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Illawarra Biodiversity Strategy

Vol. 2 Background Information

An initiative of
Wollongong City Council,
Shellharbour City Council
and Kiama Municipal Council



Illawarra Biodiversity Strategy 2011

A joint project between the Illawarra Councils; Wollongong City Council, Shellharbour City Council and Kiama Municipal Council. Funded by the NSW Environmental Trust.

Acknowledgements

This strategy has been developed by Wollongong City Council's Natural Resource Officer, Jedda Lemmon through consultation with a range of agency representatives and stakeholders. Acknowledgement should firstly go to the reference group and steering committee members that have guided the development of the strategy, Tony Miskiewicz and Vanni De Luca (Wollongong City Council), Mick Fields and Glen Isbester (Shellharbour City Council), Paul Czulowski (Kiama Municipal Council), James Dawson (DECCW), Dr Kris French (UOW), Jane Caldwell (SRCMA), Megan Rowlatt (Illawarra Landcare), and Andrew Britton (Small Farms Network).


Other significant contributions have been made through provision of expert advice, and/or participation in workshops, Gary Leonard, Garry Daly, Neill Rendell, David Pomery, Vanessa John, Denise Black, Leon Fuller, Anders Bofeldt, Peter Gill, Peter Stuckey, Andrew Knowlson, Peter Nelson, Jay Windsor, Marcus Burgess, Wendy Midgley, Karen Fildes, Claire de Lacey, Steve Chamberlain, Martin Schulz, Kylie Madden, Byron Robinson, Jamie Erskine, Mike Swanson, Tuesday Heather, Andrew Glover, Paul Formosa, Lynne Kavanagh, Richard Scarborough, Alison Scobie, Alison Mellor, Gaby Kirwood, Aimee Beardsmore and Jo Ferguson.

Thankyou to Chris Edmond for allowing the use of his photography.



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1 SUMMARY

The Illawarra Biodiversity Strategy: Volume Two Background Information provides the background technical detail around the threats, values and major datasets available for the Illawarra Local Government Areas (LGAs) of Kiama, Shellharbour and Wollongong. It provides the background detail, and rationale for the Action Plan defined in Volume One of the Illawarra Biodiversity Strategy.

2 LAND TENURE

The Illawarra Councils are responsible for an area of approximately 108,987 hectares. Table 1 gives a summary of the different tenure classes across the three LGAs.

Table 1: Tenure across the Illawarra Councils

	<i>Kiama</i>		<i>Shellharbour</i>		<i>Wollongong</i>		<i>Illawarra Region</i>	
	ha	%	ha	%	ha	%	ha	%
LGA area total	25,791		14,759		68,437		108,987	
NPWS estate	5,324	21	1,074	7	5,493	8	11,891	11
Council reserve	373	1	942	6	2,305	3	3,620	3
Water catchment land	5,832	23	14	0	36,744	54	42,590	39
Other	14,261	55	12,730	86	23,895	35	50,886	47

Figure 1 shows the spatial distribution of the different tenure classes across the region.

3 STATUTORY FRAMEWORK FOR PROTECTING BIODIVERSITY

The legislative and policy framework for biodiversity conservation is vast and includes statutes, policy, plans and agreements at the international, national, state and regional level. This section outlines that framework with a summary of those most relevant to regional biodiversity conservation.

3.1 INTERNATIONAL AGREEMENTS

A number of international agreements provide a context for policies developed at the federal, state and regional level to foster biodiversity conservation and planning. These include:

- International Convention on Biological Diversity signed in 1996;
- Kyoto Agreement ratified by Australia in March 2008;
- Rio Declaration and Local Agenda 21, emerged from the Rio Summit of 1992; and
- The Ramsar Convention on Wetlands, signed in 1971.

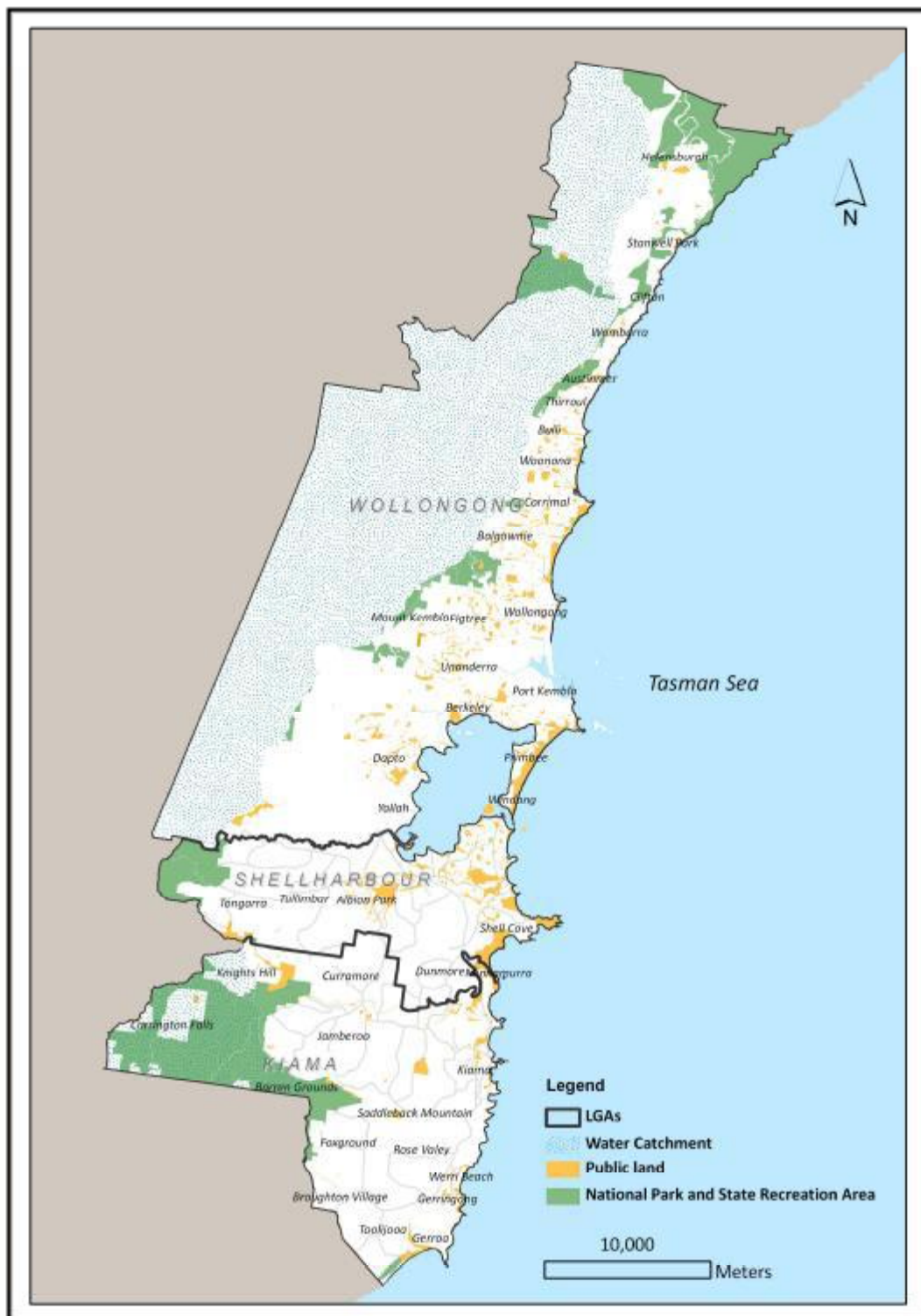


Figure 1: Tenure classes in the Illawarra region.

3.2 FEDERAL LEGISLATION AND POLICY

A number of national statutes and policies further define Australia's commitment to biodiversity conservation. The most significant are outlined below.

3.2.1 Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The EPBC Act provides a national scheme for environmental protection and biodiversity conservation. The Act identifies approved matters of National Environmental Significance (NES) and provides an assessment process for these. Matters of NES include:

- World Heritage Properties;
- National Heritage Places;
- Wetlands of International Importance (Ramsar wetlands);
- Threatened Species and Endangered Ecological Communities;
- Migratory Species - JAMBA / CAMBA / ROKAMBA Species;
- Commonwealth Marine Areas; and
- Nuclear Actions (including mining).

Impacts on matters of NES traditionally trigger a referral process to the Department of Environment, Water, Heritage and the Arts. However, since the Commonwealth and the NSW Government signed a Bilateral Agreement on 18 January 2007, pursuant to Section 45 of the EPBC Act, impacts on matters of national environmental significance are now assessed under the Impact Assessment Regimes of Part 3a, 4 and 5 of the EPA Act. This bilateral agreement will expire on 18 January 2012.

Appendices 3, 4, 5 and 6 highlight those species and communities in the Illawarra which are listed under the EPBC Act. Table 2: also lists the recovery plans made under the EPBC Act that are relevant to the Illawarra.

Table 2: National Recovery Plans for species occurring in the Illawarra

Flora	Fauna
<i>Daphandra species C</i>	Giant Burrowing Frog (in preparation)
<i>Irenepharsus trypherus</i>	Green and Golden Bell Frog (in preparation)
<i>Zieria granulata</i>	Stuttering Frog (in preparation)
<i>Pterostylis gibbosa</i>	Eastern Bristlebird (in preparation)
	Spotted-tailed quoll (in preparation)
	Grey-headed Flying-fox (in preparation)
	Broad Headed Snake (in preparation)

International migratory birds

The Australian Government has entered into three bilateral migratory bird agreements. These are:

- Japan - Australia Migratory Bird Agreement (JAMBA);
- China - Australia Migratory Bird Agreement (CAMBA); and
- Republic of Korea - Australia Migratory Bird Agreement (ROKAMBA).

All migratory bird species listed in the annexes to these bilateral agreements are protected in Australia as matters of NES under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (DEWHA, 2009). Those species which are likely to occur in the Illawarra are tabled in Appendix 7.

The agreements list terrestrial, water and shorebird species that migrate between Australia and the respective countries. The majority of listed species are shorebirds. The agreements require the parties to protect migratory birds by limiting trade of migratory birds; protecting and conserving important habitats; exchanging information; and building co-operative relationships (DEWHA 2009).

3.2.2 Australia's Biodiversity Conservation Strategy 2010-2020: Consultation Draft

Australia's Biodiversity Conservation Strategy 2010-2020: Consultation Draft (Commonwealth of Australia 2009) provides national direction for biodiversity conservation. Priorities shown in Table 3 are outlined to guide state, regional and local biodiversity planning.

Table 3: Australia's Biodiversity Conservation Strategy (Consultation Draft) priorities

Priority	Actions
Priority for change 1: Building ecosystem resilience.	Action 1.1.2: Prepare and implement plans for biodiversity conservation at all levels (local, regional, state and national) that maintain ecosystem health and protect threatened and endangered species.
	Action 1.1.3: Establish conservation linkages which provide connectivity across bioregions, including at a continental scale.
	Action 1.1.5: Establish a national framework for off-reserve conservation.
Priority for change 2: Mainstreaming biodiversity.	Action 2.1.1: Teach all primary school children about biodiversity and its benefits to their well being and the world at large.
	Action 2.1.2: Implement an ongoing national campaign that demonstrates the importance of biodiversity to the sustainability of communities and the quality of our lives.
	Action 2.3.3: Ensure arrangements for emerging markets for carbon and water take account of biodiversity risks and benefits.
Priority for change 3: Knowledge for all.	Action 3.1.1: Assess knowledge needs, identify gaps and set priorities at national, state and regional levels.
Priority for change 4: Getting results.	Action 4.3.2: Review and reform legislation to improve biodiversity conservation outcomes across all sectors.
Priority for change 5: Involving Indigenous peoples.	Action 5.1.2: Wherever possible and appropriate, recognise traditional Indigenous knowledge and environmental management expertise, and apply or extend such management for biodiversity conservation.
Priority for change 6: Measuring success.	Action 6.1.1: Build baseline datasets, including key indicators, to measure biodiversity condition and trends over time.
	Action 6.1.3: Implement and maintain a nationally representative set of long-term monitoring protocols and sites.
	Action 6.2.2: Incorporate biodiversity and ecosystem services into national accounts and corporate reporting.

