SYDNEY COASTAL COUNCILS GROUP

SYDNEY'S SALTY COMMUNITIES
turning the tide for blue+green carbon

Sydney's Salty Communities – Turning the Tide for Blue + Green Carbon

Literature, Data and Practice Review

August 2015

About this document

Statement of Authorship *This study and report was undertaken by Ecological Consultants Australia for the Sydney Coastal Councils Group. Main author of the report is Mia Dalby-Ball whose qualifications are BSc Hons 1, majoring in Environmental Management and 20 years' experience in ecological assessment and management. Others in the study from ECA are Smita Pandey BSc, Polly Simmonds BSc, and Emerald Cuthbertson BEng.*

Limitations Statement

The high volume of potential information influenced the depth of the study. In general, broad issues were identified rather than detailed investigations being undertaken.

Acknowledgements

SCCG provided mapping data. Special thanks to Prof. Gee Chapman who assisted with the structure for reviewing Biodiversity Strategies (5.1, local government section), all those council personnel and Diana Charteris at AusGrid, who participated in interviews. Special appreciation to Fiona Shadbolt of Sydney Coastal Councils Group for technical input and editing. Thanks to Smita Pandey for obtaining copies of Local Government documents and Emerald Cuthbertson from Acacia Environmental Solutions for overall project review.

Acknowledgement of Country

In this investigation of information about biodiversity in Sydney's Salty Communities, we recognise the long and continuous connection of the Original People with the coastal zone. We respect their detailed knowledge of plants, animals, seasons and longer cycles. We acknowledge the Original People, Traditional Custodians and Elders past, present and future.

Figure 1. LHS Narrabeen Lagoon by Jessica Birk and RHS Sand balls from crabs in an intertidal zone – Pittwater

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1 Summary of Key Findings

- Sydney's Salty Communities, as defined in this project, are Sydney's urban waterways and coastal environments as defined by the Australian Government in relation to the Australian Government Biodiversity Fund Round 2 projects together with SCCG Member Council LGAs and mapped in Figure 3 (p12) from littoral zone to limit of tidal influence.
- SCCG commissioned mapping of Salty Communities, which found there were 55 ecological communities present. This review notes additional Salty Communities, some human created, in the Study Area. All are presented in this document.
- Most federal and state planning documents do not have a section on coastal biodiversity management with the exception of NSW Government Marine Estate. While vision documents refer to marine environments there is a greater focus on managing terrestrial biodiversity.
- Legislation at federal and state level has protection for coastal species and communities, however these are isolated from overall strategic catchment and planning focused documents.
- While federal legislation has measures to protect biodiversity, including the coastal environment, federal level involvement rarely occurs due to the relatively small sizes of area or the low number of effected species (such as with migratory waders). This is despite these communities and species being threatened, often due to incremental loss. Examples include: littoral rainforest, saltmarsh and migratory wading birds needing 10% of flyway to trigger federal involvement.
- In the case of the NSW Vision document *A Plan for Growing Sydney* (Department of Planning and Environment); the Sydney Coastal Zone is all within the metropolitan growth area, with the exception of the existing National Parks. The biodiversity focus is in the west and predominantly covers terrestrial areas.
- Urban Coastal biodiversity is missing from state government agencies' focus and vision statements. Office of Environment and Heritage (OEH) data (e.g. Bionet) and management recommendations (as found in Recovery Plans and Priority Action Statements) are useful and used by local government with on-ground management. State government input to planning in the Salty Communities is largely within the Regional Environmental Plans (REPs) and State Environmental Planning Policies (SEPPs).
- Roads and Maritime Services (RMS), EPA and Office of Water have a regulatory and development assessment role in the coastal zone. Grey areas still exist between state and local roles and responsibilities. Sydney Water (SW) conducts on-ground works in the Coastal Zone including concrete channel naturalisation and saltmarsh creation projects. SW frequently gathers data (water quality) including in the coastal zone and is responsible for water quality as it relates to ocean outfalls and storm water and sewerage overflows. All of this can affect Salty Communities.
- Authorities such as *Sydney Olympic Park Authority* (SOPA) conduct work in intertidal ecosystems, particularly mangroves and saltmarsh, which aim to increase the quality and quantity of these communities. Utility management corporations, such as NSW Ports, AusGrid Jemena, and Rail Corp, conduct assessments and on-ground works in Salty Communities. All have biodiversity information and protocols for working in these ecosystems. These include excellent examples of systems and practices.
- Local Land Services (LLS) appears to be the closest agency to on-ground works in NRM, and the coastal zone is yet to be defined in its charter. The apparent focus is towards rural areas. Greater Sydney LLS may begin to include a greater role in facilitating biodiversity management in the coastal zone. Greater Sydney LLS is about to (re)start the process of putting together both a regional and local strategic plan. The process will include consultation with local government and the community.

- Local government information (literature and data) pertaining to biodiversity management varies considerably ranging from overarching statements to precise locations identified with targets and actions. Generally the literature and data have terrestrial biodiversity mapping, knowledge and actions. While seagrass is included in data (mapping), intertidal areas are absent.
- Visions for biodiversity are included in Community and Sustainability Plans – generally these are too broad to mention the salty strip of the coastal zone specifically. Even within Coastal Zone Management Plans, coastal biodiversity is not a focus whereas flooding and erosion are major issues.
- Local government policy, planning information and data is generally contained in DCPs and LEPs and less so in individual policies.
- Biodiversity management information is generally contained in Biodiversity Plans, Bushland Plans and Reserves Plans of Management. Level of detail varies from detailed actions and Key Performance Indicators to only high level objectives.
- Practice Review of local government shows the role of local government in Estuary and Coastal Management is key. The Estuary Management Practice has been in place for years. Local government is the co-ordinator of strategy and works with input from relevant agencies. Projects need funding from those state agencies responsible for the land, with councils generally responsible for works above mean-high water. Local governments' co-ordinating role in estuary management may be mimicked in coastal management.
- Community members, groups and NGOs such as Birds Australia, Wildlife Rescue Centres, EcoDivers and Ocean Watch collect and collate data on coastal biodiversity in Sydney. More could be obtained from the NGOs and community for review.

Gaps

Gaps found in coastal biodiversity information for management have been included in this review at the end of each section on an area of biodiversity. Key gaps are presented in the conclusions of this report. A quick summary follows:

- Coastal intertidal zone – missing from 80% of Council Biodiversity Plans or equivalent documents. Also missing, in detail, from state and federal government urban release plans.
- Coastal biodiversity is covered in federal biodiversity plans.
- Greater Sydney LLS is yet to write Regional and Local Plans (working with local government and community).
- Condition of marine communities (seagrass and soft bottom benthos) and some intertidal communities (saltmarsh and mangroves).
- Template conditions on consent or requirements for consultants advising on mitigation of works in areas of coastal biodiversity.
- Clarity of jurisdiction and responsibility over matters in the marine and intertidal zone (e.g. nets on swimming areas).
- Environmental training for planning, compliance and open space management personnel.
- Locally relevant standards for gaining base-line data and monitoring biodiversity in Salty Communities.
- Biodiversity management could be occurring more effectively across local government boundaries.
- Locally accurate science relating to potential changes in physical conditions in the coastal zone – e.g. sand dynamics: some beaches may accrete while others erode.
- Effectiveness and alternatives for mitigation of impacts in the coastal zone – e.g. is raising saltmarsh level

effective in keeping it in the optimal tidal inundation zone?

- Funding: councils as co-ordinators of the Estuary Management Practice are ready to continue their role in joint agency projects, such as seagrass work; however funding is required.
- Use and accessibility of available science by biodiversity managers in the coastal zone.

Table of Contents

2 Purpose of Report

As part of SCCG's *Sydney's Salty Communities — Turning the tide for Blue + Green Carbon* project, SCCG, engaged ECA to assist with the review and assessment of the information on coastal zone biodiversity management and knowledge with a focus at the scale of local government (LG). Information covered is literature, data and practice relating to biodiversity in the Study Area.

The Study Area is within the Sydney Coastal Area (Figure 3) and covers parts of Sydney influenced by salty rivers and coastal processes. Councils participating in this review include the SCCG members: Botany Bay, Hornsby, Leichhardt, Manly, Mosman, North Sydney, Pittwater, Randwick, Rockdale, Sutherland Shire, Sydney, Warringah, Waverley, Willoughby and Woollahra.

The review provides a snapshot of biodiversity planning in the Sydney region. Recommendations focus on local government. A snapshot of local government biodiversity information was reviewed. It identifies gaps in biodiversity information in terms of literature, data and practice.

Specifically, outcomes for the literature, data and practice review include:

1. Local government input on use of existing information (literature, data, practice) and identification of knowledge/practice gaps and priorities.
2. Review of local government biodiversity strategies and broad area management plans.
3. Review of state and federal government information online providing a summary of biodiversity vision/plan/management for the Sydney Coastal Zone.
4. Brief evaluation of some on-ground works in relation to their success and how to use this information in the future.

The review of biodiversity strategies can provide a better understanding of baseline data of the Study Area, current knowledge of biodiversity and existing management practices. It can also be used to evaluate priority areas for projects and evaluate strategic plans, research projects and other information.

Information presented contributes to existing knowledge, high level identified visions, knowledge gaps and discrepancies between planning and on-ground practices.

3 Background

Sydney's coastal zone is characterised by a wide range of geographical features, including ocean beaches, dunes, cliffs, headlands, flood-plains, estuaries, wetlands and lagoons. Sydney basin is drained by the Hawkesbury–Nepean River as well as the Parramatta, Georges, and Cooks Rivers. Four main estuary systems occur in the Sydney region. Coastal lagoons and wetlands are common. In addition to this there are 38 ocean beaches. Examples are shown in Figure 2, below.

a. *Zostera* sp. seagrass exposed at low-tide Pittwater

b. Palm Beach and Pittwater looking South from the headland

c. Bush regeneration in Littoral Rainforest Bungan Beach

d. Cliffs and rocky shores of Bronte – Clovelly

e. Coastal Alluvial Bangalay Forest EEC along Narrabeen Lagoon

Figure 2a-e. Examples of Sydney Coastal Environments (Source: Mia Dalby-Ball ECA)

Sydney Coastal environments include 11 threatened ecological communities; numerous listed threatened and migratory fauna and flora species and several endangered flora and fauna populations (Gang-gang Cockatoo, Koala, Squirrel Glider, Little Penguin, Tadgell's Bluebell, *Allocasuarina diminuta* subsp. *mimica*, *Prostanthera saxicola* and *Darwinia fascicularis* subsp. *oligantha*).

Remnant vegetation communities are usually small and highly valued by community. Fauna often moves between public and private spaces and long-term sustainability of populations requires active and on-going management in these urban areas.

> *The vast majority of the coastline is developed, with habitat located across land in private ownership, National Park, Nature Reserve, Historic Site or Aboriginal area, and Crown land.*
>
> *No single government level is responsible for the management of the coast. The various policies and programs have legislation from several government departments as their basis, and are often implemented by local councils or the community, either in partnership with the state government or independently.*
>
> (Smith 1997)

SCCG commissioned the review of literature, data and practice to assess local government management tools and practices of managing biodiversity now and into the future and to present a summary of what is known today and to highlight gaps and opportunities in coastal biodiversity management into the future.

4 Methods

Following is a summary of the methods applied during this information review. Within the resourcing and time frame it was not possible to review all literature relating to biodiversity. As a result, methods were chosen which focused on gathering information to understand biodiversity in the Study Area and how local governments manage this. In addition to this, methods sought to provide an understanding of the current state and federal government's management of coastal biodiversity in the Study Area.

The key terms, which shaped the scope of this review, were:

1. Salty Communities: For this project Salty Communities refers to a list of vegetation communities, the fauna within them and the ecosystem processes. The communities include submerged, intertidal and terrestrial environments and are provided in Attachment II.
2. Coastal Zone for the purpose of this information review: The general Study Area is shown in Figures 1-3. The mapping of communities, provided by SCCG, shows detailed locations of 'Salty Communities' in the Study Area. Attachment III contains the 1997 Coastal Policy definition of the Coastal Zone. While there was a focus on the member councils of the SCCG all other Sydney LGAs with Salty Communities were invited to be part of this study and included where they expressed interest.

A full glossary is provided in Attachment I.

Information was then categorised into three areas:

- Literature – written documents, written information on websites and to a lesser extent media releases
- Data – numbers, graphs, mapping, GIS.
- Practice – a broad area including the practices of consultation, designing, approving, contracting, engaging community and monitoring (the procedures of doing). Practice also includes the actual on-ground works and the practice of implementing the management of biodiversity. Information from the Practice Review was gained through both interviews with local government representatives and via gaps identified in literature.

In summary, the information was sourced from:

1. Local government (councils) – see list in Attachment IV.
2. NSW state government agencies in the field of Biodiversity (see list in results section).
3. Federal government agencies in the field of Biodiversity (see list in results section).
4. Authorities including Sydney Olympic Park Authority and Utility managers e.g. AusGrid and Jemena.
5. Research institutions such as the Centre for Research on Ecological Impacts of Coastal Cities (EICC) and CSIRO and individuals carrying out coastal biodiversity research such as those on the SCCG Salty Communities Expert Reference Group.
6. Community, NGOs and other relevant sources.

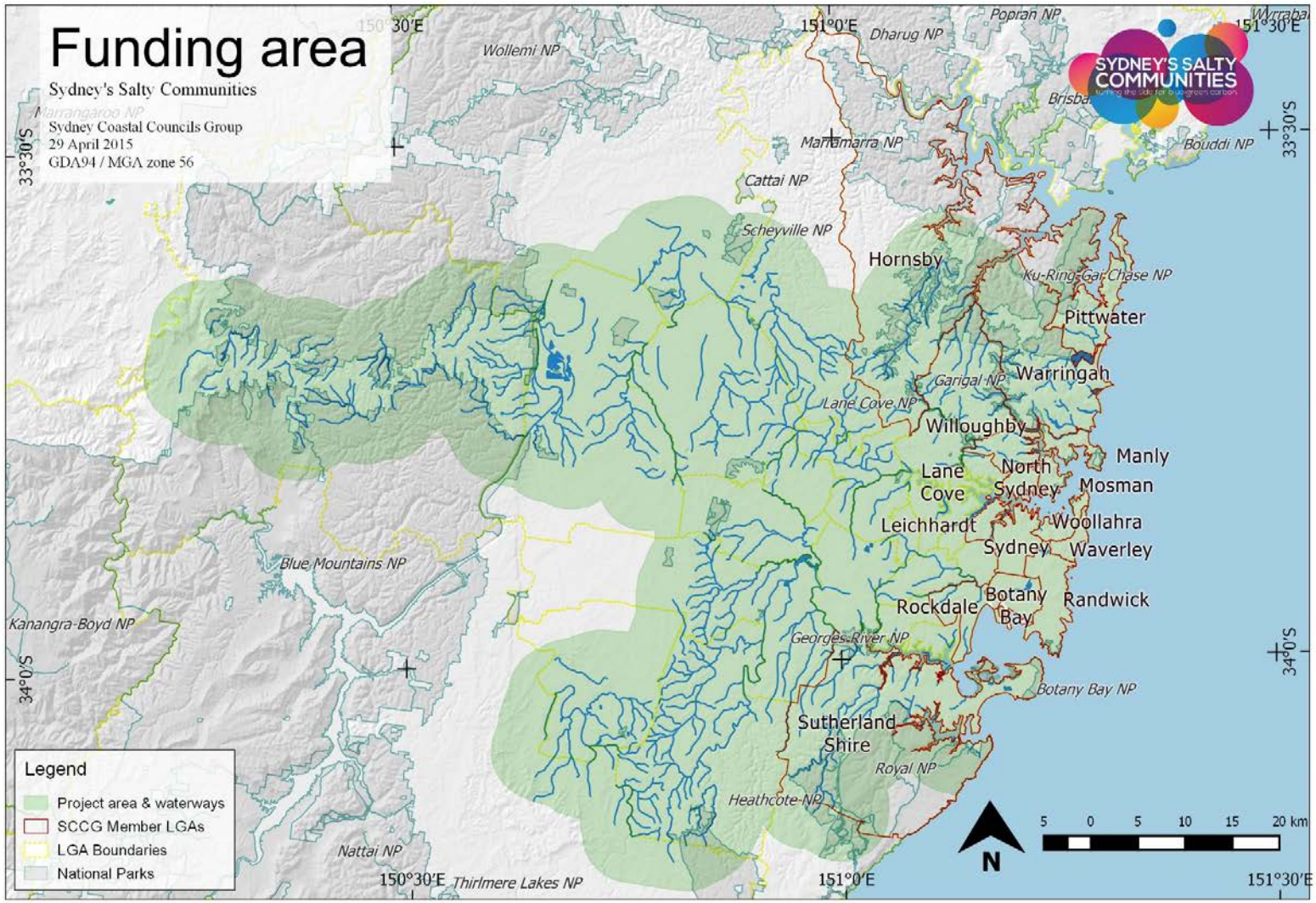


Figure 3. Green shaded area indicates the area covered by the Salty Communities project (Source: SCCG)

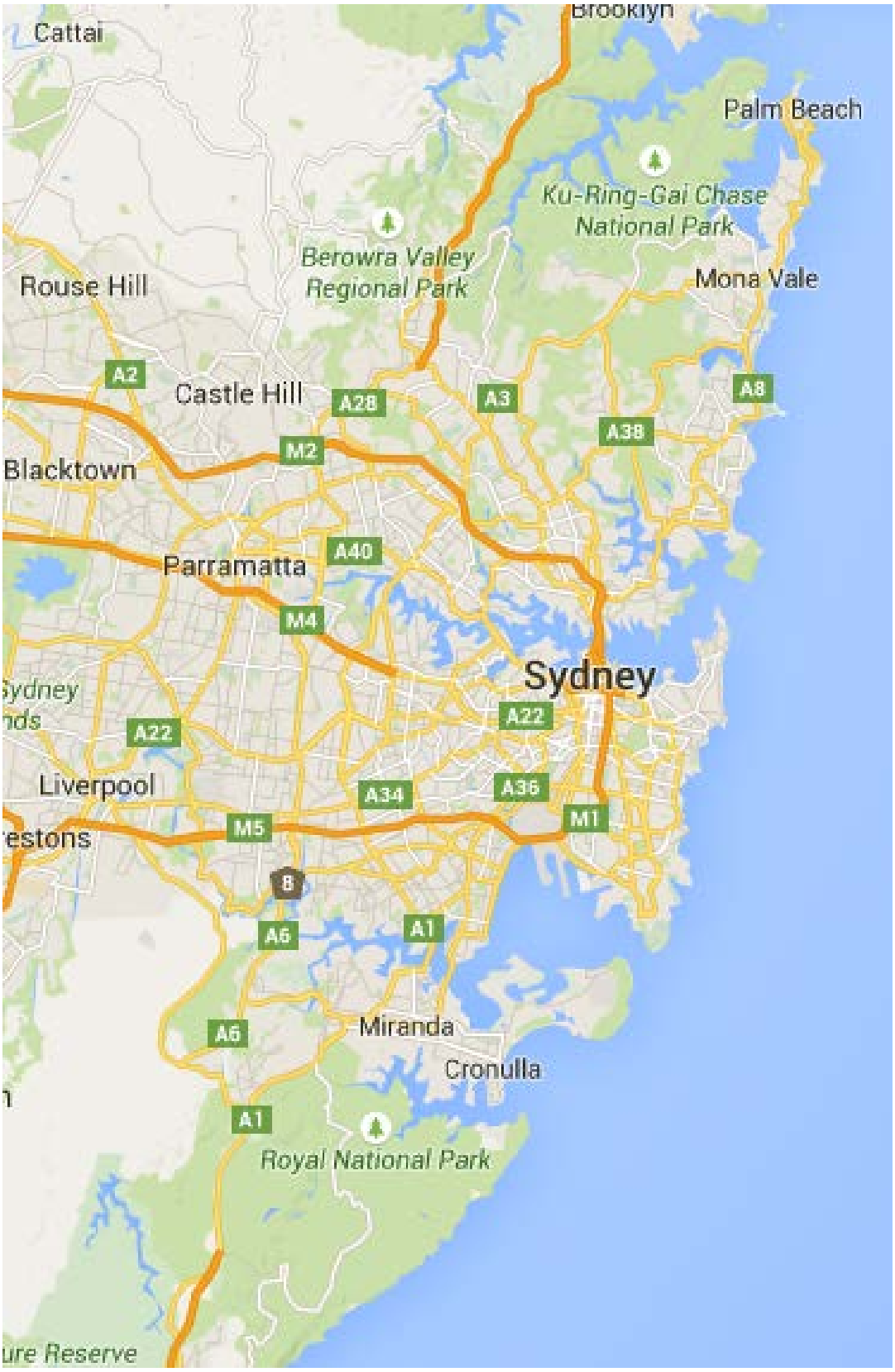
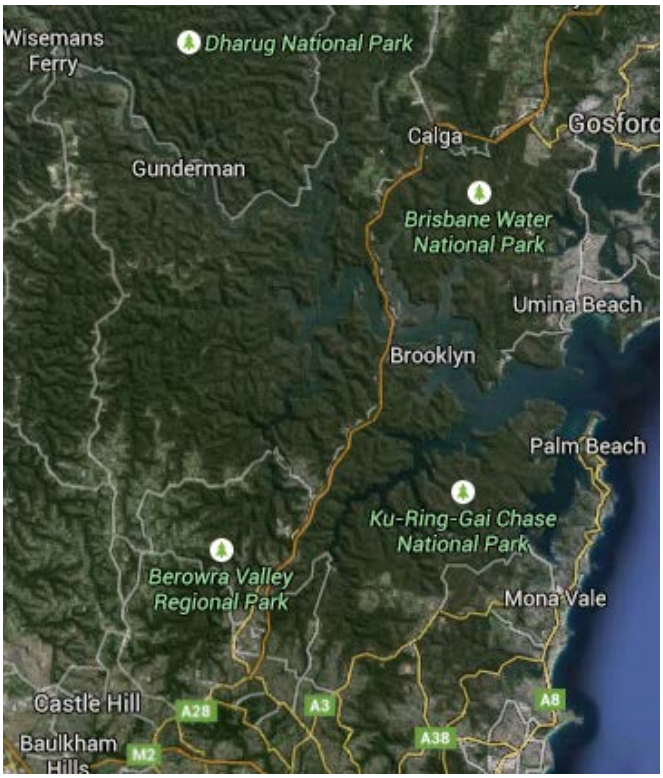


Figure 4a. Primary Locations of Salty Communities in Sydney (Source: Road map: Google. SixMap NSW)



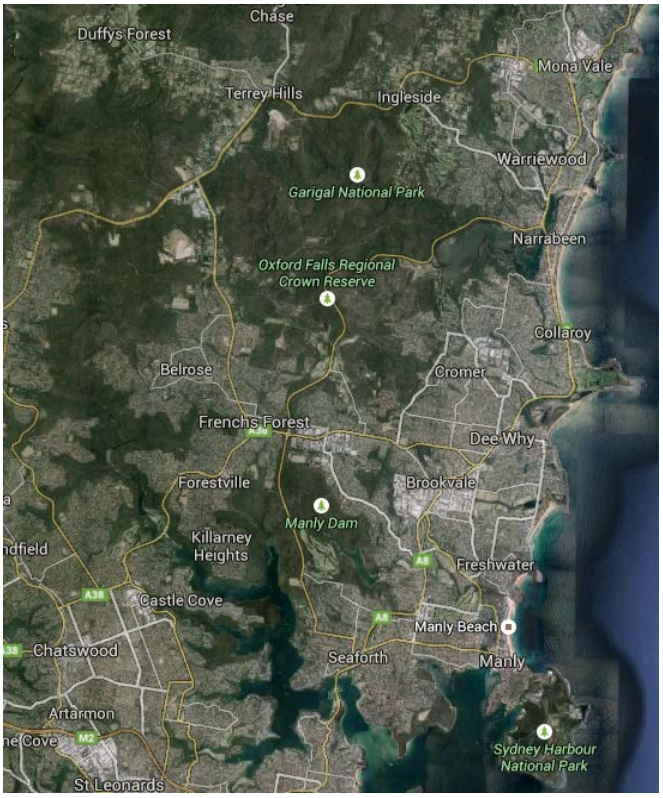
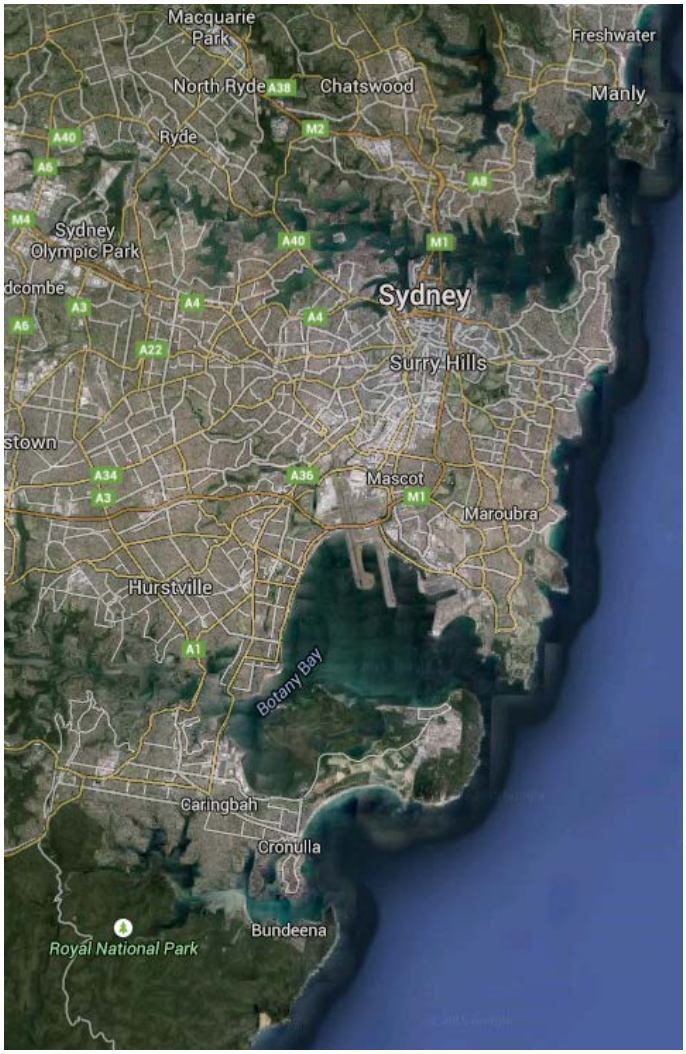


Figure 5a Top RHS: Palm Beach and Ku-ring-gai Chase National Park and west to encompass Hornsby Shire LGA.

5b Lower RHS: Mona Vale to Manly

5c LHS: Manly to Bundeena

(Source: Google Maps)



4.1 Where Information was sourced

While local government was the focus of this review, information was also sought from federal and state government agencies, authorities and corporations as well as from scientific research, community and NGOs.

Stakeholders include all Sydney councils, other government agencies, researchers, practitioners, policymakers, not-for-profit organisations and the community. The core groups for providing information to this project are the SCCG member councils, Salty Communities working group and Salty Communities Expert Reference Group.

Regional information, such as that from Greater Sydney Local Land Services (GSLLS), has been included where it was readily available.

International information was sought in terms of numbers of papers available in the key areas of interest — the ecological communities in focus and those studies relating to the theme areas of corridors and urban salty community biodiversity. Due to the volume of information, international papers were not reviewed.

The Working Group and Expert Reference Group are SCCG Committees established specifically for the Salty project.

4.2 How Information was sourced

Workshops

In December 2014 a presentation was made at a Working Group meeting and another at an Expert Reference Group meeting held in February 2015.

Email

Email was used for initial communications including information to councils about the project. Email was used to follow up after any workshop or survey to confirm the information shared.

Phone or face-to-face interviews

Interviews were conducted by ECA with each representative of the contributing councils.

During the interviews, information collated in the *Salty Communities Master Sheet* was reviewed and updated (see Attachment II). Detailed information was gained on where to access the original information (e.g. website, or if unpublished, or not public, whether it was available for review). Information that was not public, but available for review, was sent to SCCG and then, with the owner's permission, sent to ECA, or to ECA directly.

Interviews also covered the areas of practice review and gaps. The responses were written directly into the Master Sheet. Interviews allowed for open discussion on topics, including enabling findings to be considered in the report with the information being presented anonymized.

Surveys by phone were preceded with an outline of what was going to be asked, and then followed up with an email of discussion, with all data collated in the *Salty Communities Master Sheet – Council Survey Response.* Respondents were only sent information relating to their own council. No information was shared outside of ECA and SCCG without the approval from the representative providing it. Questions asked have been included in the literature findings section. Survey responses from council staff have been provided to SCCG as a separate Excel table.

Interviews with other agencies were limited to AusGrid and Sydney Water.

The Saltmarsh and Mangrove Conference (Feb 2015) was attended to discuss with representatives from Fisheries, CSIRO, NPWS and scientists working in the areas of seaweed, seagrasses, marine protected areas, mangroves and saltmarsh, and including the area of carbon sequestration in mangroves and saltmarsh.

Website Reviews

Website reviews were obtained by referring to data collected during interviews with council representatives as well as other relevant information. Website reviews were also conducted on the state or federal government sites responsible for the management of biodiversity. Specifically, these included:

- State agencies: Office of Environment and Heritage (OEH), Office of Water (OoW), Environmental Protection Agency (EPA) , Fisheries (DPI), Sydney Water (SW), Greater Sydney Local Land Services (LLS), Dept. of Planning and Environment (DPE), Dept. of Health (DoH) and state authorities: Rural Fire Service (RFS), and Sydney Olympic Park Authority (SOPA).
- Utilities: Ausgrid and Jemena
- Federal: Department of Environment (DoE) and agencies within DoE.
- Global: Instruments for conserving biodiversity based on the five key instruments of protection for biodiversity (see section 5.1).

4.3 How Information was reviewed

4.3.1 Literature

Literature was in the form of written documents including scientific papers, written information on websites and to a lesser extent media releases and other unpublished material.

Titles of relevant literature were added to the Excel Sheet *Salty Communities Master Sheet*, which is Attachment II to this report.

Federal and State Government

Information on websites, such as the Planning and Environment website, was reviewed online. Key areas reviewed were the guiding documents relating to Sydney and the relevant planning instruments including SEPPs and REPs for this region. Websites of agencies (listed above, 4.2) were reviewed online. Extracts were taken where these provided information directly relevant to the review.

Local Government

Key local government documents are the Local Environment Plan (LEP) and the Development Control Plans (DCP). During interviews with local government personal questions were asked in relation to LEPs and DCPs:

- *How current is the LEP? What was used to determine recommended zones? Any other comments?*
- *Do the DCPs include environmental controls and if so how well do you think they work? Is the coastal zone include in Development Controls and if so what is covered? Any other comments?*

For this review the focus was on biodiversity strategies or, where these were absent, bushland management plans and their equivalents. Most local governments have multiple documents that relate to biodiversity. Not all studies for each council were reviewed in detail and it is possible that some biodiversity data is in documents other than those reviewed.

Written documents of one type, such as the biodiversity strategies, were reviewed and assessed according to criteria aimed at determining the extent of information on species and types of management. An assessment matrix was developed with Professor G. Chapman (2015) for reviewing the biodiversity reports with assessment based on validity and robustness of species data and types of management actions documented. The results section includes the criteria used to assess reports. The assessment criteria and results have been provided to SCCG as a separate Excel table, Attachment III.

Research

Scientific information on the topic of coastal biodiversity is vast, particularly when international studies are also considered. The most useful assessment was deemed to be determining the amount of research in each area (ecosystem type) as measured by the number of papers published. This was done at the scale of i) Sydney, ii) NSW, iii) Australia and iv) internationally in urban areas.

The number of peer reviewed papers shows the general level of scientific information available. The next stage was to propose some specific questions on biodiversity management in a particular vegetation community and associated fauna listed in this study. Literature reviews of scientific papers could then be done for the specific question.

Community and NGO

Community information and media releases were also obtained and read from websites. Some information, along with its source, was copied and included in the review.

4.3.2 Data

The presence of data was recorded in the Salty Communities Master Sheet (see Attachment II), the data quality was not reviewed. Mapping is the key area of data available from local and state government. Interviews with local government representatives provided anecdotal information on the sources of mapping data. This included mapping from state government e.g. some seagrass mapping and point locations for threatened species (from Bionet). In general it was found that each council did its own mapping. Some councils used state mapping, such as seagrass mapping, as a basis and then made it more accurate with detailed ground truthing.

State government mapping from Bionet (threatened species) was noted but not reviewed. Other state government mapping that was looked at included that in the SEPPS and REPs relating to the Study Area, for example in the Harbour REP, the Hawkesbury Nepean REP and the lower Georges River REP.

Data also includes results held by local government on water quality monitoring and changes through time of vegetation condition and cover. Titles of this data have been included in the review, however the accuracy of the data was not reviewed. It is expected that other agencies have data although this was not available at the time of the review.

4.3.3 Practice Review

Information from the review of practice was gained through both interviews with local government representatives and via gaps identified in literature. In this area high-level aspects of practice within local government and between local and state agencies were identified by the local government representatives interviewed. This paper does not provide a detailed review of biodiversity management practice but used the matters raised to identify gaps and how common they were.

4.3.4 Assumptions and Limitations Relating to the Information Reviewed

1) This is a review of biodiversity information in the coastal zone with a focus on how it pertains to local government management of biodiversity. This is not a comprehensive review on coastal biodiversity.
2) There is an assumption that information (literature and data) provided for this review is up-to-date and accurate.
3) Analysis is based on observations of information (literature, data, and practice) and experience of SCCG, ECA staff and the Working Group. Analysis is not a scientific analysis using statistics. Data, such as mapping has not been independently reviewed as part of this project.
4) Gap analysis is based on feedback during surveys and general trends and observations of information (literature, data and projects) combined with the technical experience of ECA, SCCG and the Working Group. Gaps presented are based on current environmental conditions. It could be that under changed conditions the 'gaps' identified are superseded with ones more relevant to the changed conditions.

5) Information relating to predicted outcomes under varying changes in climate inherently includes uncertainty in the detail of ecological change with climate change and development scenarios. Uncertainty is with the magnitude of change, as well as the effects from feedback within ecosystems.

6) There is an assumption that the number of published papers approximates the quantity of useful scientific information available for the category being reviewed.

4.3.5 Coastal zone biodiversity — the focus for this review

Sydney's coastal area has a high diversity of habitats resulting from the highly varied terrain, soil, aspect and proximity to salt. This review focused on three main groups of ecosystems (landscapes). Attachment II provides a summary of vegetation communities that are within these ecosystems and are included in this review.

In general the Study Area includes the following landscapes:

1) Beaches and headlands
   - From submerged communities such as kelp beds and other seaweeds, to the
   - beaches and rock platforms of the species rich Intertidal Zone, and the
   - Coastal Grasslands, Heaths and Dry Sclerophyll Forest of headlands to sheltered gullies of Cabbage Tree Palms and Littoral Rainforest.

