Implications of

SALINITY

for Biodiversity Conservation and Management

Prepared for ANZECC by a Task Force established by the Standing Committee on Conservation

For Consideration by ANZECC
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This report summarises the issues and recommendations from a Taskforce on Salinity and Biodiversity established under ANZECC. The report was written by Benita Dillon and Simon Lewis from the South Australian Department for Environment and Heritage. The Taskforce consisted of Allan Holmes (Chair), Keiran McNamara (WA), John Burley (VIC), Helen Hofman (QLD), Sue Briggs (NSW), Peter Lyon (Commonwealth), Peter Donnelly (ACT), Alistair Scott (TAS), Lisien Loan (SA) and Denis Saunders (CSIRO). All of the Taskforce members contributed significantly towards the final report.

This Taskforce report has been endorsed by the following States and Territories; Australian Capital Territory, Queensland, Northern Territory, South Australia, Tasmania, Victoria and Western Australia (NSW did not accept the recommendations).

Front cover photograph acknowledgements:
Top photograph: Benita Dillon, National Parks and Wildlife SA
Bottom photograph: Murray-Darling Basin Commission

EXECUTIVE SUMMARY

Salinity is destroying a significant part of our Australian landscapes. It is a serious threat to biodiversity as it damages our native species, ecological communities and functioning ecosystems.

In the Western Australian wheatbelt, salinity has caused a **50% decrease** in the numbers of wetland **bird species** and **450 plant species** are threatened with **extinction** through **salinity** (*Keighery et al.2000*).

Recognition of the connection between salinity and biodiversity, and its importance as a National issue has evolved very slowly. Salinity management and biodiversity conservation have attracted considerable attention at the National, State and Regional levels over the past decade or more, but mostly as separate, unrelated issues. It has long been recognised that native vegetation clearance is a key factor in the proliferation of salinity problems but the consequent impact of salinity upon remnant native vegetation and associated ecosystems has not been widely acknowledged. Salinity has been primarily seen as a problem for agricultural production, water quality and infrastructure maintenance.

As regional biodiversity surveys have been conducted in many parts of the country, the realisation has dawned that the biodiversity represented in vast areas of rivers, wetlands, riparian zones and other generally low-lying areas is being lost or threatened by salinity. In many cases salinity will be one of a number of threats to these areas but one which is insidious and poorly understood.

It is predicted that salinity will affect **17 million ha** in Australia by 2050 including **2 million** hectares of **remnant** and planted perennial **vegetation** (NLWRA 2000).

Late in 2000, the Australian and New Zealand Environment and Conservation Council (ANZECC) requested its Standing Committee on Conservation (SCC) to establish a Task Force to examine the linkages between biodiversity and salinity. A Salinity and Biodiversity Task Force was thus established with representation from the Commonwealth, States and Territories with a brief to review the issues and to develop a paper for ANZECC consideration.

The Task Force has conducted a review of salinity and biodiversity issues and of relevant policies and programs across the country. It has confirmed that the loss of biodiversity as a result of salinity is a highly significant issue of national importance. In particular:

- A major proportion of the estimated 5.7 million hectares of land affected by salinity comprises wetlands, riparian zones and other natural ecosystems (not just agricultural land);

- In the Western Australian wheatbelt, where the most comprehensive analysis of this issue has been undertaken, 450 plant species are threatened with extinction and there has been a 50% reduction in numbers of waterbirds using wetlands as a result of salinity and
- The area of natural ecosystems affected by salinity could treble by 2050 in the absence of effective counter-measures or preventative action.

There has been significant research effort in Australia on salinity and biodiversity but largely as unrelated issues. Other than in Western Australia and some regional projects in other States, insufficient work has been undertaken on the impacts of salinity on biodiversity or the potential threat of increased salinity to biodiversity.

Most policies at National and State levels deal separately with salinity and biodiversity. Few contain more than a passing reference to the implications of salinity for biodiversity. Recent policy initiatives such as the National Action Plan for Salinity and Water Quality (NAPSWQ) acknowledge the linkages between salinity and biodiversity but whether this will flow on into integrated programs and actions remains to be seen. It is essential that the NAPSWQ and other initiatives are translated into planning and action, at all levels, which fully integrates these issues.

The Task Force has reached the following major conclusions:

- Salinity is contributing to species extinctions and loss of ecosystem health and is destroying Australian landscapes;
- The effects of salinity upon Australia's biodiversity are poorly understood and grossly underestimated;
- Extensive areas of both agricultural land and natural ecosystems that currently do not display obvious symptoms of salinity may nevertheless be at risk from salinity in the foreseeable future;
- Salinity is a critical issue for native biodiversity in Australia, not only for biodiversity represented in uncleared communities but also to native biota on agricultural lands (eg soil biota);

Our **knowledge** of the affects of salinity on biodiversity urgently needs to be **improved**.

Biodiversity conservation must be seen as an **integral component** of **policy** and **programs** dealing with salinity.

Protect and maintain the **quality** and **condition** of **existing native vegetation** in any areas with known salinity risk

Summary

- The salinity problems confronting vast areas of Australia are directly linked with the extensive clearance of native vegetation, past and present and

- Integrated programs for salinity management and biodiversity conservation are needed, incorporating long-term commitment to these programs.

Use **environmental flows** and **integrated catchment management**

The Task Force has developed a broad range of recommendations covering matters of policy, research and education, institutional arrangements and on-ground actions.

Some of the priority actions recommended by the Task Force are summarised as follows:

- Jurisdictions involved in natural resource management develop clear and consistent policies that recognise the links between salinity and biodiversity loss and ensure that biodiversity conservation and enhancement is adopted as a central objective in integrated salinity management programs;
- Programs for the protection and management of remnant native vegetation be implemented in salinity risk areas to assist in the limitation and management of salinity;
- Areas of biodiversity significance that are degraded through, or at risk from, salinity be identified and programs developed and implemented to address those salinity threats;
- The effects of salinity on biodiversity in watercourses, wetlands and riparian zones be addressed through maintenance of adequate environmental flows and appropriate management in irrigation areas to minimise irrigation-induced salinity;
- All proposals and programs relating to salinity management be assessed in terms of potential biodiversity impacts and seek to achieve positive biodiversity outcomes;
- Programs to address salinity and biodiversity be based, as much as possible, on integrated natural resource management plans developed through government - community partnerships;

Revegetate with **local native species** to help address salinity problems while also making **gains** for **biodiversity**

- Targeted research programs be undertaken to provide clear information regarding current and likely future impacts of salinity upon biodiversity and to assist in the management and restoration of areas affected by salinity and in minimising impacts upon ecosystems at risk;
- The NAPSWQ ensure that biodiversity conservation is addressed as a priority issue and that its outcomes include positive benefits for biodiversity conservation.

Public release of this report and widespread promulgation of the ideas within it is recommended.

All **actions** proposed under the NAP should be **assessed** for their **impact** on **biodiversity**

1 BACKGROUND

Salinity is a serious threat to biodiversity as it has impacts on our native species, ecological communities and ecosystem function. This report discusses the issues involved and proposes a framework for a more integrated approach to salinity management, incorporating biodiversity objectives.

Salinity is rapidly destroying significant parts of our Australian landscapes. It is a serious threat to biodiversity as it impacts on our native species, ecological communities and ecosystem function. While substantial research and funding has been directed to salinity issues (especially with regard to the impacts on agricultural production and water resources and damage to infrastructure) it is becoming evident that more integrated work and funding should be directed into the impacts of salinity on biodiversity.

The implications of salinity for biodiversity have been considered at Standing Committee on Conservation (SCC) and ANZECC meetings. ANZECC requested the SCC to establish a taskforce to address the emerging salinity impacts on biodiversity.

The terms of reference for the Salinity and Biodiversity Task Force are:

1. To determine implications of increasing salinity for biodiversity conservation and management in Australia;
2. To develop a policy paper for ANZECC consideration, including recommendations for 'on-ground' actions, institutional change and research needs to address the issue of salinity impacts on biodiversity.
3. To be a focal point for ANZECC with regard to biodiversity conservation matters, in the context of the development and implementation of the National Action Plan on Salinity and Water Quality as agreed by COAG.

At the December 2000 ANZECC meeting, it was resolved that there should be a commitment of conservation/environmental agencies to provide advice and deliver outcomes being sought through State based salinity strategies, plans and initiatives. It was also agreed that agencies have a key role to play in State, regional and catchment strategies addressing salinity.

The Council of Australian Governments (CoAG) established a National Action Plan for Salinity and Water Quality (NAPSWQ) – a $1.4 billion program for regional based programs. While Commonwealth and State funding under the plan will be used directly for salinity and water quality outcomes, conservation of biodiversity is one of the objectives of the plan.

This paper is aimed to influence Ministers and agencies responsible for the environment to ensure biodiversity conservation is integrated into all natural resource management programs, policies and strategies dealing with salinity. The Task Force wishes to promote the initiation of a process to ensure the conservation and maintenance of healthy and functioning ecosystems occurs within areas affected by, or likely to be affected by salinity.

2 REVIEW OF SALINITY AND BIODIVERSITY ISSUES

Salinity is contributing to species extinctions and loss of ecosystem health. For example, in the Western Australian wheatbelt, salinity has caused a 50% decrease in the numbers of waterbird species using the wetlands and 450 plant species are threatened with extinction as a result of increasing salinity (Keighery et al. 2000). Nationally some 5.7 million hectares of land have been affected by or are at risk from salinity. This is predicted to rise to 17 million ha by 2050 which could include millions of hectares of biodiversity significance (NLWRA 2001).

2.1 Salinity

Salt has been accumulating in the Australian landscape over millions of years from deposition in areas formerly covered by the sea and blown in from ocean spray, wind and rain. Until clearing, most of this salt resided below the root zone of native vegetation, immobile and doing very little harm. The current story is very different.

The National Land and Water Resources Audit, Australian Dryland Salinity Assessment 2000 (2001) (NLWRA) has presented some disturbing figures relating to the problem of dryland salinity in Australia. These include:

- Approximately 5.7 million hectares of land are currently mapped to be at risk or affected by dryland salinity;
- It has been estimated that in 50 years the area with a high potential to develop dryland salinity in Australia may increase to 17 million hectares;
- Not only is agricultural land and infrastructure at risk, as estimated 631, 000 hectares of remnant and planted perennial vegetation and associated ecosystems are at risk and this is projected to increase over 2 million hectares over the next 50 years;
- Up to 41,300 kilometres of streams could be significantly salt affected by 2050 and
- 24 of 79 river basins studied exceeded salinity guidelines (ie. >33% of the basins did not meet 'good' salinity guidelines).

Table 1: Summary of assets at risk from shallow watertables or with a high salinity hazard in Australia

Asset	2000	2020	2050
Agricultural land (ha)	4 650 000	6 371 000	13 660 000
Remnant and planted perennial vegetation	631 000	777 000	2 020 000
Length of streams and lake perimeter	11 800	20 000	41 300
Rail (square km)	1 600	2060	5 100
Road (square km)	19 900	26 600	67 400
Towns (number)	68	125	219
Important wetlands (1)	80	81	130

Source: NLWRA. (1) The Taskforce considers that the figures for important wetlands are likely to be an underestimate.

Salinity is now recognised as a serious issue for agriculture, water quality and infrastructure including built assets. The biodiversity impacts of salinity are not well recognised and it is only in the last decade that we have become aware of its significance. This may be due to salinity not being immediately visible, the generally low level of attention given to biodiversity by the community, and the long lag times (20-50 years) between the clearance of native vegetation and the consequences for off-site biodiversity loss and ecological processes as compared to more obvious agricultural losses.

2.2 Causes of Salinity

The land use imposed on Australian landscapes over the last two centuries is now proving fundamentally inappropriate in many areas.

Australia's salinity problem is directly linked to the losses of biodiversity and ecosystem function that have been incurred by land use change and vegetation clearance. Increased dryland salinity is most often a consequence of replacing deep-rooted native vegetation with shallow-rooted annual crops and pastures, which have increased the leakage of water below the root zone and into groundwater systems. This excess of water entering watertables has caused them to rise, mobilising salt stored in the soil and bringing it to the root zones of plants or to the surface, or moving it into surface water bodies. Rising watertables can increase the pressure further down the catchment, leading to saline discharge to the soil surface or directly into wetlands, lakes and rivers. Smaller areas of crop land in Australia are also affected by irrigation salinity. This has implications for the conservation of soil biota, terrestrial and instream biodiversity.

Increasing salinity in river and wetland systems is also linked with the loss of native vegetation, but irrigation practices and river regulation also contribute to salinity in these systems. Environmental flows are now recognised as being an important factor to consider in the management of these river and wetland environments. Biological knowledge is required to ensure environmental flows are used to improve the biodiversity of the systems and that the damage of salinity is fully understood.

Other causes of instream salinity (with potential effects on biodiversity) also need to be recognised. These include urban stormwater and wastes and run-off from industrial and mining areas. Seawater intrusion into underground aquifers, resulting from excess extraction from those aquifers, is also an issue.

2.3 Biodiversity and causes of biodiversity loss

Biodiversity is the variety of all life forms (plants, animals, micro-organisms), the genes they contain and the ecosystems of which they form part. Biodiversity in Australia is under threat from a range of processes including vegetation clearance, changing land uses, introduced plants, animals and diseases and pollution. Salinity has only recently been recognised as a threat to biodiversity.

Biodiversity is important because it is the primary source for fulfilment of human needs and is a basis for adapting to a changing environment. Rich biodiversity offers options for sustainable economic activity and nurturing human welfare. As stated in the National Strategy for the Conservation of Australia's Biological Diversity (1996) "the maintenance of hydrological cycles, functioning ecosystems, climate regulation, soil production and fertility, protection from erosion, nutrient storage and cycling, pollutant breakdown and absorption are all services dependent on biological diversity".

It also improves the recreational, cultural, aesthetic and spiritual values of the land. Biodiversity is undervalued yet is fundamental to the quality of our life and our economy.

Clearing native vegetation, both past and present, is the single most important factor in biodiversity loss across Australia (State of the Environment Advisory Council 1996). Vegetation clearance has had a direct impact on many species in terms of extinctions and reduction to critically low levels. The resultant fragmentation of native vegetation remnants has led to further losses and threats, as many species and ecological communities are non-viable in small, isolated fragments. Vegetation condition is an important factor for remaining remnants as well. Clearing also has other affects on biodiversity, as it is the primary cause of salinisation.

