Chapter 4

Cost of responding to invasive species

> Another statement that you often hear about invasive species is that managing them is just a bottomless pit of funding. We would like to counter that and say that it is potentially a very good return on investment, with biological control, for example, typically giving benefit-cost ratios in the order of 20 to one.[1]

4.1 The Committee's term of reference (b) requires it to examine the estimated cost of different responses to the environmental issues associated with particular pests and weeds. The different responses nominated are: early eradication, containment, damage mitigation and inaction. As outlined in the Preface, the Department of the Environment and Heritage advised that there is no agreed model to measure the ecological cost of invasive species in economic terms,[2] while the Invasive Species Council argued that, in any case, rather than looking at the costs of different strategies as required by term of reference (b), a strategic approach was needed, with the focus on prioritising species and habitats according to the potential for damage to indigenous biodiversity and the likely effectiveness of effort.[3]

4.2 As discussed in Chapter 1 the economic, environmental and social costs of invasive species are substantial, if somewhat difficult to quantify. Many witnesses to the Committee's inquiry sought to present evidence of the benefits of expenditure on invasive species, particularly the claim that prevention or rapid responses to pest incursions provide the greatest cost-benefit ratios for managing invasive species. The Committee summarises this evidence in this chapter.

Cost benefit ratios

4.3 The Local Government Association of Queensland (LGAQ) claimed that every dollar spent on weed and pest animal management initiatives in Queensland can deliver up to $6.40 in benefit.[4] The AEC Group's report *Economic Impact of State and Local Government Expenditure on Weed and Pest Animal Management in Queensland*, October 2002, noted that any increase in the level of expenditure on weed and pest management would increase the net benefit to the public, with the public receiving up to $3.70 in benefits for every dollar invested in weed and pest management initiatives. The report stated that:

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1 Dr Mark Lonsdale, CSIRO Entomology, *Committee Hansard*, Canberra, 18 June 2004, p. 2.

2 Department of Environment and Heritage, *Submission 61*, p. 4.

3 Invasive Species Council, *Submission 33*, p. 3.

4 AEC Group, *Economic Impact of State and Local Government Expenditure on Weed and Pest Animal Management in Queensland*, October 2002, p i.

> prevention activities provided a greater return on capital than eradication activities, which were in turn greater than containment activities undertaken after the widespread distribution of the species[5]

4.4 The CRC for Australian Weed Management submitted that early eradication of invasive plants saves 83 native species (plants and animals) from extinction for each $1 million spent. This compares with only seven species saved per $1 million spent on the herbicidal and mechanical control of weeds once they are widespread, or one species saved per $1 million spent on maintaining environmental flows in rivers.[6] Clearly, the cost-benefit ratio of action outweighs inaction. For example, Bitou bush (*Chrysanthemoides monilifera ssp. rotundata*), a species from South Africa, dominates coastal vegetation in eastern Australia and impacts on biodiversity as well as diminishing public access to beaches. The Bureau of Rural Sciences argued that a preliminary economic analysis of the cost-effectiveness of a program for the control of Bitou bush estimated that the cost of loss and damage is 20 times greater than the cost of control.[7]

4.5 The CRC for Australian Weed Management also submitted that:

- the current eradication campaign in South Australia for branched broomrape has a benefit cost ratio of 7.9 to 1;
- biological control of skeleton weed in 1970 had a benefit cost ratio of 112 to 1;
- biological control of Paterson's curse with the crown weevil had a benefit cost ratio of 52 to 1; and
- the partial control of parthenium weed in central and north Queensland by 2001 resulted in a cost benefit ratio of 18 to 1.[8]

4.6 The cost of managing invasive species varies and is difficult to quantify.[9] The South Australian Animal and Plant Control Commission noted the need to examine the cost-effectiveness of various responses to pest management.[10] The Committee considers below the response options of eradication, containment, damage mitigation and inaction.

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5 ibid, p. 100.

6 CRC for Australian Weed Management, *Submission 22*, p. 5.

7 Bureau of Rural Sciences, *Submission 62a*, p. 10.

8 CRC for Australian Weed Management, *Submission 22*, p. 5.

9 Bendigo and District Environment Council Inc. and Bendigo Field Naturalist Club Inc., *Submission* 46.

10 Animal and Plant Control Commission, *Submission 15*, p. 8.

Early eradication

4.7 The Committee heard evidence that the early eradication of pest incursions provides significant cost-benefit ratios and provides a higher chance of success than other responses:

> Costs are likely to be minimal in terms of applied resources and there is a much higher chance of success…. Value for money is probably highest at this stage, particularly if the invasive species has not established where it has impacted on the environment. [11]

4.8 In its submission to the inquiry the Bureau of Rural Sciences noted that:

> eradication is an ideal response but is technically extremely difficult, if not impossible, for most invasive species.[12]

4.9 However, the benefits of early eradication were supported by the Weeds CRC which noted that the current eradication campaign against branched broomrape is estimated to have a benefit/cost ratio of 7.9 with an internal rate of return of 22%.[13]

4.10 The WWF argued that prevention and early control are the least costly and most effective approach to managing invasive species. The Prime Minister's Science, Engineering and Innovation Council (PMSEIC) report, *Sustaining our Natural Systems and Biodiversity*, concluded that limiting the spread of pests, weeds and imported diseases is one of four areas of investment above all others that is likely to return greatest impact in heading off the diminishing value of Australia's natural systems and biodiversity.[14]

4.11 The table below illustrates the effectiveness of a $1 million investment over a range of intervention strategies.[15]

Table 4.1 – Costs and benefits of intervention strategies

OPTION		No. species secured/$1m	Collateral benefit/cost	Maintenance or Repair
A	Prevent broadscale clearing of high ecological value communities in Queensland	26	20	M
B	Prevent broadscale clearing of communities in the MDB that have high multiple ecosystem service value	13	26	M
C	Restore ecological communities which have fallen below 10% back to 10% of their original area, in the 5 IBRA regions that have <30% native vegetation remaining.	25	0.6	R
D	Restore native vegetation in all IBRA sub-regions that have fallen below 10% back to 10% of their original area	13	0.6	R

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11 Tasmanian Weed Society, *Submission* 18, p. 3.

