PRIME MINISTER'S SCIENCE, ENGINEERING AND INNOVATION COUNCIL

EIGHTH MEETING – 31 MAY 2002

SUSTAINING OUR NATURAL SYSTEMS AND BIODIVERSITY

Contents

Executive Summary

1. **Australians receive great value from the "ecosystem services"** provided by natural systems and biodiversity - fresh air, clean water, nutrients for crop growth, and pollination of crops are just some of these services. Most ecosystem services remain poorly valued economically. Most have been unrecognised and unpriced, but now we are beginning to realise that they are not a limitless resource.

   We are also realising that the cost of repairing damaged ecosystem services is very large indeed. The value of production in our agricultural industries is at risk of being eaten away by lost production due to degradation ($1.2 billion) and the costs of repairing natural systems (some $2-6 billion would be needed annually for full repair). The burgeoning tourism industry depends in large part on Australia's natural systems; fortunately, it has not yet inherited a costly repair bill.

2. The theme of this report is **better investment decision-making in sustaining natural systems and biodiversity**. Our report rests on the principle that it is far cheaper to maintain our natural systems than it is to allow them inadvertently to be damaged and, subsequently, to inherit a costly repair bill. We seek here to identify the actions that will have greatest impact by focussing on maintaining systems rather than on repairing damage.

3. **Australia's natural systems are in decline**. Comprehensive and scientifically based evidence, in the outstanding reports of the National Land and Water Resources Audit and in the 2001 State of the Environment Report, shows that many more indicators of the health of our natural systems are in decline than are stable or increasing. Species extinctions, salinity, pest outbreaks, and declining water quality are the symptoms of ecosystems that are losing the capacity to heal themselves. The causes are excessive human alteration of ecosystems without recognition of the processes that need to be maintained so that essential ecosystem services continue to be delivered to us.

4. **Government has reacted responsibly to these signs of decline** through programs such as the Natural Heritage Trust, the National Reserve System, the National Action Plan for Salinity and Water Quality, and the National Water Reform Framework. The States and Territories too are working to redress these problems. We fear, however, that these programs have sometimes struggled to achieve enough focus on the underlying causes. In our view, it is now time for Government to target its investment according to clear priorities for sustaining our natural systems and biodiversity.

5. **We evaluated 18 options for investment** based on the objectives listed in the multi-jurisdictional publication, "National Objectives and Targets for Biodiversity Conservation" (Environment Australia 2001). The investments constitute money for direct activities, education, incentives, and establishing collaboration with landholders and regional groups; the return is the payoff both in terms of sustaining natural systems and biodiversity, as well as in terms of "collateral

benefit" – those economic and social benefits that would flow from protection or repair of natural systems.

6. **Four areas of investment above all others** are likely to return greatest impact in heading off the diminishing value of Australia's natural systems and biodiversity.
   - Redressing the absence of economic signals, to urban and rural Australians alike, that connect the ecological condition of natural systems to our use of them for products and services.
   - Reducing land clearance.
   - Limiting over-extraction of water from our rivers.
   - Limiting the spread of pests, weeds and imported diseases.

7. **Australia possesses a relatively solid foundation of knowledge about natural systems and biodiversity** at the scale of a paddock or a patch of remnant bush. Predicting ecosystem responses at larger scales is the next challenge: science will need to do better in prediction of system-wide effects in the large, complex human and natural systems that comprise Australia's regions. The Working Group believes that it is now necessary for Australia's R&D funding arrangements to recognise the nature of the emerging system-wide challenge.

8. These considerations lead to the following recommendations.

RECOMMENDATION 1

That the Commonwealth Government, with the States, Territories and the Natural Resource Management Ministerial Council, develop mechanisms and lead decision-making in natural resource management that include transparent consideration of external costs and benefits of resource use.

RECOMMENDATION 2

That the Commonwealth Government urgently work with the States and Territories to limit broad-scale clearing to those instances where the proponent can demonstrate that regional biodiversity and hydrological objectives are not compromised.

RECOMMENDATION 3

That the Commonwealth Government work with the States and Territories to:

- define a set of Australia's least altered rivers as "Heritage Rivers" and consider listing them under the Environment Protection and Biodiversity Conservation Act, and
- establish a Rivers Corporation charged with acquiring water and delivering it so that river, wetland and floodplain ecosystems are maintained.

RECOMMENDATION 4

That the Commonwealth Government continue its good record in biosecurity by:

- boosting environmental risk assessment of all planned introductions or imports to Australia by building capacity to make assessments ecologically rigorous, and
- working with the States and Territories to rapidly eliminate newly introduced organisms, and small infestations of existing introduced organisms, that are assessed as potential environmental pests, weeds or diseases.

RECOMMENDATION 5

That the Commonwealth Government institute analysis of the capacity of Australia's natural systems to adapt to altered climatic patterns and anticipated climate change.

RECOMMENDATION 6

That the Commonwealth Government, though the Natural Resource Management Ministerial Council, develop options by which the present successful corporatised R&D model can strengthen investment in integrated regional-scale work on ecosystem services and sustainability.

1. NATURAL SYSTEMS DELIVER VALUE

Australia's natural systems are **lively**. Alive with variety – an estimated 500,000 different species across Australia – and alive in movement. Not always the sort of movement we can see, but an incessant transport of materials as organisms affect each other and the soil, water and air around them. This natural processing is the core of ecological sustainability.

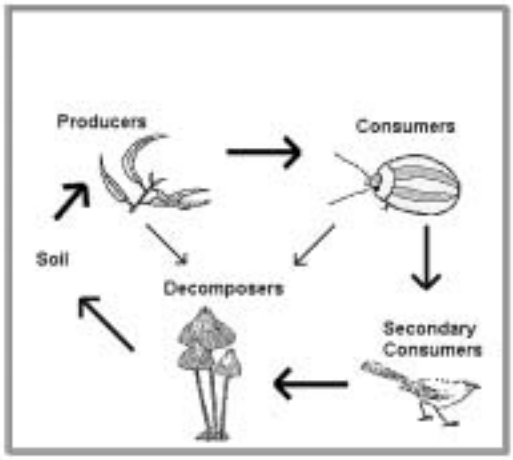
Australians receive great **value** from these ecological interactions. Fresh air, clean water, nutrients for crop growth, and pollination of crops are just some of these "ecosystem services". These services include goods that are harvested directly from nature - fish and timber - as well as those aspects of nature that contribute to a human sense of fulfilment.

Most **ecosystem services support economic activities**. Many of us depend on forest catchments to filter our water. Native insects pollinate many of our horticultural crops; without this service producers would need to pay for beehives. Farmers depend on small organisms in the soil to recycle waste plant material, releasing nutrients to support growth of the next crop. Graziers in the rangelands depend on native plants for fodder for their stock. And tourists spend money experiencing the diversity of Australian landscapes.

Few ecosystem services have yet been valued economically. Most have been **unrecognised and under-priced**, but now we are beginning to realise that they are not a limitless resource. Recognition of the vital importance of clean water from forest catchments led the Victorian Government to compare economic values of wood and water, thereby providing forest planners with clearer direction when faced with planning decisions.