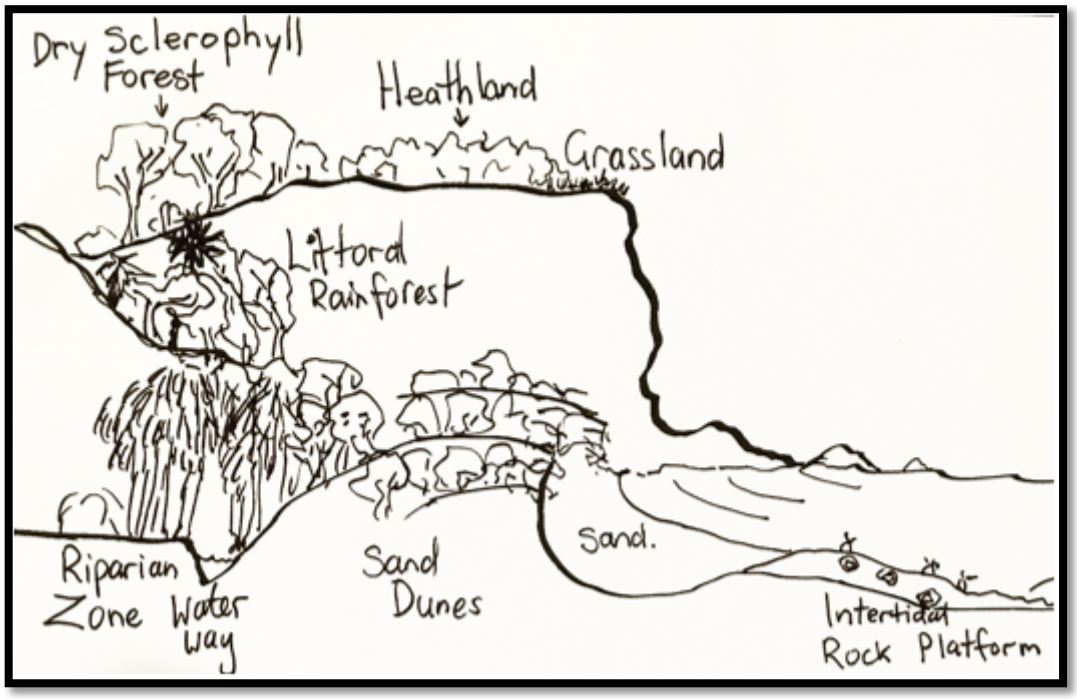


Figure 6. Beaches and headlands

2. Low-lying Lagoons and Estuaries
    - From the sand and mud with soft-bottom benthos, through to the
    - Beds of seagrasses, then up onto the
    - Floodplains, in and out of
    - Brackish and freshwater wetlands, both open water and forested, where She-Oak then Swamp Mahogany dominates the canopy, extending out along the
    - Waterways following the riparian zones and remnant terrestrial bushland or turf and exotic gardens.

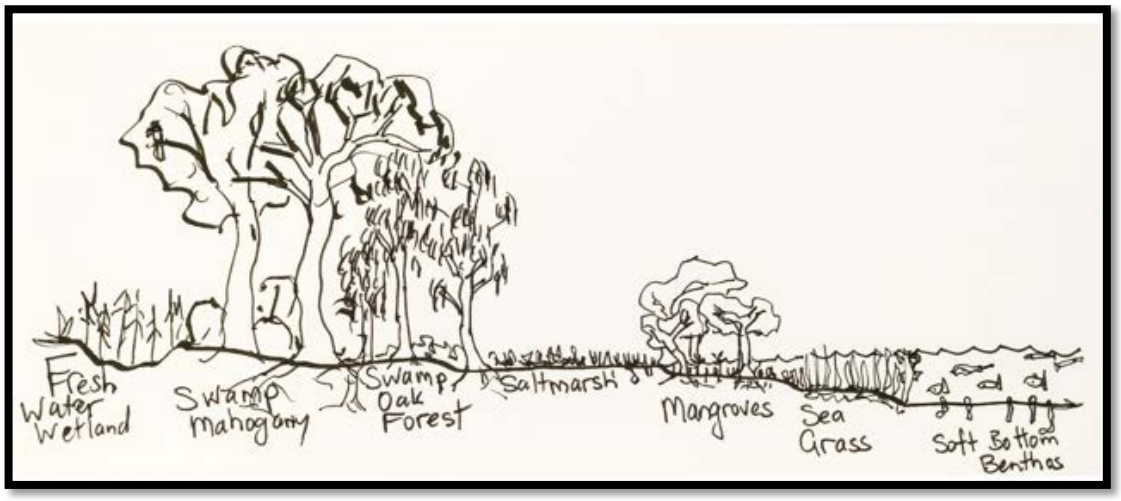


Figure 7. Low-lying lagoons and estuaries

3. Estuaries and Waterways – fringing to steep edges
    - In the intertidal zone of estuaries and tidal waterways are the:
        - seagrasses
        - mudflats
        - mangroves
        - saltmarsh
    - Landward there may be brackish or freshwater wetlands before the steep sandstone with Angophora Forest and other Dry and Wet Sclerophyll communities.

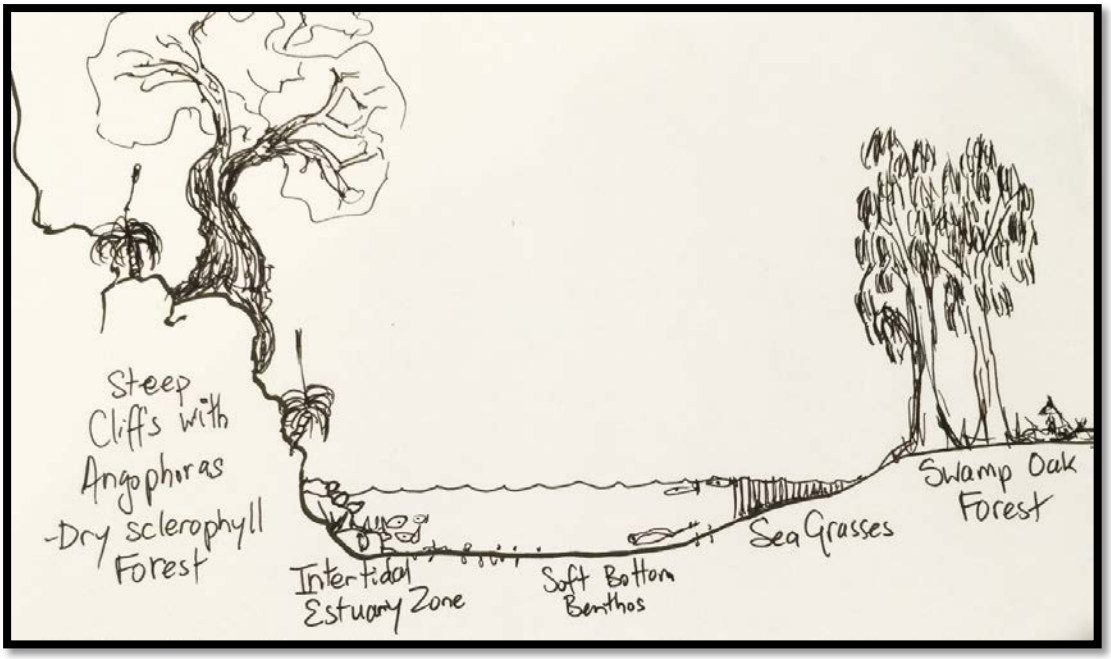


Figure 8. Estuaries and waterways

5 Blue-green Carbon

5.1 Why Salty Communities and Blue + Green Carbon

This section describes what Blue-green carbon is and how some of the Salty Communities, mangroves and saltmarsh in particular have high carbon sequestration capacity. This review provides information on the current protection of these communities in the Study Area and provides recommendations for management.

5.2 What is Blue-green Carbon?

Blue-green carbon refers to the carbon stored in submerged and intertidal coastal vegetation such as mangroves, seagrasses and saltmarsh (*The Blue Carbon Project*, 2014). Understanding carbon stored in natural habitats is critical in mitigating climate change, however past efforts have always focused on terrestrial forests (Hutchinson *et al*. 2013).

The carbon stored in marine ecosystems has always been ignored due to their small spatial extent and as a result remain poorly understood, however studies have shown that coastal vegetation sequesters carbon far more effectively and permanently than terrestrial forests (Hutchinson et al. 2013; The Blue Carbon Project, 2014). This is because coastal vegetation grows much quicker than terrestrial forests, capturing large amounts of carbon dioxide, some of which is then stored in the soil below (NOAA, 2015). Since these soils are submerged, they are anaerobic and therefore the carbon remains intact (see Figure 9, NOAA, 2015).

In contrast, terrestrial forests have soils which are aerobic allowing microbes to break down the sequestered carbon and release it as methane which is also a greenhouse gas (The Blue Carbon Initiative, 2013). In addition, coastal vegetation continues to sequester carbon for thousands of years as they accrete vertically, whereas the soils in terrestrial forests can become carbon-saturated quickly, unable to sequester more carbon (The Blue Carbon Project, 2014). As a result, the protection and restoration of our coastal vegetation is extremely important in mitigating the effects of climate change and far more cost effective than our current efforts focused on terrestrial forests (The Blue Carbon Project, 2014).

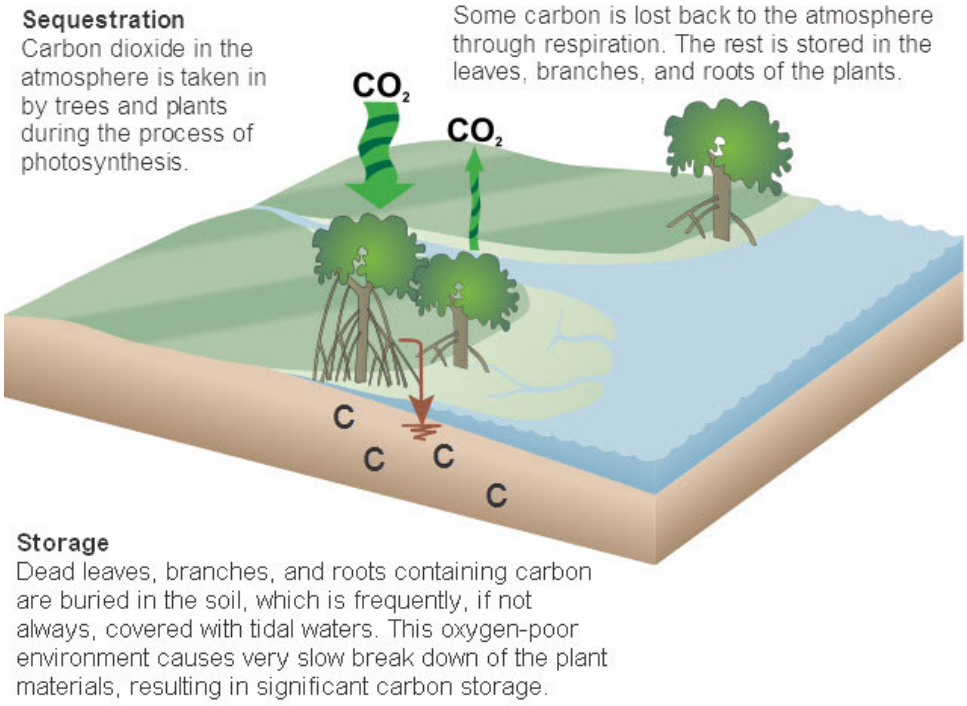


Figure 9 – Mechanisms by which carbon moves into and out of coastal vegetation (Source: NOAA, 2015)

5.3 How does Blue-green Carbon relate to the Study Area?

From the literature presented above, and the summary table below (5.4), it is evident that the salty communities of mangroves, saltmarsh and seagrass are key carbon sequestration vegetation types. The Study are contains all three communities (mangroves 879, saltmarsh 227ha, and seagrass 223ha). Using the CO_2 calculation rates from The Blue Carbon Initiative (2015) these three vegetation communities have a total of 1,544,338 CO_2 Mequiv/ha with mangroves 879ha providing 1,243,785 Mequiv/ha, saltmarsh 227ha providing 212,245 Mequiv/ha and seagrass 223ha providing 88,308 Mequiv/ha.

5.4 How is blue-green carbon calculated?

To properly manage blue-green carbon it is essential to assess blue-green carbon stocks and monitor changes in carbon stocks and greenhouse gas emissions over time (The Blue Carbon Initiative, 2015). In the past, there has been a lack of practical tools to assess blue-green carbon stocks, however The Blue Carbon Initiative (2015) have recently produced a guide with standardised recommendations and techniques for blue-green carbon measurement. The guide called 'Coastal Blue Carbon – Methods for assessing carbon stocks and emission factors in mangroves, tidal salt marshes and seagrass meadows' is available at:

http://thebluecarboninitiative.org/wp-content/uploads/Coastal-Blue-Carbon_3-23-2015.pdf

The guide provides three methods of carbon assessment with increasing accuracy. The simplest method of calculating blue-green carbon stocks can be done by multiplying the area of each ecosystem by the mean carbon stock for that ecosystem (see summary below) (The Blue Carbon Initiative, 2015).

Mean and range values of soil organic carbon stocks (to 1m depth) for mangrove, tidal salt marsh and seagrass ecosystems and CO_2 equivalents (source: The Blue Carbon Initiative, 2015).

ECOSYSTEM	CARBON STOCK Mg/ha	RANGE Mg/ha	CO_2Mequiv/ha
Mangrove	386	55 – 1376	1415
Tidal salt marsh	255	16 – 623	935
Seagrass	108	10 – 829	396

Example: Amount of blue carbon in 564 hectares of mangroves = 564 ha * 386 Mg / ha = 217 704 Mg of Blue carbon

Amount of carbon dioxide in 564 hectares of mangroves = 564 ha * 1415 CO_2Mequiv/ha = 798 974 Mg CO_2

References:

- Hutchinson et al. 2013, 'Predicting Global Patterns in Mangrove Forest Biomass', http://onlinelibrary.wiley.com/doi/10.1111/conl.12060/abstract
- The Blue Carbon Initiative 2013, When Green Is Blue, http://thebluecarboninitiative.org/when-is-green-is-blue/
- The Blue Carbon Project 2014, What is Blue Carbon? http://www.thebluecarbonproject.com/the-problem-2/
- National Oceanic and Atmospheric Administration (NOAA) 2015, Carbon Sequestration 101 http://www.habitat.noaa.gov/coastalcarbonsequestration.html
- The Blue Carbon Initiative 2015, Coastal Blue Carbon – Methods for assessing carbon stocks and emissions factors in mangroves, tidal salt marshes and seagrass meadows http://thebluecarboninitiative.org/wp-content/uploads/Coastal-Blue-Carbon_3-23-2015.pdf

5.5 Sustaining our local blue green carbon sequestration communities

While there is legislative protection for these salty communities, all are threatened by increasing sea-levels associated with climate change and possible increased erosion and sediment mobilisation and as result of increased storm frequency and / or duration.

Groups of scientists such as those in the Australian Mangrove & Saltmarsh Network (AMSN) (https://research.jcu.edu.au/tropwater/research-programs/australian-mangrove-and-saltmarsh-network) continue to add data about mangroves and saltmarsh including within the area of climate change adaptation. Natural area managers can use this data to better predict possible changes at a local scale and what management actions could be taken. Actions such as facilitating lateral (landward) migration of communities or artificially raising substrates to keep communities in their optimal tidal zones.

Managers and community can work together for implementation of both protection measures and adaptation measures. Community groups such as MangroveWatch aus.msnet@gmail.com team with scientists in research projects such as: Community Science Program Initiative of the AMSN with MangroveWatch. This project is providing a public database for recording observations of flowering and fruiting dates of Mangroves and Saltmarsh plants.

The Australian Mangrove & Saltmarsh Network www.amsn.net.au also provides a place to share information on Mangrove and Saltmarsh project outcomes at https://research.jcu.edu.au/tropwater/research-programs/australian-mangrove-and-saltmarsh-network/rehabilitation-and-restoration-projects. This valuable resource is not yet utilised by local government (as indicated by there being no LG projects on the site at the time of the writing of this report).

AMSN provides opportunities for sharing information and bridging the gap between science and management via their annual conference – the most recent in Wollongong University where a number of papers relevant to this project were presented (pers. obvs. Mia Dalby-Ball at the conference). The presentations findings have been included in this review as relevant and the full list of papers has been included in the Supplementary Reading section of reference list.

> *As a result of the Wollongong conference a position paper is in preparation about national policy issues regarding mangrove habitat in Australia. This professional view is much needed to emphasis further that while tidal wetlands are profoundly beneficial, they are also seriously threatened. At best, these shoreline habitats face an uncertain future.*
>
> *Pers Comm* May 2015 Norm Duke CEO Director, MangroveWatch Ltd.

6 Literature Review

6.1 Government Biodiversity Management – Overview

6.1.1 Global Government

Planning Instruments which relate to Coastal Ecosystems

Globally there are six instruments that directly interact with some of the coastal ecosystems. Each instrument uses different mechanisms and only a few directly address specific ecosystems such as mangroves, saltmarsh or seagrass. Global instruments rely on sovereign national powers for significant parts of their implementation. The following points summarise these instruments.

Convention on Wetlands (Ramsar)

Signed in 1971, the definition specifically includes mangroves. Ramsar provides three "pillars": wise use of wetlands, nomination of Ramsar sites, and international co-operation. Ramsar is useful for trans-boundary wetland conservation and management. It does not provide strategic regional (supra-national) overviews of coastal, or other, wetlands. Towra point in Sydney's south is the only Ramsar site in the Study Area.

World Heritage Convention (WHC)

Signed in 1972 the WHC provides protection of cultural and natural heritage of such universal value that its conservation is important for current and future generations. Some WHC sites contain coastal biodiversity like mangroves – for example the Sundarbans NP in the Ganges delta, with the world's largest area of mangroves (2,320 km^2). No sites in the Study Area are covered by the WHC.

Convention on the Conservation of Migratory Species (CMS)

Established in 1979 for the conservation of migratory species, their habitats and migration routes. The CMS contains several listed species that use coastal areas particularly mudflats, saltmarsh and wetlands. While the CMS has no specific mandate for providing guidance on conservation it assists in information sharing and knowledge transfer for the management of areas for migratory species. The Study Area does contain listed migratory species.

Convention on Biological Diversity (CBD)

Signed into effect in 1992 the CBD has no specific instruments for additional protection but has the potential for greater cooperation between nations, e.g. shared objectives for trans-boundary protection and reporting on progress to meet targets. Provides overarching statements about genetic resources, species and ecosystems including their sustainable use. The principles of the CBD are relevant to Salty Communities.

Framework Convention on Climate Change (UNFCCC)

Signed in 1992, the UNFCCC has a focus on limiting climate change as well as looking at climate change adaptation. A 2008 initiative was the Reducing Emissions from Deforestation and forest Degradation (REDD). REDD is on-going and the results of its advocacy works are available on the web. Its focus is also on conservation and sustainable management of forests and enhancement of forest carbon stocks including mangroves.

UNESCO's Man and the Biosphere Programme (MAB)

Established in 1970 MAB provides interdisciplinary research, training and communication in ecosystem conservation and use of natural resources. Biosphere reserves have been designated across all of the world's major ecosystems including coastal biosphere reserves. Currently there is little public knowledge of the biosphere sites or programme, and a low level of political interest, with associated low funding.

Australian and International Agreements

A number of International Conventions provide mechanisms for pursuing conservation outcomes for migratory birds, including migratory water birds.

Australia's Federal Environmental Agency, the Department of the Environment, is responsible for ensuring species listed on International Agreements are also listed on the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). A discussion of this Act follows in the section on federal government.

The three migratory bird agreements are:

- JAMBA: Japan-Australia Migratory Bird Agreement
- CAMBA: China-Australia Migratory Bird Agreement
- ROKAMBA: Republic of Korea-Australia Migratory Bird Agreement

Links to these documents can be found at:

- Japan-Australia Migratory Bird Agreement
- China-Australia Migratory Bird Agreement
- Republic of Korea-Australia Migratory Bird Agreement

Birds listed on the annexes to these three agreements, together with those on Appendices I or II of the Bonn Convention, must also be placed on the migratory species list under the EPBC Act.

Other international agreements

Australia has further international commitments to protect migratory birds under the Ramsar Convention and the Bonn Convention. Links to these can be found at:

- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)
- Ramsar Convention on Wetlands
- Agreement on the Conservation of Albatrosses and Petrels (ACAP)

East Asian – Australasian Flyway Partnership was launched in 2006. Its main purpose is to focus international efforts on conserving migratory waterbirds and their habitats in the Flyway. Parts of the Study Area are part of the flyway. While urban sites don't generally have the number of birds in any one area to trigger Federal involvement in decisions of management they do serve as important habitats and are collectively used by 100's of migratory wading birds, including species listed on the conventions and in the EPBC Act. More about the partnership can be found here: http://www.eaaflyway.net/

6.1.2 Federal Government

Responsibilities

In summary, the federal portfolio directly responsible for the environment is the Department of the Environment (DoE). The DoE has 10 agencies.

Federal agencies directly relevant to this study include:

Bureau of Meteorology (BOM) is the national meteorological authority for Australia. It provides weather forecasts, warnings and observations for all states and territories of Australia. There is also information about climate, hydrology and other weather services such as weather charts, radar images, satellite images and marine weather. The BOM is refining its ability to provide locally relevant data on weather and climate including to local governments.

Centre for Australian National Biodiversity Research activities are focused on the Australian National Herbarium and associated plant taxonomic research and botanical information management.

Director of National Parks (DNP) is established under the Environment Protection and Biodiversity Conservation Act 1999. The principal function of the DNP is to manage the Commonwealth reserves and conservation zones.

Sydney Harbour Federation Trust was established to conserve and preserve former Defence and other special Commonwealth land in the Sydney Harbour region. The Trust aims to conserve the cultural heritage of the lands, protect the environment, enhance the harbour and leave a lasting legacy for Sydney.

Australian Government
Department of the Environment

Threatened Species Commissioner

Australia's first Threatened Species Commissioner was appointed in July 2014 to bring a new national focus and effort to secure our threatened flora and fauna. The Commissioner is part of the senior executive team in the Federal Department of the Environment. The team is supported by the threatened species unit and an informal group of expert advisers.

The Commissioner's report on the first six months outlines achievements as *"growing community awareness and support; drawing attention to the threat of feral cats; and investing in threatened species conservation projects. It also highlights key findings and future directions."*

The report, *Threatened Species Commissioner Report to the Minister for the Environment* (February 2015) can be found at: http://www.environment.gov.au/system/files/resources/3815d52d-e2a4-41d5-ba03-973f3eb4ee52/files/tsc-report-feb2015.pdf

The Study Area of Sydney Salty Communities is not directly covered by the work of the commissioner, however it could benefit from funding incentives. A review of projects funded show they are principally on Commonwealth Land and Waters and / or in National Parks.

Key Federal Biodiversity Legislation – Environment Protection and Biodiversity Conservation Act 1999

The key federal government legislation relating to biodiversity is the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). It commenced 16 July 2000. The Australian Government Department of the Environment (the Department) administers the EPBC Act.

Objectives of the EPBC Act are to:

- provide for the protection of the environment, especially matters of national environmental significance
- conserve Australian biodiversity

- provide a streamlined national environmental assessment and approvals process
- enhance the protection and management of important natural and cultural places
- control the international movement of plants and animals (wildlife), wildlife specimens and products made or derived from wildlife
- promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources
- recognise the role of Indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity
- promote the use of Indigenous peoples' knowledge of biodiversity with the involvement of, and in cooperation with, the owners of the knowledge.

Reference: EPBC Act 1999, Environment Protection and Biodiversity Conservation Act 1999, Environment Protection and Biodiversity Conservation Regulations 2000. Both can be obtained from: https://www.comlaw.gov.au/Series/C2004A00485

In November 1997, the Council of Australian Governments (COAG) agreed in principle to the Heads of Agreement on Commonwealth/State Roles and Responsibilities for the Environment. Subsequently, all heads of governments and the Australian Local Government Association signed the agreement.

In the agreement, the states and territories and the Commonwealth agreed that reform in the following five areas was needed to develop a more effective framework for intergovernmental relations on the environment:

- matters of National Environmental Significance;
- environmental assessment and approval processes;
- listing, protection and management of heritage places;
- compliance with state environmental and planning legislation; and
- better delivery of national environmental programmes.

The EPBC Act enables the Australian Government to join with the states and territories in providing a national scheme of environment and heritage protection and biodiversity conservation and contribute to some of the above listed five areas.

The EPBC Act focuses Australian Government interests on the protection of matters of national environmental significance, with the states and territories having responsibility for matters of state and local significance. Heads of agreement for Commonwealth and state roles and responsibilities for the environment can be read at: http://www.environment.gov.au/resource/heads-agreement-commonwealth-and-state-roles-and-responsibilities-environment

Following is part of Agreement 5, that the environmental assessment and approval processes relating to matters of national environmental significance should be streamlined with the objectives of:

- relying on state processes as the preferred means of assessing proposals;
- limiting Commonwealth decisions to only those aspects of proposals concerning matters of national environmental significance;

The heads of agreement are where there is information on when and where federal rules may overrule state rules and vice versa. In general the federal legislation allows the state to prevail unless there are key reasons for federal intervention.

Key reasons for federal legislation to be enacted relate to the seven Matters of National Environmental Significance (MONES) listed below.

Part 1 of Matters of National Environmental Significance

1. World Heritage properties

The Commonwealth has a responsibility and an interest in relation to meeting the obligations of the Convention for the Protection of the World Cultural and Natural Heritage.

2. Ramsar listed wetlands

The Commonwealth has a responsibility and an interest in relation to meeting the obligations of the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention).

3. Places of national significance

Commonwealth and state Heritage Ministers (and relevant Environment Ministers) have agreed to develop a co-operative national heritage places strategy. This strategy will: (i) set out the roles and responsibilities of the Commonwealth and the states; (ii) identify criteria, standards and guidelines for the protection of heritage by each level of government; and (iii) provide for the establishment of a list of places of national heritage significance. The Commonwealth's responsibility and interest will be defined thereafter.

4. Nationally endangered or vulnerable species and communities

The Commonwealth has a responsibility and an interest in relation to meeting the obligations of the Convention on Biological Diversity and the objectives of the Endangered Species Protection Act 1992 to promote the recovery of species and ecological communities that are endangered or vulnerable, and prevent other species and ecological communities from becoming endangered.

5. Migratory species and cetaceans

The Commonwealth has a responsibility and an interest in relation to meeting the obligations of the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), the Australia/Japan Agreement for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA), the Australia/China Agreement for the Protection of Migratory Birds and their Environment (CAMBA), the International Convention for the Regulation of Whaling (International Whaling Convention) and the Whale Protection Act 1980.

6. Nuclear activities

The Commonwealth has a responsibility and an interest in relation to the assessment and approval of mining, milling, storage and transport of uranium and the development and implementation, in consultation with the states, of codes of practice as provided under the Environment Protection (Nuclear Codes) Act 1978 for protecting the health and safety of the people of Australia, and the environment, from possible harmful effects associated with nuclear activities.

7. Management and protection of the marine and coastal environment

Commonwealth responsibility involves meeting obligations contained in international agreements and in Commonwealth legislation in relation to waters outside those waters under state control pursuant to the Offshore Constitutional Settlement, except where formal Commonwealth/state management arrangements are in place (e.g. specific fisheries) or where waters are under Commonwealth direct management (e.g. the Great Barrier Reef Marine Park). The Commonwealth has responsibility for control of sea dumping in Australian waters.

Commonwealth interest involves co-operation with the states to develop strategic approaches to ensure the management and protection of Australia's marine and coastal environment.

Part 2 of Matters of National Environmental Significance

The MONES that relate most to Biodiversity in the Study Area are included in Part 1, as Part 2 relates more to management. However, the MONES from Part 2 which are relevant to the study are included below, with the number preceding each MONES corresponding to its numbering in the legislation.

10. Conservation of biological diversity (recognising that nationally endangered or vulnerable species and communities are covered under item 4 of this Attachment)

The Commonwealth has a responsibility and an interest in relation to meeting obligations contained in the Convention on Biological Diversity in co-operation with the states, including under the National Strategy for the Conservation of Australia's Biological Diversity and through relevant programs.

18. Development and maintenance of national environmental and heritage data sets arising from intergovernmental arrangements and international obligations

The Australian Bureau of Statistics has a statutory responsibility for the national collection of statistics.

The Commonwealth's interest includes the identification, development, maintenance and interpretation of national environmental and heritage data sets in co-operation with the states.

24. Natural Heritage Trust Programs

The Commonwealth has a responsibility and an interest in implementing programs under the Natural Heritage Trust in accordance with the Natural Heritage Trust Act 1997 and the Partnership Agreements entered into with the states and territories.

26. Nationally significant feral animals and weeds

The Commonwealth has an interest in relation to the development and implementation of measures and agreed programs to control feral animals and weeds identified in national strategies, agreements, policies and control plans.

27. Conservation of native vegetation and fauna

The Commonwealth interest involves taking co-operative measures with the states and other interested parties to conserve and manage native vegetation and fauna.

Federally listed threatened species, populations and communities

Federally listed threatened species, populations and communities can be found on the Species Profile and Threats Database at http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

Commonwealth, state and territory listed threatened species report can be generated at the following URL and provides information on which of the International Agreements the species is listed on.

https://dmzapp17p.ris.environment.gov.au/sprat-public/action/report;jsessionid=5B8C6155A6224210396144427EAD051C0

Recovery Plans adopted under the EPBC Act

Recovery plans are used to influence planning and on-ground works. Recovery plans are available for some species and communities listed on the EPBC Act. A full list can be found here:

http://www.environment.gov.au/cgi-bin/sprat/public/publicshowallrps.pl

Very few plans pertain directly to the Study Area. An example of one that does is *The Recovery Plan for the Nielsen Park She-oak Allocasuarina portuensis* (2001). A link to this can be found at: *Allocasuarina portuensis* Recovery plan 2000-2010

Critical Habitat

Federal biodiversity management also includes a register of critical habitats. Five sites are currently listed and 3 are for Albatross. None are in the Study Area. For more info see: http://www.environment.gov.au/cgi-bin/sprat/public/publicregisterofcriticalhabitat.pl

Threat Abatement Plans (TAP)

Threat abatement plans establish a national framework to guide and coordinate Australia's response to key threatening processes registered under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The plans identify research, management and other actions needed to ensure the long-term survival of native species and ecological communities affected by key threatening processes. The plans should be read in conjunction with their accompanying background documents which provide information on the biology, distribution, impacts and current management practices relevant to the respective threat.

http://www.environment.gov.au/biodiversity/threatened/threat-abatement-plans/approved

TAPs relevant to the Study Area are included below and can be used by state and local agencies to implement local works. Federal funding may also accompany actions that fulfil actions of TAPs. The following four TAPs are directly relevant to the Study Area.

- Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* – 2014
- Threat abatement plan for infection of amphibians with chytrid fungus resulting in chytridiomycosis – 2006
- Threat abatement plan for predation by European red fox – 2008
- Threat abatement plan for predation by feral cats – 2008

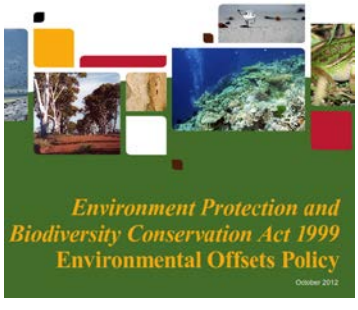
How to get updates on the EPBC Act

In managing biodiversity it is important to be up to date with additions or changes to listings, recommended management or other matters on the EPBC Act. The following URL provides updates include those directly relevant to the Study Area. http://www.environment.gov.au/news/2015/03/17/new-threatened-ecological-community-listings RSS feeds provide biodiversity managers with up to date information on Federal Environmental news as it becomes available. RSS feeds can be obtained from: http://www.environment.gov.au/rss-feed

Environmental Offsets Policy

Australian Government
Department of Sustainability, Environment, Water, Population and Communities

The offsets policy aims to offset any negative impacts which cannot otherwise be avoided. There are papers discussing the usefulness of offsetting and some of the flaws in the system. See *Fundamental Principles for Best Practice Biodiversity Offsets* (Walmsley et al 2009). The federal government provides the following literature on Offsets Policy.



> *The EPBC Act environmental offsets policy (October 2012) (the policy) and Offsets assessment guide (the guide) explain how to identify suitable offsets for matters protected under national environment law.*
>
> *The policy helps to ensure that offsets for projects approved under the EPBC Act are consistent and transparent and deliver high quality outcomes.*

The protected matters under the EPBC Act are:

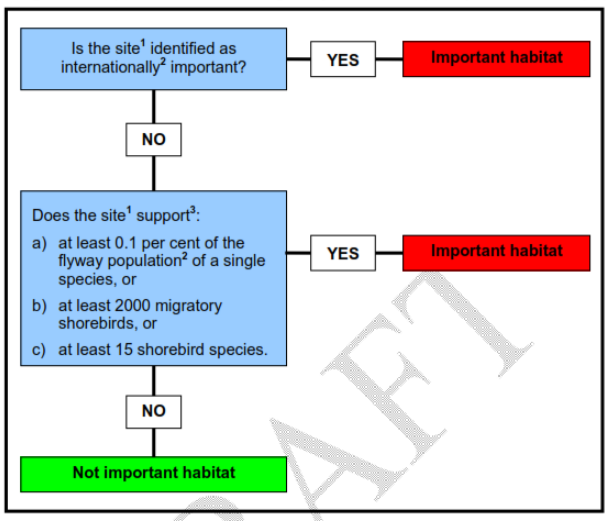
- world heritage properties,
- national heritage places,
- wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed),
- nationally threatened species and ecological communities,
- migratory species,
- Commonwealth marine areas,
- the Great Barrier Reef Marine Park,
- nuclear actions (including uranium mining),
- a water resource, in relation to coal seam gas development and large coal mining development.

The policy deals with offsets associated with all these protected matters. The Offsets Policy, Guide and "how-to' can be downloaded at:

- EPBC Act environmental offsets policy (PDF – 2.23 MB)
- Offsets assessment guide (XLSM – 51.23 KB)
- How to use the Offsets assessment guide (PDF – 567.27 KB)

In relation to the Study Area of Sydney Salty Communities the two most likely to trigger federal involvement are *nationally threatened species and ecological communities* as well as *migratory species.* For Sydney Salty areas the federal government generally doesn't get involved in migratory bird matters as the sites are deemed not significant at the National level.

Right: Extract from the Draft EPBC Act Policy Statement 3.21 – Significant Impact Guidelines for 36 Migratory Shorebird Species (2009) showing the decision tree for assessing habitat importance – at a Federal Level.



6.1.3 State Government

State government agencies and authorities directly relevant to this study

Department of Planning and Environment: advises the Minister for Planning, the Minister for the Environment and the Minister for Local Government; administers the Environmental Planning and Assessment Act 1979 and Environmental Planning and Assessment Regulation 2000; and works closely with other agencies including OEH, Office of Local Government, Sydney Harbour Foreshore Authority and Urban Growth NSW.

Office of Environment and Heritage (OEH): manage National Parks and Listed Species, Populations and Communities. On-ground works are limited to National Parks (NP). Threatened Species management is via upkeep of the Bionet database, and input to development applications where works could damage a NP or have a significant impact on a listed Species, Population or Community.