Biodiversity loss is also associated with factors that do not involve active or physical clearance. Degradation through weed invasion and impacts from cats, foxes, rabbits and other introduced animals are well-recognised examples. Salinity following extensive native vegetation clearance is a major example of biodiversity loss and it is a direct result of changed ecosystem function. These salinity factors can be caused by inappropriate land uses some distance from where the impacts are being noticed. Many plants and animals are affected when functioning ecosystems deteriorate, not only the species present in situ but also those higher in the food chain (e.g. birds of prey, humans etc). Migratory and nomadic species are also impacted, not only the sedentary species.

In its 1999 report, National Framework for the Monitoring and Management of Australia's Native Vegetation, ANZECC set out a number of objectives and principles to be followed in conserving and where possible enhancing Australia's biodiversity. Although salinity was not highlighted as a key issue, the document provides a broad framework that is relevant to the management of salinity as discussed in this report.

2.4 Salinity Impacts upon Biodiversity

Salinity has been identified as a major environmental issue. This has been well documented in a number of recent reports including the 1996 Commonwealth State of the Environment Report, the Murray Darling Basin Commission Salinity Audit (1999), the WA Salinity Strategy (2000) and the NLWRA (2001). Although there is substantial information and understanding on the impacts of salinity on agricultural production, less is available with regard to impacts on biodiversity.

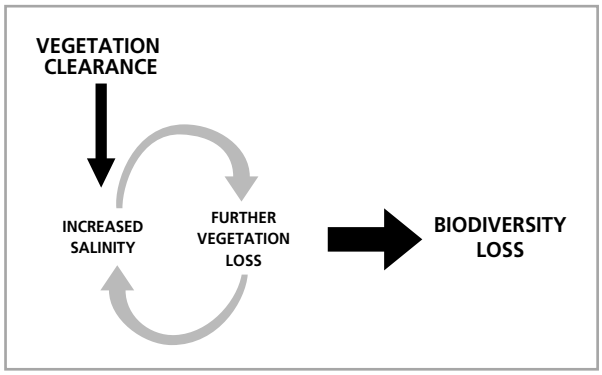
Some of the current knowledge regarding salinity impacts upon biodiversity is summarised below.

Impacts upon Native Vegetation

The most obvious effect of salinity in landscape terms is the loss of native vegetation. This occurs in low-lying areas where dryland salinity is a problem, as saline groundwater intrudes into the root zone of native plants. It occurs along rivers and streams where increasing in-stream salinity can exceed the tolerance of both aquatic vegetation, trees and other vegetation growing along channels and on floodplains.

The loss of native vegetation, in turn, compounds the salinity problem. As more native vegetation decreases in health or dies from salinity effects, the saline ground water tables rise further causing more problems to many ecosystems including rivers, wetlands, riparian

zones and remnant vegetation, especially in low lying areas. A "vicious cycle" is therefore created, as summarised in the following diagram.



As indicated in Table 1, the NLWRA estimates that 631,000 ha of remnant native vegetation and planted vegetation is currently under threat from salinity.

In-stream salinity is a serious issue for biodiversity in many of Australia's waterways. It can result from increased inflow of saline groundwater associated with broad-acre vegetation clearance and/or with inappropriate irrigation and other land management practices. The regulation of rivers and lack of environmental flows is another critical factor. Salinity levels of 1500 EC units or more can have direct adverse effects on aquatic biodiversity (source: draft South Australian River Murray Salinity Strategy).

Impacts Upon Native Fauna

The impacts of salinity upon native fauna are usually less obvious but are equally severe. These effects occur at many levels. First, there is a direct impact upon aquatic animals and other fauna that are unable to adapt to the increased salinity of their environment. Flow-on effects then occur for other animals that feed on, or are otherwise dependent on, the species that are directly affected.

Other effects on native fauna relate to the loss of habitat (eg food, nesting sites) as a result of salinity effects on native vegetation (see above). Again there are flow-on effects to other species in the food-chain or ecological relationship.

Conservation and Land Management (CALM) has estimated there has already been a 50% decline in the number of waterbird species using wetlands in the Western Australian wheatbelt due to the death of vegetation caused by salinity. Preliminary survey results indicate that the estimated extinction of approximately 220 aquatic invertebrate species in the wheatbelt is expected if all the wetlands in the area became saline, and that 450 native plant species are threatened with extinction by increasing salinity (Keighery et al 2000).

George et al. (1995) estimated that in the WA wheatbelt, 80% of all remnant vegetation on private land and perhaps as much as 50% of all remnant vegetation on public land will be lost to salinity over the next century.

Impacts upon micro-organisms

Salinity may be the major threat to soil biodiversity in Australia. The immediate effect of the action of saline groundwater on soil biota is to place them under osmotic stress. The soil organisms are no longer able to effect cellular water balance and effectively die of dehydration. This effect can be manifest not only by rising groundwater but also by application of saline irrigation waters to cropland. Where trees are being killed by rising saline groundwater, it is likely that the soil biota in the root-zone of those trees is already dead or dying before the trees roots themselves start to be directly affected by salt damage. Many native tree species rely on ectomycorrhizal fungi, which function as extensions of their root systems in

order to scavenge for phosphorous in nutrient-depleted soils. It seems likely that these fungal life-support systems, and their associated fauna, which feed on them and stimulate their growth, will be most vulnerable to salinity damage. However, there is little research to verify this.

The effects of salt build-up on micro-organisms in soils and in-stream, and the underlying importance of the role of micro fauna in maintaining ecosystem function is almost entirely unknown, and potentially grossly undervalued. Studies by CALM in Western Australia on the impact of salinity on biodiversity in wetlands have identified a clear negative relationship between invertebrate species diversity/richness and increasing salt concentration.

Sites of particular significance

Australia has obligations under the Convention of Biological Diversity, Ramsar Convention, migratory bird agreements (JAMBA, CAMBA) and the Bonn convention. The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* provides protection for sites and matters of national environmental significance. Ramsar sites, other important wetlands, recognised heritage areas, threatened species and communities and listed migratory species are at threat from salinity. Salinity therefore has potential implications for Australia's International and National obligations.

2.5 Summary of State / Territory Situations

The extent of the salinity problem and implications on biodiversity for each State and Territory are summarised below. More detailed information is included as Appendix 1 and maps are included in Appendix 2.

Australian Capital Territory

(a) General Extent of Salinity Issues

In the ACT the areas affected by salinity tend to be relatively small and isolated and are generally the result of localised conditions. Over 50% of the land area of the ACT is national park or nature reserve resulting in extensive coverage by native vegetation including many of the ridge and slope recharge areas throughout the city of Canberra. The rural areas of the ACT have not been subject to the high intensity agricultural practices undertaken in some other areas of Australia. Some small and isolated areas of land have been affected by dryland salinity.

River and stream salinity in the ACT is generally low with slightly higher concentrations in the urban stormwater retention lakes systems. River salinity is not expected to change as a result of activities in the ACT but could be affected by activities upstream of the ACT in streams flowing through the Territory.

(b) Salinity Impacts and Risks to Biodiversity

Dryland salinity and relatively low levels of stream salinity are not expected to have any marked impact on local biodiversity. The threat of river salinity increasing from another State has not been assessed at this stage, therefore the impact on biodiversity is unknown.

New South Wales

(a) General Extent of Salinity Issues

In New South Wales, the impacts of salinity on rivers, groundwater and land are becoming obvious. Salt has been mobilised across inland catchments and some coastal catchments on a large scale. It is estimated that more than

150,000 hectares of inland areas and more than 28,000 hectares of coastal regions are affected by salt (Littleboy *et al* 2001).

(b) Salinity Impacts and Risks to Biodiversity

Published figures on areas of remnant woody vegetation affected by, and at risk from, salinity (depth to water table < 2 m) include 5,000 ha (2000), 17,500 ha (2020) and 46,500 ha (2050) (Littleboy *et al*. 2001, NLWR 2001). These figures are substantial underestimates as they only include forests (not woodlands) on freehold land (plus forests and some woodlands on land of unknown tenure at a resolution of 1 km by 1 km). Remnant vegetation on Crown land (including parks, reserves and State Forests), woodlands on freehold land, and remnants smaller than 100 ha are excluded from the analyses. More reliable figures are provided in Appendix 1. Areas of native grasslands, shrublands and wetlands affected and likely to be affected by salinity are also not included in these calculations.

Northern Territory

(a) General Extent of Salinity Issues

The NLWRA indicates that Northern Territory has a relatively low salinity hazard. The greatest potential for dryland salinity is in the inland semi-arid areas (Sturt Plateau) where it would be expected to develop in isolated patches.

(b) Salinity Impacts and Risks to Biodiversity

The Northern Territory has assessed and described salinity hazard throughout the Territory. The threats are low, well known and taken into account in regional development planning.

Queensland

(a) General Extent of Salinity Issues

The NLWRA estimates that 48,000 hectares of land in Queensland is currently affected by dryland salinity. An additional 2,900 hectares is affected by salt water intrusion. Most salinity affected areas are in the eastern part of Queensland. Major areas include the lower Central Coast (lower Fitzroy and the Burnett Basin), the South East (lower Mary irrigation area, Lockyer valley) and the Murray Darling (Condamine, Balonne, Maranoa). Outbreaks are localised in extent.

(b) Salinity Impacts and Risks to Biodiversity

In Queensland there is little specific data on impacts on flora and fauna except for a small number of site specific studies on instream salinity impacts. Like South Australia and Victoria, it is expected that wetlands and rivers are most at risk from increasing salinity. Some action is under way to facilitate a better understanding (see section 3 ‘Current Work’).

South Australia

(a) General Extent of Salinity Issues

In South Australia, 410 000 hectares of land are affected by salinity with more than half of this in the Upper South East. It is estimated that a further 326,000 ha are at risk and that this figure could increase to 391,000 ha by 2050.

(b) Salinity Impacts and Risks to Biodiversity

Initial assessments of the biodiversity risk assessment mapping for SA re-iterate the high risk to natural ecosystem viability in the Mid and Upper South East, Kangaroo Island, Lower and Western Eyre Peninsula and Coorong districts. The ecosystems in South Australia

facing the greatest risk from increasing salinity are the rivers and wetlands.

Tasmania

(a) General Extent of Salinity Issues

In Tasmania, it is estimated that 53,000 ha of agricultural land (or three per cent of all agricultural land) is affected by salinity and that this could increase to 106,800ha by 2050.

(b) Salinity Impacts and Risks to Biodiversity

Salinity impacts are greatest in the low rainfall areas of Tasmania where there has already been considerable impact on biodiversity following European settlement. These areas have little remaining vegetation, and have the highest numbers of locally-extinct plant and animal species and threatened taxa. Vegetation associated with wetlands and lowland plains and river flats including herbaceous wetland communities, grasslands and several types of woodlands, which are already some of Tasmania's most endangered vegetation types, are at high risk. Fourteen forest types and 15 non-forest vegetation types are at medium risk.

Victoria

(a) General Extent of Salinity Issues

The NLWRA estimates there are currently 670,000 hectares affected by shallow water tables (less than 2 metres) in Victoria, although it is unlikely that this entire area would be salt-affected. The area at risk could increase to 1,305,000 hectares by 2020 and 3,114,000 by 2050.

(b) Salinity Impacts and Risks to Biodiversity

Up to 4-8% of all records of threatened flora in Victoria are predicted to be located in shallow water table areas by 2050 and 9-17% of all threatened fauna (Figure 1 in Appendix 1). More threatened species are currently associated with shallow water table areas in the Wimmera region than elsewhere in the State. The greatest long-term threat to such species appears to be in the Goulburn-Broken, Glenelg-Hopkins and Corangamite regions.

There are considerable but not uniform threats to many forested areas of the State. In the Mallee, rising water table is generally considered a threat only in lowland areas. There is a general increase in salinity closer to the Murray River.

Western Australia

(a) General Extent of Salinity Issues

The 1996 Western Australian Salinity Action Plan (Agriculture WA et al 1996a) and accompanying Situation Statement (Agriculture WA et al 1996b) provided estimates of past and the then current extent of salinity in the south-west agricultural region of the State, as well as predictions of future extent. The estimates and predictions of salt-affected land were 264,000 ha (1982), 1,804,000 ha (1996), 3,296,000 ha (2010/2020) and a potential extent of 6,109,000 hectares.

The revised Salinity Strategy (State Salinity Council 2000) reiterates the prediction, based on the 1996 figures, that about one-third of the south-west agricultural region will be affected by salinity, but notes that the estimated time to reach these levels varies from as little as 30 years in the southern and western areas, to as long as 50 to 100 years in the east and north.

The NLWRA reports the agricultural and perennial vegetation areas at risk of dryland salinity from shallow watertables are as follows: Agricultural land, 3,553,000 ha (2000),

4,182,000 ha (2020) and 6,490,000 ha (2050); Perennial vegetation, 600,000 ha (2000), 710,000 ha (2020) and 1,800,000 ha (2050). More refined estimates will be available during 2001 from WA's Land Monitor project.

(b) Salinity Impacts and Risks to Biodiversity

There was recognition, at the time of preparation of the Salinity Action Plan in 1996, that biodiversity values were at risk from salinity. The south-west of WA is recognised as a megadiverse region with a high degree of endemism in its flora. Most of the south-west agricultural region is highly cleared, with remnant vegetation highly fragmented and occurring mostly in small patches.

An indication of the risks to biodiversity as they were then understood and documented in the Salinity Action Plan and Situation Statement is given by the following:

- the beds and banks of 80% of the rivers and streams were seriously degraded;
- 36% of the divertible surface water resource had become brackish or saline and a further 16% was of marginal quality;
- virtually all wheatbelt wetlands had been severely degraded but their degradation had gone largely unrecorded;
- 11 species of threatened flora had at least one population considered to be at threat from salinity, and one species was considered likely to disappear; and
- up to 80% of vegetation remnants on farms and up to 50% on public lands (including conservation reserves) could be lost.

One very stark result illustrates what can be learnt by research targeted specifically at documenting biodiversity and the extent of the threat posed by increasing salinity - the number of vascular plant species classed as "in grave danger of extinction" due to increasing salinity now stands at 450 (Keighery 2000), compared to just one in the 1996 Situation Statement.

When the results of the biological survey (initiated in the 1996 under the Salinity Action Plan) are collated and analysed (by late 2002), WA will have a vastly improved understanding of the biodiversity values of the region and the actions needed to conserve them.

3 CURRENT WORK ON SALINITY IMPACTS ON BIODIVERSITY

A substantial amount of work has been conducted in Australia regarding salinity and biodiversity but as separate, essentially unrelated issues. Insufficient work has been undertaken on the impacts of salinity on biodiversity or the potential threat of increasing salinity to biodiversity.