12 Bureau of Rural Sciences, *Submission 62a*, p. 6.

13 CRC Weed management, *Submission* 22, p. 3.

14 WWF, *Submission* 30.

15 WWF, *Submission* 30, p. 21.

E	Consolidate the National Reserve System to achieve comprehensiveness targets	42	5.7	M
F	Protect the health of rivers that are least disturbed	98	13	M
G	Restore river health to rivers in poor condition	2	0.3	R
H	Ensure environmental flows are at least 15% of sustainable water yield.	1	0.3	R
I	Limit the spread of Phytophthora	35	40	M
J	Eradicate new outbreaks of naturalised plant species with weedy potential	83	1.4	M
K	Biological control of weeds of national significance	16	10	R
L	Mechanical and herbicidal control of weeds (Mimosa example)	7	0.3	R
M	Biological control of vertebrate pests	57	9	R
N	Mechanical control of feral predators (Earth Sanctuary example)	2	0.7	R
O	Strategic revegetation to prevent salinity from further affecting remnant vegetation	19	0.5	R
P	Prevent grazing of 10% of all arid and semi-arid grazing lands	4	1	R
Q	Manage grazing for conservation in threatened grasslands in South East Australia	90	0.8	R+M
R	Implement fire management regimes in native vegetation which promote a diversity of fire patterns	95	9	R+M

4.12 The Queensland Government submitted that:

> Experience in Queensland has shown that prevention and early eradication are significantly more cost effective responses than containment/damage mitigation actions for invasive species…. An essential component of any system must also be an early warning monitoring and surveillance program. To date such programs have not been widely included as part of the response to incursions. At the same time strategic control programs have been carried out on established pests when it considered that this would result in significant reductions in pest impacts. Awareness and extension activities are very cost effective.[16]

4.13 The Committee took evidence from the Quarantine and Export Advisory Council which noted that the recent incursion in Queensland of the exotic red imported fire ant required a commitment of $140 million to an eradication program and the papaya fruit fly detection and eradication program run over four years cost approximately $34 million[17] (see case study on fire ants in Chapter 5). The Queensland Government informed the Committee that:

> A Benefit Cost Analysis was undertaken by ABARE in 2001 into the proposed eradication program. This analysis found that the cost to the community if the fire ant was not controlled would be $8.9 billion over a 30-year period. The major costs were from loss of property values, cost of household repairs and treatment and the cost to agriculture. This study provided a BCR of 25:1 based on a $124m, five-year program that is well above the limit where eradication is considered worthwhile. However, this

16 Queensland Government, *Submission* 43, p.10.

17 Quarantine and Export Advisory Council, *Submission* 49, p. 2.

analysis is very conservative - it did not include the costs from the loss of environmental and lifestyle values that this ant would cause.[18]

4.14 Achieving early eradication requires a number of conditions, these include: proper planning, commitment to complete the process, putting the entire population of the target species at risk, removing them faster than they reproduce and preventing reinvasion. Although the up front costs of early eradication programs may be significant, the cost of weed and pest control activities after the pest is widespread and established are usually significantly more costly and time consuming.

4.15 The Bureau of Rural Sciences argued that six criteria that must be met for an eradication to be successful. These are:

- 1. The rate of removal must exceed the rate of increase at all population densities
- 2. Immigration must be zero or the probability of reinvasion should be considered
- 3. Target species must be detectable at low densities
- 4. All reproductive individuals must be at risk
- 5. Discounted cost-benefit analysis must favour eradication over control; economics should favour eradication
- 6. There must be a suitable socio-political environment; adequate resources must be committed to see the eradication project through to completion; and clear lines of authority must be established.[19]

4.16 The following is an example of a successful eradication program which illustrates a number of the criteria outlined above.

Case study: Eradication of the Black-striped mussel[20]

The fouling mussel, Mytilopsis sp., colloquially known as the black-striped mussel, are small marine bivalve mollusc originating from Central and South America. They have spread to several countries in the Indo-Pacific region, and are considered a serious pest because of their ability to rapidly establish large populations and cause significant environmental and economic impacts This mussel is a fast growing filter-feeder that clings to boats and pilings and has the capacity to jam water intake pipes. It is closely related to the freshwater zebra mussel that costs the United States $100 million a year to control in the Great Lakes alone.

18 Queensland Government, *Submission* 43, p. 12.

19 Bureau of Rural Sciences, *Submission* 62a, p. 13.

20 CSIRO, *Submission 34*, p. 14; NSW Fisheries website, *Black-striped mussel - Mytilopsis sallei*, at: www.fisheries.nsw.gov.au/thr/species/fn-black-striped-mussel.htm.

The black-striped mussel was discovered in three loched marinas within The Port of Darwin - Cullen Bay Marina, Tipperary Waters Marina and the Frances Mooring Basin (also known as the 'duck pond') in March 1999 at densities up to 23,650 m-2 during a opportunistic port survey. It had reached those densities in less than six months. The mussels were probably introduced into Darwin on the hull of a commercial or recreational vessel travelling from infected ports in other parts of the world.

On discovery of the invasion the Northern Territory government reacted rapidly to quarantine the infected area within three days of being informed by CSIRO of the presence of the black striped mussel in a Darwin marina. The mussel was seen as a major environmental and economic threat to the Northern Australian coastline (between Sydney to Perth) and also a major threat to the local $40 million pa pearl oyster fishery.