*Sourced from Commonwealth of Australia (2009)

3.2.3 Intergovernmental Agreement on the Environment 1992

The Intergovernmental Agreement on the Environment 1992 (IGAE) committed all Federal, State/Territory and Local Governments to pursuing Ecologically Sustainable Development (ESD). This agreement was further refined by the 'Council of Australian Governments - Heads of Agreement on Commonwealth /State Roles and Responsibilities for the Environment 1997' (LGSA 2009).

3.2.4 National Local Government Biodiversity Strategy 1998

The National Local Government Biodiversity Strategy was produced in 1998. The main aim of the policy was to recommend that Councils develop and commit to implementation of policies on biodiversity conservation.

3.3 STATE LEGISLATION, PLANS AND POLICIES

3.3.1 Threatened Species Conservation Act 1995 (TSC Act)

The TSC Act and its amendments in 2002, 2004 and 2006, identify threatened species, communities and populations, critical habitat and provisions for managing and protecting them such as recovery plans, priority action statements and threat abatement plans. It also allows for the listing of Key Threatening Processes (KTPs). At present, no critical habitat has been listed in the Illawarra.

The *Threatened Species Legislation Amendment Act 2004* (TSLA Act) outlines provisions for the bio-certification of environmental planning instruments, including Local Environmental Plans (LEPs). The Illawarra Councils have not sought biocertification of their Local Environmental Plans (LEPs).

Threatened species recovery plans

Threatened Species Recovery Plans were a former requirement of the TSC Act 1995. Recovery Plans are now replaced by the NSW Threatened Species Priorities Action Statement (PAS). Existing recovery plans that apply to the Illawarra still provide valuable direction and information for those species and are listed in Table 4.

Table 4: State Recovery Plans have been prepared for the following species occurring in the Illawarra


<i>Flora</i>	<i>Fauna</i>
<i>Pimelea spicata</i> (Draft)	Little Tern
<i>Daphandra</i> species C Illawarra	Large Forest Owls
<i>Irenepharsus trypherus</i>	Yellow-bellied Glider
<i>Zieria granulata</i>	Koala
<i>Pterostylis gibbosa</i>	Green and Golden Bell Frog (Draft)
<i>Cynanchum elegans</i>	Barking Owl - Draft

Priority actions for all threatened species and endangered ecological communities in the Illawarra are available on the PAS database at:

http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/pas_search.aspx

BioBanking

BioBanking is a market-based offsetting scheme established under the *Threatened Species Conservation Amendment (Biodiversity Banking) Act 2006* that allows 'biodiversity credits' to be generated by landowners. Developers can purchase these credits to offset the impacts on biodiversity values associated with development. Biodiversity offsets are traded on a like for like basis. For example, a



developer seeking approval to clear vegetation will be required to purchase credits from a site with the same or similar vegetation community.

More information on BioBanking can be sought at <http://www.environment.nsw.gov.au/biobanking/>

3.3.2 Environmental Planning and Assessment Act 1979 (EPA Act)

This is the principal planning legislation for NSW, providing a framework for the overall environmental planning and assessment of development activities. The EPA Act provides for the development of Local Environmental Plans (LEPs), State Environmental Plans (SEPPs), and Regional Environmental Planning Policies (REPs). Under Parts 4 and 5 of the Act, Councils are required to assess the impact on threatened species of developments arising from both applicants on private land and its own activities on public land. This is done through the Assessment of Significance (Section 5a).

Whilst applicants are required to submit assessments to this effect, Council has the primary responsibility for determining whether a significant effect is likely to occur. If the assessment shows a significant impact on threatened species or an EEC is likely to occur then a Species Impact Statement (SIS) is required to be prepared under directions from the Director General of the Department of Environment, Climate Change and Water. Alternatively, the proposal may be modified such that a significant effect on threatened biodiversity is unlikely (DEC 2004).

Councils have a responsibility to ensure that they make decisions relating to threatened species, communities and populations on the best available information. One aim of the Strategy is to improve the application of environmental assessment under the EPA Act.

3.3.3 Local Government Act 1993 (LG Act)


The LG Act sets out the responsibilities of Councils including public land management, activity approvals, corporate and operation planning, orders and enforcement powers, setting rates and charges (LGSA 2009).

Section 7(e) of the Act requires Councils, Councillors and Council employees to have regard to the principles of ecologically sustainable development in carrying out their responsibilities. The Charter (Section 8) also requires Councils to properly manage, develop, protect, restore, enhance and conserve the environment of the area for which it is responsible, in a manner that is consistent with and promotes the principles of ecologically sustainable development. Under this Act, Councils are required to have Plans of Management for all Council owned land.

3.3.4 Native Vegetation Act 2003 (NV Act)

The *Native Vegetation Act 2003* (NV Act) regulates vegetation clearing in non-urban areas. This Act applies to the Illawarra Councils in all areas, except where land is zoned “residential” (but not “rural-residential”), “village”, “township”, “industrial” or “business” under an environmental planning instrument (Schedule 1, part 3 of the Act). A range of specific Routine Agricultural Management Activities (RAMAs) and some other types of clearing are also exempt from this Act. These activities could however, still require consent for clearing under a Council’s LEP.

A person seeking to clear native vegetation under the NV Act needs to apply to the relevant Catchment Management Authority. They may also simultaneously need consent by the local Council. The CMA may require a Property Vegetation Plan (PVP) to be developed. A PVP is a negotiated, legally binding agreement between the landholder and the local Catchment Management Authority. Development consent or an approved PVP is required to clear remnant native vegetation and protected regrowth. Clearing of other regrowth (post 1 January 1990) does not require consent or a PVP. Approval of clearing will only be given if clearing of the vegetation will improve or maintain environmental



outcomes as assessed by the PVP Developer, the decision support tool used by the CMAs (Eco Logical Australia, 2007). The NV Act is currently undergoing review.

3.3.5 Fisheries Management Act 1994 (FM Act)

Part 7a of the FM Act contains provisions similar to the TSC Act 1995 in relation to aquatic animals and marine vegetation. It provides for the listing of threatened species, populations, ecological communities and KTPs, critical habitat and preparation of recovery plans and threat abatement plans.

3.3.6 Water Management Act 2000 (WM Act)

This is the main piece of water legislation for NSW ensuring that water is provided for the environment and more secure access to water users. The provisions of the WM Act are being progressively implemented in NSW. Across the entire State, works within 40 metres of a river, lake or estuary require a Controlled Activity Approval under this Act. The recently repealed Rivers and Foreshores Improvement (RFI) Act has been integrated into the *Water Management Act 2000*.

3.3.7 Noxious Weeds Act 1993 (NW Act)

Administered by Industry and Investment NSW (formerly the Department of Primary Industries), this Act allows for the listing of five categories of declared noxious weeds. It provides for the specification of control measures and public and private land responsibilities. Noxious weeds occurring in the Illawarra are listed in Appendix 2.

3.3.8 National Parks and Wildlife Act 1974 (NPW Act)

This Act is administered by the Department of Environment, Climate Change and Water (DECCW) and provides for the establishment of National Parks, other conservation reserves, and the protection of flora and fauna. The NPW Act contains provisions under Section 132, for the licensing of activities for scientific, educational or conservation purposes that may lead to harm of flora or fauna. Bush regeneration activities in threatened species habitat need to seek licensing under Section 132 of the NPW Act. The Act also contains provision for the protection of native flora and fauna.

3.3.9 NSW State Plan 2006

The NSW State Plan (Department of Planning 2006) sets the direction for New South Wales over the next ten years. The Plan includes 34 priorities and 60 targets designed to deliver better services and improve accountability across the public sector.

Priorities relevant to biodiversity include:

- Priority E4: Better outcomes for native vegetation, biodiversity, land, rivers and coastal waterways sets the following targets for Biodiversity;
 - By 2015 there is an increase in native vegetation extent and an improvement in native vegetation condition;
 - By 2015 there is an increase in the number of sustainable populations of a range of native fauna species;
 - By 2015 there is an increase in the recovery of threatened species, populations and ecological communities; and
 - By 2015 there is a reduction in the impact of invasive species.

3.3.10 NSW Invasive Species Plan 2008 - 2015

Outlines a coordinated response to minimise the impact of weeds and pest animals and is linked to national prevention systems (LGSA 2009).

3.3.11 NSW Wetlands Management Policy 1996

This policy outlines a whole of government approach toward the conservation and sustainable management of NSW wetlands (LGSA 2009).

3.3.12 State Environmental Planning Policy No. 14 Coastal Wetlands

SEPP14 aims to protect coastal wetlands. Wetlands protected under SEPP14 in Kiama include Minnamurra estuary, Werri Lagoon, and Spring Creek. Koonawong Bay wetlands, Minnamurra estuary, Killalea Lagoon and parts of Lake Illawarra entrance are listed in Shellharbour. Haywards Bay wetlands are listed for Wollongong.

3.3.13 State Environmental Planning Policy No. 26 Littoral Rainforest

The aim of this Policy is to provide a mechanism for the consideration of applications for development that are likely to damage or destroy littoral rainforest areas with a view to the preservation of those areas in their natural state.

3.4 REGIONAL AND LOCAL PLANS

3.4.1 Illawarra Regional Strategy 2006

The Illawarra Regional Strategy was prepared by the NSW Department of Planning (DoP) to guide growth and infrastructure development over a 25 year period (2006 - 2031) in the Wollongong, Shellharbour and Kiama LGAs. Recommended Actions listed under the natural environment theme are shown in Table 5.

Table 5: Illawarra Regional Strategy Actions for the Natural Environment

<i>Actions</i>
Wollongong City Council will incorporate the planning control recommended in the Illawarra Escarpment Strategic Management Plan into its LEP.
WCC and DoP will continue to work with DECCW and SRCMA towards achieving biodiversity certification of the West Dapto LEP.
Opportunities for the long term survival of <i>Melaleuca armillaris</i> shrubland EECs will be considered through the planning review of the Shellharbour / Kiama hard rock resource and implemented in the Shellharbour and Kiama LEPs.
LEPs are to maximise protection of 'Significant Native Vegetation', 'Indicative DEC Regional Habitat Corridor' and 'Other Indicative Habitat Corridors'.
Department of Primary Industry (now Industry and Investment NSW) to identify regionally significant aquatic habitats and associated riparian buffers to inform preparation of LEPs and consideration of development.
Councils will manage the impact of land use change and development in the catchments of high value coastal lakes, estuaries and wetlands. Councils will consider the NSW Government-endorsed Estuary Management and Coastal Zone Management Plans in undertaking this task.
When planning new urban areas, the Strategic Assessment of Riparian Corridors Methodology developed by the Department of Natural Resources (now DECCW) in conjunction with the DoP will be used by: <ul style="list-style-type: none">- incorporating the assessments into structure plans.- appropriate zoning.- appropriate management through a development control plan.
Development proposals affecting riparian lands will be required to suitably protect the values of riparian lands by methods such as maximising the retention of native vegetation, especially in riparian



corridors and rehabilitating disturbed areas.