Many research, monitoring and work programs have been undertaken on salinity including the recently released NLWRA. The Audit provides a preliminary assessment of dryland salinity and sets the information context for tackling Australia's dryland salinity management issues. State agencies, CSIRO, the National Dryland Salinity Program and the Murray Darling Basin Commission are undertaking other work. Most of the focus for these studies has been on the impacts of salinity on agricultural production, infrastructure and water quality.

Similarly, there have been many surveys and projects relating to Australia's biodiversity. Again these surveys and projects do not generally include specific discussion of the threat of salinity but rather to the species present, their condition and conservation significance and management issues such as weeds and introduced animals.

Programs including Landcare, Bushcare, Local Action Planning and other community and Government funded projects are all undertaking good work in salinity mitigation and/or the conservation of biodiversity. Many of these programs are however limited in scope and more integration is required with future work to improve the conservation of biodiversity throughout Australia.

Despite the deficiency in integrated work relating to salinity and biodiversity, the extensive research in WA and more localised studies in the other States have highlighted the severe impacts of salinity on biodiversity. Some of the relevant work being undertaken within the States and Territories that explores biodiversity impacts of salinity is discussed below:

Environment ACT has recently commissioned a study into stream condition trends in the ACT. Recent work includes studies into nutrients and salinity in the Upper Murrumbidgee by Starr (1999) and salinisation in the Upper Murrumbidgee by Lane, Fogarty and Walker (2000).

The NSW Salinity Strategy (NSW Government 2000) lists actions and activities to address salinity in NSW (see Section 4 'Policy Overview'). Funds are currently being sought to investigate effects of salinity on biodiversity. Preliminary work on this topic is being undertaken while funding sources are being investigated. The NSW Salinity Strategy funded a project entitled "Benchmarking Biodiversity Credits". The aim of this project is to "conduct research to benchmark biodiversity values in major ecological communities to provide the necessary basis for trading in this environmental service". It is being conducted by NPWS in collaboration with NSW State Forests.

Queensland has an extensive program for mapping its remnant native vegetation categorised into threat status (endangered, of

concern etc). Most of the south east of the State has been mapped, with work in the Brigalow and Central Coast and Desert Uplands close to completion. This data will be 'overlayed' with State-wide salinity hazard data, and other biodiversity data including threatened species and wetlands, to gain a detailed understanding of risks for biodiversity.

Queensland is also undertaking an integrated salinity monitoring program that incorporates hydrological investigation, land-use change evaluations, integrated catchment water and salt balances at the catchment scale, improved monitoring frameworks and training and information delivery (this program will be amended to suit NAPSWQ needs) which will provide a better base for examination of biodiversity impacts.

The Department for Environment and Heritage in South Australia is conducting biological surveys of plants and animals throughout the State. Regional Biodiversity Plans are being written or have been completed for all regions and highlight the conservation values, areas at risk, major threats and priority action to be undertaken in the regions. Many regions in South Australia have Local Action Plans, Salinity Management Plans and/or Catchment Management Plans to assist in the management of salinity. Many of these documents do not focus on biodiversity as targets or outcomes to be achieved.

In Tasmania, development of a Salinity Management Strategy will commence this year following work undertaken as part of the NLWRA. Monitoring to more accurately assess the severity of the emerging salinity problem, and more detailed identification of vulnerable areas, are expected to be key elements of the Strategy. Tasmania recently became a partner to the National Dryland Salinity Program.

Victoria's Salinity Management Framework provides for the preparation of Second Generation Salinity Management Plans by September. These Plans will reflect the new understanding and information of salinity processes as outlined in the Victorian Salinity Management Framework, NAPSWQ and the Draft Murray Darling Basin Salinity Management Strategy. The Victorian Biodiversity Strategy and planning at a bioregional level provide the basis for protecting the State's flora and fauna. Surveys and Statewide databases of the State's biodiversity assets are being continually updated and made more readily available to land and resource managers across the State.

A further Victorian initiative is to examine the effects of sub-lethal salinity on the developmental processes of the early life stages of Murray cod. Another project aims to improve knowledge on the constituents of saline waters and their toxicity on fish and aquatic macroinvertebrates. This will provide recommendations to water authorities, local shires and other managing bodies on the methods of saline water disposal that will not adversely effect native fish and aquatic macroinvertebrate species.

Western Australia is conducting research to increase knowledge on the impacts of salinity on biodiversity through extensive biological survey and monitoring, and through salinity responses which target biodiversity values at risk. This work identifies the biodiversity values at risk and provides information for salinity management decisions. A total of 6 'biodiversity recovery catchments' have been identified to date for targeted action, with several more being assessed. CALM also has established a monitoring program in 25 wetlands to determine the effect of various

management interventions. This project is looking at how different levels of salinity affect species richness and community composition among waterbirds, vegetation and aquatic invertebrates including macroinvertebrates.

The most significant broad-scale research on the impacts of salinity on biodiversity or the potential risk of increased salinity to biodiversity is being undertaken in Western Australia. However the relationship between increasing salinity and its impact on biodiversity that is being found in Western Australia is likely to apply elsewhere in Australia.

4 POLICY OVERVIEW

Many policies at the National and State level deal with salinity and biodiversity, but as separate issues. Very few contain more than passing reference to the implications of salinity for biodiversity. Recent policy initiatives recognise some linkages between salinity and biodiversity but whether this will flow on into integrated programs remains to be seen.

4.1 National Overview

The recognition of the links between salinity and biodiversity conservation is a very recent occurrence. Nationally focused programs dealing with natural resources date back to the late 1980s e.g. the National Landcare Program, followed by the Natural Heritage Trust. While these programs addressed salinity and biodiversity issues from the outset, they have been essentially been treated as separate issues. For example the National Strategy for the Conservation of Australia's Biological Diversity (1996) gives no recognition to the close links between salinity and biodiversity.

Relevant National policies and programs include the following:

- National Strategy for the Conservation of Australia's Biological Diversity (1996). ANZECC is currently developing a set of Key Objectives and Targets for Biodiversity Conservation, Towards 2005 in order to extend the implementation of the strategy for the next five years.
- NLWRA. The Audit has themes, including Dryland Salinity, Vegetation Management and Ecosystem Health.
- Murray Darling Basin Initiative is a partnership between the Commonwealth, NSW, Victoria, South Australia, Queensland and the ACT governments and the community.
- Natural Heritage Trust, including its Landcare and Bushcare programs.

4.2 National Action Plan for Salinity and Water Quality

The Prime Minister released the NAPSWQ in October 2000. An inter-governmental agreement was developed for signature between all States, Territories and the Commonwealth, although not all States and Territories have to date signed the agreement or the associated bilateral agreements. The NAPSWQ included funding of $1.4 billion over the next seven years, with $700 million coming from the Commonwealth and matching funds from States and Territories.

"This action plan identifies high priority, immediate actions to address salinity, particularly dryland salinity, and deteriorating water quality in key catchments and regions across Australia. It is a plan for decisive salinity and water quality related action to ensure that our land and water management practices will sustain productive and profitable land and water uses as well as our natural environments" *(Our Vital Resources - A National Action Plan for Salinity and Water Quality in Australia 2000)*. A goal from this plan is to "prevent, stabilise and reverse trends in dryland

salinity affecting the sustainability of production, the **conservation of biological diversity** and the viability of our infrastructure" (emphasis added).

As part of the plan, a new national Natural Resource Management Ministerial Council is to be established. It is imperative that this Council and ANZECC take a key role in ensuring biodiversity considerations are incorporated into natural resource management decision making.

4.3 Commonwealth Policies

The Commonwealth's salinity related policies and actions seek to address issues of national importance, including the protection of biodiversity, by working in cooperation with the States and Territories. Relevant national level policies have been discussed above. Relevant national level activities include the following:

- State of the Environment (SoE) Reports for Australia: required to be produced every five years under the Commonwealth EBPC Act 1999.

- A range of research programs and other activities supported by the Commonwealth are investigating dryland salinity issues. These include activities of the National Dryland Salinity (R&D) Program, CSIRO, the Cooperative Research Centres (CRC for Freshwater Ecology, CRC for Catchment Hydrology and CRC for Plant-based Management of Dryland Salinity), and the Rural Industries Research and Development Corporation.

4.4 States and Territories Policies

The States and Territories have varying approaches to salinity and biodiversity policies and strategies. The majority of States and Territories have existing policy initiatives to address salinity particularly in relation to agricultural production. Some salinity policies include biodiversity outcomes, but few have strategies or funding that directly support these outcomes. It is recognised that strategies that support agricultural outcomes will, in many but not all cases, have incidental positive effects on biodiversity.

Existing Salinity Policies

The situation across the States regarding salinity policies is mixed. Western Australia has had a salinity strategy since 1996 that recognises and addresses biodiversity issues. New South Wales and Victoria have state-wide salinity strategies or frameworks. South Australia has draft strategies relating to dryland salinity and River Murray salinity, including some recognition of the importance of native vegetation retention and management in salinity mitigation. Tasmania is to develop a Salinity Management Strategy following assessment associated with the NLWRA. Queensland, at this stage, does not have a separate Statewide salinity strategy but some existing policies include salinity aspects.

Existing Biodiversity Policies

There is a relatively broad range of policies across the States relating to biodiversity conservation, including controls and policies to manage native vegetation clearance.

In the ACT, the Nature Conservation Strategy makes provision for the protection of native vegetation and aquatic habitat including protection from the threat of salinity.
The *Land (Environment and Planning) Act* and the *Land Act* also contain provisions relating to development and management of land that could encompass issues of biodiversity and salinity.

Queensland does not have an overarching Statewide biodiversity conservation strategy, although it is an overt objective in many State policies. The *Vegetation Management Act 1999*, for example, aims to both protect biodiversity and reduce land degradation.

The strategic goal in the NSW Biodiversity Strategy is to protect the native biological diversity of NSW and maintain ecological processes and systems (NSW National Parks and Wildlife Service 1999). NSW also has a draft Native Vegetation Conservation Strategy (Department of Land and Water Conservation 2000). The Native Vegetation Conservation Strategy recognises that that rising saline water tables are adversely affecting productive land and infrastructure, but does not highlight effects of saline water tables on biodiversity. NSW also has the *Native Vegetation Conservation Act 1997*, which was developed inter alia to provide for the conservation and management of native vegetation on a regional basis.

Broader policies and programs for the conservation of biodiversity apply in South Australia, Victoria and Western Australia. South Australia, for example, has had a comprehensive program for the conservation of biodiversity outside of the formal parks system since 1983. There is a clear link in this program with salinity and water quality and broad-scale clearance of native vegetation effectively ceased several years ago. In addition, SA has prepared a draft Integrated Natural Resources Management Bill 2001 to promote integrated and sustainable management of the State's natural resources. South Australia's Wetlands Strategy (in prep) and Regional Biodiversity Plans (two completed, four in prep.) have a biodiversity focus and include salinity as a threatening process, but are not intended to address salinity issues in detail.

In Tasmania, a draft Nature Conservation Strategy is being finalised and is expected to identify salinity as a key threatening process to biodiversity. The strategy is also expected to recommend greater monitoring of the impact of salinity on biodiversity, and advocate the development of specific programs to maintain natural values in areas vulnerable to salinity.

The Victorian Department of Natural Resources and Environment has three integrated strategic priorities. These are:

- improved biodiversity and natural and cultural resources and
- growth of sustainable land and resource industries and markets and
- an informed and resourceful Victorian community.

The Victorian Biodiversity Strategy is being implemented through planning and action at the bioregional and catchment levels.

In Western Australia the conservation of natural ecosystems and their biodiversity was recognised as one of the key objectives in the 1996 Salinity Action Plan and 2000 Salinity Strategy. Existing agricultural, environmental and water resource legislation provides the framework for control of vegetation clearing and other forms of land degradation in Western Australia's agricultural region, and a range of policies and programs address biodiversity conservation both through the conservation reserve system and off reserves. The State is committed to new biodiversity conservation legislation and the preparation of a biodiversity strategy. Regional natural resource management groups are playing an increasing role.

Existing Policies or Strategies incorporating BOTH Salinity and Biodiversity Components

Few salinity policies or strategies within Australia integrate salinity and biodiversity issues.

Western Australia's Salinity Strategy (2000) and its predecessor (the 1996 Salinity Action Plan) include objectives and funded actions that specifically target biodiversity. South Australia has draft strategies regarding dryland salinity and River Murray salinity that recognise the links with biodiversity conservation. It is also noted that South Australia's *Native Vegetation Act 1991* and Queensland's *Vegetation Management Act 1999* include a clear link with salinity and water quality, while some other individual strategies also make the link but do not explore the interrelationship in significant detail. The NSW Salinity Strategy recognises the importance of biodiversity in salinity management, but only a few actions in the Strategy address biodiversity directly.

5 KEY ISSUES AND FINDINGS

- **Salinity is contributing to species extinctions and loss of ecosystem health and is destroying Australian landscapes;**
- **The effects of salinity upon Australia's biodiversity are unrecognised and grossly under estimated;**
- **Conserving biodiversity will help to reduce problems with salinity and water quality;**
- **Integrated programs for salinity management and biodiversity conservation are needed, incorporating long-term commitment to these programs.**

Governments and the community have tended to focus on salinity as an issue for agricultural land management. This, however, is only part of the story. Salinity is very much an issue for biodiversity on all lands including agricultural land (and water resources and infrastructure). Salinity is, in large part, the direct result of changes in biodiversity in that it is caused by the extensive loss of native vegetation which has both direct and compounding impacts resulting in changes to ecosystem functions, particularly hydrologic balance. Salinity is having a severe impact on natural ecosystems in many areas and poses a threat to larger areas that have not yet been significantly affected.

Policies and programs must include consideration of landscape scale effects of salinity on biodiversity and ecosystem functioning. A focus only on sites or individual areas affected by salinity provides an inadequate framework to address the problem.

The losses of, and threats to, biodiversity as a result of salinity have severe implications for the Australian landscape and long term effects on the economy and quality of life for Australians. Further, they have the potential to harm Australia's standing in the international community, given that areas under threat include Ramsar sites, other important wetlands, recognised heritage areas, threatened species and communities and listed migratory species.

Notwithstanding the need for a landscape scale focus, there will also need to be management intervention at smaller scales (eg. ecosystems, threatened ecological communities and populations of endangered species) if we are to save biodiversity values threatened by increasing salinity.

There is therefore a need to address biodiversity conservation as a front-line issue in all programs to address salinity and to promote a fully integrated approach in dealing with salinity and biodiversity to produce multiple benefits for Australia's natural resources.