Natural systems

In natural systems, plants, animals and smaller organisms like insects, worms and fungi and bacteria interact with the soil, water and air, and with each other, in maintaining active healthy ecosystems. Just one example of the cycling of material in ecosystems is illustrated below.



Ecosystem services

The products of natural systems that benefit people

Goods	*Ecological processes*	*Life-fulfilling*
timber	pollination	tourism
pasture	climate regulation	recreation
fish	pest control	aesthetic beauty
plant breeding material	genetic resources	lifestyle
	habitat	inspiration
	shade and shelter	sense of place
	erosion prevention	national identity
	soil fertility	ethical value
	water regulation	scientific discovery
	waste breakdown	

Now it is becoming clear that the **cost of repairing** damaged ecosystem services is very large indeed. The repair bill for salinity and water logging due to removal of the vegetation that regulated groundwater flow (another ecosystem service) is the most expensive one facing Australia at the moment. Estimates of the size of the repair bill vary from $20 - $65 billion over 10 years, depending on what aspects of salinity are included. More generally, Australia is investing $1.5 billion per annum in biodiversity and natural systems, $1.2 billion of it from government, mostly in an effort to repair damage.

As well as having very substantial economic consequences, integrating biodiversity in its ecosystem services sense into natural resource management will create **new opportunities for a "Sustainable Australia**". The growth of an environmental management industry and continued expansion in international tourism are examples. Our sources of wealth will be different in 20 years time; maintaining our natural assets with sound investments now will maximise our future economic opportunities. Tourism is already worth more than 4% of GDP; Australia's natural environments attract an increasing number of domestic and international visitors, with nature-based tourism representing an important growth segment of Australia's market. Our overseas image, our access to agricultural markets, and our attractiveness to overseas tourists are increasingly likely to depend on our sustainability record over the next 20 years.

This is not a conventional opening to a paper on biodiversity. We deliberately want to move the debate on past biodiversity as lists of species, or lists of ecosystems, to a **focus on biological processes** and the resulting ecosystem services that benefit humans. Treating biodiversity separately from the soil, water and air in which the organisms live puts biodiversity into a compartment that has no basis in nature. Of course it is important to conserve as wide a range as possible of species

The value of pollination

- The value of pollination to agriculture in Australia has been calculated as $1.2 billion pa.
- Lucerne and many horticultural crops depend on pollination by European bees and native insects to set seeds or grow fruit.
- The pollinators themselves depend on nearby native vegetation for food.
- European bees are susceptible to honeybee mite. If the mite arrives in Australia, crops will depend on free-living pollinators living in nearby remnants. The remnants need to be able to supply diverse types of shelter and food to support these pollinators.
- Native plants in remnants that are highly fragmented are also thought to be suffering lack of pollination and reduced seed set due to declines in pollinator populations.

The value of water to cities

In 1994, an independent study of future options for harvesting timber and water from the Thomson Catchment (largest source of Melbourne's water) showed that the value of clean fresh water outweighs that of the timber in the forest. Extending the current harvest rotation from 80 to 200 years increases the catchment's net present value by $81 million, while shorter 20-year rotations would decrease it by $525 million and require building a $250 million water treatment works.

and ecosystems, for ethical and aesthetic reasons - of the half million or so species that make up Australia's biodiversity, about 80% are found nowhere else in the world! Right now, though, it is the economic impact of declining species and ecosystems that we emphasise.

In summary, then, our natural systems and biodiversity underpin the health of two great Australian industries – agriculture and tourism. The annual costs to agriculture of lost production (around $1.2b) and of environmental repair ($2-6b) are already eating into annual production value ($25b). As a more recent economic producer, the tourism industry fortunately has not yet begun to incur direct losses due to degradation of biodiversity and natural systems. The theme of this report, therefore, is about **making better investment decisions** in sustaining natural systems and biodiversity. Our report rests on the principle that it is far cheaper to maintain our natural systems than it is to allow them inadvertently to be damaged and, subsequently, to inherit a costly repair bill.

The value of attractive landscapes to tourism

Australian landscapes, with their open spaces, distinctive landforms and unique biodiversity attract many domestic and international tourists. International tourism is a growth industry in Australia, forecasted by the Department of Industry, Tourism and Resources to grow from 4.8 million to 10.4 million visitors in the next 10 years. In 2000-01 this industry was worth $16 billion to Australia, and DITR predicts growth to $30 billion by 2010.

2. THE STATUS OF OUR NATURAL SYSTEMS IS OF GRAVE CONCERN

Stress in Australia's ecosystems

Australia's **natural systems are in decline**. There is no doubt about this. Across the nation, many more indicators of the health of our natural systems are in decline than are stable or increasing. More than at any time in our history we now have comprehensive and scientifically based evidence of these facts, in the outstanding reports of the National Land and Water Resources Audit and in the 2001 State of the Environment Report.

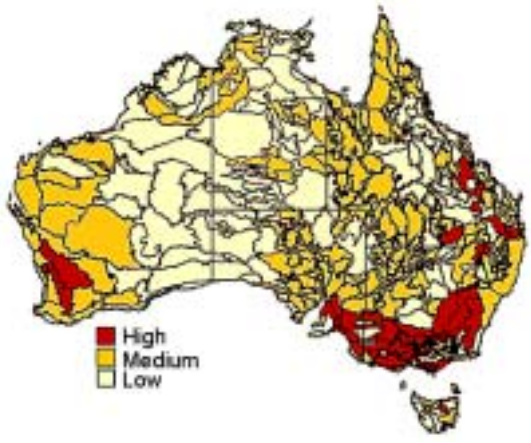
The **condition of biodiversity** in Australia is poorer today than it was in 1996. Many serious pressures on biodiversity remain to be dealt with effectively. For example, despite the known deleterious consequences of broad-scale clearing, approximately 500,000 hectares of native vegetation are cleared in Australia annually. The rate has accelerated, with as much cleared during the last 50 years as in the 150 years before 1945.

Biodiversity is particularly threatened where **salinity** is creeping through remnant vegetation in the agricultural zone - already 630,000 hectares are likely to face this threat. We estimate that this salinity will cause the loss of some 18,000 species of plants, fungi and animals, small and large. If nothing is done, the area is likely to grow to 1.8 million hectares by 2050, risking a further large loss of species.

Australia's **wetlands** have deteriorated greatly since European settlement. Some 40-80% of wetlands have been lost through draining or changed water regimes. Many are now much saltier than before European settlement, and large numbers of native aquatic species have become threatened or endangered.

> *"Degradation of lands and waters remain of critical concern, especially in the intensive land use zone upon which much of Australia's agricultural production depends."*
>
> Executive overview, 2001 State of Environment Report

Stress in Australia's ecosystems



National Land and Water Resources Audit

River systems too are in decline. Most surface waters in the southern states are approaching or have exceeded their extraction limits. Most of the basins in the intensive use zone of mainland Australia fail to meet water quality standards over a third or more of the area of each basin. The extent of the problem is probably underestimated because some basins are not sufficiently monitored for adequate assessment.