Require LEPs to zone all SEPP14 Wetlands and SEPP26 Littoral Rainforest to achieve environmental protection through zones such as E2 or W1.

Councils to consult with SRCMA to ensure the appropriate integration of Catchment Action Plan (CAP) and LEPs.

3.4.2 Southern Rivers Catchment Action Plan 2006

Southern Rivers Catchment Action Plan (CAP) (Southern Rivers CMA 2006) details key priorities for the whole of the Southern Rivers CMA for the next ten years (2006-2016) from Wollongong LGA in the north to the Victorian border, including the Illawarra Councils. Table 6 lists biodiversity targets relevant to the Illawarra.

Table 6: The CAP Biodiversity Targets

Community and landholder knowledge and skills	B1	By 2016 there will be an increase in the number of land managers who adopt management practices that conserve biodiversity and promote sustainable production.
Native vegetation conservation	B2	By 2016 through voluntary participation by land managers, the area of land actively managed to conserve priority vegetation types will increase from 11,000 hectares to at least 41,000 hectares.
	B3	By 2016 through voluntary participation by land managers, an additional 10,000 hectares of native vegetation will be actively managed to build a resilient landscape with good connectivity which conserves biodiversity.
Native species conservation	B4	By 2016 the priority recovery actions identified in the Southern Rivers threatened species strategy will have been implemented.
Invasive species	B5	By 2016 vertebrate pest species will be controlled in key locations.
	B6	By 2016 priority weed species will be controlled in key locations.

The intent of targets B2 and B3 is to ensure priority vegetation types are targeted, that is, those with less than 30% of their original distribution currently being managed for conservation. Or, if they are already cleared below 30% of their original distribution, to ensure the rest is managed for conservation (Southern Rivers CMA 2006).

3.4.3 Local Environment Plans

Local Environment Plans (LEPs) are the principal legal document for controlling development at the Local Government level. Local Environment Plans identify the zoning provisions for all land within a Local Government Area that establish permissible uses and standards that regulate the use of that land. They are prepared by council and approved by the Minister for Planning after public exhibition.

The three Illawarra Councils have revised their Local Environmental Plans. Within Wollongong LGA, the Wollongong LEP 2009 and Wollongong LEP (West Dapto) 2010 are in force. Within Kiama LGA, the draft Kiama LEP has been publicly exhibited and submitted to the NSW Department of Planning for approval. Within Shellharbour LGA, the draft Shellharbour LEP has been approved by the Department of Planning and Infrastructure for exhibition and will be publicly exhibited in the near future. New Development Control Plans (DCPs) will be developed alongside the LEPs to provide more detailed guidance on land use activities and development assessment processes.



3.4.4 Illawarra NRM Plan 2010

The Illawarra NRM Plan was finalised in 2010 by the Southern Rivers CMA. It sets out a ten year program of actions which contribute to meeting the 2006 Catchment Action Plan (CAP) targets in the Illawarra region. The plan identifies existing programs, and highlights additional potential projects that would contribute to targets.

3.4.5 Illawarra Sustainability Roadmap 2008

The Sustainability Roadmap (2008) is a partnership of the Illawarra Councils which outlines a program to embed sustainability into all areas of Council, including decision-making, processes, planning, reporting and operations.

4 DATA AUDIT

A review of biodiversity data was undertaken of both spatial (GIS) and non spatial biodiversity data held by the three Councils. The objective of the data audit was to establish a knowledge base to ensure the Strategy considered all available and up to date information. The collation of this information also enabled the identification of knowledge gaps so that future data collection work can be targeted to priority areas. Assessing biodiversity knowledge needs, identifying gaps and setting priorities are also one of the priority actions in Australia's *Biodiversity Strategy-Consultation Draft* (Commonwealth of Australia 2009).

The review targeted the following biodiversity information, including:

- Threatened species records;
- Vegetation mapping;
- Flora and fauna studies;
- Conservation assessments;
- Corridors; and
- Wetlands;

Appendix 1 provides a summary of the major data sources reviewed.

4.1 VEGETATION MAPPING

There have been challenges in developing this Strategy due to non - standardisation of regional vegetation mapping. Classifying and mapping vegetation communities has been undertaken using a range of methods in NSW and the Illawarra. Each methodology comes with their varying strengths and weaknesses (NPWS 2002a). This has presented challenges in the preparation of the Illawarra Biodiversity Strategy.

In the Illawarra, there are six major vegetation maps that cover all or parts of the Illawarra region. Unfortunately, they each come with different terminology for plant communities, and have mostly been derived from different methods. As such, they do not align well to each other. The data audit in Appendix 1 provides more detail about each mapping dataset.

The key vegetation maps for the Illawarra are:

- Tozer *et al.* (2006) Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. NSW Department of Environment and Conservation and NSW Department of Infrastructure, Planning and Natural Resources, Sydney.
- Mills and Associates (2006a) The Natural Vegetation in the Municipality of Kiama, NSW.
- NPWS (2003b) Native Vegetation of the Woronora, O'Hares and Metropolitan Catchments.

- NPWS (2002a) Native Vegetation of the Illawarra Escarpment and Coastal Plain. NSW National Parks and Wildlife Service.
- Mills and Associates (2001) The Natural Vegetation in the City of Shellharbour, NSW.
- DECCW (2009) Draft Native Vegetation of the Sydney Metropolitan Catchment Management Authority Area.

The South Coast-Illawarra Vegetation Integration (SCIVI) (Tozer *et al.* 2006) is the most recent map that gives the only consistent classification across the Illawarra region. The other maps are limited to specific LGAs or parts thereof. They have also taken different approaches to vegetation classification, hence they can not be aligned easily for a regional assessment of biodiversity values. The biodiversity strategy has therefore partly relied upon SCIVI mapping for its assessment of biodiversity priorities.

Limitations with SCIVI mapping

The SCIVI mapping is produced at a scale of approximately 1:100 000; this is somewhat broader than the LGA specific mapping which varies between 1:14,000 and 1:25,000. Some local vegetation assemblages are not well defined in the SCIVI mapping. The following vegetation assemblages, and possibly others, are not well defined amongst the map units in the SCIVI mapping:

- Spotted Gum Forest of Mangerton and Tarrawanna escarpment footslopes
- Brown Myrtle Forest - Stanwell Park
- Redgum/ Red Mahogany association - Helensburgh (C. deLacey pers. comm.)
- *Melaleuca armillaris* shrubland (EEC) located at Dunmore is mistakenly mapped in part as Morton Mallee Heath (G. Daly 2009, pers. comm.)
- Southern Sydney Sheltered Forest (EEC)

4.2 DATA GAPS

The data audit highlighted the following data gaps and knowledge management issues across all three councils. These are outlined in Table 7.

Table 7: Data gaps and priorities

Theme	Gap	Priority to address
Vegetation and mapping	Mapping inaccuracies. Some smaller communities including EECs are not mapped in Kiama and Shellharbour LGAs. Any further survey work should target EECs.	ü
	Lack of data on pre-European extent of vegetation communities.	
	Vegetation mapping inconsistencies between Councils.	
	Some local vegetation communities not well described in regional mapping (Tozer <i>et al.</i> 2006).	
	Lack of knowledge on appropriate fire regimes for local vegetation communities, especially for areas managed for asset protection.	ü
	Vegetation communities not always aligning clearly to EEC determinations.	
	Vegetation condition.	ü
	Absence of more recent GIS data delineating extant (existing) vegetation.	
Threatened species	Lack of records, particularly in Shellharbour and Kiama LGAs.	ü
	Lack of targeted surveys.	ü
	Poor management of new survey data. Not always included in the Wildlife Atlas Database.	ü
Aquatic data	No regional datasets. Limited site specific surveys only.	
Flora and fauna general	Non vascular plants such as bryophytes (mosses, liverworts and hornworts), and algae are not generally recorded. Poorly known.	
	Fauna survey data poor, particularly in Shellharbour and Kiama LGAs.	
	Incompatible mapping systems and data management systems which limits data sharing between councils.	
	Fauna habitat modelling not available for Kiama and Shellharbour.	
	Inconsistent reporting on key indicators between Councils in State of Environment Reporting.	ü
Invertebrates	Few site specific studies only. Very poorly known.	
Genetic diversity	No data available.	

As stated in Volume One, it is recommended that the Illawarra Councils work toward addressing these data gaps over time when funding and resources are available. Projects addressing data gaps should focus on priority areas, species or communities where limited resources are available.

5 THREATS TO BIODIVERSITY

Destruction and disturbance of native vegetation represents the greatest threat to biodiversity (Coutts-Smith *et al.* 2007). The introduction of pest species (exotic animals and weeds) poses the second greatest threat, and is also recognised globally as a major cause of biodiversity decline (Coutts-Smith *et al.* 2007). The following section describes the various threats to biodiversity in the Illawarra.

5.1 KEY THREATENING PROCESSES

The Commonwealth EPBC Act, the *NSW Threatened Species Conservation Act* (TSC Act, schedule 3), and *Fisheries Management Act* (FM Act, Schedule 6) allow for the listing of KTPs as outlined in Section 3. In general, threats are listed when they cause an adverse affect to threatened species, populations or ecological communities; or it could cause species, populations or ecological communities that are not threatened to become threatened. Table 8 lists those listed threats that are relevant to the Illawarra and indicates under which legislation.

In addition to listed KTPs, there are a number of other threats impacting on biodiversity in the Illawarra. Through engagement with key regional stakeholders, identification of additional threats was undertaken. These are also included in Table 8. All threats were then classified into major threat categories recognised by Coutts-Smith *et al.* (2007) as shown in Table 8.

Table 8: Key threatening processes relevant to the Illawarra

Threat category	Regional Threat	TSC Act	EPBC Act	FM Act
Anthropogenic destruction and disturbance of native vegetation	Clearing of native vegetation.	*	*	
	Extinctions of local populations of species (due to lack of recruitment, inbreeding depression, fragmentation or other).			
	Grazing and disturbance by stock.			
	Hard rock extraction/ quarrying activities.			
	Loss of hollow bearing trees.	*		
	Roadside mowing (weed dispersal, and impacts on native vegetation wetlands).			
	The degradation of native riparian vegetation along NSW water courses.		*	*
Anthropogenic destruction and disturbance of native fauna	Fishing and harvesting of aquatic resources (including fish, shellfish and crustaceans).			
	Roadkill.			
	Bushrock removal.	*		
Anthropogenic modification and degradation of physical factors	Alteration of habitat following subsidence due to longwall mining.	*		

	Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands.	*		
	Bushrock removal.	*		
	Dumping garden refuse, and rubbish.			
	Ecological consequences of high frequency fires.	*		
	Human-caused climate change.	*	*	*
	Instream structures and other mechanisms that alter natural flow.			*
	Removal of deadwood and deadtrees.	*		
	The removal of large woody debris from NSW rivers and streams.		*	
	Use of insecticides, herbicides, fertilizers.			
	Water quality degradation arising from increased urbanization.			
Introduction of alien species	Competition from feral honeybees.	*		
	Impacts associated with feral animals: rabbit, bees, deer, pigs, goats, exotic fish, cat, red fox, and plague minnow* (Listed separately as KTPs).	*	*	
	Introduction of non-indigenous fish and marine vegetation to the coastal waters of NSW.			*
	Invasion of exotic garden plants, exotic grasses, vine and scramblers; invasion of Lantana, and Bitou Bush. (Listed separately as KTPs)	*		
	Diseases			
	Disease/ soil pathogens Eg. <i>Phytophthora</i> spp.			
	Infection of frogs by amphibian chytrid causing the disease chytridiomycosis.	*	*	
	Infection by Psittacine circoviral (beak and feather) disease affecting endangered Psittacine species and populations.	*	*	

DECC (2007a: Appendix A) provides further guidance on which threatened fauna in the Greater Southern Sydney Region are at risk from these threats.