The main conclusions of the Task Force are set out in more detail below:

- Salinity is a critical issue for both agricultural lands and biodiversity in Australia.
- Salinity has had, and will have a significant impact on natural landscapes and ecosystems in many regions of Australia.

- salinity impacts are degrading native bushland, scattered trees, wetlands and instream ecosystems and associated biota;
- salinity is contributing to species extinctions, destruction of ecological communities and loss of ecosystem health.

- Extensive areas of both agricultural land and natural ecosystems that currently do not display obvious symptoms of salinity are at risk from salinity in the foreseeable future.
  - the development of salinity impacts is an insidious, long-term process;
  - it is estimated that the area across Australia under threat from dryland salinity could treble to 17 million hectares by 2050; and that 41,300 km of streams could be affected by 2050, with considerably greater increases in some States and Territories.

- The salinity problems confronting vast areas of Australia are directly linked with the extensive clearance of native vegetation, past and present.

- The protection and management of native vegetation is vital to conserving biodiversity in its own right, but is also essential in terms of its role in combating salinity;
  - A "win – win" situation for both salinity and biodiversity can therefore be achieved through the conservation, restoration and reestablishment of native vegetation.

Specific issues and findings for policy, research and information, institutional arrangements and on-ground actions are as follows:

5.1 Policy

1) The natural resource management policies of jurisdictions have not sufficiently recognised that salinity is a significant an issue for conservation of all Australian landscapes and biodiversity as it is for agricultural land.

2) Programs for salinity management have tended to focus on solutions for agricultural lands rather than being integrated programs that also address biodiversity issues.

3) Few existing natural resource management policies and procedures contain biodiversity targets and monitoring, or aim for positive biodiversity outcomes.

4) Jurisdictional policies have given insufficient priority to the retention and management of native vegetation as tools in salinity management.

5) There are significant opportunities for programs and actions to achieve salinity benefits for biodiversity on all lands, including agricultural lands.

5.2 Research and Education

6) The impacts of salinity upon biodiversity are very poorly documented and publicised with the exception of some regional studies (mainly in Western Australia).
A substantial amount of additional research is needed to guide policy development, on-ground actions and monitoring programs.

7) There is a relatively low level of government and community awareness about the implications of salinity for biodiversity conservation. The paucity of up-to-date information is an impediment to improved awareness.

5.3 Institutional Arrangements

8) The linkages between salinity and biodiversity loss are not adequately reflected in institutional planning and decision making processes, including land use planning and development control processes.

9) Data systems and processes relating to salinity effects on biodiversity tend to be ad hoc and uncoordinated.

10) There is a lack of consistent programs for the conservation and management of native vegetation in areas where salinity management is a priority issue.

11) There is inadequate assessment of projects relating to salinity management in terms of potential impacts upon biodiversity.

12) Biodiversity outcomes are not always specified for, or integrated into, the roles of agencies managing land, water and vegetation resources.

5.4 On-ground Actions

13) Effective control of further native vegetation clearance is needed in priority areas at risk of being affected by salinity.

14) Management programs are needed to conserve and enhance remaining areas of native vegetation in the areas at risk from salinity to maximise benefits for both salinity and biodiversity.

15) Water courses, wetlands and riparian zones must be managed in an integrated way to avoid or alleviate salinity impacts upon biodiversity. The provision of environmental flows and management of adjoining land use are two important factors in this.

16) Revegetation programs with local native species are needed at strategic sites in priority areas to help address salinity problems while also making gains for biodiversity.

17) Actions to address problems of salinity should, as far as possible, be integrated so as to achieve other natural resource management objectives, such as biodiversity conservation and enhancement and be guided by the best available hydrological understanding.

18) In choosing strategies to address salinity, options that achieve biodiversity outcomes (such as revegetation rather than engineering solutions, or planting trees rather than crops) may seem less attractive because:

- initial costs are high, and/or
- productive agricultural land may be lost, and/or
- a long time is needed for results (in some cases, 100s to 1000s of years), and/or
- there is often considerable distance between recharge areas and salinity effects.

Assigning biodiversity outcomes a market value would assist in making such options more attractive.

19) On-ground actions should be based on careful and strategic setting of clear targets and priorities at appropriate scales for management (eg on a catchment or bioregional basis, but also on a localised scale where necessary to protect specific biodiversity values).

5.5 National Action Plan for Salinity and Water Quality

20) The NAPSWQ contains a clear goal to "prevent, stabilise and reverse trends in dryland salinity affecting …..the conservation of biological diversity" and to "improve water quality and secure reliable allocations for ….the environment".

21) It is imperative that the benefits of retaining and managing native vegetation for salinity mitigation and the impacts of salinity upon biodiversity are reflected adequately in the implementation of the NAPSWQ. The Plan has considerable scope to be the main driver in addressing the issues and findings described above and the Task Force's recommendations as set out below.

6 RECOMMENDATIONS

The detailed recommendations of the ANZECC Salinity and Biodiversity Task Force are set out below under key headings in line with the Task Force's terms of reference. It is understood that many of these recommendations are not new, however they are seen as important in addressing the issue of the implications of salinity for biodiversity conservation and management.

Priority Actions

1) Priority actions recommended by the Task Force are summarised as follows. The Task Force recommends that:
   - Jurisdictions involved in natural resource management develop clear and consistent policies that recognise the links between salinity and biodiversity loss and ensure that biodiversity conservation and enhancement is adopted as a central objective in integrated salinity management programs;
   - Programs for the protection and management of remnant native vegetation be implemented in salinity risk areas to assist in the limitation and management of salinity;
   - Areas of biodiversity significance that are degraded through, or at risk from, salinity be identified and programs developed and implemented to address those salinity threats;
   - The effects of salinity on biodiversity in watercourses, wetlands and riparian zones be addressed through maintenance of adequate environmental flows and appropriate management in irrigation areas to minimise irrigation-induced salinity;
   - All proposals and programs relating to salinity management be assessed in terms of potential biodiversity impacts and seek to achieve positive biodiversity outcomes;
   - Programs to address salinity and biodiversity be based, as much as possible, on integrated natural resource management plans developed through government –community partnerships;
   - Targeted research programs be undertaken to provide clear information regarding current and likely future impacts of salinity upon biodiversity and to assist in the management and restoration of areas affected by salinity and in minimising impacts upon ecosystems at risk;
   - The National Action Plan for Salinity and Water Quality ensure that biodiversity conservation is addressed as a priority issue and that its outcomes include positive benefits for biodiversity conservation.

More specific recommendations reflecting the Task Force's Terms of Reference are set out below:

6.1 Policy

2) Jurisdictions need to develop and promote clear and consistent policies for natural resource management that:
   - embed biodiversity targets and monitoring into NRM policies;
   - recognise the impacts of salinity upon biodiversity and the role of native vegetation in salinity management;

- give high priority to the protection and management of native vegetation management as a salinity management tool in areas affected by or at risk from salinity;
- ensure that biodiversity conservation is integrated into salinity programs and accredited management plans (as targets and outcomes) especially those being funded under the NAPSWQ, MDBC and State/Territory strategies;
- address issues of salinity and biodiversity at landscape scales as well as site specific scales;
- integrate and coordinate government and community efforts in achieving biodiversity objectives, while retaining regional or catchment based community involvement;
- provide for assessment of programs and actions to address salinity issues to determine their impacts upon biodiversity:
  - where potentially negative impacts are identified the programs and actions should not proceed unless management measures are incorporated to avoid or minimise those impacts;
  - individual projects and actions to address salinity issues should seek to achieve an overall biodiversity improvement.
    On a regional and district scale, programs to address salinity must achieve an overall biodiversity gain.
- recognise the importance of adequate environmental flows in river systems in avoiding or addressing salinity problems in wetlands and other riparian communities;
- give high priority to the protection and management of native vegetation as a salinity management tool in areas affected by, or at risk from, salinity;
- include a risk assessment process for any proposals for native vegetation clearance in salinity risk areas to determine the likely implications for both salinity and biodiversity and
- reflect the policies and principles set out in ANZECC's National Framework for the Management and Monitoring of Australia's Native Vegetation.

6.2 Research and Education

Research

3) Jurisdictions involved in salinity and biodiversity issues should undertake, assist and/or promote research to:
   - provide clear information regarding the current and likely future impacts of salinity upon biodiversity;
   - provide a better basis for evaluating ecosystems at risk from salinity and for determining priorities for action;
   - develop solutions for management and restoration of ecosystems affected by salinity and for avoiding or minimising impacts on ecosystems at risk;
   - provide improved tools for monitoring of ecosystems affected by, or under threat from, salinity;
   - develop innovative economic mechanisms such as biodiversity credits to assign biodiversity outcomes with a market value;

- enable modelling of the effects of further biodiversity loss on agriculture and infrastructure through salinity and
- provide a basis for innovative approaches to salinity management that also achieve biodiversity outcomes.

Education

4) Educational programs are needed to raise the level of public awareness about the impacts of salinity on biodiversity.
5) Mechanisms are needed to promote the sharing and transfer of knowledge and data to assist the processes of capacity building and integration.

6.3 Institutional Arrangements

6) Relevant jurisdictions and funding bodies should:
   - ensure that clear biodiversity outcomes or targets are included in their salinity action/work plans and other natural resource management plans;
   - ensure that project proposals addressing salinity are assessed in terms of potential biodiversity impacts and that, where adverse impacts are identified, management measures are incorporated to avoid or minimise those impacts and
   - ensure an overall goal of all jurisdictions and funding bodies should be to achieve a progressive overall improvement in biodiversity status and condition as a result of salinity programs at local, catchment and relevant regional levels.

7) State and relevant regional jurisdictions should:
   - ensure that there are adequate controls relating to the protection and management of native vegetation in salinity risk areas;
   - promote and assist programs for strategic revegetation in salinity risk areas to achieve joint benefits in terms of salinity management and biodiversity enhancement;
   - ensure that State of the Environment monitoring and reporting processes, including salinity and biodiversity, are in place, and that they address salinity and biodiversity;
   - ensure that contingency plans are developed for areas where biodiversity is vulnerable or sensitive to salinity impacts and
   - promote and assist property management planning processes in priority salinity areas, incorporating biodiversity conservation and enhancement.

8) Programs are required to ensure that Local Government and relevant Government agencies are aware of biodiversity issues associated with salinity and have access to up-to-date advice on the issues.

9) Statutory and land use planning processes and controls need to be reviewed and revised as appropriate to ensure that they address issues of salinity and biodiversity and do not promote or facilitate development that will contribute to salinity problems or biodiversity loss.

10) The management of salinity in areas of high conservation significance should incorporate a landscape scale as well as more localised actions within the area itself.

11) ANZECC agencies must play a key role in State, regional and catchment strategies addressing salinity.

- These strategies should incorporate principles set out in ANZECC resolution no. 431 from its meeting in December 2000, including:
  - identifying and publicising the extent to which biodiversity is threatened by increasing salinity,
  - focussing increased management effort on conservation reserves at risk from salinity, and on specific biodiversity values such as threatened species and ecological communities both on and off reserves,
  - assisting landowners and catchment and community groups to address biodiversity issues in their responses to salinity,
  - fostering research and development aimed at developing systems to manage threats from salinity and
  - monitoring and evaluating the effects on biodiversity values of actions to control or manage salinity.

6.4 On-ground Actions

12) Programs and actions for salinity management must be based upon an integrated approach to natural resource management, incorporating biodiversity conservation principles as follows:

- on-ground actions for salinity management must be based on consistent planning processes that incorporate clear biodiversity outcomes and targets;
- in choosing between options for action (e.g. planting trees or crops), options with better biodiversity outcomes should be more heavily weighted, that is, assigned a value which may not otherwise be recognised;
- areas of remnant native vegetation in salinity risk areas should be protected from clearance and managed to maintain or enhance their health (or condition) in order to maximise potential benefits for both salinity and biodiversity;
- specific and targeted actions should be taken to conserve high priority biodiversity assets (e.g. threatened species and ecological communities, Ramsar and other important wetlands) at risk from salinity;
- programs should be considered to provide assistance/incentives for the protection and management of areas of native vegetation in priority salinity areas (as above) to maximise biodiversity and reduce salinity;
- revegetation programs using local native species of various forms should be promoted and supported in strategic areas in salinity risk areas to achieve both salinity and biodiversity benefits (research into appropriate species needs to undertaken to avoid the problem of environmental weeds);
- watercourses, wetlands and riparian zones must be managed in an integrated way that ensures that environmental water regimes are maintained to avoid or alleviate salinity impacts upon biodiversity and that land management practices (eg irrigation) in adjoining areas do not increase in salinity;
- engineering solutions should be considered, and if appropriate carefully used, to assist in the conservation of areas with high biodiversity values;

- on ground actions must be assessed in terms of potential biodiversity impacts and that, where adverse impacts are identified, management measures must be incorporated to avoid or minimise those impacts;
- in dealing with salinity issues, alternative farming solutions and tree crops should be trialed (eg diverse mixtures of species, bush foods, eucalypt oil, salt bush farming) which mimic the water use of native vegetation to provide salinity, biodiversity and economic benefits;
- the overall goal of on ground actions should be a progressive improvement in biodiversity status and condition as well as salinity and water quality enhancement and
- actions to conserve biodiversity threatened by salinity generally require long-term commitment and funding, given the time scales involved in stabilising or reversing groundwater rise.

6.5 National Action Plan on Salinity and Water Quality

13) The National Action Plan on Salinity and Water Quality (NAPSWQ) should ensure that biodiversity conservation is addressed as a priority issue in salinity management and that its outcomes include positive benefits for biodiversity conservation. This may be through the following means:
    - elevating biodiversity through bilateral agreements, regional partnership agreements, targets and standards and integrated catchment management (ICM) plans at the regional level;
    - all actions proposed as part of the NAPSWQ should be assessed for their impact on biodiversity and those assessed to have a negative impact on biodiversity should not be supported unless they are modified to remove or offset that impact;
    - to advocate the adoption of a position that at least 25% of NAP funding should target salinity issues that affect the highest biodiversity values based on relevant biodiversity strategies and plans;
    - under the NAPSWQ, regional integrated catchment management plans that adequately address all natural resource management issues including the protection of biodiversity from salinity and provision of environmental flows should have priority in funding and
    - consideration should be given to the draft National Objectives and Targets for Biodiversity Conservation 2001-2005 in determining priorities for funding.

7 IMPLEMENTATION

Any natural resource management program, policy or strategy (especially those aimed at combating salinity) needs to accommodate the recommendations of this report and in particular recognise the need to address both salinity and biodiversity outcomes.
In order to promulgate the findings of this report the Task Force has made recommendations to ANZECC relating to the release of the report and to the adoption of the recommendations in the programs of relevant jurisdictions.