Environmental Protection Authority (EPA): provides a role in pollution protection. Authorised to implement penalties and fines.

Department of Primary Industries (DPI) (Fisheries): provides a role in fisheries management including marine vegetation (seagrass, mangroves and seaweeds). Work is more management / strategy, including DA assessment, and less on-ground. On-ground works on Fisheries managed areas are generally through Estuary Management Plans and coordinated by local government. Authorised to implement penalties and fines.

Office of Water (OoW): Work is management / strategy, including DA assessment. Authorised to implement penalties and fines.

Crown Lands (CL): NSW Crown Lands Division (CLD) is a part of the Department of Primary Industries (DPI) and is responsible for approximately half of NSW land. Much 'reserve' land that is managed by local government is Crown Land. Bondi Beach is Crown Land as are other nature reserves, coastal lands, waterway corridors in the Study Area. CLD manages leases and licenses of Crown land for a range of commercial, agricultural, industrial, community, residential and private uses. CLD manages the sale of Crown lands not required for public purposes.

Sydney Water (SW): management / strategy of water supply infrastructure and natural assets. On-ground works include sediment and wetland construction and management.

Roads and Maritime Authority (RMS): provides a role in waterway management. Work is principally management / strategy, including DA assessment, rather than on-ground. On RMS managed areas that overlap with local government, on-ground works are planned through Management Plans, e.g. Estuary Management Plan, and works are co-ordinated by local government.

Marine Estate Management Authority (MEMA)

Marine Estate Management Act 2014 (The MEM Act) provides for strategic and integrated management of the whole marine estate –marine waters, coasts and estuaries. The Act commenced on 19 December 2014 and "sets the legal foundation for delivering on the NSW Government's vision for a healthy coast and sea, managed for the greatest well-being of the community, now and into the future. It will mean that decisions will be made by considering environmental, economic and social factors."

The MEMA *Act does this by:*

- *Providing for the management of the marine estate consistent with the principles of ecologically sustainable development.*
- *Establishing two advisory committees, a Marine Estate Management Authority and Marine Estate Expert Knowledge Panel.*

- *Requiring the development of a Marine Estate Management Strategy to address priority threats identified through threat and risk assessment.*
- *Facilitating the maintenance of ecological integrity, and economic, social, cultural and scientific opportunities.*
- *Promoting the coordination of government programs.*
- *Providing for a comprehensive system of marine parks and aquatic reserves.*

The MEMA *Act is supported by regulations that set out the rules for managing the marine estate and marine parks, and an aquatic reserve notification is in place with management rules for aquatic reserves:*

- *Marine Estate Management Regulation 2009*
- *Marine Estate Management (Management Rules) Regulation 1999*
- *Aquatic Reserves Notification 2013*

The Study Area has the highest population of any location within the area managed by the MEM. Research and educational projects are conducted in the Study Area.

MEM manages Marine and aquatic reserves in NSW.

Marine protected areas are parts of the NSW marine estate managed to conserve marine biodiversity and support marine science, recreation and education.

<u>Marine Protected Area System</u>

The NSW marine protected area system includes:

- Six marine parks,
- Nine intertidal protected areas (IPAs) and
- Twelve aquatic reserves covering marine and estuarine habitats within national parks and nature reserves.

All nine IPAs are within the Study Area.

Right: IPA Map (Source: Extract from DPI website)
Below: example of map from Bungan Head IPA
www.dpi.nsw.gov.au

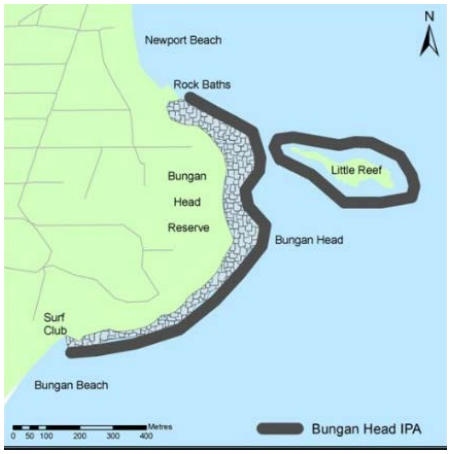


Table 1. Aquatic Reserves within the Study Area (Source: DPI website http://www.dpi.nsw.gov.au/fisheries/habitat/protecting-habitats/mpa)

Aquatic Reserve	Estab.	Region / Area	Bioregion*	Map
Barrenjoey Head	2002	Northern Sydney / Palm Beach	Hawkesbury Shelf	Map
Narrabeen Head	2002	Northern Sydney / Narrabeen	Hawkesbury Shelf	Map
Long Reef	1980	Northern Sydney / Collaroy	Hawkesbury Shelf	Map
Cabbage Tree Bay	2002	Northern Sydney / Manly	Hawkesbury Shelf	Map
North (Sydney) Harbour	1982	Northern Sydney / Manly	Hawkesbury Shelf	Map
Bronte–Coogee	2002	Eastern Sydney	Hawkesbury Shelf	Map
Cape Banks	2002	Eastern Sydney / La Perouse	Hawkesbury Shelf	Map
Boat Harbour	2002	Southern Sydney / Kurnell	Hawkesbury Shelf	Map
Towra Point	1987	Southern Sydney / Botany Bay	Hawkesbury Shelf	Map
Shiprock	1982	Southern Sydney / Port Hacking	Hawkesbury Shelf	Map

Issues with managing these areas arise from a combination of a lack of resourcing, low skills in the specific area of intertidal and marine environments and the grey area of responsibility between local and state government.

Greater Sydney Local Land Services (GS LLS): brings together agricultural production advice, biosecurity, natural resource management and emergency management into a single organisation. The relevant legislation is the Local Land Services Act 2013 No 51 which established Local Land Services (LLS), repealing the Rural Lands Protection Act 1998, the Rural Lands Protection Amendment Act 2008 and the Catchment Management Authorities Act 2003. http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+1+2014+cd+0+N

The Natural Resources Commission (NRC): provides independent advice to the New South Wales Premier and Ministers on managing natural resources and related issues to improve production, biodiversity and community well-being across the state, in line with the *Natural Resources Commission Act 2003*. The first two objectives of the Act have direct relevance to coastal biodiversity management (see extract below from the NSW government legislation website): http://www.nrc.nsw.gov.au/

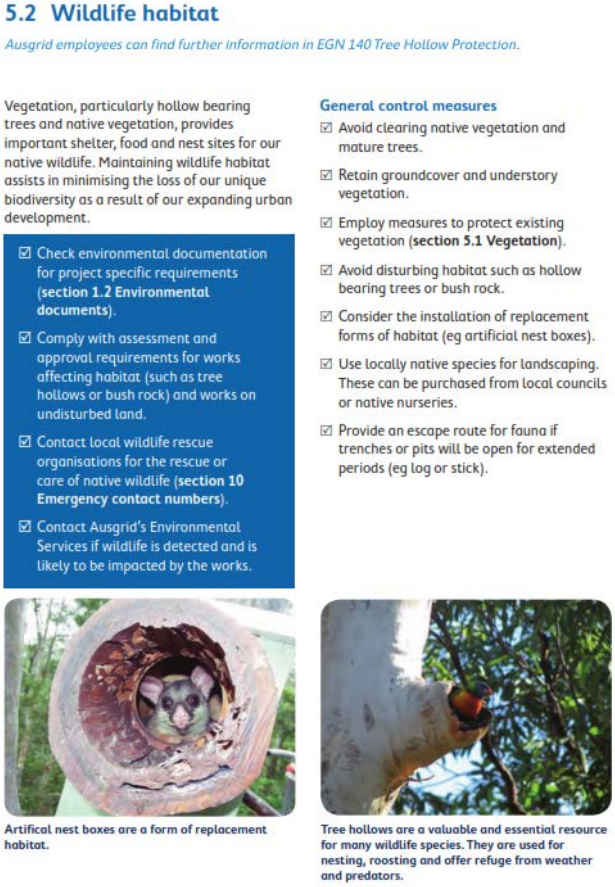
The object of this Act (http://www.legislation.nsw.gov.au/maintop/view/inforce/act+102+2003+cd+0+N) is to establish an independent body with broad investigating and reporting functions for the purposes of:

1. *Establishing a sound scientific basis for the properly informed management of natural resources in the social, economic and environmental interests of the state, and*
2. *Enabling the adoption of state-wide standards and targets for natural resource management issues,*
3. *Advising on the circumstances in which broad scale clearing is to be regarded as improving or maintaining environmental outcomes for the purposes of the Native Vegetation Act 2003.*

Utilities Providers: AusGrid and Sydney Water were the two utility providers which provided input to this review. (With increased time and resourcing other Utility providers could have their systems reviewed and/or personnel surveyed with regard to biodiversity management in the Salty areas.)

In general both have systems and processes in place for assessing possible impacts on biodiversity, including up-to-date mapping and linkages with suppliers of data layers at federal and state levels.

AusGrid have an Environmental Handbook for Construction and Maintenance (Ausgrid 2014) which provides a guide of for people working with Ausgrid. An extract is included below. http://www.ausgrid.com.au/~/media/Files/Network/Documents/NS%20and%20NUS/NUS174C.pdf



5.2 Wildlife habitat

Ausgrid employees can find further information in EGN 140 Tree Hollow Protection.

Vegetation, particularly hollow bearing trees and native vegetation, provides important shelter, food and nest sites for our native wildlife. Maintaining wildlife habitat assists in minimising the loss of our unique biodiversity as a result of our expanding urban development.

- ☑ Check environmental documentation for project specific requirements (**section 1.2 Environmental documents**).
- ☑ Comply with assessment and approval requirements for works affecting habitat (such as tree hollows or bush rock) and works on undisturbed land.
- ☑ Contact local wildlife rescue organisations for the rescue or care of native wildlife (**section 10 Emergency contact numbers**).
- ☑ Contact Ausgrid's Environmental Services if wildlife is detected and is likely to be impacted by the works.

General control measures

- ☑ Avoid clearing native vegetation and mature trees.
- ☑ Retain groundcover and understory vegetation.
- ☑ Employ measures to protect existing vegetation (**section 5.1 Vegetation**).
- ☑ Avoid disturbing habitat such as hollow bearing trees or bush rock.
- ☑ Consider the installation of replacement forms of habitat (eg artificial nest boxes).
- ☑ Use locally native species for landscaping. These can be purchased from local councils or native nurseries.
- ☑ Provide an escape route for fauna if trenches or pits will be open for extended periods (eg log or stick).

Artifical nest boxes are a form of replacement habitat.

Tree hollows are a valuable and essential resource for many wildlife species. They are used for nesting, roosting and offer refuge from weather and predators.

Sydney Water has completed mapping of the vegetation communities along its intertidal stormwater assets including Saltmarsh EEC (Dalby-Ball 2012). This data was then supplied to OEH to update mapping layers. Sydney Water has PoMs for the wetlands on land they own including Botany, Eve Street and Chullora Wetlands. The wetland PoMs include EEC mapping of ESBS and SFW as well as biodiversity management recommendations. Sydney Water also has a program of asset renewal which sees the naturalisation of waterways – most of which are in the Study Area.

Botany Wetlands – urban biodiversity including Salty Communities

High diversity Eastern Suburbs Banksia Scrub at Bonnie Doon golf course

Sydney Olympic Park Authority (SOPA): conducts on-ground work in saltmarsh, mangroves and freshwater wetlands, produces biodiversity information and on-ground training courses including training on managing coastal biodiversity through WET (Wetland Education and Training) workshops.

State Planning and Policy: State-wide Profile 2014 (Department of Planning and Environment), outlines the factors shaping growth and change in communities throughout NSW; including the key role of Regional Growth Plans in planning for sustainable growth; and local government in developing and delivering the Plans. The Regional Growth Plan for Metropolitan Sydney predicts Sydney population to rise by 64 percent to 5,861,750 people by the year 2031. http://www.planning.nsw.gov.au/Portals/0/PlanningYourRegion/2014_NSW_StatewideProfile.pdf

Key relevant points from the plan:

- A healthy and resilient environment is one of five clear listed outcomes for Sydney
- The government's vision for Sydney is *a strong global city, a great place to live*. To achieve this vision, the government has set down goals that include that Sydney will be *a sustainable and resilient city that protects the natural environment and has a balanced approach to the use of land and resources*.
- Direction 4.1 is *Protect our natural environment and biodiversity*, however mention of works and biodiversity management is rural not coastal.
- Action 4.1.1 is:
    - "Protect and deliver a network of high conservation value land by investing in green corridors and protecting native vegetation and biodiversity", and the following relevant quotes are included:
        - *A strategic approach to managing long-term biodiversity and promoting environmental resilience as housing and economic development occurs will have greater benefits than site-by-site decision making*;
        - *Applying mitigation measures can prevent or reduce the impacts of development on areas of high conservation value, native vegetation and diversity from development. Offsets can be used to address the remaining impacts and protect other areas of land with high conservation value;*
        - *The Government will invest in areas of high conservation value and protect our biodiversity through* [Biodiversity Banking and Offsets Scheme]….;
        - *Working with private industry to manage bushland on private lands in areas of high conservation value, including biodiversity corridors….;*
        - *Continuing to use state planning policies and local planning controls to protect high conservation value areas, native vegetation and biodiversity. Many of these areas are identified during the planning and development process.*
- Direction 4.2:
    - *Build Sydney's resilience to natural hazards – Some of the natural hazards we currently experience are predicted to occur more frequently and, in some cases, with greater intensity in the future. Planning work must take these changes into account. The risk of flood, drought and water shortage can impact on our urban, agricultural, industrial and natural environments.*
- Action 4.2.1:
    - "Provide local councils and communities with tools and information to shape local responses to natural hazards".

The Plan focuses on conservation within corridors outside of major urban areas, which does not include major parts of the Sydney Coastal Zone. Figure 10, below, from the Plan, shows the Sydney Coastal Zone as 'metropolitan urban area'. There is potential in the Plan for conserving areas as part of building resilience to natural hazards:

> *The Government is responding to community concerns about coastal hazard risks through a coastal reform process. This process involves establishing a simpler and more integrated legal and policy framework for coastal management, providing improved guidance and technical advice to councils, while enabling and supporting local decision making and identifying potential funding and financing options, particularly to implement coastal management strategies. These changes will deliver longer-term improvements in the way that councils and landowners manage coastal erosion risks.*
>
> *The Government will:*
>
> - *work with councils to assess how vulnerable their community is to changing coastal conditions to improve the resilience of communities and urban infrastructure;*
> - *publish local-scale vulnerability information and assist communities to minimise the impacts of natural hazards;*
> - *work with communities and organisations to understand and respond to the impacts of natural hazards and changing coastal conditions through the provision of guidance material and decision support tools. These tools should enable a fuller assessment of economic, environmental and social impacts of adaptation options; and*
> - *use the recommendations of the* Towards a Resilient Sydney *project to contribute to strategic land use planning."*

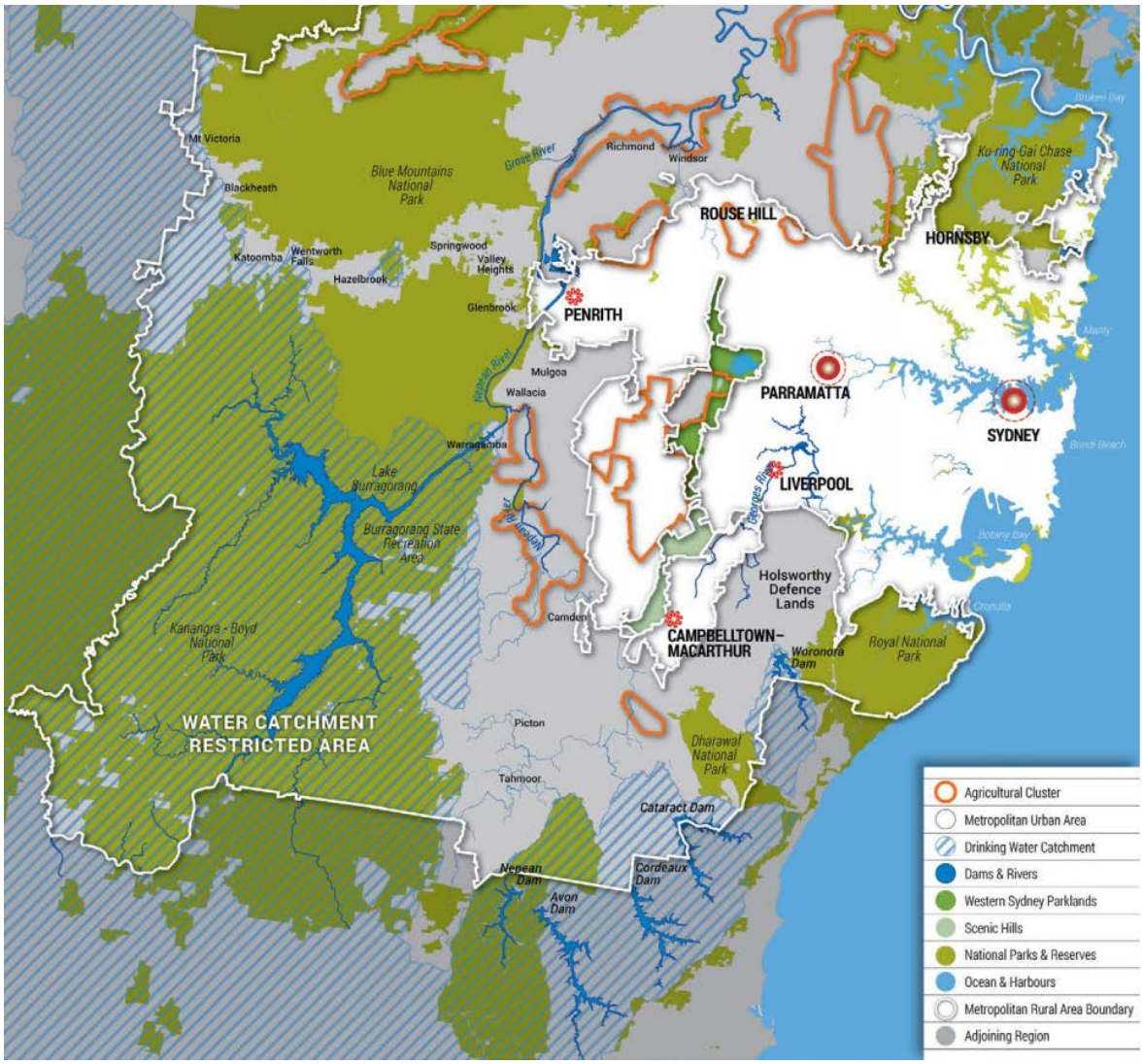


Figure 10. Map showing Sydney Coastal Zone as "Metropolitan Urban Area" (Source: A Plan for Growing Sydney (Source: Department of Planning and Environment)

State Government Legislation

The *In Force database* (http://www.legislation.nsw.gov.au/) has the NSW Acts, regulations, planning instruments and other statutory instruments. This site is frequently consolidated and updated and has tables of information summarizing legislation. Legislation relating to this review has been included in the glossary at the end of this document (Attachment I), with links to relevant sites.

State government – SEPPs and REPs: State Environmental Planning Policies (SEPPs) and Regional Environmental Plans (REPs), are initiated by state government with their content ultimately determined by the Minister for Planning. These two planning instruments provide a framework for local councils to prepare plans that are consistent with these and make decisions on developments. Following is a summary of the review findings.

SEPPs: SEPPs are designed to protect or plan for areas deemed to be important to the state. SEPPs and REPs don't automatically take precedence over LEPs. The NSW Planning and Environment Act has a list of SEPPS that apply in Sydney.
http://hub.planning.nsw.gov.au/PlanningControls/StateEnvironmentalPlanningPolicies/ListofStateEnvironmentalPlanningPolicies(SEPPs).aspx

Following is a summary of biodiversity related SEPPs applicable in the project area:

- SEPP 19 Bushland in Urban Areas – applies on parcels over 1ha.
- SEPP 44 Koala Habitat – applies to land over 1ha (excluding National Parks)
- SEPP 71 – Coastal Protection – applies to the Study Area
- SEPP (Kurnell Peninsula) 1989 – applies to Kurnell Peninsula which in Study Area
- Infrastructure SEPP – 2007 – not a biodiversity SEPP but has biodiversity considerations. Applies to projects in the Study Area

Not covered in the Study Area:

- SEPP 26 Littoral Rainforests – the current mapping does not including areas within the Sydney http://www.environment.gov.au/biodiversity/threatened/communities/pubs/76-map.pdf
- SEPP 14 Coastal Wetlands – Policy applies to local government areas outside the Sydney metropolitan area that adjoin the Pacific Ocean.

State Environmental Planning Policy 19 Bushland in Urban Areas

SEPP 19 applies on parcels over 1ha

Protects and preserves bushland within certain urban areas, as part of the natural heritage or for recreational, educational and scientific purposes. The policy is designed to protect bushland in public open space zones and reservations, and to ensure that bush preservation is given a high priority when local environmental plans for urban development are prepared.

State Environmental Planning Policy 44 Koala Habitat

SEPP 44 applies to land over 1ha (excluding National Parks)

State Environmental Planning Policy No. 71 – Coastal Protection Gazetted: 01.11.02

Abstract: The policy has been made under the Environmental Planning and Assessment Act 1979 to ensure that development in the NSW coastal zone is appropriate and suitably located, to ensure that there is a consistent and strategic approach to coastal planning and management and to ensure there is a clear development assessment framework for the coastal zone SEPP No. 71 – Coastal Protection

State Environmental Planning Policy (Kurnell Peninsula) 1989

> *The general aims and objectives of this Policy are to conserve the natural environment of the Kurnell Peninsula and ensure that development is managed having regard to the environmental, cultural and economic significance of the area to the nation, state, region and locality. To apply environmental performance criteria which will ensure that the environment is not adversely affected by development. To promote, encourage and facilitate opportunities for commercial, industrial and tourist development consistent with the conservation of the unique ecological and landscape attributes of the Kurnell Peninsula. To ensure that development is co-ordinated to allow the economic and efficient provision of public services and amenities having regard to the environment. To promote the sharing of responsibility for environmental planning on the Kurnell Peninsula between the council, the Department of Planning, the Department of Environment, Climate Change and Water, the Department of Industry and Investment and Sydney Water Corporation. To protect, enhance and utilise the tourism, leisure and recreation potential of the Kurnell Peninsula so far as it is consistent with the conservation of its ecological and heritage value.*
>
> NSW Planning and Environment SEPP.

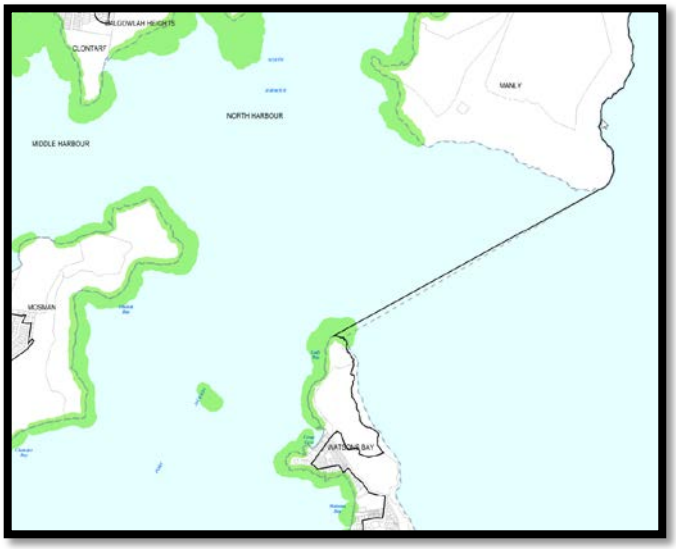
The Environmental Planning and Assessment Act states that the most recent planning instrument prevails over earlier ones unless one of the instruments states that this is not the intention. For SEPP 14 and 26 there is a note that where there is any inconsistency with other planning instruments the SEPP shall prevail.

REPs: REPs deal with matters important to a specific region and so provide a broad planning and development framework. Once approved by the Minister for Planning, REPs come into force and directly influence local environmental plans. A REP can cover a large geographical area or a small area. Before a REP is prepared, there must be an environmental study and consultation with government agencies and affected local government authorities.

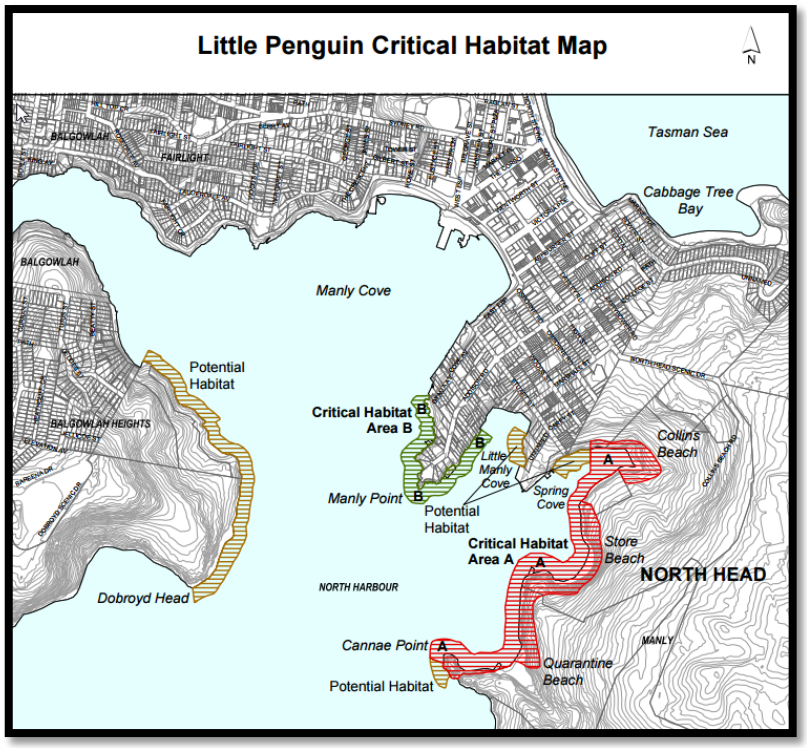
REPs in the Sydney Coastal Zone include:

- REP 20 Hawkesbury-Nepean River: http://www5.austlii.edu.au/au/legis/nsw/consol_reg/srepn20r21997640/
- Sydney Harbour REP: http://www.legislation.nsw.gov.au/viewtop/inforce/epi+590+2005+cd+0+N/
- Georges River REP: http://www.planning.nsw.gov.au/plansforaction/pdf/rep_grc.pdf

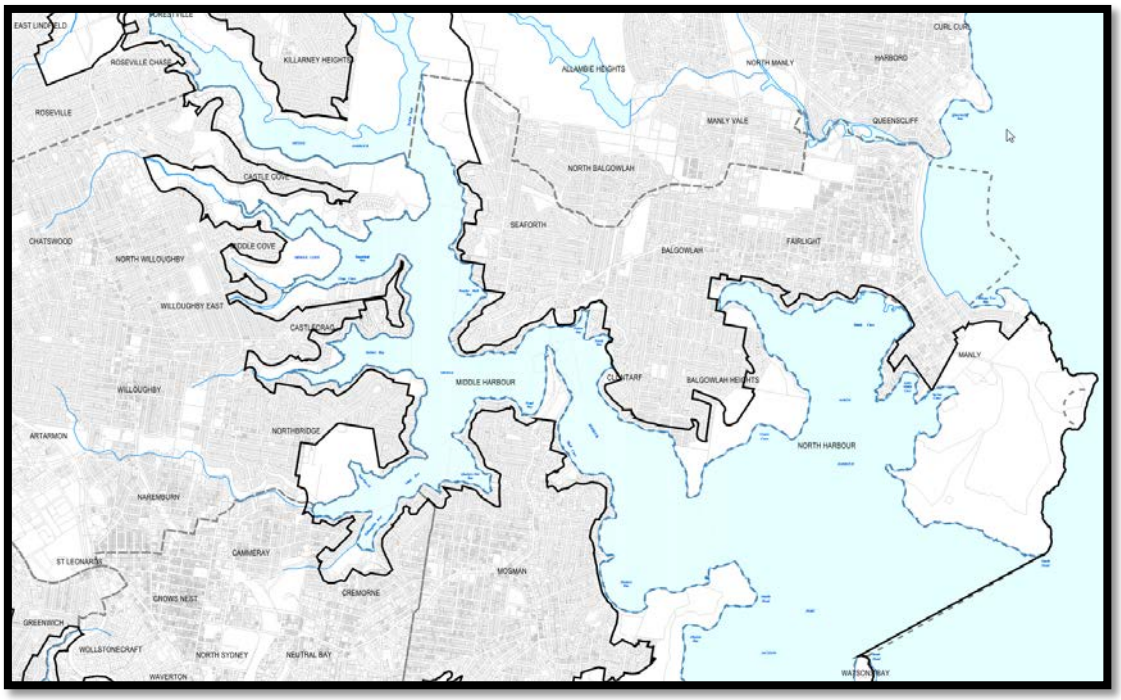
The Harbour REP includes mapping such as *Wetlands Protection Area Maps (16 sheets), Litle Penguin Critical Habitat Map* and a *Foreshore Area and Boundary Map.* See Figure 11 below.



11a. Extract from the Wetland protection area maps. Wetlands are in green.



11b. Little Penguin Critical habitat



11c. Foreshore Area and Boundary

Figure 11a-c. Example of Mapping in the Sydney Harbour REP(Source: Sydney Harbour REP (2005) *Wetlands Protection Area Map)*

The Georges River REP includes part of the Sutherland Shire. The REP has catchment information: http://www.planning.nsw.gov.au/en-us/planningyourregion/catchmentsandwaterways/georgesrivercatchment.aspx

Guidelines for better practice in foreshore works are also in the REP and address a range of issues relevant to foreshore works including those relating to strategic planning, site planning and works and ecological rehabilitation.

The Guidelines for Better Practice in Foreshore Works provide an ecologically sustainable approach to the management of lands along the foreshores of the Georges River and its tributaries.

http://www.planning.nsw.gov.au/en-us/planningyourregion/catchmentsandwaterways/georgesrivercatchment/foreshoreworksguidelines.aspx

Thee Guidelines provide a review of existing and emerging methods, techniques and practices in planning and implementing river foreshore and related improvement works. They draw on a number of separate studies in the catchment including studies of the cultural heritage and biodiversity as well as the built environment and public access along the foreshores of the waterway itself.

6.1.4 Local Government

Responsibilities

The New South Wales Minister for Local Government has responsibilities which includes all local government areas and related legislation in NSW.

Local Government NSW is the peak industry association representing the 152 NSW general purpose councils, 12 special purpose councils and the NSW Aboriginal Land Council. http://www.lgsa.org.au/

Local governments are also organised into groups relating to geographical areas called Regional Organisation of Councils (ROCs). Councils are also grouped based on common management areas — such as the Sydney Coastal Council Group (SCCG) http://www.sydneycoastalcouncils.com.au/.

Legislation

Local Government Act (1993)

The Local Government Act is a key instrument for guiding all areas of local government. Key areas relating to Salty Communities include the section on how to plan for and manage community land and how to assess and condition development applications and council works. This has been discussed in more detail in the Practice section of this review. A copy of the Act can be found at:

http://www.legislation.nsw.gov.au/xref/inforce/?xref=Type%3Dact%20AND%20Year%3D1993%20AND%20no%3D30&nohits=y

Environmental Planning and Assessment Act (1979)

Planning in NSW is largely governed by the following two pieces of legislation.

- Environmental Planning and Assessment Act 1979 (or "the EP&A Act") and the
- Environmental Planning and Assessment Regulation 2000 (or "the EP&A Regulation")

The Environmental Planning and Assessment Act (1979) is frequently used by local government as they are the key agency for assessing and approving development in the state. Other legislation is used by local government to directly manage biodiversity. This includes legislation already presented under the federal and state government sections of this review.

While the Act and the Regulation provide the overarching structure for planning in NSW, the statutory documents that support that structure are State Environmental Planning Policies (SEPPs) and Local Environmental Plans (LEPs).

Local Environmental Plans (LEPs)

Each local government area has a LEP to guide development and protect natural resources such as waterways and heritage within local government areas. LEPs are prepared by local councils, in consultation with their community and approved by the Minister for Planning (or their delegate).

Although the rules and guidelines for land use within local council areas are dictated to some degree by State Environmental Planning Policies, local councils can administer more specific rules about land use through their LEPs, and can provide additional guidance in their development control plans (DCPs).

A LEP covers part or all of a local government area and outlines the zoning of the land in the LGA. A standard template has been provided for creating LEPs and this can be found at http://www.planning.nsw.gov.au/en-AU/Plans-for-Your-Area/Local-Environmental-Plans. Zone names and permissibility within a zoning area are defined in the Template and associated resource documents available on the website. Zoning applies to both land and waterways. Existing land attributes influence the choice of zoning. Environmental Zones include zones for reserves and where there are environmental attributes on public and private land. Environmental zonings have sub-categories (E1, E2, E3) which influence the degree to which development can occur within them.

Outcomes from the interviews with council staff revealed a range in the level of detail that informs the mapping of environmental attributes. This mapping is then used to inform the decisions about land zoning. The quality of mapping can influence zoning and thus potentially the long-term protection of areas. For example, areas of seagrass are generally zoned at a level that is more restrictive to development than areas without seagrass. Seagrass provides a useful example for another issue with mapping in that maps used are generally static. Seagrass, mostly *Zostera*, has been observed to grow in different locations through time. Examples are given in the seagrass mapping in Narrabeen Lagoon, Pittwater/Warringah and Penrhyn Estuary in Botany which shows changes in distribution and abundance over a four to ten year period. The mapping of seagrass habitat rather than just the seagrass patches would better inform mapping that is to be used for seagrass conservation.

An LEP does not require a mandatory environmental study, but must be approved by the Minister for Planning. Local government is therefore in the forefront of environmental management, and is the main land use decision-making body. To be able to fulfil this role, local councils need to have a strong environmental presence within their organisation.

Development Control Plan (DCPs)

A Development Control Plan (DCP) is a document that supports the LEP with more detailed planning and design guidelines. Feedback from council staff during interviews revealed many policies have now been included in DCPs. Examples are tree and bushland preservation orders. DCPs guide development, assessment of DAs and associated application of conditions. DCPs also provide a framework for setting acceptable actions and consequences of breaches.

Through interviews with local council officers it was found environmental policies were being moved into DCPs as the DCPs were upgraded. An example is tree management changing from being enacted through Tree Preservation orders to Development Control Plans.

On-ground Works

Local government plays a major role in management and on-ground works in the Salty Communities of Sydney. The key document types reviewed were biodiversity strategies, bushland management plans and equivalent documents. Biodiversity strategies (or equivalent) were reviewed and assessed according to criteria (an assessment matrix was developed with G. Chapman 2015) aimed at determining the extent of information on species and types of management.