The response management committee coordinated the on-ground containment and treatment actions (involving over 300 personnel). The main actions undertaken included the tracking and treatment of vessels that had left infected sites, the treatment of three sites and almost three hundred vessels in the Darwin area and the initiation of a public awareness program to meet local and national needs. Commonwealth agencies led by Agriculture Fisheries and Forestry - Australia (AFFA) established a national working group on 6 April 1999 to coordinate national action to prevent the spread of the mussel to other States. Other agencies involved included Environment Australia (EA), Commonwealth Scientific and Industrial Research Organisation's

(CSIRO) Centre for Research on Introduced Marine Pests (CRIMP), the Australian Fisheries Management Authority (AFMA), the Australian Quarantine and Inspection Service (AQIS), the Australian Maritime Safety Authority (AMSA), the Australian Customs Service (ACS), the Australian Government Solicitor (AGS) and the Department of Defence (Navy). A local scientific sub-committee comprising representatives from CSIRO CRIMP, NT Museum and Art Gallery, DPIF and the Northern Territory University developed national protocols to detect and treat the Black Striped Mussel at the Darwin sites and on vectors considered to be at risk.

Between 31 March and 19 April 1999, chlorine (calcium and sodium hypochlorite) and copper sulphate were added to the marina waters at a cost of over $2 million in materials alone. Both treatments killed mussels but the copper sulphate proved more effective. On 23 April 1999, 100% of the exotic Black Striped Mussels were deemed successfully eradicated and , all three marinas were re-opened for normal use. Procedures were established for continued monitoring to detect possible new infestations. No further infestations have been detected to date.[21]

Chronology of response to the Black Striped Mussel outbreak[22]

September 1998 Divers from CSIRO CRIMP and the NT Museum & Art Gallery surveyed Darwin Harbour and marinas, including Cullen Bay Marina, (as part of the

21 Mr Rob Ferguson, Department of Environment and Heritage website*, The effectiveness of Australia's response to the Black Striped Mussel incursion in Darwin, Australia*, December 2000. At: www.deh.gov.au/coasts/imps/pubs/bsmfinalreport.pdf.

22 ibid.

	Port of Darwin baseline survey) and did not detect any Black Striped Mussels (BSM).
27 March 1999	CSIRO divers conducted the second component of the baseline survey and detected massive infestations of BSM in Cullen Bay Marina.
29 March 1999	NT Museum & Art Gallery alerted NT Department of Primary Industry and Fisheries (DPIF) of BSM detection. The Minister and Chief Executive Officer of DPIF were b
30 March 1999	Follow-up dive surveys were coordinated by DPIF to determine the extent of the outbreak outside Cullen Bay Marina A special meeting of the NT Cabinet to pass regulatory amendments, approved the establishment of the Taskforce and the expenditure of funds.
31 March 1999	NT Cabinet and Executive Councils convened and legislative changes were approved. A second BSM outbreak was found at Tipperary Waters Estate Marina. Six vessels were contained within Tipperary waters. An emergency management committee was convened, response teams were established, an information campaign commenced (including telephone hotline, Internet site, public meetings), and marina locks were dosed with sodium hypochlorite to create a sterile plug. One hundred and forty seven vessels were contained within Cullen Bay Marina.
1 April 1999	A vessel originally from Cullen Bay Marina moored in Frances Bay Mooring Basin was found to be carrying BSM. 70 vessels were contained within Frances Bay. An interstate alert was issued to owners of vessels from Cullen Bay Marina to check vessels and not scrape hulls. The NT Government quarantined the three infected marina sites to prevent further spread of BSM, using a combination of the powers in the NT *Fisheries Act 1988* and the Commonwealth *Quarantine Act 1908.*
2 April 1999	Four vessels from Cullen Bay Marina moored in Sadgroves Creek were found to have BSM and were removed from the water. Dive teams checked potential contamination sites around Darwin Harbour. A list of potentially contaminated vessels that had left the marinas was developed by AQIS with the support of Australian Fisheries Management Authority.
3 April 1999	Two vessels from Cullen Bay Marina lifted at Spot On Marine were found to have BSM and were removed from the water. Another contaminated vessel located at Frances Bay Mooring Basin was also removed from the water. Trial of copper sulphate treatment commenced in Tipperary Waters Marina Estate.
4 April 1999	Chlorine treatment of Cullen Bay Marina. Further copper sulphate treatment of Tipperary Waters Marina Estate was undertaken. A vessel tracking database was established and 420 vessels were identified as “at risk” of contamination (either those still in the marinas or those which had left since the infection period). Treatment of internal systems of vessels was trialled.

5 April 1999	Further chlorine treatment of Cullen Bay Marina. Fish species killed during treatment of the marinas were identified by the NT Museum. No further sign of BSM infestation were found outside the three marinas.
6 April 1999	Further chlorine treatment of Cullen Bay Marina. The National BSM Taskforce was established led by Agriculture, Fisheries and Forestry - Australia. Copper sulphate was found to have a 100% kill rate of mussels in Tipperary Waters Marina Estate. Four boats were slipped and found to be infested with BSM.
7 April 1999	Copper sulphate treatment of Cullen Bay. Vessel cleaning protocols were released. Scientific sub-committee of the National BSM Taskforce met to develop National Protocols for treatment of vessels and anchorages between Fremantle and Sydney potentially infected with the BSM. Chlorine treatment of Frances Bay Marina. Second public meeting at Cullen Bay.
8 April 1999	Copper sulphate added to Frances Bay. Gove Harbour was declared clear of BSM. NT DPIF staff commenced checking the internal systems of Cullen Bay Marina vessels with endoscopes.
9 April 1999	Further chlorine treatment of Cullen Bay Marina after heavy rain during previous 24 hours.
12 April 1999	Some cleaned vessels were allowed to leave Cullen Bay Marina after a check of monitoring areas in the marina revealed no live mussels.
15 April 1999	A recently dead mussel found on a yacht from Cullen Bay Marina when lifted at Sadgrove's Quay.
16 April 1999	Surviving mussels were detected on vessels leaving Cullen Bay Marina. Both Cullen Bay and Tipperary Waters marinas were again closed and quarantined. Intensive re-surveying and re-sampling commenced in Cullen Bay Marina. National Protocols formally released.
17-19 April 1999	Intensive sampling of Cullen Bay Marina revealed two live mussels, followed by two recently dead mussels in amongst hundreds of thousands of dead mussels. Copper sulphate was added at specific sites in Cullen Bay Marina.
20 April 1999	Cullen Bay Marina reopened at high tide for limited access in and out of the marina. Clearance dives were conducted in Tipperary Waters Marina Estate.
22 April 1999	Clearance dives were conducted in Frances Bay Mooring Basin.
23 April 1999	Quarantine conditions were lifted from Cullen Bay, Frances Bay and Tipperary Waters marinas and all were re-opened for normal use. Monitoring and sampling surveys continued.
29 April 1999	National BSM Taskforce ceased operation.

