NSW National Parks and Wildlife Service

Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island nature reserves

Planning considerations

Acknowledgement of Country

Department of Climate Change, Energy, the Environment and Water acknowledges the Traditional Custodians of the lands where we work and live.

We pay our respects to Elders past, present and emerging.

This resource may contain images or names of deceased persons in photographs or historical content.

Cover photo: Cowan Creek at Bobbin Head. David Finnegan/DCCEEW

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How to use this document

This planning considerations report outlines the matters considered in preparing the *Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island nature reserves Plan of Management*, including the parks' key values, management principles and management considerations. Further information, including common and scientific names of flora and fauna species found in these parks, is provided in the appendices.

It is recommended that readers of this document also read the plan of management.

The plan of management describes the desired outcomes for the parks' values and actions NSW National Parks and Wildlife Service (NPWS) proposes to undertake to achieve these outcomes. It also sets out the recreational and business activities that are permitted in the national park and any requirements to undertake these activities, including whether consent must be sought from NPWS to undertake them.

This planning considerations report may be updated where appropriate, for example, if we have new information on:

- the values of the parks (e.g. new threatened species)
- management approaches (e.g. new feral animal management techniques)
- new programs.

Changes will only be made to this document if they are consistent with the plan of management.

Acknowledgements

NPWS acknowledges that Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island nature reserves are the Country of Aboriginal custodians who continue to maintain a connection and care for the lands in the national park and nature reserves.

This planning considerations report was prepared by NPWS staff.

Contact us

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- NPWS Sydney North West Area at npws.northwesternsydney@environment.nsw.gov.au Lane Cove National Park, 2 Max Allen Road, Lindfield, or by telephone on 02 8448 0400.

Connection to Country

The parks covered in this report are part of an ancient landscape that includes the Aboriginal people. Aboriginal people have a deep spiritual and cultural connection to this Country. Their ancestors have lived here for thousands of years and, in doing so, form part of this living landscape.

Connections to Country and the significance of these parks to Aboriginal peoples — past, present and future — are respected by NPWS and acknowledged in this report. NPWS supports and acknowledges the role of Aboriginal people in identifying traditional connections and custodians for this place.

What is 'Country'

Country refers to all parts of the natural environment and these parts cannot be separated. This means the land, water, animals and plants are viewed as one, and form Aboriginal peoples' cultural and spiritual identity.

Aboriginal people develop intimate knowledge and connections with places, animals, plants and landscapes that create an interdependence with nature which is based on respect. Aboriginal people care for Country through ceremony, cultural activities, sharing stories of songlines and maintaining connections with the world around them.

Country is a place of birth, a place of tribal or clan connections, a place where you belong to.