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APPENDIX 1 : SUMMARY OF CURRENT SALINITY AND BIODIVERSITY ISSUES IN THE STATES AND TERRITORIES

Australian Capital Territory

Physical (summary, size and nature of problem)

In the ACT, the region is characterised by localised shallow fractured rock aquifers that generally align with surface drainage patterns. Over 50% of the land area of the ACT is national park or nature reserve resulting in extensive coverage by native vegetation including many of the ridge and slope recharge areas throughout the city of Canberra. The rural areas of the ACT have not been subject to the high intensity agricultural practices undertaken in some other areas of Australia. Some relatively small and isolated areas of land have been affected by dryland salinity. Their extent is measured in square meters rather than hectares and they are generally accepted to be the result of very localised conditions. River and stream salinity in the ACT is generally low with slightly higher concentrations in the urban stormwater retention lakes systems.

Much of the land, particularly the rural and peri-urban areas of the ACT have been the subject of land capability surveys during the 1980s and early 1990s that have identified salinity as either not being a threat or as being an extremely low threat. It is not expected that dryland salinity will become a problem in the foreseeable future in the ACT. River salinity is not expected to change as a result of activities in the ACT but could be affected by activities upstream of the ACT in streams flowing through the ACT. No assessment of this threat has been made at this time.

Salinity Impacts and Risks to Biodiversity

The lack of impact of dryland salinity and relatively low levels of stream salinity are not expected to have any marked impact on local biodiversity.

New South Wales

Physical (summary, size and nature of problem)

In New South Wales, the impacts of salinity on rivers, groundwater and land are becoming obvious. Salt has been mobilised across inland catchments and some coastal catchments on a large scale. The current area of salt-affected land is between 120,000 ha and 180,000 ha or greater (NSW Government 2000, Littleboy et al. 2001). Increasing salinity in NSW is due to agricultural, industrial and urban activities. These include clearing of native vegetation, its replacement with crops and pastures with different water use patterns, introduction of irrigated crops, and use of inappropriate drainage and watering systems. These activities have caused groundwater to move through the landscape, bringing salt with it. Depending on the cause of salinity, and where it is expressed, it can be categorised as irrigated, dryland, urban, river or industrial (NSW Government 2000).

Table 1: Areas currently affected by salinity (NSW)

State	Region	Area affected (ha)
NSW	Inland	150,000 +
NSW	Coastal	28,000 +

Definition: Estimated areas (ha) affected by depth of water table of less than 2 m under current conditions (Littleboy et al. 2001)

Table 2: Areas at risk of salinity (NSW)

State	Region	Current area at risk (ha)	2020 area at risk (ha)	2050 area at risk (ha)
NSW	Lake Hume	127	3,973	19,254
	Murray	39,526	168,978	293,191
	Murrumbidgee	58,098	286,848	469,500
	Lachlan	19,793	38,845	153,264
	Macintyre	3,800	25,500	67,224
	Gwydir	? 0	? 0	2,944
	Namoi	2,896	4,288	27,837
	Castlereagh	1,197	12,005	174,664
	Macquarie	25,072	36,767	90,848
	Sub-total inland	150,509	577,204	1,298,726
	Richmond	155	nd	nd
	Clarence	91	nd	nd
	Bellinger	27	nd	nd
	Manning	34	nd	nd
	Hunter	22,954	nd	nd
	Hawkesbury	4,806	nd	nd
	George/Cooks	13	nd	nd
	Deua	11	nd	nd
	Sub-total coastal	28,091	nd	nd
	TOTAL	178,600	not known	not known

Definition of risk: Current area at risk - see above. 2020 and 2050 areas at risk - depth to water table estimated to be < 2 m by these years. Limited data are available for the Gwydir catchment. nd = no data available. Catchment areas were derived from digital elevation models (M. Littleboy pers. comm.), and are not statutory catchment boundaries.

Salinity Impacts and Risks to Biodiversity

Preliminary figures on areas of remnant woody vegetation affected and areas likely to be affected by salinity (depth to water table < 2 m) include 5,000 ha (2000), 17,500 ha (2020) and 46,500 ha (2050) (Littleboy *et al.* 2001). These figures only include remnant forest vegetation on freehold land (plus some woodlands on land of unknown tenure), which is identifiable at a resolution of 1 km by 1 km and exclude smaller patches. The resolution problem alone means that the figures exclude around 20% of remnant woody vegetation in the areas of NSW most affected by salinity (Briggs, Doyle and Seddon unpublished data). More seriously, the figures exclude most woodland, as well as vegetation on Crown land, such as parks, reserves and State Forests. Areas of native grassland, shrubland and wetland affected and likely to be affected by salinity are not included in these calculations.

More recent and more accurate figures on areas of remnant vegetation affected and likely to be

affected by salinity in NSW are 13,500 ha in 2000, 51,400 ha in 2020 and 173,000 ha in 2050 (Doyle, Turbill and Briggs unpublished data). Close to 10% of remnant woodland vegetation in the central sheep/wheat belt of NSW will be affected by salinity by 2050. The figures above do not include isolated trees, which are very susceptible to effects of dryland salinity. Nor do they include terminal and semi-terminal wetlands which are likely to become saline as a result of river salinity. Estimated areas of National Parks and Nature Reserves affected and likely to be affected by salinity are 2,100 ha in 2000, 10,400 ha in 2020 and 44,300 ha in 2050. Approximately 10% of parks and reserves in the areas of NSW prone to salinity will be affected by salt by 2050. These figures substantially underestimate (possibly by 100% or more) the areas of native vegetation in NSW currently and likely to be affected by salinity. No information is available on specific risks to ecological communities or species (including threatened communities and species) in NSW from current or future salinity. The risks to biodiversity from salinity are likely to be severe because:

(i) the percentages of native vegetation (often below 15%) remaining in the areas at risk from salinity in NSW are very low,
(ii) effects of salinity on biodiversity and ecological functioning are often diffuse. At an individual site they may be small (eg, the death of one paddock tree), but across the landscape they are large (eg, the likely death of 10% of paddock trees in the sheep/wheat belt of NSW from salinity),
(iii) there have been large declines in woodland bird species and other fauna in the areas of NSW affected by salinity, and
(iv) there are relationships between decline in ecosystem health such as dieback caused by salinity and reduced habitat value for declining wildlife.

Queensland

Physical (summary, size and nature of problem)

The NLWRA estimates that 48,000 hectares of land in Queensland is currently affected by dryland salinity. An additional 2,900 hectares is affected by salt water intrusion. Most salinity affected areas are in the eastern part of Queensland. Major areas include the lower Central Coast (lower Fitzroy and the Burnett Basin), the South East (lower Mary irrigation area, Lockyer valley) and the Murray Darling (Condamine, Balonne, Maranoa). Outbreaks are localised and small in extent (NLWRA 2001).

Within the Queensland portion of the Murray–Darling Basin about 1,000 hectares are currently affected by dryland salinity (predominantly on the basaltic landscapes of the eastern Darling Downs (MDBMC 1999). One million hectares of Queensland could be seriously threatened in 50 years unless land is properly managed, while a further two million hectares could experience less severe threats. The regions most at risk from future dryland salinity would be the high-value cropping lands in Fitzroy, Murray-Darling, Gulf and Burdekin. The north coastal, Burnett, south-east coastal, central coast and Curtis regions would also be affected. Up to 92,000 ha of remnant vegetation and 43 important wetlands could be affected.

It is estimated that 633,000 hectares (2.4 per cent) would be at risk of water tables within 2 metres of the surface by 2020, in the 15% of Queensland that is in the Murray-Darling Basin. This area is predicted to stabilise at this level due to the 'at risk' hydrogeomorphic units filling and no additional units filling within the modelled time frame (MDBMC 1999).

Data collected between 1992 to 1996 indicate that most surface water across the State is 'fresh' (less than 500TDI/800 EC units) (DEH/DNR 1999, DPI 1994). Little is known on trends in stream salinity and there is no detectable trend across the State in the available data. An increase in salinity has been noted in parts of the Condamine-Balonne, the Burdekin, Lockyer Creek, the lower Mary, the South Burnett, Three Moon Creek and some tributaries of the Fitzroy.

In the Murray-Darling Basin, salinity levels throughout the mid and upper catchments are low. However, marginal sites are found on the western slopes of the Divide around Warwick, probably associated with land clearing and agriculture on soils with naturally high salt content. Treated sewerage effluent discharge from Toowoomba results in slightly elevated levels in Gowrie and Oakey Creeks.

A sharp increase in salt loads and salinity levels is predicted for the Condamine–Balonne, Border and Warrego Rivers. Salinity levels will, on average, exceed the 800 EC threshold in all modelled catchments by the year 2020, and the 1500 threshold will be exceeded from 14 to 60 per cent of the time. After an initial sharp increase, the exceedance levels will not alter significantly for the next 100 years. Any variation in the current levels of inflow and diversion would require revision of the river salinity projections (MDBMC 1999).

Table 3: Estimates of area potentially affected by dryland salinity by 2050 under current land use (Queensland)

State	Catchment Region	Predicted Area Affected in 2050 (ha)
QLD	Fitzroy	732421
QLD	Murray-Darling	628393
QLD	Gulf	546412
QLD	Burdekin	476886
QLD	North Coastal	206534
QLD	Burnett	180837
QLD	Southeast Coastal	179970
QLD	Central Coast	90101
QLD	Curtis	87399
QLD	Western	2687
	TOTAL	**3131639**

Definition: Data from the NLWRA, from collated data on geology, soils, elevation, landuse change and potential excess rainfall.

Salinity Impacts and Risks to Biodiversity

In Queensland there is little specific data on impacts on flora and fauna except for a small number of site specific studies on instream salinity impacts from industrial discharges which indicates that there is minimal effect on aquatic macrophytes, invertebrates and vertebrates, possibly due to species being well-adapted to naturally high variability in tropical streams (Duivenvoorden et al 1999 (unpub), pers.comm. Dr Jules Powell, 1 February 2001). Like South Australia and Victoria, it is expected that wetlands and rivers are most at risk from increasing salinity. Some action is under way to facilitate a better understanding through analyses of risk data and biodiversity data.

South Australia

Physical (summary, size and nature of problem)

In South Australia, there has been a dramatic increase in the area of land estimated to be affected by salinity. In 1982, 55 000 hectares of land were estimated to be affected; that number increased to 224 500 hectares in 1990 and 392 500 in 1993. Currently, 410 000 hectares of land are affected by salinity in South Australia. However, the dramatic increase in areas affected by dryland salinity in some regions is most likely the result of increased awareness and better recognition of the problem, rather than the physical expansion of salinisation (however, in some areas, salinisation has increased significantly, especially after very wet years).

Table 3: Areas affected by salinity (SA)

State	Region	Area affected (ha)
SA	Upper South East	272,000
SA	Murray Basin	36500
SA	Eyre Peninsula	55600
SA	Kangaroo Island	6100
SA	Mid North	15100
SA	Yorke Peninsula	21900
SA	Mt Lofty Ranges	1200
SA	**TOTAL**	**410000**

Definition: Data from the NLWRA and was captured using 1:40,000 aerial photography and mapped using a GIS. The area mapped included both primary (pre-European) and secondary (human-induced) areas affected. Lagoons, wetlands and coastal areas have been excluded from the mapping coverage.

Table 4: Areas at risk of salinity (SA)

State	Region	Current area at risk (ha)	2020 area at risk (ha)	2050 area at risk (ha)
SA	Upper South East	250 000	324000	409 500
SA	Murray Basin	19 800	29600	34 000
SA	Eyre Peninsula	20 400	24000	27 000
SA	Kangaroo Island	5 600	6500	8 000
SA	Mid North	14 800	18000	21 000
SA	Yorke Peninsula	13 900	17500	20 000
SA	Mt Lofty Ranges	1 200	1400	1 500
SA	**TOTAL**	**326 000**	**421000**	**521 000**

Definition of risk: Areas at risk of salinisation were assessed on the basis of where the rising groundwater would rise within 1-2 metres of the land surface.

Salinity Impacts and Risks to Biodiversity

Initial assessments of the biodiversity risk assessment mapping for South Australia re-iterates the high risk to natural ecosystem viability in the Mid and Upper South East, Kangaroo Island, Lower and Western Eyre Peninsula and Coorong districts.

Landscape units particularly vulnerable to shallow saline groundwaters and poor quality surface run-off includes fresh/brackish wetland ecosystems, tea-tree shrublands, red gum woodlands and native grasslands low in the landscape. The ecosystems in South Australia facing the greatest risk from increasing salinity are the rivers and wetlands. The altered hydrology of wetland areas brought about by the process of salinisation (waterlogging and increased salinity of surface waters) often impacts significantly on the aquatic vegetation character, biodiversity and long-term health of rivers and wetlands.

The Department for Environment and Heritage has undertaken wetland survey inventories on Kangaroo Island, Eyre Peninsula and Yorke Peninsula. Preliminary results indicate that within these regions up to 18,000 hectares of inland water bodies are affected by increases in salinity and pose risks to wetland biodiversity. Approximately another 120 000 hectares of water bodies exist on Kangaroo Island, Eyre Peninsula and Yorke Peninsula, (based on wetland mapping, Planning SA 2000). Extrapolating preliminary results from the 18,000 hectares surveyed, it is likely that salinity is causing a risk to biodiversity in the remaining 120,000 hectares of wetlands within these regions. The impacts of salinity on invertebrate biodiversity can be devastating, freshwater wetlands on Kangaroo Island contain up to 50 species of invertebrates, those wetlands that were once fresh but now saline contain up to 5 species of invertebrates. This indicates an ecosystem collapse for many freshwater wetlands, (Seaman & Walsh 2001, In Prep).

Table 5: Risk to biodiversity (SA)

Impact	Current	2020	2050
Remnant Vegn (ha)	18000	22000	25000
Rivers ephemeral (km)	160	190	210
Wetlands (ha)	45000	52000	57000
Wetlands of National Significance (no.)	4	4	4

Definition: Data from the NLWRA and was derived from overlaying biological data (veg associations, landcover type, threatened species, wetlands and conservation tenures) with the GIS coverages of depth to watertable and shallow aquifer salinity.

Native grassland areas are at risk in the Coorong and Mallee districts and extensive riparian tea-tree habitat is under threat in the Upper South East. Extensive clearance of vegetation and drainage of wetlands in this district has had severe implications for sedgelands and seasonal wetland ecosystems. Woodlands are also negatively affected by rising saline groundwater in the Upper South East, Kangaroo Island and Eyre Peninsula. Several significant National Parks, Conservation Parks and Wildlife reserves have been identified as having high potential for biodiversity degradation from rising saline groundwater. These reserve areas are listed in the following table.