8 May 1999	21 day “all clear” issued for all three marinas. Precautionary vessel checking and treatment arrangements remained in place.
May 1999	The Aquatic Pest Management Program was established to monitor the impacts of BSM response activities and oversee a continuing program of pest surveillance and control in the Northern Territory.
July 1999	The National Taskforce for the Prevention and Management of Marine Pest Incursions was established to examine improvements to all aspects of introduced marine pest management. The Taskforce’s report was delivered to Government Ministers on 23 December 1999.

Containment/exclusion

4.17 Measures to effectively halt or minimise the spread of invasive species can involve either keeping species within a fixed area (containment) or keeping species out of an area (exclusion). Responses range from physical barriers (e.g. fences or high security facilities) to chemical barriers (e.g. poison baited buffer lines) through to virtual containment lines (e.g. mapped containment areas). The cost of these activities is often greater than prevention and it is likely that these actions will be integrated with damage mitigation for many species. The Tasmanian Weed Society argued:

> Containment costs can range from minimal expenditure associated with early eradication extending to on-going high levels of cost associated with restricting an established invasive to a particular area as eradication is not considered possible or is considered too difficult or expensive. The latter reason is flawed, as containment is very expensive when applied over a long period. Additional expenses are incurred where containment provisions impact on business enterprises in the containment area and restrict movement of people and products. Environmental costs are higher as the invasive species will continue to impact on the environment to a greater or lesser extent depending on mitigation actions in the containment area. However, for many invasive species present in Australia this will be the most likely option for management.[23]

4.18 As an example of the complexities of containment and the difficult in achieving successful outcomes the CSIRO submitted:

> Attempts to confine spiralling whitefly to the northern tip of Cape York Peninsula proved ineffective. There were no serious attempts to combine containment with eradication and the infestation, which soon spread south to Cairns and beyond, is now too widespread to contemplate eradication. In retrospect, there was little point in bothering with a containment policy for this pest in the absence of any clearly defined commitment to fund an eradication program.[24]

23 Tasmanian Weed Society, *Submission* 18, p. 3.

24 CSIRO, *Submission* 34, p. 14.

4.19 The following case study provides an example of the difficulty of containment with a view to eradicating established weed species.

Case study: Containment of Branched Broomrape - Orobanche ramosa

Branched Broomrape (Orobanche ramosa) is a parasitic weed of broad leaf crops and is found throughout many parts of Europe, Central Asia, South Africa, North and Central America. Broomrapes are root parasites that extract all their nutrient requirements from their host plants. They have no leaves or chlorophyll and do not photosynthesise. The weed is only detectable during a short flowering period and is underground for the remainder of the life cycle. Infestations have been masked by grazing and other factors, which would limit the detection of the flower stalks and seed heads. Broomrape species infest 16 million hectares world wide, which is 1.2% of the world's arable land. They affect 51% of the world's sunflower crops, 35% of the world's faba bean crops, and 45% of the world's lentil. It can directly reduce yields up to 40% in some crops.

The potential impact of broomrape in Australia is very serious in terms of both production losses and threats to export markets. The main industries at risk are oilseeds, field peas, vegetables, lupins and vetch, and in particular, the seed industry for these crops.

Branched Broomrape was first detected in Australia in 1992 near Bow Hill South Australia. Until 1997, South Australian officials have conducted an ongoing management program. In October 1998 South Australian authorities detected a further spread to over 160 ha. The Commonwealth Chief Plant Protection Officer (CPPO) was notified in February 1999 of the new infestations.

Further surveys were carried out and a national Orobanche ramosa consultative committee, chaired by the CPPO was convened to assess the infestation in March 1999. In early 1999 the infestation area had grown to over 100 ha and the Australian Weed Committee (AWC) and Standing Committee on Agriculture and Resource Management (SCARM) agreed on a national eradication program. A decision to eradicate was delayed until the distribution of the weed was clearly determined. A strategy to conduct a national awareness program, delimiting surveys in South Australia and research on the host range of the weed was developed.[25]

Surveys in the springs of 1999 and 2000 established that the known infestation was contained within an area of about 70 x 70 km, northeast of Murray Bridge in south Australia. Infested Paddocks in 130 properties total about 11,000 ha. A national survey and awareness campaign has not revealed the presence of branched broomrape elsewhere in Australia.

