TOTAL	1 054 894	2 379 152	2.26	663 357	1 591 215	2.40	782 083	1 620 098	2.07	2 163 102	1 542 434	0.71

Source: Australian Bureau of Statistics

Note: Includes fresh, salted, dried, limed and pickled horse hides

damaged during field dressing, or ruined when the carcase is quartered with the skin on. Therefore, most hides entering the commercial trade are taken from animals slaughtered at knackeries for pet food or human consumption. Feral horse hides are generally smaller than those from domestic horses.

Most horse hides produced in Australia are exported to Japan in a raw salted state. Buyers pay by weight, and the average export price was $0.70 per kilogram in 1991–92 (table 12.7), when 2160 tonnes worth $1.5m were exported. Prices vary depending on weight class. Small hides are less cost-efficient to process, and hides weighing 4–9 kilograms are usually worth half that of hides weighing 9 kilograms and above. The market preference is for hides that average 12–14 kilograms each.

It takes about 1200 hides to fill a shipping container, making it difficult for low-volume processors, such as domestic pet meat knackeries, to enter the export market.

There are several tanneries in Japan which specialise in processing horse hides. Horse leather is more porous than bovine leather, and one end use is as innersoles in women's fashion shoes.

Although several Australian leather processors have the machinery and expertise to tan horse hides, there is negligible further processing in Australia. Processing of horse hides is made awkward by the mane, which bisects the hide, as well as by distortion over the rump. Further, the supply of horse hides from within Australia is probably too small to support a tannery dedicated for horse hides.

Hair

Horse hair was once widely used as a filler in upholstery and mattresses, but has now been largely replaced by synthetic materials. Nonetheless, a company in New South Wales still processes and exports small quantities of horse hair. Exports have tended to decline over the past decade (table 12.8). However, exports increased recently from about 1.2 tonnes worth $35 000 in 1989–90, to 32 tonnes worth $183 000 in 1991–92. The destinations of horse hair exports have varied, but the USA, New Zealand, Belgium/Luxembourg and, recently, China are frequent buyers of horse hair produced in Australia.

Domestic knackeries and export abattoirs in Australia prepare the manes and tails of horses for sale by preserving them in salt. Prices received for salted manes and tails vary with the quantity, length and condition of the hair that is removed. The average price received in 1991 was about $3–4 per kilogram. Many pet meat processors are unaware of the market for horse hair.

Table 12.8: Quantity and value of horse hair imports and exports (all values in Australian dollars)

	EXPORTS			IMPORTS		
	Quantity (kg)	Value $	Price $/kg	Quantity (kg)	Value $	Price $/kg
1983–84	18 299	62 519	3.42	12 108	36 069	2.98
1984–85	6 963	38 506	5.53	14 744	73 584	4.99
1985–86	7 327	38 675	5.28	19 371	98 483	5.08
1986–87	1 235	62 601	50.69	6 973	41 379	5.93
1987–88	2 290	52 307	22.84	83	1 418	17.08
1988–89	5 116	63 351	12.38	1 149	3 071	2.67
1989–90	1 276	35 405	27.75	3 008	25 140	8.36
1990–91	9 348	57 369	6.14	10	6 637	663.70
1991–92	32 103	182 961	5.70	1 504	13 114	8.72

Source: Australian Bureau of Statistics

On arrival at the factory, the hair is stripped from the skin, combed, washed and stretched in readiness for sale or further preparation. Hair from the tail is primarily used to blend with synthetic or vegetable fibres to produce brushes. Industrial brushes, such as roller brushes used in paper mills, are the main end-product. Other uses for tail hair include false tails for show horses and manufacture of traditional dartboards.

Good quality pale or white hair from the tail is used in violin bows. Quality black hair is similarly used in bass bows. Sixty kilograms of this high quality horse hair, worth $14 700 (i.e. average price of $245 per kilogram), was exported to the USA in 1989–90.

Hair from the mane is shorter and softer than tail hair and is primarily used in automobile upholstery. The hair is twisted to produce curls, and then rubberised with latex. Most of the rubberised hair is exported to Europe to use in the upholstery of quality motor vehicles.

The local supply of horse hair for the manufacture of brushes is inadequate to satisfy demand and small quantities are imported for domestic use or processing for re-export. Three tonnes of horse hair worth $25 104 (i.e. average price of $8.36/kg) was imported from China in 1989–90 (ABS). Smaller quantities of horse hair have also been imported from Belgium/Luxembourg in the past.

By-products

Horse by-products such as hearts and spleens can be used for extraction of pharmaceutical compounds. One compound extracted from horse hearts, Cytochrome C, is worth over $325 per gram. In 1991, most hearts and spleens were exported to the Netherlands, with hearts worth $1.50–2.00 per kilogram, and spleens worth $2.50–3.50 per kilogram. The total quantity exported in unknown. Australian and Japanese pharmaceutical companies also bid for these by-products.

Non-commercial killing

Feral horses can cause significant environmental damage and losses to rural industries (Berman & Jarman 1987). Therefore, many land managers work to reduce the density of feral horse populations to minimise losses.

In the past a variety of methods, including trapping, mustering, shooting and poisoning, have been used to control feral horses. During the 1930s some landowners paid shooters a bounty for the ears (about 2 shillings per pair) and many thousands of horses were killed (Rolls 1969). Today, control of feral horses is limited to mustering, trapping at watering points or shooting. Trapping is more effective during dry periods.

Because of their abundance, control of feral horses is of particular concern in the Northern Territory. The Conservation Commission of the Northern Territory (CCNT) provides advice to landowners on the methods of reducing feral horse populations. Where helicopter shooting proves to be the most practical and cost-effective method to control feral horses, stock inspectors or CCNT staff usually do the shooting. Helicopter shooting occurs at the landowner's expense. Shooting from a helicopter represents the most humane method of controlling feral horses in inaccessible locations (Senate Select Committee on Animal Welfare 1991).

Table 12.9: Removal of feral horses by helicopter in the Northern Territory 1985–1990

Region	Method of operation	
	Shooting	Mustering
Pastoral leases	5348	1410
Reserves	2331	459
Total	**7679**	**1869**

Source: Conservation Commission of the Northern Territory submission to the Senate Select Committee on Animal Welfare (1991)

The commercial harvest is integrated to some extent with feral horse control programs in the Northern Territory. Horses which cannot be captured and used may be removed by a combination of field and helicopter shooting. Shooting feral horses

to waste is the least cost-efficient means of controlling their numbers.

CCNT records show that less than 8000 feral horses were killed by helicopter shooting in the Northern Territory for the period 1985–1990 (table 12.9). The majority (70 per cent) of these horses were killed on pastoral leases. It is likely that many more horses were killed during helicopter shoots than are shown in table 12.9, because statistics from shoots sponsored by landowners are unavailable. Horses killed by helicopter shooting are not used.

Discussion

Australia supplies only about 5 per cent of the horse meat (for human consumption) that enters international trade. Therefore, Australia can be described as a price-taker on the world market—we have little control over market prices and must accept the going rates or opt not to export.

The total demand for horse meat on the world market appears to be static, although individual markets are exhibiting trends for increased or decreased demand. For example, Japan has represented the major export market for horse meat from Australia, but demand from Japan seems to be declining. Conversely, demand for horse meat is increasing in some European countries, such as Italy. These observations have implications for Australian exporters, given that higher prices are received in Western Europe. This suggests that Australian exporters need to concentrate on better penetration of European markets.

However, the European market is accustomed to larger cuts of marbled meat that are supplied locally or from North America. Feral horses are smaller than domestic horses and the meat is leaner, which can be a disadvantage in the EC market. Nonetheless, the lean characteristics of meat from feral horses, combined with a small residue content, could in the long term provide Australian exporters with a trade advantage, given that consumers are becoming more health-conscious.

An additional factor that could adversely influence Australian market prospects in the EC is future competition from developing countries. The EC extends preferential market access, such as exemption or reduction of duties and tariffs, to developing economies. For example, the Lome IV Convention allows products from over 65 developing countries in the African, Caribbean and Pacific region to enter the EC free of quota restrictions, customs duties and charges.

Meat from feral horses now accounts for less than half of total production in Australia, but many more feral horses could be used if their products could be profitably supplied to the market. Using feral horses to produce meat for human consumption is the option which provides the highest prices. However, live capture for transport to abattoirs is impractical or uneconomical in many regions. Horses from these areas can be shot for pet meat.

As stated previously, Japanese importers object to pet meat from Australia because it is stained with brilliant blue dye. These importers are now opting for supply of horse pet meat from other exporting countries. The prospects for developing of the exports of horse pet meat from Australia to countries such as Japan are not encouraging.

There is little value-adding to horse hides produced in Australia. Most hides are exported salted to Japan. Further, by-products such as hearts and spleens, which can be used to extract pharmaceutical compounds, are exported as raw products.

Australia now imports horse hair from China, while tails and manes from many feral horses killed for pet meat are not used. Many pet meat processors are not using horse hides, hair or by-products.

The commercial harvest is integrated with control of feral horses in the Northern Territory, which enhances the efficiency of feral horse management. Further development of the commercial harvest could reduce current waste and mitigate control costs. However, there are animal welfare concerns associated with capture, handling and transport of feral horses. Field slaughter to produce pet meat may be more acceptable from an animal welfare perspective in some instances.

13 EUROPEAN WILD RABBIT

Introduction

European wild rabbits (*Oryctolagus cuniculus*) were deliberately introduced to Australia in 1859 for sport and food (Rolls 1969). They rapidly colonised 4 million square kilometres of southern and Central Australia (Myers 1983) and were attributed with causing devastating losses to agricultural production during the first half of this century (Fennessy 1962).

Rabbit numbers have now been suppressed in the cool, higher rainfall regions where control is most cost-effective and vectors for the myxoma virus are common. In contrast, rabbit populations periodically erupt in semi-arid Australia where control is less cost-effective and vectors for the myxoma virus are uncommon. Wild rabbit populations are now spread over most of Australia, and most are found south of the Tropic of Capricorn (Wilson, Dexter, O'Brien & Bomford 1992).

Rabbits continue to cause substantial damage to pastoral enterprises, such as wool production, by competing with stock for pasture, reducing grazing area due to warren construction, and contributing to soil erosion (Sloan Cook & King Pty Ltd 1989). Losses due to rabbits vary with population density and pasture cover. However, the impact of introduced and native herbivores is greatest during and immediately after droughts (Mills 1986; Bomford & Breckwoldt 1989).

Wild rabbits cause widespread environmental damage. Recent studies have shown that low densities of rabbits can inhibit regeneration of native vegetation in many habitats, including cool subalpine regions (Leigh et al. 1987) and arid Central Australia (Lange & Graham 1983; Wood 1984; Foran et al. 1985). It is difficult to separate the environmental damage caused by rabbits from the effects of native and introduced domestic and feral herbivores. Many years of intensive grazing by sheep, cattle, goats, kangaroos and rabbits have permanently changed some habitats (Leigh et al. 1989).

Rabbits are the primary food of introduced predators such as foxes and feral cats (Catling 1988). The level of predation on native fauna can increase when rabbit populations decline (Wood 1984; Catling 1988), however the impact of this relationship on the viability of native animal populations is poorly understood. Similarly, there is little quantitative information on the effects of competition between rabbits and native herbivores.

Status

Wild rabbits are proclaimed pests in all States and Territories. Therefore, landowners are legally obliged to control rabbit numbers. State and Territory pest control agencies advise landowners on suitable techniques for controlling rabbits, and are involved in the release of myxoma virus.

Commercial use

The domestic and international trade in rabbit products is described in detail elsewhere (Ramsay 1991), and the following discussion provides an overview.

The international trade in rabbit meat

World production of wild rabbit meat is unknown. However, world production of farmed rabbit meat was at least 1 million tonnes in 1984 (Lukefahr 1985), but most of this production was consumed on-farm and did not enter commercial trade.

Total imports of rabbit meat to major consumer countries amounted to at least 67 339 tonnes in 1990 (table 13.1). The value of these imports was approximately $219m, averaging about $3.25 per kilogram (based on exchange rates for the various currencies as at June 1990).

Table13.1: Quantity and value of imports of wild and domestic rabbit meat for selected countries

IMPORTING COUNTRY	1988 QUANTITY (TONNES) DOMESTIC RABBIT	1988 QUANTITY (TONNES) WILD RABBIT & HARE	1988 QUANTITY (TONNES) TOTAL	1988 VALUE $A MILLION	1989 QUANTITY (TONNES) DOMESTIC RABBIT	1989 QUANTITY (TONNES) WILD RABBIT & HARE	1989 QUANTITY (TONNES) TOTAL	1989 VALUE $A MILLION	1990 QUANTITY (TONNES) DOMESTIC RABBIT	1990 QUANTITY (TONNES) WILD RABBIT & HARE	1990 QUANTITY (TONNES) TOTAL	1990 VALUE $A MILLION
EUROPEAN COMMUNITY												
BELGIUM/ LUXEMBOURG	3 209	1 036	4 245	12.5	2 973	889	3 862	12.7	3 045	856	3 901	15.8
WEST GERMANY	4 274	4 423	8 697	23.9	3 901	4 676	8 577	26.9	3 301	4 078	7 379	28.8
FRANCE	12 282	4 273	16 555	35.1	15 636	4 865	20 501	46.1	12 280	4 343	16 623	46.1
ITALY	16 692	1 238	17 930	38.7	18 505	1 124	19 629	51.4	17 680	1 176	18 856	60.3
NETHERLANDS	3 985	1 846	5 831	13.2	4 182	1 544	5 726	13.4	3 983	1 941	5 924	16.2
PORTUGAL	1 279	4	1 283	2.4	617	13	630	1.5	331	382	713	2.2
SPAIN	1 090	6	1 096	2.0	1 138	9	1 147	3.3	955	18	973	4.9
UNITED KINGDOM	2 333	78	2 411	4.0	2 583	160	2 743	4.7	2 725	141	2 866	6.4
OTHER	43	23	66	0.1	82	38	120	0.4	222	1	223	0.9
EC TOTAL	**45 187**	**12 927**	**58 114**	**132.0**	**49 617**	**13 318**	**62 935**	**160.3**	**44 522**	**12 936**	**57 458**	**181.6**
JAPAN	NA	NA	5 613	16.2	NA	NA	6 604	16.3	NA	NA	5 682	12.3
SWITZERLAND	NA	NA	3 348	19.1	NA	NA	3 624	19.4	NA	NA	4 097	24.6
UNITED STATES OF AMERICA	NA	NA	NA	NA	NA	NA	314	0.9	NA	NA	102	0.2
TOTAL			**67 075**	**167.3**			**73 477**	**196.9**			**67 339**	**218.7**

NA = Not available as a separate category

Compiled from the national foreign trade statistics of the countries concerned. Components may not add to totals due to rounding. All values in current dollars

The European Community (EC) is the major importer of rabbit meat supplied to the international market. In 1990, the EC imported 57 458 tonnes or about 85 per cent of rabbit meat that entered world trade. The largest importing countries in the EC were Italy (18 856 tonnes), France (16 623 tonnes), Germany (7379 tonnes) and the Netherlands (5924 tonnes).

In 1990, EC countries imported 12 936 tonnes of non-domestic rabbit and hare meat, which equates to about 30 per cent of rabbit meat imported. However, at least half of this meat was probably wild hare meat supplied from South America.

The total quantity of world imports of rabbit meat has remained stable for the period 1988 to 1990 inclusive (table 13.1). Further, the quantity imported by the leading buyers, Italy and France, has remained constant over the past decade (International Trade Centre 1983), suggesting that these markets are stable. There have, however, been some changes in the patterns of trade. For example, rabbit meat imports have tended to decline in some countries (for example, the United Kingdom), whereas other countries (for example, Switzerland) have increased their imports.

The Australian rabbit industry

Before 1950, the trade in rabbit products was a major domestic and export industry in Australia, providing significant employment and income for the rural sector. During the Great Depression, rabbit meat or 'underground mutton' was a staple food for many Australians, who caught rabbits with gin (leg hold) traps (Rolls 1969).

Australian exports of rabbit meat peaked in 1948–49 when 50 million rabbits were shipped (Commonwealth Bureau of Census and Statistics 1949). The value of rabbit meat exports in 1948–49 was 4.1 million pounds, which was equal to all exports of mutton and lamb in the same year.

When myxomatosis was introduced to Australia in the 1950s, rabbit populations collapsed and supply of rabbits for commercial use was severely reduced. Concurrent improvements in husbandry practices for farming domestic rabbits in Europe (Lebas & Matheron 1982) and China (Feng-Yi 1990) enabled large quantities of meat and fur to be produced at very competitive prices. These two developments led to a steady decline in the scale and value of the commercial harvest of wild rabbits in Australia.

Today, the rabbit industry is a wild harvesting operation that takes 2–3 million rabbits annually. Most rabbits are harvested to supply the domestic meat market. However, increased local demand for rabbit fur to use in felt hat manufacturing and a growing overseas demand for rabbit meat has recently led to an expansion of the Australian rabbit industry.

Wild rabbits are also a significant resource for subsistence and sport hunters. Many Aboriginals living in Central Australia actively hunt wild rabbits for food (Hetzel 1978). Aboriginal hunters may also sell rabbits to their community store or to commercial processors supplying domestic and export markets (Wilson, McNee, & Platts 1992).

Nature of markets for rabbit meat

Information on consumer preference for wild or domestic rabbit meat is limited. Consumers in traditional European markets for rabbit meat have expressed preference for wild rabbit because of better taste (Lebas & Matheron 1982). Indeed, farmed rabbit meat was considered tasteless by comparison.

A taste panel evaluation of the comparative quality of farmed and wild rabbit meat concluded that wild rabbit meat was markedly superior to domestic rabbit regarding tenderness, texture, juiciness and flavour characteristics (Nath & Narayana Rao 1983). The authors noted, however, that meat flavour will vary with the rabbits' diet. Consumer preference will also vary with the social and cultural background of the individual.

The supply of wild rabbits is insufficient to satisfy existing markets for rabbit meat.

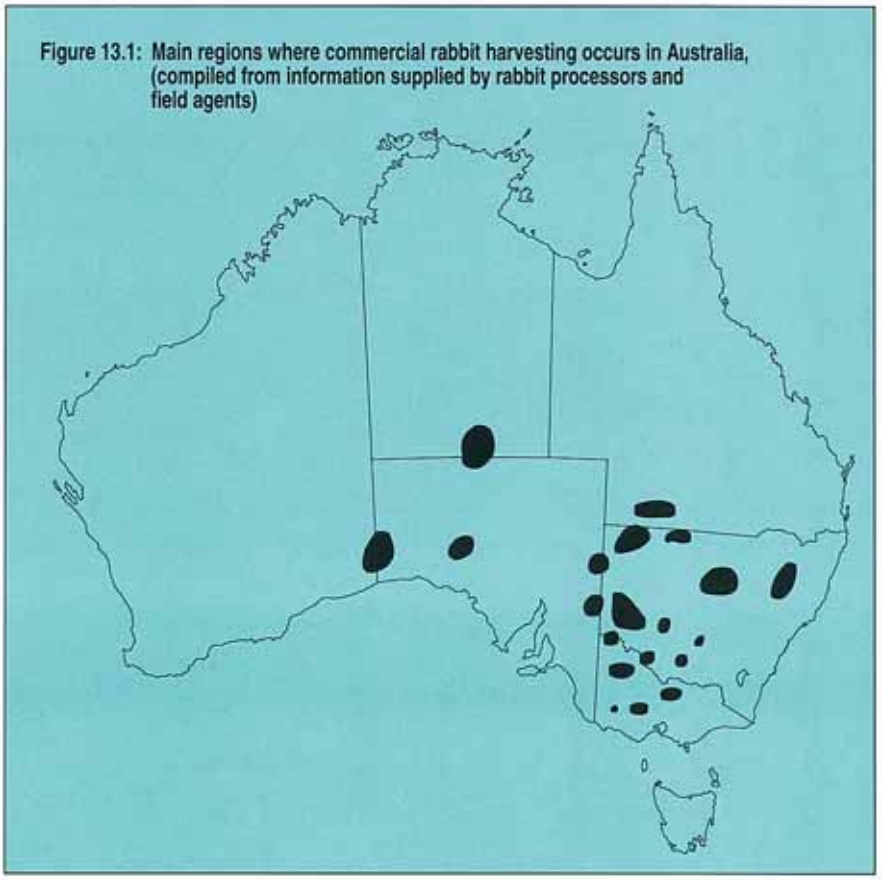


Figure 13.1: Main regions where commercial rabbit harvesting occurs in Australia, (compiled from information supplied by rabbit processors and field agents)

Many consumers also seem reluctant to pay a premium for wild meat over domestic meat. Hence, most rabbit meat produced is from domestic animals, and consumers have become accustomed to the products and prices produced by farming.