5.2 THREAT ABATEMENT PLANS

Threat abatement plans are prepared under the TSC Act and EPBC Act to research and propose management actions to address KTPs. Many of the recommended actions are not site specific; however some plans list priority sites, such as for Bitou Bush control. Threat abatement plans relevant to the Illawarra are listed in Table 9.

Table 9: Threat abatement plans prepared under the TSC Act and the EPBC Act

<i>Threat Abatement Plan</i>	<i>TSC Act</i>	<i>EPBC Act</i>	<i># of site specific actions listed for the Illawarra</i>
Competition and land degradation by rabbits.		*	Nil
Predation by the European red fox.	*	*	1 priority site targeting Long-nosed Potaroo at Barren Grounds Nature
Infection of amphibians with chytrid fungus resulting in chytridiomycosis.		*	Nil
Competition and land degradation by unmanaged		*	Nil

goats.		
Predation by feral cats.	*	Nil
Bitou bush and boneseed.	*	3 priority sites: Bass Point, Killalea and Seven Mile Beach
Predation by the plague minnow (<i>Gambusia holbrooki</i>).	*	Nil
Plan to protect environmental assets from Lantana (Draft).	*	No specific sites identified. A number of actions apply generally.

Given the lack of spatial information available on the location of specific threats, a spatial analysis of threats was not undertaken. It is for this reason a values based approach has been taken for prioritising works and priority actions in the strategy. That is, works to reduce the impact of threats should be undertaken in areas of highest known biodiversity value.

5.3 CLIMATE CHANGE

Climate change is the most pervasive, least understood and least predictable of all the threatening processes (Auld and Keith 2009). Evidence suggests changes in the Earth's physical environment consistent with global warming are already occurring. It is very likely (>90% certain) that greenhouse gas increases caused most of the warming already seen in the mid twentieth century (DECC 2007b). Increases in greenhouse gases are primarily due to fossil fuel combustion, agriculture and land use change (DECC 2007b). On a per capita basis, Australians are responsible for releasing greater volumes of greenhouse gases than any other country (DECC 2007b).

There still remain some unknowns over the timing and extent of projected changes in climate this century due to uncertainties about the amount of greenhouse gases that will be released into the atmosphere later this century, compounded by uncertainties about the climate system itself (DEFRA 2007).

For biodiversity, there is expected to be a range of direct and indirect impacts of a changing climate. DECC (2008a) have summarised predicted climatic changes by 2050 for the Illawarra to be:

- Hotter days over all seasons (1.5-3°C increase).
- Substantial increases in summer rainfall and a slight to moderate increase in spring/autumn rain.
- Increased evaporation leading to slightly drier conditions in winter and spring.
- Increased sea level rise - up from 1990 levels by 40cm by 2050, and 90cm by 2100.
- Increased storminess, intensity and frequency of storms.

For biodiversity, the main threat from climate change is whether species and communities can adapt to survive the magnitude and rate of change. Individual species have two possible survival mechanisms – adaptation or migration (DECC 2007b). Adaptive evolution is considered unlikely due to the predicted rapid rate of change which is 10-60 times faster than has occurred in the past (DECC 2007b), therefore migration and behavioural change is more likely to be the major survival mechanism.

General expected changes to biodiversity include (DECC 2007b):

- Species range shifts to cooler latitudes (south) or higher elevations;
- Changes to flowering and fruiting times;
- Vegetation thickening in eucalypt woodlands from carbon dioxide enrichment;

- Behavioural changes in fauna populations;
- Extinctions of local populations along range boundaries;
- Increasing invasion of highly mobile, opportunistic, weedy plant species;
- Progressive 'decoupling' (breakage) of species interactions (e.g. timing of food availability);
- Increasing threat to fresh water ecosystems through changes in water temperature and chemistry and potential saline inundation;
- Increased carbon dioxide will favour plants utilizing the C₃ photosynthetic pathway of photosynthesis (rather than C₄) – this will alter competitive relationships between plants and may result in substantial changes in species composition, and increased competition from weedy species (Adam 2009); and
- Decoupling of pollinator – plant relationships, leading to reduced pollination (Adam 2009).

Ecosystems in the Illawarra which are likely to be vulnerable to climate change are outlined in Table 10.

Table 10: Communities and species vulnerable to climate change in the Illawarra

Type	Threat
Riparian vegetation.	Increased disturbance from predicted increase in storm and flood events.
Coastal zone vegetation.	Increased pressure from sea level rise, coastal erosion and storm events. Likely to impact dune vegetation, saltmarsh, wetlands, littoral rainforest, and estuarine vegetation.
Low lying coastal areas.	At risk from inundation, potential saline influences.
Freshwater wetlands.	Saline influences from sea level rise or intrusion from the water table. Increasing threat from decreasing water flows and changes in water temperature and chemistry.
Rainforest.	Increased evapotranspiration leading to decreased moisture levels / humidity.
Species at the northern limits of their range.	Species likely to shift range to cooler latitudes or higher elevations.
Species and communities already stressed due to fragmentation.	This applies to all vegetation of the Illawarra coastal plain.
Species with geographically restricted distributions and specialist habitat requirements.	Many of the threatened and rare species in the Illawarra. Potential to migrate is more likely to be constrained by habitat fragmentation or other barriers (Adam 2009).
Areas vulnerable to high fire intensity and frequency.	Vast areas of the sandstone plateau, and escarpment.

Plant species with wide ranging seed dispersal strategies such as via frugivorous birds and bats, water and wind are expected to be more capable of accommodating climate change and crossing migration barriers than plants that disperse seed close to the parent plants such as myrmecochorous (ant dispersed) species (Adam 2009).

Vegetation clearing and fragmentation

Decades of clearing and development on the Illawarra coastal plain has resulted in many isolated and small pockets of remnant vegetation. Fragmentation has many negative impacts on native vegetation including: genetic deterioration (loss of diversity and increased inbreeding); changed landscape processes and disturbance regimes; increased edge effects; increase abundance of invasive species; and altered species interactions affecting pollination, seed dispersal, predation, competition (Hobbs and Yates 2003). A recent study (Broadhurst 2007) has shown small populations are highly susceptible to declining seed production, loss of genetic diversity increased inbreeding leading to poor seedling vigour

and increased hybridisation. Increasing patch size and reconnecting such isolated remnants is one way to increase the viability and reduce threats to these remnants.

5.4 WEEDS

Weed invasion in the Illawarra has been occurring since 1815, with the earliest non-indigenous settlements and has continued since (BES, 2006). There are more than 200 weed species known in the Illawarra, which are listed in Appendix 2. Most are environmental weeds that pose threats to biodiversity, however some are also listed as noxious, as national Weeds of National Significance (WONS), or as KTPs under the Threatened Species Act. Weeds threaten biodiversity due to their ability to outcompete native plants. This leads to a reduction in the diversity of flora and fauna habitat.

Weeds in the Illawarra include a range of grasses, forbs, shrubs, trees and vines and aquatic weeds. Due to the absence of weed mapping, the Illawarra Escarpment Weed Strategy (BES 2006) recommends weed control to be targeted at biodiversity sites of highest value. It is recommended that this approach is taken across the Illawarra region.

5.5 PEST ANIMALS

Since European settlement of Australia, more than 220 terrestrial vertebrates have been introduced to Australia (Coutts-Smith *et al.* 2007). Of these, many have established populations that pose significant threats to biodiversity and some have been implicated in the extinction of many native species and in the decline of others (Coutts-Smith *et al.* 2007). Pest animals pose direct threats to biodiversity through various means including degradation of habitat, competition; along with inadvertent impacts from associated pest control, grazing and browsing (Coutts-Smith *et al.* 2007).

Table 11 outlines pest animals and priorities for control in the Illawarra. The impacts and priorities for control are based on recent work by DECC (2007a) for the metropolitan region. Some species priorities were modified based on their known impacts and abundance in the Illawarra.

Table 11: Pest animals and priorities for control

<i>Pest animal</i>	<i>Impacts on biodiversity</i>	<i>Priority for control</i>
Deer (Rusa, Red and Fallow deer).	Overgrazing, trampling, ring-barking, dispersal of weeds, acceleration of erosion, concentration of nutrients and degradation of water quality (NSW Scientific Committee 2004 in DECC 2007a). Contributing to traffic accidents.	High - potential to expand range to the south.
Feral cat.	Prey on native animals.	Moderate.
Feral goat.	Soil damage and erosion, trampling, dispersal of weeds, prevention of native species regeneration through grazing, competition with native fauna for food and resources.	High.
Feral pig.	Prey on native animals; compete with native fauna for food resources, habitat alteration by wallowing, rooting and foraging, spread of weeds, reduction in water quality, spread of root rot fungus (<i>Phytophthora cinnamomi</i>).	Moderate.
Fox.	Preying on native species, competition with native fauna for food and resources.	High - refer to Red Fox Threat Abatement Plan.
Indian Myna.	Potential competition for nesting sites and hollows.	Low.
Rabbit.	Land degradation through grazing, ring barking of trees, construction of burrows, soil erosion. Competition with native fauna for food and resources.	Moderate.

There are a number of other pest animal species present in the region; however these have not been listed as they are considered to have less significant impacts on biodiversity (DECC 2007a).

Rusa, Red and Fallow deer are the most significant current threat. Wide ranging impacts across the Illawarra Escarpment include destruction of understorey vegetation. In recent years, they have migrated from the Royal National Park to Ulladulla, and have the potential to significantly expand their range further south (DECC 2007a).

6 BIODIVERSITY VALUES

The landforms of the Illawarra region gives rise to a high level of biodiversity. The Illawarra Councils cover an area approximately 108,000 hectares in size. Approximately half of this is vegetated. Most of the retained vegetation is found on the Illawarra Escarpment slopes and sandstone plateau west of the escarpment, which is largely water catchment land. The Illawarra coastal plain however, has mostly been cleared, leaving mostly isolated remnants of vegetation vulnerable to a number of ongoing threats.

Biodiversity values applied in the Strategy are more fully described below.

6.1 ENDANGERED ECOLOGICAL COMMUNITIES

There are 19 Endangered Ecological Communities (EECs) listed as threatened under the NSW TSC Act or the Commonwealth EPBC Act in the Illawarra. Some are distributed across all three LGAs, others are restricted to particular LGAs as indicated in Table 12.

Due to the high level of vegetation clearing on the coastal plain for agriculture industry and residential development, most vegetation types that occur on the Illawarra coastal plain are now listed as EECs. Other EECs also occur on the Illawarra Escarpment, Woronora Plateau and Moss Vale Tablelands. Table 12 provides a list of the EECs and the prioritisation of those communities based on an assessment of the level of threat to the community, and population status. This assessment method was adopted from DECC (2008b), however, with a focus on the Illawarra region. Appendix 3 provides further information on the distribution of EECs.