Managing Biodiversity

Biodiversity definitions:

> *The Oxford Dictionary defines biodiversity as "the variety of plant and animal life in the world or in a particular habitat, a high level of which is usually considered to be important and desirable."*
>
> *The 1992 United Nations Earth Summit defined biological diversity as "the variability among living organisms from all sources, including, 'inter alia', terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part: this includes diversity within species..."*
>
> *The number and variety of species found within a specified geographic region.*

Hence for this review, biodiversity is measured by the diversity of plants and animals — that is, a species count. While this limited definition is being used for this study we note that biodiversity is far greater than just plants and animals: the role of fungi, bacteria and micro-organisms is considerable in the functioning of ecosystems.

Thus, the first part of the review looked at the data that each strategy / plan had on flora and fauna.

Questions asked included:

- What was the source of the flora/fauna data? Was it qualitative (a list) and /or quantitative (list and counts)?
- Was the information from anecdotal sources or systematically collected data?
- What vegetation was recorded with what accuracy?
- What types of fauna were recorded e.g. mammals, birds, reptiles and amphibians (and for each, were the data anecdotal or systematic and quantitative)?
- How often was the information obtained (once, more than once, and how old is it)?
- When was the information obtained (did it take seasons into account)?
- Where was information obtained (was it in different habitats, was it in more than one replicate of each habitat)?
- How were the data collected: transect, quadrat, bird calls or play call-back (in set area) etc.?
- Were all habitat types included?

The following were also asked:

- Was the intertidal zone included in flora data collection?
- Was the intertidal zone included in fauna data collection?
- Was the submerged zone included in flora data collection?
- Was the submerged zone included in fauna data collection?

The Excel sheet (Attachment II) provides a snapshot of the robustness of data that make up species lists in the local government reports.

After reviewing what is present, the second part of a Biodiversity Strategy or Bushland management plan is generally management. Management involves human interventions to maintain or increase native species in the LGA. Biodiversity management in urban areas is closely linked to the management of people and human activities.

The second part of the review looked at what management scenarios were recommended:

- Doing nothing
- Removing a physical structure e.g. a block to fish passage, a fence between bushland areas

- Removing an activity (behaviour) e.g. riding bikes on saltmarsh, cutting down trees
- Removing biota e.g. feral animals, weeds
- Adding a physical structure e.g. a nest box
- Adding an activity (behaviour) e.g. education
- Adding biota e.g. tree planting

To complete the review of local government biodiversity management plans and equivalent, the following questions were asked:

- Are there recommendations for specific actions?
- Are the actions council resourced and if not, how are they paid for?
- Are the actions by others with no supervisory role from council (with the exception of council permitting work on public land)?
- Is monitoring proposed?

Other Documents Included

Six of the 16 councils reviewed had Biodiversity Strategies and five others had documents with similar information to a Biodiversity Strategy. Attachment II has a list of the relevant local government biodiversity documents reviewed. The types of plans and strategies containing biodiversity information include:

- Biodiversity Management Plans – covering flora and fauna generally;
- Vegetation Survey and Management Plans;
- Fauna Survey and Management Plans;
- Bushland Management Plans – individual reserve or groups;
- Open Space Management Plans – parkland and recreation reserves, and usually beaches;
- Street tree management plans – street trees and;
- Estuary and Coastal Management Plans – has not translated to the biodiversity of these environments being included in the Biodiversity Strategies or equivalent plans.

A review of these documents found high variability in the level of detail.

Sydney councils chiefly manage and plan for terrestrial vegetation. Data on intertidal flora / fauna is limited to seagrass mapping. Intertidal area management is usually linked to estuary management plans and relates more to mangroves and saltmarsh than rocky shores.

Other studies which were reviewed and found to have a focus other than biodiversity were:

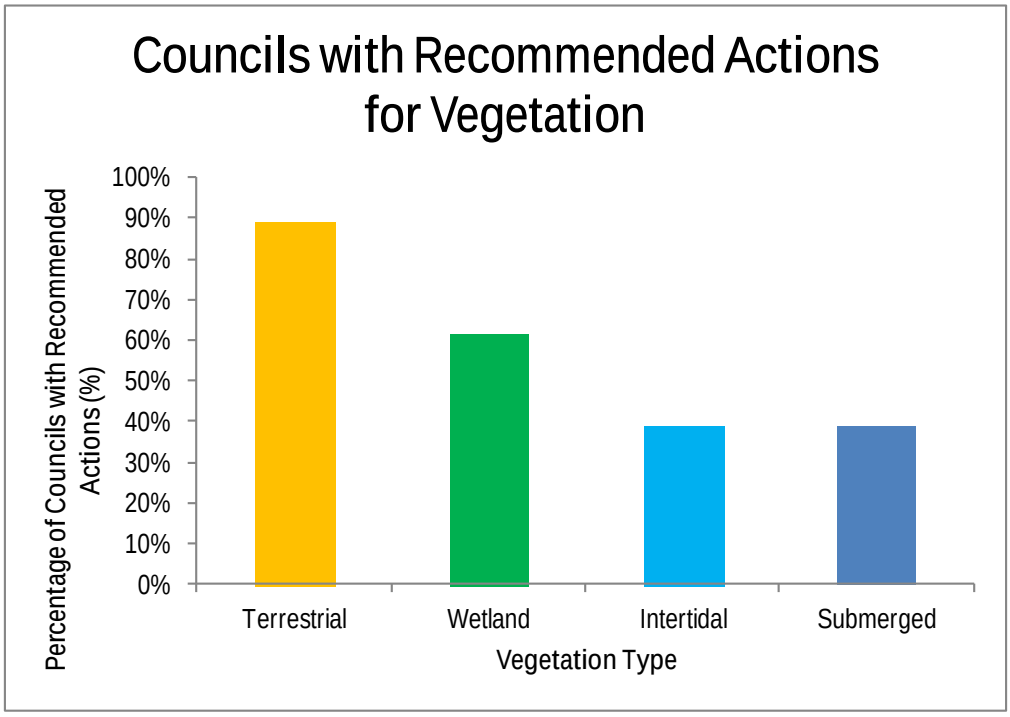
- Beaches and Coastal Plans of Management – focus on erosion and recreational management
- Flood studies and Flood Plans of Management – focus on risk and protection of life and property

DCPs: Feedback from council staff during interviews revealed many policies have now been included in DCPs. Examples are tree and bushland preservation orders. DCPs guide development, assessment of DAs and associated application of conditions. DCPs also provide a framework for setting acceptable actions and consequences of breaches.

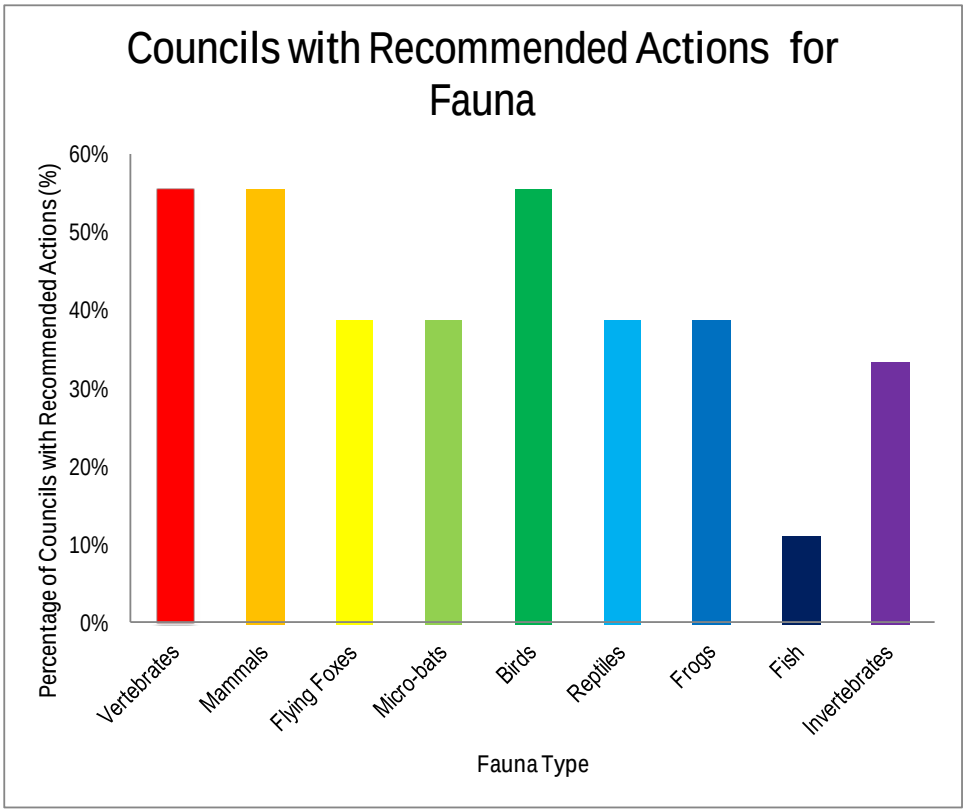
Evaluation of Local Government Biodiversity Strategies

A comparison of local government Biodiversity Strategies (see Attachment III) revealed that only 44% of local government councils had biodiversity strategy documents; however a further 36% had other documents with similar information to a Biodiversity Strategy. In addition, only 33% had new flora and fauna data and it was found that all councils covered vegetation management; however no councils looked at studies specifically for intertidal and submerged vegetation. Furthermore, only 33% of all councils had surveys of fauna in all habitat types and had replicated their fauna surveys for accuracy.

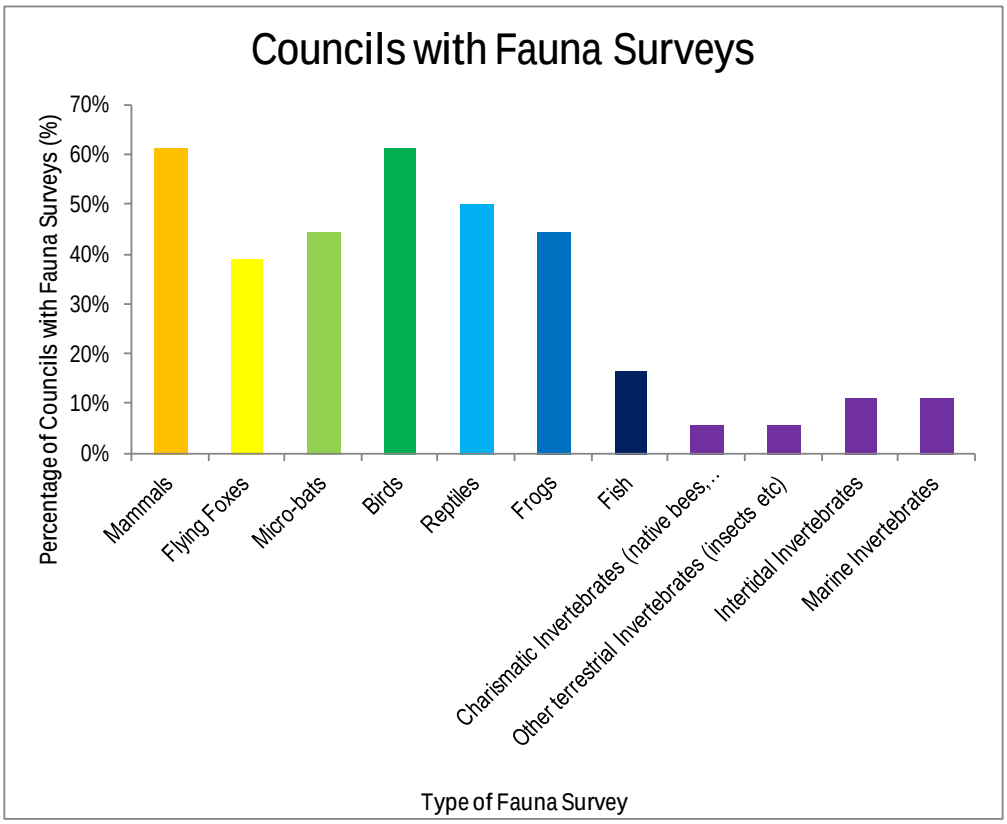
Graph 1 below reveals that while the majority of councils provide recommended actions for terrestrial vegetation, only 40% provide recommended actions for submerged and intertidal vegetation. In Graph 2 it can be seen that recommended actions for fauna are only given by 55% of councils, with only 10% providing recommendations for fish. Graph 3 reveals that fauna surveys for fish and invertebrates were carried out by only 10% of SCCG councils.



Graph 1. Councils with Recommended Actions for Vegetation



Graph 2. Councils with Recommended Actions for Fauna



Graph 3. Councils with Fauna Surveys

6.1.5 Gaps and Recommendations

Summary of findings for global governance

In summary, the Convention on Migratory Species is the instrument with the most direct relevance to the Study Area. None of the other global instruments, (with the exception of RAMSAR), directly protect the biodiversity of salty communities in the Sydney area. Biodiversity work in the Study Area to conserve and better manage these communities will contribute to the aims of each of these global instruments. Reversing the trend from incremental loss to incremental replacement / restoration / regeneration is key in managing biodiversity in urban areas.

Summary of findings for federal government

Federal agencies' biodiversity work is focused on Commonwealth land. A key role of federal government management of coastal biodiversity is through providing grant funding for Natural Resource Management (NRM) works and research.

Federal government information is used by local government as input to decision making. Examples include adding federal level mapping data to the LEP layers; and using objectives of Acts such as migratory bird international agreements and commonwealth listed species, to assist with, or provide support for, management aims.

The conclusion from the literature and data reviewed, combined with interviews with local government representatives, is that the focus of federal visions, strategies and actions is on a broader scale than that managed at local government (LG) level. Federal government environmental priorities are supported by federal funding such as the Caring for Country funding programs. Listings in the EPBC Act are also apply to the Salty Communities (see discussion under Federal Literature).

LG manages areas and species of national significance. Local level impacts on these listed communities, populations and species are usually managed by LG and the trigger for Federal level involvement is not often reached. The outcome is an incremental loss and degradation of biodiversity in the urban areas. This is often the case for Endangered Ecological Communities (EEC) such as Themeda Grasslands, and migratory wading birds listed on international agreements (JAMBA, CAMBA, ROKAMBA). For example for federal involvement in migratory bird management a site has to have a nominated percentage of the flyway population of migratory birds (there different percentages for different species). This level is rarely triggered in urban areas. So despite urban locations providing steps for travel and rest on long migrations they miss direct federal protection.

Key points:

- No obvious plan or recognition for Sydney's coastal biodiversity by federal agencies.
- Blue-Green Zone of Coastal Biodiversity (the marine and intertidal areas) protection is via existing planning instruments.
- Federal agencies do not do on-ground works in Sydney coastal biodiversity areas, but they do fund projects.
- Federal agencies focus on Commonwealth Land or biodiversity (NRM) matters at a federal level. Usually "Sydney level" biodiversity matters do not trigger input from federal agencies (see discussion earlier in this section).
- The federal government is an important provider of funds for larger-scale projects and for on-ground works conserving federally listed species.

Summary of findings for state government

- No specific plan or recognition for Sydney's Coastal biodiversity in *The Regional Growth Plan for Metropolitan Sydney* (2014).

- Blue-Green Zone of Coastal Biodiversity (the marine and intertidal areas) protection is via existing planning instruments (as stated in *The Regional Growth Plan for Metropolitan Sydney)*, as well as the NSW Offsets Policy for Major Projects (2014). Agreements include the IPA, and Aquatic Reserves.

State agencies:

Their on-ground work focus is, in general, outside of the Sydney area, with the exception of SW, RMS and SHFT, DPI (fisheries) for aquatic reserves and seagrass.

State agencies have biodiversity data and OEH's Bionet is the most commonly accessed resource by users including local government. Biodiversity guiding documents relating to the coastal zone include OEH's Recovery Plans and Priority Action Statements for listed species, populations and communities. The following summary is from the review of biodiversity guiding documents.

- Managing biodiversity in the urban zone is suggested to occur via offsets, bio banking and the existing regulatory framework including REPs and SEPPs.
- Cumulative impacts are not accounted for. The bulk of coastal environmental damage is linked to a very large number of small problems. The inability of the planning system to take this into account is a serious deficiency.
- With the exception of saltmarsh and mangroves, intertidal biodiversity is not "seen", partly due to the low level of knowledge and / or mapping of these communities, and partly due to this ecosystem occurring in the intertidal zone that falls between two tiers of government (local and state).
- Understanding landforms and the influence of physical changes with climate change is needed.
- Co-ordination of Marine Pest planning and management has gaps.
- Coordination of planning in the Coastal Zone is a "gap" as there are a number of statutes applicable and government agencies responsible for the coast. The lack of integration and coordination of these agencies and this legislation is a problem that will be exacerbated by changing climatic conditions.
- Authorities such as SOPA have good on-ground biodiversity data, and utility mangers such as AusGrid have effective systems and processes in place for assessing impacts on biodiversity, including map based data coordinated from multiple agencies. SW have biodiversity in their planning and conduct on-ground works in the area of Salty Communities, including channel naturalisations.
- Estuary Management, through the co-ordination of local government, appears to provide a usable framework for inter-agency and inter government on-ground works.

Summary of findings for local government

- Six of the 15 councils reviewed had Biodiversity Strategies, five others had documents with information similar to a Biodiversity Strategy but under a different name. There was high variability in the level of detail between documents.
- Local governments in the Study Area have areas with 'bushland' managed in a variety of ways. "Bushland Management Plans (BMP)" are a common tool. Of the 15 councils surveyed 8 had BMPs or equivalent. BMPs cover either single reserves or the whole LGA.
- The Bushland Management Plans reviewed range from simple (stating location and area of reserves, a species list and key threats) to detailed (with vision and management well-articulated and including milestones for set actions). The BMPs are generally used to guide on-ground works. Some BMPs are prescriptive and specific in what management is to occur, while others are general.

- Sydney councils chiefly manage and plan for terrestrial vegetation. Data on intertidal flora / fauna is limited to seagrass, mangrove and saltmarsh mapping. Intertidal area management is usually linked to estuary management plans and relates more to mangroves and saltmarsh than rocky shores.
- A review of plans found that studies such as Plans of Management for Beaches and Flood Studies have a focus other than biodiversity (see list in Attachment II). This conclusion is supported by feedback from LG personnel interviewed about these plans and their scope. For example:
    - Beaches and Coastal Plans of Management focus on erosion and recreational management
    - Flood studies and Flood Plans of Management focus on risk and protection of life and property
- Local Environment Plans (LEPs) are in place in all the councils surveyed. LEPs are increasingly used as biodiversity management tools with mapping of environmental areas influencing development type.
- Feedback from council staff during interviews revealed a number of key biodiversity policies have now been included in DCPs, for example, Tree and Bushland preservation orders.
- Wording in legislation, particularly the federal EPBC Act, International agreements (e.g. JAMBA, CAMBA and ROKAMBA), and the NSW TSC Act, is used to support local level recommendations that relate to protection and conservation of species and populations of communities. Biodiversity Strategies reference such legislation. It is noted that federal level legislation rarely provides direct protection at the local level. This has been discussed in section 6.1.2 pertaining to federal government and including reference to the EPBC Act 1999 and the Heads of Consideration.
- Bionet (flora and fauna location counts) and mapping e.g. NSW Government mapping (Six Maps) including vegetation layers are used by local government in decision making.
- The intertidal zone and marine environments are commonly missing from local government documents. These are areas of biodiversity where responsibility for management of those lands is, at times, ambiguous.
- Accuracy of threatened species and EEC mapping and the extent of ground truthing varies between councils. This generalisation is based on the feedback from LG personnel surveyed as part of this project. Some had resources for accurate on-ground studies while other utilised less fine scale data from state government records.
- General findings relating to vegetation mapping are that:
    - Vegetation mapping excludes seaweeds but includes seagrasses
    - Vegetation mapping includes threatened species mapping, generally direct from BioNet
    - There is no automated system for updating maps in LG systems when the original data (e.g. OEH) updates their map layer.

6.2 Scientific Papers

Scientific information on the topic of coastal biodiversity is vast, with 100s of papers per ecosystem type. It is not useful or practical to review 100s of papers on general topics. Instead a number of more specific questions were asked and then papers relating to these specific topics was sought and reviewed. The example below for mangroves shows over 110 papers when searching 'mangroves' and 'Sydney' yet only 5 when looking at 'mangroves' and 'nesting' 'bird' 'diversity'.

Other search terms used were: i) Sydney, ii) NSW, iii) Australia and iv) internationally in urban areas, in addition to the community, for example *mangroves* and a topic, for example *sea-level rise*.

Table 2. Example of Table for Mangroves

Category	Search Area	Number of papers Found
Mangroves	Sydney	110
	NSW	222
	Australia	1577
	Urban	500
Mangroves – examples of specific question		
	Mangroves nesting bird diversity	5

Effective review relies upon there being a particular question to answer and the resources to review the required amount of information.

6.2.1 Gaps and Recommendations

Existing Research

The key message is that much research has already occurred and much is in progress. Research is available from local and international projects on topics relating to Salty Communities. It is vital to make use of the existing local and international studies.

Increased Communication and Ease of Presenting Information

Another recommendation is to increase the effectiveness of communication between scientists and managers. In general, managers are not going to read scientific papers. Additionally, papers are often published months if not years after the research is done. Considering a widespread sense of 'information overload' it's suggested scientific papers and current research be summarised into short videos or posts on topic-specific social media such as Facebook groups. Example of existing Facebook groups include: Saltmarsh and Mangroves, We Love Estuaries and Seaweeds of Sydney.

Specific Questions for Research

To best use the existing information specific questions could be proposed for an area of interest and then a specific literature review done for that question.

It is recommended that specific questions be asked in relation to management of salty community biodiversity. Each can then have a specific literature review done and research designed. Some suggestions are provided below.

Example questions that could be posed for specific review of scientific papers:

- How important are mangroves in coastal defence? Are mangroves within Sydney identified as having a role in coastal defence?
- Response of Coastal Heathland to fire?
- Is Themeda Grassland EEC another stage of Coastal Heath?
- Can Littoral Rainforest be successfully re-established in urban areas?
- What is the diversity of plants in the intertidal zone in Sydney?
- Where are the intertidal zones on Sydney's rocky platforms?
- How susceptible are intertidal seaweeds to changes in sea level?
- Can Saltmarsh be manipulated to keep the inundation level optimum for Saltmarsh despite increasing sea-level rise?
- What is the role of Grey Headed Flying Foxes in pollination of Coastal Eucalypt trees in Sydney?
- Does misting reduce Grey Headed Flying Fox mortality during extreme heat days?
- What is the condition of seagrass in Sydney's estuaries?
- What size corridor is needed for successful movement of Blue Wrens between otherwise isolated populations?
- Can foxes be effectively managed in urban coastal areas?
- What are the impacts of foxes on migratory wading birds in Sydney (or in urban areas)?
- Effective restoration techniques for *(insert any of the EECs in the Coastal Area*) in Sydney (if nothing then in urban areas in NSW and go wider from there)?
- Can community bird (or micro-bat) monitoring data be collected in a scientifically robust way?
- Does increasing corridor connectivity in urban areas increase impacts of foxes on native fauna?
- How to manage algal blooms in urban freshwater wetlands with increased temperatures?
- How robust are native bees to sustained high temperatures (above 40°C)?
- Sea-horse re-establishment after replacement of submerged nets?
- Does a constructed saltmarsh contain the same substrate invertebrate diversity and abundance as naturally occurring saltmarshes?
- Are there any shellfish reefs in the Study Area? If yes what condition are they in? (NB Australia has lost 99% of shellfish reefs).
- Fox management in Sydney – can it be effective?
- How accurate are camera traps in monitoring the effectiveness of fox and cat control?
- Chemical-free weed management in urban areas – which methods are effective?
- Does thermal weeding effectively manage weeds in native grasslands?

For any gap identified in this study, or others, questions can be created and asked. The more specific the question the more closely the papers will match the question, allowing a quick review of what is already known in published works.

A range of scientific papers on coastal biodiversity has been included in the *Salty Communities Master Sheet* (Attachment II). The selection has been arbitrary and does not represent a thorough search for papers on a topic with any particular question. The purpose of inclusion is to show examples of research projects already undertaken and to

inspire the reader to look for research prior to starting a new project. Papers included are those which have been sent to us, or found, during the course of this project.

6.3 NGOs and Community

Who Cares About Salty Community Biodiversity in Sydney? We Do!

Community care, such as Dunecare, Coastcare and Bushcare is essential for long-term survival of Coastal Urban Bushland. Urban bushland inspires and provides a space of community cohesion and happiness. Indeed in Sydney a high level of community focus is around the bushland remnants, beaches dunes and waterways.

Local government surveys generally find community feedback ranks the care of natural areas as a high priority.

Education programs that explain the connection that people have to the natural environment can help to build appreciation for biodiversity and knowledge on how to maximise its survival.

Independent groups caring for biodiversity work throughout the Sydney coastal area. Carers can stay in communication with resources such as the *Sydney Nature Carers Network*. Sydney's Nature Carers (SNaC) is a group of people who take an active interest in the natural environment within the Sydney Metropolitan region. Communication is via the yahoo group SNaC-subscribe@yahoogroups.com.

Community has a key role in managing biodiversity works, which are usually coordinated through local government or programs through LLS programs including Landcare. http://www.landcare.nsw.gov.au/.

Local government manage possibly the highest number of volunteers of any sector and provide weekly on-ground support for regular groups. Council personnel were asked in the survey about Bushcare and all councils surveyed have active Bushcare groups and Bushcare programs.

NGOs

Major NGOS working in Salty Communities include:

- Ocean Watch, http://www.oceanwatch.org.au/
- The Nature Conservancy – including the current "Great Southern Oceans" Project which includes the Study Area. http://www.nature.org/
- Birdlife Australia http://www.birdlife.org.au/
- Landcare (Dunecare, Bushcare etc.), http://www.landcarensw.org.au/
- Nature Conservation Council of NSW (NCC) http://www.nature.org.au/

Along with smaller interest specific groups like:

- Frog and Tadpole Study Group (FATS) http://www.fats.org.au/en/
- Sydney Fungal Studies Group Inc. (SFSGI) http://www.sydneyfungalstudies.org.au/lanecove.htm
- Bushcare http://www.bushcare.org.au/index.php/resources/volunteer/
- Volunteer Co-ordinators Network (VCN) http://greatersydney.lls.nsw.gov.au/our-region/community-groups

Groups such as Birdlife Australia have long records of bird data. A review of such data could result in recommendations for collection that would make it more reliable through time and space and easier to access/use by local government. Reviews of some community bird data are available for use via the federal government's *Atlas of Living Australia* (ALA).

Datasets and analyses of these data are produced in reports and scientific papers – see the ALA website for more detail.

Environmental Groups

Most Councils have organised environmental community groups. The aims of these key groups vary but include input to planning decisions and on-ground works including community walks and talks, outdoor activities and collection and collation of biodiversity data including bird surveys.

Sydney is fortunate to have these existing and organised groups which can facilitate new people joining and the continuing care for biodiversity. Examples include the Wolli Creek Bushcare Group, the "mud-crabs", the Frog and Tadpole Study Group (FATS), the Sydney Fungal Society, and other long-established Bushcare groups which, usually with the support of local government, can encourage new members to get involved in caring for biodiversity. Other groups in the coastal zone include Eco-Divers, Stream Watch and many more.

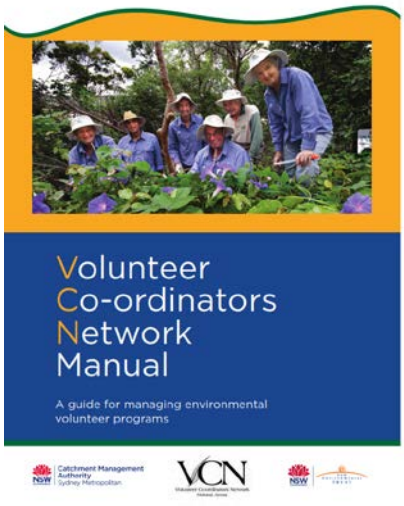
Community Days

Community days include one-off events where the community is involved in caring for the environment in a number of ways such as tree planting, rubbish removal, environmental education and engagement. Direct work with schools also fosters a greater environmental appreciation and knowledge of biodiversity in the area. Examples of annual community biodiversity care events include National Tree Planting Day (July) and Clean Up Australia Day.

Bushcare

Bushcare groups are comprised of volunteers contributing time and expertise to sustain bushland and re-create natural areas through planting and weed removal.

Councils usually support Bushcare groups through coordination, providing training, providing weed bags and a weed bag collection service. Bushcare can include council paying for supervised works on public land and / or Adopt-A-Patch programs, where residents can elect to revegetate and care for a local public space following an agreed plan.



Apart from the direct value of on-ground work, these hours also assist council in securing grants for environmental works where matching resourcing is required, which can be cash or in-kind. Volunteer hours are a key component of in-kind grant matching of on-ground hours. This provides council with the opportunity to leverage this volunteer input to secure grant funding.

Volunteer Co-ordinators Network (VCN)

The Volunteer Co-ordinators Network (VCN) is an Australia-wide network of people employed to co-ordinate community volunteer involvement in natural resource management and on-ground work. The Sydney Region VCN meets quarterly, hosted by different organisations across the Greater Sydney region, facilitated by the Regional Landcare Facilitator of LLS. http://greatersydney.lls.nsw.gov.au/our-region/community-groups

The 2012, 3rd edition of the Volunteer Coordinators Manual includes 39 case studies that show the diversity of environmental volunteer programs in urban and rural areas throughout Australia.
http://www.aabr.org.au/images/stories/resources/manuals/vcn.pdf

Corporate Sponsorship

Corporate days include Bushcare-like activities in the Study Area. Generally these are managed by the local council working in the area and the volunteers are generally staff from large corporations such as banks.

6.3.1 Gaps and Recommendations

NGOs

The following areas are gaps or situations that need input to maximize the long-term effectiveness of groups:

- Funding long-term
- Recruitment of volunteers
- Demographics of volunteers (age, location, ethnicity, etc.) with the aim of better working with and retaining and growing volunteer involvement
- Sustainability of volunteer hours into the future – noting the current demographic of Bushcare volunteers is anecdotally skewed towards older people.
- Capture and passing on of the detailed site-specific and expert knowledge of communities, and care sites, held within the intellectual knowledge of volunteers.
- Review of biodiversity information collection and reporting done by NGOs with the aim of determining ways to maximize the usefulness of data collected to other groups including local government. Also to maximize consistency and reliability of data between NGOs and others.
- Opportunities for local government to work with NGOs exist particularly in the area of community engagement and information sharing.

In relation to long-term biodiversity management in the Study Area it would be useful to know the:

- number of Bushcare volunteer hours per year in the Study Area Salty Communities
- number of Bushcare sites actively worked within the Study Area Salty Communities
- existing support (resourcing, funding etc.) and the security of this support long-term, for volunteer work within the Study Area Salty Communities.

Volunteer Coordinator Sponsorship and Corporate Sponsorship

The viability of corporate staff days doing environmental volunteers programs depends on what local government wants to achieve from a site and the effective engagement with corporations. Opportunities for biodiversity management, other than weeding, could be utilised — such as a Bushcare group having the services of a corporate PR or marketing person for a day.

To date there appears to have been little corporate involvement in supporting on-ground biodiversity projects through sponsorship. Sponsorship tends to be for workshops and events. This is shown by input from LG biodiversity personnel during surveys. It is also demonstrated by the lack of information on the internet about sponsoring Bushcare or other environmental works. It is also shown in the lack of ecological elements in councils' sponsorship information (web searches of Manly Council, Pittwater Council). This may be an area for effective engagement, particularly given the local visibility of on-ground projects. The Greater Sydney LLS appear to seen an opportunity here as they have this as an item on their web page.

Other funding sources:

Pittwater Environment Foundation (PEF) is a registered Foundation with tax deductibility status. PEF provides a mechanism for donations, grants and bequests to conserve and enhance the natural environment of Pittwater.

http://www.pittwaterenvironmentalfoundation.org.au/projects/

Figure 12. Care Groups in Sydney Salty Communities. Cromer golf course group caring for EECs along the waterways.

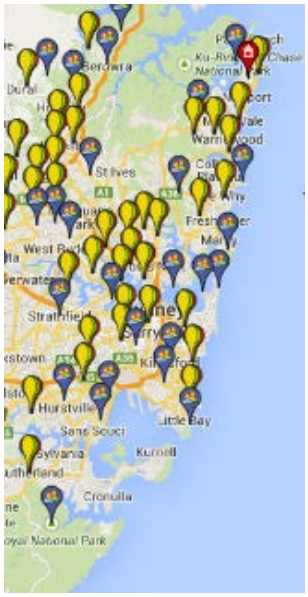


Figure 13. Some of the Landcare sites in Sydney (Source: Landcare website).

7 Data Review

7.1 Government

Key biodiversity data produced and used by federal, state and local government is in the form of vegetation mapping and species records which locate flora and fauna. Following is a brief summary of the main data sources. Local government generates high quantities of biodiversity data and often this is held in unpublished reports. The official system capture of basic biodiversity data in NSW (that is species presence / absence) is by providing all data to the state government (OEH) for recording in Bionet. It is a requirement of the license (provided by OEH) for any research or works in areas with biodiversity that the findings be uploaded to the Bionet database or provided to OEH so they can upload the data.

Federal government data collection areas include The Atlas of Living Australia and provision of data to this is voluntary rather than linked to any licensing.

A US report, *Data Management Best Practices and Standards for Biodiversity Data Applicable to Bird Monitoring Data* for the North American Bird Conservation Initiative Monitoring Subcommittee Data Management Team (Martín et al, 2010), has a comprehensive summary of best practice data management. Many of the recommendations from this document are not implemented fully in most of the reports covered as part of this review.

The purpose of the state and federal databases (Bionet and Atlas of Living Australia) is to be a central place to hold data and in the case of the Atlas of Living Australia it provides a list of what databases are available elsewhere. Neither is set up to answer any particular question or track changes through time.

Local government data is chiefly in the form of species lists, counts and mapping. Local government data is generally in unpublished reports. This is provided in more detail in other sections and below.

7.1.1 Federal Government

Australia's Biodiversity Conservation Strategy 2010-2030 was written to inform and guide governments, the community, industry and scientists who will manage and protect Australia's plants, animals and ecosystems over the next twenty years. Accessible at http://www.environment.gov.au/biodiversity/conservation/strategy this strategy relies on data to measure progress.

Species Profile and Threats Database

A key federal government location for storage of biodiversity data is on the *Species Profile and Threats Database* (SPRAT). The database is designed to provide information about species and ecological communities listed under the Environment Protection and Biodiversity Conservation Act 1999.

Available at http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl, it provides information on what a species looks like, its population and distribution, habitat, movements, feeding, reproduction and taxonomic comments. The information has been compiled by summarising information from a range of sources and contributors. Profiles are not present for all species or ecological communities and are being added to the database when they are available.

Local governments need to use this database when considering impacts on species, populations and communities listed on EPBC Act.

Atlas of Living Australia

The key federal repository for listing biodiversity data is at the federal level *Atlas of Living Australia* (ALA) can be accessed at: http://www.ala.org.au/. The database has the following areas:

- Australian Species: Search for Australian flora and fauna species by common, scientific name or search by category
- Species by Location: Search by pre-defined region, or enter an address or location to find the recorded species nearby
- Collections: Learn about the institution, the collections they hold and view records of specimens that have been databased.
- Mapping and Analysis: A spatial portal for investigating species occurrences within specified locations and the environmental impacts.
- Data Sets: Refine the list of all the data sets contained within the Atlas by institution, integration status, content, resource, and license.
- Partnerships with data collection and case studies: Partner profiles, collaborations, and case studies. See how key contributors help grow the Atlas of Living Australia.