Therefore, wild rabbit meat products compete almost directly with farmed rabbit meat. The supply and price of farmed rabbit meat influences market opportunities for wild rabbit meat.

Rabbit meat production in Australia

Quality assurance in the domestic rabbit industry is controlled by State and Territory authorities, primarily the departments of health. Rabbit meat can be sold for human consumption, or pet food, throughout Australia. Premises where rabbits are processed for meat are subject to periodic inspection.

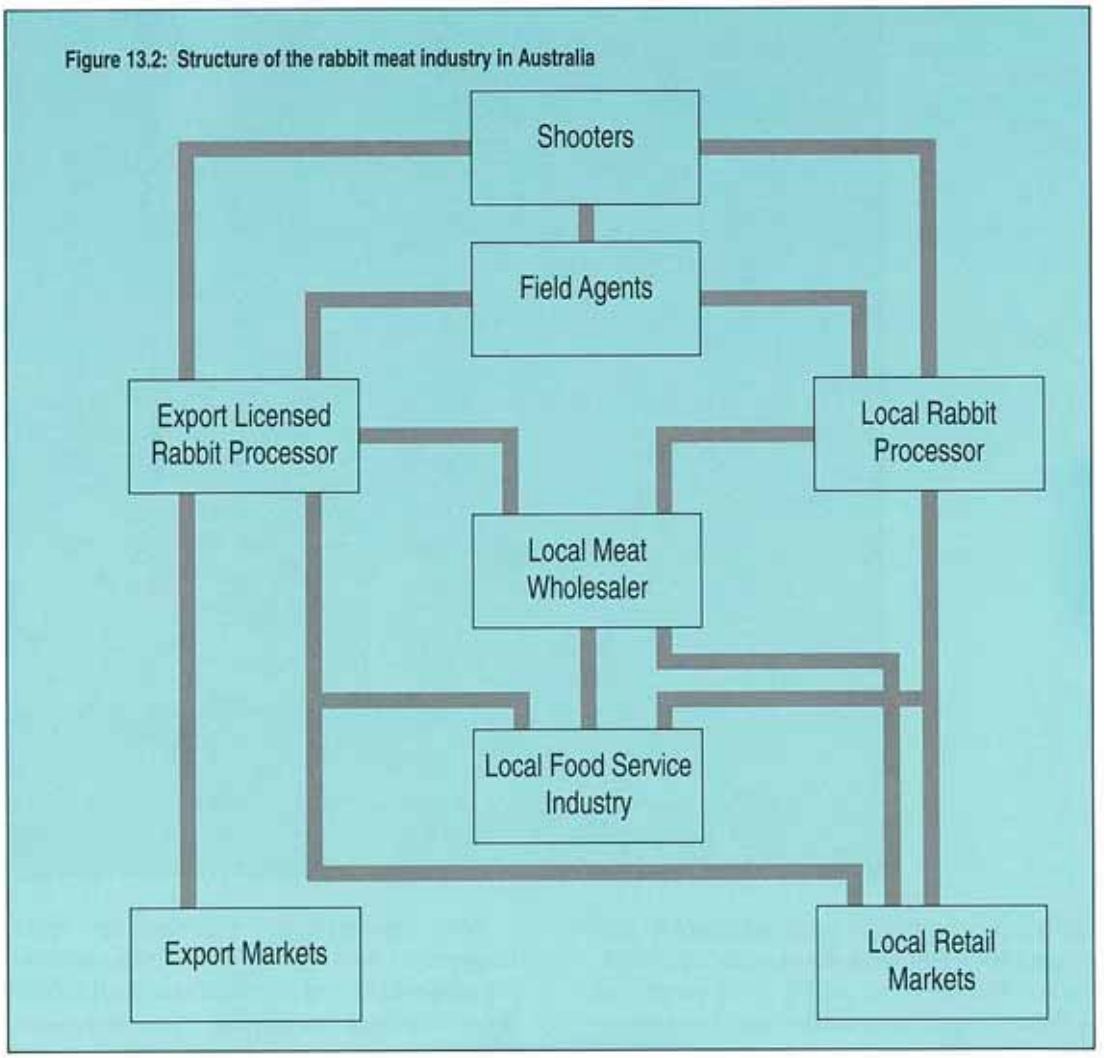
The Australian Quarantine and Inspection Service (AQIS) is responsible for inspection and certification of all rabbit meat destined for export. Requirements are specified in the Game, Poultry and Rabbit Meat Orders (1985) of the *Export Control Act 1982*. Wild rabbits are field-shot, eviscerated without ante-mortem inspection, and delivered to processing establishments with the skin on.

Structure and size of the industry

The wild rabbit industry in Australia is based on production of meat for the domestic market. Rabbit skins are essentially a by-product of the meat trade.

The industry consists of a field-based component—shooters and field agents—who supply dressed, skin-on rabbit carcases, as well as a city-based component—processors and wholesalers—who prepare products and distribute them to the markets (figure 13.1).

Figure 13.2: Structure of the rabbit meat industry in Australia



Shooters

Full-time professional hunters take most of the rabbits harvested commercially, while part-time hunters are less important. A survey of kangaroo shooters in New South Wales found that 26.8 per cent of shooters hunt rabbits opportunistically (Young & Delforce 1984), when prices are favourable and rabbits are abundant.

Rabbits are field-shot and eviscerated by hunters and delivered to field chillers. The skin, head and feet are left on, and the lungs, liver and kidneys are left inside the carcase for inspection purposes. Head-shot animals are preferred, to minimise bruising of meat.

Studies of kangaroo harvesting have found that head shooting is a very humane method of killing (RSPCA 1985; Senate Select Committee on Animal Welfare 1988). Killing rabbits by head shooting may also be considered humane. Commercial rabbit trappers no longer operate, and leg hold traps have been banned in many jurisdictions.

Field agents

Some rabbits are sold directly to processors by hunters, but most are handled by field agents. Field agents have extensive contact with shooters, landowners and processors. They also have a good knowledge of rabbit abundance and distribution, and arrange for chiller units to be relocated when rabbit numbers decline.

Field agents therefore coordinate the activities of hunters to ensure continuous and adequate supply of fresh carcases to processors.

Processors

Chilled rabbit carcases are transported by refrigerated trucks from remote areas, where they are purchased from shooters, to the processing facilities, which are based mainly in Adelaide, Melbourne, and Sydney.

On arrival at the processing facility, carcases are placed in a holding chiller before the heads, feet and skin are removed, and the carcases trimmed and packed to customer requirements. Rabbit meat prepared for export is inspected and certified by AQIS to the requirements of the importing country and packed to buyer specifications.

Distribution

Rabbit processors distribute the meat by direct retailing, direct sale to the food service industry (restaurants, hotels), or by wholesaling through distributors. Some large retailing chain stores buy fresh rabbit meat directly from processors.

Harvested regions

The commercial harvest is concentrated in regions of low rainfall and high rabbit density (figure 13.2). Commercial harvesting occurs in all States and Territories except the Australian Capital Territory and Tasmania, where rabbits are uncommon and commercial hunting is not profitable.

Consumers prefer rabbit meat that is white with white body fat. Rabbits from the drier regions meet this requirement and are preferred to those from the higher rainfall regions which have a darker meat with yellow kidney fat. Therefore, product characteristics required by the market would be an important consideration when assessing the potential role for the industry in rabbit management.

The domestic trade in rabbit products

The domestic market consumes most products from the wild rabbit harvest in Australia. Therefore, the size and stability of the domestic market for rabbit products has strongly influenced the viability of the wild rabbit harvest.

Meat

Rabbit shooters are paid per rabbit shot and prices paid per rabbit vary with size class (table 13.2). Processors pay field agents a commission ($0.25–0.35) per rabbit supplied.

Table 13.2: Size classes, typical weights (with head and skin on) and field prices (in 1990) for rabbit carcases

Class	Weight (grams)	Value ($ each)
Kitten	400–600	0.50
Young	601–750	0.75
Large	751 +	1.20

Demand is strongest for large rabbits, which weigh about one kilogram with the head and skin on. Very few kitten-size rabbits are purchased. As a result, at least $3m are paid to shooters annually—a significant input to the economy of some rural communities.

When skinned, an average commercial wild rabbit carcase weighs about 750 grams. At least 2.5 million of the 3 million animals harvested in 1989 were sold on the domestic market. Therefore, annual production of rabbit meat for domestic use was about 1800–2000 tonnes in 1989, equating to a national consumption rate of about 0.1 kilograms per person per year. By comparison, domestic consumption of beef in 1989–90 was 40.4 kilograms per head (Anon. 1990a).

The low per capita consumption of rabbit meat in Australia is not surprising: most Australians do not have a cultural tradition of consuming game meat of any type, including rabbit meat. In addition, rabbit

meat continues to be regarded as less desirable than beef, sheep and chicken meat.

The wholesale value of large rabbit carcases was about $2.80 per kilogram in 1989. Based on a national consumption of about 2000 tonnes per annum, the wholesale value of rabbit meat traded within Australia is roughly $5–5.6m dollars (i.e. excluding exports).

Melbourne is the largest (and hence the most competitive) market in Australia for rabbit meat, although Sydney, Tasmania and Adelaide are also major consumer markets. An example of the variety and retail value of rabbit meat products is shown in table 13.3.

Table 13.3: Fresh rabbit products and prices ($) at the Queen Victoria Markets in Melbourne

Product	Value 11/10/89	Value 21/6/91
Rabbit mince (pet food)	$1.50 per kg	$1.70 per kg
Small rabbit	$1.50 each	$1.50 each
1/2 grown whole rabbit	$2.00 each	$2.00 each
Large rabbit	$2.60 each	$2.75 each
Extra large rabbit	–	$3.00 each
Rabbit fillets	$7.50 per kg	$8.00 per kg
Rabbit forelegs	$0.20 each	$0.20 each
Rabbit portions	$3.80 each	$4.00 per kg
Boneless rabbit	$4.90 per kg	$5.30 per kg
Whole hares	$9.00 each	$12.00 each

There is also a demand for rabbit meat in the food service industry, particularly in up-market restaurants where rabbit meat is prepared and sold as an exotic and expensive dish. The restaurant trade primarily buys fresh fillets or whole large carcases.

Pet food and by-products

Rabbit bones and poor quality carcases are minced and sold as pet food. The pet mince is sold through retail stores as a chilled product, or sold frozen ($0.60/kg) to a pet food cannery. Some rabbit pet mince has recently been exported to overseas pet food canneries.

Rabbit heads and feet are frozen in 20-kilogram cartons and sold for use in the production of canned pet food. Frozen heads and feet are worth about $0.25 per kilogram and the current demand is being met.

Crocodile farms in the Northern Territory have recently purchased small trial shipments of rabbit heads for use as a stock food. Prices paid were about $0.45 per kilogram, excluding delivery costs.

Rabbit brains can be used for extraction of thromboplastin, a pharmaceutical compound. An Australian pharmaceutical company was paying up to $100 per kilogram for rabbit brains, but recently ceased buying due to competition from a manufacturer in the United States of America. There are export markets for rabbit brains, but these are better serviced by the farmed rabbit industry (wild rabbits are head-shot).

Fur skins

There are two sources of rabbit skins for the fur trade. The main supply is from the meat trade. These are termed 'butchered' skins, and have been cut lengthways along the stomach to enable evisceration. The other form, 'sleeved' skins, are supplied by recreational hunters who remove the skin by cutting between the thighs and pulling the skin down the body.

All rabbit skins are air-dried before sale. Some rabbit meat processors have drying sheds, but most sell the chilled skins to specialist skin-handling companies where the skin is turned inside out and stretched over a wire 'coathanger' to dry. Recreational hunters stretch and dry their catch of rabbit skins in readiness for sale at auction or directly to fur dealers or manufacturers.

Quantity and value

Dried skins are graded according to colour and quality and sold by weight. Winter skins have more fur and are heavier than summer skins. Therefore, the number of dried skins per kilogram varies from 12–14 skins per kilogram during winter, to 14–18 skins per kilogram during summer.

Table 13.4: Seasonal variation in the value of rabbit fur skins—five-year average 1986–1990

TYPE	PRICE	MAY	JUNE	JULY	AUG	SEPT	OCT
BUTCHERED	($A/KG)	4.38	4.77	4.72	4.94	4.61	4.02
SLEEVED	($A/KG)	4.99	5.53	6.15	6.10	5.66	5.18

Source: Australian Skin Auctions Pty Ltd

Not surprisingly then, the value of rabbit skins will vary during the year, with the highest prices being received during winter months. This seasonal variation in rabbit skin prices is shown in table 13.4 and figure 13.3, where the average monthly value of first and second grade skins have been calculated from records of fur auctions held over the five-year period from 1986 to 1990.

Sleeved skins yield more fur and hence return prices that are 10–30 per cent higher than those for butchered skins (figure 13.3). The prices shown in table 13.4 can be used to estimate the unit value of rabbit skins. Butchered skins vary from about $0.25 to $0.35 each, whereas sleeved skins vary from about $0.30 to $0.40 each.

Export statistics and data supplied by the main user of rabbit fur—a felt hat manufacturer—show that total production of dried wild rabbit skins in Australia has remained at about 200 tonnes per year for the past decade. An estimate of the total present value of the Australian rabbit skin industry can be made by using the average value of raw rabbit skin exports in 1989–90 as an average market price (i.e. $5.04/kg, or about $0.35 per skin). Hence, the wholesale value of raw rabbit skins produced in 1989–90 was roughly $1.01m.

The role of recreational hunters in supplying the commercial rabbit skin trade can be gauged by examining the quantity of sleeved rabbit skins sold at auction. The number taken is surprisingly high (table 13.5), suggesting that skin-only hunting could be substantial if skin prices increase.

The number of sleeved rabbit skins sold peaked at 303 000 in 1988 (i.e. about 10 per cent of total production), and has declined as fur prices dropped. The quantity of sleeved rabbit skins sold through other channels is unknown. Further, the regions harvested by skin-only hunters are unknown as there is no way of collecting the data.

Figure 13.3: Seasonal variation in the value of rabbit skins—five-year average 1986–1990

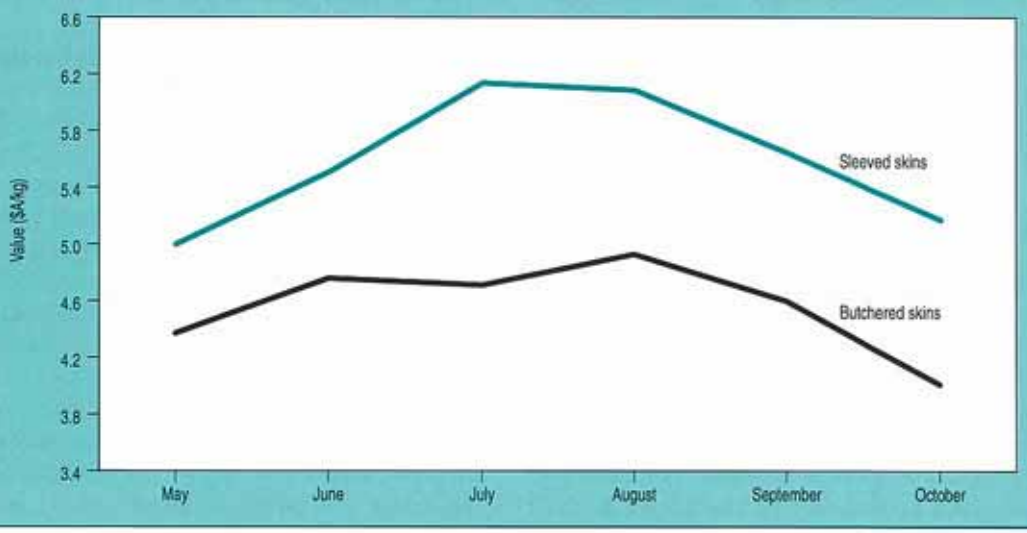


Table 13.5: Quantity and estimated number of sleeved rabbit skins sold at auction in Australia

Calendar year	Quantity (kg)	Estimated number*
1986	17 906	250 700
1987	19 937	279 100
1988	21 652	303 100
1989	18 570	260 000
1990	16 372	229 200

* assumes 14 skins/kilogram
Source: Australian Skin Auctions Pty Ltd (unpublished data)

The fur felt market

An increasing proportion of the annual rabbit skin production is being used for felt hat manufacture in Australia. The skins are purchased either directly from processors or by bidding at auction.

Some cut rabbit fur (i.e. skin and hair is removed) from farmed rabbits is imported to Australia from Europe and China for use in felt hat manufacture. Most of this fur is fawn or grey, although some white fur is imported for manufacture of white or pastel-coloured hats. Rabbit fur produced on farms in Western Australia may gradually replace some of these imports. Many felt hats manufactured in Australia retail for around $75 each, representing a high level of value-adding.

More fur can be cut from rabbit skins taken during the winter harvest. Therefore, skins from cool regions attract higher prices, as do skins taken in winter (figure 13.3). Conversely, skins taken from the arid regions during summer have little or no value. The cooler climate of countries such as New Zealand could produce rabbit skins of greater value to the fur industry.

Furrier market

There is a small local fur dressing industry that prepares fur skins for garment manufacture. Dressed rabbit fur skins have many uses, but are primarily used in linings for jackets and gloves. Furriers buy the best quality furs. However, the number of furs purchased by furriers is small compared to the number purchased by the fur felt trade.

Export of Australian wild rabbit products

Meat

Exports of rabbit meat from Australia declined to zero in 1986–87 and 1987–88 (table 13.6). This decline was due to low prices for rabbit meat on the world market and to increased costs associated with exporting (the Game Poultry and Rabbit Meat Orders (1985) had more stringent requirements for establishments that export rabbit meat). However, since 1988 four export establishments have been licensed by the Australian Quarantine and Inspection Service, and exports of rabbit meat have been steadily increasing. Licensed game meat processing plants can also process rabbits for export, although this has not occurred as yet.

In 1989–90, the total quantity of rabbit meat exported from Australia was 142 tonnes, of which 75 per cent (i.e. 106 tonnes) went to the United States of America (table 13.6). The total value of meat exported amounted to $0.41m, with an average value of $2.91 per kilogram.

The opportunity for exports of Australian wild rabbit to the United States of America arose because of the competitive prices offered by Australian supplies. The trade was assisted by the growing consumer acceptance of rabbit meat as a nutritional and healthy alternative to other meats (Gebremedhin 1990).

Exports of Australian wild rabbit meat continued to expand in 1990–91, rising fivefold from the previous year, to reach 755 tonnes valued at almost $2.5m, or $3.28 per kilogram. Exports increased again in 1991–92, reaching 1081 tonnes worth $4.5m. The improved export performance is largely due to diversification of markets to include countries in Western Europe, particularly Portugal and France, as well as other markets such as Reunion Island.