Unlike other weeds, broomrape species are spread by millions of minute spore-like seeds and, except for a few weeks in the flowering season, grow underground. The weed is spread mainly by soil contamination through cultivation machinery and livestock. Its control

[25] Department of Agriculture and Fisheries and Forestry website at: www.affa.gov.au/content/output.cfm?&OBJECTID=0BFA0A07-108E-48CB-8071D0CAED6EBA85.

requires a similar strategy to the control of a disease epidemic, that is, isolation and sterilisation of infested sites.[26]

In South Australia the SA Government committed to a program of fumigation to eradicate Branched Broomrape and to compensate the landowners who make their living from the land hit by infestations. The fumigation and incentive program for the eradication of Branched Broomrape will cost $7.6 million over four years.[27]

Damage mitigation

4.20 The management of established pests generally involves reducing the impact from the species (damage mitigation). In Queensland it is estimated that these activities make up 30% of the programs funded by the Department of Natural Resources and Mines and Local Government (AEC 2002). Control activities include; chemical, mechanical or physical control, biological control or habitat modification depending on the species. The Committee heard that European foxes, feral cats and pigs, lantana and parkinsonia are all managed to some level.[28] The Tasmanian Weed Society submitted:

> This course of action is one of the most difficult to employ as by the nature of choosing this management option it is understood the invasive species cannot be fully checked. Often not been feasible to eradicate from a site or keep from reinvading without ongoing management input. It requires the development of adequate means of control and a rationale to determine where efforts should be focused. In many instances expensive biological control programs are required to manage the impacts of weeds that fall into this category. Localised efforts at damage mitigation by manual, herbicide and other integrated techniques are similarly costly and cannot be applied on a large scale by individual landholders or governments. A targeted approach based on a strategic focus on the assets at risk is the most effective way of applying resources.[29]

4.21 The Bureau of Rural Sciences also noted the complexity of a damage mitigation strategy in the management of invasives.

> Damage mitigation through sustained control is a more complex strategy than eradication or containment. Optimal management depends on knowing when and where to intervene with optimal levels of control, and this depends on a good understanding of the relationships between vertebrate

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26 River Link Newsletter number 48, December 1999, website at: www.sardi.sa.gov.au/ riverlink/news/rlno48.htm.

27 Government of South Australia, Government Achievements, website at: http://203.6.132.27/achievements_ 6m/group_display.asp?Group_ID=9&Commitment_ID=67.

28 Queensland Government, *Submission* 43, p. 15.

29 Tasmanian Weed Society, *Submission* 18, p. 3.

> pest densities and resource conditions. The benefits need to be predicted or measured to optimise the management.[30]

4.22 The following case study illustrates the use of biological control as a method of damage mitigation once an invasive species is established and eradication and other forms of control are no longer a viable option.

Case study: Biological control of bridal creeper

Bridal creeper, *Asparagus asparagoides*, is an environmental weed that was introduced from South Africa into Australia in the middle of the 19th century as an ornamental plant.

Bridal creeper is now a major weed and has become naturalised in many temperate Australian ecosystems, ranging from wet and dry sclerophyll forests to riparian and coastal vegetation systems. Its climbing vegetation smothers native plants and it forms a thick mat of underground tubers which impedes the root growth of other plants and often prevents seedling establishment. In many instances it forms dense monocultures, and is regarded as a very serious threat to biodiversity. Bridal creeper is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts and has been declared a weed of national significance (WONS).[31] Mr Peter Mirtschin from Venom Supplies in South Australia told the Committee that:

> This weed is now at epidemic proportions in southern Australia. In South Australia it abounds on the West Coast, Eyre Peninsula, Yorke Peninsula, Adelaide Hills, Barossa valley, the southeast and parts of the Riverland … The weed is the dominant understorey plant in many areas. Not only does it smother and replace low native plants but large trees also succumb to its advance (see pictures on Kangaroo Island and Waikerie above).
>
> Bridal Creeper threatens to cover all of southern Australia in the next 15 years.[32]

Biological control

Once invasive plants are established and widespread, the most cost-effective control method is biological control using insects or plant diseases introduced from the country of origin of the weed. Biological controls deliver high cost-benefit ratios, are sustainable in the long-term and have very few undesirable non-target effects. Biological control programs are long-term, typically requiring funding for 5 to 10 years as well as expensive quarantine infrastructures.[33]

Three biological control agents of bridal creeper have been released in Australia: the leafhopper *Zygina sp*. in 1999, the rust fungus *Puccinia myrsiphylli* in 2000 and the leaf beetle *Crioceris sp*. in 2002.

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30 Bureau of Rural Science, *Submission* 62a, p. 19.

31 CRC for Australian Weed Management, Weed Management Guide: Bridal Creeper, at: http://www.weeds.crc.org.au/documents/wmg_bridal_creeper.pdf.

32 Mr Peter Mirtshen, Venom Supplies, *Submission* 6, p. 1.

33 CRC for Australian Weed Management, *Submission* 22.

A national redistribution program established in 2002, with the financial assistance from the Natural Heritage Trust, has fast tracked the release and spread of the leafhopper and rust fungus across the entire range of bridal creeper infestations.

The bridal creeper leafhopper has been released at more than 700 sites throughout southern Australia since 1999. The adult insect is white, 2-3 mm long and lives on the underside of bridal creeper leaves. Both the adult and juvenile stages feed on the leaves of the weed, causing them to turn white and, in severe cases, fall off. The plant will continue to grow but with much less vigour. Continual damage over several years will reduce new tuber production, making it less competitive.

The bridal creeper rust fungus was released in 2000 and more than 700 releases have been made across Australia. The rust fungus attacks leaves and stems, reducing the amount of green plant material.

The bridal creeper leaf beetle (*Crioceris sp.*) was first released in 2002 in Western Australia. The grubs of the beetle can cause major damage to bridal creeper by stripping the shoots and leaves that enable the plant to climb. Stopping it climbing will stop it fruiting and spreading to new areas. Nursery sites of the leaf beetle are being established and monitored in order to support future redistribution efforts.

In June 2004 CSIRO Entomology announced it had received funding from the Natural Heritage Trust to support the continued delivery of biological control agents in collaboration with community groups and land managers.