One of the most damaging declines is in **soil health**. Between 1996 and 2001, indicators of salinity, acidity, nutrients and soil carbon all indicate increasing problems such that increased inputs will be required if land sustainability is to be achieved. Also of concern is rising soil acidity, which if not addressed through liming has the potential to rival salinity as a natural resource management challenge. Since 1991 the area affected by soil acidification has increased by 13 million ha.

Such declines matter, especially when **concentrated in the one place**. The National Land and Water Resources Audit shows that 37 of Australia's 354 Interim Biogeographic Regional Areas sub-regions - that is 10% - are highly stressed. Most of them have been heavily cleared, and the remaining fragmented vegetation faces threats with rising water tables, salinity, pests, weeds, altered soil fertility and declining biodiversity. While representing only 10% of all sub-regions, they are the source of a substantial proportion of our present agricultural income. These sub-regions are at risk of finding themselves in a spiralling cycle of declining biodiversity, declining ecosystem function, escalating natural resource management problems, and increasing costs to agriculture itself.

Why do these feedback effects occur? Consider the importance of a service such as pest control. It is estimated that 1,000 to 2,000 birds are lost for every 100 ha of native woodland that is cleared. Where there are fewer insect-eating birds there are more insects; more insects eat more leaves; the

Stress in the suburbs

Six months after the imported red fire ant (*Solenopsis invicta*) was discovered in Brisbane, a $123 million five year effort has commenced to eradicate it. No other country has eradicated fire ants. Uncontrolled, the ant could spread up to 600,000 square kilometres over the next 30 years and cost rural industries $6.7 billion. Fire ants are thought to have arrived in Australia 3-5 years before their discovery.

Current distribution (dot) and potential fire ant distribution (shaded) in Australia

Degradation costs

Land degradation costs $1.15 billion pa in lost production which is 5% of the total value of agricultural production.

Australian Bureau of Statistics

remaining trees become more stressed. Some perish through dieback. Poorer erosion control results from fewer trees, and more moisture enters the groundwater. The accumulated impact downstream is reduced water quality for all other uses – growing irrigated crops, drinking water and the livelihood of native species in rivers and wetlands.

Stressed ecosystems are losing their liveliness – the biological processes provided by biodiversity, and the ecosystem services and agricultural production that stem from it. Up till now we have managed to hide the costs of degradation because agricultural productivity has continued to rise through innovation; however, this trend is most unlikely to proceed forever.

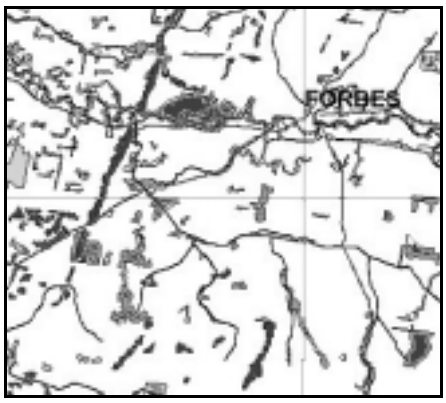
Healthier systems

Not all Australian ecosystems are in such poor shape. The National Land and Water Resources Audit showed that 152 sub-regions (43%) were in relatively good health. These sub-regions have been less attractive for agriculture, although some are now being cleared and will be as susceptible to damage as areas cleared earlier in our history. As with preventative health in human society, relatively small interventions to address hazards in these areas, done soon, will be many times more cost-effective than if left until later.

The remaining 165 sub-regions (47%) fall into intermediate classes of stress, and are spread across the intensively and extensively used lands. In the intensive zone, they are areas where moderate levels of native vegetation remain. Moderate stress is usually due to grazing or perhaps infestations of pests and weeds in the extensive zone. Investment in these areas, if well targeted, could well provide for sustainable use, that is productive use of the land while maintaining the natural assets.

Stress in the paddocks

In developed areas, natural systems have become highly fragmented and ecosystem services are lost. Because ecosystem services such as water table control and soil health maintenance have been removed, these agricultural areas are now suffering the effects of dryland salinity and widespread erosion. The WA wheatbelt is an example of this. Only 8% of the native vegetation remains, and this is 85% fragmented, existing in over 13,000 separate patches. Soil and water degradation in this area is severe as a result.



Fragmentation of remnant vegetation is common in south-eastern Australia too. This map shows remnants (shaded) around Forbes in New South Wales.

Pest control

Silvereye feeding insects to its young

3. MOVING FORWARD

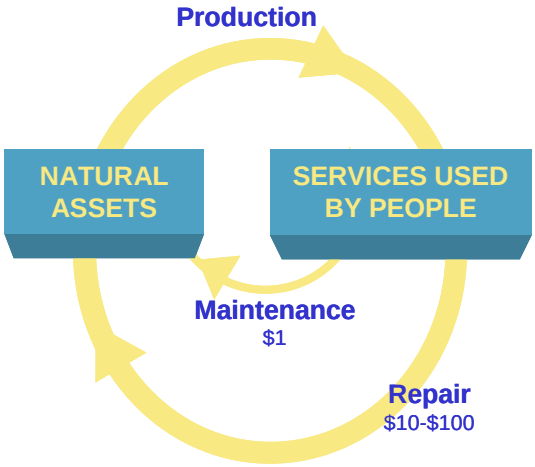
The fundamental principle: maintain rather than have to repair assets

We repeat the principle that it is **cheaper to maintain** natural systems than it is to pay the repair bill resulting from inadvertent or careless damage or to suffer the resulting loss of production. Most of us understand this principle intimately. We have our cars serviced reasonably regularly - we know how much it costs to replace a motor damaged by inadequate care, and we know that our lives depend on the precise functioning of the vehicle. It pays us to look after the car; it will pay us to look after our natural systems and biodiversity.

The corollary principle is that it is more efficient to address causes than symptoms. Species extinctions, salinity, pest outbreaks, and declining water quality are the **symptoms** of ecosystems that are losing the capacity to heal themselves. The **causes** are excessive degrees of human alteration of ecosystems without recognition of the processes that need to be maintained so that essential ecosystem services continue to be delivered to us. Legitimate human expectations - our need to eat, drink, shelter and play - lie behind these causes; we now need to understand and manage the tradeoffs.

Accelerating impacts

The principles outlined above are obvious and unexceptionable. Why, then, have they not been widely enough applied in natural resource management? Of the two major reasons, we have already listed one – the fact that most services have been unrecognised and under-priced. The second reason is the **time lag** between excessive demand on a natural system and decline in the asset. Ecosystems have inbuilt resilience. The first five species to go extinct might have no noticeable impact on



Sooner rather than later

"Over in the west too many had their heads in the sand. We were 15-20 years too late in acting. The salinity problem is well and truly too far gone in many places - irrecoverable. Unless the Eastern States act now they'll be facing the same fate, not just with salinity but soil acidification, weeds, vegetation …

Garry English, WA Farmers Federation Spokesman for Land Management and Conservation, and McKell Medal Winner.