Table 6: Risks to habitat from dryland salinity (SA)

Region	Habitat	Conservation Parks
Upper South East	Seasonal wetlands, watercourses	Messent, Bunbury, Tilley Swamp and Gum Lagoon
Coorong District	Tea-tree shrublands, native grasslands	
Lower Eyre Peninsula	Native Vegetation, seasonal swamps, tea-tree shrublands	Hincks and Bascombe Well
Kangaroo Island	Sedgeland, tea-tree ecosystems	Murrays Lagoon

Definition: Data from the NLWRA derived from overlaying biological data (veg associations, landcover type, threatened species, wetlands and conservation tenures) with the GIS coverages of depth to watertable and shallow aquifer salinity.

Risks to habitats within the Murray-Darling Basin are occurring, the Murray-Darling Basin Salinity Audit estimates that 68,000 hectares of the Basin in South Australia are salt affected. Of this, 26,000 hectares or 25% of the River Murray Floodplain in South Australia is currently influenced by salt, (Murray-Darling Basin Ministerial Council, 1999). This represents a considerable risk to several habitats within the Basin including River Red Gum Woodlands, Lignum Shrublands, Chenopod Shrublands and aquatic vegetation contained within wetlands (Kahrimanis 2001).

Tasmania

Physical (summary, size and nature of problem)

It is estimated that the area of salinity in agricultural land in Tasmania is as follows:

Table 7: Area affected by salinity (Tasmania)

Year	Area of salt affected land (ha)
1992	45 000 (30 000 – 60 000)
2000	53 500 (36 200 – 71 200)

Definition: Data from the NLWRA based on field observations at the land system scale updated by expert and landholder input, and some ground truthing

It is likely that some of the increase in salinity recorded since 1992 is due to increased detection of land previously affected. Assuming about half is an actual increase, the average rate of increase between 1992 and 2000 was 1.5% per year. In summary, about three percent of agricultural land in Tasmania may be salt affected.

Fifty land systems have been mapped as containing areas of salinity. Twenty-five of these systems, comprising about 25 percent of the area mapped, have been shown to contain areas of salinity wherever they occur in the State. Fifteen comprise about 75 percent of the area mapped and include areas where salinity has not yet been visually expressed. These areas can be considered at risk if the present rate of increase continues.

Table 8: Estimated area of salt affected agricultural land, 2020 and 2050 (Tasmania)

Year	Area of salt affected land (ha)
2020	69 550 (47 000 – 92 500)
2050	93 625 (63 350 – 106 800)

Definition: Data from the NLWRA based on field observations at the land system scale updated by expert and landholder input, and some ground truthing

Salinity Impacts and Risks to Biodiversity

The potential impact on biodiversity values of increasing dryland salinity was assessed as part of the NLWRA. These impacts are greatest in the low rainfall areas of Tasmania where there has already been considerable impact on biodiversity following European settlement. These areas have little remaining native vegetation, and have the highest numbers of plant and animal species which have become locally extinct, and threatened taxa. A number of vegetation communities and threatened plant and animal species are considered to be potentially at risk from salinity.

The impact was assessed at a land systems level, and the four land systems most at risk were in low rainfall areas (< 700 mm per annum), low-lying topographically and were on sedimentary substrates or Holocene sands. The bioregions (complex area of land, composed of a cluster of interacting ecosystems that describe the dominant landscape scale attributes of climate, lithology, geology, landforms and vegetation) potentially most affected by salinity are the Flinders and Northern Midlands bioregions. Vegetation associated with wetlands and lowland plains and river flats is considered to be most at risk. Vegetation types at high risk of being impacted by salinity include herbaceous wetland communities, silver tussock (Poa labillardierei) and kangaroo grass (Themeda triandra) grasslands, and swamp gum (Eucalyptus ovata), cabbage gum (Eucalyptus pauciflora) and swamp peppermint (Eucalyptus rodwayi) woodlands, which are already some of Tasmania's most endangered vegetation types. Fourteen forest types and fifteen non-forest vegetation types are at medium risk.

Victoria

Physical (summary, size and nature of problem)

The NLWRA report estimates there are currently 670,000 hectares affected by shallow water tables (less than 2 metres) in Victoria. It is unlikely that this entire area mapped as having water table depths less than 2 m would be salt-affected. The areas depicted as having shallow water tables are considered to contain rather than be land likely to be affected by dryland salinity. The consultants (Sinclair Knight Merz) assumed that areas with contiguous forest vegetation would not be affected by shallow water tables. This assumption is not supported by the study on salinity risk assessment for Parks Victoria (Sinclair Knight Merz, 1999).

Dryland salinity risk significantly affects rivers, streams, riparian zones and wetlands as evidenced by the shallow water tables around Lakes Hindmarsh and Albacutya, Raak Plains and the Hattah Lakes area and along many river systems. In the Mallee, rising water table is generally considered a threat only in the areas of topographic lows. There is a general increase in salinity closer to the Murray River. Surface salinity is high in parts of Little Desert National Park and the west of Murray Sunset NP. In the Wimmera, risk is high in the Wimmera trench including the lakes and the Wimmera River. Areas surrounding the Grampians National Park and the drainage areas of the Corangamite catchment, especially around the increasingly saline Corangamite Lakes, are areas of high risk. In the lower (northern) parts of the North Central and Goulburn Broken regions, salinity risk has been assessed as high to moderate based on water table monitoring. This assessment has not been extended into the irrigated parts of these catchments where the water table can be moderated by irrigation practices.

Table 9: Areas of land predicted to currently be in each depth to water table class (Victoria)

CMA Region	Coastal (000 ha)	<2m (000 ha)	2-5m (000 ha)	5-10m (000 ha)	>10m (000 ha)	%<2m (000 ha)
Corangamite	9.9	51.2	333.3	545.0	91.5	5.0%
East Gippsland	25.1	1.8	78.6	87.6	166.7	0.5%
Glenelg-Hopkins	6.4	144.5	697.8	1051.5	280.7	6.6%
Goulburn-Broken		123.6	320.8	416.4	334.7	10.3%
Mallee		60.7	167.7	351.0	2062.9	2.3%
North Central		124.3	437.6	879.4	566.0	6.2%
North East		40.4	301.6	91.0	216.5	6.2%
Port Phillip	20.1	8.5	205.6	399.9	157.8	1.1%
West Gippsland	53.2	14.1	192.4	335.7	187.2	1.8%
Wimmera		96.4	106.3	215.9	1557.2	4.9%
Total	114.8	665.4	2841.5	4373.3	5621.3	4.9%

Source: Victoria's Salinity Management Framework, August 2000.
Definition: ('000 ha) for CMA regions and percentage of CMA region with shallow water tables (<2m).

Table 10: Areas at risk of salinity (Victoria)

		1998		2020 upper limit		2050 upper limit	
State	CMA Region	Area (ooo ha)	%	Area (ooo ha)	%	Area (ooo ha)	%
Victoria	Corangamite	51.2	5.0	213.3	20.7	499.1	48.5
Victoria	East Gippsland	1.8	0.5	1.8	0.5	19.1	5.4
Victoria	Glenelg-Hopkins	144.5	6.6	429.6	19.7	947.2	43.4
Victoria	Goulburn-Broken	123.6	10.3	193.5	16.2	739.8	58.3
Victoria	Mallee	60.7	2.3	63.5	2.4	74.4	2.8
Victoria	North Central	124.3	6.2	176.5	8.8	401.4	20.0
Victoria	North East	40.4	6.2	48.0	7.4	68.1	10.5
Victoria	Port Phillip	8.5	1.1	43.2	5.5	134.1	16.9
Victoria	West Gippsland	14.1	1.8	14.0	1.8	70.6	9.0
Victoria	Wimmera	96.4	4.9	122.5	6.2	160.8	8.1
Victoria	Total	665.5	4.9	1305.9	10.1	3114.6	22.8

Definition of risk: Those areas predicted to have a depth to water table of 2 metres or less.
Area excludes irrigation and urban areas and those with substantial contiguous forest or woodland coverage. Parts of the Mallee and North Central regions were included in the salinity extent component of this study, thus giving slightly different shallow water table areas for upper and lower limit trends.

Salinity Impacts and Risks to Biodiversity

Up to 4-8% of all records of threatened flora in Victoria are predicted to be located in shallow water table areas by 2050 and 9-17% of all threatened fauna (Figure 1). More threatened species are currently associated with shallow water table areas in the Wimmera region than elsewhere in the state. The greatest long-term threat to such species appears to be in the Goulburn-Broken, Glenelg-Hopkins and Corangamite regions. Over 20% of these regions' threatened flora records and over 30% of their threatened fauna records are predicted to be located in areas of shallow water table by 2050 under the worst case trend scenario. Across the state, all records for one species of animal and 13 species of plant are located in areas predicted to have shallow water tables. Under the worst case trend scenario, there are predicted to be five CMA regions (Corangamite, Glenelg-Hopkins, Goulburn-Broken, North Central and Wimmera) where at least 10 species of threatened plant or animal are predicted to have all of their records within the shallow water table area.

to many forested areas of the State. Salinity risk is lowest in the eastern highlands, Grampians, Otway and Strzlecki Ranges. Water tables may be near the surface at areas break of slope, discharge at drainage lows, along alluvial slopes and under certain other conditions.

Non-forested vegetation areas are also at considerable risk. This includes many areas around the lake systems of the Corangamite, Wimmera and North Central regions. Within the parks system, the Melaleuca swamps and woodland of Holey Plains State Park (SP), the heath and healthy woodland of French Island and the native grasslands of Terrick Terrick National Park have all been assessed as being at highest risk from salinity, rated as moderate to high (SKM, 1999).

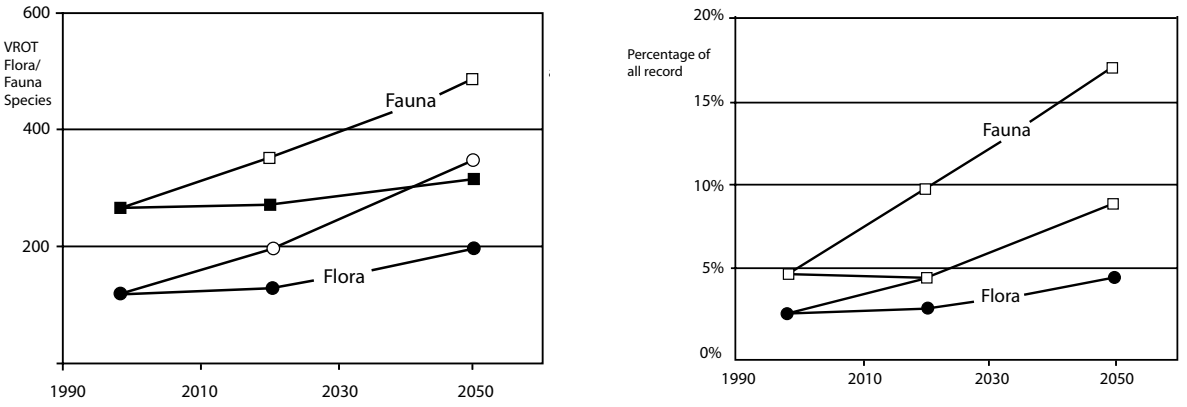


Figure 1. Changes in association between VROT classified rare or threatened species and land predicted to develop under best and worst case trend scenarios.

There are considerable but not uniform threats

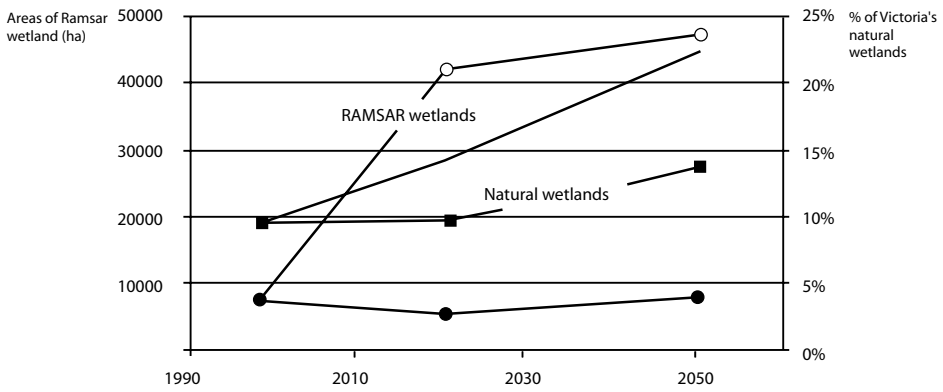


Figure 2. Predicted change in area of RAMSAR wetland and percentage of all Victorian natural wetlands in areas with shallow water tables based on best and worst case scenarios.

The analysis of impact on wetlands predicts a substantial increase in the area of wetland habitat occupying landscapes in which shallow water tables develop, particularly for the upper limit trends. The area of Ramsar wetland in shallow water table areas is predicted to increase by over 30 000 ha during the next 20 years as land surrounding the Western District lakes and wetlands develops shallow water tables (upper limit trend only). The number of natural wetlands in landscapes with shallow water tables is predicted to increase to between 13 and 22% of all natural wetlands in the state by 2050.

Table 11: Potential area of Ramsar wetlands, number of natural wetlands and percentage of regional and state natural wetlands in areas predicted to have shallow water tables (Victoria).

CMA Region	1998			2020 upper			2050 upper		
	RAM	Nat	%	RAM	Nat	%	RAM	Nat	%
Corangamite	1306	476	15.5	31005	866	28.1	32020	1256	40.8
East Gippsland	279	66	4.3	280	69	4.5	557	266	17.3
Glenelg-Hopkins	176	831	9.7	483	1455	16.9	483	2479	28.9
Goulburn-Broken	0	381	9.4	1864	792	19.6	1864	1652	40.8
Mallee	161	337	12.2	166	360	13.1	325	382	13.9
North Central	0	317	10.8	0	448	15.2	0	570	19.4
North East	476	110	4.3	0	187	7.4	0	250	9.9
Port Phillip	664	59	2.3	2921	121	4.8	6883	282	11.2
West Gippsland	4111	218	4.7	657	208	4.5	717	431	9.3
Wimmera	120	772	14.3	4252	838	15.5	4440	879	16.3
State total	7273	3567	9.4	41628	5344	14.0	47288	8447	22.2

RAM - Ramsar wetland area (ha)
Nat - Number of natural Wetlands - includes deep marsh, meadow, open water, permanent saline, semi-saline and shallow marsh categories
% - % of total number regional or state wetlands or state wetlands

Western Australia

Physical (summary, size and nature of problem)

The 1996 Western Australian Salinity Action Plan (Agriculture WA et al 1996a) and accompanying Situation Statement (Agriculture WA et al 1996b) provided estimates of past and the then current extent of salinity in the south-west agricultural region of the State, as well as predictions of future extent, as follows:

Year	Area of salt affected land (ha)
1982	264,000
1996	1,804,000
2010/2020	3,296,000
"potential"	6,109,000

The revised Salinity Strategy (State Salinity Council 2000) reiterates the prediction, based on the 1996 figures, that about one-third of the south-west agricultural region will be affected by salinity, but notes that the estimated time to reach these levels varies from as little as 30 years in the southern and western areas, to as long as 50 to 100 years in the east and north.