Table 12 : Endangered Ecological Communities (EECs) of the Illawarra

<i>Endangered Ecological Community (EEC)</i>	<i>TSC Act</i>	<i>EPBC Act</i>	<i>Wollongong LGA</i>	<i>Shellharbour LGA</i>	<i>Kiama LGA</i>	<i>Priorities</i>
Bangalay Sand Forest	yes		*	*	*	High
Coastal Saltmarsh	yes		*	*	*	High
Freshwater Wetlands on Coastal Floodplains	yes		*	*	*	High
Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion	yes		*	*	*	Highest
Illawarra Subtropical Rainforest in Sydney Basin Bioregion	yes		*	*	*	Highest
Littoral Rainforest (TSC Act); Littoral Rainforest and Coastal Vine Thickets of Eastern Australia (EPBC Act)	yes	yes	*	*	*	High

<i>Melaleuca armillaris</i> Tall Shrubland	yes			*	*	Highest
O'Hares Creek Shale Forest	yes		*			Highest
River-flat Eucalypt Forest on Coastal Floodplains	yes	yes	*	*		High
Robertson Basalt Tall Open-forest	yes			*	*	High
Robertson Rainforest	yes			*	*	High
Shale/ Sandstone Transition Forest	yes	yes	*			High
Southern Highlands Shale Woodlands				*		High
Southern Sydney Sheltered Forest	yes		*			Highest
Swamp Oak Floodplain Forest	yes		*	*	*	High
Swamp Sclerophyll Forest on Coastal Floodplains	yes		*	*	*	High
Sydney Freshwater Wetlands in the Sydney Basin Bioregion	yes		*	*		Highest
Temperate Highland Peat		yes	*			High
Themeda Grassland on seacliffs and coastal headlands	yes		*		*	High

6.2 ENDANGERED POPULATIONS

The NSW TSC Act allows for the listing of endangered populations. There are currently 35 listed populations in NSW, with three occurring in the Illawarra. Table 13 details the Illawarra populations.

Table 13: Listed Endangered Populations of the Illawarra

<i>Population</i>	<i>Description</i>	<i>LGA</i>
<i>Lespedeza juncea</i> .	Known from just one roadside population south of Dapto. Disjunct from other populations in Western Sydney, far south coast and southern tablelands.	Wollongong
<i>Chorizema-parvillorum</i> .	This population has been recorded from between Austinmer and Albion Park. It typically occupies woodland or forest dominated by Forest Red Gum (<i>Eucalyptus tereticornis</i>) and/or Woollybutt (<i>E. longifolia</i>). At Austinmer, the species is recorded from a coastal headland.	Shellharbour and Wollongong
<i>Callitris endlicheri</i> , Woronora Plateau Population.	This population represent the eastern limit of the species, and is disjunct from other known populations. The Woronora population is restricted to a single sandstone outcrop approximately two hectare in area.	Wollongong

The *Lespedeza* and *Chorizema* populations are most at risk, particularly as they are within fragmented habitats that will face increasing threats with proposed future urban expansion of West Dapto/Yallah Calderwood area. The *Callitris endlicheri* population is actively managed by the National Parks and Wildlife Service as part of Dharawal Nature Reserve.

6.3 THREATENED SPECIES

Threatened species records for the Illawarra were compiled using ATLAS data (dated Feb 2009), engagement with experts, and herbarium records from the NSW and Janet Cosh Herbariums.

There are 66 threatened fauna species, and 31 threatened flora species which have been recorded within the study area. Appendices 4, 5 and 6 provide detailed lists of those flora, fauna and aquatic species. Of the threatened fauna, the majority are birds and mammals that are threatened. A high proportion of the locally occurring frogs are also threatened.

Threatened species have been prioritised based on the level of threat and their importance to the Illawarra region. These priorities are also shown in Appendix 4 and 5. The prioritisation was initially taken from the Threatened Species Prioritisation and Implementation Strategy for the Priorities Actions Statement for the Metropolitan Region (DECC 2008b). However, as this region is a much larger study area, it was considered a local review of these priorities was required to better reflect priorities and threats in the Illawarra. The prioritisation rules devised by DECC (2008b) that were used to guide the review are shown in Table 14.

Table 14: Prioritisation rules for revised rankings

<i>PRIORITY</i>	<i>Level of endemism</i>	<i>Level of threat</i>	<i>Population status</i>
Highest	High to medium level of endemism and abundance to Illawarra	High	Extremely rare to rare
High	Medium to Low level of endemism and abundance to Illawarra	High to medium	Extremely rare to rare
Medium	Medium to Low level of endemism and abundance to Illawarra	Medium to Low	rare to locally common
Low	Medium to Low level of endemism and abundance to Illawarra	Medium to Low	Uncommon to common

It is noted that several species have become extinct in the region. Protected migratory birds are also listed in Appendix 7, and covered in section 3.2.1.

The Illawarra Councils will support DECCW to prioritise key actions from the Priority Actions Statement, and Recovery Plans so that opportunities to invest in threatened species recovery will be targeted appropriately.

6.4 CRITICAL HABITAT

Part 3 of the TSC Act 1995 allows for the listing of critical habitat. There is currently no listed critical habitat in the Illawarra.

6.5 RARE FLORA

Regionally rare flora for the Illawarra have been identified in previous work (NCC 1999, Mills and Associates 2000, and Fairley 2004) and incorporated into this Strategy in Appendix 8. 94 species in total have been flagged as rare in the region. Some of these are listed as Rare or Threatened Australian Plants (ROTAPS) under the schedule prepared by Briggs and Leigh (1996).

6.6 RARE FAUNA

Rare fauna have been compiled from several datasets collated within the region (Chafer *et al.* 1999, Mills and Associates 2000, NPWS 2002b, Mills and Associates 2006b, DECC 2007a). There has been comparatively less systematic fauna survey across the Illawarra than for flora, as a result there is less understanding of rare fauna species. Given the active membership of the Illawarra Bird Observers Club, there is more known about birds than other fauna groups in the region. Appendix 9 contains the list of rare fauna compiled for the Illawarra.

6.7 FAUNA HABITATS

Fauna data across the region is very variable. Fauna data is more available for the north of the region, with fewer records and less systematic studies available in Shellharbour and Kiama LGAs. Given this paucity of consistent fauna data across the Illawarra, broad vegetation classes were used as an indicator of threatened fauna habitats. Habitat types were used that had been defined in recent studies (DECC 2007a, DECC 2007d). The habitat approach is often more practical compared with a species-by-species approach, especially when there are many threatened species in an area (DECC 2007a), and an absence of systematic survey data.

Each threatened fauna species recorded for the region has been assigned to its predominant habitat type based on knowledge of their distributions described in existing literature (DECC 2007a, DECC 2007d, and NPWS 2003b). The full list of species by habitat can be seen at Appendix 10.

6.8 VEGETATION COMMUNITIES

There are three major landform types in the Illawarra: the coastal plain; Illawarra Escarpment; and plateau, comprising the Woronora and Budderoo Plateaux. Each landform gives rise to different geologies and climate, leading to a very high diversity of vegetation types.

The coastal plain is highly urbanised in the north of the region, and progressively more rural towards the south. Most of the vegetation of the coastal plain has been cleared, and what little remains is mostly listed as EEC. There remain scattered remnants of grassy woodlands, wetlands, saltmarsh, rocky coastal headlands and dune vegetation. Most of the coastal plain is flat and mildly undulating with volcanic hills giving rise to dry and subtropical rainforests.

The Escarpment slopes are mostly vegetated with moist eucalypt forests and rainforests, which provide a scenic backdrop to the coastal plain.

The Woronora and Budderoo sandstone plateaux beyond the Escarpment include another suite of vegetation types including woodlands, heaths, upland swamps, shale forests and sheltered gully forests. Table 15 shows the distribution of extant (current) vegetation across the council areas of the Illawarra.

Table 15: Proportion of vegetated lands across the Illawarra Region

	<i>Kiama</i>	<i>Shellharbour</i>	<i>Wollongong</i>	<i>Illawarra Region</i>
LGA total area (ha)	25,791	14,759	68,437	108,987
Total vegetation (ha)	12,841	5,309	47,666	65,816
% of LGA	50	36	72	100
% of Illawarra region	12	5	44	60

Extant vegetation figures in Table 15 are based on mapping by Tozer *et al.* (2006) from aerial photos taken between 1994 and 2001. Therefore, these figures are likely to over represent current extant vegetation.

As shown in Table 15, most of the vegetation is distributed within the Wollongong LGA. A large portion of this is within the control of the Sydney Catchment Authority. Appendix 11 lists the vegetation units as defined by Tozer *et al.* (2006) that occur in the Illawarra, alongside a summary of the key species and habitat for each community.

6.9 VEGETATION PRIORITIES

The Southern Rivers CMA Catchment Action Plan (CAP) (2006) broadly defines priority vegetation types as those with '30% of their original distribution being managed for conservation'. The barrier to determining this is that there is no reliable mapping of the pre-European extent of vegetation communities in the Illawarra. To define a more specific list of vegetation priorities for the Illawarra we devised a classification of vegetation priorities using SCIVI vegetation mapping (Tozer *et al.* 2006).

To do this, an assessment was made of the endemism and reservation status of each vegetation community in the Illawarra compared with the entire SCIVI study area. The SCIVI study area extends from Sydney in the north to the Victorian border in the south and west to Goulburn (Tozer *et al.* 2006). This enabled a comparison to be made between the distributions of plant communities within the Illawarra against the whole SCIVI study area. Using this information, a ranking of three priority classes has been developed (1 being highest). This is designed to help inform the meeting of CAP targets and priority conservation areas across the Illawarra.


Table 16: Vegetation priority classes

<i>Priority</i>	<i>Endemism % of distribution within the Illawarra</i>	<i>Proportion of community reserved in NPWS reserves in the Illawarra</i>
1	>60%	<15% reserved
2	<60%	<30% reserved or listed as EEC
3	<60%	>30% reserved

Table 16 shows those communities with a higher endemism (>60% distribution) to the Illawarra that have not met their conservation targets ranked as Priority 1. These communities have very limited distribution beyond the Illawarra region. As such, their management and conservation hinges on regional efforts. Those EECs which are highly endemic to the Illawarra were included in this class.

Most of the Priority 1 vegetation occurs on the Illawarra coastal plain and foothill rainforests south of Wollongong. Priority 1 vegetation communities include Illawarra Grassy Woodland, Illawarra Subtropical Rainforest, Bracelet Honey Myrtle Scrub and Coastal Upland Swamps. The first three of these communities are all very poorly protected in reserves, and are mostly restricted to the Illawarra region. Coastal Upland Swamps are relatively protected within water catchment lands, however they are under threat from longwall mining and the associated impacts of subsidence resulting in cracking of valley floors and creeklines leading to altered surface hydrologies (NSW Scientific Committee 2005).

Priority 2 areas are those communities that are still poorly reserved (<30%), but have a distribution which extends beyond the Illawarra. This priority class captures most other vegetation communities within the Illawarra. Vegetation communities that fell into Priority 3 on the basis of their reservation



and endemism status, but are listed as EECs, were also included in Priority 2 due to their threatened status under the TSC Act or EPBC Act.

Priority 3 communities were those that meet the 30% reservation status, and are not particularly endemic to the Illawarra. In the Illawarra region, they are confined mostly to the Budderoo Plateau within National Park estate. This class included sandstone woodlands, gully forests and heaths.

Appendix 12 shows the complete list of vegetation units with their determined priority class.

Vegetation priorities should be used to guide priorities for investment and conservation efforts on land outside of the regional corridors. These priorities can also be used to target opportunities for land acquisition or incentives.