Increasing demands on natural resources

In 1900 it must have seemed as if our natural resources were unlimited. These are how some of our demands from the land have grown in the last 100 years.

Item	*Increase 1900 – 2000*
Population	5x
Energy use	33x
Cropland (area)	7x
Wheat production (tonnes)	17x
Cattle population	3x
Wool production	3x

ecosystem services, whereas loss of the last five species might have drastic consequences; clearing 100,000 hectares of bush will have little impact on levels of salinity for as much as fifty years, but the impact eventually may be conversion of productive land into saltpans. Our perceptions of these slow changes have a big effect on our willingness to act. Urban people in particular are unlikely to be aware of the declining asset base because it so rarely touches them directly. While damage is silently accumulating, the costs of intervention are spiralling upwards.

Into the future

Government has reacted responsibly to these signs of decline as they have emerged in recent years. The Natural Heritage Trust, the National Reserve System, the National Action Plan for Salinity and Water Quality, and the National Water Reform Framework are evidence of strong governmental commitment. The States and Territories too are working to redress these problems.

We fear, however, that these programs have sometimes struggled to achieve enough **focus on the underlying causes**. Too frequently they seem to us to be directed towards repair rather than to maintenance of the asset. In our view, it is now time for Government to target its investment according to clear priorities for sustaining our natural systems and biodiversity.

The beginning of a century is a good time for review. In the 19th and 20th centuries we built a successful society through exploitation of our natural resources. **A successful 21st century Australian society** will tend its natural assets as carefully as it does its financial assets. Australia can be a global leader in these matters. Just as we led the world in designing the Landcare movement, we can now develop Australian approaches to resource management that rest upon maintaining the asset base for long term benefit.

Worst case scenario

The worst-case scenario is images like this ending up in our grandchildren's textbooks as examples of ecosystem failure.

Revitalising wetlands

The Barmah-Millewa redgum forest straddles the River Murray between Echuca and Tocumwal and is the largest river redgum forest in the world. After the Hume Dam was built in 1936, forest flooding stopped and the plants and animals of the floodplains declined.

Since being allocated water in 1993 the forest has flooded several times, resulting in the first successful bird breeding event since the 1970s, as well as excellent breeding results for the frogs and numerous species of insects and small animals that live there.

Ecosystem services like water filtration and pest control have been restored. Ibis will fly 25 km to feed on insects and a flock of 1000 can eat a quarter of a million insects a day.

4. PRIORITIES FOR ACTION

Selecting priorities

We have spelt out our view that investment in sustaining natural systems and biodiversity should now be based on **clear strategies**. Faced with the scale of issues that compromise achievement of a "Sustainable Australia", we believe it essential to take a business-like approach to determining priorities for investment. Not using the best available knowledge, or not making decisions about tradeoffs, means we may invest wastefully.

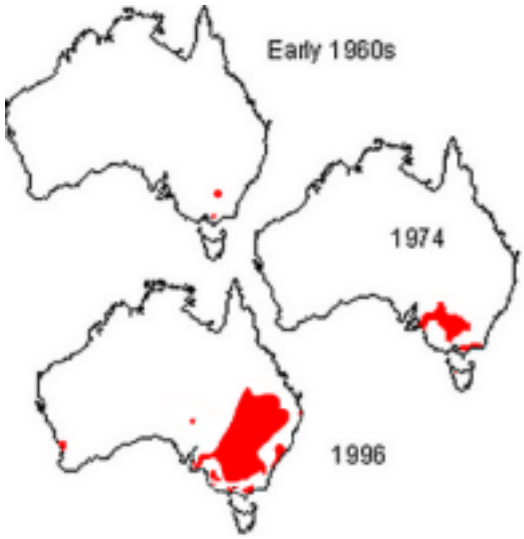
Robust analyses of return on investment are just now possible because of recent scientific efforts such as the National Land and Water Resources Audit; previously unlinked pieces of information have coalesced into overviews of our natural systems from multiple angles. The knowledge is not complete, but combined with some expert judgement, is now sufficient to underpin more targeted investments than previously possible.

Our approach compared a possible range of actions on the basis of **return on investment**. The investments constitute money for direct activities, education, incentives, and establishing collaboration with landholders and regional groups. The return is the payoff both in terms of sustaining natural systems and biodiversity and in terms of "collateral benefit", which is the scale of economic benefit that would flow from protection or repair of natural systems as a result of each action.

Using this approach we compared, with help from a group of experts, **18 options for investment** based on the objectives listed in the multi-jurisdictional publication, "National Objectives and Targets for Biodiversity Conservation" (Environment Australia 2001). Full details of our methodology and individual results will be available in a background document. Appendix 3 of this report outlines the methodology and presents a sample calculation.

Spread of carp in Australia

Imagine how the costs of carp control would have been contained if we had acted in the 1960s when they were found only in the area in the top map.



The recommendations have been developed with three principles in mind.

1. The focus should be on the **very highest priority actions**. What few targeted, immediate investments would produce a noticeable lift in natural system and biodiversity benefit for Australia?

2. Actions that **maintain** natural systems and biodiversity are preferred over remediation, as they return far more benefits per dollar invested. Our analyses suggest that it costs between

ten and a hundred times more to repair a damaged natural system than it does to maintain it.

3. The recommendations should recognise the **need for ecosystem services to be economically recognised and priced so that public and private sector responsibilities become clear**. Regulation and public investment are particularly effective for those actions that occur at a landscape and national scale, that are urgent, and that act to ease transitions as resource users take on an elevated duty of care. Incentive and market-based approaches are likely to be more effective for actions that take place at the local scale where private benefit can be captured, that depend on community participation and capacity-building, and that are not so urgent.

Signposts to ACTIONS

Four areas of investment above all others are likely to return greatest impact in heading off the diminishing value of Australia's natural systems and biodiversity.

- Redressing the absence of economic signals, to urban and rural Australians alike, connecting the underlying ecological condition of natural systems to our use of them for products and services.
- Reducing land clearance.
- Limiting over-extraction of water from our rivers.
- Limiting the spread of pests, weeds and imported diseases.

5. RECOMMENDATIONS

Signalling the importance of maintenance

It is time for a national debate about what **types of ecosystem services** we need to invest in maintaining. We cannot afford to save everything and should not expect to do so. What we want are "working rivers" and "working landscapes" which provide food and income for people indefinitely because the natural assets are kept in good condition.

Degradation of natural systems occurs because our economy makes it **cheaper to degrade Australia than to look after it**. The market signals are back to front. As a nation, we now have the opportunity to signal that we are determined to look after our resources. Systems are needed that would reward stewardship – those who contribute actively to the solution – and, simultaneously, generate the revenue necessary to finance the transition to sustainability. Those who can invest in the maintenance of natural systems should be given the opportunity to do so privately and, consistent with recommendations from the Council of Australian Governments, those who cannot do so need to contribute to the cost of managing the externalities their activities impose on others.