Australian exporters attribute the continued expansion of rabbit meat sales to improved market access and prices following outbreaks of rabbit haemorrhagic disease

Table 13.6: Quantity, value and destination of rabbit meat exported from Australia

DESTINATION		1980–81	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91	1991–92
NETHERLANDS	kg	119 685	33 585	99 619	0	0	0	0	0	0	210	47 010	39 770
	$	132 000	43 150	152 000	0	0	0	0	0	0	1 773	128 364	139 444
	$/kg	1.10	1.28	1.53	0	0	0	0	0	0	8.44	2.73	3.51
NEW CALEDONIA	kg	7 905	2 790	5 871	2 176	0	0	0	0	0	0	0	0
	$	12 000	5 659	14 000	7 482	0	0	0	0	0	0	0	0
	$/kg	1.52	2.03	2.38	3.44	0	0	0	0	0	0	0	0
PAPUA NEW	kg	7 069	2 778	0	0	3 080	0	0	0	0	3 750	16 005	0
GUINEA	$	13 000	4 460	0	0	7 610	0	0	0	0	10 417	38 012	0
	$/kg	1.84	1.61	0	0	2.47	0	0	0	0	2.78	2.38	0
PORTUGAL	kg	0	0	0	0	0	0	0	0	0	1 500	486 615	76 451
	$	0	0	0	0	0	0	0	0	0	5 230	1 579 592	215 413
	$/kg	0	0	0	0	0	0	0	0	0	3.49	3.25	2.82
SINGAPORE	kg	0	9 323	5 580	4 515	7 245	0	0	0	1 095	0	0	600
	$	0	12 158	11 000	11 892	16 247	0	0	0	1 653	0	0	2 369
	$/kg	0	1.30	1.97	2.63	2.24	0	0	0	1.51	0	0	3.95
UNITED	kg	129 224	15 036	0	0	0	0	0	0	0	0	72 000	152 718
KINGDOM	$	110 000	12 631	0	0	0	0	0	0	0	0	202 857	377 372
	$/kg	0.85	0.84	0	0	0	0	0	0	0	0	2.82	2.47
UNITED STATES	kg	16 329	0	0	0	0	0	0	0	89 730	106 429	2670	124 260
OF AMERICA	$	24 000	0	0	0	0	0	0	0	221 040	266 763	20 055	329 582
	$/kg	1.47	0	0	0	0	0	0	0	2.46	2.51	7.51	2.65
OTHER	kg	20 805	67 188	26 752	4 952	30 739	9 766	0	0	17 760	30 420	131 236	687 438
	$	35 000	76 579	27 000	9 122	77 789	26 549	0	0	14 813	129 523	508 139	2 412 836
	$/kg	1.68	1.14	1.01	1.84	2.53	2.72	0	0	0.83	4.26	3.87	3.51
TOTAL	**kg**	**301 017**	**130 700**	**137 822**	**11 643**	**41 064**	**9 766**	**0**	**0**	**108 585**	**142 309**	**755 536**	**1 081 237**
	$	**326 000**	**154 637**	**204 000**	**28 496**	**101 646**	**26 549**	**0**	**0**	**237 506**	**413 706**	**2 477 019**	**3 477 016**
	$/kg	**1.08**	**1.18**	**1.48**	**2.45**	**2.48**	**2.72**	**0**	**0**	**2.19**	**2.91**	**3.28**	**3.22**

Source: Australian Bureau of Statistics Note: All values in current dollars

(RHD) in overseas rabbit farms. Rabbit meat production has been curtailed in many European countries since the onset of rabbit haemorrhagic disease, leading to an increasing deficit in meat available for local markets (Cancellotti & Renzi 1991).

Veterinary authorities in Portugal have stopped the import of rabbit meat from countries where RHD outbreaks have occurred. Hence the recent rapid growth in exports of Australian wild rabbit meat to Europe.

Wild rabbit meat has also benefited from the growing international concern over chemical residues in foods. Farmed rabbit meat is more likely to have residues.

Fur

There are no estimates of the size and value of the international trade in rabbit skins. However, most rabbit skins are used for felt-making, although the hat-making industry is in decline worldwide (Rougeot 1986).

Most rabbit skins produced are of poor quality. This is especially true of rabbit farming systems, where the animals are slaughtered at a young age. The coat of domestic rabbits slaughtered at 8–11 weeks is in its mid-infant period or at the beginning of its sub-adult moult, and produces a thin, unstable coat that is unsuitable for fur (Rougeot 1986). By comparison, mature wild rabbits are killed to supply the meat industry, and the fur is stronger, has better 'felting' properties and produces more durable felt hats (Bowen 1988).

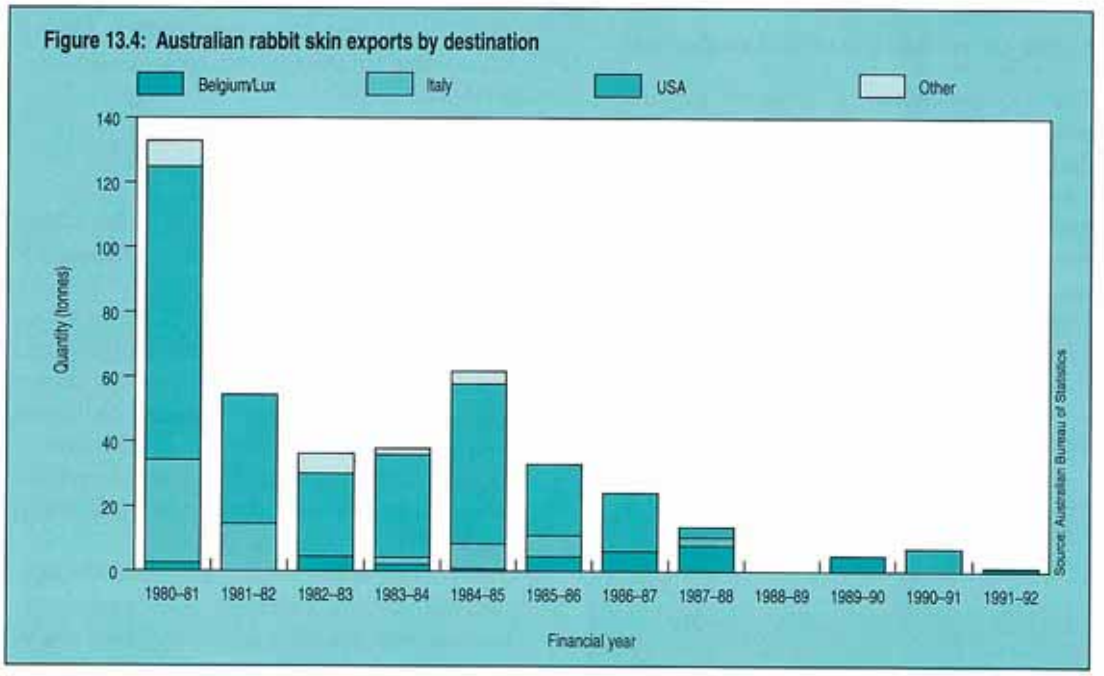
A few rabbit furs are used by furriers for garment manufacture, but the demand for fur garments fluctuates markedly with the whims of the fashion industry. Rabbit fur garments are a down-market product. Some of the high prices shown for rabbit skin exports from Australia (table 13.7) are probably shipments of high quality furs for garment manufacture.

Substantial quantities of raw rabbit skins were exported to the United States of America and Italy a decade ago (table 13.7).

Table 13.7: Quantity and price of exports of raw rabbit fur skin from Australia

DESTINATION		1980–81	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91	1991–92
BELGIUM/	kg	2 688	0	4 676	2 185	851	4 804	6 503	8 313	0	5 079	0	1 000
LUXEMBOURG	$/kg	7.12	0	3.42	2.53	7.05	4.67	4.34	6.40	0	5.04	0	7.88
ITALY	kg	32 783	15 084	0	2 219	7 929	6 694	0	2 562	0	0	0	0
	$/kg	5.16	9.55	0	2.07	5.79	5.99	0	5.85	0	0	0	0
UNITED STATES	kg	93 715	41 144	26 496	32 828	51 142	22 687	18 517	3 339	0	0	0	0
OF AMERICA	$/kg	5.28	8.62	2.34	2.92	4.73	5.09	4.22	7.08	0	0	0	0
OTHER	kg	8 278	120	6 392	1 900	3 963	40	0	0	0	0	7 360	331
	$/kg	6.28	18.08	2.97	2.89	4.40	48.02	0	0	0	0	4.18	4.47
TOTAL	**kg**	**137 444**	**56 348**	**37 564**	**39 132**	**63 885**	**34 225**	**25 020**	**14 214**	**0**	**5 079**	**7 360**	**1 331**
	$	**735 000**	**500 852**	**97 000**	**111 308**	**311 337**	**179 873**	**106 269**	**91 870**	**0**	**25 620**	**30 743**	**9 353**
	$/kg	**5.35**	**8.89**	**2.58**	**2.84**	**4.87**	**5.26**	**4.25**	**6.46**	**0**	**5.04**	**4.18**	**7.03**

Source: Australian Bureau of Statistics   Note: All values in current dollars



The quantities exported have since declined and there were no exports in 1988–89 (figure 13.4). The decline in exports was due to the growth in demand within Australia for wild rabbit fur to use in the manufacture of felt hats. Few rabbit skins are now exported.

In 1990–91, seven tonnes of skins were exported to the Federal Republic of Germany returning an average value of $4.18 per kilogram. Exports fell to 1.3 tonnes worth $9000 in 1991–92. Australia now imports much more rabbit fur than it exports.

Dressed or tanned rabbit fur skins were not recorded separately in Australian foreign trade statistics until after January 1988. One shipment of 5400 tanned rabbit fur skins went to Malaysia in 1989–90, returning $13 899 or $2.57 per skin. In 1990–91, 5000 tanned rabbit skins were exported to the Republic of Korea, returning a total of $6482 or $1.30 per skin. This increased to 45 502 skins worth $58 180 in 1991–92.

The large quantity of skins available from overseas rabbit farms depresses the international market, and keeps the price of rabbit skins low.

The rabbit farming industry

Production of meat from domestic rabbits is based on slaughter of young animals (8–10 weeks old) that have a live weight of 2–2.5 kg, yielding a dressed carcase of 1.0–1.5 kg (Fennell et al. 1990). Consumers are accustomed to products from rabbits in this weight class. Hence, producers of smaller (e.g. wild) rabbit carcases are at a disadvantage in the broader market. Further, the unit cost of deboning the larger domestic rabbit carcase will also be proportionally less than the cost for smaller (wild) rabbits. The small size of wild rabbits could disadvantage Australian exporters competing for markets for value-added cuts.

Farming of domestic rabbits has a comparatively short history in Australia. The first farms were established in Western Australia in November 1987, following changes in State legislation. By June 1990, 25 farms had been issued with a permit by the Western Australia Agriculture Protection Board. Farmed rabbit meat has not proven competitive with the price of wild rabbit meat in Australia. Further, Australian farmed rabbit meat is generally not priced competitively on the world market.

Value of rabbit products exported

The composition of exports of rabbit products from Australia has changed markedly over the past decade (table 13.8). Raw rabbit fur skins accounted for most export earnings in 1980–81. Today, rabbit meat is the best performer on the export market, and sales continue to grow. Unfortunately, it is not possible to extract the export value of felt hats manufactured from wild rabbit fur. Exports of rabbit products, excluding hats, were valued at $2.5m in 1990–91 and $3.5m in 1991–92.

Table 13.8: Value ($A) of all rabbit products exported from Australia

Financial Year	VALUE OF PRODUCTS ($A)			
	Meat	Raw fur skin	Tanned fur skin	Total
1980–81	325 000	735 000	N/A	1 060 000
1981–82	154 637	500 852	N/A	655 489
1982–83	203 000	97 000	N/A	300 000
1983–84	28 496	111 308	N/A	139 804
1984–85	101 646	311 337	N/A	412 983
1985–86	26 549	179 873	N/A	206 422
1986–87	0	106 269	N/A	106 269
1987–88	0	91 870	N/A	91 870
1988–89	237 506	0	7 329	244 835
1989–90	413 706	25 620	13 889	453 215
1990–91	2 477 019	30 743	6 482	2 514 244
1991–92	3 477 016	9 353	58 180	3 544 549

Source: Australian Bureau of Statistics
Note: All values in current dollars

Factors influencing trade and harvesting

Patterns of trade in wild rabbit products vary with economic, social, environmental and legal factors. The market share of any company or country will depend on their comparative advantage, although trade barriers can also influence competitiveness and market access. Wild rabbit products have attributes that can either be an advantage or disadvantage in consumer markets.

Local supply

The remote localities of the wild rabbit populations present a major challenge for dealers to maintain a supply of quality products to distant markets. Morris and Young (1985) identified many supply and demand problems associated with the market for kangaroo products. Similar problems face the wild rabbit industry, and some of Morris and Young's (1985) observations have been incorporated into the following discussion.

Wild rabbit harvesting has an advantage over commercial rabbitries, which are costly to construct and have expensive husbandry requirements. In contrast, the capital input required to harvest wild rabbits in the field is quite low, and the populations are abundant and have high recruitment rates (during good seasons).

For example, the current wholesale value of farmed rabbit meat from Western Australia is valued at $6.70 per kilogram, or double that of wild rabbit meat. While the cost of production of farmed rabbit meat in Australia remains high, the prospects for the domestic rabbit farming industry will remain poor.

Price of rabbit meat

The price of rabbit meat on the domestic market has not varied significantly over the past few years, suggesting that further supply of meat to the market may cause a drop in price.

Environmental conditions

Environmental conditions at a national, regional and local level strongly influence the availability of rabbits for markets.

For example, wet weather makes it difficult for shooters to work in the field. Also, wet weather in areas not serviced by sealed roads can prevent deliveries to processors. Therefore, local weather patterns

can restrict supply in the short term. Field agents can overcome this shortage to some extent by gaining supply from other areas.

Longer term environmental conditions, such as a prolonged drought, cause major supply problems due to a widespread decline in rabbit populations. Therefore, the flexibility of rabbit harvesting field operations, in that field agents can move chiller units and shooters interstate to new areas, is crucial to maintaining supply. Processors may also purchase rabbits from other field agents or other processors to reduce supply fluctuations.

The commercial harvest takes a small proportion of the wild rabbit population, but sometimes suffers shortages in supply, particularly during periods of environmental stress. For example, Australian exporters had great difficulty supplying markets during the widespread and severe drought in 1991 and 1992 when rabbit populations crashed.

Pest control

Outbreaks of myxomatosis cause rabbit populations to crash, requiring shooters to move to new areas. However, rabbit numbers can increase rapidly, and shooters often move back into affected areas within a year. Extensive warren ripping has a longer term impact on rabbit abundance (Mutze 1991) and hence commercial operations.

Rabbits occur over a wide area and the effects of control tend to be local. Therefore, sizeable populations will usually be available, given the flexibility of the industry.

Availability of shooters

Experienced shooters can take over 200 rabbits per night. Because there are no restrictions on rabbit shooting, the number of shooters working has a strong influence on the number of rabbits harvested.

Rabbit harvesting is concentrated in remote areas, where skilled shooters can be scarce. Further, shooters may switch to other species, such as kangaroos or wild boar, when prices are favourable. Therefore, the availability of shooters can limit the capacity of the industry to supply the market. Alternatively, when rabbits are abundant and demand is strong, shooters will participate in the industry opportunistically to take advantage of the situation. This can result in a rapid increase in the number taken and cause field prices to drop.

Shooters can supply more rabbits in summer (unless drought causes populations to crash), which is also the period in which they prefer to work (warmer conditions). Most areas harvested by the commercial industry receive winter rainfall, which complicates supply by reducing shooter access to rabbits.

However, local demand is strongest in winter. Therefore, field agents manipulate the price paid per rabbit to obtain extra supplies of rabbits in winter and, in good seasons, may place shooters on a weekly quota during summer.

Demand for rabbit meat is also seasonal in the northern hemisphere, being strongest in winter. The recent increase in rabbit exports to Europe and North America is allowing harvesting to occur year-round.

International supply

The People's Republic of China is the largest exporter of meat from domestic rabbits. Rabbit farmers in China can supply large quantities of meat and skins at low prices. Exports of rabbit meat from China rose from 308 tonnes in 1957 to a maximum of 53 200 tonnes in 1983 (Feng-Yi 1990). Due to the size of its production, China greatly influences the price, quantity and market share of other suppliers.

Exports of rabbit meat from China have declined in recent years, while domestic consumption has apparently increased (Feng-Yi 1990). Import statistics for Switzerland, Japan, the United States of America and all member countries of the EC reveal that in 1990, China and Hungary had equal market share (about 17 000 tonnes) as suppliers of rabbit meat. France

and the Netherlands are also major exporters of rabbit meat.

European countries are major consumers of rabbit meat, but they are also largely self-sufficient. Overproduction of other commodities such as milk has led to quotas to reduce production and to proposals for development of new animal enterprises. For example, development of deer and goat farming and production of horse meat is being encouraged (Adams 1987). In the longer term, this policy could extend to other species, such as rabbits, and reduce the prospects for suppliers outside the EC. Proposals to protect producers in EC member countries from external suppliers of rabbit meat are not new (e.g. International Trade Centre 1983).

Rabbit haemorrhagic disease (RHD) has killed millions of domestic rabbits and is of major concern to many countries with a domestic rabbit farming industry. RHD was first recorded in China in 1984, and has subsequently spread to Italy, Spain, Poland, France, the Netherlands, Switzerland, Germany, Hungary, Korea and Mexico (O'Brien 1991). The supply of farmed rabbit meat for international trade has been disrupted by outbreaks of RHD.

The opportunity for other exporting countries to enter the market and compete with Australian exporters will depend on their production capacity, and the prevailing market price. However, the high costs associated with constructing and maintaining a rabbit processing establishment to EC standards make it difficult to enter and leave the market opportunistically.

Animal and public health requirements

Some importing countries now require that rabbit meat be subjected to ante-mortem inspection. Examples include Canada and Saudi Arabia. However, wild rabbit meat cannot enter these markets because ante-mortem inspection is impractical. It is similarly impractical to provide halal certification for wild rabbits. Halal certification is a requirement by Islamic countries that animals be slaughtered by Muslims only, while fully conscious at the time of slaughter, and a special prayer is said as the animal is killed. Such markets are supplied exclusively by the farmed rabbit industry.

There is some evidence that meat from rabbits infected with RHD remains infectious after freezing (Gutierrez 1990), and Portuguese authorities have recently stipulated that all rabbit meat imports come from RHD-free countries. If this requirement is adopted by other importing countries, it could have a major effect on patterns of trade. Countries free of RHD will have a clear market advantage, which has implications for New Zealand and Australia, both of which are considering introduction of RHD for rabbit control (O'Brien 1991).

Duties and tariffs

Most countries impose a tariff or duty on imports of rabbit meat. An exception is Japan. However, wild rabbit meat is sometimes subject to a lower duty than meat from farmed rabbits. For example, in the United Kingdom a duty of 3 per cent applies to wild rabbit meat, whereas the duty on farmed meat is 10 per cent. This gives wild rabbit meat a competitive advantage over farmed rabbit meat.

Developing countries

Many developing countries are experimenting with farming rabbits to supply domestic and export markets (Viana 1988; Opoku & Lukefahr 1990). Further, the International Trade Centre (1983) has encouraged developing countries to supply world markets for rabbit meat.

Eastern European countries such as Hungary and Poland produce substantial quantities of rabbit meat for export. Imports of rabbit meat from Eastern Europe to countries in the EC may receive preferred treatment regarding tariffs and duties in response to the recent political changes in Eastern Europe. The proximity of these

countries to major consumer markets in the EC provides a further advantage of reduced freight costs, making it profitable to supply fresh rabbit meat.

Developing countries could play an increasing role in supplying international markets for rabbit meat.

Local demand

Price and consumer preference

The Australian market for rabbit meat is seasonal, with greatest demand in winter. However, the market is typically oversupplied, resulting in sustained low prices. There are several suppliers of rabbit meat in Australia, and many points of sale for the products. By comparison, the rabbit meat processors are the main suppliers of skins, and one buyer (a felt hat manufacturer) takes most skins produced. This situation could lead to market failure, because sellers must accept prices offered or seek export markets.

Rabbit meat is regarded as a down-market product in Australia. This perception has a historical component: rabbit meat was consumed by many Australians during the Great Depression. Without increased and targeted promotion, demand for rabbit meat will tend to decrease when disposable income rises.

However, the restaurant trade represents one segment of the Australian market where consumption increases when disposable income increases. Many Australians and overseas tourists will buy rabbit meat at a restaurant because it is a novel dish.

Consumers prefer fresh rabbit meat, and there is very little trade in frozen meat. A consequence of this preference is that processors cannot hold frozen meat in storage to ensure supply.

Rabbit meat must compete with a wide range of substitute products including fresh chicken, pork, lamb and beef. Consumers may switch to other products if supply of rabbit meat fails, or if the price of the substitute product falls. Chicken meat is perceived by Australian rabbit processors as the main substitute product for rabbit meat. Retail prices for fresh chicken meat and fresh rabbit meat are similar.

International demand

Price and consumer preference

Rabbit meat is a traditional food in many countries, particularly in Europe. The international markets for rabbit meat are seasonal, with demand strongest in winter (Maertens & Peeters 1989). Prices of rabbit meat follow this trend and tend to be higher in winter. Whole carcases are preferred, although there is some trade in cuts.

The available data on consumption in major importing countries indicates that rabbit meat is consumed mainly by those belonging to the lower income groups, and by middle-aged and elderly people (International Trade Centre 1983). Therefore, rabbit meat is seen as a budget product and because suppliers can produce large quantities, international trade is very price-competitive.