The ALA also provides areas for public involvement in data capture with a program to ID species from camera footage and be part of Citizen Science programs where people collect biodiversity data with trained scientists and provide that data to the coordinating group. The name of the data set and who to contact for it is then listed on the Atlas.

7.1.2 State Government

Vegetation Mapping

The key site publically providing aerial imagery and vegetation mapping is the NSW Lands Department Six Maps: https://maps.six.nsw.gov.au/.

Six Maps provides access to cadastral and topographic information, satellite data and aerial photography for New South Wales. Six Maps is the Department of Lands (Lands) Spatial Information eXchange. The web site provides spatial information related to applications published by Lands. The site also includes viewing applications for both imagery and standard mapping data.

Six Maps has land imagery from current high resolution aerial photographs to imagery from 1943 for much of the Study Area. Comparison of the two aerial images, from both dates, can provide useful biodiversity data in identifying remnant areas and noting how these areas have changed. See examples below in Figures 14a-14d which show Botany Wetland and ponds and also Manly Lagoon, from 1943 and 2014. A particular observable change from 1943 to 2014 at Botany is the reduction of densely vegetated marsh and the increase in open water areas.

Figure 14a. Inflow to the Botany wetlands above Pond 6 – 1943 dense marsh (Source: SIX Maps).

Figure 14b. Inflow to the Botany wetlands – 2014 filled and channelled inflow area (Source: SIX Maps).

Figure 14c. Manly Lagoon image 2014 (Source: Six Maps)

Figure 14d. Manly Lagoon image 1943 (Source: Six Maps)

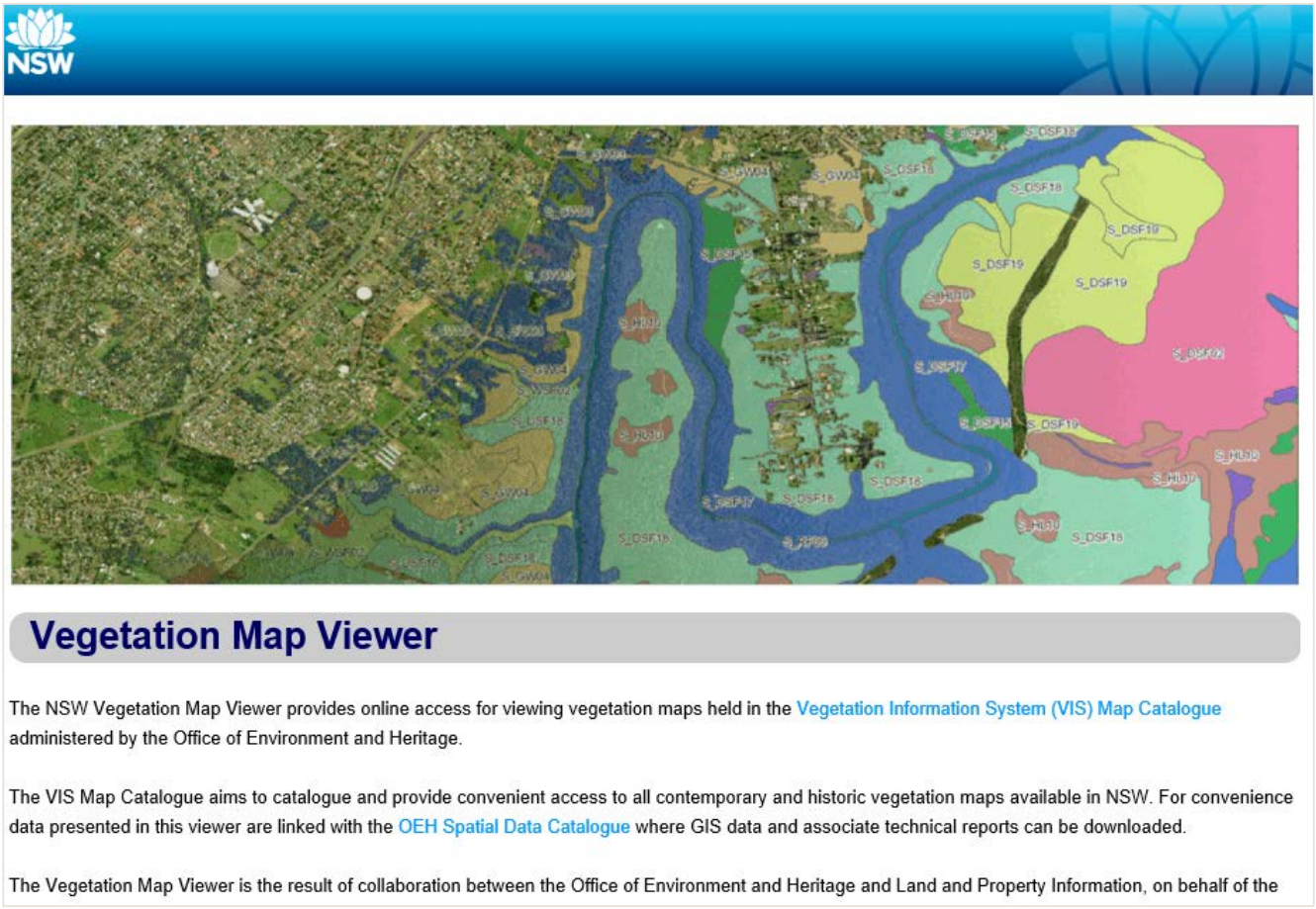
Vegetation Information System (VIS) Map Catalogue

Six Maps also provides access to The NSW Vegetation Map Viewer. The Vegetation Map Viewer is the result of collaboration between the Office of Environment and Heritage and Land and Property Information, on behalf of the New South Wales Government.

http://maps.six.nsw.gov.au/apps/channels_3.5/landing/vegetation/vegetation.html

The Vegetation Map Viewer provides online access for viewing vegetation maps held in the Vegetation Information System (VIS) Map Catalogue administered by the Office of Environment and Heritage.

The VIS Map Catalogue aims to catalogue and provide convenient access to all contemporary and historic vegetation maps available in NSW. For convenience, data presented in this viewer are linked with the OEH Spatial Data Catalogue, where GIS data and associate technical reports can be downloaded.



Other sites for vegetation mapping

Detailed vegetation site data can also be accessed through the Atlas's Vegetation Information System (VIS) flora survey module. http://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/YETI_/FloraSearch.aspx

Vegetation maps and reports for the Sydney metropolitan area, which update the 2009 Sydney Metropolitan Catchment Management Authority (SMCMA), are available. This set of products provides comprehensive coverage of all land tenures across 39 local government areas of the eastern Sydney area.
http://www.environment.nsw.gov.au/surveys/VegetationSydMetro.htm

A two volume report details the vegetation mapping methods, the vegetation types and their relationships to threatened ecological communities (TECs) listed under the NSW Threatened Species Conservation Act 1995 and/or Commonwealth Environment Protection and Biodiversity Conservation Act 1999.

There are 79 vegetation types identified. The reports provide a detailed profile of each vegetation type including floristic composition, conservation status and technical data to assist in identifying the community in the field.

Map coverage is provided by a digital data file suitable for use in geographic information systems (GIS) and by 23 pdf format A0 maps presented at a scale of 1:15,000.

Flora and Fauna Mapping

The key site for locational data on flora and fauna in NSW is Bionet http://www.bionet.nsw.gov.au/

Via BioNet, you can search and map records of flora and fauna sightings held in the Atlas of NSW Wildlife. BioNet is a portal for accessing government-held information about plants and animals in NSW. It is supported by several NSW government agencies, including:

- Office of Environment and Heritage, National Parks and Wildlife Service
- Royal Botanic Gardens and Domain Trust
- Department of Primary Industries, Forests NSW
- Australian Museum

Records in the Atlas come from a variety of sources, including from members of the public and scientific surveys. An Atlas search will retrieve species records from across the entire Atlas database, including records held in the fauna and VIS flora survey modules.

Detailed vegetation site data can also be accessed through the Atlas's Vegetation Information System (VIS) flora survey module. http://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/YETI_/FloraSearch.aspx

Other State Government Data

Other types of data for the Study Area are held by BoM (weather data), DPI (fisheries, seagrasses and aquatic weeds), MEM (community surveys and more), Sydney Harbour Federation Trust (information on Sydney Harbour include fish species list and sea weeds), RFS (bushfire locations). None of the data was assessed for accuracy.

7.1.3 Local Government

Local government biodiversity data is chiefly in the form of species lists, species counts and mapping. The source of data ranges from:

i) using the species list directly from state government (such as Bionet) to

ii) scientifically rigorous collection of species data including abundance, frequency and timing, with collections replicated through time and locations.

Likewise for mapping the data ranges from:

i) direct use of mapping from NSW Fisheries (e.g. seagrass maps) to

ii) detailed on-ground mapping that is at a considerably finer scale than any of the state government, or other agency, mapping.

Data Location

Data is generally in mapping layers and or lists within documents such as Flora and Fauna Reports, Reserve Management Plans, Biodiversity Strategies and others. A list of the documents obtained for this review are listed, by LGA, in the Master Data Table.

Data Sharing

Local government data is generally in unpublished reports, however data sharing between councils does occur.

Sydney councils work on regional projects. A group of councils may be linked through an official organisation or agency such as a ROC (Regional Organisation of Council) or Sydney Coastal Councils Group (SCCG) or unofficially through working on a combined project such as a grant.

Councils also work together and with other agencies through committees such as Sydney Weeds Committees and Feral Animal Committees. Within committees data sharing is usual, however there was no known central database of weed or feral animal data.

Councils were submitting, and some continue to submit, State of the Environment (SoE) Reports. SoE reports had high level (summary) data. Council SoE data was combined to report on regional biodiversity.

While this study does not include an assessment of the vegetation data quality, it does include a brief overview of each of the main communities identified within the Study Area and provided by SCCG as part of this project. The following section summarises ecological communities and their general biodiversity characteristics along with recommendations as they pertain to the Study Area.

Local Government – Ecological Communities – Data Summary

Sydney's coastal area has a high diversity of habitats resulting from highly varied terrain, soil, aspect and proximity to salt. Ecological communities present are those of the beaches, estuaries, lagoons and riparian zones along waterways, which link the Salty Communities with more in-land vegetation.

While this section of the report presents information on communities, it is noted that modern biodiversity management is at a landscape scale, rather than focusing on individual species or vegetation types.

Communities are the basis of this section of the report because Community Mapping was provided by SCCG to define the *Salty Communities* and hence the Study Area. This "Communities" section is worded with a focus on vegetation, however inherent in this is the recognition that vegetation is habitat for fauna.

Definition of Community as used in this study:

- Community: *is a collection or association of plant species within a designated geographical unit, which forms a relatively uniform patch, distinguishable from neighbouring patches of different vegetation types.*

It is acknowledged that this section of the report has not discussed ecological processes, such as microbial action or physical components of landscapes such as hydrology, soil types etc.

"Gaps" relating to biodiversity management of each of the major groups of fauna (invertebrates, fish, frogs, reptiles, birds and mammals) are provided in Attachment II.

Collation of Mapping Data

The 2014 collation of mapping by SCCG listed 55 communities present in the Salty Communities of the Sydney Region. Table 3 (below) is an extract from that document and lists the communities that have been mapped, as well as additional Salty Communities covered in the text of the document. From the mapping and Table 3, vegetation has been split into 55 groups from 11 vegetation types. Table 3 shows the area of each community estimated to be remaining and the percent within reserved land. Four additional habitat types have been included: Soft-Bottom Macrofauna Community, Artificial structures, Intertidal mud and sand-flats, Beach dunes, sand areas.

The mapping is based on existing map data from OEH, Greater Sydney LLS and councils supplied by SCCG. Limitations in the reliability of the mapping data were not assessed as part of this project. Condition assessments do not accompany the mapping data.

Key for Table 3 Colour Coding

EEC or TEC	Area total	Reserved total	Ratio in reserve: reserved / total area
EEC light red TEC orange	< 50 ha dark red > 50 < 100 ha light red > 100 < 500 ha orange > 500 < 10000 ha white > 10000 ha green	< 33 ha dark red > 33 < 50 ha light red > 50 < 250 ha orange > 250 < 10000 white > 10000 ha green	< 0.5 light red > 0.5 < 0.66 orange > 0.66 < 0.95 white > 0.95 green

Table 3. Summary of mapping data from the 2014 collation of existing mapping – areas shaded are for the Study Area

Code	Type	Community	TSC Act Listing	EPBC Act Listing	EEC or TEC	Area total (Ha)	Reserve Total (Ha)	Ratio in Reserve
S_RF02	Rainforest	Coastal Sandstone Gallery Rainforest				219	205	0.94
S_RF03	Rainforest	Coastal Warm Temperate Rainforest				390	314	0.81
S_RF06	Rainforest	Coastal Dune Littoral Rainforest	Coastal Dune Littoral Rainforest	Littoral Rainforest and Coastal Vine Thickets	EEC TEC	23.5	19.1	0.81
S_RF07	Rainforest	Coastal Escarpment Littoral Rainforest	Coastal Dune Littoral Rainforest	Littoral Rainforest and Coastal Vine Thickets	EEC TEC	64.1	49.6	0.77
S_RF08	Rainforest	Coastal Headland Littoral Thicket	Coastal Dune Littoral Rainforest	Littoral Rainforest and Coastal Vine Thickets	EEC TEC	131	129	0.98
S_WSF02	Wet Sclerophyll Forest	Coastal Enriched Sandstone Moist Forest				1037	741	0.71
S_WSF03	Wet Sclerophyll Forest	Coastal Sand Littoral Forest	Kurnell Dune Forest		TEC	81.9	47.4	0.58
S_WSF06	Wet Sclerophyll Forest	Coastal Shale Sandstone Forest				378	247	0.65
S_WSF08	Wet Sclerophyll Forest	Sydney Foreshores Shale Forest				180	174	0.97
S_WSF11	Wet Sclerophyll Forest	Pittwater Spotted Gum Forest	Pittwater and Wagstaff Spotted Gum Forest		TEC	117	66.6	0.57
S_WSF33	Wet Sclerophyll Forest	Central Coast Escarpment Moist Forest				269	234	0.87
S_WSF34	Wet Sclerophyll Forest	Central Coast Escarpment Dry Forest				248	235	0.95

Code	Type	Community	TSC Act Listing	EPBC Act Listing	EEC or TEC	Area total (Ha)	Reserve Total (Ha)	Ratio in Reserve
S_WSF35	Wet Sclerophyll Forest	Coastal Diatreme Forest				53.2	53.2	1.00
S_WSF36	Wet Sclerophyll Forest	Coastal Flats Tall Moist Forest				47.9	47.3	0.99
S_GL01	Grassland	Beach Spinifex Grassland				22.6	10.5	0.46
S_GL02	Grassland	Coastal Headland Grassland	Themeda Grassland on Seacliffs and Coastal Headlands		TEC	120	117.0	0.98
S_DSF03	Dry Sclerophyll Forest	Coastal Sand Apple-Bloodwood Forest				147	128	0.87
S_DSF04	Dry Sclerophyll Forest	Coastal Enriched Sandstone Dry Forest				1674	1223	0.73
S_DSF05	Dry Sclerophyll Forest	Sydney South Exposed Sandstone Woodland				13,971	10,293	0.74
S_DSF06	Dry Sclerophyll Forest	Coastal Sandstone Foreshores Forest				612	403	0.66
S_DSF08	Dry Sclerophyll Forest	Coastal Sandstone Riparian Forest				532	359	0.67
S_DSF09	Dry Sclerophyll Forest	Coastal Sandstone Gully Forest				17,708	14,488	0.82
S_DSF10	Dry Sclerophyll Forest	Hornsby Enriched Sandstone Exposed Woodland				349	277	0.79
S_DSF11	Dry Sclerophyll Forest	Sydney North Exposed Sandstone Woodland				9088	8326	0.92
S_DSF21	Dry Sclerophyll Forest	Coastal Sand Bangalay Forest	Bangalay Sand Forest		TEC	14.9	12.7	0.85
S_DSF69	Dry Sclerophyll Forest	Hawkesbury River Escarpment Dry Forest				530	521	0.98
S_HL01	Heathland	Coastal Headland Clay Heath				61.6	40.4	0.66

Code	Type	Community	TSC Act Listing	EPBC Act Listing	EEC or TEC	Area total (Ha)	Reserve Total (Ha)	Ratio in Reserve
S_HL02	Heathland	Coastal Sand Tea-tree-Banksia Scrub				170	130	0.76
S_HL03	Heathland	Coastal Sand Mantle Heath	Eastern Suburbs Banksia Scrub		EEC	126	78.4	0.62
S_HL04	Heathland	Coastal Sandplain Heath	Eastern Suburbs Banksia Scrub		EEC	343	308	0.90
S_HL05	Heathland	Coastal Foredune Wattle Scrub				228	128	0.56
S_HL06	Heathland	Coastal Headland Banksia Heath				379	325	0.86
S_HL07	Heathland	Coastal Headland Cliffline Scrub				144	141	0.98
S_HL08	Heathland	Coastal Sandstone Heath-Mallee				10,237	8771	0.86
S_HL09	Heathland	Coastal Sandstone Rock Plate Heath				229	189	0.83
S_HL10	Heathland	Sydney Hinterland Dwarf Apple Heath-Woodland				3514	90.6	0.03
S_HL14	Heathland	Coastal Clifftop Marsh				7.9	7.8	0.99
S_FoW01	Forested Wetland	Coastal Alluvial Bangalay Forest				89.0	82.0	0.92
S_FoW02	Forested Wetland	Coastal Flats Swamp Mahogany Forest	Swamp Sclerophyll Forest on Coastal Floodplains		TEC	40.0	16.3	0.41
S_FoW03	Forested Wetland	Coastal Freshwater Swamp Forest				45.7	11.6	0.25
S_FoW04	Forested Wetland	Coastal Sand Swamp Mahogany Forest				22.9	15.5	0.68
S_FoW08	Forested Wetland	Estuarine Swamp Oak Forest	Swamp Oak Floodplain Forest		TEC	277	160	0.58
S_FoW12	Forested Wetland	Coastal Swamp Paperbark-Swamp Oak Scrub	Swamp Oak Floodplain Forest		TEC	42.3	21.7	0.51
S_FoW20	Forested Wetland	Coastal Sandstone Riparian Scrub				494	272	0.55
S_FoW21	Forested Wetland	Sandstone Cliff-face Soak				1.1	1.1	1.00

Code	Type	Community	TSC Act Listing	EPBC Act Listing	EEC or TEC	Area total (Ha)	Reserve Total (Ha)	Ratio in Reserve
S_FrW01	Freshwater Wetland	Coastal Upland Damp Heath Swamp	Coastal Upland Swamp		TEC	675	339	0.50
S_FrW02	Freshwater Wetland	Coastal Upland Wet Heath Swamp	Coastal Upland Swamp		TEC	1408	1100	0.78
S_FrW03	Freshwater Wetland	Coastal Freshwater Wetland	Freshwater Wetlands on Coastal Floodplains		TEC	131	52.5	0.40
S_FrW06	Freshwater Wetland	Estuarine Reedland	Swamp Oak Floodplain Forest		TEC	69.6	31.0	0.45
S_FrW13	Freshwater Wetland	Coastal Sand Swamp Scrub	Sydney Freshwater Wetlands		TEC	33.7	22.7	0.67
S_FrW19	Freshwater Wetland	Coastal Lagoon Fringing Scrub	Sydney Freshwater Wetlands		TEC	17.8	10.1	0.57
S_SW01	Saline Wetland	Estuarine Mangrove Forest				879	589	0.67
S_SW02	Saline Wetland	Estuarine Saltmarsh	Coastal Saltmarsh	Coastal Saltmarsh	EEC TEC	227	199	0.88
S_SW03	Saline Wetland	Seagrass Meadows				962	335	0.35

In general, the remaining vegetation communities are in small patches. The data shows the percent remaining in reserves which, while useful, is not a measure of the degree of 'safety' of a community. This is because there can be a small fragment remaining and all of it in a reserve. The fragment however, may be less than 5 percent of the original distribution and despite being in a reserve, could decrease in ecosystem sustainability to the point of failure, due to loss of landscape scale features and characteristics that make up the community. For example the Sandstone Cliff-face Soak Community is 100 percent in a reserve, however its entire area is 1.1 hectares.

Threatened ecological communities in the Sydney Coastal Region

Threatened ecological communities listed under the Federal EPBC Act and/ or the NSW TSC Act make up some of the characteristic communities of the Coastal Zone.

Following is a brief discussion providing an overview of the Community types in relation to the Study Area:

- Definition: This is a direct link back to OEH for EEC information. Other community definitions are from the parent mapping source.
- Status: Listed on state and federal government lists as an Endangered or Threatened Community
- Extent: Vegetation community extent as per the mapping has varying levels of reliability. Two considerations are made here (i) different levels of input to mapping accuracy, for example some councils have paid for separate mapping with on-ground truthing of maps, while other maps have the raw OEH data which has been completed on a coarser scale than that would be achieved through more ground-work; (ii) communities that are more difficult to identify from aerial studies may have been under or over estimated.

- Condition: Mapping (with the exception of weed mapping, associated with contracts) rarely includes a condition assessment. Condition assessment has been determined by individual councils in either their biodiversity strategies or bushland plans.
- Issues: In this urban context, issues and threats are common to groups of communities such as Terrestrial, Wetlands, Intertidal and Submerged. Issues and threats have been grouped for each type of vegetation community.
- Gaps and Opportunities: For each Community type perceived gaps have been raised during interviews with local government and / or determined during literature reviews. Following are some issues common to all communities.
- Condition assessments: represent a gap as mapping rarely includes assessment of condition. There is no standard 'condition assessment method' used across Local Government Areas (LGAs). Vegetation / community mapping would be best done at the same time across all locations using a standard method.

Opportunities for standardising condition assessments for vegetation are available. Condition assessment methods have been developed by the CMA (now LLS) for a number of vegetation communities including riparian areas. Rapid assessment tools are also available for wetlands (Sainty and Jacobs 1997) and saltmarsh (Sainty and Jacobs 1997). See also review of rapid assessments by J. Ling and Jacobs (2011) and references within.

Specific questions have been presented for possible further investigation. A procedure for evaluating opportunities has been presented and includes:

i) review of OEH Recovery Plans and Priority Action Statements;

ii) detailed review of scientific papers;

iii) talking with those working in the area of research of the particular community (people can be found by reviewing papers and seeing the common names for a particular topic);

iv) finding out from others e.g. other LGA personnel what work is being done in a particular community type and what are the outcomes (review also what and how 'success' is being measured);

v) working with bush regenerators and the Association of Bush regenerators (AABR) http://www.aabr.org.au/ to determine best-practice methods for working in urban EECs.

Metadata recommendation

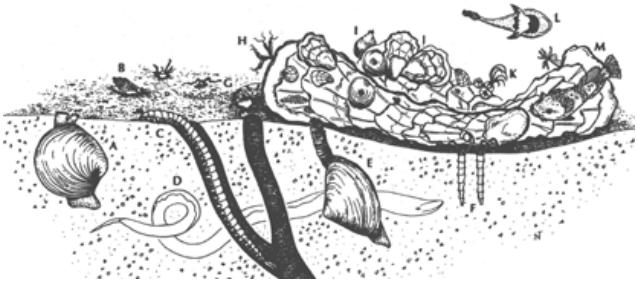
For all mapping data it is recommended that standard metadata should be used so data sharing can occur with maximum compatibility. See metadata example on OEH website at: http://www.environment.nsw.gov.au/resources/soils/LSC_NSW_v2.5_metadata.pdf

Communities in the Study Area

Following is a brief summary of identified ecological communities in the Study Area. Mapping data is from OEH with the summary provided by SCCG. The text following draws heavily on the *Vegetation of Sydney*, Keith (2009). Issues and recommendations are from experience working in the Study Area and interviews with local government and practitioners working in biodiversity management in the area. This section provides an overview and aims to provide ideas for further investigation / work. It is not a comprehensive review of each community.

SUBMERGED AND INTERTIDAL COMMUNITIES AND HABITATS

Soft-Bottom Macrofauna Community



Definition

Soft-Bottom Macrofauna Community is the term used to generally describe the group of animals that live in the submerged sandy and muddy substrates of waterways and water bodies. Typical species are worms, bivalves and other invertebrates.

Extent

Estuaries and beaches are the main location of soft-bottom benthos in the Study Area. Environmental conditions in these habitats varies greatly as do the typical species assemblages.

Condition

An overall the condition for soft-bottom benthos in the Study Area is unknown, however specific studies have monitored the communities before and after works, such as the study at Penrhyn Estuary associated with the expansion of Port Botany. Soft-bottom benthos are used as indicators of impacts of ecological quality, although well designed, comprehensive studies are uncommon. OzCoasts has detailed information on benthic invertebrates including http://www.ozcoasts.gov.au/indicators/benthic_inverts.jsp

Legislative Protection

While there is protection for the plants that are often growing from the soft-bottom sediments, there is no specific protection for soft-bottom benthic fauna or the protection of the sediments in general. Dredging permits are usually required if an area is proposed to be damaged, however this is related to potential water quality issues rather than the fauna in the sediment.

Issues

- Soft-bottom benthos are rarely considered in impact assessments despite the area sometimes being potential habitat for sea grasses. Even if considered, there are no requirements to minimise impacts on this habitat or the faunal communities.
- A key issue is that much of the diversity and abundance is made up of species of small size, such as worms or invertebrates under 5cm in length. Being somewhat out-of-sight has resulted in this community having relatively little known about it and not considered in planning or assessments.
- Changes in water flow, illumination and rates of sedimentation can be detrimental for animals living on the sea floor and soft-bottom benthos. Studies have shown dredging impacts soft-bottom macrofauna (Cruz-Motta et al., 2004).
- Provision of a hard surfaced habitat can cause an increase in the number of hard-bottom species, including introduced species, in areas that otherwise lacked suitable habitat, resulting in changing species composition.

Gaps and Opportunities – Soft-bottom Macrofauna Community

Opportunities exist to include benthic invertebrate communities to a greater extent in biodiversity assessments. Benthic invertebrates include species sensitive to contamination, eutrophication and physical disturbance and hence can be used as indicators of conditions and changes in conditions. A key gap is the knowledge of base-line condition of benthic invertebrate communities in the various habitats within the Study Area. Existing studies include those by SIMS (http://harbourprogram.sims.org.au/projects) and EICC (http://sydney.edu.au/science/bio/eicc/research/ecology/soft_bottoms/index.shtml).

Seagrass

Definition

Seagrasses are marine plants that have evolved from land plants. Leaves are either strap-like or oval-shaped and they grow from rhizomes (underground stems). Seagrasses occur in sheltered areas and shallow waters up to about 3.5 metres depth, growing in soft sediments such as sand or mud. Seagrasses reproduce both sexually with flowers and seeds and asexually via rhizomes.

Extent

Australia's coastline contains the largest, most diverse seagrass assemblage in the world. The most widespread species in the Sydney region include *Posidonia australis* (strapweed), *Zostera capricorni* (called eelgrass or ribbonweed) and *Halophila ovalis* (Paddle Weed).

With three major river systems and associated sheltered bays in estuaries, the Sydney area has many areas of seagrass habitat. Mapping indicates a total area of 223 hectares. Seagrass mapping is of patches of sea grass (above a certain size) rather than seagrass habitat. This is a limitation in that seagrasses are mobile, some species more than others. Studies that include detailed monitoring of distribution have shown seagrass patches disappear and reappear in different areas over a relative short space of time (months). Seagrasses are growing in waters adjoining six LGAs.

Condition

Condition assessments of seagrasses have not been completed for the Study Area. Individual seagrass studies include detailed observation for purposes such as monitoring aquatic weed *Caulerpa taxifolia.*

Seagrass meadows display variation in response to local environmental gradients although the mosaics and environmental relationships are simpler than those in Saltmarsh.

Salinity, turbidity and water depth influence the distribution of different seagrass species.

Zostera species (Eel Grass) can grow in water shallower than 5 metres and tolerate temporary exposure at low tide. *Posidonia australis* may grow to 10 metres in clear water. *Halophila* sp. grows in the deepest waters usually at depths of 5 to 20 metres (Sainty and Jacobs).

The local distribution of seagrass meadows is a dynamic shifting in response to shifting estuarine sediments, extreme tides, storms and intense wave action.

Changes in the distribution of seagrass meadows over the past hundred years or so are poorly documented, although there certainly has been a contraction in the overall extent of seagrasses.

Seagrasses play an important role in stabilising the substrate, with rhizomes forming a mat over the sediment.

Legislative Protection

Protected under:

- Fisheries Management Act
- Classified as Marine Vegetation

Issues

- Turbidity from the catchment
- Sewerage outfalls
- Dredging

- Construction of marinas and breakwaters
- Recreational boats driving over and through seagrasses
- Increase of nutrients (increased algal growth and also changing dynamics of the vegetation – to favour sea-weeds)
- Swing Moorings
- Climate change and associated impacts (increase storms, turbidity, exposure and heat on low tides)
- Higher nutrient levels resulting in seaweeds dominating over sea grasses
- Coastal squeeze (loss of habitat due to urban development preventing landward migration with sea-level rise)
- Understanding how local stressors modify adaptive capacity for climate change

Additional impacts on seagrass are presented in a DPI Fact sheet (see link) and many of these are relevant to the Study Area: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0019/203149/seagrasses-primefact-629.pdf

Figure 14. *Halophila* sp. (photo by ECA)

Figure 15. *Zostera* sp. (photo by ECA)

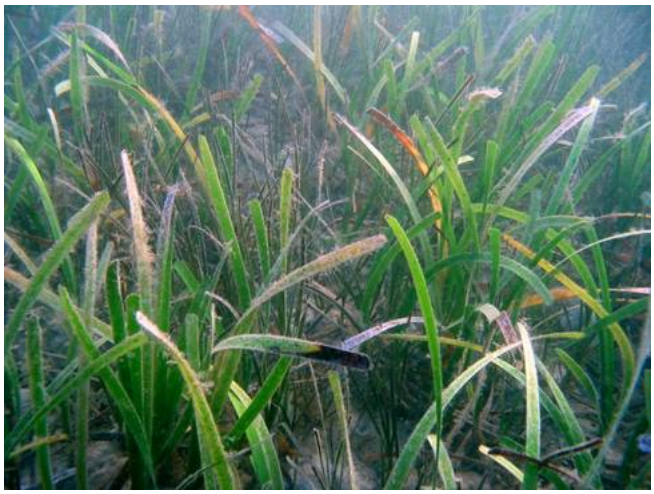


Figure 16. *Posidonia australis* (photo by ECA)

Gaps and Opportunities – Seagrass

Habitat mapping could be done based on mapping the actual and potential distribution of seagrasses. This would be beneficial as seagrasses are known to have variation in distribution from year to year. This habitat mapping could be combined with the mapping of patches of seagrass existing at the time of mapping.

- Species mapping: in most areas it is possible to identify the zones of each of the major Seagrass species *Zostera* sp. and *Posidonia* sp.
- Condition assessment criteria for Seagrasses can be developed and assessment conducted.
- Thresholds for seagrass 'health' (e.g. how much heat or turbidity or velocity – or a combination of these – can occur before Seagrass condition declines) need to be developed.
- Planning regulation and education should consider habitat as well as locations.
- Understanding of how climate change physical changes can impact seagrasses needs to be developed (e.g. increase in extreme weather events: turbid conditions, velocity, pollutants washing into estuaries, extreme heat days coinciding with low tide and exposure of shallow sea-grasses etc.).
- Get a base-line of seagrass species distribution and seagrass condition.
- Understand the implications of current research on seagrass transplanting.
- Research is available to show seagrass changes in some parts of the Study Area, like Botany Bay.
- Research is currently underway looking at seagrass replanting and rehabilitation of seagrass meadows.
- Valuation of carbon sequestration to allow inclusion on carbon markets.

Artificial structures (e.g. pontoons, pilings, seawalls, revetments, breakwaters, ocean beach pools)

Definition

Intertidal structures are common in urban areas.

- Pontoon: an air-filled structure providing buoyancy
- Piling: a column of wood or steel or concrete that is driven into the ground to provide support for a structure
- Seawall: a wall or embankment erected to prevent the sea encroaching on or eroding an area of land
- Revetments: sloping structures placed on banks or cliffs in such a way as to absorb the energy of incoming water
- Breakwater: a barrier built out into the sea to protect a coast or harbour from the force of waves

The use of artificial structures like seawalls, revetments and breakwaters is rapidly increasing to manage coastal erosion. Pressure to create or amplify structures is expected to increase as sea level rises and the intensity and frequency of storms increase due to climate change. Over the past decade these structures have been acknowledged as providing important habitats for algae, invertebrates and fish, as they are similar to natural rocky habitats. Beach pools and netted areas are frequently habitat for a diversity of native flora and fauna. Seahorses and sea hares are commonly associated with these structures.

Extent

Every local government area in the Study Area has structures in the intertidal zone. The total extent of these is not known, however each LGA should have the structures listed in their asset management systems, so a total number of each type of structure could be gained.

Condition

With regard to these structures as habitat, the assessment of condition is different from that of assessing the asset for its stability and functional use. With regard to habitat, a poor or failing asset often provides more habitat than a new asset. New or replacement structures can be designed and constructed to maximize habitats and examples of this occur in the Study Area.

Legislative Protection

- Fisheries Management Act: for seaweeds, fish habitat and seahorses
- Local government DCPs: such as Manly Council's DCP
- Fairy Penguins, listed species, critical habitat declaration includes areas with intertidal structures such as wharves in Manly.

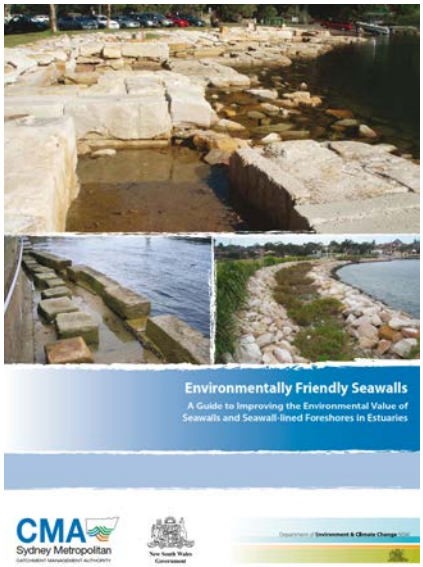
Issues

- Assets renewal often includes the removal of old structures and replacement with new. This can result in temporary and or permanent loss of species using that structure. Where the replacement structure differs in habitat provision this can have an impact on the resulting species use. Impacts can include the loss of, or increase in, habitat diversity and abundance.
- Loss of species can also occur at specific points in time such as when the structure is cleaned or removed. This is obvious for some fauna, such as seahorses on intertidal netted swimming areas, and management actions can be put in place to minimize impacts. Generally this is not done for more common species such as oysters, barnacles and the diversity of marine algae living on these structures.