Debate about these matters needs to be informed by **transparent analysis of costs and benefits** based on sound scientific, economic and social analysis. Clear policy principles are needed in the areas of property rights, duty of care and the circumstances under which resource users might be compensated or paid for the work they do. Recently, COAG agreed to move towards full cost pricing, including consideration of externalities, in the water industry.

The Commonwealth Government, in partnership with the States and Territories, has also begun to pioneer the use of **innovative instruments** for biodiversity protection and natural resource management. We suggest that governments, perhaps through the new Natural Resource Management Ministerial Council, are well placed to speed up development of approaches such as those listed here:

- Greater use of tender-based project selection, which recent trials in Victoria have revealed produce the same outcome for as little as 33% of the cost to government
- Greater use of biodiversity offsets and mitigation banking
- Integrated ecosystem service trading
- Tradeable land clearing rights
- Revolving funds
- Environmental management systems
- Tax incentives
- Consideration of environmental stewardship rebates.

These considerations lead us to the following recommendation.

RECOMMENDATION 1

That the Commonwealth Government, with the States, Territories and the Natural Resource Management Ministerial Council, develop mechanisms and lead decision-making in natural resource management that include transparent consideration of external costs and benefits of resource use.

An environmental stewardship rebate could

- be available to all individuals and businesses,
- signal the value of looking after natural systems and biodiversity for Australians today as well as those who will come after us, and
- reward those who privately make the investments necessary to maintain and or improve these values and collect the residual cost of doing this from others.

Building upon recent initiatives in the United Kingdom, we suggest that one means of effecting an environmental rebate would be to increase every marginal income tax rate by 1% and offer **an environmental rebate** to each and every business and individual whose actions and practices are smart in an environmental sense.

A **certification scheme** could be used to determine eligibility for a rebate. Those who live in high-certification houses or conduct such businesses would receive the rebate and would not experience an increase in costs. Money from those unable or unprepared to look after the natural system could be used to help expand government programs such as the Natural Heritage Trust, or initiatives mentioned elsewhere in this report. Advice from Treasury would be vital in determining the most cost-effective ways of achieving these aims.

All such systems need to be **simple**, in order to signal the nature of changes to be made; then **time** needs to be allowed for individuals and businesses to develop low-cost solutions to the challenge.

Protecting assets: vegetation

Our analysis of return on investment in limiting future land clearing reveal it to be of enormous value in maintaining natural systems and biodiversity. The value of biodiversity, and the collateral benefits in heading off future problems with environmental repair in salinity, land degradation and revegetation, would be substantially enhanced if clearing were limited.

The inventories of natural vegetation that have recently been conducted by the States, plus data from the National Land and Water Resources Audit, are ready to provide for priority setting to protect biodiversity and limit future salinity and waterlogging. Agencies in New South Wales and Queensland have suggestions ready to **implement coherent clearing "contracts",** especially in critical regions in the north-eastern Murray-Darling Basin and catchments in north-eastern Queensland. It is time to increase the reward and incentives for those who, through conserving biodiversity and natural systems, will leave an enduring legacy for future Australians.

The resulting recommendation is based upon ANZECC's "National Framework for the Management and Monitoring of Australia's Native Vegetation" (2000).

RECOMMENDATION 2

That the Commonwealth Government urgently work with the States and Territories to limit broad-scale clearing to those instances where the proponent can demonstrate that regional biodiversity and hydrological objectives are not compromised.

The Working Group recognises the political complexity of this issue, and also the immense amount of pre-existing work on possible mechanisms to achieve a

reduction in clearing. Given the potential significance of control of clearing in maintenance of our biodiversity and natural systems, we urge continued leadership in this area by the Commonwealth Government.

Protecting assets: water

Degrading natural systems funnel sediment, nutrients and salt into rivers, and **most Australians live right near the end of river catchments**. Almost all southern Australian rivers are highly altered, and the immediate socio-economic impact of degradation is considerable and growing. Our analyses suggest that very high return on investment would be gained by limiting the likelihood of damage occurring in rivers currently little affected by human activity.

RECOMMENDATION 3

That the Commonwealth Government work with the States and Territories to:

- **define a set of Australia's least altered rivers as "Heritage Rivers" and consider listing them under the Environment Protection and Biodiversity Conservation Act, and**
- **establish a Rivers Corporation charged with acquiring water and delivering it so that river, wetland and floodplain ecosystems are maintained.**

Rivers that might meet the criterion of least altered river, and which would benefit from protection of their assets, include the **Mitchell, Ovens, Georgina, Diamantina, Cooper and the Paroo**. Existing land uses could be maintained, but intensification would be precluded without careful analysis. The recommendation complements the protection of terrestrial ecosystems under the National Reserve System and marine ecosystems under the proposed National Marine Reserve System.

A major challenge since the water reforms stimulated by the Council of Australian Governments in the previous decade has been the **return of water to rivers** that have experienced over-extraction. Governments now need to address the governance and delivery arrangements for these environmental flows. This challenge provides an opportunity not only to rehabilitate damaged aquatic and floodplain ecosystems, but also to maintain existing assets such as the Barmah-Millewa forests. Establishing a Rivers Corporation under the Corporations Act has the advantage of requiring appropriately qualified Directors who act in the interests of the Corporation rather than of particular interest groups. It may also be able to attract philanthropic support for providing water for the environment.

Dealing with pests, weeds and diseases

Pests, weeds and diseases are **insidious invaders** of the Australian environment. Unfortunately, we may not yet have seen the worst of this biosecurity risk - there are still many potential invaders waiting in the wings. Investment in early detection and rapid response will provide some of the best returns of all possible actions for maintenance of natural systems and biodiversity. Biological control solutions will continue to be sought for established pests and weeds; but, as with human health, prevention is almost always cheaper than cure (see "Biosecurity – a future imperative", Australian Academy of Technological Sciences and Engineering, Western Australian Division, 2001).

RECOMMENDATION 4

That the Commonwealth Government continue its good record in biosecurity by:

- **boosting environmental risk assessment of all planned introductions or imports to Australia by building capacity to make assessments ecologically rigorous, and**
- **working with the States and Territories to rapidly eliminate newly introduced organisms, and small infestations of existing introduced organisms, that are assessed as potential environmental pests, weeds or diseases.**

Recent expansion of effort by the Australian Quarantine and Inspection Service in **intercepting illegal introductions** is an excellent start to this recommendation. AQIS's work will become an important backup to environmental screening, because we may have to anticipate an increase in illegal introductions as proposed introductions are rejected on these more rigorous grounds.

The nature of outbreaks of organisms such as fire ants tells us that each **week's delay costs dearly in later damage and costs**. A rapid response may mean the difference between eliminating the invader, and having to pay for control forever. Acute invaders should be treated as seriously as invasions of agricultural pests, like foot and mouth disease. The Northern Australia Quarantine Survey is a fine model; extending it into the southern states where there are many more latent invaders already in place would repay huge benefits.