The effectiveness of biological control

Reports in 2003 of natural spread of the rust fungus of up to 1km from release sites after one year are positive. The rust was seen to cause severe defoliation of plants in the middle of the weed's growing season. This was particularly apparent in Western Australia, New South Wales and Kangaroo Island in South Australia.[34]

While the leafhopper has readily established at most release sites, their performance is variable. In many places they simply establish and populations stay in numbers too low to make any impact on bridal creeper. At other sites they perform extremely well, spreading considerable distances and causing early defoliation of bridal creeper.[35] It will take many years for the biocontrol agents to reduce the density of bridal creeper due to the huge reserves stored underground in tubers, however, it remains a cost-effective method of control.

4.23 Evidence received by the Committee strongly supported the use of biocontrol methods to address invasive species.[36] The Animal and Plant Control Commission submitted:

34 CSIRO Entomology website at: http://www.ento.csiro.au/weeds/bridalcreeper/news.html.

35 CSIRO Entomology website at: http://www.ento.csiro.au/weeds/bridalcreeper/leafhopper/index.html.

36 Weed Management Society of South Australia, *Submission 35*, p. 7.

> Biological control remains one of the few options for controlling invasive species over large areas. However these programs are expensive and time consuming due in part to legislative and consultation requirements. Support for biological control should be reaffirmed and negotiations between Commonwealth and states should focus on simplifying these processes to minimise the costs.[37]

4.24 Dr Rachel McFadyen, CEO of the Weeds CRC, told the Committee that:

> The problem with biocontrol is that it needs long-term resources and national support and that is what it is not getting. Again, I think there needs to be some national support for biocontrol. To re-emphasise this, we are saying that coordinated weed control, if it comes in early, can make a real difference. It is important that we do something. We have made good progress on some issues but we do need long-term national resources for those points. Essentially, we are saying that it is a saving of national money.[38]

4.25 Another method of control that is being developed for damage mitigation is gene manipulation. The funding and support mechanisms for the development of control methods using gene manipulation requires are similar to the development of biological control agents as it can take a significant period of time from inception to release of this technology. Contact with the Gene Technology Regulator is required regarding regulations that may cover more advanced stages of the project to ensure that there are no adverse impacts. Gene manipulation technology is controversial and legal, logistical, environmental and community barriers to release must be addressed prior to the release of the technology.

Case study: Daughterless Carp - Control through Gene Manipulation[39]

Carp (Cyprinus Carpio), usually referred to as European Carp, are native to Central Asia. They were introduced to China, Japan and Italy in ancient times, and were first introduced into Australian waterways over 100 years ago. Since the 1960s they have bred particularly fast and now make up more than 90 per cent of the total fish population in some Murray-Darling Basin rivers.

Carp significantly degrade waterways by causing increases in water turbidity and water nutrient levels. They also damage the riverine habitat, uprooting aquatic plants and competing with the native fish for food and habitat. River conditions that have

37 Animal and Plant Control Commission, *Submission* 15, p. 9.

38 Dr Rachel McFadyen, *Committee Hansard*, Canberra, 26 November 2003, p. 7.

39 CSIRO and the Murray-Darling Basin Commission, *Carp Management in the Murray Darling Basin: Daughterless Carp Technology.*

reduced native fish numbers also favour carp. Carp prefer slow running waters and river pools, and are most common in the highly regulated waters of the Murray River and Murrumbidgee River.

Controlling Carp

A variety of methods have been tried for controlling Carp.

- Targeted fishing has the potential to significantly reduce carp numbers. In some parts of South Australia targeted fishing has reduced carp from 80% to less than 40% of the biomass.

- A number of community groups have reportedly been successful in removing carp from wetlands and preventing re-entery by screening inlet channels

- Scientists have been investigating the use of a virus known as spring viremia since the 1970s when it attacked farmed carp in Europe. However, it is not an option at this stage because introducing such a virus may affect native fish and Australia's 'clean-green' status.

- Carp have been successfully eradicated from lakes using the chemical poison rotene. However, the use of poison in quantities large enough to affect carp is likely to have significant impact on native plants and animals.

While some of these methods can be effective in eliminating carp from enclosed water or in reducing their numbers they are unlikely to provide a permanent solution. A more promising avenue for control is the daughterless carp technology being developed by the CSIRO, with support from the Murray Darling Basin Commission.

Daughterless Carp Technology

Daughterless carp technology involves manipulating the genes of carp to produce an inheritable 'daughterless' carp. Despite breeding normally, with each succeeding generation fewer and fewer females will be produced in the wild population as this biological control method restricts all offspring to males. It is predicted that this technology will significantly reduce carp numbers in the Murray-Darling Basin within 20-30 years of release.

The daughterless gene consists of a promoter that activates the daughterless gene to express only in females. During its brief period of activation, the daughterless gene inhibits production of the key enzyme required for the fish to develop as a female – as a result the fish defaults to a male. The genetic sequence used to produce daughterless carp is found in the carp itself. This is species-specific technology and native fish will not be affected by the technology.

This technology is still in a developmental stage. For it to be effective it must be ecologically safe, socially acceptable, economically affordable and cost effective. Research into these factors must be conducted before any consideration can be given to releasing 'daughterless' carp. A final decision on the release of carp that carry the 'daughterless' gene will not be made until 2009.

Conclusion

Gene manipulation technology opens a new avenue for controlling invasive species and it is likely that a similar approach could be effective in combating other invasive species.

Inaction

4.26 Several factors influence the decision to adopt an approach of inaction in relation to an invasive species. These include the burden placed on landowners if a species is declared, the impact of a pest, the geographic distribution of the pest, and whether the short-term management cost is greater than longer-term cost if the species does spread. Inaction on a pest may also be a valid response if no cost effective method of control is available, although this may also lead to funds being set aside for research. As the Queensland Government argued, however:

> In many cases, inaction is not an option, public sentiment will require at least extension material and research to improve management.[40]

4.27 The cost of inaction is often felt in the longer term when management costs and negative environmental effect maybe significantly higher.[41] Failure to act can lead to a situation where control, management, and damage mitigation are no longer possible and the community has to suffer the effects of the invasion in the longer term. The Tasmanian Weed Society submitted:

> Short term costs of inaction are practically nil and this is often an attractive option for jurisdictions that have limited budgets, or fail to understand the implications of invasive species. Mid-term costs of inaction are moderate where the invasive incident gradually impacts on production, trade, aesthetics, and environment. The long term costs of inaction can be immense and translate to the most expensive response to an invasive incident … Our environmental and cultural heritage is at risk and being slowly and insidiously changed through inaction.[42]

4.28 Cane toads are an example of what can occur as a result of a failure to address a pest species.

4.29 Cane toads, which are native to Central and South America, were released in Queensland in 1935. Within a brief period of time they became established pests. Cane toads are primarily environmental pests not agricultural, and have significant impact on biodiversity:

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40 Queensland Government, *Submission* 43, p. 16.