However, developed countries, which can afford to pay higher prices, are the major importers of rabbit meat. With the current trend towards consumption of leaner meats (Jasper 1990; Overton 1990), which are free of residues, consumer preferences may improve the prospects for rabbit meat. The meat is lean, with very little visible or intramuscular fat, and it is low in cholesterol (Sinclair & O'Dea 1987; Lukefahr et al. 1989).

Unfortunately for rabbit producers, rabbit meat is not widely promoted. Data on rabbit meat consumption in the United Kingdom reveals that consumption declined dramatically from 5.72 oz per person per year in 1980, to only 1.56 oz per person per year in 1988 (UK Meat and Livestock Commission 1990). The main reasons for the decline were that consumers perceive rabbit meat as a down-market product, and that supply was sporadic.

By comparison, a recent study in Belgium (Maertens & Peeters 1989) revealed that rabbit production and consumption have tended to increase. Consumption of rabbit

meat in Belgium rose from 1.56 kilograms per inhabitant in 1976 to 2.48 kilograms per inhabitant in 1986. The authors did not offer reasons for the increasing consumption, but noted that output from intensive rabbit farms in Belgium rose from 6250 tonnes per annum to 16 200 tonnes per annum over the same period. Also, production of wild rabbit meat declined from 2800 tonnes to 2000 tonnes.

European consumers prefer fresh rabbit meat, but shortfalls in local production make it necessary to import meat to satisfy demand (International Trade Centre 1983; Maertens & Peeters 1989). Hence, there is a substantial international trade in frozen rabbit meat, live rabbits for slaughter, and in fresh rabbit meat from countries close enough to service the market profitably. The low international market prices for rabbit meat and high cost of air freight make distant suppliers such as Australia uncompetitive in the supply of fresh meat.

Rabbit meat used in manufacturing may be traded at lower prices than meat intended for retail sale.

Farmed rabbit meat is clearly the main substitute product for wild rabbit meat on the world market. The high production of farmed rabbit meat has a dominating effect on the international market price. This situation is unlikely to change in the short term.

Meat produced on rabbit farms in Western Australia may displace sales of wild rabbit meat within Australia. However, the production costs associated with farming will have to be lowered substantially before this would be feasible.

Non-commercial killing

Commercial harvesting has limited capacity to mitigate damage caused by wild rabbits. The rate of harvest must be consistently very high to compensate for the high rate of increase. Further, rabbits are regarded as pests in many regions where harvesting is not now commercially viable.

A variety of techniques are employed by landowners and pest control agencies to suppress rabbit population density and thus reduce the damage they cause. These techniques include poisoning, biological control using the myxoma virus, and warren ripping and fumigation. These techniques have proven very successful at reducing rabbit populations to low levels in many parts of Australia. However, rabbit populations continue to erupt periodically in many arid and semi-arid regions.

Research is continuing to develop cheap, effective methods of controlling rabbit populations in the drier regions. For example, a rabbit flea adapted for arid regions has been imported from Spain to enhance transmission of the myxoma virus; the prospects for controlling rabbit fertility through modifying the myxoma virus are being investigated; and a new biological control agent—rabbit haemorrhagic disease—has been imported and is now being tested at the Australian Animal Health Laboratory in Victoria.

If new techniques prove successful at keeping rabbit populations in arid and semi-arid Australia at low levels, they will reduce the supply to the rabbit industry.

Discussion

There is a substantial international trade in rabbit products. Prospects exist for expanding Australian exports and developing the domestic market. However, several supply and demand factors limit the performance of the industry in both the short and long term.

The supply of rabbits in Australia is strongly influenced by environmental conditions, which can cause populations to crash. As a result, the field component of the rabbit industry must be very flexible to enable rapid relocation of operations to unaffected areas, which may be several hundred kilometres away. The impact of adverse environmental conditions and the impact of pest control on rabbit populations tend to be localised. Because rabbit populations are widely distributed in Australia, this flexible industry can usually ensure supply. The flexibility of the rabbit

industry is acknowledged by Fennessy (1962), who observed that it was 'remarkable and disturbing' that the rabbit industry could continue operating despite the severe setback caused by myxomatosis.

In the longer term, the greatest risk to supply seems to lie with pest control activities. Although eradication of wild rabbits from Australia is impossible, the potential role of the rabbit industry in rabbit management is poorly understood and rarely afforded more than cursory appraisal. There will always be an inherent risk associated with basing an industry on species that are also managed as agricultural and environmental pests. However, this risk may be reduced if a more flexible approach to rabbit management is developed, to integrate the rabbit industry with rabbit management programs.

Introduction of new biological control agents poses a significant threat to the development of the wild rabbit industry. For example, some importing countries have restrictions or special certification requirements for import of rabbit meat from countries where myxomatosis or rabbit haemorrhagic disease (RHD) occurs. Australian exporters generally have a competitive advantage in world trade due to Australia's freedom from RHD. Therefore, introduction of rabbit haemorrhagic disease to Australia for pest control would remove any existing and future advantage a commercial industry would have in accessing these markets, despite its impact on rabbit populations.

Successful introduction of a new biological control agent would, ideally, suppress rabbit populations over a wide area for many years. The damage caused by rabbits would then be greatly reduced, as would the supply of rabbits for the industry. However, the procedures to allow introduction of a new biological control agent are lengthy, and introduction must be demonstrably in the national interest. Once a new biological control agent is introduced, it is important to ensure that the benefits from reduced populations are captured in the long term.

Commercial use may be a socially acceptable method of controlling rabbits. For pest control to be cost-effective, particularly in regions of low economic productivity, or with conservation value, the cheapest methods must be used—poisoning or biological control. It is likely that the community will increasingly view these techniques as less humane than commercial shooting (RSPCA 1985).

There is little data on Australian attitudes to pest control and commercial use of rabbits. However, a survey of 1000 adult people in New Zealand was recently carried out to find out attitudes to various forms of pest control, particularly regarding rabbits, possums and wasps (Sheppard & Urquhart 1991). It was found that 74.1 per cent of respondents considered commercial harvesting as a very suitable or suitable method of controlling pests. Use of diseases, poisons and gas were considered less acceptable. As eradication is unachievable, it may be appropriate to manage rabbits to use their products, if this does not compromise other management goals.

There is strong demand for quality wild rabbit skins for the felt hat trade in Australia. Wild rabbit fur is considered superior to that of farmed rabbits. The process of manufacturing felt hats is labour-intensive and represents a high degree of value-adding. However, prices offered for rabbit skins are low ($0.25–0.35 each). The meat must also be sold, as it is not commercially viable to harvest skins alone. Therefore, the fortunes of the rabbit meat industry influence the supply of fur to manufacture hats for domestic and export markets. As a priority, the Australian rabbit industry needs to pursue a strategy to expand sales of rabbit meat.

The rabbit meat industry is concentrated in regions where rabbit population density is high and rainfall is low. The rabbits in these arid regions yield the lean white meat with a white body fat preferred by consumers. Wild rabbits also occupy large tracts of fertile land in higher rainfall zones, but the meat of animals from these regions is generally less attractive to consumers. The commercial harvest may extend into higher

rainfall zones when demand is high or supply from preferred areas dwindles.

Australian consumers are accustomed to buying wild rabbit meat. The Australian market is typically oversupplied by local processors, and prices are low. It would be difficult to expand sales in the domestic market without a higher level of product promotion. The rabbit meat industry does not have any infrastructure to facilitate promotion of products.

Export markets for rabbit meat are large and some sectors offer prospects for growth. Rabbit meat consumers in Europe and North America prefer dressed rabbit carcases that weigh between 1.0 and 1.5 kilograms. Australian consumers prefer dressed rabbit carcases that weigh at least 750 grams. Wild rabbits could be at some disadvantage in the marketplace due to their smaller size. The rabbit meat industry needs to promote the positive qualities of the Australian product to better position it in world markets.

Rabbit meat is perceived as a down-market product in many countries, and because there are many suppliers of rabbit meat, the prices paid on the international market are low. Commercial operations must consequently be very efficient and geared for high volume and low margins. It is costly to enter and leave the export market opportunistically, and greater diversity of markets and better penetration of key markets is needed to ensure sustained growth in exports.

Farmed rabbit meat dominates the export trade in rabbit meat. China is the major supplier, but developing economies such as Hungary are gaining increasing market share. Access to countries in the EC, which account for 85 per cent of international trade, may become more difficult for suppliers from developed countries. It is important to promote the Australian product aggressively to establish and maintain a larger market share.

The commercial reality of the rabbit industry is that processors are now selling most of their products to low-income consumers, at low margins, with increasing competition, in markets that are static or declining in the long term. Commercial rabbit production has consequently become known internationally as the '18-month industry', this being the average duration of participation by new operators. Reversing this situation will require extensive promotion of rabbit products.

Australian exports of wild rabbit meat have been rising steadily since 1988, which demonstrates that the Australian product is accepted by overseas consumers and that it is competitive with substitute products. Careful attention to quality assurance, along with thoughtful but aggressive marketing, should ensure that sales continue to expand. However, there remains a need for improved organisation within the wild rabbit industry to better coordinate marketing and promotion of products within Australia and overseas and thereby ensure industry development.

14 EUROPEAN BROWN HARE

Distribution and abundance

The natural distribution of the European brown hare, *Lepus capensis*, includes Africa and southern Europe as far east as central China (Lever 1985). It has been introduced to many countries and has established wild populations in Ireland, Finland, Sweden, Siberia, the USA, Canada, the West Indies, Argentina, Chile, Uruguay, Brazil, Falkland Islands, Australia, New Zealand and Hawaii (Lever 1985).

Hares were introduced to Australia from England several times since 1837 for sport hunting (Rolls 1969). Coursing, which involves using hunting dogs to chase a hare, was a popular sport in Britain and Ireland, and Australian settlers were keen to establish a population of wild hares to hunt.

A breeding colony of hares was set up in 1863 on Phillip Island in Victoria by the Acclimatisation Society of Victoria to supply hares for further introductions to mainland Australia, Tasmania and New Zealand (Rolls 1969). These new introductions were successful and by 1870 hares were distributed throughout south-eastern Australia, including Victoria and parts of New South Wales, South Australia, Tasmania and Queensland. Hares were introduced to Western Australia in 1874 and 1902 but did not establish persistent populations (Long 1988).

Hare populations erupted to initial high densities in south-eastern Australia and rapidly occupied suitable habitat—a pattern typical of introduced mammals (Caughley 1977). Unlike rabbits, hares do not burrow and are generally solitary, except during late winter breeding. They prefer grasslands and open woodland habitats (Mahood 1983a). It is likely that agricultural practices, such as clearing of forests, helped in expanding the distribution of hares by increasing the amount of suitable habitat.

By the 1890s, hares had reached plague proportions and were widely regarded as pests (Rolls 1969). Evidence of this high pest status for hares included attempts to kill them with phosphorous poisoned oats, hare drives, commercial use of hares and bounties on hare scalps (Rolls 1969; Lunney & Leary 1988). Farmers and gun clubs organised shoots, where hundreds and sometimes thousands of hares were killed in a single morning (Rolls 1969). Traders advertised for hares for meat and fur. Pastures Protection Boards in New South Wales began paying a bounty on hare scalps, and between 1890 and 1902 at least 300 000–400 000 scalps were taken annually (Jarman 1986).

Following the eruption in hare numbers, populations appeared to decline rapidly during the latter part of the first decade of this century (Rolls 1969). The cause of the decline is unclear, though such declines typically follow eruptions by introduced species as they come into an ecological balance with their new environment (Caughley 1977).

A review of native and exotic animals in the Bega district of New South Wales showed that the peak and subsequent rapid decline of hares coincided with the arrival of the fox and with a rise in rabbit numbers (Lunney & Leary 1988). Jarman (1986) made a similar observation for the Armidale district of New South Wales, and added that introduced herbivores and parasites may have contributed to the population decline. Hares in the Armidale district now occur at a density of 0.02–0.06 hares per hectare (Jarman 1986).

All explanations for the continued low abundance of hares in Australia are unproven. Management of hares in Australia and overseas is complicated by the lack of data on the ecology and population biology of wild populations. It would be useful, for example, if there were sufficient data to predict the response of hare populations to land management practices that dramatically reduce the population density of rabbits and foxes.

Status

Hares are not protected and are hunted throughout the year. They are regarded as minor agricultural pests, but are also considered as a resource by recreational and commercial hunters.

Commercial use

The international trade in hare meat and skins is difficult to quantify, because hares and rabbits are grouped together in the foreign trade statistics of major importers.

Hares are highly valued by sporting hunters in Europe (Stuttard 1979), but hare numbers have declined in Britain and continental Europe for the last two decades. The cause of this decline is poorly understood, but may include disease, pesticides, predation (especially by foxes) and hunting (Pielowski 1979; Kovacs & Heltay 1979). To maintain adequate stock for hunting, countries such as France and Italy have adopted a policy of restocking by importing live hares from Argentina, Hungary, Poland and Scotland (Stuttard 1979; Jackson 1986).

European hunters shoot hares for sport and food, but there is also a significant trade in meat. Demand is strongest in Western European countries, such as France, Germany and Italy, which import hare meat to satisfy local demand. Argentina and Eastern European countries, including Hungary and Poland, are major suppliers.

Hares were introduced to Argentina in 1888 for sport, and within two decades the population had exploded and hares were declared a national pest (Jackson 1986). Subsequently, a multi-million dollar industry developed, based on the harvest of 5–10 million hares annually (Amaya 1979). Argentina is now the world's largest exporter of wild hare meat, and annual exports amount to 10–14 thousand tonnes, worth up to $38m (Mares & Ojeda 1984; Jackson 1986).

Germany imports about one-half of the hare meat exported from Argentina, and France takes about one-third. Lesser quantities go to Austria, Belgium, Italy, the Netherlands and Switzerland (Jackson 1986). However, the most lucrative sector of the hare industry in Argentina is the capture and sale of live hares to Europe. In 1981, a total of 9900 hares worth $60 each were exported from Argentina to Europe (Jackson 1986).

Australia—Meat and skins

The method of harvesting hares in Australia is identical with that for rabbit shooting, although the rabbit harvest occurs on a much larger scale. Few hares are shot because they have a limited distribution and occur at low population densities. Consequently, it is uneconomical to hunt only hares, and hunters tend to shoot hares opportunistically while hunting for other species such as rabbits, foxes or kangaroos. The habitats of hares and these other species may not overlap completely, which influences supply of hares; availability of hunters is a major factor controlling the size of the hare harvest. Nonetheless, hunters will detour through areas of higher hare density when prices warrant the extra effort.

Fox hunters and professional rabbit shooters probably harvest most hares. The area that produces the largest quantity of good quality fox furs is a crescent shape, stretching from the New England region of north-eastern New South Wales, southwards towards Sydney and then west through Canberra to Victoria. Hares are most common in this cool, higher rainfall zone (Mahood 1983a). Buyers report increased hare harvests when fox fur prices are high, which reflects the increased hunting effort for foxes. The fox harvest is highly seasonal and only operates during winter when fur quality is highest. Consequently, supply of hares is also seasonal. There is no data to verify a correlation between fur prices and the size of the hare harvest.

Most rabbits are shot by professional shooters in arid Central Australia where hares are absent or rare. However, the

rabbit harvest occasionally shifts to higher rainfall areas, such as central and north-eastern New South Wales, when rabbit numbers crash in Central Australia (for example, due to the effects of drought). Hares are common in these higher rainfall areas, and the professional rabbit shooters will harvest hares opportunistically.

Meat production and distribution

Like the rabbit meat industry in Australia, the local trade in hare meat is largely unregulated. Shooters sell dressed hares to specialist meat wholesalers, or directly to retailers or restaurants. Alternatively, shooters can sell the eviscerated carcase, with the skin and head attached, to a chiller operator (located in rural centres), who supplies rabbit processors. Supplying hares through the rabbit meat processing industry is the most efficient means of distributing the meat to domestic markets. This production line is explained below.

Hunting takes place late in the afternoon, during the night or early in the morning. Most hares are shot from a vehicle during the night, using a .22 calibre rifle and spotlight. Head shooting is encouraged to reduce spoilage of the meat.

The carcase is eviscerated in the field, leaving the skin, head, feet, heart, liver and lungs attached. It is then hung on a rack on the rear of the hunting vehicle and delivered to a field chiller at dawn. Hunters are paid about $4–5 per hare, although prices may reach $7 or more when demand is strong. The total number of hares shot is unknown, but industry estimates vary from 10 000–20 000 annually.

The hares are collected from the field chillers and transported in refrigerated vehicles to rabbit processing establishments. The head, feet and skin are removed at the processing works, and the carcase is trimmed and prepared for sale. A whole dressed carcase can weigh up to 2.5 kilograms. The carcases are usually graded by weight, with small hares weighing less than 1.5 kilograms, and large hares weighing over 1.5 kilograms. Some dealers require that large hares weigh over 2 kilograms.

Little is known about the Australian market for hare meat. Melbourne is considered the largest market, and demand is strongest in winter. Most hare meat is sold as chilled carcases, primarily to the restaurant trade, although lesser quantities are sold at retail through specialty delicatessens. Wholesale prices vary between $8–13 per hare, and retail prices are from $13–15 or more per hare.

The Argentinian hare meat industry operates differently from the Australian industry. Hunting is seasonal in Argentina, extending from May to September, and shooters deliver whole carcases, with the gut intact, to the processing factory daily (Jackson 1986). The average weight of a hare carcase varies according to sex, age, season and also between regions and countries in which they are taken (Pepin 1979; Alsina & Brandani 1979; Jarman 1986). The average weight of a dressed carcase produced in Argentina is about 1.8 kilograms (Amaya 1979), which is comparable to that for Australian hares.

Hare skins are also used commercially in Australia. The raw skins are stretched over a wire frame and hung to dry. Once dried, the skins are worth $0.30–0.70 each. The highest prices are received during winter, when quality is highest. Most hare skins entering commercial trade are from carcases processed through a rabbit meat establishment. If hunters remove the skin in the field and sell the meat directly to a wholesaler or retailer, the skin is usually discarded. Nonetheless, hunters or rabbit processors can sell dried skins at auction, to a fur dealer, or directly to a felt hat manufacturer. Most dried hare skins are now sold direct to a felt hat manufacturer in New South Wales.

Industry value

The total wholesale value of the hare meat and skin industry in Australia is worth $200 000 at most, based on production of 20 000 animals with a value of $10 each. Hares are only a sideline for existing industries.

Pest control

Hares are not regarded as major pests in Australia. They are generally tolerated on farmland, although they can cause damage by gnawing bark in orchards or forestry plantations and by eating some crops (Jarman 1986). However, apart from damage to small trees due to eating the bark, hares are considered less harmful than rabbits, because they do not graze as close to the ground and occur at low population densities (Smith 1987).

Hares are not susceptible to myxomatosis and do not readily take poisoned baits (Mahood 1983a). Therefore, field shooting is the principal method of reducing the density of hare populations. Other methods include exclusion fencing, use of repellents, and use of snares and steel-jawed traps (Smith 1987). The number of hares killed for pest control is unknown.

Discussion

There is little quantitative data on the impact of hares on agriculture and the environment in Australia. However, the limited distribution, low population densities and browsing habits has led to a perception that hares are a minor pest. Hares can frustrate efforts to revegetate degraded habitats by eating the bark from young trees. Nevertheless, damage is usually localised, and shooting is the most efficient means of control. Although the commercial harvest of hares reduces the population density, the role of hunting in controlling the adverse impact of hares is unknown. There is a need for more specific information on hare density and impact.

The commercial harvest of hares in Australia is small and limited by the availability of hares rather than by markets for the products. Further, hunters usually shoot hares as part of a multi-species harvest, and the cost of shooting hares is thereby subsidised by income from other species (e.g. rabbits, foxes, kangaroos) taken during the hunt. The implication of this interdependence on other species is that supply can be limited by reduced availability of hunters when prices for other products fall. For example, the fox fur harvest is highly seasonal, and varies significantly between years in response to volatile international fur prices. As fox hunters are major suppliers of hares, the fortunes of the fur industry can influence the supply of hares. Australian processors could supply more hares to the domestic market, and perhaps enter export markets on a small scale, if hares were more abundant, supply was more stable, or prices for hare meat were much higher.

Several factors limit the capacity of the Australian industry to enter export markets. Firstly, low population density increases the unit costs of harvesting, and limits the capacity of the industry to supply container-sized (that is, about 18 tonnes) shipments for export. Further, the large volume and low price of hare products exported from Argentina will influence the opportunity for Australian exporters to enter international markets. The prices now offered for hare meat on the export market are unlikely to change significantly unless the continued decline of wild hare populations in Europe results in much stronger demand for imported meat.