Continued effort

Many **current activities** in sustaining natural systems and biodiversity are not mentioned in our report. Some of them, such as building community capacity in natural resource management, lifting involvement of indigenous people in natural resource management, and the further development of a comprehensive, adequate and representative National Reserve System, are vital efforts that simply must continue to be supported.

Others, such as salinity mitigation, revegetation, pest and weed control and endangered species recovery, lie in the realm of **dogged persistence** – they are tasks that we cannot escape, representing repair bills stemming from past inadequate management. Our report does not ignore the importance of these tasks; it focuses instead on recommendations for actions to limit the repair bill of the future.

One matter presently on the horizon does need attention, however. **Climate variability and anticipated climate change** are vital issues requiring increased attention. For example, shifting climatic patterns, and climate change itself, both expose Australia to greater risks of invasion by pests, weeds and diseases. Likewise, risks of dryland salinity are liable to be significantly affected by these influences. Moderate investment in analysing the capacity of Australian's natural and production systems to adapt to these changes could well return huge benefits in future.

RECOMMENDATION 5

That the Commonwealth Government institute analysis of the capacity of Australia's natural systems to adapt to altered climatic patterns and anticipated climate change.

6. ROLE OF SCIENCE, ENGINEERING AND INNOVATION

In several key areas Australia's natural systems and biodiversity have been wonderfully well served by science and innovation; in other respects, big challenges and opportunities remain.

Where we've done well

Australian science for the Australian land

Using natural resources and biodiversity wisely depends on **sound understanding** of how Australian ecosystems work. Australia's great geological age, its flat land, variable climate and unique biodiversity produce ecosystems unlike those in most other places in the world. Australian science has therefore had to pioneer its own pathways to understanding of how this land works. It has outlined the extraordinary nature of Australian biodiversity, and sketched out the identities of a large proportion of the half-million species that share the continent with us. We import world science to build understanding of basic processes, but quantifying them, and identifying what's most important in our own ecosystems, is something we cannot bring from elsewhere.

A telling example is the **impact of broad-scale clearing**. In European and American landscapes where our agricultural heritage developed, the landscapes are steeper, water drains faster, and due to geological youthfulness there has been less time for salt to accumulate. Hence, broad-scale clearing in those places does not cause the salinity problem that is challenging Australia. Australian science has produced this knowledge; similar understanding will underpin the transition to more sustainable land uses.

International reputation

Australia's biodiversity and natural

International scientific influence

Australia's reputation for scientific excellence in these areas of science is very high. For example, CSIRO was rated the third most influential research agency in the world in environmental science over the last decade by an independent international analysis. Based on how often scientific publications were cited, the analysis placed CSIRO behind the US Environment Protection Agency and the US Department of Agriculture but ahead of the University of California at Berkeley and the University of Minnesota. Over the decade, CSIRO published 1,523 scientific papers in this area, and these were cited 14,385 times by other researchers.

Conservation planning

A small network of Australian scientists in several Universities, the NSW National Parks and Wildlife Service the Australian Museum and CSIRO has had a major global impact on the scientific development of reserve network planning. Amongst their achievements are:

- The methods developed have been adopted by planning agencies in many countries, e.g. throughout Europe, the UK, the USA, Mexico, South Africa and Namibia, by the World Bank and by the major international conservation NGOs, WWF and Conservation International.
- One software package is now the core software planning tool for marine and terrestrial reserve system design and ecoregional planning across much of USA. In Australia it is being used to evaluate the existing reserves of the Great Barrier Reef.
- Leading conservation scientists from South Africa, Mexico the UK and the USA have visited Australian laboratories, some for extended periods, to be trained in the use

resource science **attracts international attention**. An analysis of the citation rates of scientific papers between 1991-1995 shows that Australia is at or ahead of the world average in atmospheric sciences, earth sciences, botany, ecology, soil and water sciences, hydrology, forestry sciences and fisheries sciences. Our reputation is growing also because of efforts in stretching knowledge through connections among science, community, and the political arena.

An example concerns analysis of ecosystem services. Originating from a project initiated with support from the Myer Foundation in 1999, this effort has grown into an extensive network of science and regional partners that is at the **leading edge of developments in ecological economics** around the world. A new book, "The new economy of nature: the quest to make conservation profitable", by Gretchen Daily and Katherine Ellison, eminent American scientists, relies heavily on these Australian case studies.

Information sharing

Australia's natural resource and biodiversity science as a basis for innovation and management **attracts international attention**. For example, we predict that many delegations will come to Australia to learn about the National Land and Water Resources Audit. It is Australia's capacity at the system scale that is particularly ahead of most others. The USA and the UK, for example, still focus their conservation investments on individual species. The level of interaction of Australian scientists with the community and with policy makers has been noted, and envied, by scientists visiting from elsewhere.

Major opportunities

Agreeing on sustainability

At the start of this **"Century of Sustainability"** we lack a shared agreement on what is meant by the term. We have an inadequate understanding of what attributes of

and application of these methods.

- One of the scientists was invited by the prestigious journal Nature to write a global review of conservation planning methods.

Predicting invasions

BIOCLIM is a software tool that predicts where species will survive, based on their known climatic range and the known patterns of temperature and rainfall across Australia. Developed at the Australian National University, it has been widely used around Australia to predict the potential spread of:

- Pests, such as cane toads and fireants
- GMOs, such as pest resistance genes in cotton
- Weeds, such as bridal creeper, and
- Diseases, such as Phytophthera.

Healthy rivers

How do you know if a river is healthy? The CRC for Freshwater Ecology has developed methods for assessing the ecological health of rivers to assist river managers make better decisions about rivers. The Assessment of River Condition, developed for the National Land and Water Resources Audit, included the effects of catchment condition, changes to river flows, alteration of instream habitat and streamside vegetation and water quality. These were brought together in a national assessment at the scale of river reaches and related to stream animals as a measure of the response of river ecosystems to these interacting ecological components of the environment.

The CRC has also developed methods of assessing river health using the invertebrates that live in a river. These were used in the First National Assessment of River Health. Data from about 5000 sites from all over Australia were used to produce the summary assessment for the 2001 State of the Environment Report.

the social, economic and natural systems of Australia contribute to sustainability; and we do not have a coherent basis for measuring it. For example, we do not yet know how to determine sustainable river and groundwater flow regimes that take into account river, wetland, estuary, aquifer and catchment health, water quantity and quality, and production and social issues. A major effort is required to:

- identify vital components of sustainability,
- begin measuring the patterns of resource use in Australia's regions for comparison against agreed criteria for sustainable development.

Scaling up to the region

Most of the last 100 years was spent building a solid foundation of understanding about ecological processes at the scale of the paddock or the patch of remnant bush. Using this understanding to predict ecosystem responses at the **regional scale is the next challenge**. Science will need to do better in prediction of system-wide effects in the large complex human and natural systems that comprise Australia's regions. The National Land and Water Resources Audit has produced an outstanding springboard for future capacity in this area, and Australia does well at marshalling multi-disciplinary scientific teams.