41 Bureau of Rural Science, *Submission* 62a, p. 20.

42 Tasmanian Weed Society, *Submission* 18, p. 3.

> Cane toads are seen as a major threat to biodiversity, not only because they voraciously out-compete some native species for food and consume others, but also because their skin toxins are thought to kill carnivorous predators which mistake them for local amphibians. Although the impact of cane toads on native Australian species is perceived to be detrimental, most reports so far are anecdotal, a fact recognised at the workshop [*Biological Control of Cane Toads*, held in February 2004] by a number of ecologists. Gradually, however, more quantitative data on the impacts of native species are becoming available to greatly assist in confirming the toads effects.[43]

4.30 Dr Alex Hyatt, Senior Principal Research Scientist, Australian Animal Health Laboratory, CSIRO told the Committee that:

> To see the long-term impacts, you need long-term studies. … If you have short-term discontinuous studies over a long period of time, you are not going to derive the data whereby you can say definitely over a long period of time there is a significant impact or not. Short term, however, as my colleagues have said, there are published data to show that the impact of the cane toad is dramatic in a short-term time frame in all areas—culture as well as biodiversity.[44]

4.31 A failure, across all tiers of government, to commit adequate resources to manage them and to invest in the development of an effective control method has resulted in their spread across vast areas of Queensland, the Northern Territory and New South Wales. Their range now extends to Kakadu National Park. It is estimated that they are spreading at a rate of 27 kilometres per annum.

4.32 There is a dearth of research into both the impact of, and measures to control, cane toads. Evidence indicates that they have been placed in the 'too hard basket' by many decision makers.

4.33 The case study below demonstrates what the outcome can be if a new species is released without being subjected to thorough risk assessment prior to release and the consequence of inaction once a species is identified as being invasive.

Case study - Cane Toads [45]

Cane toads were deliberately introduced to Australia from Hawaii in 1935 in an attempt to stop French's Cane Beetle and the Greyback Cane Beetle from destroying sugar cane crops in North Queensland. The Australian Bureau of Sugar Experimental Stations made the release of 101 cane toads at Gordonvale in Queensland. The cane toad was unsuccessful in controlling cane beetles.

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43 ECOS*, Battlelines drawn against the cane toad march*, 119 Apr-Jun 2004, p.28.

44 Dr Alex Hyatt, *Committee Hansard*, Canberra, 18 June 2004, p. 8.

45 CSIRO, *CSIRO* cane toad research website at: http://www.csiro.au/index.asp?type=faq&id=CaneToadControl&stylesheet=sectorInformationSheet and Australian Museum, *Fact sheets Cane Toads, Giant Toads or Marine Toads* at: http://www.austmus.gov.au/factsheets/canetoad.htm*,* accessed 11 October 2004.

In Australia, most cane toads are found in urban areas and in areas with grassland or woodland. Average adult-sized cane toads are 10-15 cm long. They are a fecund species; females lay 8,000 to 35,000 eggs at a time and usually breed twice a year. Cane toads need between 6 and 18 months to reach sexual maturity and have a lifespan, in the wild, of about 5 years. About 0.5% of cane toads that hatch from eggs survive to reach sexual maturity and reproduce.

Due to their adaptability and the fact that they have no known predator in Australia, with the possible exception of keelback snakes, cane toads have been able to become established across a vast area. Their food and habitat requirements are easily met. Cane toads eat mainly insects, but will eat any small creature that fits in their mouth, including marine snails, native frogs, small snakes, and small mammals. Adult cane toads can survive the loss of up to 50% of their body water, and in temperatures ranging from 5 - 40ºC and they can tolerate salinity levels of up to 15%.

Cane toads are toxic in all stages of their life cycle. Australian native fauna, such as freshwater crocodiles, goannas, tiger snakes, dingos and western quolls have died from cane toad venom. In Australia, no humans have died from cane toad venom, however, it may cause intense pain, temporary blindness or inflammation if it is absorbed by humans.

The ecological impacts of cane toads have been hard to identify as the research required to determine the impacts is long term and multidisciplinary.[46] However, the significant impact of cane toads on biodiversity is undisputed. While some birds have learnt to turn them over and take out the intestinal contents without eating the toxic skin and evidence indicates that goannas learn to avoid them after experiencing non-lethal doses of cane toad venom, other native species, such as quolls, do not seem to learn to avoid the cane toads.[47] Although no extensive environmental monitoring studies have been undertaken, evidence indicates that there has been a decline in quoll, snake and native frog numbers in areas where large numbers of cane toads are found. The acute effects of cane toads on biodiversity, such as through the killing of freshwater crocodiles and quolls, can be readily seen in areas where they have more recently moved.[48]

Despite the negative impact cane toad have on a number of species they are not officially recognised as a threatening process in Australia, because not all States consider toads to be a problem. Only animals that are of national significance are officially recognised as threatening processes.

At present there is no national strategy to address cane toads and there is no broad-scale control method that can be applied to the vast area where cane toads have spread. Current control activities for cane toads are mainly taking place through quarantine checks and public awareness campaigns. In Queensland no funds are currently expended by state agencies as current control methods and the wide distribution of cane toads suggest that funds will not effectively deliver an outcome as the species has already reached its extent in the state.[49]

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46 Dr Mark Lonsdale, *Committee Hansard*, Canberra, 18 June 2004, p. 8.