A continued decline in European hare populations could lead to a growth in demand for live hares for restocking. Australian exporters have not investigated the prospects for export of live hares. The trade in livestock is limited, but potentially lucrative. More income is derived from the sale of live hares rather than from sale of hare products. However, several issues would need to be explored to determine if export of live hares from Australia is viable. For example, suitable methods of capture and transport would need to be developed, veterinary and import requirements would need to be identified, and market characteristics, such as trends in the quantity and price demanded, need to be explored.

Hare meat is sold on domestic and export markets as an up-market gourmet

product at roughly double the price of rabbit meat. Further, most of the skins are used within Australia to manufacture high quality felt hats. Although the Australian hare industry is small, it receives high prices for the meat, and value-adding of the skins is maximised. However, the existing domestic and export prices offered for hare meat and skins, and the limited distribution and low densities of hares in Australia, suggest that the Australian harvest will remain small.

15 EUROPEAN RED FOX

Distribution and abundance

The European red fox, *Vulpes vulpes*, is the most widely distributed carnivore in the world (Voigt 1987), occurring through most of Asia, North America, Europe and Northern Africa. Red foxes were introduced to Victoria from Britain for sport hunting in the 1860s, and a wild population established by the 1870s (Rolls 1969). Today, only Tasmania remains free of this predator as foxes have otherwise colonised all mainland States and Territories. Fox distribution does not extend to the wet tropics (Coman 1983). Competition with and predation by dingoes could be a limitation on fox distribution and abundance (Marsack & Campbell 1990).

Foxes are opportunistic predators and scavengers, with diet varying geographically and seasonally with prey availability (Coman 1973; Croft & Hone 1978; Triggs et al. 1984; Catling 1988; Lunney et. al 1990). Small mammals are the main prey, and the European rabbit, *Oryctolagus cuniculus*, is the staple food. In areas where rabbits are absent or rare, foxes eat small native animals, such as the ringtail possum, *Pseudocheirus peregrinus*, and *Antechinus spp* (Triggs et al. 1984).

The long-term effects of fox predation on native animal populations are unclear. It is difficult to separate fox predation from the effects of habitat change and loss, introduction of domestic livestock, and predation by other carnivores such as the dingo and the feral cat since European settlement. However, there is mounting circumstantial evidence suggesting that foxes limit the distribution and abundance of some extant small mammals and may have had a role in the extinction of others.

Much of the evidence implicating foxes as a threat to native species is anecdotal, and usually derived from gut content studies. However, evidence from a study on remnant rock wallaby population dynamics in Western Australia suggests that fox control is important to protect endangered animals (Kinnear et al. 1988).

Foxes will also feed on sheep carrion (Croft & Hone 1978; Lunney et al. 1990), but actual stock losses have not been established. There is some evidence that fox predation on goat kids may be significant (Long et al. 1988), because female goats hide the kid in undergrowth while they forage.

Rabies does not occur in Australia. However, foxes could play a significant role in the spread and persistence of rabies in Australia (Murray & Snowdon 1976; Wilson & O'Brien 1989). The red fox is the major rabies host in Europe (Anon. 1989a). Extensive and expensive fox control measures have not eliminated rabies from Europe (Anderson 1986), except in small areas (Harris et al. 1988). In Australia, foxes occur in both urban and rural habitats, and therefore have close contact with people, domestic livestock and wildlife. Rabies would be very difficult to eliminate should a fox-adapted strain become established in the wild fox population in Australia. However, some authors consider that the risk of introduction of a dog-adapted rabies biotype from Asia is greater (Garner 1992).

Status

Foxes are declared pests in all States and Territories of Australia. Landowners, State and Territory pest control agencies, and conservation agencies, carry out fox control to reduce agricultural and environmental damage.

Commercial use

The Soviet Union is considered the largest producer of furs from wild animals in the world (Shieff & Baker 1987), but most of this production is for domestic use rather than for export. The major exporters of wild furs are Australia, Canada and the United States of America. Canada and the USA are major consumer markets for fur products, but the Australian fur market is very small.

The value of wild furs produced in North America in 1982–83 was about $268m (Shieff & Baker 1987). The most valuable species

are the raccoon ($97.4m), followed by the muskrat ($35.3m) and the red fox ($30.5m).

In 1982–83, the total production of wild red fox furs in Australia and North America amounted to over 885 000 furs valued at $38.6m (table 15.1). Australia supplied about 40 per cent of the total quantity produced in these countries in 1982–83, but only 21 per cent of the total value of production. Fox furs produced in North America have a higher average value because the colder climate produces a better quality fur. Some Australian fox furs match the quality of those from North America, but in general the average quality is lower. In terms of quantity, Australia is the world's largest exporter of wild red fox fur.

Table 15.1: Quantity and value of wild red fox fur production in Australia, Canada and the United States of America in 1982–83

COUNTRY	Unit value	Number produced	Value of products
AUSTRALIA	23.20	350 981	8 152 000
CANADA	57.03	88 800	5 063 000
USA	57.03	445 630	25 414 000
TOTAL		885 411	38 629 000

Sources: Shieff & Baker 1987; Australian Bureau of Statistics. Australian figures refer to exports only. All values are expressed in current Australian dollars.

Australia's commercial fox fur harvest operates during the winter months in the cool southern regions of the country. Most wild foxes are field-shot, and use of steel-jawed traps and poisons are uncommon. Hunters do not require a special permit to hunt foxes, but they must comply with State or Territory firearms legislation. Professional and recreational hunters shoot foxes for fur. When fur prices are high, professional kangaroo shooters may switch to fox hunting during winter.

The fur industry estimates that about 60 per cent of fox furs supplied to the commercial trade come from New South Wales, 30 per cent from Victoria, and 10 per cent from South Australia. About one per cent of furs from the commercial fox harvest come from Queensland and Western Australia.

Hunters peg the furs out to air-dry in preparation for sale. Hunters sell the dried furs in two ways—at auction houses, or by selling to a local, regional, or national fur buyer. There are about 12 auctions held in Melbourne between May and December every year (table 15.2).

At the auction house, the furs are sorted and classified according to size and quality, and offered to buyers. The size categories used are large, medium and small. Demand is strongest for large furs (table 15.3), which are generally over 85 centimetres in length from the base of the tail to the eyes. Medium furs measure from 60–85 centimetres and small furs are less than 60 centimetres in length.

In a study in Victoria, Coman (1988) found that hunting by night shooting killed a high proportion (77 per cent) of foxes under two years old, when compared with other methods of capture. Table 15.3 shows that 60–70 per cent of furs going to auction are

Table 15.2: Number, value and end use of fox furs auctioned in Melbourne

CALENDAR YEAR	TOTAL NUMBER OF FURS AUCTIONED	AVERAGE VALUE *	NUMBER OF FURS USED LOCALLY	LOCAL USE (%)
1986	109 271	22.23	20 127	18.4
1987	105 654	21.40	21 805	20.6
1988	101 982	9.80	18 133	17.8
1989	44 145	10.46	8 406	19.0
1990	56 427	8.39	5 414	9.6

* Average value refers to regular quality furs.
Source: Australian Skin Auctions Pty Ltd
Note that fur used locally may ultimately be exported. All values in current Australian dollars

from large foxes. Therefore, hunters probably discard the furs from many small and immature foxes because of low demand and prices. The annual fox cull by recreational and professional hunters could be much higher than the number of furs entering commercial trade.

Table 15.3: Size classes (%) of fox furs auctioned in Melbourne

Size class	1989	1990
Large	62.8	73.5
Medium	36.9	25.2
Small	0.3	1.4

Source: Australian Skin Auctions

Furs in each size category are divided into three classes—first, second or third—depending on the quality and length of fur. The condition of furs in each class is then classified as sound, slightly damaged, or medium damaged. Usually, the damage is caused by bullet wounds or knife cuts from poor skinning techniques. For simplicity, all large and medium furs of sound or slightly damaged condition are termed 'regulars' by the fur trade, while all other furs are termed 'lows'.

Most raw furs are sold to manufacturers within a year of harvest. If kept for longer, the skin deteriorates, resulting in fur loss, and the natural oils in the fur dry out, causing it to become dull and flat. Therefore, as most Australian fox furs are exported as raw furs, export statistics reflect the scale of the harvest during the same year.

The main importers of Australian fox furs are Germany, Hong Kong, and the United Kingdom (table 15.4). Most furs exported to the United Kingdom are sold at auction in London and re-exported to manufacturers, particularly in Germany. Furs are similarly re-exported from Hong Kong as raw furs. Most Australian fox furs are ultimately sold at retail stores in Germany and Spain.

The structure of the fur industry, with many hunters, and many buyers bidding for furs at domestic and international auctions, allows a very free interaction of market forces. As a result, there is a strong correlation between export prices and the number of furs exported (figure 15.1). The size of the commercial harvest is constrained by overseas demand (reflected in the price paid) for fur rather than any limitations on supply of wild foxes.

The distribution channels of fox furs from hunter to domestic or overseas manufacturers can vary (that is, through a fur dealer, or through auction), but all raw furs must be tanned or dressed before being used in commercial garments. Dressing involves cleaning, tanning, stretching and combing the pelts. After dressing, the pelts may be dyed or coloured to improve their

Figure 15.1: Relationship between fur prices and export volume

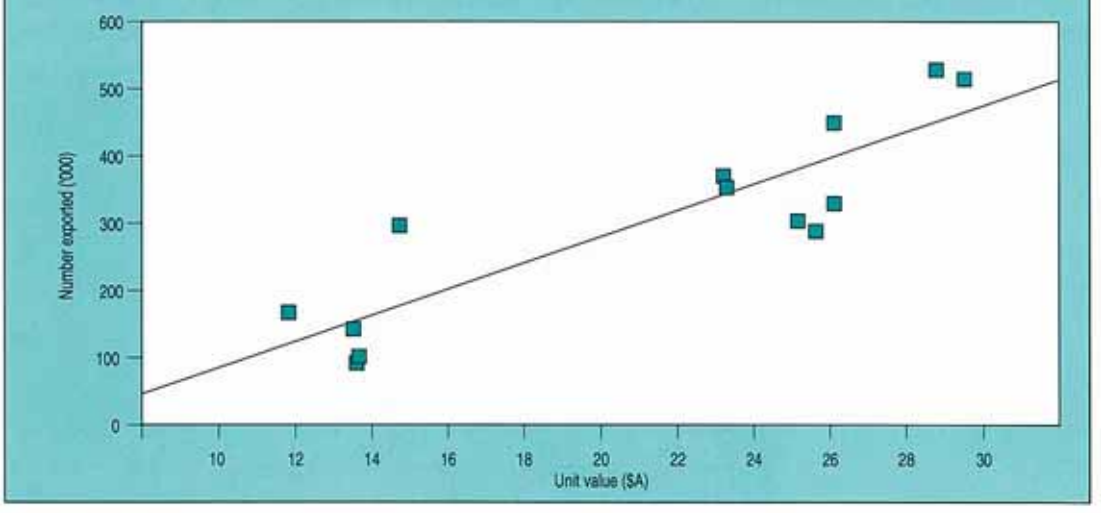


Table 15.4: Number, value and destination of raw fox fur skins exported from Australia (all values are in Australian dollars)

FINANCIAL YEAR	CHINA		DENMARK		GERMANY		HONG KONG		UNITED KINGDOM		OTHER COUNTRIES		ALL COUNTRIES		UNIT
	NUMBER	VALUE	NUMBER	VALUE	NUMBER	VALUE	NUMBER	VALUE	NUMBER	VALUE	NUMBER	VALUE	NUMBER	VALUE	VALUE
1979–80 *	15 116	423 000	17 034	313 000	267 843	7 814 000	46 762	1 416 000	116 919	3 485 000	51 965	1 583 000	515 604	15 034 000	29.16
1980–81 *	550	15 000	41 485	1 240 000	243 422	6 762 000	106 737	3 271 000	114 882	3 387 000	24 531	446 000	529 821	15 068 000	28.44
1981–82	12 537	324 145	19 313	496 856	224 620	6 365 425	101 163	1 832 741	79 674	2 221 696	12 453	410 446	449 760	11 651 309	25.91
1982–83 *	10 604	250 000	5 325	111 000	170 476	3 898 000	77 010	1 678 000	70 507	1 723 000	19 159	541 000	350 981	8 152 000	23.23
1983–84	780	21 165	2 785	63 355	156 861	3 965 808	20 063	431 228	103 653	2 579 336	19 127	563 521	303 269	7 624 413	25.14
1984–85	0	0	2 471	49 500	141 932	3 526 427	9 362	209 181	120 814	3 239 771	13 912	324 398	288 491	7 349 277	25.47
1985–86	19 612	288 341	4 306	34 048	117 813	1 736 512	20 834	319 444	118 908	1 772 992	17 260	343 531	298 733	4 494 868	15.05
1986–87	10 750	352 648	1 125	16 905	157 496	3 627 753	70 008	1 542 491	117 723	2 583 062	10 802	392 011	367904	8 514 870	23.14
1987–88	100	3 802	5 815	89 525	120 423	3 350 432	47 230	1 139 433	145 456	3 580 537	10 920	378 680	329 944	8 542 409	25.89
1988–89	3 475	22 887	1 395	9 228	103 347	1 311 105	20 574	277 270	40 948	452 678	32	552	169 771	2 073 720	12.21
1989–90	2 197	25 884	1 200	15 600	60 397	817 847	31 876	435 414	1 047	10 613	2	1 460	96 719	1 306 818	13.51
1990–91	5 300	48 135	17 772	217 102	62 422	859 367	13 453	204 749	0	0	3 250	54 580	102 197	1 383 933	13.54
1991–92	0	0	16 244	182 234	73 751	979 479	2 000	19 600	0	0	52 177	759 493	144 172	1 940 806	13.46

* Values rounded to '000's. Totals adjusted for re-exports. All values in current dollars

Source: Australian Bureau of Statistics

attractiveness to the fashion market. Finally, the pelts are matched to ensure consistency in quality, size and colour, before cutting and stitching to produce a garment. The process of preparing and manufacturing fur garments is described in detail by Schipper (1987). There is little waste during the manufacturing process, because the fur trimmings are used for cuffs, collars or pockets.

Wild furs have many more variations in fur colour and quality than farmed fur. Farmed furs are easier to match because the animals are of similar genetic lines, raised on identical diets and pelted (slaughtered and skinned) at the same time. Therefore, it is necessary to buy larger quantities of wild furs, to match garment lots. This can make wild fur products more expensive. Most furs sold on the world market are now supplied from farmed animals. There are no fur farms in Australia.

The fur dressing and manufacturing process requires specialised knowledge and technical skills. On the world scene, most fur processing occurs in several plants in Greece, Canada, Germany, Italy and Finland. The Australian fur dressing and manufacturing industry is very small, because of the small domestic market for fur garments, the limited quantities of high quality furs and the lack of skilled workers in Australia.

About 20 000 raw fox pelts are purchased through the Melbourne fur auction each year by domestic manufacturers (shown previously in table 15.2), although additional furs can be purchased directly from fur traders. Nonetheless, exports of raw fox fur far outweigh domestic consumption. Most garments manufactured from Australian fox fur are sold to middle income consumers, through department stores in Germany and Spain. High grade farmed fur and wild furs from colder climates dominate the specialty fashion boutique markets.

Australian consumers seem to prefer imported furs such as mink, and local manufacturers would handle more imported raw furs than locally produced fox fur. In 1986–87, when world demand for fur products was quite strong, 103 244 raw mink fur skins worth $1.48m were imported into Australia for garment manufacture. To place the Australian market in a world perspective, over 30 million mink furs were available on world markets in 1984 (Shieff & Baker 1987).

Australian fur exporters claim that the wild fox fur is more durable than fur obtained from overseas fox farms. This durability has allowed Australian fox fur to remain competitive with farmed fox fur, although it is marketed more as a practical and affordable fur rather than as a high fashion fur. However, some authors contend that there is no significant difference between wild and farmed fur of comparable grades (Shieff & Baker 1987).

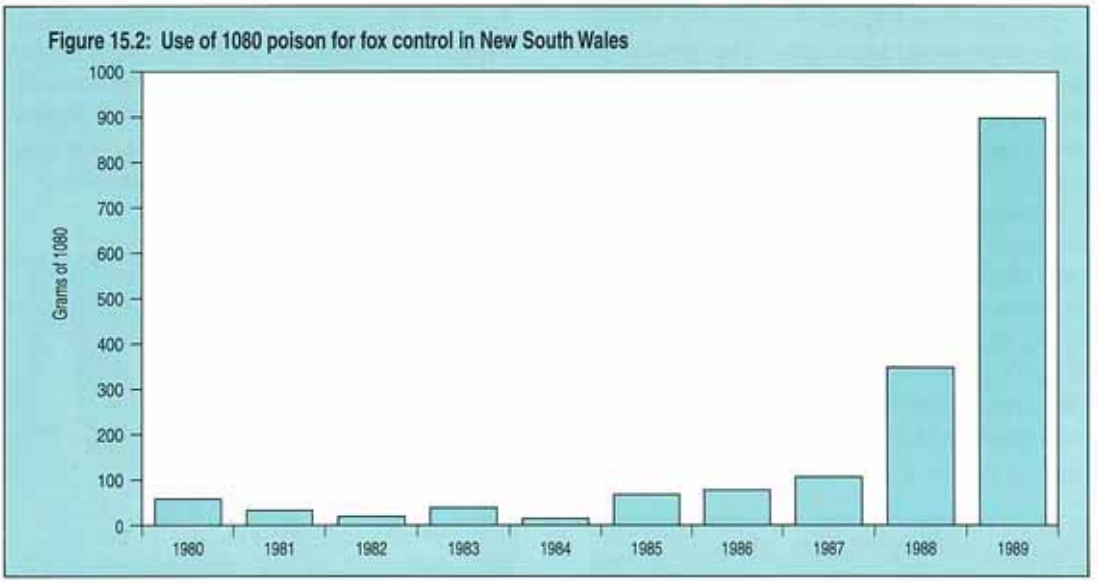
World demand for fox fur has been poor in recent years. Trade in fur products has traditionally shown cyclic patterns in response to changes in economic conditions, consumer demand and the supply of fur (Jorgensen 1982). If this pattern is consistent, the fur trade may soon enter a recovery phase. However, it is likely that the current slump in demand reflects the activities of animal rights groups, which have influenced consumer and retailer attitudes to furs. This was a clear outcome of the campaign to stop the harvesting of harp seal pups in Canada (Royal Commission on Seals and the Sealing Industry in Canada 1986). The long-term influence of the animal rights movement on the fur industry is difficult to predict.

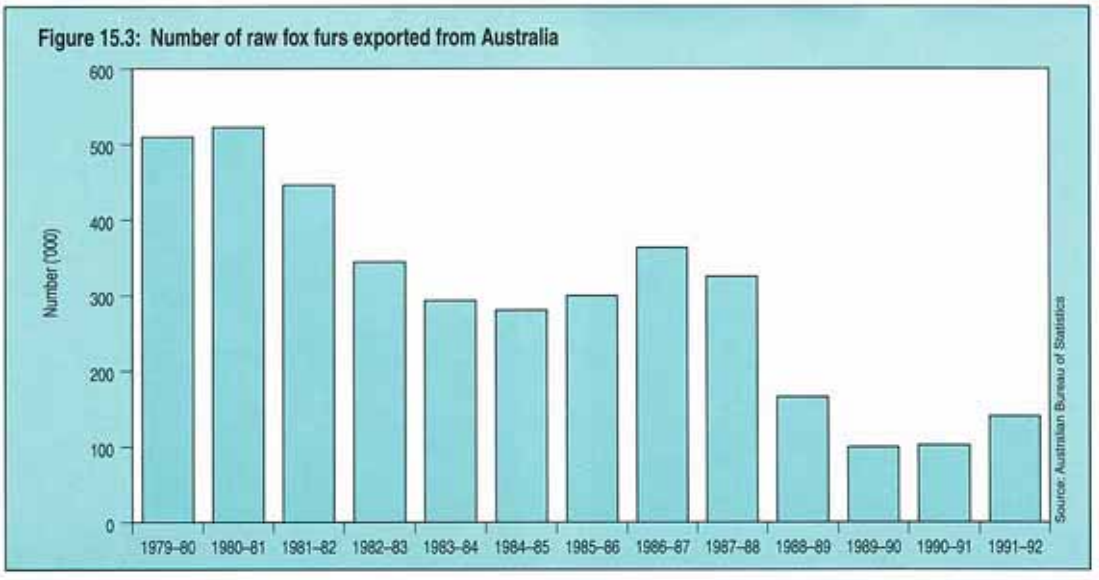
The fur industry in the Northern Hemisphere is based on farming and trapping. These practices have raised serious welfare concerns, leading to calls for more restrictive legislation to control fur production and marketing (Commission of the European Communities 1991). In particular, the European Community is considering restrictions on trade in furs from animals caught in steel-jawed traps. The Australian fur industry could take advantage of such laws, because field shooting is the most common method of killing foxes. However, steel-jawed leghold traps are permitted in many jurisdictions in Australia to kill vertebrate pests, which may jeopardise future access to the European market.