Guidelines exist for sea-walls

http://www.environment.nsw.gov.au/publications/coasts/090328-env-friendly-seawalls-guide.htm

Some councils have information on their websites, such as:
http://www.pittwater.nsw.gov.au/environment/water/estuaries/best_practice_guidelines/best_practice_guideline_3_-_seawalls



- Asset maintenance generally doesn't require ecological impact assessments, however best practice measures could be more widely known and implemented. An example is to avoid cleaning beach rock pools when the sea hares are spawning or providing public information about the sea hares and the time they are expected to be in the pools.
- Asset renewal generally requires a Statement of Environmental Effects to be written. For most projects these are done within council and generally do not have a focus on mitigating impact but simply consider whether the 'harm' is acceptable. Some councils are actively seeking ways to improve the habitat of new structures and this could be supported with the introduction of best practice minimum guidelines for including habitat replacement asset creation and renewal.
- Approvals for structures could be streamlined with minimum requirements, and compensatory measures, set by NSW Fisheries in conjunction with local government. An emphasis should be on on-ground works and follow up monitoring rather than reports.
- Time of approvals is an issue in the area of structures in salty communities. Time pressure often doesn't allow for the best outcome to be developed. A region wide assessment and (minimum) standard conditions could assist with approval times and on-ground outcomes.

Figure 17. Example of sea walls that include habitat areas (Source: *Ecological Impacts of Coastal Cities*)

Artificial structures – Gaps and Opportunities

- Opportunities for increased sharing of the existing findings from research on structures as habitats.
- Opportunities for minimum habitat management and replacement with asset maintenance and renewal.
- Opportunities for increased understanding of the biodiversity utilising artificial structures and how best to retain and/or increase appropriate habitat.

Intertidal Estuarine Mud and Sand flats

Definition

Mud and sand flats are found in sheltered bays, lagoons and estuaries along the coastline. They are formed when mud or sand is deposited by tides or rivers. As they are in the intertidal zone, they are submerged and exposed approximately twice daily. Intertidal flats are important ecosystems which support a large population of wildlife such as migratory birds, crabs, molluscs and fish.

Extent

Mud and sand flats in the Study Area are in sheltered bays, lagoons and estuaries, with many locations associated with mangrove forests. Southerland Shire has the key areas around Kurnell, Careel Bay in Pittwater and Penrhyn Estuary in Botany also have area of intertidal flats large enough to be used by wading birds.

Condition

There is no study-wide condition assessment, however studies at specific locations provide information on condition. From the perspective of habitat, condition includes both the physical make-up of the flats, the contaminant levels in the sediment and the level of disturbance to the area in general.

Individual areas have been studied and information is available for Careel Bay, Penrhyn Estuary (Botany LGA) and parts of Towra Point and Kurnell in general (Southerland LGA).

Legislative Protection

No specific protection exists for intertidal flats, however the legislation that provides protection for migratory birds (including state legislation with some species listed on the TSC Act, Federally EPBC Act and internationally with migratory bird agreements of JAMBA, CAMBA and ROCAMBA) provides awareness of intertidal flats as key habitat.

Issues

- Rising sea level
- Dredging for boating access
- Disturbance – recreation use of flats and use by dogs
- Chemical pollution
- No legislative protection for intertidal flats. Migratory bird legislation rarely provides protection at the urban level as the areas have too few birds to trigger federal input to decision making. A stated percentage (varying by species) of the flyway for a species is required at an area to trigger federal response.
- Decisions for managing intertidal flats are left to local government who often manage the zone under the Care Control and Management (CCM) of other authorities.

Mud and Sand – Gaps and Opportunities

- Mapping of the extent of intertidal mud and sand flats in the Study Area. It would be good to have this as base-line data and to monitor how it changes through time.
- An agreement, between land owners and managers, of the ideal future for intertidal areas within the Study Area in relation to management and what activities are appropriate.
- Identification of areas where the intertidal areas could expand into as sea-level rises. Research to understand the possible outcomes of slowly adding sediment to an area to artificially assist it to remain as an intertidal area as sea-level rises and the impacts of this on all associated biodiversity.

Mangroves

Definition

Mangroves grow around the margins of coastal estuaries on mudflats that expose the tidal inundation. In the Sydney area two species of mangrove occur. The dominant mangrove is *Avicenna marina* (Grey Mangrove). The other species, *Aegiceras corniculatum* (River Mangrove) is less common and usually occurs close to where freshwater creeks join the Estuaries.

Mangrove forests or scrubs have a closed canopy 2 to 8 metres tall with either no groundcover or a sparse cover of herbs.

Figure 17. Mangroves with regeneration.

Extent

Mangroves grow in a specific tidal zone and hence the extent is linked to suitable habitat locations.

Table 4. Summary of mangrove area and protection (extract from Table 3).

Code	Type	Community	Area total (Ha)	Reserve total (Ha)	Ratio in Reserve
S_SW01	Saline Wetland	Estuarine Mangrove Forest	879	589	0.67

Locations of mangroves are along each of the three main waterways, the Hawkesbury River, Parramatta River and Georges River, as well as smaller estuaries. Main locations are within the local government areas of Hornsby, Warringah, Pittwater, Parramatta and Sutherland.

Condition

Condition assessments of mangroves have not been completed for the Study Area.

Legislative Protection

Protected under:

- Fisheries Management Act 1994 – Classified as Marine Vegetation
- National parks and Wildlife Act 1974
- Marine parks (Zoning Plans) Regulation 1999
- Can also be protected through reserve protection

Issues

- Sea-level rise including changes in inundation and mangrove incursion into other communities.
- Mangroves in narrow zones abutting steep land having no location to migrate landward.
- Scientific studies on mangroves include increasing understanding on the reproduction and biochemistry that enables mangroves to live while being periodically submerged and in high saline conditions.
- Erosion by boat wake e.g. there has been a significant loss of mangrove from the upper Parramatta River due to ferry wake.
- Defoliation events caused by insects.

- Rubbish dumping e.g. there is a huge amount of rubbish dumped in mangrove forests along the Parramatta River.
- Coastal armouring, which sometimes occurs in estuaries to keep mangroves out of people's backyards.
- Understanding how local stressors modify adaptive capacity for climate change.

Figure 18. Mangrove pneumatophores

Figure 19. Mangroves and Saltmarsh

Gaps and Opportunities – Mangroves

- Condition assessment and mapping of mangroves.
- Understanding of findings of literature on the intertidal invertebrates in mangroves.
- Knowledge on the capability of mangroves to persist in rising sea level.
- Identify areas for expansion (note previous work on this topic).
- Knowledge of mangrove invertebrates and other fauna and their role in the mangrove ecosystem.
- Papers on mangroves are common and diverse in subject matter. For example there is one on introduced bees being key pollinators.
- Understanding the applicability of existing literature on mangroves to management in the Study Area.
- Identify areas where mangroves could extend to under given climate change scenarios and zone / manage / purchase land accordingly.
- Determine where mangroves could be planted to assist in coastal erosion.
- Continue and increase education (community, councillor, industry etc.) about the role of mangroves in the Study Area.
- Use the existing detailed information on mosquito management, including via habitat modification.
- Valuation of carbon sequestration to allow inclusion on carbon markets.

Saltmarsh

Definition

Saltmarshes are complex mosaics of closed sedge-land grasslands and open fields and occasionally have emergent shrubs. For more detail see Keith, page 238.

Common species in the Study Area include *Sarcocornia quinqueflora, Sporobolus virginicus, Suaeda australis, Baumea juncea, Ficinia nodosa, Juncus kraussii, Samolus repens, Selliera radicans, Triglochin striata* and *Zoysia micrantha*.

Saltmarsh occurs in the intertidal zone on the shores of estuaries and lagoons including when they are intermittently closed. Local conditions including salinity, inundation period, depth of inundation and shading are some of the factors influencing particular species distribution.

Research is available on aspects of saltmarsh, such as carbon cycling, biomass accumulation, invertebrates fauna (crabs, foraminifera, spiders) and other fauna e.g. use of saltmarsh by migratory birds. Other research has been undertaken to increase understanding of the patterns of saltmarsh plants. Research is currently underway that will assist in increasing the understanding of the factors that shape saltmarsh communities and predict how saltmarshes may be influenced by climate change particularly sea-level rise.

Extent

In NSW, 50% of the original area of saltmarshes may have been destroyed by clearing and landfill for coastal development.

In the Study Area this percentage is likely to be far higher, particularly with the loss of saltmarsh from most of the Cooks River system and a great reduction in saltmarsh and tidally inundated floodplains in all of the estuarine waterways in the Sydney region.

Examples of this community in the Study Area include Taren Point Nature Reserve in Botany Bay and the smaller saltmarshes in Hornsby and Pittwater, such as Careel Bay.

Table 5. Summary of Saltmarsh existing area and area in reserves (extract from Table 3).

Code	Type	Community	TSC Act Listing	EPBC Act Listing	Area total (Ha)	Reserve total (Ha)	Ratio in Reserve
S_SW02	Saline Wetland	Estuarine Saltmarsh	Coastal Saltmarsh	Coastal Saltmarsh	227	199	0.88

Condition

Condition assessments of saltmarshes have not been completed for the Study Area.

Legislative Protection

Protected under:

- Protected under Fisheries Management Act 1994
- National parks and Wildlife Act 1974
- Environmental Protection Biodiversity Conservation Act
- Marine parks (Zoning Plans) Regulation 1999
- Threatened Species Conservation Act

Issues

- Changes in species composition caused by fresh water run-off into saltmarshes.
- Trampling and other disturbance such as bike riding and walking through saltmarsh areas.
- Weed invasion in higher areas, with weeds such as Pennywort, Buffalo grass and Kikuyu entering into saltmarsh areas. The key saltmarsh weed *Juncus acutus* (Spiny Rush) occurs in saltmarshes throughout the Study Area. This has partly been spread by nurseries selling this weed instead of the native Sea Rush.
- Sea-level rise, including changes in inundation and mangrove incursion.
- Mosquitoes and mosquito management.
- Limited opportunities for lateral migration.
- Understanding how local stressors impact adaptive capacity for climate change.

Figure 20. Constructed Saltmarsh at Kooroowall reserve, Mona Vale, Pittwater – showing boundaries of estuary and pathway

Figure 21. Constructed Saltmarsh along the Cooks River – this one boarded by a concrete pathway.

Figure 22. *Sarcocornia quinqueflora*

Figure 23. *Suaeda australis*

Gaps and Opportunities – Saltmarsh

- Continue and increase education (community, councillor, industry etc.) about the role of mangroves in the Study Area.
- Note that areas already identified as possible locations for saltmarsh lateral migration zone / manage / purchase land accordingly.
- Identify areas where saltmarsh could be created, taking into account climate change scenarios.
- Use the existing detailed information on mosquito management, including via habitat modification.
- Knowledge on the capability of saltmarsh to persist in rising sea-level when the substrate height is being artificially increased.
- Map the types of saltmarsh e.g. *Sarcocornia* dominated and *Juncus kraussii* dominated.
- Understand the findings of literature on intertidal invertebrates in saltmarsh.
- Creating saltmarshes with low suitability for mosquitoes while performing other saltmarsh ecological functions.
- Education – this will increase appreciation and result in behaviours that retain or enhance saltmarsh (e.g. Bushcare group in Gough Whitlam Park constructed Saltmarsh in Canterbury).
- Research the effectiveness of raising substrate levels to prolong the suitable habitat for saltmarsh in area of sea-level rise.
- Valuation of carbon sequestration to allow inclusion on carbon markets.

Coastal Lagoons – Saline

Definition

Coastal Lagoons are not listed in Table 3 as a Community, rather they are a water body where a number of vegetation communities grow. This section is included to present Lagoons in general. Other sections summarise the vegetation communities commonly found in and around Lagoons. Communities include seagrass, saltmarsh, saline or fresh reedlands, dunes and forested wetlands.

Extent

Coastal Lagoons that can be either open or closed to the sea are called *Intermittently Closed and Open Lakes and Lagoons (ICOLL)*. ICOLLs are present in Pittwater, Warringah, Manly, Narrabeen, Dee Why, Collaroy, Manly as well as examples in the south of the Study Area in Sutherland.

Legislative Protection

Protected under:

- Fisheries Management Act 1994 (for marine vegetation and management of fisheries e.g. prawns)
- National Parks and Wildlife Act 1974
- Environmental Protection Biodiversity Conservation Act (where saltmarsh and migratory birds are present)
- Threatened Species Conservation Act (where listed species, populations, Communities occur)

Land tenure typically includes: Department of Lands for the bed of the water, RMS for the water, local government or Crown Lands for the land surrounding the water body.

Condition

Condition of ICOLLs in the Study Area varies greatly. Condition has to be defined in order to assess it. For lagoons, condition can be based on water quality, vegetation quality, flora, fauna etc. Standard research into the condition of the ICOLLs could be useful. Prior to any assessment questions need to be posed as to what is being assessed and there needs to be known targets (or a bench-mark) to compare to. Each of the ICOLLs are included in a management plan for the council(s) area around it. These plans have a section on condition, however the criteria for assessing condition are not constant across LGAs.

Issues

- Flushing
- Smell
- Human traffic
- Connectively with landward vegetation
- Connectivity with ocean
- Sea-level rise impacts on fresh and brackish water species at the top of ICOLLs
- Understanding how local stressors modify adaptive capacity for climate change.

Figure 24. Dee Why Lagoon

Gaps and Opportunities

- Opportunities for increasing the understanding the estuarine fauna – both permanent and visitors
- Standard criteria for 'condition assessments' and conditions for developments
- Conversion of turf areas to native edge-vegetation while allowing flooding
- Flora – including mapping of vegetation and identifying zonation (inundation levels/duration)
- Up-to-date bathymetry and understanding of potential changes in levels under different climate change and natural in-fill scenarios
- Understanding natural variability of these systems in the absence of entrance management
- Understanding how various options for entrance management alters coastal lagoon ecology
- Understanding how climate change will influence ICOLL entrance dynamics
- Understanding Sea-level rise impacts on fresh and brackish water species at the top of ICOLLs

Sandy Beaches

Definition

Sandy beaches habitat here refers to the sand area from the dunes to the intertidal and wave zone

Extent

The extent of this zone has not been calculated for the Study Area.

Condition

The condition of sandy beaches has not been assessed across the Study Area, however there is information on individual beaches in relation to pollution and cleanliness. There is not a comprehensive condition assessment based on biodiversity of this habitat.

Legislative Protection

There is no specific Legislative protection for this habitat only for threatened species should they occur in this area.

Issues

- Biodiversity of the sandy beaches, especially those in the intertidal and wave zone, is generally left out of biodiversity studies (some information in studies for Sydney Harbour, Manly and Southerland).
- Fauna in this area is generally hidden and hence doesn't receive attention or management actions.
- Sand raking and seaweed removal are practices within this habitat that can impact fauna in this area. Some councils have stopped mechanical beach raking.

Opportunities

- Opportunities to provide information to a high volume of people is great due to the number of people who visit this habitat. This includes opportunities to work with existing groups like Nippers (Surf LifeSaving NSW).

Intertidal Rocky Shores

Definition

The intertidal rocky shore is an extreme habitat that is in a state of almost constant change when compared to land or the sea. Due to water movements associated with tides, waves and spray, conditions affecting different levels on the rocky shore vary continuously throughout the day.

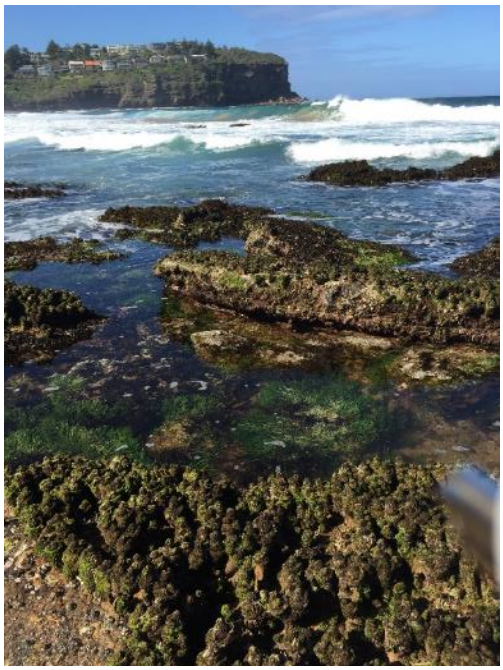


Figure 25. Intertidal Zone

Figure 26. Rocky Shores

Extent

Intertidal rocky shores are in a specific tidal zone and hence the extent is linked to suitable habitat locations. Twelve of the councils in the study have intertidal rocky shores along the open ocean and four have rocky intertidal areas in estuaries.

Condition

Condition assessments of Intertidal Rocky Shores have not been completed for the Study Area. Intertidal Rocky Shores are well studied, including those in the Study Area. Research topics are varied from assemblages of fauna species at different zonation's of the platform to simulated impacts of removal of invertebrates, to diversity of seaweeds. While the data is useful for the questions asked it doesn't provide a baseline of current condition.

Legislative Protection

Protected under:

- Fisheries Management Act 1994 (for marine vegetation and management of fisheries and intertidal invertebrates)
- National Parks and Wildlife Act 1974
- Environmental Protection Biodiversity Conservation Act (where migratory birds are present)
- Threatened Species Conservation Act (where listed species, populations, communities occur)

Land tenure typically includes: Department of Lands for the bed of the water, RMS for the water, local government or Crown Lands for the land surrounding the water body.

Issues

- Human pressure
- Sea-level rise
- Increased storm events, increased temperature, decreased oxygen in the warm water
- Increased recreation usage
- Narrow zones of rock platform abutting steep land resulting in no opportunities for landward migration
- Pest and disease and changes in species composition with warmer water species moving south
- Lack of base-line data (existing zonation, species, condition)
- Understanding how local stressors modify adaptive capacity for climate change.

Figure 27. Limpets along moisture in rock crack on intertidal platform

Figure 28. High diversity of plant species. Diversity influenced by heterogeneity of the habitat

Figure 29. Cunjevoi with Sea Lettuce in the lower intertidal zone

Figure 30. Intertidal invertebrates have particular niches throughout the intertidal zone

Figure 31. Barnacles

Figure 32. Mulberry Whelk

Gaps and Opportunities – Intertidal Rocky Shores

- Knowing the extent of intertidal habitats (zones) – baseline survey the start and stop of each of the key zones in the intertidal area of rocky shores. This could be for open coast and estuaries.
- Knowing what is there – base-line survey of flora and fauna of the intertidal zones in Sydney. This could be for open coast and estuaries.
- Understanding findings of extensive literature on the intertidal invertebrates
- Understanding findings of extensive literature on the intertidal vegetation
- Knowledge on the capability of the intertidal flora and fauna to persist in changed climatic conditions.
- Identify areas for expansion / lateral migration landward (first investigate previous scientific work on this topic)
- Identify and monitor for warmer water species that may extend their range south.
- Education about rocky intertidal shores with the aim of maximising behaviour that support and protect life in the intertidal zone.
- Conduct education and engagement with those already working in this area – e.g. Coastal Environment Centre (Narrabeen) and or as part of existing on-beach programs like nippers.

Wetlands

Definition

Wetlands are areas of land where the ecological processes are affected by permanent or temporary inundation either by standing or running water (Bolton and Brock 1999). In this section the focus is on naturally occurring wetlands, however constructed wetlands *can* have the same functional outputs and biodiversity values as natural wetlands. Robust scientific research into the values of constructed wetlands compared to reference natural wetlands is available for some wetland types. Biodiversity values of constructed wetlands also require planning and management.

Wetlands are highly important in the processes and functioning of entire landscapes. In urban areas when the waterways are often altered, wetlands may be natural or created.

Thirteen different types of freshwater communities have been identified in the mapping for the Study Area. The two general areas are Freshwater Open Wetlands and Forested Wetlands.

Freshwater Open Wetlands

Freshwater Open Wetlands category has six different wetland types and all are listed as threatened communities.

A large freshwater wetland community in the Study Area is *Coastal Freshwater Lagoons on Coastal Floodplains.* These mostly occur at less than 10 m above sea level and have periodic or permanently standing water.

Examples of freshwater open wetlands in Sydney are shown below in Figure 33-35.

Figure 33. Reedland Wetland – Narrabeen lagoon – Warringah

Figure 34. Native Water Lily *Nymphoides indica* – Botany

Figure 35. Sydney Freshwater Wetlands – Botany Wetlands

Extent – freshwater open wetlands

Freshwater wetlands formation includes six classes of wetland that are dominated by shrubs, sedges and herbs. The combined area makes up one to two percent of New South Wales and possibly a lower percentage cover in the Study Area.

Different types of wetlands are found in different areas. One wetland example, *Coastal Heath Swamps,* is restricted to depressions associated with swales in coastal sand sheets on headwaters of creeks, and coastal sandstone plateaus up to 600 metres in elevation in areas with 1000 to 1500 mm of rain annually.

Coastal Heath Swamps develop slowly. The ones existing today appear to have developed 10,000 to 17,000 years ago, as climate became warmer and wetter at the end of the last ice age (Young 1986).

The coastal sandstone plateaus of Sydney contain the most diverse and extensive heaths of mainland Australia (Keith 1993). Up to 60 plant species may be found within a 10m² area; the highest local plant diversity known in scrub dominated vegetation anywhere in the world.

The complex vegetation mosaics in coastal heaths are related to moisture gradients. An example can be seen in the wettest areas in the centre of swamps, which tend to have lush growth of large shrubs, ferns and sedges and exclude smaller plants. On the outer edges where inundation is less frequent and the soils have less organic matter and nutrients, the vegetation is shorter and more open and allows diversity of small shrubs, sedges and herbs.

As these highly diverse swamps have plant diversity directly related to inundation levels of groundwater along with water holding capacity of the organic soils, more information is required on how these communities will alter with changes in hydrology that could be expected in relation to climate change.

More common examples of freshwater swamps include Botany Wetlands (currently within golf course lease lands) and the modified remnants of the original wetlands at Centennial Parklands.

Forested Wetlands

The second wetland type is Forested Wetlands. Eight community types of Forested Wetlands occur in the Sydney area, including two listed as threatened (Swamp Sclerophyll Forest on Coastal Floodplains – which has less than 25 percent in reserves, and; Swamp Oak Floodplain Forest).

Forested wetland formation includes classes of freshwater wetlands dominated by trees. These are restricted to riverine corridors and floodplains subject to periodic inundation.

The flat depression landforms have fertile soil and generally occur at lower altitudes (under 800 metres).

Forested wetlands also have sclerophyllous trees such as eucalyptus, tea trees, paper barks or She-oaks.

Examples in the Study Area include the vegetation categories in the freshwater areas along Narrabeen Lagoon in Warringah LGA. Figure 36-40 show four examples of Forested wetlands in Sydney – all of which grow in close proximity to each other. Ground water extent, as well as salinity, is thought to influence the type of vegetation community that will grow in an area.

Figure 36. Coastal Flats Swamp Mahogany Forest

Figure 37. Coastal Alluvial Bangalay Forest

Figure 38 Estuarine Swamp Oak Forest

Figure 39a. Coastal Swamp Paperbark-Swamp Oak Scrub

Figure 39b. Eastern dwarf tree frog *Litoria fallax*

Condition

Condition assessments of Wetlands are present on a wetland by wetland basis. Condition measurement is largely restricted to weed versus native vegetation cover.

Legislative Protection

- National Parks and Wildlife Act 1974
- Environmental Protection Biodiversity Conservation Act (where migratory birds are present)
- Threatened Species Conservation Act (where listed species, populations and communities occur)
- Land tenure typically includes: local government or Crown Lands.

Issues

General

- Flood studies reviewed do not take into account these flood plain communities when recommending actions to manage flooding.
- Development being permitted in flood plain areas without due consideration to potential increase in flooding associated with the changing climate. Historically it has been shown that built structures are valued more highly that the natural assets when it comes to flood management decisions.
- Ground water being altered (+ or -) and the unknown impacts on these ground water influenced communities.
- Coastal floodplains in much of the Study Area have been comprehensively cleared, drained and built on, or converted to playing fields, over the past 200 years.
- While some areas have open space where wetland communities could migrate landward, these areas are also favoured for open space recreation. The demand for open space is expected to increase with increasing population.
- Poor management including inappropriate use of herbicides.
- Polluted water
- Inappropriate water regimes
- Sedimentation
- Physical removal and damage of vegetation
- Accidental and intentional herbicide damage
- Loss of diversity from interspecies competition (e.g. from Typha)
- Sea-level rise with salt intrusion to otherwise freshwater communities
- Understanding how local stressors modify adaptive capacity for climate change.

Open Water Wetlands

- Heat, storm intensity, algal blooms
- Pest animals: mosquitoes and carp
- Ground water reliability
- Ibis
- Aesthetics driving management

- Weeds including species with increasing southern range with increasing temperature
- Disease

Forested Wetlands

- Ground water availability/ reliability
- Weeds including species with increasing southern range with increasing temperature
- Feral animals
- Development
- Disease – fungal and other

Gaps and Opportunities – Wetlands

Gaps

- Knowledge in wetland management from those responsible for management.
- Understand the level of dependence on ground water particularly for wetland types such as *Sandstone Cliff-face Soaks* and *Coastal Upland Damp Heath Swamps.*
- Get detailed mapping of the rare, small wetlands such as *Sandstone Cliff-face Soaks* and *Coastal Upland Damp Heath Swamps* and establish a system of care and monitoring.
- Effective ways to manage frog habitat
- Understanding effective mosquito management
- Adopted management plans for wetlands

Opportunities

- Increased shared knowledge on the management of wetlands particularly for wetland types that occur in more than one LGA.
- Use of treated stormwater to re-charge wetlands in urban areas.
- Integrating the regeneration of Forested Wetland into passive recreation areas.
- Education and engagement
- Care and enhancement of the high diversity hot-spots
- Effective weed management that supports the retention and expansion of a diversity of native aquatic species.
- Identification, protection and enhancement of a diversity of wetland types: including: open water, riffles, runs, pools, areas with dense vegetation and shaded area.
- Retain and expand aquatic edge vegetation into designated areas.
- Improve the engagement of wetland vegetation in water flows – that is, manipulate flows such that water moves through wetland vegetation rather than around it.
- Improve habitat features and areas so that wetland native species can thrive. In particular habitat can be improved for frogs, native fish and macro-invertebrates.
- Improved stormwater management and treatment devices at source and before water enters wetlands.

Figure 40a. Composite images showing biodiversity in and around Botany Wetlands within the Study Area.

Figure 40b. Paper-bark Forest with Fern and *Carex* understorey (Biodiversity Hot Spot)

TERRESTRIAL COMMUNITIES

Sand Dunes

Definition

Sand dunes are a hill of sand built by either wind or water. Most sand dunes occur along coastal regions, however they are also found inland, in deserts which were once an ancient lake or sea bed.

Coastal sand dunes run parallel to the beach and are built up by dry beach sand blown inland and trapped by plants. They play an important role in protecting the coastline against wave damage, tides, sea spray and strong winds during storms. The dunes also act as a source of sand to replenish and maintain the beach during periods of erosion.

Extent

In the study areas there are original sand dunes and areas where dunes have been removed or modified and stabilised. The extent of dunes in the Study Area has not been calculated.

Condition

Condition varies from diverse complex dues with hectares of native vegetation to small patches of sand dominated by weeds particularly Bitou Bush and in some areas Asparagus Fern.

Legislative Protection

There is no particular legislation for dunes, only for listed species, populations and communities. This includes Eastern Suburbs Banksia Scrub EEC.

Issues

- Uncontrolled vehicle and pedestrian access on beaches can cause loss of vegetation resulting in destabilization via blowouts and mobile sand sheets
- Climate change effects such as sea-level rise, increased intensity and frequency of storms and more contrasted distribution of wet and dry seasons will modify coastal erosion and sea-flooding hazards
- Human impacts e.g. waste dumping, trampling, vegetation removal (including for views)
- Tourism and increase of summer visitors and potential impacts of increase or unregulated use on dune systems e.g. tracks
- Management of invasive and exotic species

Sand Dunes – Gaps and Opportunities

- Opportunities to better understand the role of vegetated dunes in foreshore protection
- Opportunities to engage a wider portion of the community in DuneCare, including involving Surf Life Saving NSW
- Opportunities for better understanding of sand dune biodiversity and the use of dunes as corridors in urban areas
- Opportunities to collate the methods and outcomes of dune rehabilitation and stabilisation works and have this as a resource for future works and to develop best practice guidelines

Heathland

Definition

Sydney Coastal Heath grows between Gosford in the north and Jervis Bay in the south; usually along the exposed coastal sandstone plateau with infertile, shallow and moderately damp soils.

The shrubs are typically up to 1.5 metres tall and represent a diverse array of sclerophyllous genera, and are interspersed with an equally rich complement of sedges and herbs. Several species of mallee eucalypts up to 4 metres high may emerge above the other layers. If fires have been infrequent, large shrubs may form dense thickets up to 4 metres tall.

Although more limited in extent than the famous 'kwongan' heaths of coastal south-western Australia, the Sydney Coastal Heaths rank among the world's most floristically rich shrub-dominated vegetation.

Figure 41. Headland with Coastal Heathland

Figure 42. Coastal Heathland

Figure 43. Coastal Heathland – tight canopy of low (10m) shrubs

Fine scale subtle mosaics of communities within the Sydney coastal heaths are associated with variations in shale depth, drainage and fire history. Cliff tops exposed to salt spray and rocky platforms both support particularly distinctive plant communities within the heathland mix.

Less exposed sites on the plateaus are occupied by Sydney coastal sandstone forest, while more poorly drained depressions and seepage slopes are occupied by coastal heath swamps.

Extent

Sydney coastal heaths are generally along the coast to plateaus from Gosford to the Royal National Park.

Heathlands are wide spread in the Sydney Coastal Zone with Sydney Coastal Heath in 9 of the 15 LGAs. An essential part of the distribution of Heathlands from Collaroy to Ingleside and from Woollahra to Maroubra, have been almost completely lost, owing to urbanisation of Sydney's northern and eastern suburbs. Pockets of heathland remain in the Ingleside area and preservation needs to be a priority.

Coastal heath that remains in the Study Area is included in Ku-ring-gai Chase National Park and the Royal National Park. Coastal heath also occurs in Brisbane Waters National Park just north of the Study Area.

From the data in Table 5 most of the Heathland communities have over 60% of their extant area within reserves.

Coastal Clifftop Marsh has the smallest extent in the Study Area covering only 7.9m^2

The most extensive heathland type is *Coastal Sandstone Heath-Mallee* with 10,237 Ha.

Table 6. Summary of Heathland Communities existing area and area in reserves (extract from Table 3).

Code	Type	Community	TSC Act Listing	Area total (Ha)	Reserve total (Ha)	Ratio in Reserve
S_HL01	Heathland	Coastal Headland Clay Heath		61.6	40.4	0.66
S_HL02	Heathland	Coastal Sand Tea-tree-Banksia Scrub		170	130	0.76
S_HL03	Heathland	Coastal Sand Mantle Heath	Eastern Suburbs Banksia Scrub	126	78.4	0.62
S_HL04	Heathland	Coastal Sandplain Heath	Eastern Suburbs Banksia Scrub	343	308	0.90
S_HL05	Heathland	Coastal Foredune Wattle Scrub		228	128	0.56
S_HL06	Heathland	Coastal Headland Banksia Heath		379	325	0.86
S_HL07	Heathland	Coastal Headland Cliffline Scrub		144	141	0.98
S_HL08	Heathland	Coastal Sandstone Heath-Mallee		10,237	8771	0.86
S_HL09	Heathland	Coastal Sandstone Rock Plate Heath		229	189	0.83
S_HL10	Heathland	Sydney Hinterland Dwarf Apple Heath-Woodland		3514	90.6	0.03
S_HL14	Heathland	Coastal Clifftop Marsh		7.9	7.8	0.99

Eastern Suburbs Banksia Scrub (ESBS) is an Endangered Ecological Community at both the state (TSC Act) and Federal (EPBC Act) level. ESBS is the name listed on the TSC Act to describe *Coastal Sand Mantle Heath* and *Coastal Sandplain Heath.* The cover is *Coastal Sand Mantle Heath* (126m^2) and *Coastal Sandplain Heath* (343m^2). This area is less than 5% of the original extent of this vegetation community.

Figure 44. ESBS – Bonnie Doon Golf Course - Botany

Condition

Condition assessments of Heathland have not been completed systematically in the Study Area. Condition assessments are available for some patches of the community. Usually the condition assessment is in terms of weed density. Some studies, like that in the Botany Wetlands PoM, also include species richness.

Research

Since the mid-1970s Sydney coastal heaths have been a focus of research into fire ecology of native plants. See Keith, *Ocean Shores to Desert Dunes* (2004), and references within for links on information re fire on soil and Banks patch dynamics response to fire survival and regeneration. Research has provided information in relation to what fire management strategies are enhancing to communities and those that are damaging.

Issues

- The patches of heathland in Ingleside (Pittwater), Red Hill (Warringah) and areas in Sutherland are a high priority for retention. Proposed land releases in these areas threaten the remaining heathland (Warriewood Ingleside Land Release Strategy – 1995). This is partly due to the development of individual blocks triggering large areas of heath to have to be removed / modified to manage for bush-fire. A comprehensive plan of larger areas is underway in some locations and ideally this will result in areas for conservation with retained heathland and areas for development clustered to reduce the need for clearing for fire management.
- Conservation issues in national parks and public areas include appropriate management of fire regimes. Public reserves are still subject to clearing if private land owners are deemed to be at risk due to the heathland on public property. Local government can be required to reduce fuel areas of heath near residential property.
- Controlling degradation associated with increased recreational use.
- In the urban areas, vandalism of taller plants is a management issue particularly where heathland obscures ocean views.
- Fire: the lack of fire is also an issue. Lack of fire is not a high priority management option used by councils because the resourcing for such “ecological” burns takes a lower priority to hazard reduction burns. Hence, despite burns being scheduled, they are missed, sometimes for a number of years.
- Pest and disease: pathogens such as Myrtle Rust and soil fungi such as *Phytophora* can kill plants in heathland and other vegetation communities. Increased fragmentation of patches increases the possibilities for these to be spread.
- Understanding how local stressors modify adaptive capacity for climate change.

Gaps and Opportunities – Heathland

- Trialling the effectiveness of flame weeders on soil to simulate a hot burn where ecological burns cannot be conducted in a timely manner.
- Develop and implement a marketing strategy for getting heathland plants into gardens, including increasing availability in nurseries.
- Community education and engagement programs.
- Removal of environmental weeds from shops and public places e.g. species such as *Gazania* spp.

Grasslands

Definition

Coastal grasslands are communities of grasses, graminoids and salt tolerant forbs that occur on coastal headlands, beach strandlines and islands around the coast. Grasslands exist in harsh dry conditions subject to full exposure to salt laden winds, storms and king tides. Species richness is generally low. Grasslands can grow in closed tussocks on rocky substrates or as open grasslands with networks of sparse runners on beach sands.