6.10 REGIONAL BIODIVERSITY CORRIDORS

The Strategy consolidates and maps a network of regional biodiversity corridors across the Illawarra. The biodiversity value of corridor networks is well known. Landscapes that retain more connections between patches of otherwise isolated areas of vegetation are more likely to maintain more numerous and more diverse populations of various plant and animal species (Lindenmayer and Fischer, 2006). Conversely, a lack of landscape connectivity can have a range of negative impacts on species populations (Lindenmayer and Fischer, 2006). It is thought that if existing remnants are left to persist without sufficient immigration to maintain genetic diversity, continued losses of biodiversity are certain (Parker *et al.* 2008).

Most of the areas defined in the Strategy as forming part of a regional corridor network have already been flagged as core conservation areas in previous studies. This is because they are large, biologically diverse, contain a diversity of habitats and vegetation communities, contain habitats for threatened species, and contain vegetation communities that are significant to New South Wales and the Illawarra region (Mills and Associates 2000).

There is a clear mandate for planning for biodiversity corridors as shown by the various state, regional and local policies and plans promoting them including Australia's Biodiversity Conservation Strategy-draft (Commonwealth of Australia 2009), The Southern Rivers Catchment Action Plan (Southern Rivers CMA 2006), Illawarra NRM Plan (Southern Rivers CMA 2010), and the Illawarra Regional Strategy (DoP2006).

This Strategy has responded to these high order targets and regional plans by consulting with local experts, and review of previous studies to delineate and map boundaries in order to define a regional corridor network. This was done to facilitate improved incorporation of the corridors into planning instruments, and to guide biodiversity planning and conservation priorities.

The proposed objectives of the Illawarra biodiversity corridors are to:

- Delineate areas of high quality habitat;
- Conserve and protect areas of high quality habitat;
- Enhance existing connectivity within corridors by regenerating or revegetating missing links where possible;
- Consolidate and manage these continuous links to provide large scale connectivity through the landscape;
- Implement effective planning controls to prevent further fragmentation;
- Maintain viability of native vegetation and provide dispersal corridors for fauna;
- Minimising further clearing within these areas; and

- To minimise the impact of development on land within and adjoining the regional corridors.

Method used to Map Illawarra Biodiversity Corridors

Regional corridors for the Wollongong LGA have already been largely defined through existing studies (Mills and Associates 2000, NPWS 2002b, NPWS 2003a, Eco Logical 2004, WCC 2005, Mills and Associates 2006b, WCC 2007, DECC 2007d, and DoP 2006). They include a north-south escarpment moist forest corridor, and an east-west corridor linkage through Yallah and Marshall Mount. The Marshall Mount corridor boundary needs to be negotiated as part of the upcoming West Dapto LEP Stage 5.

Through engagement with local flora and fauna experts and review of existing studies, regional corridors to the south of Wollongong LGA were defined. The north-south escarpment moist forest corridor was extended along the escarpment to the southern boundary of Kiama LGA, and major east-west links were also identified.

The information which was considered in the drafting of corridor boundaries includes:

- Aerial photography;
- Buffering of extant vegetation by 50m using SCIVI mapping - where other mapping did not exist;
- Mapping of high conservation value areas (Mills and Associates 2001 and 2006, NPWS 2003a);
- Advice from engagement with local flora and fauna experts; and
- Other studies which have outlined significant linkages (Mills and Associates 2001, SRCMA 2008, DoP 2006, WCC 2007).

The regional corridors maps are shown in Appendix 1 of Volume One. A summary of the main corridor links is provided below.


Escarpment Moist Forest Corridor

The escarpment moist forest corridor was originally defined in the Wollongong LGA from Helensburgh in the north, to the Calderwood Valley in Shellharbour (NPWS 2003). However, the southern boundary of this corridor was defined at Calderwood due to study area limitations. Physically, the moist forest corridor continues the length of the Illawarra Escarpment from the Royal National Park in the north, and continues to the south along the Escarpment through Shellharbour and Kiama LGAs, south to the Shoalhaven, where it ends at Cambewarra.

For the purposes of the Strategy, the boundaries were delineated only to Foxground to the southern boundary of the Kiama LGA. The Escarpment supports large area of native vegetation and a diversity of habitat types, and therefore contains a large proportion of the biodiversity of the Illawarra (Mills and Associates 2006b). The moist eucalypt forests provide quality habitat for bird, arboreal mammal, reptile and bat assemblages (NPWS 2002b). The Escarpment corridor provides the largest, continuous core conservation area in the region. Protection and improved connectivity of this corridor may allow for the recolonisation of fauna species that may be locally extinct in Wollongong, but are known to occur further south such as the Stuttering Frog and the Spotted-tail Quoll (NPWS 2002b). Threats to the Illawarra Escarpment occur mostly from development pressure in the foothills, and from pest animal and weed invasion.

Yallah Corridor

A few studies have attempted to define a corridor through the Yallah-Marshall Mount precinct (NPWS 2002b, Eco Logical 2004, WCC 2007). A Growth Centres Commission report (2008) on the West Dapto Release Area recommended review of this corridor. This corridor presents the main opportunity in the



Illawarra for conservation of the largest remnants of Illawarra Grassy Woodlands. This community is endemic to the Illawarra, and due to its distribution on the coastal plain in prime agricultural land, has been severely depleted. The conservation and management of this significant community will need to be managed through revised corridor designs that maximise connectivity and viability of this community into the future. Grassy woodlands in the Illawarra also provide quality habitat for bird, reptile and bat assemblages (NPWS 2002b). It is recommended that state agencies including DECCW, and the SRCMA are included in the redesign of this corridor as part of the West Dapto LEP Stage 5.

Catchment Corridor

The Catchment Corridor delineates the operational area of the Sydney Catchment Authority (SCA). These are lands that have been declared under the *Sydney Water Management Act 1987* for their value in the protecting the quality drinking water provided to greater Sydney, and for their ecological integrity (SCA and DEC, 2007). This land is managed by the SCA in accordance with the Special Areas Strategic Plan of Management (SASPoM). This plan is guided by two primary goals, firstly to protect water quality, and secondly to conserve ecosystem integrity, natural and cultural values (SCA and DEC, 2007).

Johnstons Spur Corridor

Johnstons Spur is an eastern corridor extension from the Escarpment Moist Forest Corridor. It has been identified as a core conservation area by Mills and Associates (2000) for its extensive area of dry foothills forests, including Red Gum and dry rainforest communities; habitat for several forest dwelling threatened fauna species; and habitat for many regionally significant flora and fauna species (Mills and Associates 2000).

Tongarra - Stockyard Mountain Corridor

Tongarra - Stockyard Mountain area in Shellharbour and Kiama LGAs has been identified as a core conservation area in Mills and Associates (2000) for its extensive areas of moist escarpment forests, extensive dry foothills forests including Red Gum and dry rainforest, habitat for forest dwelling threatened fauna species and several threatened and regionally significant flora and fauna species.

Saddleback Corridor

The slopes of Saddleback Mountain have previously been identified by Mills and Associates (2006b) as a core conservation area as it supports large stands of Illawarra Subtropical Rainforest known to provide habitat for several threatened species including *Daphnandra* sp. Illawarra, *Zieria granulata* and *Cynanchum elegans*.

Dunmore Hills Corridor

This area is defined as a core conservation area in Mills and Associates (2000) extending from Oak Flats, Dunmore and the Jamberoo Valley. It contains habitat for a range of threatened species and three EECs including Bracelet Honeymyrtle Shrubland (*Melaleuca armillaris*) which is restricted to the Killalea-Dunmore-Jamberoo area on volcanic outcrops (Gaia Research 2009). Recent fauna survey work (Gaia Research 2009) show the area supporting habitat for four threatened fauna species, and three threatened plant species.

Minnamurra River Estuary Corridor

The Minnamurra River forms the boundary between Kiama and Shellharbour LGAs. The estuary provides a rich diversity of habitats including mudflats, mangroves, saltmarsh and floodplain vegetation with important values for both terrestrial and aquatic fauna (Mills and Associates 2006b). The Minnamurra provides the largest estuarine system between Lake Illawarra and the Shoalhaven River (Mills and Associates 2006b).

Crooked River and Seven Mile Beach Corridor

The Crooked River and Seven Mile Beach form part of a coastal corridor south from Gerroa into the Shoalhaven LGA. The area supports several EECs including Littoral Rainforest, Swamp Oak Floodplain Forest, and Bangalay Sand Forest.

Corridor Considerations for Establishing Corridors

In urban and rural landscapes, corridor networks will require not only the use of public lands, but also private lands and the involvement of landholders and residents if local biodiversity is to be adequately maintained (Parker *et al.* 2008). Enlisting the support of local residents is a significant challenge for local government (Parker *et al.* 2008). The Southern Rivers CMA 'Escarpment to Sea' project will also provide incentive support to key landholders within the regional corridors for biodiversity improvement actions.

Local corridors have not been identified as part of this process, as the emphasis has been placed on regional strategies which will guide co-ordinate common biodiversity goals across the Illawarra. Local corridors have been identified in other previous work, however, require further consideration include:

- Croome - Blackbutt corridor;
- Keira green corridor;
- Kembla corridor; and
- Towradgi corridor;

6.11 ESTUARINE AND WETLAND HABITATS

Wetlands and estuaries in the Illawarra provide important habitats for a range of resident and migratory bird species, and unique plant assemblages. More than 1,500 hectares of wetland have been reclaimed in the Illawarra since European settlement for industrial, urban, sporting and agricultural purposes (Chafer 1997). In 1997, the area of wetland remaining was 1,044 hectares (Chafer 1997), and has possibly further been reduced since this time. The large majority of wetlands in the Illawarra occur in the Lake Illawarra and Minnamurra catchments.

Four wetlands in the Illawarra region are recognised as nationally important in the Directory of Important Wetlands in Australia (Environment Australia 2001). Table 17 outlines those listed wetlands and the LGA they lie within.

State Environment Planning Policy No. 14 (SEPP14) also lists certain coastal wetlands in the Illawarra region. The policy is designed to ensure coastal wetlands are protected. Under SEPP14, a proposal to carry out clearing of land, drainage works, land filling or the construction of levees within a classified wetland is designated development and requires an Environmental Impact Statement and consultation with the NSW Department of Planning. Table 17 outlines wetlands listed under SEPP14 and the LGA they occur within.

Table 17: Illawarra wetlands listed on the National Directory of Important Wetlands and SEPP14

<i>Wetland</i>	<i>LGA</i>	<i>National Directory of Important wetlands</i>	<i>SEPP14</i>
Lake Illawarra	Wollongong and Shellharbour	Yes	
Killalea Lagoon	Shellharbour	Yes	Yes
Coomaditchie Lagoon	Wollongong	Yes	
Minnamurra River Estuary (Including Dunmore Swamp)	Kiama and Shellharbour	Yes	Yes
Werri Lagoon	Kiama		Yes

Spring Creek	Kiama	Yes
Albion Park Aerodrome	Shellharbour	Yes
Haywards Bay	Wollongong	Yes
Koona Bay	Shellharbour	Yes
Wollingurri Point (Yallah)	Wollongong	Yes
Picnic and Werrang Islands	Shellharbour	Yes

The Ramsar Convention or 'Convention on Wetlands of International Importance' is an international register of significant wetlands. This convention recognises over 120 million hectares of internationally significant wetlands. Australia has more than 60 Ramsar sites registered (DECC 2008c), however, none to date are listed from the Illawarra region.