An indication of future demand for Australian fox fur may come from overseas prices for premium furs. Farmed mink fur is the premium fur product on the world market. Therefore, when the supply of farmed mink fur exceeds demand, the price falls, as does the price for other furs, such as Australian fox fur. Scandinavian countries, particularly Denmark and Finland, produce and export most farm-raised mink fur. The rapid growth in production farmed mink fur over the past decade (Shieff & Baker 1987) may have exacerbated the current poor market conditions.

Non-commercial killing

Land managers and vertebrate pest control agencies in all States and Territories of Australia (except Tasmania, where the red fox is absent) kill foxes to reduce the population density and distribution. The methods of killing foxes include poisoning using meat baits impregnated with 1080, cyanide or strychnine; shooting; fumigation of dens with phosphine gas, or trapping using steel-jawed traps (Thompson et. al 1990). Exclusion fencing can be used to limit the distribution of foxes. However, it is expensive





and usually only applied in localised areas where fox predation is especially undesirable, such as for conservation or research purposes.

Techniques used to kill foxes vary between and within States and Territories. For example, steel-jawed traps are illegal in many jurisdictions. Nonetheless, for every non-commercial technique used, an unknown number of foxes are killed in Australia by land managers and vertebrate pest agencies. Records of poison usage are available, although some States combine data for fox baiting with wild dog/dingo data, and a national total on poison usage—specifically for fox control—is unavailable.

The most widely used method of killing foxes is by using 1080 baits. The amount of 1080 poison used per bait varies between States and Territories, but 2.5 milligrams per bait appear to be ample (McIlroy & King 1990).

A closer examination of fox control in one State can be made by using the quantity of 1080 used as a guide to control effort. Foxes are abundant and widely distributed in New South Wales, and the State vertebrate pest control agency maintains detailed records of 1080 use. New South Wales is also the most important region, regarding quantity and quality, for the commercial harvest.

Table 15.5: Use of 1080 poison for fox control in New South Wales

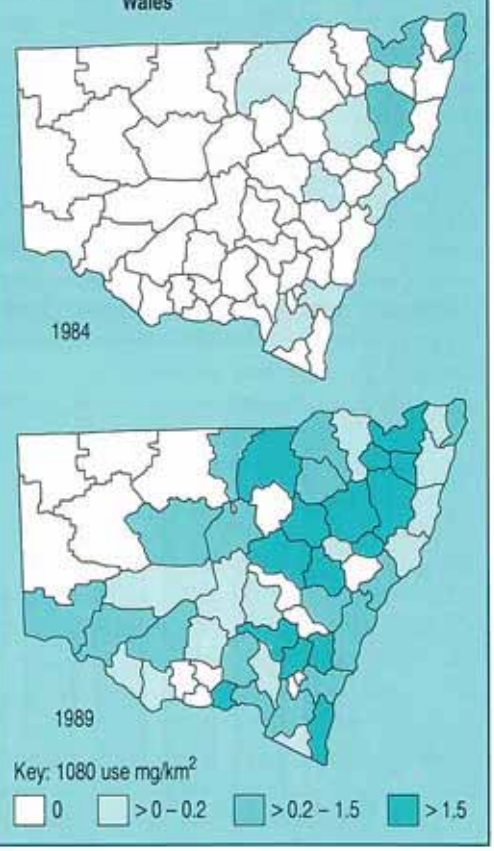
CALENDAR YEAR	*1080 (GRAMS)*	*ESTIMATED NUMBER OF BAITS*
1980	57.31	14 328
1981	32.24	5 373
1982	17.32	2 887
1983	37.12	6 187
1984	12.23	2 038
1985	63.76	10 627
1986	72.99	12 165
1987	104.05	17 342
1988	351.19	58 532
1989	896.13	149 355

Source: NSW Agriculture and Fisheries

Use of 1080 in New South Wales has increased markedly in recent years, while the commercial harvest in Australia has declined (figures 15.2 and 15.3). Figure 15.4 shows the change in patterns of use of 1080 within New South Wales following the collapse of fur prices. The eastern and southern parts of New South Wales are the focal areas for the commercial harvest, and it appears that these regions are now the subject of increased baiting.

Considering the general lack of data on either the damage caused by fox predation or the success of 1080 poisoning in limiting that damage, growth in use of 1080 in New South Wales in recent years is difficult to explain and alarming. Between 1985–86 and 1988–89 inclusive, use of strychnine by landowners in South Australia for fox control was quite stable by comparison, varying between 2.8 and 3.7 kilograms annually.

Figure 15.4: Patterns of use of 1080 in New South Wales



Conclusions

The commercial harvest of red foxes in Australia has been substantial in the past, and could account for more animals than other non-commercial efforts to reduce population densities. The commercial harvest therefore contributes to reducing control costs, and may reduce damage to agriculture and the environment caused by fox predation. However, whether foxes are shot or poisoned, the amount of control required to limit damage is unknown.

One limitation of the commercial harvest is that it does not extend to warmer regions, where fox populations may be abundant (for example, in northern New South Wales and Western Australia). However, it is likely that when fur prices are high, a wider range of fur qualities is marketable. Further, the geographic range of the fox harvest would expand to include regions producing lower quality fur. The relationship of price to patterns of harvesting has not been investigated in Australia. Monitoring of the commercial fox harvest is the primary method of evaluating changes in fox distribution and abundance in North America (Voigt 1987).

The scale of the commercial harvest in Australia is directly correlated to international fur prices. It would be useful to have a better understanding of the market factors that underpin price variations. Such knowledge is valuable for understanding the prospects for the fur industry in Australia, and could also be useful when developing strategies for control of foxes in some regions. The tight linear relationship between price and number harvested provides a mechanism for using bounties to manipulate hunter effort. To do so effectively requires: first, an understanding of the numbers to be removed; and second, application of bounties that vary in value with animal density.

The fur industry in Australia is small in a world context, but export-oriented, and the world's largest supplier of wild red fox furs. The best prospects for increasing export earnings from fox fur is by increasing the quantity sold through better penetration of overseas markets. There is scope for diversifying into Northern Asia and the new markets in Eastern Europe.

The Australian fox fur industry should develop and implement marketing strategies that position their product as environmentally acceptable—foxes are a potential threat to native fauna, and all furs are taken by field-shooting. Encouraging the harvest to reach unsustainable levels in some regions is consistent with pest management objectives.

The two main threats to the fur industry are market access and changing fashions. Western Europe is the largest market for Australian fox fur. However, proposed (European) legislation to restrict trade in furs of wild animals from countries where steel-jawed leghold traps are used will jeopardise access for the Australian fur products. This is both a major threat and a significant opportunity for the Australian fur industry. It is a threat because steel-jawed leghold traps are used for pest control in Australia, and an opportunity, because supply from competitors in North America and Eastern Europe will be restricted.

From an animal welfare perspective, it may be irrelevant whether a steel-jawed leghold trap has a pest control or commercial function—it is either humane, or it is not. The steel-jawed leghold trap has been banned in 67 countries and animal welfare groups in Australia are now lobbying for the device to be banned here (Anon. 1992). It would seem timely for the Australian fur industry and relevant government authorities to review the need for and effectiveness of steel-jawed leghold traps in Australia.

There are poor prospects for increasing the value of fox fur exports by further processing in Australia. Dressing furs or manufacturing garments are specialised processes, and it is difficult to establish a competitive industry without a larger domestic market as a base. The prospects for the Australian fox fur industry will continue to depend on the whims of the international clothing fashion industry.

16 FERAL CAT

Distribution and abundance

The domestic cat (*Felis catus*) was introduced into Australia by early European settlers. Feral cats established when domestic cats escaped from households or were released into the wild to control rabbits (Rolls 1969). Feral cats are now distributed throughout Australia, occupying all habitats (Jones 1989).

Although the total population of feral cats in Australia is unknown, densities of at least one cat per square kilometre have been recorded in favourable habitats (Jones 1983). In farmland regions in New Zealand, feral cats have been recorded at a density of 3.5 cats per square kilometre (Langham & Charleston 1990).

Feral cats are opportunistic predators and scavengers (Coman & Brunner 1972), and there is a community perception that native animals are major prey species. However, there is a lack of empirical evidence to

Figure 16.1: Number of raw cat furs exported, 1982–83 – 1989–90

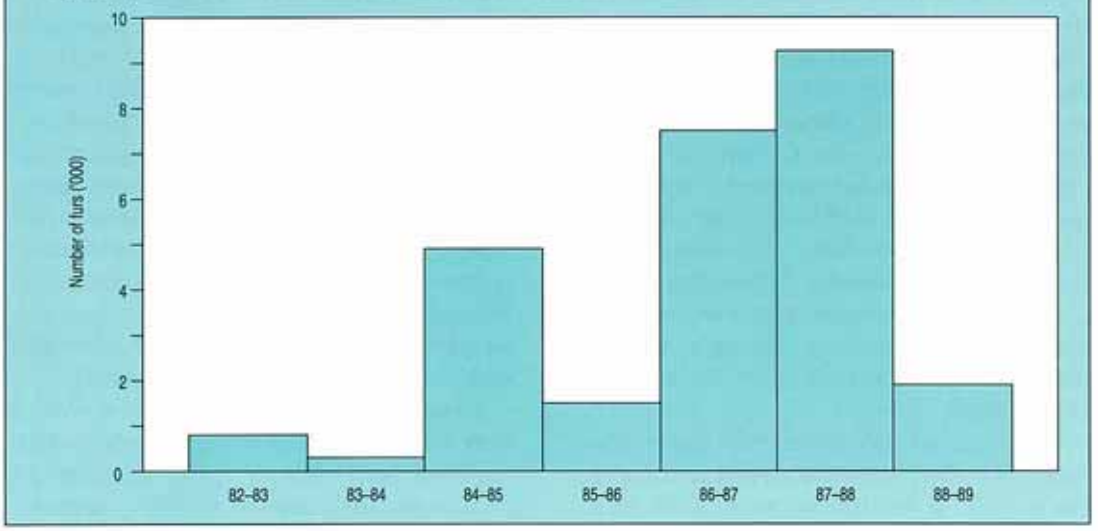


Table 16.1: Number and value of raw cat fur skins exported from Australia, 1982–83 – 1989–90

(all values are in Australian dollars)

DESTINATION	*ITEM*	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90
AUSTRIA	*NUMBER*	*	0	0	0	720	0	1 190	0
	VALUE	*	0	0	0	9 000	0	12 078	0
FEDERAL REP OF GERMANY	*NUMBER*	*	311	2 956	1 439	4 817	5 153	0	0
	VALUE	*	2 474	30 074	16 651	87 974	86 824	0	0
UNITED KINGDOM	*NUMBER*	*	0	1 923	103	1 894	4 008	680	0
	VALUE	*	0	23 336	927	30 957	35 391	2 550	0
TOTAL ALL COUNTRIES	*NUMBER*	831	311	4 879	1 542	7 431	9 161	1 870	0
	VALUE	7 000	2 474	53 410	17 578	127 931	122 215	14 628	0
	UNIT VALUE	8.42	7.95	10.95	11.40	17.22	13.34	7.82	0

Source: Australian Bureau of Statistics (all values are in current dollars) * No country details supplied

describe the effects of predation by feral cats on the abundance of small native animals. In pastoral areas, the diet of feral cats consists mostly of young rabbits (Catling 1988). In habitats where rabbits are less common, feral cats mainly eat small mammals, rodents, reptiles and invertebrates (Coman & Brunner 1972; Triggs et al. 1984).

Status

Feral cats are not declared as pests in any Australian State or Territory. However, State vertebrate pest control and conservation authorities may control feral cats by poisoning, shooting or trapping.

Commercial use

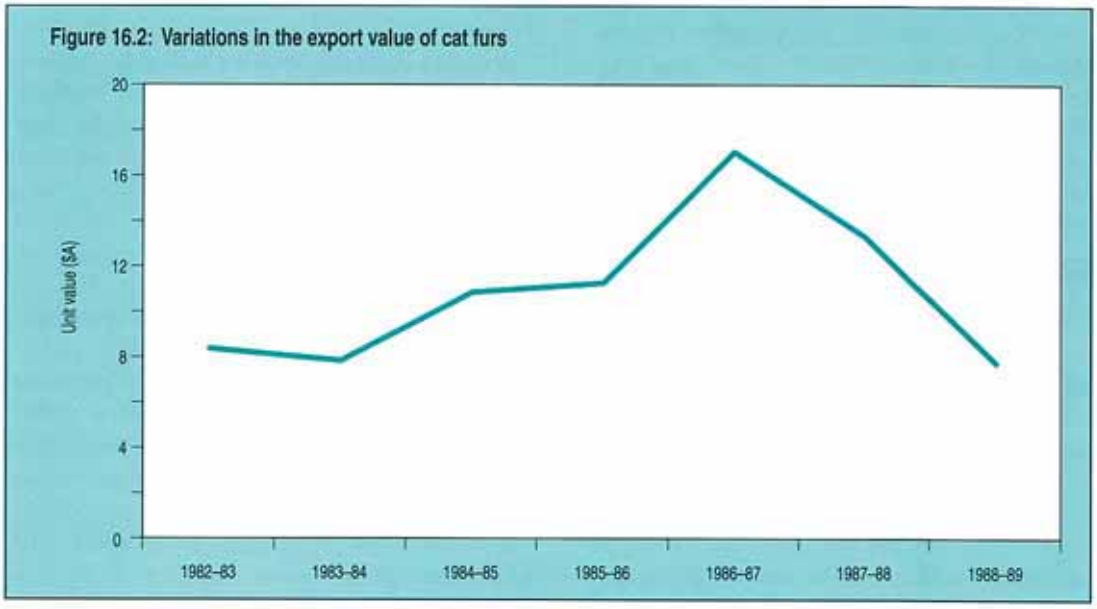
Feral cats are harvested for their fur. Commercial hunting only occurs in the cooler parts of Australia, such as southern New South Wales and Victoria, where the best quality fur is produced. However, large quantities of feral cat furs are sometimes taken from the Nullarbor Plain region in South Australia. No special licence is required to hunt feral cats, although hunters must have the landowners' permission and comply with State firearms laws.

Fox hunters and licensed kangaroo shooters probably take many of the feral cats harvested, particularly when fur prices are low, because the acquisition cost would be subsidised by the value of other species shot. However, when fur prices are high, feral cats may then become a prime target for recreational hunters.

Hunters kill feral cats by field-shooting at night with the aid of a spotlight. The pelt is then removed, and pegged out to dry in readiness for sale. Hunters may sell furs directly to furriers, or alternatively, send the furs to one of the fur auctions held in Melbourne between May and December each year. Furs are graded by colour (tabby, ginger, black or mixed) and quality (first, second or poor). First grade tabby furs are the most valuable type, returning about $2.00 each at fur auctions during 1989. During 1986–87, when demand for fur products was high, first grade tabby furs returned up to $22.00 each at auction.

The Australian retail market for fur products is small, due to the relatively warm climate, lack of tradition associated with wearing fur garments and the high cost of finished garments. Therefore, most furs from feral cats are exported. The main end use of cat fur is to line gloves, jackets and collars, although they are also manufactured into garments.

Figure 16.2: Variations in the export value of cat furs



The principal importers of Australian furs are the Federal Republic of Germany, followed by the United Kingdom (table 16.1). Most furs imported to the United Kingdom are sold at auction in London and re-exported, mostly to Germany. Since 1982–83, the largest quantity exported was 9161 furs in 1987–88, while the highest export earning was $128 000 in 1986–87 (figure 16.1).

Since 1982–83, the average export value of cat fur has ranged between about $8 and $18 per fur (figure 16.2). It appears that the increased commercial harvest in 1987–88 was due to increased supply in anticipation of the higher prices received in the previous year. This response suggests that supply of feral cat fur will increase rapidly when market conditions are favourable.

Trade in feral cat fur can be controversial (Anon. 1986) because it is not possible to distinguish between furs from feral cats and furs from the common domestic cat. Further, the feral status can vary from semi-domesticated cats living in urban areas through to truly feral cats living in remote rural areas. It is likely that some cat fur entering the commercial trade originates from domestic cats.

World demand for fur products has declined in recent years in response to diminished demand for high fashion fur garments. No exports of raw cat fur skins have been recorded by the Australian Bureau of Statistics since 1988–89. The long-term trend in demand for fur products remains unclear; however, it will be some time before any improvement in demand will influence feral cat fur production.

Non-commercial harvesting

It is worth noting that Aboriginals in many rural communities in Northern and Central Australia include feral cats in their diet. Indeed, some groups consider feral cats to be a delicacy and make special efforts to hunt them (Macfarlane 1978).

Although feral cats are not declared pests in Australia, they are perceived as a potential threat to small native animals. Therefore, government pest control agencies will take actions to control feral cats in problem regions. The main method of control is by poisoning, although shooting and trapping are also used (Mawson et al. 1990).

The extent of baiting for feral cats is very low and records of the quantity of poison used are therefore difficult to retrieve. For example, in Tasmania during the five-year period between 1984–85 and 1988–89 inclusive, baits were laid specifically for feral cats on only five occasions. The main purpose was to control feral cats on Macquarie Island where predation by cats is thought to have contributed to the extinction of some native animals (Taylor 1979). The poisons used included 1080, alphachloralose and pindone. The number of cats killed in Tasmania and other States by vertebrate pest control agencies is unknown. A few feral cats may be killed on mainland Australia during baiting programs for other carnivores such as the European red fox.

Biological control of feral cats has been attempted by South African conservation authorities on sub-Antarctic Marion Island (Van Rensburg et al. 1987). Feline panleucopenia, a highly infectious viral disease, was introduced to the feral cat population on the island in 1977, resulting in a 29 per cent annual rate of decrease in the population over five years (from 3400 cats in 1977 to 615 in 1982). Once infected, mortality is high. However, cats that recover remain immune for life. Feline panleucopenia is endemic in Australia, and could already exert some control on feral cat abundance.

Diseases

Feral cats are capable of distributing the infective stages of parasites that cause diseases in humans and domestic livestock (Hartley & Munday 1974; Munday 1975; Langham & Charleston 1990). The protozoan parasite *Toxoplasma gondii* is of particular concern because it can cause congenital abnormalities if pregnant women are infected.

Toxoplasmosis causes abortion and perinatal mortality in sheep (Hartley & Munday 1974). The disease also threatens the conservation of endangered small native mammals such as the Eastern barred bandicoot *Perameles gunnii* (Obendorf & Munday 1990). Gregory and Munday (1976) found 51 of 53 feral cats serologically positive to *Toxoplasma gondii* in Tasmania.

Another protozoan parasite that is spread by feral cats is *Sarcocystis spp*. It causes economic losses to the sheep meat industry in southern Australia because macrocysts must be trimmed from the carcase and heavily infected carcases are condemned (Munday 1975). The main option for control of these parasites is to reduce the density of feral cats (Callow 1984).

Conclusions

Commercial use of feral cats in Australia is negligible, although it could increase significantly with higher market prices. As most cat fur is exported, the scale of harvesting will remain sensitive to changes in overseas demand for fur products. Fur products are now out of fashion, and the long-term prospects remain uncertain.

There is growing concern about the damage that feral cats may be causing to native fauna populations. If more evidence of the adverse impact of feral cats on populations of small native animals emerges, greater efforts may be needed to control cats in environmentally sensitive regions.

17 WATER BUFFALO

Distribution and abundance

Water buffalo (*Bubalus bubalis*) were brought to Australia between 1824 and 1886 as a source of meat (Letts 1962). They came from Timor, Kisar, and probably other islands from the Indonesian archipelago. The first importations of water buffalo were to Melville Island and to the Cobourg Peninsula on the mainland. Stock were left behind when the first settlements were abandoned, and herds of wild buffalo were observed as early as 1843 (Letts 1962). These animals subsequently colonised Melville Island, and also the northern coastal floodplains and, to a lesser extent, inland timbered areas adjacent to waterways on the mainland (Letts et al. 1979).