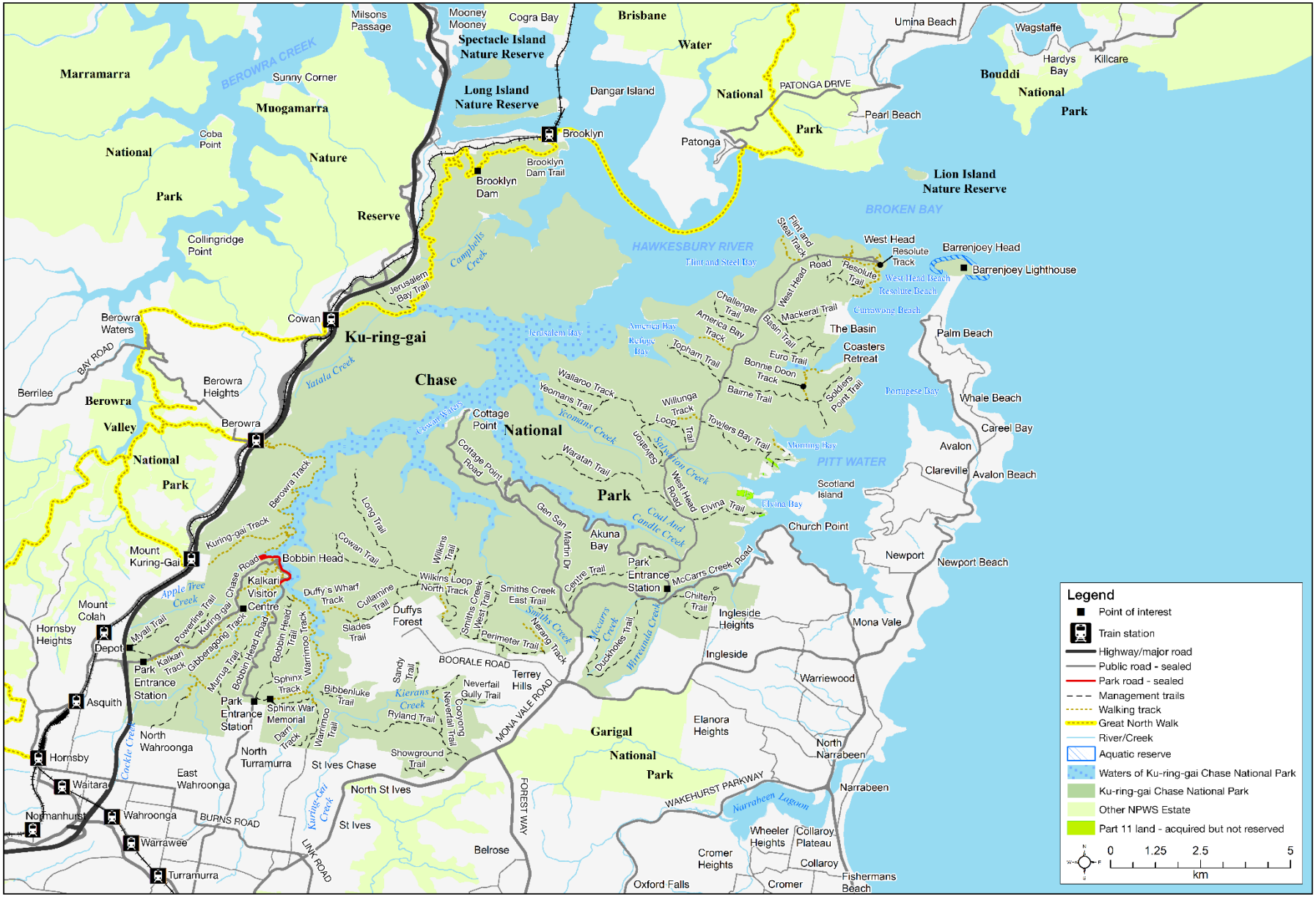


Figure 1 Ku-ring-gai Chase National Park, Lion Island Nature Reserve, Long Island Nature Reserve and Spectacle Island Nature Reserve

1. Ku-ring-gai Chase National Park, and Lion Island, Long Island and Spectacle Island nature reserves

The parks are just over 20 kilometres north of the centre of Sydney. The national park includes most of the land between Pittwater and the Pacific Motorway (M1) and is bounded to the north by the Hawkesbury River and to the south by Mona Vale Road and the suburbs of St Ives, Turramurra and Wahroonga. The national park also includes Barrenjoey Head on the eastern side of Pittwater at Palm Beach. Lion Island Nature Reserve sits in Broken Bay near the Central Coast suburb of Pearl Beach, and Long Island Nature Reserve and Spectacle Island Nature Reserve are in the Hawkesbury River near the townships of Brooklyn and Mooney Mooney (Figure 1).

Ku-ring-gai Chase National Park is surrounded by medium-density residential areas of Mount Colah, Mount Ku-ring-gai, Turramurra, Wahroonga, St Ives and Hornsby and semi-rural properties at Duffys Forest and Terrey Hills. Increased urbanisation in the surrounding area has increased demand on the national park to provide open space and recreational opportunities for growing numbers of visitors.

Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island nature reserves are in the north-east part of the Sydney Basin Bioregion on the dissected Hornsby Plateau, the Hawkesbury River and Broken Bay.

The parks are part of a network of protected areas north of Sydney that includes Garigal, Marramarra, Bouddi, Brisbane Waters, Popran, Dharug and Berowra Valley national parks; and Muogamarra Nature Reserve and Berowra Valley Regional Park. This large network of parks and reserves forms a connected corridor of native vegetation that stretches to parks in the Greater Blue Mountains World Heritage Area and makes a significant contribution to the protection of natural and cultural values of the Sydney Basin Bioregion.

What is the Sydney Basin Bioregion?

Bioregions are large areas of land characterised and defined by landscape scale natural features such as landform, geology, as well as biodiversity and environmental processes such as climate that influence the functions of whole ecosystems.