Species present may include *Ficinia nodosa, Lomandra longifolia, Sporobolus virginicus, Themeda australis, Austrofestuca littoralis, Poa poiformis, Zoysia micrantha*. On the beach sands Spinifex (*Spinifex sericeus*) and Pig Face (*Carpobrotus glaucescens*) usually dominate. A few herbs may be present, such as Warrigal Greens (*Tetragonia tetraganoidies*) or *Atriplex cinerea*. Occasional stunted coastal shrub species such as *Banksia integrifolia* and *Leucopogon parviflorus* may be present.

Threatened community Themeda Grassland on Seacliffs and Coastal Headlands is a typically closed tussock grassland dominated by *Themeda australis, and* occurs on seacliffs and coastal headlands. It can also be open shrubland or open heath with a grassy matrix between the shrubs.

Extent

Across NSW, individual stands of the community are often very small, a few square metres, but at some sites larger stands of up to several hectares or tens of hectares occur. There are 142m^2 of mapped coastal grasslands in the Sydney Coastal Zone area. However, the small nature of patches means that many patches may not be mapped. The majority of the threatened *Themeda Grassland on Seacliffs and Coastal Headlands* in the Sydney coastal area is located in reserves.

Table 7. Summary of Grassland existing area and area in reserves (extract from Table 3).

Code	Type	Community	TSC Act Listing	Area total (Ha)	Reserve total (Ha)	Ratio in Reserve
S_GL01	Grassland	Beach Spinifex Grassland		22.6	10.5	0.46
S_GL02	Grassland	Coastal Headland Grassland	Themeda Grassland on Seacliffs and Coastal Headlands	120	117.0	0.98

Issues

- Weed invasion – Bitou bush, Lantana, Marram Grass, Pennywort, Cakile, Kikuyu and other exotic grasses
- Changed fire regimes and reduced grazing pressure (such as from wallabies)
- Invasion by shrubs (both exotic and native) and conversion to dense shrub land
- Coastal development and beach erosion
- Recreational use, including by use of off-road vehicles
- Climate change: rising sea levels, increased storm events and high surf (erosion of fore-dune) events
- Understanding how local stressors modify adaptive capacity for climate change.

Figure 45. Themeda Grassland EEC on Headland above Bilgola Beach. NB log in foreground as edging between exotic turf grass and remnant native grasses.

Figure 46. Spinifex in the foreground mixed with Pig Face. Mid-ground (grey-green) Spinifex and rear stunted coastal shrub with Coastal Banksia and Coastal Tea-tree.

Gaps and Opportunities – Grasslands

- Small areas not mapped
- Areas not adequately managed for protection
- Fencing areas in some locations
- Identifying areas for expansion
- Effective education and engagement including with organised beach groups such as Surf Life Saving NSW/Australia.
- Install effective edges including removal of abutting turf and placement of porous pathways (e.g. compressed sandstone mix).
- Trial methods such as flame (thermal) weeding to manage exotic grasses and annuals and to remove built up seed source of weed species. Use thermal 'weeding' to mimic ecological burns and keep TGL communities in a grassland state rather than reverting to shrub dominated heathland.
- Map areas to be kept as TGL and those where the vegetation community will be managed as a changing community from grassland to health and back to grassland (using fire or manual modification).

Figure 47. Themeda Grassland EEC on Headland – showing management issues. Ineffective border between exotic and native grass. Maintenance restricted to mowing so edge of native grass is dominated by annual weeds. Remnant native grass is in isolated patches with a high edge ratio. Lack of fire is allowing woody plants Banksia, Acacia, and Eucalyptus to establish.

Dry Sclerophyll Forest (DSF)

Definition

Dry Sclerophyll forest grows on Sydney sandstone generally in shallow soils. Ten DSF community types are listed in Table 32. The most diverse class is Sydney Coastal DSF. This community grows below 700 metres in elevation and where annual rainfall is between 1000 to 1300 mm. This class is unique to the greater Sydney geological basin and examples in the Study Area are in Ku-ring-gai Chase National Park and the Royal National Park. The height of this type is strongly linked to the depth of the soil and the degree of shelter of the location.

Communities of Sydney Coastal DSF each contain a diversity of species. Local hotspots may contain over 100 different species, species and varieties of native plants in just one tenth of a hectare. In addition, specialised habitats including rock overhangs, seepage stones and Ironstone soils, result in highly distinctive plant communities, which include several species only found in those habitats.

For more detail on DSF see Keith, *Ocean Shores to Desert Dunes* (2004) pages 146 to 154.

Extent

DSF are widespread in the Sydney Coastal Zone. All of the 15 councils in the study have DSF in their LGAs. Generally these communities are on the rocky areas, which are sometimes steep. The geography of the location and poor soils has resulted in areas of DSF being retained.

DSF communities range from large areas such as the Coastal Sandstone Gully Forest with a total area of 17,708 Ha to small patches of the Coastal Sand Bangalay Forest (TEC) with a total area of only 14.9 Ha.

From Table 3 it can be seen that most of the remaining DSF communities have at least 60% of their area within reserves.

Figure 48. *Tetratheca*

Figure 49. *Hibbertia*

Figure 50. *Angophora*

Figure 51. Sydney Coastal DSF

Condition

Condition assessments of DSF have not been completed in a systematic way for the Study Area. Condition assessments are available for some patches of the community in terms of weed density.

Issues

- Fire
- Pests and disease
- In the Study Area some of the remnants are in small patches and despite the low fertility of soils, weeds are a management issue
- Forest areas in local government management close to residential development have the pressures of perceived fire risk and vandalism to increase views
- Areas along the ridgeline in both northern and southern Sydney have pressure for new housing despite their environmental importance
- The “tidy up”: residents are often ill informed about the importance of forest understory and mid-story and so clear and turf around trees
- Understanding how local stressors modify adaptive capacity for climate change.

Gaps and Opportunities – DSF

- Understand the species diversity
- Better understand and manage pathogens e.g. myrtle rust and the fungus phytophora
- Tree, shrub and ground planting
- Education about weeds (commonly planted landscape plants) and increased availability of aesthetically pleasing locally native species available for residential use
- Councils leading by best-practice and using a suitable array of locally native plant species in areas of this vegetation community.

Wet Sclerophyll Forest (WSF)

Definition

Wet Sclerophyll Forests (WSF) are tall open eucalypt forests with an understorey of soft-leaved (mesophyllous) shrubs, fern and herbs, many of which are rainforest or rainforest related species.

WSF occur on moderately fertile soils in high rainfall areas. There are two forms – one with a shrubby understorey and the other with a more open form with fewer shrubs and small trees, which has a grassy sub-formation, and occurs in slightly drier habitat. Generally these communities occur in gullies or on south facing slopes.

Figure 52. Pittwater Spotted Gum with wet understory. Western slope of Pittwater. High diversity of understory spp.

Figure 53. Spotted Gum in turf on nature strip – this public land was turfed and remnant spotted-gum understory (and seed source) covered. The public land could be restored as PSG-EEC

Extent

WSF communities range from the more common *Coastal Enriched Sandstone Moist Forest* to the small areas of *Coastal Flats Tall Moist Forest* and *Coastal Diatreme Forest*

Six of the 15 councils in the study have WSF in their LGAs. There are 2412m^2 of mapped Wet Sclerophyll Forest in in the Sydney Coastal Zone area. Percentages of the extent vegetation located in reserves varies depending on the vegetation category. The EEC Pittwater / Wagstaff Spotted Gum Community has just over 50% in reserves, with the rest in urban areas

Wet Sclerophyll Forest in the Study Area includes the threatened communities Kurnell Dune Forest, Pittwater and Wagstaff Spotted Gum Forest and Blue-Gum High Forest.

Table 8. Summary of Wet Sclerophyll Forest existing area and area in reserves (extract from Table 3).

Code	Type	Community	TSC Act Listing	Area total (Ha)	Reserve total (Ha)	Ratio in Reserve
S_WSF02	Wet Sclerophyll Forest	Coastal Enriched Sandstone Moist Forest		1037	741	0.71
S_WSF03	Wet Sclerophyll Forest	Coastal Sand Littoral Forest	Kurnell Dune Forest	81.9	47.4	0.58
S_WSF06	Wet Sclerophyll Forest	Coastal Shale Sandstone Forest		378	247	0.65
S_WSF08	Wet Sclerophyll Forest	Sydney Foreshores Shale Forest		180	174	0.97
S_WSF11	Wet Sclerophyll Forest	Pittwater Spotted Gum Forest	Pittwater and Wagstaff Spotted Gum Forest	117	66.6	0.57
S_WSF33	Wet Sclerophyll Forest	Central Coast Escarpment Moist Forest		269	234	0.87
S_WSF34	Wet Sclerophyll Forest	Central Coast Escarpment Dry Forest		248	235	0.95
S_WSF35	Wet Sclerophyll Forest	Coastal Diatreme Forest		53.2	53.2	1.00
S_WSF36	Wet Sclerophyll Forest	Coastal Flats Tall Moist Forest		47.9	47.3	0.99
Other EEC wet sclerophyll forest community types: Blue Gum High Forest, Sydney Turpentine Ironbark Forest occur in the Study Area.						

Issues

- Removal of the under and mid-story (usually replaced by turf)
- Lack of natural regeneration of canopy species, often due to mowing
- Weeds
- Heat affecting pollinators e.g. Grey Headed Flying Fox (GHFF)
- Pest and disease
- WSF grows in urban areas and a large portion of threatened communities Kurnell Dune Forest and Pittwater and Wagstaff Spotted Gum Forest are not in protected national parks and are in existing residential areas.
- The lack of canopy tree replacement is an issue as is the clearing of understory and mid species and replacing trees with exotic landscape gardening. This occurs on both public and private property

- Considerations with climate change include the complex factors of pollinators and dispersal agents. For example the grey headed flying fox is known to be impacted on days of high heat. The grey headed flying fox has an important role in pollinating spotted gums, including moving their camps over large distances that link the genetic outputs from the south coast, Pittwater and the central coast spotted gum communities
- Understanding how local stressors impact adaptive capacity for climate change.

Gaps and Opportunities – WSF

Gaps

- Knowledge in WSF management from those responsible for management
- Location of threatened communities in residential zones
- Understanding GHFF population movement patterns in relation to location of threatened forests
- Lack of council-wide awareness of the importance of these communities and the resulting 'business-as-usual' management of public spaces, including turfing and mowing and planting exotic plants into the EECs.

Opportunities

- Creating improved landscape connectivity by linking areas
- Creating greater protection for remaining areas not in reserves
- Scope exists for local government to create best practice examples of managing these endangered ecological communities on public land such as nature strips or roadside reserves and within the vegetated zones of recreational playing areas
- Significant opportunities exist for retaining and expanding the mid and understory of the WSF EECs of Sydney Turpentine Ironbark Forest (STIF), Pittwater Spotted Gum (PSG), Blue Gum High Top Forests (BHTF)
- Education and increased availability of aesthetically pleasing locally native species available for residential use
- Streamlining and standardising conditions of consent for DAs and TPOs including effective remediation and works methods e.g. prune large trees and keep stable trunk rather than removing the entire tree. Ensure tree replacement and seed collection occurs as a standard. Use a crane where large hollows are being removed and re-locate hollows. This will keep habitats for the species that are pollinators including micro-bats and arboreal mammals
- Canopy, mid and ground layer planting in areas of public open space that would be enhanced by planting. This includes around playing fields
- Councils leading by best-practice and using a wide array of locally native plant species in areas of this vegetation community
- Implement effective plans to manage the communities.

Littoral Rainforest (LRF)

Definition

Littoral Rainforest (LRF) is rainforest that grows by the sea. LRF occurs in a scattered distribution from the south of New South Wales to eastern Queensland. Within the Study Area it occurs in pockets from Palm Beach to Sutherland.

LRF species mix depends on the extent of exposure to salt laden winds.

The most exposed headlands have LRF that is dense with low species numbers and there is a windshield thicket a few metres tall. In sheltered locations canopy is diverse and up to 20 metres high, with relatively few ferns and epiphytes common.

A number of species characteristic of Littoral Rainforest in NSW reach their southern limits at various places along the coast (for example *Cupaniopsis anacardioides* reaches its southern limit between Sydney and the Illawarra) the total Littoral Rainforest flora declines from north to south.

Littoral Rainforest in Sydney often has an interesting species mix. North of Sydney the rainforest species are more like those of the tropical forests of northern New South Wales and Queensland. South of Sydney the littoral rainforest species are more like those of cool temperate rainforest.

LRF includes one EECs *Littoral Rainforest and Coastal Vine Thickets,* which in the vegetation classification correlates with Coastal Dune Littoral Rainforest, Coastal Escarpment Littoral Rainforest and Coastal Headland Littoral Thicket.

Figure 54. Littoral Rainforest

Figure 55. Littoral Rainforest

Figure 56. Grassland, to Heath then LRF over the slope. South Bilgola Headland.

Extent

LRF in the Sydney Coastal Zone area is summarised below – extracted from Table 3.

Three of the 15 councils in the study have LRF in their LGAs.

Generally LRF is located in gullies or on south facing slopes. LRF tends to grow in the depressions and swales of coastal sand hind dunes and headlands in sheltered areas which can support the forests. In Sydney examples of LRF include within the Royal National Park and in small pockets in Pittwater and Warringah.

From the data in Table 8 most of the LRF communities have over 70% of the small fractions remaining within reserves.

Table 9 Summary of Littoral Rainforest Forest existing area and area in reserves (extract from Table 3).

Code	Type	Community	TSC Act Listing	Area total (Ha)	Reserve total (Ha)	Ratio in Reserve
S_RF02	Rainforest	Coastal Sandstone Gallery Rainforest		219	205	0.94
S_RF03	Rainforest	Coastal Warm Temperate Rainforest		390	314	0.81
S_RF06	Rainforest	Coastal Dune Littoral Rainforest	Coastal Dune Littoral Rainforest	23.5	19.1	0.81
S_RF07	Rainforest	Coastal Escarpment Littoral Rainforest	Coastal Dune Littoral Rainforest	64.1	49.6	0.77
S_RF08	Rainforest	Coastal Headland Littoral Thicket	Coastal Dune Littoral Rainforest	131	129	0.98

Condition

Condition assessments of LRF have not been completed in a systematic manner for the Study Area. Condition assessments, mainly of weed density, are available for some patches of the community.

Issues

- Fire
- Weeds
- Heat effecting pollinators (e.g. GHFF)
- Pest and disease
- Any patch of LRF in the Sydney area should be conserved and its species list accurately collected.
- It is common for canopy species in LRF to have fleshy fruits which are spread by vertebrates. Hence, the management of LRF should include ensuring ongoing pollination and seed dispersal by vertebrate animals.
- Current threats to littoral rainforest include weed invasion, particularly by Bitou Bush, Lantana and Asparagus Fern.
- Considerations for LRF under potential climate change include the drying out of the forest and increased risk of fire.
- Understanding how local stressors modify adaptive capacity for climate change.

Gaps and Opportunities – LRF

- Improve edge management including trialing methods to create effective barriers to weeds.
- Install effective edges including removal of abutting turf and placement of porous pathways (e.g. compressed sandstone mix).
- Trial methods such as flame (thermal) weeding to manage exotic grasses and annuals and to kill built up seed source of weed species. Use thermal 'weeding' to mimic ecological burns and keep TGL communities in a grassland state rather than reverting to shrub dominated heathland.
- Manage stormwater inflows and consider supplementing water via carefully managed and directed treated stormwater. Including effective catchment management and education about environmental weeds including on private properties.
- Manage weeds effectively – funding needs to be ongoing, with reduced funds in each area once effective edge management is achieved.
- Have full species list for LRF and a Sydney wide database for species.
- Recreate LRF in suitable areas.
- Understand the role of pollinators and dispersal agents of LRF.
- Support Bushcare groups.
- Encourage community to register LRF plants of interested that are naturally growing on their properties particularly those species at their southern limit. Have seed collecting and propagation from these specimens. Examples of species are Leopard Wood and Scentless Rosewood, *Synoum glandulosum.*
- Share resources between councils such as the provision of education and engagement for properties neighbouring LRF, walks and talks and fliers. See Pittwater example. http://www.pittwater.nsw.gov.au/__data/assets/pdf_file/0014/35132/Pittwater_Littoral_Rainforest_Brochure_-_final.pdf

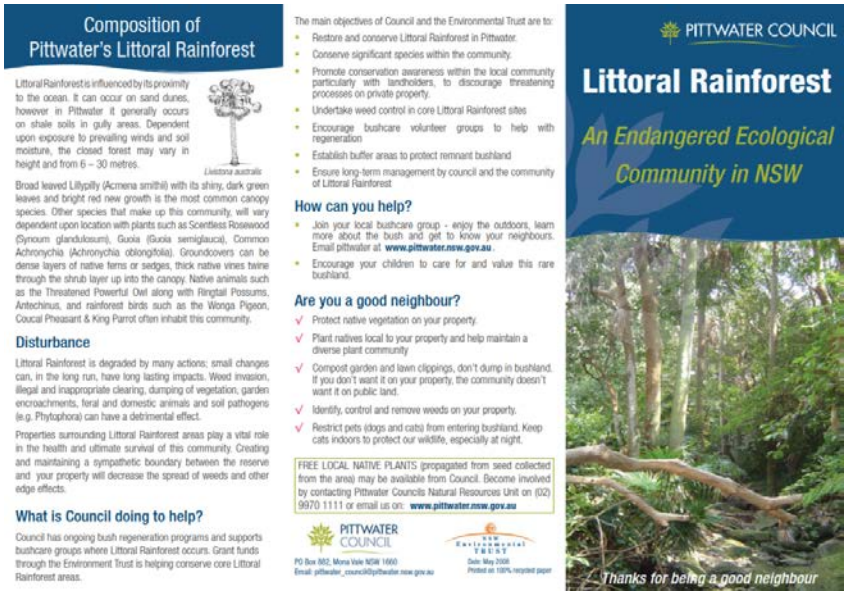


Figure 57. Example of Brochure on Littoral Rain Forest (Pittwater Council)

- Encourage local nurseries to propagate and supply locally native LRF species. Local councils to provide plants to residents in and surrounding LRF areas for planting on-site.

8 Practice Review

8.1 Government

While there are many practices in government at all levels the focus here is on biodiversity management in the Salty Communities.

This section looks at common areas of biodiversity management in the Study Area. It provides:

- examples of guidelines from federal and state government that relate to Salty Community management in the Study Area;
- biodiversity management at local government level including a list of common practices relating to on-ground works and, where available, references to guidelines relating to management.

8.1.1 Federal

Strategic and Biodiversity Plans

Examples of federal government practice include the creation of strategic plans associated with funding for biodiversity management considerations of National Significance. References for plans have been provided in the Literature Review section at the beginning of this report.

Funding

Federal government is a key source of funding for state and local government as well as for regional bodies such as LLS (for example the Caring for Our Country program).There are specific and detailed processes for how to assess projects, allocated funds and monitoring and reporting.

Data collection from Monitoring and Reporting

Projects funded must implement the Monitoring, Evaluation and Reporting and Improvement (MERI) system of Australian Government Natural Resource Management (NRM).

Results from multiple projects are collated in the MERI system and used to track progress and outcomes of funded works. More on MERI can be found at http://www.nrm.gov.au/my-project/monitoring-and-reporting-plan/meri . This review doesn't assess the validity of MERI as a practice. Example templates are available at http://www.nrm.gov.au/system/files/pages/f89b9d3e-9dac-4413-8bed-d90875c0c198/files/example-meri-plan.pdf

Development Assessment and Offsets

It is acknowledged that federal government practice includes the assessments of major infrastructure projects and other developments that are of national significance. This can include the implementation of the federal level offsets policy. A guideline for how to apply the federal offsets policy has been written by Environment Australia and can be accessed at: http://www.environment.gov.au/system/files/resources/12630bb4-2c10-4c8e-815f-2d7862bf87e7/files/offsets-how-use.pdf

8.1.2 State

State government projects include planning, on-ground works, data collection and sharing, mapping and development assessments and the determination of offsets required under the NSW offsets policy.

On-ground works include major infrastructure projects such as port expansion, new roads etc.

Strategic and Biodiversity Plans

Examples of state government practice include the creation of strategic plans to manage biodiversity and the review of these plans. References for plans have been provided in the Literature Review section at the beginning of this report.

Funding

State government also provides funding to local government and NRM agencies. Examples include the Recreational Fishing Grants from NSW Fisheries (Department of Industry and Investment), which are provided to local government and communities.

Data collection from Monitoring and Reporting

Data held by OEH that is frequently relied upon by local government and private enterprise includes the flora and fauna sighting information in Bionet. An issue with this data is that it comes from the users who are required to provide it as part of license agreements to survey for or work in areas with native flora and fauna.

Surveys of local government personnel and environmental consultants revealed there are many records that have not been submitted to OEH for keeping Bionet up to date. Reasons given are lack of time and lack of knowledge about how to enter data.

Development Assessment (DA)

State government agencies, such as Department of Planning and Environment (DoPE), Office of Environment and Heritage, Office of Water, Department of Industry and Investment (NSW Fisheries), are involved in the assessment and conditioning of large scale development projects that have the potential to impact biodiversity in this zone. At times the State agencies will defer back to local government to do the assessments and conditioning where the impacts are considered to be relatively small scale. At times this includes the requirement for offsets. It would be advantageous to have all offset areas compiled in a map that is accessible by all land managers including future owners of land with offsets.

Documents with guidelines for decisions on offsets have been provided (see list of agencies referenced in the literature review section relating to biodiversity and DA assessments. This can include the implementation of the NSW State Offsets Policy (see detail and references in the Literature section of the report).

On-ground Works

State government agencies such as Roads and Maritime Services and Sydney Water, are involved in the on-ground works of major infrastructure projects. This includes roads, stormwater management and infrastructure renewal.

Within each agency there are processes for assessing developments of the state and managing impacts on biodiversity. The minimum requirements are as per the Environmental Planning and Assessment Act and include Review of Environmental Factors and / or Statement of Environmental Effects. More comprehensive studies are sometimes required. While the processes of assessing developments have not been evaluated here, surveys of local government personnel indicated there are opportunities for improving the communication between state and local government.

8.1.3 Local Government

While there are many practices in local government this section focus on Biodiversity Management in the Salty Communities. This section looks briefly at planning and strategy and then at on-ground works and education. Other areas to consider in the area of 'Practice' are listed below. Each of these topics were discussed during interviews with council officers. The findings have been included in the Gaps and Recommendations sections throughout the report.

Local government practice includes:

- planning (LEP, DCP, Policies and topic specific areas such as biodiversity plus Plans of Management);
- data collection and mapping;
- assessment of development applications (within council and public DA);
- on-ground works (environmental/bush regeneration, works, roads, buildings, storm-water management etc);
- Bushcare and community engagement relating to biodiversity, and;
- tree assessments and removal.

Planning and Plans

The practice of planning for the management of bushland, wetlands, watercourses and foreshore is covered in Division 2 of the Local Government Act (1993). The Act states what must be in a PoM, how land is to be categorised and what activities can occur under each class of categorisation. Following is an extract showing some of the considerations. All community land managed by local government is to have a Plan of Management.

Division 2 Use and management of community land

35 What governs the use and management of community land?
36 Preparation of draft plans of management for community land
36A Community land comprising the habitat of endangered species
36B Community land comprising the habitat of threatened species
36C Community land containing significant natural features
36D Community land comprising area of cultural significance

Source: Local Government Act (1993)
http://www.legislation.nsw.gov.au/xref/inforce/?xref=Type%3Dact%20AND%20Year%3D1993%20AND%20no%3D30&nohits=y

The PoMs are fairly similar across councils yet other studies such as biodiversity strategies vary in the topics covered and depth of base-line data and specificity of action and outcomes.

Biodiversity Data Collection and Mapping

Data collection and mapping are important biodiversity management tools. Mapping makes up the bulk of data to inform the choice of zoning categories in the LEPs and DCPs. Thus the more accurate the mapping the higher the certainty with which to understand and therefore manage biodiversity.

During the survey of local government professionals and the review of the biodiversity strategies and equivalent plans it was evident that the accuracy, frequency and scale of data collection varies widely between councils. Refer to the Local Government section of the Literature review for some examples and Attachment III for raw data.

Councils such as Waverley have fauna surveys including all major taxa as well as terrestrial invertebrates. Waverley Council also has separate, replicated surveys for micro-bats (Microbat Survey Waverley Council). The data collection methods are clearly described and relevant to the questions being asked by council about each taxon.

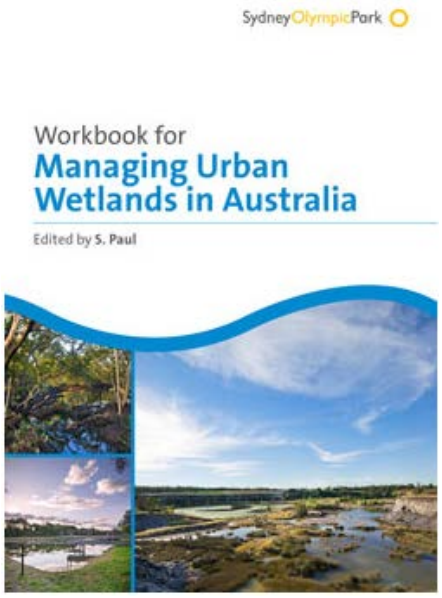
Data in other councils' plans varied from specific flora and / or fauna surveys that were conducted at approximately 5 yearly intervals to those that had no surveys commissioned by council but used the lists from Bionet or aggregated results from multiple surveys over a wide time span, with different non-standard data collection methods between surveys.

Mapping effort also varies between councils. Some LGAs have detailed on-ground vegetation mapping including fine-scale recording of changes in vegetation communities such as Pittwater Council's *Native Vegetation Management Plan* (2011). Vegetation mapping in some LGAs included estuarine vegetation with the ground truthing of NSW Fisheries Maps in *Seagrasses of south-eastern Australia* (Williams et al) and the noting of the presence/absent of seagrass (*Estuarine habitat mapping and geomorphic characterisation of Lower Hawkesbury River and Pittwater estuaries*).

Some LGAs had just the mapping by others (usually state government eg Bionet and OEH Vegetation Mapping) or regional agency vegetation mapping such LLS vegetation Mapping.

The detail in actions and reporting also varied. Some councils include annual reporting on outcomes, for example *Hornsby Bushland and Biodiversity 2014 Annual Report* (2014). Other councils have specific and detailed actions and clear desirable outcomes for bushland areas, including bushland road reserves (e.g. Manly, with bushland plans for each reserve (see Attachment II for a list of plans).

Training in techniques



Training is available in many areas of NRM and much is tailored to local government. An example is the Wetland Education and Training (WET) programs from Sydney Olympic Park Authority which include workshops with practice elements as well as an eBook on Managing Urban Wetlands. This eBook is a distillation and distribution of the contents, partnership, collaboration and research comprising the Wetland Education and Training (WET) program at Sydney Olympic Park. It is both a culmination and celebration of the WET Program, which has been developed and delivered by the Authority over 10 years.

The eBook has 5 sections and 28 chapters, from wetland scientists, practicing ecologists and other dedicated professionals. The chapters contain useful hands-on information about managing both freshwater and estuarine wetlands in urban Australia. It is available for free download at http://www.sopa.nsw.gov.au/resource_centre/wet_ebook_workbook_for_managing_urban_wetlands_in_australia

Techniques for mapping and data collection for urban ecology is available including through workshops such as '*Emerging Technologies for Monitoring Wetlands Vegetation and Fauna*' (Dalby-Ball, WET workshop, 2015).

Development Application Assessment (internally and externally)

The review of practice in local government assessment of DAs both internally and externally was limited to a question in the survey interview of council employees.

An interesting outcome from interviews was that the smaller councils said they had good internal communications between those involved in biodiversity assessment and the planning team. They also said it was because they knew the people in planning and communicated frequently. This was less so in the larger councils.

Terrestrial Zones

On-ground works by local government occur through the following mechanisms:

- On public land, council land or land under council Care Control and Management (CCM). Works undertaken are usually Bush Regeneration by internal staff and / or contractors
- On private land with works aimed to minimise vegetation loss and retain corridors. This is done via planning controls to influence on-ground works and requirements like landscape plans via DCP and LEP. Works are usually done by private companies or people.
- Community facilitated, through tree planting and education about habitat and weeds.

Intertidal and Submerged Zones

On-ground works by local government are generally restricted to those areas above the mean high-water mark. Exceptions include ocean bathing pools and swimming nets, as these are facilities connected to dry land. Some wharfs and jetties are also managed by LG.

Areas of management include:

- on public land, under council CCM Bush Regeneration, internal staff and contractors;
- on public land (estuaries), via council as a coordinator of state and local government personnel;
- on private land – DCP and LEP controls aim to protect and retain saltmarsh and seagrass and protect migratory birds and listed species, and;
- management can also be facilitated by NGOs and community through education and on-ground works such as Clean Up Australia Day and some oyster-shell reef projects.

In summary, on-ground works range from being planned strategically to being *ad hoc* and based solely on grant funding. Local government varies in its ability and processes for funding on-ground works. A key advantage for biodiversity management is reliability of funds over a long timeframe. Levies are an effective strategy to provide base income for on-ground works. Levy monies can then be increased with core funding, grants and other sources.

Bushcare and Community Guidelines

A workshop program called Bushcare Boosters was developed by the Greater Sydney Local Land Services (former Sydney Metropolitan Catchment Management Authority). The Boosters support training material for Bushcare volunteers and these training manuals are available from LLS at http://greatersydney.lls.nsw.gov.au/our-region/community-groups. Boosters workshops aim to help volunteers value and understand their Bushcare and other on-ground work as part of the big picture of biodiversity restoration across Australia. The program encourages recognition of the interconnectedness of work across all sites, big or small, and its contribution to habitat health and landscape change. Three modules were produced and are summarised below.

Module 1 covers weed characteristics, basic weed control techniques, and general safe work practices and methodology

- Bushcare Booster Module 1 Working Safely and Weed Control Techniques Participants Workbook
- Bushcare Booster Module 1 Working Safely and Weed Control Techniques Facilitator's Notes

Module 2 helps participants to understand the values and key concepts of Bushcare and provides guidelines for developing action plans for Bushcare sites

- Bushcare Booster Module 2 Bushcare and the Big Picture Participants Workbook
- Bushcare Booster Module 2 Bushcare and the Big Picture Facilitator's Notes

Module 3 looks at the often forgotten side of the Bushcare equation, the fauna. While it will not give detailed solutions for every situation, it aims to provide some tips for making a Bushcare project as fauna friendly as possible.

- Bushcare Booster Module 3 The Birds and the Bees of Bushcare Participants Workbook
- Bushcare Booster Module 3 The Birds and the Bees of Bushcare Facilitator's Notes

Bushland Management

Bush Regeneration

The industry association Australian Association of Bush Regenerators (AABR) is an excellent resource for up to date information and training workshops for those involved in Bush Regeneration. AABR is also compiling guidelines and assessments to fill a gap in the area of 'proven' (i.e. field-tested) expertise in Ecological Restoration (rebuilding environments rather than just rehabilitation). Their website http://www.aabr.org.au/ includes the following guides:

- Assessing wildlife habitat (AssessHabitat.pdf, 923KB) – designed to help landholders identify aspects of their property that may be important to native animals.
- Watching and surveying wildlife (WatchSurvWild.pdf, 336KB) – a practical guide to help landowners discover what native birds and other animals are on their property at different times of year. It provides an overview of non-invasive observation techniques and equipment.
- The NSW Atlas of Wildlife (WildlifeAtlas.pdf, 321KB) – records sightings of flora and fauna. Landholders can both use and contribute to the Atlas. This note describes the Atlas and provides advice about contributing.
- Integrating wildlife conservation and farm management (WildlifeFarmMan.pdf, 679KB) – describes some farm management practices and projects that benefit wildlife as well as farm health and productivity.
- Corridors and Connectivity (CorridorsConnec.pdf, 313KB) – looks at how corridors might be used to maximise the wildlife habitat value of a fragmented landscape, and what to consider when planning a corridor project.

Weed Management

Weed Management can be a component of Bush Regeneration. Weed management is also conducted on hard assets like pathways and drains. Chemical Free Weed Management is being investigated by a number of councils and implemented by some already such as Leichhardt Council.

Weed management practices range from effective to ineffective and can be great or poor bushland management. Over-use of herbicide has been observed to be an issue in some local government areas.

Saltmarsh Restoration

Saltmarsh was chosen as a salty community in which local government has been playing a role in on-ground works. Works range from bush regeneration by experienced and trained personnel to the creation of new areas of saltmarsh. A paper relating to saltmarsh creation projects in the Study Area was presented at the Australian Mangrove and Saltmarsh Network Conference (23-15 February 2015), entitled "*Constructed Saltmarsh: Years on are they working*? (Sainty et al 2015). It looked at over 10 saltmarsh creation projects in the Study Area and concluded:

- Yes it is worth building saltmarshes
- Yes there are many things to consider
- Ask someone who really knows and can demonstrate it – not just say they can
- INUNDATION is everything… then there are other things too!

Figure 58. Tempe Saltmarsh, Cooks River. Under/Over Inlet Structure

Figure 59. Tempe Saltmarsh after 5 years

Figure 60. Kooroowall Reserve Before Works – Noxious Weeds

Figure 61. Kooroowall Reserve Creating saltmarsh inundation are.

Figure 62. Kooroowall Reserve Constructed Saltmarsh 2015

8.1.4 Gaps and Recommendations

On-ground Works Recommendations

Terrestrial Zones – Gaps

- Resources to apply for and manage projects from grant or other funding sources.
- Loss due to small patches that don't trigger protection from the federal government (such as loss of littoral rainforest).
- On-ground works for some councils are well funded (those with small areas of bushland relative to area) while others don't have resourcing to effectively manage noxious weeds.
- Weed management – regional and resourcing (this wasn't a problem in LGAs with small areas of vegetation).
- Sydney Weeds Committee is effective in sharing knowledge on 'new weeds and diseases', as well as being a forum for people across government sectors to come together and plan for weed management. Usage of Sydney Weeds as a resource could be increased.
- Knowledge is needed on weeds that are likely to establish in warmer weather. Sydney Weeds and GS LLS could be supported to provide information on what to look out for and how to get fast regional sharing of information on new weeds and their management.
- No specific protection for coastal heath
- Themeda Grassland on Coastal Headlands is a listed EEC. This community however reverts to a coastal heath in the absence of fire. As coastal heath is not an EEC its protection is not strong.
- Connection between research and available information and data for management.

Intertidal and Submerged Zones

- Seaweeds and intertidal vegetation are not included in mapping, monitoring, reporting or management. An exception to this is the mapping of seaweeds and intertidal vegetation in Sydney Harbour as part of the SIMS. Seaweeds only are managed in relation to their removal from beaches (when that has occurred).
- Mapping varies in the categories used and dates conducted.

- Seagrass – should map habitat not just location at time of mapping. Need bathymetry data to determine habitat.
- The full science behind the benefits of washed up seaweed and seagrass wrack on beaches (to remove or to leave?) is missing.
- Saltmarsh – data is needed on retreat options and if the substrate level can be slowly raised to keep it in the optimum tidal regime.
- Connection between research and available information and data for management.