Feral buffalo herds are restricted to the Northern Territory, although occasional sightings have been reported in Western Australia and Queensland (Long 1988; Wilson et al. 1992a). A habitat preference for swamps and floodplains has limited the distribution of feral buffalo. Water buffalo form distinct family groups numbering up to 250 and tend to live in well-defined home ranges (200–1000 hectares) for many years (Letts et al. 1979).

A series of aerial surveys in the Northern Territory estimated that the feral buffalo population was 282 000 in 1981, rising to 341 000 in 1985, then declining to 122 000 in 1989 (Bayliss & Yeomans 1989). The dramatic decline in feral buffalo numbers since 1985 is due to extensive culling under the national Brucellosis and Tuberculosis Eradication Program (BTEC). Bovine tuberculosis is regularly found in feral buffalo (Garner & O'Brien 1988), and uncontrolled populations are being removed as part of a national effort to eradicate the disease.

Feral buffalo can cause extensive environmental damage, including vegetation damage through grazing and trampling; soil compaction; saltwater intrusion into low-lying freshwater swamps through breaching of natural levee banks by swim channels; wallowing and erosion; siltation and pollution of water bodies; noxious weed dispersal; and impact on other animals through modification of habitat (Letts et al. 1979; Fogarty 1982). On the other hand, water buffalo are well adapted to the wet tropics, and have been the basis of a commercial industry since the 1880s.

Status

Feral water buffalo are variously considered a resource for hunting and supply of livestock and commodities, a pest causing environmental damage and a reservoir for bovine diseases. Water buffalo are recognised as slaughter animals under the Northern Territory Abattoirs and Slaughtering Act and the Pet Meat Act. They are classed as stock under the Northern Territory Stock Diseases Act, but regarded as pests when present on national parks.

Commercial use

The resource value of the feral buffalo population in Australia was recognised over a century ago. An industry based on field shooting for the hides commenced in the 1880s, and buffalo hide exports averaged 4000 per annum between 1886 and 1911 (Letts 1964). Omitting the war years, 1939–45, an average of 7000 bull hides were exported annually between 1911 and 1956, with a record of 16 549 in 1937–38. The buffalo hide industry caused a marked reduction in the abundance of feral water buffalo and in 1939 the Buffalo Protection Ordinance was introduced to control hunting and protect the animals (Letts et al. 1979). The hide market collapsed in 1956 due to competition from other hide exporters, declining international prices and poor hide preparation by Australian suppliers. This caused industry participants to seek alternative markets for feral buffaloes.

Slaughters for human consumption

Production of buffalo meat for human consumption began in 1959 to supply domestic and export markets. Most buffalo

Table 17.1: Number of buffalo slaughtered at export and domestic abattoirs, by the BTEC program, or exported live from the Northern Territory

PURPOSE	1980–81	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91
Export abattoirs	34 811	23 954	27 827	19 729	12 375	12 024	28 195	33 879	26 946	21 275	11 442
Domestic abattoirs	9 142	9 321	6 632	9 616	12 695	14 128	6 119	2 019	1 221	859	135
Total all abattoirs	**43 953**	**33 275**	**34 459**	**29 345**	**25 070**	**26 152**	**34 314**	**35 898**	**28 167**	**22 134**	**11 577**
BTEC slaughters	0	0	0	0	0	4 302	16 668	16 975	16 203	NA	NA
Live exports	698	736	2 802	2 903	4 367	4 014	5 468	3 487	1 736	2 498	1 807
Total number taken	**44 651**	**34 011**	**37 261**	**32 248**	**29 437**	**34 468**	**56 450**	**56 360**	**46 106**	**24 632**	**13 384**

Source: Northern Territory Department of Primary Industries and Fisheries BTEC = Brucellosis and Tuberculosis Eradication Campaign

Table 17.2: Quantity, destination and value of buffalo meat exported from the Northern Territory (all values in Australian dollars)

Destination		1980–81	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91
Germany	Tonnes	2 541	1 920	1 598	1 902	125	17	1 894	1 374	82	904	633
	($'000)	5 311	3 571	3 356	4 755	256	43	5 076	5 482	331	3 761	2 089
Benelux *	Tonnes	2	0	0	0	0	0	67	653	1 312	17	33
	($'000)	4	0	0	0	0	0	216	1 953	4 749	71	108
Sweden	Tonnes	713	75	536	0	507	225	253	833	493	1 082	0
	($'000)	1 854	129	965	0	1 339	565	855	3 357	2 874	4 663	0
Taiwan	Tonnes	199	564	582	456	877	443	775	408	1 068	241	536
	($'000)	416	1 128	1 571	1 249	1 868	1 112	2 596	1 485	4 432	1 041	2 214
Other	Tonnes	15	228	236	0	0	0	0	2	38	0	4
	($'000)	39	416	497	0	0	0	0	6	165	0	4.4
Total	Tonnes	3 470	2 786	2 951	2 358	1 509	686	2 989	3 270	2 993	2 243	1 206
	($'000)	7 624	5 244	6 389	6 004	3 463	1 719	8 744	12 283	12 551	9 536	4 415
	$/kg	2.2	1.88	2.17	2.55	2.29	2.51	2.93	3.76	4.19	4.25	3.66

Source: Northern Territory Department of Primary Industry and Fisheries * Benelux includes Belgium, The Netherlands and Luxembourg. All values in current dollars Figures may not add to totals due to rounding

meat produced by the first enterprises was derived from field-shot animals. However, since 1968 export certification has required ante-mortem inspection and all feral water buffalo are now captured live and transported to an abattoir for slaughter.

Water buffalo weigh up to 1000 kilograms live weight, and have carcase characteristics similar to cattle, but the meat is consistently leaner (Johnson & Charles 1975).

Feral buffalo are mustered into yards using helicopters and four-wheel drive vehicles. Young animals that are suitable for domestication are retained, and the remaining animals are transported to an abattoir for slaughter. Care must be taken during the capture, holding and transport of feral buffalo to reduce stress and injury to the animals (Senate Select Committee on Animal Welfare 1991).

Harvesting operations are usually carried out during the dry season (April to November), because high rainfall received during the wet season prevents access to buffalo habitat.

The number of buffalo slaughtered at abattoirs in the Northern Territory has tended to decline since 1980–81, when 43 953 animals were processed (table 17.1). In addition, the number of buffalo killed at domestic abattoirs has decreased markedly since 1985–86 when over 14 000 animals, or 54 per cent of the total abattoir kill, were processed at domestic abattoirs. The domestic meat manufacturing industry purchased most of this meat. However, by 1989–90 buffalo slaughters at export abattoirs amounted to over 21 000 animals, or 96 per cent of the total abattoir kill. The growth in the number slaughtered at export abattoirs has been due to higher demand and prices offshore, compared with domestic markets.

Taiwan, Germany, Sweden and the Benelux group, which includes Belgium, the Netherlands and Luxembourg, are the major importers of Australian buffalo meat (table 17.2). The quantity of buffalo meat shipped and the principal destination have varied widely over the past decade. Annual exports have varied from 686 tonnes (1985–86), to 3470 tonnes (1980–81), but the average volume of trade is 2000–2500 tonnes per annum. In 1989–90, 2243 tonnes of buffalo meat worth $9.5m or $4.25 per kilogram were exported. Exports slumped to 1206 tonnes worth $4.4m in 1990–91, primarily due to the shortage of livestock for slaughter following the extensive culling of wild herds by BTEC.

Germany has tended to be the principal destination for Australian buffalo meat exports. However, when demand and prices were depressed in Europe in the mid-1980s, Taiwan was the leading buyer, which was in turn surpassed by Sweden in 1989–90. The volatility of sales between importers has occurred because the supply of buffalo meat is limited, and exporters are trading with the highest bidder.

Within Australia, there is a small but profitable market in the food service industries for prime cuts of buffalo meat.

Slaughters for pet food

Water buffalo are field-shot to produce pet meat for domestic and export markets. Most buffalo pet meat is sold on the domestic market, but the scale of the trade has declined as demand and prices for buffalo meat for human consumption has increased. An increased demand for live animals for domestication has undoubtedly also contributed to this trend.

There is little information on the scale of buffalo pet meat trade. To comply with the Northern Territory regulations, hunters are required to submit monthly returns showing the number of animals killed. These records showed that at least 304 buffalo were harvested for pet food during the 1988–89 financial year.

An unknown number of buffaloes slaughtered during BTEC helicopter shoots are used by pet meat processors. The processors follow the helicopter and collect carcases, but the success of this tactic is limited by rough terrain and low ground speed.

Hides

Water buffalo hides and by-products are absorbed into the wider market for cattle products. In 1989–90, over 21 000 hides worth an estimated $509 000 were produced in the Northern Territory. This dropped to 11 005 hides worth $198 000 in 1990–91.

Trade in livestock

Exports of live water buffalo from the Northern Territory peaked in 1986–87 when over 5000 animals worth $2.5m were shipped overseas (table 17.3). Major buyers include Brunei, Indonesia and, more recently, Cuba. Brunei imports live animals primarily for slaughter, while most other importers are purchasing breeding stock. In 1990–91, exports had fallen to 1807 head, worth $975 000. All these animals were shipped to Brunei. The value of breeding stock is enhanced by the absence of major bovine diseases in Australia (Garner & O'Brien 1988).

Domestication of water buffalo has been experimented with in Australia since 1920, but several factors have recently hastened progress. These include the dramatic effects of the BTEC program, which is reducing the feral population, and changes in land use such as the expansion of national parks (e.g. Kakadu), which is reducing habitat available for feral buffaloes. As a consequence, the size and distribution of feral herds have been substantially reduced, and farmed stock now offer the best option for development of the buffalo industry. This has generated a strong demand for good quality disease-free breeding stock for domestic producers.

Table 17.3: Number, destination and value of live buffaloes exported from Australia (all values in Australian dollars)

Destination		1980–81	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91
Brunei	Number	118	43	692	227	1 593	1 332	1 649	2 345	1 365	1 231	1 807
	($'000)	28	9	189	51	370	306	474	961	754	609	975
Indonesia	Number	580	492	1 429	2 676	2 749	2 328	2 106	27	0	0	0
	($'000)	180	320	507	1 524	1 358	1 429	1 137	27	0	0	0
Sarawak	Number	0	0	0	0	0	199	160	926	371	0	0
	($'000)	0	0	0	0	0	55	77	357	185	0	0
Cuba	Number	0	0	0	0	0	0	1 466	0	0	1 267	0
	($'000)	0	0	0	0	0	0	806	0	0	1 140	0
Other	Number	0	201	681	0	25	155	87	189	0	0	0
	($'000)	0	136	272	0	6	38	25	89	0	0	0
Total	Number	698	736	2 802	2 903	4 367	4 014	5 468	3 487	1 736	2 498	1 807
	($'000)	208	464	969	1574	1 735	1 827	2 520	1 434	939	1 749	975

Source: Northern Territory Department of Primary Industry and Fisheries (all values in current dollars) Figures may not add to totals due to rounding

Non-commercial

Pest control

Water buffalo are culled by conservation authorities to control environmental damage. This culling is usually timed to take place after commercial harvesters

have removed as many animals as economically viable. The remaining feral buffaloes are removed by helicopter shooting, which is the most cost-efficient and widely employed method (Senate Select Committee on Animal Welfare 1991).

During the period 1985–1990, 5564 feral buffalo in parks and reserves administered by the Conservation Commission of the Northern Territory were shot from helicopters.

Disease eradication

Culling under BTEC has escalated since 1985 to account for at least 36 per cent (16 203 animals) of all water buffalo slaughtered in 1988–89 in the Northern Territory (table 17.1). Implementation of BTEC has had a dramatic and controversial impact on feral water buffalo herds and the domestic buffalo industry.

As with the pest control programs operating in environmentally sensitive areas, commercial harvesters initially remove feral buffalo from regions designated for destocking. However, some regions harbour populations that are either too small to be economically viable or are inaccessible to commercial operators. Infected herds in these regions are usually removed by helicopter shooting.

Hunting

Water buffalo are Australia's largest game animal and a highly prized quarry for local and international hunters. There were at least nine professional safari outfitters in the Northern Territory in 1990 and the water buffalo trophy fee averages about $1000 per bull. The number of animals taken by this form of hunting is difficult to establish. Safari outfitters are very independent and there is no formal industry structure. In addition to guided hunting, many animals are also taken by private hunters. The scale of private shooting is also unknown.

The declining populations of feral water buffalo could result in the demise of this species as a valuable hunting resource in Australia. An alternative viewpoint is that reduction in numbers will increase their value if managed adequately. At best, hunting will be restricted to specific regions where disease-free herds can be maintained.

Discussion

The buffalo industry in the Northern Territory is in a state of dramatic change due to depletion of the feral herds upon which the industry has previously depended. The rapid population decline is due to a combination of commercial and non-commercial harvesting pressures. However, since 1985 slaughters for disease eradication have become the dominant component of the total cull.

Meat production for export markets was the basis of the buffalo industry during most of the 1980s. With the collapse of the feral buffalo herds on which the industry has been dependent, the future of the water buffalo industry will now depend on development of domesticated disease-free herds. The growing demand for domesticated stock in Australia will boost livestock prices on the domestic market. However, there is a conflict between the objective of increasing the size of the domesticated herd and the need to maintain cash flow by slaughter. The buffalo industry is undergoing a huge transition.

In recognition of the opportunity to maintain a profitable buffalo industry, the Northern Territory government is supporting domestication efforts through the Buffalo Development Scheme. In this scheme, young buffaloes are captured during BTEC destocking and retained for local farms. Funds for erection of new fences have also been provided through BTEC. In 1981, there were about 2700 domesticated water buffalo in Australia. By 1988, domesticated buffalo herds had increased to about 18 000 animals (Standing Committee on Agriculture 1989). Domesticated buffaloes are now also being farmed in Western Australia.

There are ready markets for high quality buffalo meat in Australia and overseas, and large tracts of land in tropical Australia are suitable for buffalo production. The outlook for the Australian buffalo industry is encouraging. The challenges now facing the industry are to solve livestock production and husbandry problems, and to develop an efficient and profitable trade based on domesticated buffalo.

18 ARABIAN CAMEL

Distribution and abundance

One-humped or Arabian camels (*Camelus dromedarius*) were brought to Australia several times between 1840 and 1907 to provide personal transport and for use as a draught animal in arid and remote regions (McKnight 1969). Their role was supplanted by motorised vehicles in the early 1900s, and many camels were either released or escaped to establish feral populations. The total population of feral camels in Australia is now at least 43 000 animals, distributed throughout Central Australia (Short et al. 1988). About 50 per cent of the camel population live in Western Australia, 27 per cent in the Northern Territory, and most of the remainder are in South Australia. Isolated populations also occur in Queensland.

Feral camels are well-adapted to the arid environments of Central Australia. Anatomical adaptations include the thermal insulation provided by the animal's coat, long legs that enable rapid movement over long distances, and a heavy pad on the foot which insulates against hot ground surfaces and provides good traction over sandy or stony substrates. Physiological adaptations include their ability to use water economically, to maintain blood volume during periods of water deprivation, and their capacity for rapid and complete rehydration (McKnight 1969).

Feral camels are primarily browsers and feed opportunistically on a wide range of plants (McKnight 1969). This habit, combined with an ability to travel great distances from water to forage, gives camels an advantage over other livestock in arid regions.

Camels are gregarious. An aerial survey showed that the average group size is about five animals, while the population density is generally less than one animal per square kilometre (Short el. al. 1988). Larger groups occur during drought, when camels are forced to congregate at scarce water supplies (Letts et al. 1979).

The effect of camels on the ecosystem is poorly documented. The low population density, browsing habits, broad dietary range, and soft feet have been the basis for suggestions (McKnight 1969; Letts et al. 1979; Grigg 1987; Long & Mawson 1990) that their impact in arid regions is likely to be less than for other feral animals such as donkeys and horses. Detrimental effects would increase with population density, for example during drought, or when farmed.

Feral camels in Australia represent the only substantial population of wild camels in the world.

Status

Feral camels are unprotected in all States and Territories of Australia. The introduction and keeping of camels is subject to conditions and restrictions in the Northern Territory, Western Australia, Queensland and South Australia.

Camels are classed as stock in the Northern Territory and Queensland, where they are slaughtered at abattoirs for the domestic meat trade. Feral camels present on national parks and conservation areas are regarded as environmental pests.

Commercial use

The worldwide population of Bactrian (two-humped) and Arabian (one-humped) camels is about 19 million (FAO 1989). Arabian camels account for most of the world camel population, and most Arabian camels (14.3 million) are found in Africa.

Camels are an important means of transport, and a significant source of meat, milk, and fibre in some African and Middle East countries (Wilson 1978; Babiker 1984; Khalifa 1988). For example, in the Sudan (which has the second largest population of camels in the world after Somalia), camels produced 33 657 tonnes of meat in 1985–86, or 8.8 per cent of total meat consumption in the nation (Salih & Musa 1988). The trade in camel meat is the most important commercial use of camels in the Middle East and Africa. However, it is usually consumed

by low income groups who purchase it owing to their income limitations, rather than by preference (Babiker 1984; Khalifa 1988). Camel hide has little commercial value (Wilson 1984).

In Australia, commercial use of feral camels only occurs on a small scale. The three main uses are slaughter for meat production, sale as livestock, and for tourist pleasure rides.

Meat production

Two types of camel meat production occur in Australia. Firstly, camels are field-shot in the Northern Territory or Western Australia to produce pet meat for the domestic market. The carcases are cut into portions and transported to field chillers to await transport to a processing facility for boning and packing for sale. The meat is retailed in Western Australia and the Northern Territory as fresh or frozen meat or mince. The retail value in 1990 was between $1.50 and $2.00 per kilogram.

Camels can also be slaughtered for pet meat at registered knackeries in Queensland, but no slaughters have been recorded since 1985. There are no readily available figures to show either the number of animals killed or the quantity of pet meat produced from camels in Australia.

Secondly, camels may be captured, transported to an abattoir, and slaughtered to produce meat for the domestic restaurant trade. This is a new and novel industry, which began in 1988 when an abattoir near Alice Springs in the Northern Territory began processing camels for meat. The methods of capture are trapping at watering points using a yard enclosure, or mustering into portable yards using vehicles. Live adult camels are worth about $300 when delivered to an abattoir. The slaughter method and processing is the same as for domestic cattle.

Adult male camels can weigh more than 700 kilograms (Newman 1983; Babiker 1984). A study in the Sudan (Yousif & Babiker 1989) found that the average live weight of adult male camels in good condition was about 450 kilograms, yielding a dressed chilled carcase of about 252 kilograms (table 18.1). By comparison, 159 camels that were slaughtered in the Northern Territory during 1989–90 produced 41 646 kilograms of meat, or 262 kilograms per animal (Anon. 1991).

Table 18.1: Carcase composition of Sudanese camels

Product	Percentage	Kilograms
Muscle	56	141
Bone	19	48
Fat	13.7	35
Trim	7.5	19

Source: Yousif & Babiker 1989

Sale of camel meat to restaurants and retail stores is new to Australia, having commenced in October 1988. Wholesale prices vary depending on cut: prime cuts such as scotch fillet sold for $32 per kilogram in early 1991, while lower grades such as topside and silverside sold for about $8 per kilogram. Trade in prime cuts is strong; however, lower grade cuts have proven difficult to sell because there is little demand for these products within the restaurant industry. Camel meat is clearly a novelty product that is sold to upmarket consumers (mainly tourists), particularly in Queensland and the Northern Territory. No camel meat has been exported in commercial quantities to date.

Livestock

Australian feral camels are free of major livestock diseases (Garner & O'Brien 1988; Siebert & Newman 1989) and represent a potential source of breeding stock for overseas countries where the camel is used as a production (milk and fibre) or racing animal.

Very few camels are captured, domesticated, and exported from Australia. Most exports are from the Northern Territory, and records held by the Northern Department of Primary Industry and

Fisheries show that since 1978–79:

- 38 camels were exported in 1984–85;
- 93 camels were exported in 1988–89 (eight to Brunei and 85 to the United States of America); and
- 30 camels were exported in 1989–90 (six to Brunei and 24 to Cuba).