The National Land and Water Resources Audit (2001) reports areas at risk of dryland salinity from shallow watertables:

Year	Area of salt affected land (ha)	Area of salt) affected land (ha)
	Agricultural land	Perennial land
2000	3,553,000	600,000
2020	4,182,000	710,000
2050	6,490,000	1,800,000

The 1996 estimates given above were based on a definition of salt-affected areas as having excess salts in the root zone such that the potential yield of salt-sensitive crops and pastures is reduced by 50%. By contrast, the National Land and Water Resources Audit reports areas at high risk of developing dryland salinity, with 'high risk' defined as areas with water tables 'less than 2m' and '2-5m and rising'.

Refined estimates will be available during 2001 from WA's Land Monitor project, which uses satellite imagery and accompanying field validation and extrapolation to define areas that have 'a consistently low productivity' which fall within areas considered likely to be saline. The Land Monitor estimates will be the most reliable and accurate available, with indications being that the findings will be similar to the 1996 and Audit figures.

Salinity Impacts and Risks to Biodiversity

There was recognition, at the time of preparation of the Salinity Action Plan in 1996, that biodiversity values were at risk from salinity. The south-west of WA is recognised as a megadiverse region with a high degree of endemism in its flora. Most of the south-west agricultural region is highly cleared, with remnant vegetation highly fragmented and occurring mostly in small patches.

An indication of the risks to biodiversity as they were then understood and documented in the Salinity Action Plan and Situation Statement is given by the following:

- the beds and banks of 80% of the rivers and streams were seriously degraded;
- 36% of the divertible surface water resource had become brackish or saline and a further 16% was of marginal quality;
- virtually all wheatbelt wetlands had been severely degraded but their degradation had gone largely unrecorded;
- 11 species of threatened flora had at least one population considered to be at threat from salinity, and one species was considered likely to disappear; and

- up to 80% of vegetation remnants on farms and up to 50% on public lands (including conservation reserves) could be lost.

One of the projects funded through the Salinity Action Plan was a biological survey of the south-west agricultural zone, to document its biota and the extent to which it is threatened by salinity, and to better inform decision making on salinity responses. The survey is the most comprehensive ever undertaken in the area and covers all or significant parts of six of the eight biogeographic regions recognised in temperate south-western Australia. The survey methodology is quantitative and site-based, and therefore repeatable. Field work is largely complete but specimen sorting and identification, data collation and analysis will not be completed until during 2002. A major publication is due for completion in 2002 or 2003.

Preliminary results are available and are being utilised in implementation of actions under the Salinity Strategy. The survey has:

- revealed that 450 endemic vascular plant species are in grave danger of extinction as a result of increasing salinity, and that a further 400 to 500 taxa will be subject to major genetic erosion as salinity wipes out many of their populations;
- shown that the death of shrubs and trees in many wheatbelt wetlands due to salinity has caused a 50% decline in the number of waterbird species using them, and that without intervention, three-quarters of the region's waterbird species will severely decline;
- shown that most fresh wetlands contain about 50 invertebrate species compared with only four in the most saline areas, and that about one-third of the aquatic invertebrate fauna would disappear from the wheatbelt if all wetlands became saline; and
- dramatically increased our knowledge of the distribution, status and habitat of small wheatbelt animals, both invertebrates and vertebrates.

When analysis of the biological survey results is completed, WA will have a vastly improved understanding of the biodiversity values of the region, the extent to which they are threatened by salinity, and the actions needed to conserve them.

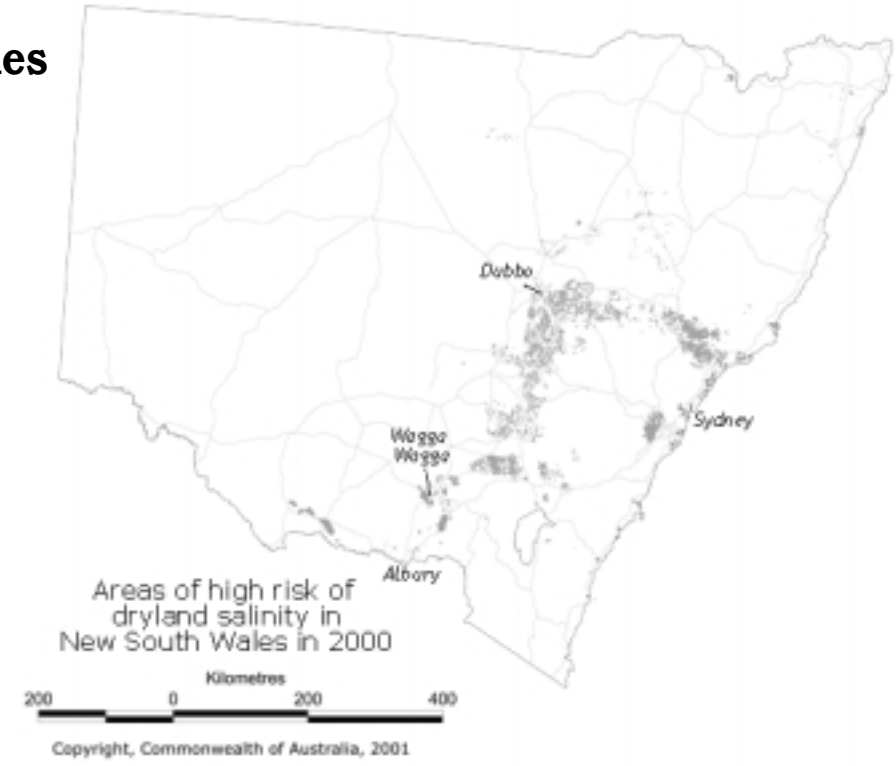
Conservation of natural ecosystems and their biodiversity was recognised as one of the key objectives in the 1996 Salinity Action Plan and 2000 Salinity Strategy. As well as a range of policies and programs addressing such issues as clearing controls and assistance to landholders in protecting remnant vegetation, the Government committed new, ongoing funding through the Department of Conservation and Land Management for:

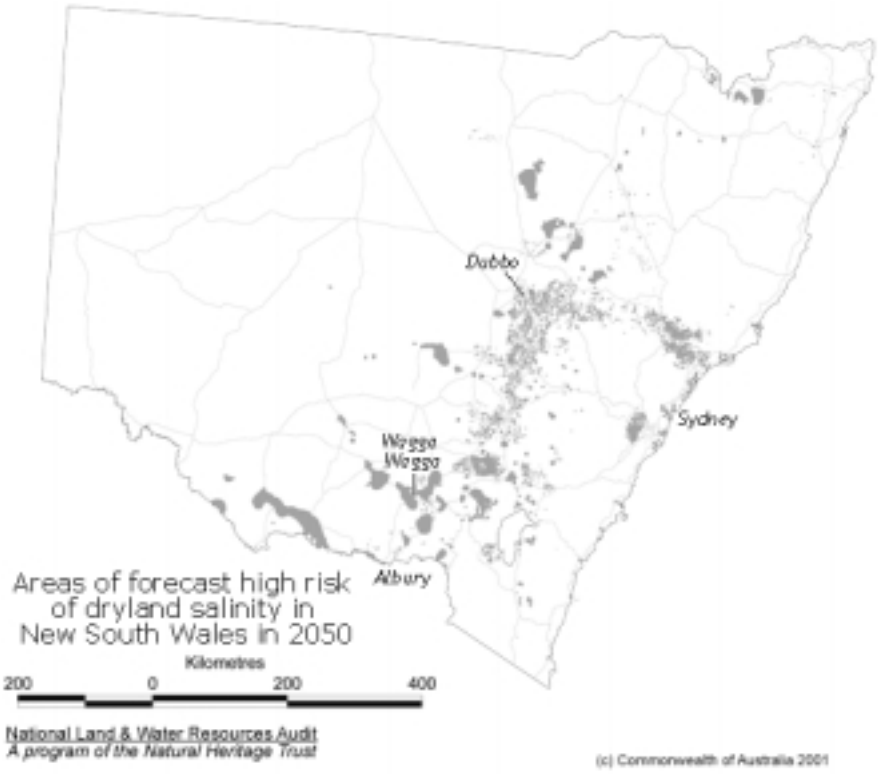
- the biological survey (referred to above);
- improved management of Crown reserves, particularly the conservation reserve system;
- a natural diversity recovery catchments program, targeting priority areas selected on biodiversity criteria (the six identified to date include three Ramsar wetlands);
- a program of monitoring of the condition, flora and fauna of selected wetlands.

There is also a strong emphasis on revegetation and particularly on examining the potential of native plants as commercial crops so as to achieve the scale of planting necessary to address hydrologic imbalances.

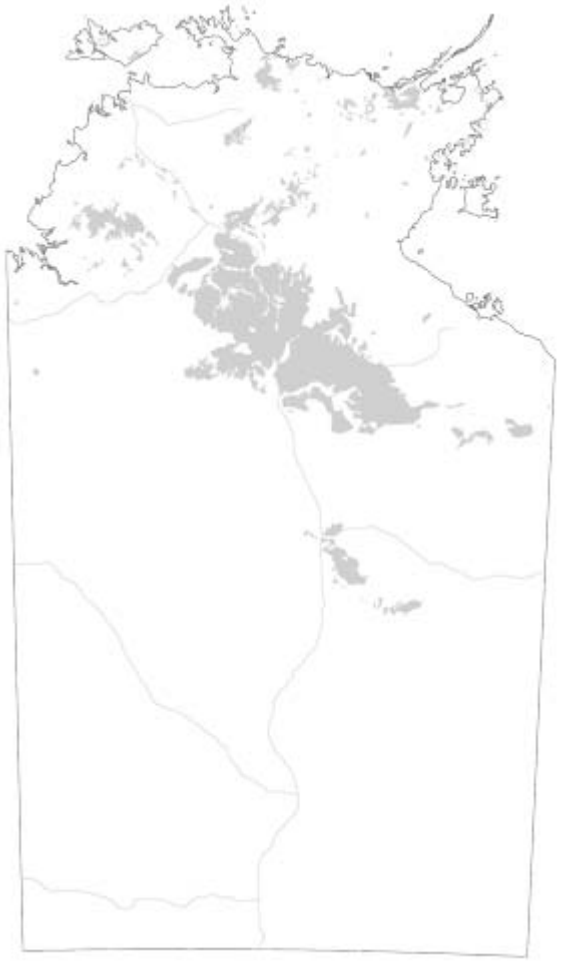
APPENDIX 2 : NLWRA MAPPING FOR AUSTRALIA'S STATES AND TERRITORIES

New South Wales





Northern Territory



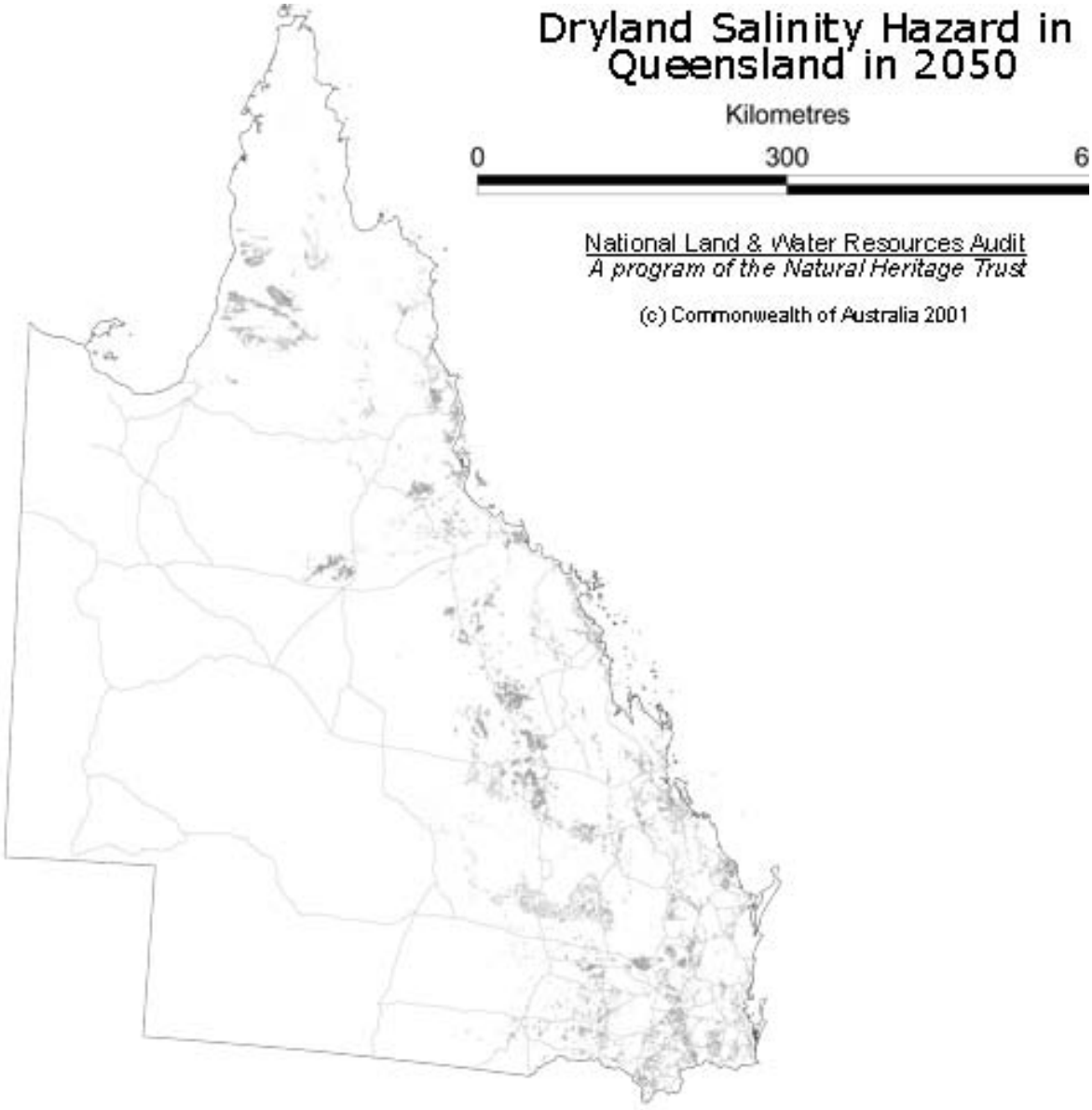
Moderate hazard of dryland salinity in Northern Territory 19