Planning and Strategy Recommendations

- Federal, state and local government should have a common way of acknowledging and recording incremental loss and increase in biodiversity – at least as measured in area and condition of mapped communities.
- Biodiversity to be included in Asset Management Systems
- Identify biodiversity offset areas. Identify and have accurate maps of condition of biodiversity.
- Bush fire management pressure to remove trees and other vegetation (habitat). Need science based management. Ensure a sequence of steps required in managing biodiversity and risks e.g. require a fire management plan prior to approvals to remove trees being granted.
- Plan and implement feral animal management across the region, particularly for foxes and feral cats.
- Companion animal management – share educational resources and media coverage across the Study Area.

Education and Engagement Recommendations

- Generally education and engagement within local government and the community is poor. During surveys it was noted that smaller councils reported a high level of cross-area interaction while it was generally reported as being lower in larger councils or in those councils where the environmental team is separated from other areas of council.
- Internal education and engagement includes engaging and informing those in the areas of Planning, Open Landscape Management, Tree Works and Compliance regarding the importance of biodiversity locally and their role in biodiversity management. Also learning from this wider group is required about the barriers to be overcome to assist them in biodiversity management.
- Cross business unit understanding and input to projects is required to get better biodiversity outcomes.

Project Management and Collaboration Recommendations

- Integration and joint ventures with NGOs, other councils, state agencies, scientists, community and business.
- Database with who (person's contacts and agency) is working on what biodiversity projects (on-ground, practice or data).

Biodiversity Plantings and Protecting and Enhancing Existing Native Vegetation

- Replace incremental loss with incremental *increase*. *Learn, test, improve and share* "best-practice-management" for vegetation, especially EECs such as Themeda grasslands, saltmarsh, forested wetlands and forests (LRF, SG, STIF, BGHF etc.) and threatened species at the local level.
- Form an information group (online) for that community, share information on research, successes/lessons, PR, contract management scope, milestones etc. Private user group plus public group. Schedule field engagement days with those involved – agencies, scientists, community and council.
- Identify offset areas and costs. Have on-ground biodiversity projects ready to implement.

Reporting and Monitoring Recommendations

- Standard minimum planning requirements for consultant reporting and offset information (across LGAs).
- Biodiversity plan templates with minimum requirements for base-line and monitoring. Inclusion of best practice management and tailored-to-site species actions in each LGA.
- Template plans and regional management objectives co-ordinated via OEH or key species e.g.: Grey Headed Flying Fox.
- Template Plan of Management (PoM) for wetlands.
- Monitor similar projects across as many examples as possible in an LGA. Pool funds from relevant councils for standard, scientifically robust monitoring across the Study Area.

8.2 Scientific Papers

Abundance of Information

Changes in the marine environment happen over both short and long (decades or more) timeframes. It is critical that Australia has the capability for monitoring and managing our coasts and oceans in the long term.

Research institutions such as *The Centre for Research on Ecological Impacts of Coastal Cities* (EICC) http://sydney.edu.au/science/bio/eicc/ and *Sydney Institute of Marine Studies* (SIMS) http://sims.org.au/ have lifespans beyond short term research projects and have a major role in ensuring that critical research necessary for understanding long term change in the marine environment is undertaken.

Much data has and is being gathered that is relevant to the Study Area. Site and topic specific examples include research on restoration projects (e.g. friendly seawalls and swing moorings in sea-grass) as well as more generally on ecology, human disturbance, animal behaviour and cross-disciplinary projects.

Projects have produced data in ecological patterns and processes on intertidal and sub tidal rocky habitats. See examples at http://sydney.edu.au/science/bio/eicc/research/ecology/rocky_reefs/index.shtml and http://sims.org.au/research/current-projects/ for summaries of projects. Data from scientific papers was not gathered, nor assessed, as part of this study.

Sharing Information

Scientists at the 2015 AMSN conference were seeking ways to better integrate their research and findings with 'what land managers need'. Scientists were keen to get the scientific information to the wider public in a way that is useful. The keynote presentation, 'Communication Strategies for the 21st Century Scientist' (Dr Karen McKee) included the use of many social media platforms and an increased use of YouTube videos for results and instructional videos on monitoring, sampling etc. A list of the presentations is available at http://smah.uow.edu.au/sees/amsn-conference/program/index.html. General recommendations from the conference have been included in the Gaps and Recommendations sections of this review.

8.2.1 Gaps and Recommendations

It is recommended that any papers reviewed in relation to specific research questions include an assessment of the data:

- Is there a clear question stated for the research?
- Was the data gathering properly replicated in time and space?
- What was the time frame over which the data were gathered?
- Was the sampling done in a way that retained the independence of data?
- How old are the data?
- Are the findings of the research in keeping with findings in similar research? (Disagreement doesn't invalidate, but it does require more questions to be asked).

There is a gap between science, management and politics. It is recommended that the overviews of research findings be made more accessible: easy to understand overviews and summaries shared on social media, and including research projects presented by students as videos on YouTube.

8.3 Community and NGOs

The amount of data from NGOs and community groups is vast and was not recorded or analysed in this review.

8.3.1 Gaps and Recommendations

Original Community (Indigenous)

Biodiversity information from Original People (Indigenous) is largely missing from the knowledge of local government. During survey questions it was clear that despite there being interest from biodiversity managers there was little knowledge of where to get such data and what protocols were required. Those surveyed were interested in knowing more and working with Indigenous People. Opportunities exist for this to occur in the Study Area and it would be beneficial particularly given that traditional knowledge extends back to times prior to more recent major coastal changes (~ 12,000 years ago). It is recommended that a program of working with Original Peoples is developed to better understand long-term biodiversity information and seasons and cycles of the Study Area.

NGOs and Community Groups

During surveys with local government biodiversity managers, a question was asked about councils' use of data from NGOs and community groups. The common response was that there was a limited ability to capture and use such data but the potential value of the data was recognised. Key data sources mentioned from community included that from the Wolli bird group and other bird groups and the Eco-divers group, with underwater species information that was otherwise unknown.

Working with Community and NGOs

It is recommended that an active approach be taken to identify which biodiversity NGOs and community groups are working in the Study Area and provide more forums for people from NGOs, the community, government and science and arts to come together to learn from each other. Any such events should be filmed and put on YouTube so those who can't attend can still have access to what is discussed. Where possible find synergies in programs and maximise usability of data collected. See examples like Canada's BioBlitz which uses citizen science to document life. The Ontario BioBlitz has resulted in over 1500 km^2 of habitat being surveyed, 2012 – 2014, documenting over 2500 unique species and 15 records new to Canada (see www.ontariobioblitz.ca).

With smart devices having inbuilt GPS and quality cameras it is possible for photos to be taken frequently and uploaded onto sites for assessment by specialists. For example Photo monitoring points are being set up for anyone to take a photo and upload it to a given site. Birds Australia and Cumberland Bird observes have comprehensive data on bird sightings in western Sydney. *Wolli Creek Birds* have a high volume of bird data (presence / absence) from central Sydney and surrounds.

Example case study: Bird Surveys, Tolderol SA

http://www.birdssa.asn.au/index.php/bird-surveys-monitoring/tolderol-monitoring

Photo-point monitoring is regularly used in wetland monitoring in the SA Murray-Darling Basin. Signs and instructions are set up at certain points in the wetlands being monitored, and members of the public are asked to send in their photos. This is one of the most simple and effective ways of capturing visual changes over time. Three photo points for public use have recently been installed at Tolderol which are ready and easily accessible. Instructions are attached to each point and community members are encouraged to take as many photos as they can. Smartphone photos are welcome. Photos can be emailed to regina.durbridge@gwlap.org.au.

Figure 63. One of the three public photo-point monitoring sites installed at Tolderol

9 Conclusion and Recommendations

Gaps and recommendations have been identified throughout this report. Following are considerations including areas not covered in this report.

9.1 Literature

Literature on the topic of the biodiversity of Salty Communities in the Sydney region and beyond is vast. Summaries have been made throughout this report. The key message is that science and management would both benefit from having a closer working relationship and more communication. Also, the mode of communication will not be effective if it is only via scientific papers. Social media is an increasingly used communication tool for science and biodiversity management alike.

Biodiversity Strategies are not standard in LGAs in the Study Area and less than 50% of 16 councils reviewed had a biodiversity strategy. Equivalent information was generally contained in other strategies like Bushland or Open Space plans. Overall the lack of similarity in plans makes it difficult to assess the status of biodiversity across the Study Area from local government plans. A Biodiversity Strategy template of minimum requirements could assist in building a locally relevant, yet regionally applicable, plan based in maps as far as practical. Some agencies have mapping of the whole Sydney Area such as AusGrid. For more information go to https://www.ausgrid.com.au/~/media/Files/Network/Documents/NS%20and%20NUS/NUS174C.pdf.

Information from Original People is a major gap in many stakeholders' knowledge and steps should be taken as a matter of urgency to increase communications with knowledge holders and increase the long-term knowledge of biodiversity in the Study Area.

9.2 Data

- Consistent baseline data and condition is required for all communities in the Study Area.
- Baseline information is required for the intertidal zone of rocky shores including whole-area mapping of zonation of intertidal areas, or comprehensive mapping of intertidal seaweeds to build on the mapping done in Sydney Harbour (SIMS).
- An LGA layer needs to be added to the vegetation community mapping so that LGAs with same communities, and communities occurring in single LGAs can be readily identified – important for landscape scale planning and coordination and shared knowledge on successful actions.
- Management and understanding of the intertidal zone is a key gap – it is not covered in mapping or policy and while there is abundant research in this area there are gaps relating to strategic management.
- Local government to have a map with layers consistent between LGAs and between LGAs and state agencies.
- Management of biodiversity by offsets to be clearly defined. Minimum requirements for offsetting required for each community type. Comprehensive mapping of offset areas so they are not available for any future developments and are out of high-risk areas (in relation to climate change impacts). Offsets to be required *irrespective of condition*.
- Consistency in monitoring – there needs to be a standardised method for condition assessment
- Natural assets are not included in Local Government Asset Registers — it is recommended that they be added and that this is to be done consistently across LGAs.

9.3 Practice

9.3.1 Planning and Management

- Urban bushland is fragmented and along with ongoing bush regeneration new approaches to management are likely to be required. This includes the possible assisted translocation of fauna (such as reptiles and small birds) to reduce the likelihood of in-breeding in these otherwise isolated "islands" of biodiversity.
- Maintenance and plantings in public areas to be consistent with the aim of maximising biodiversity, while also taking into consideration other requirements. Includes considerations of no-mow areas and assisted natural regeneration of vegetation communities and seed collection and planting.
- Co-ordinated seed collection and propagation of native species – this is particularly relevant for small remnants and where canopy exists as isolated street trees.
- Stormwater management and associated stormwater management devices have to be understood in terms of their 'real' capacity to treat stormwater and the maintenance requirements. New technologies are coming and will continue to come onto the market with improved capacity to manage stormwater. Local government and approval agencies require training in stormwater management devices (including all aspects of WSUD) with the aim of having devices in-ground that can and do perform stormwater treatment to the design specifications.
- Sewage management will be an increasing issue particularly in relation to sewerage overflows and the release of excessive nutrients into both terrestrial zones (weed plumes) and into estuaries, and the subsequent impacts on seagrasses and soft-bottom benthos. More at-source treatment systems and recycling may need to be considered by approval authorities.
- Effective cross-boundary weed management
- Effective cross-boundary feral animal management
- Local and state government and agency work to demonstrate 'best-practice' biodiversity outcomes
- For areas that cross jurisdictions, it appears that the estuary management practice is an effective way for the different bodies to coordinate management and implement it via local government.
- Environmental works (offsets) for developments are to be linked to different stages of the development so that they are completed prior to development progressing to the next stage. Environmental requirements associated with development must include on-going monitoring and defined minimum target levels for the life of the development. Opportunities for this already exist under the *Environmental Offset Act* 2014 – this can be more effectively used by local, state and federal government.

9.3.2 Education

- Internal training on how to recognise, value and manage biodiversity is required for local governments – in planning, parks and gardens, bush regeneration and compliance departments
- Increased co-ordinated interagency and cross-government communication and clarification of roles and responsibilities at the scale of on-ground management.
- Education for the community can be improved by local governments, state agencies and NGOs working together, having agreed outcomes of training and standardised cost-effective outcome based training.
- Effective education and incentives are required within local government to assist in culture change towards a greater awareness of and appreciation for urban biodiversity. Training is required in the areas of: Parks and Reserves (open space maintenance), Landscaping (plant section and placement), Planning and DA approvals

(including the areas of stormwater management), Environmental Compliance (for how to get effective outcomes through both education and fines).

- Community Biodiversity Surveys could be better co-ordinated at a scale beyond LGA boundaries see the Grassland Biodiversity Survey example at http://www.qmdc.org.au/publications/download/16/fact-sheets-case-studies/monitoring-our-environment/hodgson-grassland-biodiversity-survey.pdf

9.3.3 Funding

- Infrastructure works to include a 1-2% of budget for on-ground ecological work in addition to environmental works required as a direct result of the development. This figure will enable incremental increase in biodiversity while being a small enough percent of overall project so that it is financially achievable. The figure of 2% is not based on a review of studies but is based on a review of the cost of infrastructure projects (roads) and the Botany Port Expansion and the required cost of restoring biodiversity (the source of project costs is based on that publically available on web pages showing predicted expenditure).
- Funding in biodiversity is effective when projects can be planned and implemented over long (5+yrs) timeframes. Levies and other reliable income sources are recommended.
- Grant funding for biodiversity works to include funding for project management. Local government biodiversity personnel are time poor given the current requirements and commitments within their positions. Savings can occur in projects occurring across LGAs and having shared external resources and or delegation of parts of projects to different councils (e.g. one to PR and media, one do contract management overview, one to do community program organisation etc.).

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12 Attachments

List of Attachments:

Attachment I – Glossary

Attachment II – Salty Communities Master Sheet – references

Attachment III – Review of Local Government Biodiversity Strategies – excel summary of review

Attachment IV – List of councils notified of the project and contributing information to the review

Attachment V – Legislation relating to Coastal biodiversity

Attachment I – Glossary

Word	Definition
Agency	A representative body or person providing service/ acting on behalf of a person(s) or entity for a particular purpose; such as a government department or local council.
Australian Natural Heritage Charter	The Australian Heritage Natural Charter aims to assist everyone with an interest in natural places to establish their natural heritage values and manage them. It can be applied to a wide range of places whether terrestrial, marine or freshwater.
Beaches Management Plan (BMP)	A plan which helps to manage and erosion, access and weeds
Biodiversity	Bios = life. Biodiversity refers to the diversity of all forms of life.
Bush Regeneration	Removal of weeds from areas of Native Vegetation with the aim of increasing the likelihood of the native species surviving and spreading.
Bushcare group	A group of people, often community volunteers, who meet regularly to care for local areas of bushland, usually by weeding and planting.
Burra Charter	Charter adopted by Australia ICOMOS, which establishes the nationally accepted principles for the conservation of places of cultural significance.
Catchment Management Plan (CMP)	A plan which helps manage the catchment by integrating the management of land, water and related biological resources in order to achieve the sustainable and balanced use of these resources
Coastal Management Plan (CMP)	A plan which helps to manage the coastal zone by integrating the management of erosion, flooding, coastal development, access and recreation
Coastal Zone definition by Coastal Council of NSW	The 1997 Coastal Policy has adopted a combination of the above definitions, and defines the coastal zone as: • three nautical miles seaward of the mainland and offshore islands; • one kilometre landward of the open coast high water mark; • a distance of one kilometre around: all bays, estuaries, coastal lakes, lagoons and • islands; and tidal waters of coastal rivers to the limit of mangroves, as defined by NSW • Fisheries (1985) maps, or the tidal limit whichever is closer to the sea; • with the line on the maps being taken to the nearest cadastral boundary and/or easily • recognisable physical boundary, in consultation with local councils.
Conservation	All the processes of looking after an item so as to retain its cultural significance; it includes maintenance and may, according to circumstances, include preservation, restoration,

Word	Definition
	reconstruction and adaptation, and will be commonly a combination of more than one of these.
Conservation management plan (CMP)	A CMP is a document which sets out what is significant in a place and, consequently, what policies are appropriate to enable that significance to be retained in its future use and development. For most places it deals with the management of change.
Conservation policy	A proposal to conserve a heritage item arising out of the opportunities and constraints presented by the statement of heritage significance and other considerations.
Consolidate and Connect	Planting and edge management. For example Cooks River Corridor and Major Reserves and along selected major roads and rail corridors.
Corridor	A continuous and long term viable, usually linear, stretch of native vegetation/ habitat that allows movement of species and genetic material
Critically Endangered	At extremely high risk of extinction in the immediate future.
'Countries' / 'Country'	Country refers to the land and water, people, plants and animals, as well as the seasons, stories and creation spirits of Aboriginal people. It includes both tangible (physical) and intangible (non-physical) aspects – the landscapes, places, objects, customs and cultural traditions and practices – that communities have inherited from the past and wish to conserve as part of their Country for the benefit of current future generations.
Cultural heritage	Includes both Aboriginal and non-Aboriginal heritage
Curtilage	The geographical area that provides the physical context for an item and which contributes to its heritage significance; land title boundaries do not necessarily coincide; SHR curtilage is its listing boundary to which applications or permits may be required for certain proposed works.
CMA	Catchment Management Authority. NB now LLS Local Land Services
Critically Endangered	At extremely high risk of extinction in the immediate future.
DCP	Development Control Plan
Diadromous fish	Fish species dependent on movement between freshwater and saltwater to complete their lifecycles
Eastern Suburbs Banksia Scrub (ESBS)	Eastern Suburbs Banksia Scrub, a protected endangered ecological community, listed under the TSC Act as Eastern Suburbs Banksia Scrub in the Sydney Basin Bioregion and under the EPBC Act as Eastern Suburbs Banksia Scrub of the Sydney Region

Word	Definition
Ecological Services	Services and resources provided by ecosystems that contribute to the well-being of the environment and/or people.
Ecological Value	Importance in terms of maintaining or improving biodiversity, soil, air and water quality; and the relationships between these.
ESBS	Eastern Suburbs Banksia Scrub – as per definition in TSC Act
Ecosystem	An ecological system; a network of living (plants, animals and microbes) and nonliving things (air, water and mineral soil), that interact as an interdependent system.
EEC	An *Endangered Ecological Community*; An ecological community (often highly disturbed) with a particular distribution, combination of soil type/ substrate, plant and animal species; that has been so fragmented and reduced in occurrence from clearing and impacts of human development that it's continued survival is threatened; as described and listed under the TSC Act and/ or EPBC Act.
Endangered	At very high risk of extinction in the near future.
Environmental Weed	A plant (usually an introduced species), that grows, thrives, reproduces and spreads rapidly; suppressing other flora; and/or damaging ecological communities and waterways. Although it is not a legislative requirement to remove these weeds, they do impact on the natural environment and therefore should not be encouraged. See also http://www.weeds.org.au/index.html
EPA Act	The NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	The Commonwealth Environment Protection and Biodiversity Conservation Act 1999; which lists matters of national environmental significance; including heritage sites and places, nationally threatened species and ecological communities, wetlands of international importance and migratory species.
Ecologically Sustainable Development (ESD)	Ecologically sustainable development requires the effective integration of economic and environmental considerations (including cultural heritage) in decision-making processes. It has the same meaning as in Section 6(2) of the *Protection of the Environment Administration Act 1991*. In regard to cultural heritage, ESD can be achieved by applying the principle of intergenerational equity and the precautionary principle.
Environmental Offset Act 2014	An Act to counterbalance the significant residual impacts of particular activities on prescribed environmental matters through the use of environmental offsets.
Estuary	A partly enclosed coastal body of brackish water with one or more rivers or streams flowing into it, and with a free connection to the open sea.

Word	Definition
Estuary Management Plan	A plan to manage a particular estuary and its catchment in order to ensure the sustainability of its ecological systems.
Estuary Practice Study	A comprehensive report on the physical, chemical and biological condition of the estuary that will enable appropriate management decisions to be made in the future.
Fauna	Animals: usually pertaining to a particular area.
Flora	Plants: usually pertaining to a particular area.
Fish Passage	Enables fish to travel through / over what would otherwise be a barrier in a waterway.
GIS	Geographic Information System – software, on a computer in which maps and map layers can be created, viewed, manipulated, analysed and edited.
Golf Course Environmental Management Plan	Environmental Management Plan (EMP) is a plan commissioned by a golf club to prescribe the best practice and the requirements of environmental management on the land they lease.
Gross Pollutant Trap (GPT)	Structures that use physical processes to trap solid waste such as litter and coarse sediment
Gross Pollution Stormwater	Stormwater which contains solid waste
Habitat and Wildlife Gardens	Habitat creation for small birds, lizards and frogs.
Habitat Garden	A garden designed and created to attract, feed and house fauna.
Harm	Includes any act or omission that destroys, deface or damages the Aboriginal object or place, or in relation to an object, moves the object from the land on which it has been situated.
Heritage	Environmental heritage, as defined in the *Heritage Act 1977*, is formal recognition of an item's historic, scientific, cultural, social, archaeological, rarity or representative value(s) in NSW's cultural or natural history. Items of environmental heritage can have cultural and/or natural significance.
Heritage items or items of 'environmental heritage' (from section 4 definitions in the *Heritage Act 1977*)	Items of 'environmental heritage' means those places, buildings, works, relics, moveable objects and precincts that have State or local heritage significance. 'Environmental heritage' is listed by local council, the Heritage Council of NSW or government instrumentalities as items that an organisation or the community want protected for future generations.

Word	Definition
Heritage Significance	Of aesthetic, historic, scientific, cultural, social, archaeological, natural or aesthetic value for past, present or future generations.
High Edge Ratio	A high edge ratio in the context of this plan relates to a shape of a management area. It is the area of edge compared to the total size of the area. EG a long-thin reserve will have a high edge ration whereas a large round reserve will have a lower edge ratio.
Holocene	The '*Holocene*' is the name given to the last 11,700 years of the Earth's history
ICOLLs	Intermittently Closed and Open Lakes and Lagoons
Indigenous	Originating or occurring naturally in a particular place
In-line wetland / water-way	A Wetland or Water-way receives high flows
Intergenerational equity	Intergenerational equity is the principle whereby the present generation should ensure the health, diversity and productivity of the environment for the benefit of future generations.
Integrity	A heritage item is said to have integrity if its assessment and statement of significance is supported by sound research and analysis, and its fabric and curtilage and still largely intact.
ISEPP	State Environmental Planning Policy (Infrastructure) 2007
Lagoon	A stretch of salt water separated from the sea by a low sandbank or coral reef.
Lake	A large area of water surrounded by land.
Legislation	Lawmaking; the preparation and putting into place of laws; and the body of laws or Acts made.
LEP	Local environmental plan
LLS	Local Land Services former Catchment Management Authorities.
LLS Act (2013)	Local Land Services Act 2013 established Local Land Services (LLS), repealed the Rural Lands Protection Act 1998, the Rural Lands Protection Amendment Act 2008 and the Catchment Management Authorities Act 2003. http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+1+2014+cd+0+N Responsible Minister: Minister for Primary Industries
LLS Regulation (2014)	http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+1+2014+cd+0+N

Word	Definition
Local Government Area (LGA)	The area under the management of the local council.
Macrophyte	An aquatic plant that grows in or near water and is emergent, submerged or floating.
Mapping	Includes figures in this document and the accompanying Mapping CD, which contains a set of map figures, and source MapInfo layers and workspace files.
Minor Works	Work that will have little impact on the heritage significance of a listed heritage item
Noxious Weed	Serious weeds that are required to be controlled under the *Noxious Weeds Act 1993*.
Native Vegetation (NV) Act	The NSW Native Vegetation Act 2003 regulates the clearing of native vegetation in non-urban areas in NSW.
Natural Resources Commission Act 2003 No 102	http://www.legislation.nsw.gov.au/maintop/view/inforce/act+102+2003+cd+0+N The object of this Act is to establish an independent body with broad investigating and reporting functions for the purposes of: (a) establishing a sound scientific basis for the properly informed management of natural resources in the social, economic and environmental interests of the State, and (b) enabling the adoption of State-wide standards and targets for natural resource management issues, and (c) advising on the circumstances in which broad scale clearing is to be regarded as improving or maintaining environmental outcomes for the purposes of the Native Vegetation Act 2003.
OEH	State government agency: Office of Environment and Heritage (NSW)
Off-line waterway / wetland	A Wetland or Waterway that has high flows diverted around it.
On-ground Work	Physical works done on site, such as planting and weeding.
OoW	state government agency: Office of Water
PAS	Priorities Action Statement (specific statements are contained in *Threatened Species Priorities Action Statement* – DECC 2007 publication)
PASS	Potential Acid Sulphate soils – soils that if exposed to air or otherwise dried can produce acid which can harm the environment around it (also ASS) Acid Sulphate Soil

Word	Definition
Pleistocene	The Pleistocene is the geological epoch which lasted from about 2,588,000 to 11,700 years ago. It spanned the world's recent period of repeated glaciations that resulted in dramatic changes in sea levels.
PoM	Plans of Management are made for most community lands and set out how they can be used and managed appropriately
PoO	Plans of Operation are made for community lands and state which activities need to be carried out to manage the site in a relevant time frame
PoE Act (2014) NB: this replaces POEO Act	Protection of the Environment Legislation Amendment Act 2014 amending the Contaminated Land Management Act 1997, the Radiation Control Act 1990, the POEO Act, the Protection of the Environment Administration Act 1991, the Land and Environment Court Act 1979 and the POEO (General) Regulation 2009.
A Recovery Plan	A Recovery Plan in this example refers the specific plan produced by OEH aiming to maximise the survival of a particular threatened or endangered species, group or species or community.
REF	Regional Environmental Plan (planning legislation at a State Government Level) or REF is Review of Environmental Factors a review of a specific project in relation to potential environmental impacts and how to manage them.
Rehabilitation	To improve and/ or recover condition (make better).
Remnant Vegetation	Remaining native vegetation. Has a specific meaning under the NSW Native Vegetation Act.
Restoration	To get back to original condition.
Revegetation	Planting and / or seed sowing to grow locally native plants in areas where they are not currently growing due to disturbance or presence of weeds.
Riparian	Of a creek, river or stream (usually referring to vegetation of the beds and banks of natural waterways).
Saltmarsh	An ecological community of low growing salt tolerant plant species and diverse marine fauna; that occurs in the intertidal zone between land and calm open salt water and along the margins of brackish estuaries. Also listed as “Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions” as an EEC under the TSC Act.
SBB	Sydney Basin Bioregion.

Word	Definition
SCCG	Sydney Coastal Councils Group
SEPP	State environment planning policy
SFW	Sydney Freshwater Wetlands
SHR	State Heritage Register, established under the *Heritage Act 1977* (NSW)
Site-specific exemptions	Site-specific exemptions are works other than those in the standard list of exemptions. These works can be identified as exempt development in a CMP or CMS, or approved by the Minister on the recommendation of the Heritage Council. They are works that have been assessed and will not materially impact the heritage significance of an item
Soil Type	Broad soil classifications, e.g. Podosols, sodosols; described in terms of agricultural potential based on chemical properties, structure, composition and source.
Standard Exemptions	Standard exemptions apply to all properties listed on the State Heritage Register. Certain activities are granted exemption from approval by the Heritage Council of NSW or its delegate (Sydney Water); these activities are considered minor in nature and will only have minimal impact on the heritage significance of a place. They include maintenance, repairs and minor alterations (refer to OEH's Heritage Division's standard exemption guidelines for specific details about activities considered minor in nature)
Standard Work	Any works that are routine and would not usually require a development application. Standard work is *not* that done in times of emergency or as one-off major works.
Strategy	Plan for achieving a desired aim or outcome.
Sydney Freshwater Wetlands (SFW)	Sydney Freshwater Wetlands of the Sydney Basin bioregion, listed as a protected endangered ecological community under the TSC Act
Terrestrial	Land based.
Threatened	At risk of extinction.
Threatened Species	A species or group of species listed on the NSW Threatened Species Act or the Fisheries Management Act or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
TSC Act	The NSW Threatened Species Conservation Act 1995; which lists species, populations and ecological communities threatened with extinction in NSW.
Vulnerable	At a high risk of extinction in the medium-term future.

Word	Definition
Water Management Act (WM Act)	The NSW Water Management Act 2000 regulates water management; including drainage management, floodplain protection and controlled activities on land within 40 metres either side of the bed of any river, lake or estuary.
WSUD	Water Sensitive Urban Design – Urban planning and design that is sensitive to natural hydrological and ecological cycles and aims to manage, protect and conserve the urban water cycle.
Waterway	A body of water, such as a concrete channel, canal, river, stream, creek or estuary, used as a route or way of travel or transport (usually in context of water craft, but meaning may extend to transport of seed, genetic stock, pollutants etc.).
Weir	A low structure built across a river to raise the level of water upstream or regulate its flow
Weed	A weed is a plant growing where it is not wanted.
Weed Management	In this Plan Weed Management refers to the focus of removing weeds. Bush Regeneration is the management of an area to enhance natural regeneration.

Attachment II – Salty Communities Master Sheet

See separate Sheet. To be released later.

Attachment III – Review of Local Government Biodiversity Strategies – Excel summary

See separate digital sheet. To be released later.

Attachment IV – List of Councils Notified and Contributing Information to the Review

REVIEW Key:

- **Green –SCCG member councils**
- Black – welcomed to be included if interested

LGA	Data	LGA	Data
Ashfield, Municipality of		Leichhardt, Municipality of	
Auburn City		Liverpool, City of	
Bankstown, City of		**Manly Council**	Yes
Blacktown, City of		Marrickville Council	
Botany Bay, City of	Yes	**Mosman, Municipality of**	Yes
Burwood Council		**North Sydney Council**	Yes
Camden Council		Parramatta, City of	
Campbelltown, City of		Penrith, City of	
Canada Bay, City of		**Pittwater Council**	Yes
Canterbury, City of		Randwick, City of	Yes
Fairfield, City of		**Rockdale, City of**	Yes
The Hills Shire		Ryde, City of	
Holroyd, City of		Strathfield, Municipality of	
Hornsby Shire	Yes	**Sutherland Shire**	Yes
Hunter's Hill, Municipality of		**Sydney, City of**	Yes
Hurstville, City of		**Warringah Council**	Yes
Kogarah, City of		Waverley Council	Yes
Ku-ring-gai Council		**Willoughby, City of**	Yes
Lane Cove, Municipality of		Woollahra, Municipality of	Yes

Attachment V – Legislation Relating to Coastal Biodiversity

Legislation	Conclusion
International Agreements	
JAMBA, CAMBA, ROCKAMBA	Internal Agreement (Japan, China and Korea) on the protection of migratory birds and their habitats.
National Legislation	
Environmental Protection and Biodiversity Conservation Act 1999	Mandates actions relating to nationally listed threatened species and communities, including the Endangered Ecological Communities. Matters of National Environmental Significance need to be self-assessed once identified; pending on a scope of proposed works
Aboriginal and Torres Strait Islander Heritage Protection Act	May be relevant if any item of Aboriginal significance to an Aboriginal community is under threat of injury or desecration and state-based processes are unable to protect it.
State Legislation	
National Parks and Wildlife Act 1974 (NP&W Act) [Note: The NPW Act and Heritage Act apply simultaneously.]	All proposed activities in undisturbed land must be assessed: in accordance with the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (2010), by anyone as long as it is follows the reasonable and practicable steps set out by OEH, or in accordance with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (2010) by an appropriately qualified archaeologist, to determine if Aboriginal objects or areas likely to contain Aboriginal objects will be impacted.
Heritage Act 1977 [Note: The NPW Act and Heritage Act apply simultaneously.]	All proposed activities must be assessed by an appropriately qualified heritage consultant / archaeologist to determine if locally or state significant heritage items or areas likely to contain relics will be impacted.
Aboriginal Land Rights Act 1983	This Act established Aboriginal Land Councils (at State and local levels). These bodies have a statutory obligation under the Act to: take action to protect the culture and heritage of Aboriginal persons in the Aboriginal land council's area, subject to any other law, and promote awareness in the community of the culture and heritage of Aboriginal persons in the Aboriginal land council's area.
Native Title Act 1994	This Act was introduced to work in conjunction with the Commonwealth Native Title Act. Native Title claims, registers and Indigenous Land Use Agreements (ILUAs) are administered under the Act.
Environmental Planning and Assessment Act 1979 (EP&A Act).	Any potential environmental impacts of all proposed activities must be considered to the fullest extent possible, as part of an environmental assessment; including exempt development.
Sydney Water Act 1994	Works and their impacts, assessed under an environmental assessment, need to comply with the standards of service and environmental performance dictated by this Act

Protection of Environmental Operations Act 1997 (POEO Act).	Any works undertaken must have safeguards / mitigations that ensure there will be no pollution of the surrounding environment.
Threatened Species Conservation Act 1995	Provides for the creation of recovery plans for species or communities listed as threatened. Endangered Ecological Communities, Threatened Species and Endangered populations are within the Sydney Coastal Zone. Public authorities are obliged to implement the recovery plans for these. All proposed activities must be assessed by an appropriately qualified environmental specialist to determine if threatened flora or fauna species or communities will or are likely to be impacted.
Fisheries Management Act 1994	Provides for the protection of fish and their habitats – including aquatic vegetation. A key requirement is keeping fish passage open and maximising the quality of water.
State Environmental Planning Policy Example (Infrastructure) 2007 (ISEPP)	Local Government may not be not required to obtain development consent, under the EP&A Act, for certain projects like maintenance works.
Coastal Policy 1997	The 1997 NSW Coastal Policy sets the context in providing for population growth and economic development at the same time protecting the natural, cultural, and spiritual and heritage values of the coastal environment. To achieve this, the Policy has a strong integrating philosophy based on the principles of ecologically sustainable development (ESD).
Regional Environmental Plans (REP)	Regional Environmental Plans (REP)
Noxious Weeds Act 1993	Requires landowners to control classified weeds on their land, with required control measures depending on level of classification.
Local Legislation	
Local Environment Plans (LEP) One per LGA	The LEP of any LGA is a key planning instrument. Local councils are required to ensure draft LEPs give effect to and be consistent with the Coastal Policy (1997). Councils are also required to consider the Coastal Policy when determining development applications under Section 90 of the EPPA. Appendix C of the Coastal Policy also provides explanatory notes for local councils. These notes also include development design and locational principles for consideration in local environment plans. State government work, and agencies such as Sydney Water are ordinarily, subject to Division 20 of the SEPP, development consent under an LEP is not required.
Development Control Plans (DCP) One per LGA	The DCP of any LGA is a key planning and regulatory instrument. Local Governments may use their DCP is organise and add strength to policies such as Tree and Bushland Management Orders which are often in DCPs now rather than stand along policies..
Open Space Plans of Management	Informs council staff, community and other stakeholders on matters concerning public open space or parks. It ensures that the methods of caring for and managing parks are all clearly identified and publicly available.

Coastal Management Plans	Strategic plans with a long-term time frame of 10-20 years which respond to legislative requirements and community issues in accordance with current best practice for the management of coastal foreshores.
Estuary Management Plans	A strategic plan used to understand the complex nature of estuarine systems and the actions needed to effectively manage human impacts upon this system.
Beach Management Plans	A strategic plan for future management of beaches in response to community issues and in accordance with current best practice management of beaches.
Flood Plans	Plans which aim to manage flooding events.