The relationship between **biodiversity and the quality of the ecosystem services** upon which humans depend is one particular case where our knowledge of the whole system is too poor. Advances in natural resource management will depend on better analysis of the trade-offs between immediate resource use and longer-term flow of ecosystem services. For example, many ecosystems that are managed for agriculture are "simplified", and contain only some of the biodiversity that once lived there. Some of these ecosystems are degraded, but others are apparently still capable of producing steady flows of important services. Regions are embarking right now on

Healthy country

This project is one of five of CSIRO's new flagship projects designed to tackle issues of national significance with large scale multi-disciplinary research investment. Its goal is to identify, develop and demonstrate landscape systems in which the generation of wealth and the improvement of environmental quality can be compatible goals. The science will provide a capacity to:

- Specify appropriate ecological function at paddock, farm and landscape scales
- Identify current systems that generate wealth, and maintain appropriate ecosystem function and community wellbeing
- Identify probable locations for implementation of the successful systems
- Identify and prototype options for regions which currently appear not to be successful in managing wealth generation and maintenance of appropriate ecosystem functions or community wellbeing.

Active discussion with potential partners in three regions are underway right now: the southern Murray-Darling Basin, the Burdekin in north Queensland, and the south-west of Western Australia. Lively discussion is also taking place about a fourth urban component.

determining biodiversity targets that will influence their actions for the next 20 years. Science has pointed out the deficiencies, but is not yet able to say precisely enough how much biodiversity needs to be maintained in a region.

In view of these considerations, the Working Group believes that it is now necessary for Australia's R&D funding arrangements to recognise the nature of the emerging system-wide challenge.

RECOMMENDATION 6

That the Commonwealth Government, though the Natural Resource Management Ministerial Council, develop options by which the present successful corporatised R&D model can strengthen investment in integrated regional-scale work on ecosystem services and sustainability.

Capacity building

Getting ecology and biodiversity science **connected to catchment, regional and farming groups** is a fundamental challenge. Government has actively recognised this demand throughout the delivery of the Natural Heritage Trust and during planning for the National Action Plan for Water Quality and Salinity. Scientists are still learning how to be effective in this task; communities are still learning how to capitalise on scientific knowledge; and Governments are still struggling to deliver resources in such a way that this vital marriage is brought about. Developing and maintaining repositories of sustainability knowledge, skills and capacity will be vital support to this marriage, both at regional and national levels.

Environmental business

Due to the leading role taken by Australian scientists and resource managers in the fields mentioned above, there appears to be substantial potential for **international application of our expertise** in environmental business. As nations around the globe strive to achieve understanding of the trade-offs between resource use and ecosystem services in search of sustainability, Australian innovators will be superbly placed to capitalise on these new markets.

Conclusion

In conclusion, the scientific base that underpins Australia's ecological sustainability is strong. However, emphasis needs to be shifted to more quantitative large scale studies that cross the spectrum of natural resource disciplines, and include their interaction with economics and social sciences. This research must be strongly linked with resource managers and policy makers to be effective. Australian science is moving in the right direction; it has much to contribute to "Sustainable Australia".

Sustaining our Natural Systems and Biodiversity APPENDIX 1

PMSEIC Working Group Membership

Dr Steve Morton (Chair)	Chief, CSIRO Sustainable Ecosystems
Mr Greg Bourne	Regional President BP Australia Limited
Mr Paul Cristofani	Policy Manager, Environment National Farmers' Federation
Professor Peter Cullen	Chief Executive CRC for Freshwater Ecology
Professor Hugh Possingham	Director of The Ecology Centre University of Queensland
Dr Mike Young	CSIRO Land & Water

Departmental Observers

Mr Max Kitchell	First Assistant Secretary Natural Heritage Division Environment Australia
Mr Ian Thompson	Executive Manager Natural Resource Management Agriculture, Fisheries and Forestry Australia

Scientific and drafting support

Dr Sarah Ryan	Strategic Adviser CSIRO Sustainable Ecosystems

Secretariat support

Department of Education, Science & Training	Science Programs / PMSEIC secretariat
Department of Environment & Heritage	Biodiversity / Environmental Economics Sections

Sustaining our Natural Systems and Biodiversity APPENDIX 2

Terms of Reference

The purpose of this item as recommended to the Prime Minister was to:

- Describe the state of Australia's biodiversity and the natural systems within which that biodiversity exists;
- Explain how science, engineering and innovation have contributed to the understanding and sustainability of our biodiversity and natural systems; and
- Recommend innovative ways to conserve the nation's biodiversity and the contributions science, engineering and innovation can make.

At its first meeting the Working Group decided agreed that their PMSEIC report provides a strong opportunity to inform decision makers of more recent thinking on new approaches to the issues, and take the debate significantly further (e.g. into economic issues, innovative market mechanisms, etc). It was resolved that the report should aim for two major outputs:

- Identifying methods of priority setting, what the major priorities are, and where resources and activity should be directed; and
- The nomination of innovative ways, beyond education and regulation, of achieving results in these priority areas.

This could involve:

- Consideration of what biodiversity is and its broader values (ecosystem services);
- Using specific examples and case studies to illustrate and support major points;
- Providing examples of collapse/degradation of ecosystems, and the impacts such adverse changes can have (e.g. eastern wheat belt, WA).

Sustaining our Natural Systems and Biodiversity APPENDIX 3

Summary of Expert Priority Setting Workshop

Participants

A workshop on biodiversity priorities was held 29-30 January in Bungendore. Participants were:

Jenny Baxter	CSIRO Sustainable Ecosystems, Canberra
Sue Briggs	NSW NPWS, Canberra
Mark Burgman	Department of Botany, University of Melbourne
Marc Carter	Environmental Economics Unit, EA
Paul Cristofani	National Farmers' Federation Ltd
Wendy Craik	Earth Sanctuaries Limited
Peter Cullen	CRC for Freshwater Ecology, Canberra
Jane Elix	Community Solutions (facilitator)
Michael Kennedy	Humane Society International
Max Kitchell	Natural Heritage Division, Environment Australia
Chris Margules	CSIRO Sustainable Ecosystems, Atherton
Paul Marsh	Biodiversity Policy Section, Environment Australia
Norm McKenzie	CALM, WA
Steve Morton	CSIRO Sustainable Ecosystems, Canberra
Henry Nix	CRES, Australian National University
Hugh Possingham	Department of Zoology & Entomology, University of Queensland
Rick Roush	Weeds CRC, Adelaide
Sarah Ryan	CSIRO Sustainable Ecosystems, Canberra
Paul Sattler	NLWRA, Queensland
Jann Williams	Department of Geospatial Science, RMIT
John Woinarski	Parks and Wildlife Commission, NT

The methodology used in the workshop

The workshop adopted a **decision analysis style approach** to setting priorities for biodiversity conservation. This approach follows the general philosophy that underlies Hugh Possingham's Tela paper "The business of biodiversity" (2001), which argues that maximising long term biodiversity should be dealt with in a business-like way. While the currency of business is dollars and the currency of nature conservation is biodiversity, for a fixed financial investment we should aim to maximise our long-term biodiversity gains.