The Sydney Basin Bioregion covers about 4.53% of New South Wales and consists of a sedimentary basin of gently dipping sandstones, shales, conglomerates, coal measures and volcanic rocks of Permian to Triassic age that overlies basement rocks of the Lachlan Orogen and is overthrust by slightly older rocks of the New England Orogen north-east of the Hunter Valley.

Sandstones dominate scenically and include those of the Narrabeen Group that prevail in the Greater Blue Mountains. Closer to the coast the Hawkesbury Sandstone forms the Illawarra Escarpment and the dissected tablelands flanking the Hawkesbury valley, including much of Ku-ring-gai Chase and Berowra Valley national parks. Periods of uplift, erosion and subsequent post-glacial sea level rise created a complex drowned coastline in Ku-ring-gai Chase, and isolated Lion Island, Long Island and Spectacle Island with their nature reserves.

The Sydney Basin Bioregion is recognised for its high species richness and diversity associated with Hawkesbury Sandstone landforms.

The national park includes the beds of Cowan Creek, Cockle Creek, Smiths Creek, Coal and Candle Creek, Apple Tree Creek and The Basin lagoon. These largely undeveloped tidal waterways protect significant estuarine environments and provide boating and fishing opportunities which contrast with the busier waterways of Pittwater, Broken Bay and the lower Hawkesbury River.

Steep sandstone cliffs and a rugged sandstone plateau provide a spectacular scenic backdrop to the waterways, winding creeks, sheltered beaches, hidden coves, river and coastal islands and the wide expanses of blue water. Bushland covers the island nature reserves and the national park and is a dominant feature of the area. The views from West Head, Barrenjoey Head and Kalkari Lookout and the picturesque settings of Barrenjoey Lighthouse, Bobbin Head and The Basin draw large numbers of local, national and international visitors to the national park and surrounds.

Ku-ring-gai Chase was established following a long campaign by a local citizen, Eccleston Du Faur, to create a national park for north Sydney. In 1894, an area of 13,500 hectares, including most of Cowan Water was set aside as Ku-ring-gai Chase and placed under the care, control and management of trustees. It was named Ku-ring-gai to recognise the local Aboriginal people and a ‘chase’ to indicate it was an area of natural bush not enclosed by fences (letter from Du Faur to the Minister for Lands 1892).

In 1967, Ku-ring-gai Chase became a national park under the care, control and management of the Director of National Parks and Wildlife. Several additions of land have increased the size of the national park to 14,976 hectares.

The 9-hectare Lion Island was dedicated a fauna reserve in 1956 and declared a nature reserve in 1967.

Long Island Nature Reserve includes 73 hectares of Long Island originally set aside for public recreation in 1911, before being dedicated a nature reserve in 1972. A small area at the eastern end of the island is managed by Transport for New South Wales and is not part of the nature reserve. A railway tunnel and associated buildings are located on this section of Long Island.

The 36-hectare Spectacle Island was reserved for public recreation in 1919 before being declared a nature reserve in 1972.

The national park and nature reserves are located within the local government areas of Northern Beaches, Wahroonga, Davidson, Hornsby and Gosford. They are also within the Greater Sydney Local Land Services, Metropolitan Local Aboriginal Land Council and Darkinjung Local Aboriginal Land Council regions.

The national park system provides an important contribution to achieve priorities identified in state and local government strategic environmental and land-use planning initiatives. This includes the Local Land Services’ Greater Sydney local strategic plan 2021–2026 (LLS n.d.) and the *Greater Sydney Region Plan: A Metropolis of Three Cities* (Greater Sydney Commission 2018).

Box 1: Future additions and boundary adjustments

The national park and island nature reserves are part of a network of protected areas that conserve and protect the biodiversity of New South Wales. The NPWS reserve establishment program sets the direction for establishing a comprehensive and representative network of protected areas. This is achieved by securing additional lands to be reserved and refining the boundaries of existing parks and reserves over time.

Several lots on the western shores of Pittwater at Elvina Bay and Lovett Bay have been acquired for additions to the national park. These unreserved lands are vested in the Minister under Part 11 of the *National Parks and Wildlife Act 1974*. Part 11 lands are managed consistent with the objectives of the Act and are subject to the National Parks and Wildlife Regulation 2019.

In future there may be other opportunities to refine and adjust the boundaries of the national park to include important conservation values, link the park to surrounding reserves or improve park management more generally.