The largest export market for Australian camels is the United States of America where they are used by tourist enterprises and zoological collections.

Camel racing is of some social and economic importance in countries such as Saudi Arabia and the United Arab Emirates, and a small market exists for well-bred animals in these countries (Babiker 1984). Good quality racing camels can be worth almost as much as a thoroughbred racehorse (Snow et al. 1988). However, feral camels are unlikely to be competitive with animals that have been selectively bred for racing, in the same way that wild horses are unlikely to be valuable to the thoroughbred horseracing industry. The main value of Australian feral camels for livestock concerns their resilience to environmental stress, which is a result of their wild origins.

Most of the feral camels exported so far have been for zoological collections. The unit value of live camels destined for export is unknown. However, the costs of capturing feral camels from remote regions, and then domesticating and delivering them to a port are considerable.

Tourism

A few feral camels are captured, broken in, and used to provide short tourist rides, or longer treks. Most of these enterprises are based in the Northern Territory. Camel racing has developed into a novelty event in some centres such as Alice Springs in the Northern Territory and Bordertown in South Australia. The success of these ventures is tied to the fortunes of the tourist industry.

Non-commercial

Feral camels damage fences and foul watering points, particularly during times of drought (Letts et al. 1979). However, there is no coordinated control of feral camels in any Australian State or Territory, and landowners are responsible for controlling camel numbers. Therefore, there are little data on the number of feral camels killed for pest control.

Control techniques include field-shooting and enclosure trapping at watering points. Some feral camels are shot as part of other control activities by State and Territory pest control agencies. The Agricultural Protection Board in Western Australia shot at least 111 feral camels in 1988–89 and at least 578 in 1989–90 (Agricultural Protection Board 1990).

Discussion

Commercial use of feral camels in Australia is negligible and the short-term prospects for expansion are uncertain. The best prospects for increasing the size of the camel industry in Australia are probably to expand sales of meat on the domestic market and to develop tourist enterprises. Livestock exports are often touted as potentially lucrative, but the small number of these exports so far suggests that these specialist markets are uncertain.

A greater degree of industry organisation may improve the scale of the live camel export industry. The current arrangements are ad hoc, with suppliers capturing wild camels in response to occasional import inquiries, rather than being based on preparation and marketing of animals with the required qualities.

A long-term strategy of capturing wild camels, and selecting and breeding animals with characteristics required in particular markets, such as for racing, milk, meat or fibre, may prove successful. Careful market research would be necessary before investing in such an enterprise. However, a camel farm that also incorporated a tourist enterprise could be a more attractive investment.

The commercial viability of harvesting camels for meat, either as pet food or for human consumption, is limited by the practical and economic constraints associated

with operating in remote regions. The freight costs to haul livestock or refrigerated trailers over long distances are high. Further, handling and transporting wild camels could injure the animals, unless special care is taken. Injuries reduce the value of stock and raise animal welfare concerns.

The Australian domestic market for camel meat has not been fully tested. At present, all camel meat is sold through gourmet restaurants. There has been little effort to define the various cuts of meat, which complicates development of more efficient marketing of camel meat. Further, the meat quality can be highly variable, depending on the age, sex and condition of the animals captured. Abattoirs tend to slaughter animals in batches, pack the meat, and store it for many weeks (or months) until sold. This practice is economical for the processor, but frustrating to restaurant owners seeking fresh high quality product.

The largest overseas markets for camel meat are in developing countries such as Egypt and Nigeria, where the meat is sold as a down-market product. Increasing camel populations overseas, combined with declining demand for the meat, has led major producers such as the Sudan and Somalia to seek new markets outside Africa and the Middle East (Babiker 1984). The prospects for export of camel meat from Australia are not encouraging at present. If an export market for Australian camel is established, strong competition from developing countries can be expected.

The low population density and wide distribution of feral camels increases harvest (or control) costs. The most cost-effective time to harvest camels is likely to be during a drought, when the animals are concentrated around watering points.

Non-commercial harvesting carried out by State and Territory vertebrate pest control authorities is usually an adjunct to the control of more important pest animals. If more evidence of the deleterious effects of camels is presented, greater control may become necessary, particularly in areas with conservation value.

Camels are well adapted to the arid regions of central Australia. Until profitable markets for camel products are identified and developed, there is little incentive to expand commercial use by wild harvesting or farming. Nonetheless, the scale of production and trade in camel products overseas is sufficiently large to encourage periodic reappraisal of the prospects for Australian feral camel products.

19 CANE TOAD

Distribution and abundance

The cane toad (*Bufo marinus*) is an amphibian with a natural distribution across Central and South America (Easteal 1981). It has been extensively introduced to the Caribbean Islands, Hawaii, the Philippines, New Guinea and many other Pacific Islands (Easteal 1981). Many of these introduced populations have since thrived and are now regarded as pests.

Cane toads were introduced into North Queensland in 1935 to control the grey-backed cane beetle, *Lepidoderma albohirtum* (Easteal 1981). Although overseas experiences have yielded circumstantial evidence of the efficacy of cane toads as a biological agent (Freeland 1984), there is no experimental evidence that they have provided short-term control of any agricultural pest in Australia.

Cane toads have colonised most of northern and coastal Queensland, as well as recently extending into coastal areas of northern New South Wales and eastern Northern Territory (Freeland & Martin 1985). Population densities around waterholes in the Gulf of Carpentaria lowlands reach as high as 5000 animals per hectare during the dry season (Freeland & Kerin 1988).

The total number of cane toads in Australia is unknown, but apparently increasing as their range extends into new regions. A notable observation relating to the spread of cane toads is an apparent tendency for a decrease in population density with time (Freeland 1986). Reductions in body size and body condition have also been associated with the drop in population density (Freeland 1986); however, the explanation for this observation is unclear.

Status

Cane toads are not declared as pests in any State or Territory of Australia. Besides the present lack of convincing evidence of the impact of cane toads, there is no practical method available to control them. As a result, cane toads are unprotected fauna and no special licenses are necessary to harvest them for commercial purposes.

One legislative restriction that can influence commercial trade is that cane toads are prohibited entrants to some States and Territories. For example, live cane toads cannot be imported into the Northern Territory because they are not included in Schedule 4 of the Territory Wildlife Regulations of the *Territory Parks and Wildlife Conservation Act 1988*. Live cane toads can only be imported into Western Australia and South Australia for research purposes if permits are issued by State vertebrate pest control authorities.

Commercial use

Cane toads are used commercially in Australia in three ways: as biological specimens, for their products, and by taxidermists to produce souvenir items (figure 19.1). The estimates of use provided by industry participants show that less than 30 000 toads are used each year, and use as biological specimens is the most important component of trade.

Research and teaching laboratories in northern Queensland have been using cane toads as biological specimens for at least two decades. Indeed, many schools and universities in Queensland can now collect all the cane toads they require from local sources, and therefore don't rely on commercial suppliers. However, institutions outside Queensland depend on commercial suppliers to obtain cane toad specimens.

Cane toads are collected from the wild and then air-freighted to buyers of biological specimens. These animals are shipped interstate from Queensland to all parts of Australia, except the Northern Territory. Between 16 000 and 20 000 live cane toads are sold interstate from Queensland each year. The number used within Queensland is unknown.

The value of live specimens varied from $1.50 to $5.00 each in 1990, depending on size. Cane toads over 130 mm long fetch

the highest price; however, they are generally only available in limited numbers. A few cane toads are preserved (either in phenol, formalin, alcohol or glycerin) and sold as biological specimens. Some of the preserved specimens are exported to universities in Germany and New Zealand.

The second and more recent commercial use of cane toads is for production of goods such as leather from the skin and toxin from the parotoid glands. Cane toad skins can be tanned to produce a high quality exotic leather which is used as a feature or highlighting material on fashion articles such as wallets and handbags. The average value of tanned cane toad skins was about $4.00 each in 1990, while the average retail value of finished products, such as wallets or keyholders, was about $27.00.

Production and sales of cane toad leather developed rapidly in Australia since early 1988. The main limitation to further commercial use is the lack of adequate large toads. Unless the skin is at least 80 mm long, it is uneconomical to process.

Trade in toad skins has also developed in other countries, such as the Philippines, where abundant populations of cane toads occur. Nonetheless, the skin market, both in Australia and overseas, demands large toads, which are difficult to supply.

Toads secrete a toxin through parotoid glands and dorsal glands located just posterior to the eye. The venom is a passive defence mechanism that is highly toxic. Domestic dogs that are well exposed to the toxin can die within 15 minutes of the onset of symptoms (Knowles 1964). The toxicity of cane toad venom has raised concerns over the potential impact of cane toads on native predators such as snakes, goannas, and birds (Freeland 1984). However, no studies have proven any persistent effect of predation by cane toads on other animals in Australia.

Cane toad venom, or bufotoxin, is used for pharmaceutical purposes, particularly in traditional medicine in some Asian countries. Market prices vary according to quantity and demand. Quantities of less than 1 kg traded for around $100 per gram in 1990. Adult cane toads are individually 'milked' for bufotoxin, but the quantity produced is highly variable. The bufotoxin is vacuum-dried and sold as a powder. To collect the venom efficiently, it would be necessary to farm cane toads.

Taxidermists have recognised the novelty value of the cane toad and now collect and preserve whole toads for sale as souvenir items. Several thousand preserved cane toads were sold at the World Expo in Brisbane in 1988. The retail value is about $20 each.

Non-commercial

There is presently no organised non-commercial killing of cane toads. However, the Council of Nature Conservation Ministers has provided funding for research into options for biological control of cane toads. Further, in early 1990 the Federal Government committed $1.25m over three years for research into ways of controlling cane toads. The search for biological control agents is now underway (Speare 1990).

There is little data to support the perception that cane toads have a substantial negative impact on native animals. Indeed, a recent study (Freeland & Kerin 1988) found that cane toads had no observable impact on native frog communities or populations. Nonetheless, some action may be taken to stop or slow the spread of cane toads to ecologically sensitive regions such as Kakadu National Park in the Northern Territory.

Conclusions

Commercial use of cane toads occurs on a small scale, and the best opportunity for expansion appears to lie with toad products such as leather and bufotoxin. The total revenue generated by the commercial use of cane toads is likely to be less than $150 000 per year.

Some doubt remains over the impact of the cane toad on native ecosystems. Present data suggest the effect may be nil or small. However, if the negative impact is

determined to be unacceptably high, and a practical and cost-effective method of control can be devised, organised pest control may happen.

The evidence from Australia and overseas which suggests that invading cane toads decrease in size and population density in the long term has important implications for both commercial use and pest control. Future commercial use of cane toads will depend on a steady supply of large animals, while the impact of cane toads on native habitats could decrease with population density. It appears that farming is likely to be the best option for efficiently producing large quantities of bufotoxin, along with skins of adequate size.

20 DEER AND OTHER SPECIES

Over 20 species of deer were introduced into Australia, largely during the nineteenth century, and six species now survive in the wild. These are fallow (*Dama dama*), the chital (*Axis axis*), hog (*A. porcinus*), red (*Cervus elaphus*), rusa (*C. timorensis*) and sambar deer (*C. unicolor*) (Bentley 1978). The distribution of these deer is patchy, which partly reflects the sites of first release rather than areas into which deer have dispersed (Wilson, Dexter, O'Brien & Bomford 1992). The largest species is the sambar, with males weighing on average 190 kilograms, while the smallest is the hog deer, with males weighing 42 kilograms on average.

The legal status of wild deer is inconsistent, with Victoria and Tasmania affording them protection under wildlife legislation, and other States classifying wild deer as feral animals. Accurate estimates of wild deer numbers in Australia are scarce, but a rough estimate of the total is 48 200 head (Cribb 1991).

The main purpose of the introductions of deer to Australia was for recreational hunting with firearms or hounds. Today, wild deer are still a sought after quarry for recreational hunters in Australia. However, these deer have also been a valuable source of breeding stock for the emerging deer farming industry. Deer farming was initially reliant on the use of enclosure traps to capture wild deer for breeding stock (English 1981). Dependence on wild captures has declined recently, with emphasis now on farm breeding and import of red deer and wapiti (*C.e. nelsoni*) from New Zealand (Ramsay & English 1991).

In 1991, the Australian deer farming industry held about 130 000 head of livestock on farms. During the mid-1980s, fallow deer were the dominant species, comprising some 65 per cent of the national herd. This proportion has now declined to about 40 per cent, with red deer comprising 50 per cent and other species (rusa, chital and sambar) the remaining 10 per cent (AACM 1991).

The deer farming industry in Australia

During the 1980s, the Australian deer industry was aiming to increase stock levels, and consequently, trade in breeding stock and sale of velvet were the main sources of income. However, the deer industry is entering a new phase of its development where venison and velvet are the principal sources of income. This is a challenging time for the industry, which faces the classic dilemma of a small and emerging industry with a long agenda of important actions, but few resources to implement them. The deer industry is now working closely with the Rural Industries Research and Development Corporation (RIRDC) and is implementing an industry development strategy.

A detailed analysis of the Australian and international trade in deer and deer products was prepared recently in a report on deer marketing and production for the RIRDC by AACM (1991). The following discussion draws heavily on the AACM report.

World trade in venison is thought to be about 11 000 tonnes per annum. Germany is the dominant importer, but Japan, the USA and other European countries import significant quantities. Taiwan and South Korea are also emerging as potential growth markets for venison.

The largest exporter of venison is Poland, followed by New Zealand and eastern European countries including Hungary. Australia exports small quantities of venison, but domestic slaughters are still too low to supply the domestic market. A large component of the domestic venison market is therefore supplied by imports from New Zealand. Venison is a meat with low fat attributes which should appeal to health-conscious consumers. However, most venison consumed within Australia, and in many overseas countries, is sold through the food service industry as a gourmet food.

A consumer survey by AACM (1991) found that people who consume venison

in Australia tend to be in higher income professional occupations, in the 41–65 year age group, and have at least one parent born in Europe. Venison marketing in Australia is at a very early stage of development. Product quality and availability have, at least in the past, tended to be highly variable. The Australian deer industry is now working to improve the quality and consistency of venison supplies, and has developed a formal descriptive language for the various meat cuts available.

An important component of the income from deer farming comes from the sale of the antler velvet. This is used to manufacture oriental medicines, and Korea is the major importer on the world market. Other products of value are the skin, which is used for high quality garment leather, and the tails, pizzles and tendons which are used for oriental medicines.

The New Zealand deer industry is about ten times larger than the Australian deer industry, with over 1 million animals in farms, and will continue to have a major influence on the prospects for the Australian industry throughout the 1990s.

Other species

There are many other species of wild animals that are used commercially, or have commercial potential.

Native birds

One industry with a significant volume and value of trade is the native bird industry. Many abundant native birds, including the sulphur-crested cockatoo and the galah, are collected as hatchlings each year to supply the domestic pet trade. These harvests are controlled by the State agencies responsible for conservation. The domestic market for native birds seems to be saturated, but there is considerable demand for these birds in international markets. However, no native birds can be exported live for commercial purposes under existing Commonwealth legislation.

The question of whether to allow exports of live native birds is a controversial issue. Species such as the sulphur-crested cockatoo and the the galah are regarded as a significant pest in some grain-growing areas, and landowners shoot and poison large numbers each year. It has been argued that it would be more appropriate to have a sustainable harvest of these populations to reduce the impact on agricultural productivity. This would also be consistent with the philosophy of sustainable use of wildlife as a method of achieving conservation objectives. However, adult birds are not suitable for the pet trade. It has also been argued that allowing a legal trade would reduce the incentive for poachers and smugglers involved in supplying overseas buyers. However, there are also concerns that this would encourage poachers to switch their activities to less common species. Further informed debate on the merits or otherwise of commercial use and export of native birds is needed.

Feral donkeys

Several thousand feral donkeys (*Equus asinus*) are shot for pet meat in the Northern Territory and Western Australia each year to supply domestic and export markets. The animals are shot with a heavy calibre rifle, before being eviscerated, cut into quarters and transported to a field chiller to await transfer to a processing

Table 20.1: Number of donkeys killed by helicopter shooting in Western Australia since 1981–82

1981–82	56 000
1982–83	31 800
1983–84	43 500
1984–85	29 057
1985–86	27 228
1986–87	26 441
1987–88	33 990
1988–89	30 822
1989–90	49 990

Source: Agricultural Protection Board 1990

facility. A major problem for the industry is that the large donkey populations are in remote and rugged areas which are difficult to access and costly to operate in. Industry participants report that the harvest was substantial during the 1970s, with in excess of 30 000 donkeys being processed annually.

Today, the commercial harvest has largely been supplanted by helicopter shooting for pest control, where the animals are shot to waste. Table 20.1 shows the scale of the helicopter shoots in Western Australia. The cost of the Western Australian helicopter shoots in 1989–90 was $312 000.

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SUMMARY

This publication was produced as the major output of a research project to examine ways of increasing the value of wild animal exports. It provides a national and, where possible, an international perspective on the impediments and opportunities for industries using wild animals. Further, it explores the existing and potential interrelationships between wild animal industries, new animal industries that use non-traditional livestock and mainstream animal industries. The work was funded by the Rural Industries Research and Development Corporation, the Bureau of Resource Sciences Vertebrate Pests Program and the Australian Game Meat Producers Association.

Several species of introduced and native wild animals have significant export potential. Wild animal industries with the best prospects for substantial gains are those based on abundant wild animal populations. These include commercial harvests of kangaroos, wallabies and wild boar, goats, rabbits and foxes. Industries based on farming of stock derived from the wild also have good prospects, but are primarily limited by a lack of adequate breeding stock. Emerging industries with growth potential include farming of emus, crocodiles, goats, buffalo, deer and camels.

A rough estimate of the annual wholesale value of trade in wild animals and their products is $132–156m. The largest industry is the kangaroo industry ($50–60m), followed by the goat ($27–28m), horse ($22–25m) and wild boar ($15–20m) industries. Wild animal industries make a small contribution to the national economy, but their local significance should not be underestimated, particularly when they can generate export trade from rural areas where other opportunities are limited.

The key factors which contribute to the competitiveness of these industries are that populations of wild animals are abundant and widespread, reproductive rates are high and the capital input required to harvest animals is low; international trade in wild animal products is almost free of distortions; products of wild animals have attributes that can appeal to consumers and attract a premium in the marketplace, such as low fat content in game meats; Australia is free of all major livestock diseases; and Australia's environment has low levels of contamination with chemical residues, nuclear radiation and other pollutants, compared with many countries.

The key issues and impediments to the development of wild animal industries are public perceptions, parochial attitudes, administrative and legislative structures, the variable operating environment, current (low) product values, newness of product, small size of industries, lack of information and poor information transfer, animal welfare, and pest control activities which conflict with commercial harvesting. Overall, marketing activities need to be improved and coordinated if these industries are to develop.

Many farmers are searching for opportunities to diversify their enterprise, and new animal industries could offer profitable alternatives or supplements to production from domestic species. Commercial use of animals that cause agricultural and environmental damage is also an innovative and cost-effective way of managing vertebrate pests. This approach has been developed with kangaroos and applied for some time. The difficulty, however, is to identify the level of control desired by the rural community and deliver the desired outcome through management action. Increasing harvesting levels will complement other initiatives to protect native habitats and improve agricultural productivity.

This study found that Australia's wild animal industries have much potential and that further development of individual industries cannot be viewed in isolation from the development of related industries. There is a strong case for closer alignment between these new and emerging industries, for example, by using multi-species abattoirs or by joint marketing of products. This would strengthen the existing linkages and gain the benefits of scale and consequent cost-savings. An appropriate strategy would seem to be one with the kangaroo industry taking a central role within a group of industries based on wild animals or farming of non-traditional livestock.

Development of these industries could generate significant economic, social and environmental benefits for the rural sector and the nation. The challenge is for industry to take the initiative and work with government to overcome impediments to industry growth and capitalise on emerging opportunities.

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Australian animals such as kangaroos, possums, crocodiles and emus, and introduced animals such as feral goats, horses and wild boar are the basis of industries with a wholesale value exceeding $100 million each year.

Industries based on wild animals have expanded in recent years and there are good prospects for continued growth.

Where they can be harvested humanely and, in the case of native animals, sustainably, wild animals can be profitable supplements or alternatives to domestic animals. Their use can also contribute to pest management.

This book is the first comprehensive collection of reliable information on Australia's wild animal industries. It also provides a detailed analysis of the opportunities and impediments to commercial use of wild animals.

The book will be a valuable source of facts, figures and industry developments for anyone with an interest in wild animal use and management in Australia.

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