In the past, biodiversity conservation problems have not always been efficiently solved, often because the problem is not properly posed, objectives are not clearly stated, constraints are not identified and relevant data are not been used in decision making.

Describing the system in cost and benefit terms presents a challenge, as the available data are woolly at best. However, the quantification of the different options does allow for comparison between them, at least to an order of magnitude. The set of options are not mutually exclusive and no importance should be attached to the sum of all the options.

The following process was used in considering each of the options put forward as a biodiversity priority.

1. Outline the ***nature of the current risk*** to biodiversity of each major threatening process.
2. Clearly state the ***objective(s)*** in addressing each risk. We took most objectives straight from the national list just described.
3. In locations where the risk is greatest, list ***some management options*** to reduce or remove each risk. Make these options as specific and quantifiable as possible.

   Quantify the ***risk*** in terms of the number of native species at risk due to that particular threatening process - in the area addressed by each option. Species (or regional ecosystems in one case) are used as a surrogate for biodiversity because data on genetic diversity or ecosystem diversity are even less available than data on threatened species. The total numbers of species affected are estimated by extrapolating from available data on either threatened birds, other vertebrates or plants, using a multiplier based on their estimated proportions amongst all Australian biodiversity. The concept here is that when a plant or animal becomes extinct, many unrecorded species associated with them are also likely to become extinct: beetles, nematodes, spiders, fungi etc. However, the focus is not intended to be on threatened species per se. Rather, the numbers of threatened species have been used to indicate the **relative strength of the threatening process** that each management option addresses.

   From the number of species at risk, calculate a ***biodiversity benefit***, depending on the assumed effectiveness of the action.
4. Estimate the ***financial cost*** of the management option. Actions are either one-off costs, or require multi-year efforts. If the latter, costs have been estimated over a 10 year period. At this stage, costs do not include on-going maintenance costs, monitoring or R&D costs.
5. Calculate a ***cost per species secured*** for each option.
6. Describe the nature of the ***collateral benefits*** (those beyond biodiversity itself) that would flow from the management option, and estimate the value of the most important in orders of magnitude.

We emphasise that the purpose of the calculations was for comparison between options where options might differ by orders of magnitude.

The biodiversity priorities under consideration

The priorities identified in National Objectives and Targets for Biodiversity Conservation 2001-2005 have been used as a starting point. These priorities are to:

1. Protect and restore native vegetation and terrestrial ecosystems,
2. Protect and restore freshwater ecosystems,
3. Protect and restore marine and estuarine ecosystems,
4. Control invasive species,
5. Mitigate dryland salinity,
6. Promote ecologically sustainable grazing,
7. Minimise impacts of climate change on biodiversity,

8. Maintain and record indigenous people's ethnobiological knowledge,
9. Improve scientific knowledge and access to information, and
10. Introduce institutional reform.

Priority 3 was not considered in this workshop, as marine ecosystems fell outside the framework of this working group, which is concerned with terrestrial biodiversity. Priorities 8, 9 and 10 were also not included, as they concern issues which were addressed by the sub-group considering mechanisms for biodiversity conservation.

Outcomes of workshop

The workshop confirmed that the attempt to prioritise biodiversity conservation actions with this methodology was worthwhile. While the lack of precision in the data used was a concern, it was felt that a well reasoned attempt to provide a basis for better decision making was useful; a good starting point for further debate and future refinement of the approach.

Specific comments from workshop participants about individual priorities have been incorporated into the full version of the priority setting paper.

Sample option

The following excerpt from the accompanying paper on priority setting illustrates how the options were developed and evaluated.

Clearing and habitat fragmentation

Current risk

Native vegetation management is a major issue for Australia's biodiversity, with the extent of woody vegetation currently less than half that prior to white settlement (Barson et al 2000). Land clearing, particularly in Queensland has attracted recent political attention, and legislation protecting vegetation from clearing varies across states.

Objectives

- Reverse the long term decline in the quality and extent of Australia's native vegetation and ecological communities and the ecosystem services they provide [NOTBC[1] 1.1]
  - Stop clearing of ecological communities below 30% of their pre-1750 extent [NOTBC 1.1.2]
  - Achieve zero net national rate of land clearance [NOTBC 1.1.4]
- Protect a representative sample of Australia's terrestrial ecosystems [NOTBC 1.2]
  - By 2005, a representative sample of each bioregion … is protected within the National Reserve System or network of Indigenous Protected Areas or as private land managed for conservation under a conservation agreement [NOTBC 1.2.3]
  - Restore communities below 10% of their pre-1750 levels to that benchmark [NOTBC 1.2.4]

Some management options

A. Prevent broadscale clearing of communities of high biodiversity value in Queensland.

B. Prevent broadscale clearing of ecological communities in the Murray Darling Basin that have high multiple ecosystem service values.

[1] National Objectives and Targets for Biodiversity Conservation 2001-2005, Environment Australia.

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.

D. Restore native vegetation in sub-regions which have fallen below 10% back to 10% of their original area. (A variation on C).

E. Consolidate the National Reserve System to achieve comprehensiveness targets.

Costs and benefits

A. Prevent broadscale clearing of communities of high biodiversity value in Queensland

- The largest areas of land still being cleared in Australia are in Queensland (an estimated 425,000 ha in 1999 and in 2000, 2001 State of the Environment Report).
- There are 1,085 regional ecosystems defined for Queensland. 243 are in the "of concern" category – those with 10-30% of pre-clearing extent, plus those with >30% but remnant area is small (<10,000 ha). There are 2,270,400 ha in the "of concern" category (Fensham and Sattler, unpublished data).
- Queensland government has calculated it needs $200m to compensate landowners for not clearing the "of concern" area.
- Additional costs could be incurred in the future if the same approach taken with areas currently 'not of concern' but that reach the 30% threshold as clearing for development continues. These costs are not included in these calculations.
- 12 bird taxa (ultrataxa) are extinct or threatened by clearing in rainforest and tropical and sub-tropical woodland (Garnett and Crowley 2000), vegetation types most represented in 'of concern' ecosystems.

Factor	Value
No. of species saved	5,280
Area (ha)	2,270,400
Cost/ha	$88
Total cost	$200m
No. species saved/$1m	**26**
Collateral benefit	$4,008m
Collateral benefit/total cost	**20**

- Using the ultrataxa multiplier[2] (440), this action would prevent 5,280 species becoming threatened.
- The collateral benefit[3] would be predominantly in carbon credits and prevention of erosion and salinity. At $1,400 per ha, carbon credits would contribute $3,178m. Assuming a third of the area is susceptible to salinity, prevention of salinity would be valued at $830m over a 10 year period. The total is $4,008m.

[2] Underlying data outlined in accompanying paper *Setting Biodiversity Priorities.*

[3] as above.