Note: No incidence of high hazard of dryland salinity

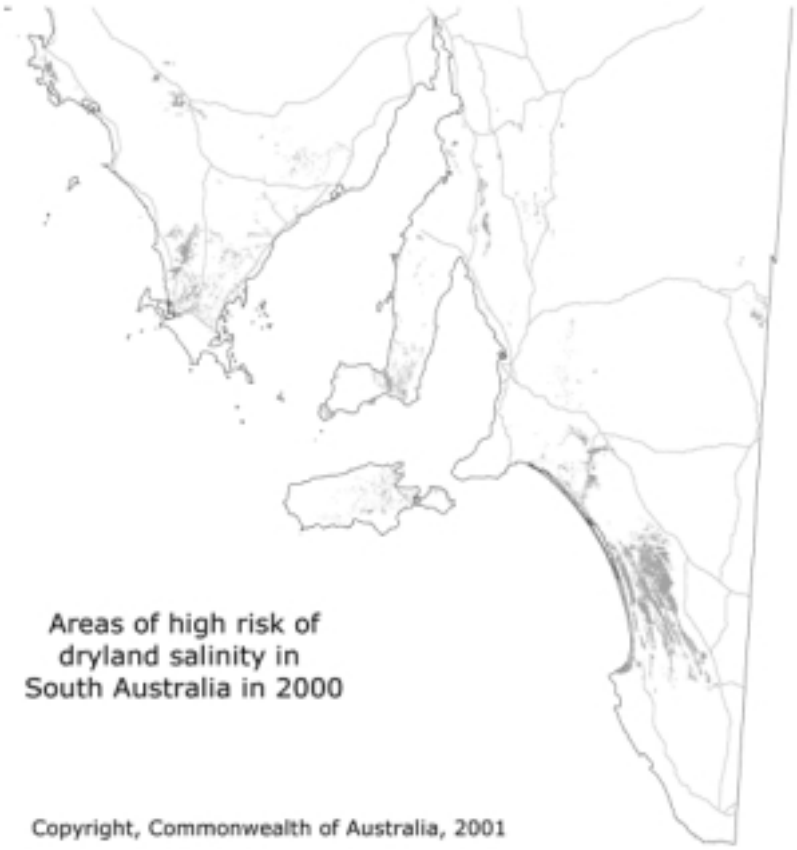
Kilometres

0 200 400

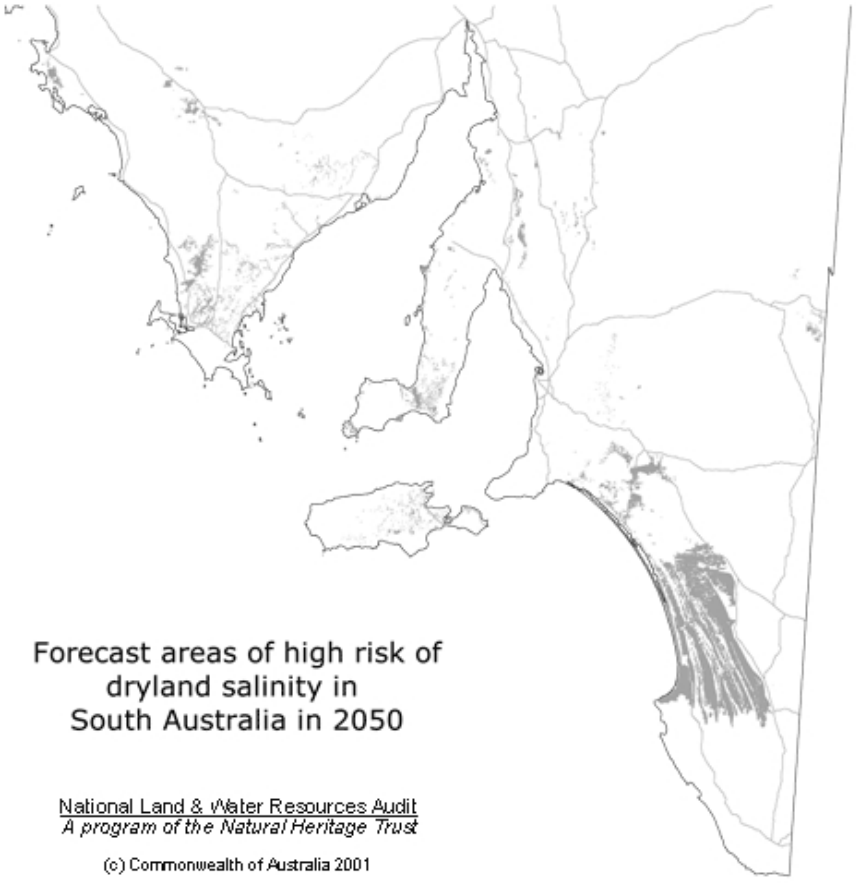
Queensland


Dryland Salinity Hazard in Queensland in 2050
Kilometres
0
300
6
National Land & Water Resources Audit
A program of the Natural Heritage Trust
(c) Commonwealth of Australia 2001

South Australia



Areas of high risk of
dryland salinity in
South Australia in 2000



Forecast areas of high risk of
dryland salinity in
South Australia in 2050

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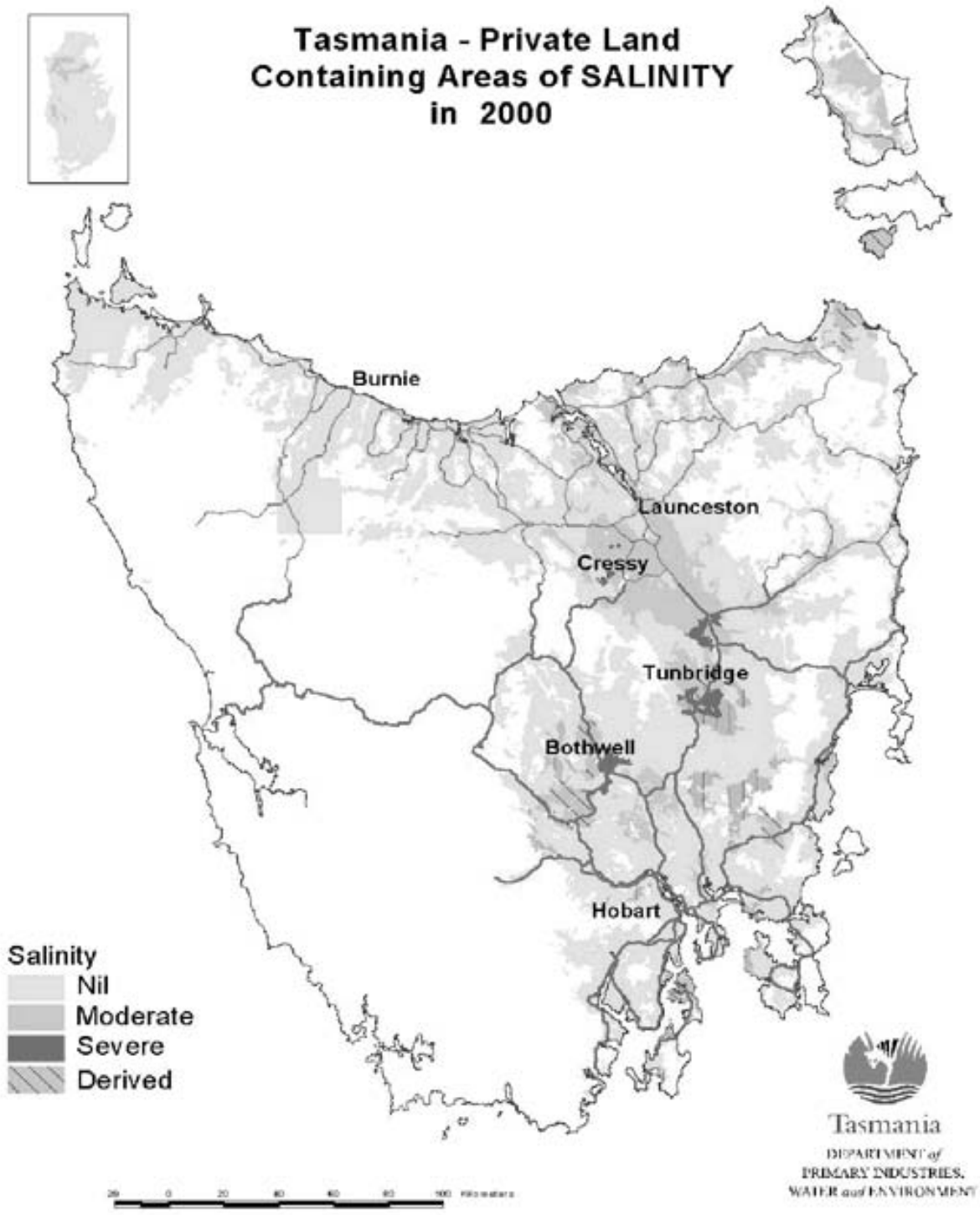
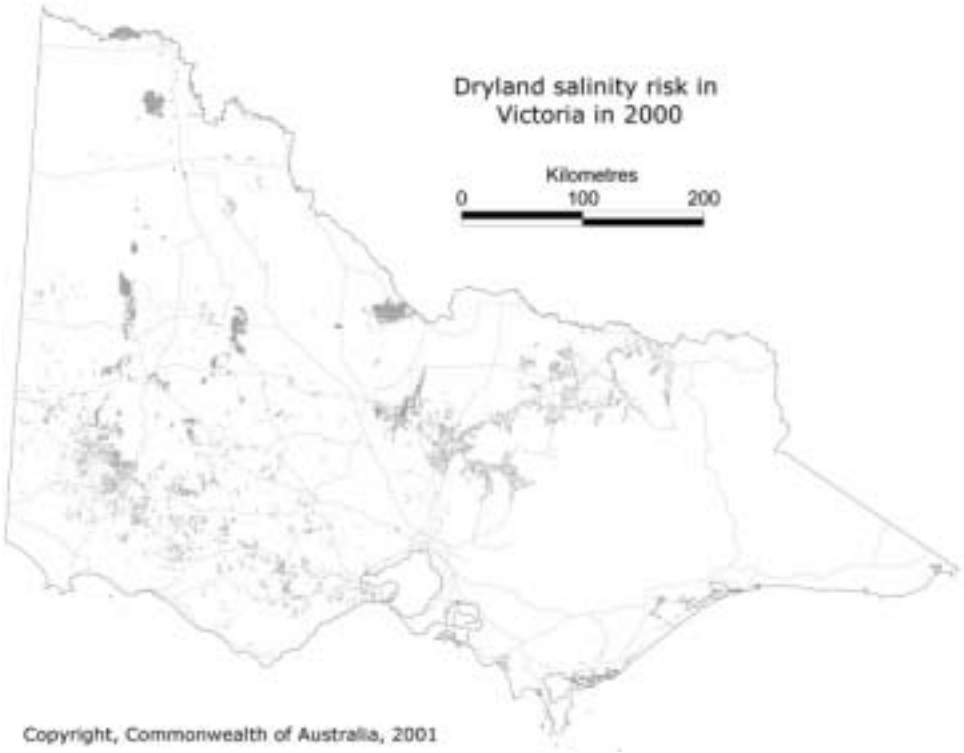
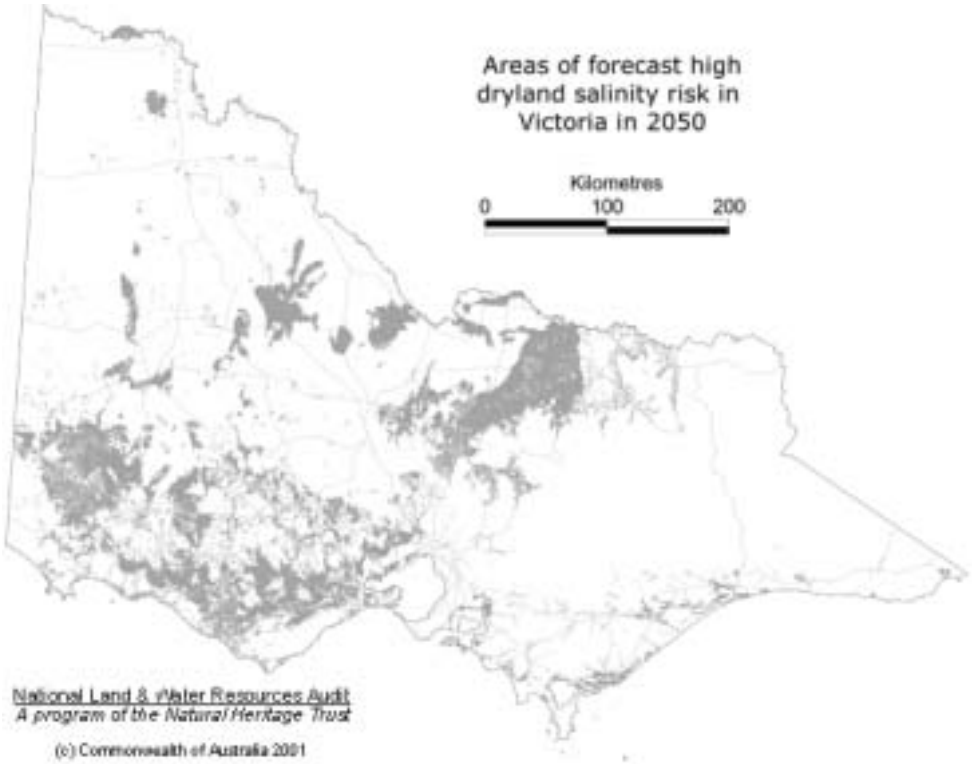
Tasmania


Tasmania - Private Land
Containing Areas of SALINITY
in 2000
Burnie
Launceston
Cressy
Tunbridge
Bothwell
Hobart
Salinity
Nil
Moderate
Severe
Derived
Tasmania
DEPARTMENT of
PRIMARY INDUSTRIES,
WATER and ENVIRONMENT

Victoria





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Western Australian