47 Dr Tony Robinson, *Committee Hansard*, Canberra, 18 June 2004, p. 7.

48 ibid, p. 7.

49 Queensland Government, *Submission 43*, p. 31.

A solution to cane toads is proving elusive. A number of options for controlling cane toads have been investigated, and the Commonwealth Government has spent $5 million on studies of how to eradicate cane toads.[50] However, a successful control method has yet to be identified. From 1987-1989 researchers at James Cook University investigated possible controls focusing on diseases in Australia that could affect cane toads, unfortunately the research was unsuccessful. From 1989-1994 research focused on the original habitat of the cane toad, Venezuela, and looked at diseases in South America that had the potential for use in Australia. Researchers identified a potential virus, however, the virus killed one species of Australian amphibian and was therefore ruled out.

Currently hope for a solution rests with the CSIRO. In 2001 CSIRO researchers commenced a project to investigate the possibility of creating a biological control from a native amphibian virus which can interrupt the metamorphosis of the cane toad and disrupt development. It aims to develop a biological control option which could be deployed across the range of the cane toads. The goal is to identify and manipulate a critical toad gene to disrupt development and prevent the tadpole from maturing and therefore reproducing. The second goal is to develop a method for delivering the gene effectively to the toads genetics, using a viral infection.[51]

The CSIRO project is high-risk research, at the frontiers of research knowledge. It is expected to take 10-years from inception before results can be delivered.[52]

Biological control agents can be the most effective method for addressing an invasive species. However, their development requires significant financial and time investments from involved parties. As has been demonstrated by previous research into control methods for cane toads, viable solutions have proved elusive. It is hoped that with the support of the Commonwealth, State and Territory Governments the CSIRO will be able to identify a solution.

On 26-27 February 2004, a workshop titled "Biological Control of Cane Toads" was held in Queensland. It was sponsored by the Australian Government Department of Environment and Heritage under the National Threat Abatement Component of the Natural Heritage Trust. The purpose of the workshop was to provide information to the Australian scientific community and public interest groups about the current CSIRO biological control project and to discuss key issues relating to the impact and control of cane toads. At the meeting it was agreed that there was a need for cane toads to be controlled through a combination of short-term, local, methods as well as long-term, nation-wide methods. It was also recognised that an effective national strategy is required and research into cane toads must be coordinated if cane toad populations are to be controlled.[53]

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50 Senator Ian Campbell, *Cane toad invasion threat - joint taskforce to defend WA*, Media Release, 29 August 2004.

51 ECOS*, Battlelines drawn against the cane toad march*, 119 Apr-Jun 2004, p. 28.

52 Dr Tony Robinson, Committee Hansard, Canberra, 18 June 2004, p. 7.

53 Department of Environment and Heritage, *Initiative for Future Research on the Control of Cane Toads in Australia*, website at: http://www.deh.gov.au/biodiversity/invasive/ferals/canetoad-year-3/pubs/canetoad-year-3-summary.pdf.

The general recommendations arising from the workshop were:

- establish a national cane toad group to coordinate research;
- collate and document all current knowledge on the short and long-term impacts of cane toads;
- identify gaps in impact knowledge and support further research;
- identify and implement short-term control and damage mitigation measures;
- identify research gaps in short and long-term control methods; and
- provide support for research into short and long-term control measures.

Recognition of the need for action has resulted from an increase in awareness of the threat posed by the continued spread of cane toads, and their impact on biodiversity.

At the Natural Resource Management Ministerial Council (NRMMC) meeting in April 2004 there was consensus on the need to address cane toads and the NRMMC directed its Vertebrate Pests Committee to investigate options for a national approach to eradicate them.[54] The inaugural meeting of the National Cane Toad Taskforce was held in Darwin on 21 and 22 November 2004. The taskforce will report to the Vertebrate Pest Committee.

The Minister for the Environment, Senator Campbell, also foreshadowed the development of a national cane toad group to coordinate a drive against the pest and called on the Western Australia Government to work with the Commonwealth Government to halt the migration of cane toads into Western Australia. Senator Campbell advised that:

> The Australian Government will take all measures available to stop the cane toad reaching Western Australia in order to safeguard the state from the impacts of this menace.[55]

4.34 Cane toads have been able to spread across Australia as a result of policies of inaction. It has only recently been recognised that the impacts of cane toads are too significant for them to continue to be ignored. The cost of this delayed response will be considerable and a solution is many years away from being realised. The Committee expresses its hope that a solution to the cane toads can be identified and implemented.

Conclusion

4.35 In 2002 the Prime Minister's Science, Engineering and Innovation Council identified invasive species as one of four areas in which addressing the decline of Australia's natural systems and biodiversity provided the greatest return on investment. The Committee acknowledges that the cost of inaction is high and the most cost effective measure for dealing with invasives is prevention. Those

54 Natural Resource Management Ministerial Council Communique, 16 April 2004, at: http://www.mincos.gov.au/pdf/nrmmc_06.pdf.

55 Senator Ian Campbell, *Cane toad invasion threat - joint taskforce to defend WA*, Media Release, 29 August 2004.

propositions are axiomatic. Early intervention and the prospect of eradication depend upon effective emergency response arrangements.

4.36 In theory, the Committee would wish to see total eradication adopted as the national goal, while recognising that such a course is not without pitfalls given evidence that some invasive species have actually proven beneficial to the survival of some native species,[56] and may take many decades to be achieved.

4.37 In conclusion, in discussion the cost of responding to invasive species, the Committee believes that the environmental impacts of invasive species are substantial, the challenges are immense and the need for action is urgent.

56 Mr Peter Tucker, *Committee Hansard*, Adelaide, 28 June, 2004, p. 76.