Wetland Care Australia and the Southern Rivers CMA have prioritised and mapped wetlands of the southern rivers region (Wetland Care Australia 2010). This work should be used as a guiding document for wetland priorities in the Illawarra region.

A number of coastal estuaries provide further wetland habitat in the Illawarra. Most of these are classified as ICOLLs (Intermittent Closed and Open Lakes and Lagoons) for which conditions within vary depending on whether they are open or closed to the sea (Industry and Investment NSW 2009).

Macrophytes (aquatic plants) of major estuaries and lakes of the Illawarra have recently been mapped (Industry and Investment NSW, 2009). This mapping covers Towradgi Creek, Allans Creek, Lake Illawarra, Elliott Lake, Shellharbour Creek, Killalea Lagoon, Minnamurra River, Werri Lagoon and Crooked River. This mapping delineates the distribution of seagrasses such as *Zostera*, *Halophila*, *Ruppia*, and mangrove and saltmarsh communities.

Table 18: Estuaries of the Illawarra

<i>Estuary</i>	<i>Management Plan</i>	<i>Council Responsibility</i>
Hargraves	Yes	Wollongong
Stanwell Creek	Yes	Wollongong
Stony Creek	Yes	Wollongong
Flannagans Creek	Yes	Wollongong
Hewitts Creek	Yes	Wollongong
Tramway Creek	Yes	Wollongong
Slacky Creek	Yes	Wollongong
Whartons Creek	Yes	Wollongong
Collins Creek	Yes	Wollongong
Bellambi Gully	Yes	Wollongong
Towradgi Creek	Yes	Wollongong
Fairy Creek	Yes	Wollongong
Tom Thumb Lagoon	Yes	Wollongong
Lake Illawarra	Yes	Lake Illawarra Authority in partnership with Wollongong and Shellharbour
Allans Creek	No	Wollongong
Lake Elliott	Yes	Shellharbour
Minnamurra	Yes	Kiama
Crooked River	Yes	Kiama on behalf of the Department of Lands.
Werri Lagoon	Yes	Kiama
Spring Creek	Yes	Kiama

Estuaries in the Illawarra are managed under estuary management programs. Each Council is guided by an estuary management program which defines priority actions, including actions relevant to biodiversity, in the estuaries under its responsibility.

Table 19: Estuary Management Plans

<i>LGA</i>	<i>Estuary Management Plans</i>
Wollongong LGA	Estuary Management Plan for Estuary Management Study and Plan for Fairy, Towradgi, Hewitts and Tramway Creeks 2005. Estuary Management Plan for Several Wollongong Creeks and Lagoons 2007. This addresses the following estuaries: Tom Thumb Lagoon (including Springhill and J.J. Kelly catchments; Bellambi Lagoon; Bellambi Gully (including Farrahars Creek catchment); Collins Creek; Whartons Creek; Slacky Creek; Flanagans Creek (including Thomas Gibson Creek); Stoney Creek; Stanwell Creek; and Hargraves Creek.
Shellharbour LGA	Elliot Lake Estuary Management Plan 2003.
Kiama LGA	Minnamurra River Estuary Management Plan 2003. Crooked River Estuary Management Plan 2003.

7 PRIORITISING RESTORATION WORKS ON PUBLIC LAND

As part of the Strategy, an assessment of the biodiversity values of public lands under Council care and control (Community and Crown land) was undertaken to identify priority sites for undertaking bush restoration.

Through engagement with the biodiversity reference group, a hierarchy of variables was identified to prioritise those sites with the highest biodiversity value. Each of these variables was classified to enable a systematic ranking of sites and their relative values. The ranking was based on a combination of variables including vegetation type, connectivity (presence within a regional corridor), patch size, and type of existing management. Each variable was classified with different score weightings as shown in Table 20.

Priority vegetation types were deemed to have the highest importance in determining priority sites. Once the priority vegetation types were identified, these were combined with the other variables. The existing management regime was also included so that current efforts would be acknowledged.

Table 20: Assessment matrix for determining priorities for protection and restoration of public lands

<i>Variable</i>	<i>Scoring approach</i>
Priority Vegetation	Priority 1 = 4 Priority 2 = 2
Connectivity	= 2 if intersects with mapped regional corridor
Patch size	>10ha = 3 2-10ha = 1 <2ha = 0
Management regime	Qualified bush regenerators = 2 Volunteer sites = 1 No active bush restoration = 0

The values in Table 20 are further explained below. The final ranking was determined by adding these scores as shown in Table 21.

Table 21: Community Land Priority Scores

<i>Score</i>	<i>Priority</i>
10 -11	Highest Priority
7-9	High Priority
3-6	Moderate Priority
<= 2	Low Priority

These priorities were reviewed by each of the partner Councils for anomalies brought about by weaknesses in the spatial data used. Amendments were made to the score where the generated score did not reflect biodiversity values known in the field.

Priority Vegetation Types

The classification of priority vegetation types is explained in Section 6.9.

Patch Size

Patch size classes were defined into three categories, 0-2ha, 2-10ha, and >10ha. This categorisation is based on studies that demonstrate that 2ha is the threshold for plants under which biodiversity declines rapidly (Drinnan 2006). Patch size was determined by assessing the extent of continuous vegetation beyond property boundaries.

Priority Sites

As a result of the assessment process described above, a ranking of Community and Crown land sites were derived for each LGA. The maps showing these priority sites are shown in Appendix 13.

In summary the highest priority sites for investment in the region are listed in Table 22. A larger number of High and Moderate Priority sites are also defined, and can be seen in the complete set of maps in Appendix 13.

Table 22: Highest priority sites for investment

<i>Reserve</i>	<i>LGA</i>
Minnamurra River Estuary	Kiama
Crooked River Estuary	Kiama
Jerrara Dam	Kiama
Bass Point Reserve	Shellharbour
Blackbutt Reserve	Shellharbour
Croome Reserve	Shellharbour
Bellambi Lagoon Recreation Area	Wollongong
Integral Energy Park-Darkes Rd	Wollongong
Mt Brown Reserve	Wollongong
Perkins Beach	Wollongong
Puckeys Estate	Wollongong
Purrungully Woodland	Wollongong
Bardess Crescent Reserve, Farmborough Heights	Wollongong

8 GUIDING PRINCIPLES FOR THE MANAGEMENT OF NATURAL AREAS

The management of natural areas should be guided by a clear set of management principles. The primary principle is the biodiversity benefits of protecting and enhancing existing remnant vegetation far outweigh those of 'compensatory' planting in cleared areas (AABR 2005). It is important to be mindful that clearing and planting in existing natural areas can irreversibly damage the integrity of natural areas and undermine their natural recovery potential. In an effort to minimise this threat, it is proposed the Illawarra Councils adopt the '3R Principles' as defined by AABR (2005) in 23.

Table 23: The 3R Principles

Retain first.	Conserving existing natural areas is the first priority. Efforts should be directed to protecting these areas from threatening processes such as weeds, grazing, stormwater, mowing etc.
Regenerate second.	Where bushland is degraded by threats such as weed invasion, grazing, or other disturbances, regeneration is the primary goal. This involves mitigating threats such as weed invasion to encourage natural regeneration.
Replant last.	Planting should only be considered after a site's natural ability to regenerate has been assessed as very poor.


A common barrier to this approach is the time constraints associated with grant funding and budget cycles. Grant funding is often an annual program, where insufficient time is allowed to monitor natural recruitment. Where possible, longer contracts should be negotiated so recruitment can be monitored and a planting schedule developed accordingly, if needed.

Other guiding principles for natural area management are:

- Threatening processes such as erosion, stormwater, and weed invasion should be controlled prior to revegetation work where possible.
- Plantings in or near bushland should ensure that no plant pathogens or weed propagules are introduced via potting media, on boots, gloves, tools, materials, equipment, vehicles etc.
- Mulch should only be used if it can be guaranteed weed free.
- Species selection should aim to replicate species diversity and structural complexity of prior original vegetation type. Species selection should aim to include species from all strata of the community.
- Plantings in natural areas should be recorded, including a map, date, species planted, number of plants of each species planted, provenance of each species, and source nursery.

8.1 PROVENANCE

Provenance is a term that refers to the location from where plant seed has been collected. Collecting from 'local' provenance has been the dominant approach in recent years due to the theory that local species exhibit provenance variation in morphological and physiological features, and are better able to cope with the local conditions. 'Local' has often been interpreted as from the target site, or as close as possible. However, due to the many various pollination strategies of different plant species, distance is thought to be a poor indicator of adaptive variation (Florabank 17/8/09). Collecting from the closest possible site may result in seed being collected from small, inbred populations which may have negative consequences for the receiving vegetation (Florabank 17/8/09).



It is now accepted that it is more important to match the environmental conditions at the seed collection site with those at the revegetation site (HNCMA, 17/8/09). Soil type, aspect, elevation, and the vegetation community are the obvious features to compare between sites.

Climate change brings new questions to the local provenance approach (Adam 2009), and debate is now turning to whether we should modify the 'local' provenance standards. A recent study (Broadhurst 2007) on the genetic diversity of small, isolated plant populations has shown that major negative genetic effects were observed when population size fell below 100-200 reproductive plants. Populations under this threshold are associated with declining seed production, inbreeding and increased hybridisation. For this reason, seed collection undertaken for revegetation projects should be sourced from large populations greater than 100-200 plants.

The Illawarra Councils propose to adopt the following recommendations adapted from the Hawkesbury-Nepean CMA (undated) and Broadhurst (2007) for provenance:

- Collect seed from large, healthy, genetically diverse, natural populations (more than 100 plants) or combine several collections from smaller populations within the Illawarra sub-catchment (defined by Wollongong, Shellharbour and Kiama LGAs).
- Identify target species for seed collection and collect mature seed.
- Collect seed from at least 20 widely spaced, healthy parent plants to maximise genetic diversity.
- Collect no more than 10% of the seed or 20% of the fruit on any individual plant.
- Ensure that seed is not over-collected from any site or population. and
- Seed collection should be undertaken from natural areas rather than parks and gardens.

Nurseries generally need 6-8 months lead time to grow tubestock, or up to 18 months if provenance seed is not available and is required to be collected. Seed collection needs to comply with licensing conditions set out in Section 132C of the National Parks and Wildlife Act 1974 (HNCMA, 17/8/09).

9 GRANT OPPORTUNITIES

The following outlines the major grant opportunities that can be sought to assist with implementation of the Illawarra Biodiversity Strategy.

9.1 CARING FOR OUR COUNTRY

Caring for our Country is the Federal Government's natural resource management program. It commenced on 1 July 2008 and integrates delivery of the Commonwealth's existing natural resource management programs: the Natural Heritage Trust; the National Action Plan for Salinity and Water Quality; the National Landcare Program; the Environmental Stewardship Program; and the Working on Country Indigenous Land and Environmental Program.

Further information : <http://www.nrm.gov.au/funding/index.html>
Phone: 1800 552 008.

9.2 LAND AND PROPERTY MANAGEMENT AUTHORITY – CROWN LANDS PROGRAM

The Land and Property Management Authority NSW (LPMA) provides grant opportunities to assist managers of Crown land. Funding is made available to improve facilities, and protect the heritage value of the Crown land.

Further information: http://www.lands.nsw.gov.au/crown_land/crown_reserves/funding
Phone: 02 9228 6666.



9.3 INDUSTRY AND INVESTMENT NSW - FISH HABITAT RESTORATION PROGRAM

Habitat Action Grants are open to individuals, community groups, and local Councils for projects to enhance fish habitat including rivers, creeks, estuaries, and wetlands in NSW. Grants are limited to \$30,000 (GST excl) and proposals should include matched funds or contributing in-kind support from the applicant or other sources. Habitat Action Grant proposals are advertised by Industry and Investment NSW (formerly DPI) every year, usually around August.

Further information : [http://www.dpi.nsw.gov.au/fisheries/recreational/your-fees/habitat-action-grants-funding-up-to-\\$30,000](http://www.dpi.nsw.gov.au/fisheries/recreational/your-fees/habitat-action-grants-funding-up-to-$30,000)

Ph: (02) 6626 1107 or (02) 4916 3926.

9.4 NSW ENVIRONMENTAL TRUST

The Restoration and Rehabilitation Program aims to protect, restore and enhance degraded natural ecosystems, and for waste avoidance and recovery. Funds are usually available for community groups, and State and Local Governments.

Further information : <http://www.environment.nsw.gov.au/grants/restoration.htm>

Phone: (02) 8837 6093.

9.5 EDUCATION FOR SUSTAINABILITY GRANTS PROGRAM

The Education for Sustainability Grants Program aims to support projects that facilitate changes in community attitudes and behaviours in support of sustainable development in Australia.

Further information : <http://www.environment.gov.au/education/programs/index.html>

Ph: 02 6274 1111.

9.6 SOUTHERN RIVERS CMA

'Caring for our Coasts' is a NSW wide program, funded by the Australian Government's Caring for our Country Program. This program aims to strengthen the awareness and capacity of coastal communities to rehabilitate and protect priority coastal ecosystems. Community groups and Councils with an interest in protecting and restoring coastal environments are able to submit proposals for funding between \$5,000 and \$50,000.

Further information : <http://www.southern.cma.nsw.gov.au>



10 REFERENCES

AABR and National Trust (2005) Planting in Bushland? (factsheet).

Adam, P. (2009) Going with the flow? Threatened species management and legislation in the face of climate change. *Ecological Management and Restoration* Vol 10 (1), 44-52.

Auld, T.D. and Keith D.A. (2009) Dealing with threats: Integrating science and management. *Ecological Management and Restoration* Vol 10 (1), 79-87.

BES (2006) Strategic Weed Management Plan. Illawarra Escarpment. A report for Wollongong City Council by Bushfire Environmental Services.

Briggs, J.D. and Leigh, J.H. (1996) Rare or Threatened Australian Plants. Revised Edition, CSIRO Publishing, Collingwood.

Broadhurst, L. (2007) Managing genetic diversity in remnant vegetation. Technical Note 01/2007. Published by the Australian Government Department of Land and Water. Retrieved on 10/9/09 from <http://lwa.gov.au/files/products/native-vegetation-program/pk071323/pk071323.pdf>

Chafer, C. (1997) Biodiversity of Wetlands in the Illawarra Catchments, An inventory. Illawarra Catchment Management Committee.

Chafer, C.J, Brandis, C.C.P. and Wright, D. (1999) Handbook of Birds found in the Illawarra, Shoalhaven and Adjacent Tablelands. Illawarra Bird Observers Club, Wollongong.

Commonwealth of Australia (2009) Australia's Biodiversity Conservation Strategy 2010-2020. Consultation draft. Prepared by the National Biodiversity Strategy Review Task Group.

Coutts-Smith, A.J., Mahon, P.S., Letnic, M. and Downey, P.O. (2007) The threat posed by pest animals to biodiversity in New South Wales. Invasive Animals Cooperative Research Centre, Canberra.

DEC (2004) Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities. Working Draft. Department of Environment and Conservation (NSW).


DECC (2007a) Terrestrial Vertebrate Fauna of the Greater Southern Sydney Region. Volume 2: Fauna of Conservation Concern and Priority Pest Species. A joint project between the Sydney Catchment Authority and the Department of Environment and Climate Change (NSW).

DECC (2007b) Adaptation Strategy for Climate Change Impacts on Biodiversity. Actions to implement the National Biodiversity and Climate Change Action Plan and the NSW Biodiversity and Climate Change and Adaptation Framework. Published by DECC, Sydney, NSW.

DECC (2007c) Introducing the NSW Threatened Species Priorities Action Statement (PAS).

DECC (2007d) Terrestrial Vertebrate Fauna of the Greater Southern Sydney Region. Volume 4: The Fauna of Metropolitan, O'Hares Creek and Woronora Special Areas. A joint project between the Sydney Catchment Authority and the Department of Environment and Climate Change (NSW).

DECC (2008a) Summary of Climate Change Impacts, Illawarra Region.



DECC (2008b) Threatened species prioritisation and implementation strategy for the priorities actions statement. EPRG, Metropolitan Branch.

DECC (2008c) (updated 21/2/08) Ramsar Wetlands. Retrieved on 21/9/09 from <http://www.environment.nsw.gov.au/wetlands/RamsarWetlands.htm>

DECC (undated) Threatened Species Priorities Action Statement Database. Retrieved from http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/pas_search.aspx

DECCW (undated) Native Vegetation Type Standard. Department of Environment Climate Change and Water.

DECCW (2009) The Native Vegetation of the Sydney Metropolitan Catchment Management Authority Area. Department of Environment and Climate Change NSW, Hurstville.

DEFRA (2007) Conserving biodiversity in a changing climate: guidance on building capacity to adapt. Department of Environment and Food Affairs, UK.

DEWHA (2009) (updated 22 Jan 2009) Bilateral Migratory Bird Agreements. Department of Environment Heritage, Water and the Arts. Retrieved 9/11/09 from <http://www.environment.gov.au/biodiversity/migratory/waterbirds/bilateral.html#rokamba>

Drinnan, I.N. (2006) The search for fragmentation thresholds in a southern Sydney suburb. *Biological Conservation*. Vol 124, 339-349.

Department of Planning (2006) Illawarra Regional Strategy 2006-2031. New South Wales Government Department of Planning.

Eco Logical Australia (2004) Flora and Fauna assessment, West Dapto Transport Link. Report prepared for Wollongong City Council.

Eco Logical Australia (2007) Goulburn Mulwaree Biodiversity Strategy. Prepared for Goulburn Mulwaree Council.

Environment Australia (2001) A Directory of Important Wetlands Australia. Retrieved on 13/8/09 from <http://www.environment.gov.au/water/publications/environmental/wetlands/directory.html>


Fairley, A. (2004) Seldom Seen. Rare plants of Greater Sydney. Reed New Holland, Australia.

Florabank (undated) Species and Provenance Selection. Retrieved on 17/8/09 from http://www.florabank.org.au/default.asp?V_DOC_ID=961

Gaia Research Pty Ltd (2009) Fauna surveys in remnant forests in the Dunmore region of the Illawarra. Report prepared for the Department of Environment and Climate Change.

Growth Centres Commission (2008) West Dapto Release Areas Review. Planning report prepared for Wollongong City Council.

HNCMA (undated) Using plants of local provenance in the Hawkesbury–Nepean catchment. Factsheet. Hawkesbury Nepean CMA. Retrieved on 18/8/09 from



http://www.hn.cma.nsw.gov.au/multiversions/4230/FileName/provenance%20fact%20sheet_low%20res.pdf

Hobbs, R.J. and Yates, C. J. (2003) Turner Review No. 7. Impacts of ecosystem fragmentation on plant populations: generalising the idiosyncratic. *Australian Journal of Botany*. Vol. 51 (5) 471-488.

Industry and Investment NSW (2009) Mapping the habitats of NSW estuaries. A report to the Hunter Rivers Catchment Management Authority. <http://www.dpi.nsw.gov.au/research/areas/systems-research/aquatic-ecosystems/estuarine-habitats-maps>

Lindenmayer, D. B. and Fischer, J. (2006). Habitat fragmentation and landscape change: an ecological and conservation synthesis. Island Press, Washington D.C.

Lindenmayer, D. (2007) On Borrowed Time. CSIRO Publishing.

LGSA (2009) Integration of Natural Resource Management into Local Government Operations: Volume 2: Land Use Planning. A report prepared for the Local Government and Shires Association.

Mills, K. and Associates (1988) The Conservation of Rainforest Plant Species, Illawarra of New South Wales: Inventory, Assessment and Recommendations for Management. National Parks and Wildlife Service of New South Wales, Hurstville, Australia.

Mills, K. and Associates (2000) Nature Conservation Study Rural lands Study Area, City of Shellharbour. Unpublished report for Shellharbour Council.

Mills, K. and Associates (2001) The Natural Vegetation in the City of Shellharbour. Unpublished report for Shellharbour Council.

Mills, K. and Associates (2006a) The Natural Vegetation in the Municipality of Kiama, NSW. Unpublished Report for Kiama Municipal Council.

Mills, K. and Associates (2006b) The Fauna of Kiama. Unpublished Report for Kiama Municipal Council.

NCC (1999) Toward an Illawarra Regional Vegetation Management Plan Unpublished report prepared by Robinson, M.V., Robinson, A.G, Bofeldt, A.T., Corby, R., Clegg, M., Asquith, J. and Kravchenko, P. Nature Conservation Council of NSW, Sydney. Volumes 1 & 2.


NPWS (2002a) Bioregional Assessment Study Part I. Native Vegetation of the Illawarra Escarpment and Coastal Plain.

NPWS (2002b) Bioregional Assessment Study Part II. Fauna of the Illawarra Escarpment, Coastal Plain and Plateau.

NPWS (2003a) Bioregional Assessment Study Part III. Conservation Assessment identifying areas of National, State and bioregional significance for biodiversity within Wollongong LGA.

NPWS (2003b) The Native Vegetation of Woronora, O'Hares and Metropolitan Catchments. Unpublished report commissioned by the Special Areas Plan of Management (SASPoM).

NSW Government (2006) State Plan. A New Direction for NSW. Retrieved from <http://www.nsw.gov.au/stateplan/>



NSW Scientific Committee (2005) Final Determination: Alteration of habitat following subsidence due to longwall mining.

Parker, K., Head, L., Chisolm, L. and Fenely, N. (2008) A conceptual model of ecological connectivity in the Shellharbour Local Government Area, New South Wales.

Puslednik, L. (2002) Dietary preferences of two species of *Meridolum* (Camaenidae: Eupulmonata: Mollusca) in southeastern Australia. *Molluscan Research* 22; 17-22.

Southern Rivers CMA (2006) Catchment Action Plan. Southern Rivers CMA, Wollongong, NSW.

Southern Rivers CMA (2010) Illawarra NRM Action Plan. Southern Rivers CMA, Wollongong, NSW.

SCA and DEC (2007) Special Areas Strategic Plan of Management. Prepared by the Sydney Catchment Authority, and the Department of Environment and Conservation.

Tozer M.G., Turner, K., Simspon, C., Keith, D.A., Beukers, P., Mackenzie, B., Tindall, D., and Pennay, C. (2006) Native Vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. NSW Department of Environment and Conservation and NSW Department of Infrastructure, Planning and Natural Resources, Sydney.

Wetland Care Australia (2010) Map compilation, Wetland Classification and Prioritisation Attribute Assignment. Healthy wetlands for healthy catchment in the Southern Rivers region (SRCMA). A project undertaken for Southern Rivers CMA.

WCC (2005) Illawarra Escarpment Strategic Management Plan. Prepared by Wollongong City Council.

WCC (2007) Yallah - Marshall Mount Precinct Native Vegetation Strategy. Draft for public exhibition. Prepared in conjunction with DECC, Dept. of Planning and SRCMA. Prepared by Wollongong City Council.



11 APPENDICES

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