2. Protecting the natural environment

2.1 Geology, landform and hydrology

The landscapes of Ku-ring-gai Chase National Park and the island nature reserves carry a record of the latter stages of the geological history of the Sydney Basin. These landscapes are part of a complex drowned valley system dissecting a Hawkesbury Sandstone tableland that preserves an ancient land surface which incorporates mature, gentle valley headwaters that carry upland swamps and heathlands including threatened plant communities. Those ancient valleys have been stranded by uplift and to reach sea level their streams must fall precipitously via waterfalls and rapids known as knickpoints, adding a striking scenic element to the park terrain. The national park's rugged landscape of deep, drowned valleys, waterfalls, woodland, heath and shrubland, and the islands, headlands and extensive coastal waterways are places of great natural beauty. The landforms in the park provide many high vantage points with views over Cowan Water, Broken Bay, Pittwater and the Tasman Sea.

The national park and island nature reserves are near the centre of the Sydney Basin, a major structural unit of Permian and Triassic age (around 295 to 230 million years ago) consisting mostly of gently dipping sedimentary rocks. During its formation, the Sydney Basin evolved from a shallow, subantarctic sea to a terrestrial landscape of river floodplains, boreal swamp forests and coastal lagoons and swamps. Midway through came the end-Permian extinction event 252 million years ago that ended coal deposition and had dramatic consequences for life on our planet. When the basin matured, the area became dry land, but its strata were punctured by numerous volcanic diatremes of Early to Middle Jurassic age and these were accompanied by dykes. Dyke intrusion and volcanic activity recurred sporadically until about 12 million years ago.

One such dyke cuts through West Head near the Resolute Picnic Area, and deeply weathered breccia-filled diatremes have formed the amphitheatre-shaped valleys of Campbells Crater near Cowan, and Smiths Crater near Smiths Creek in Cowan Water.

The current river systems have a long history and at times major drainages like the Hawkesbury–Nepean (or Dyarubbin), meandered over lowlands. Eventually the great bends and valleys of these river systems became deeply entrenched by subsequent uplift of the land in the late Cenozoic Era.

During the last Ice Age (20,000 years ago) sea level was 120 metres lower than it is today, and the Sydney coastline was kilometres offshore. Following that glacial period, rising sea levels flooded the lower valleys and isolated some of the more remote peaks to form Lion Island, Long Island, Spectacle Island and Barrenjoey Head. Subsequent sand deposition reconnected Barrenjoey Head to the mainland by an isthmus.

Ku-ring-gai Chase National Park ranges in altitude from the bed of Cowan Water to Willunga Trig on the Lambert Peninsula at 233 metres above sea level. The geomorphology of the national park and nature reserves has formed a distinctive landscape, which is a major factor in the attractiveness of the Pittwater, lower Hawkesbury River and Broken Bay areas.

NPWS is currently supporting work by local governments and community groups in the northern Sydney region in developing a geo trail tourism experience that will promote the significant natural, cultural and geological features of the Ku-ring-gai parks and surrounding areas. This work could lead to the establishment of a Ku-ring-gai GeoRegion that includes the national park and the island nature reserves and eventually consideration as a UNESCO Global Geopark.

Geology and soils

The oldest rocks in the parks belong to the Newport Formation of the upper levels of the Narrabeen Group. This formation is essentially of quartz lithic or impure sandstones with minor interbedded shales and laminites – a 5 to 10 metre thick laminite band encircles the lower slopes of Barrenjoey and is clearly visible on the north side of Lion Island. The rocks of the Newport Formation weather more readily than the quartz rich Hawkesbury Sandstone, creating deeper soils that support the endangered Pittwater and Wagstaffe Spotted Gum Forest community, and pockets of littoral rainforest on the west side of Barrenjoey and the shores of Pittwater.

Hawkesbury Sandstone is the most extensive rock type in the national park and nature reserves and forms the plateaus and hill slopes of the region, as well as the cappings of Barrenjoey, the eastern end of Lion Island, and most of Long Island and Spectacle Island. Soils derived from Hawkesbury Sandstone are coarse grained and form shallow sandy profiles on the broad ridges and deeper yellow earths in the valleys. In a few places bodies of alluvial sand have accumulated and formed unusual podsol soil profiles. Along the broad ridge of the Lambert Peninsula, wide rock benches, some based on shale lenses, alternate with upland swamps in the drainage lines that contain peat soils.

Upper levels of the Hawkesbury Sandstone include thick intervals of shale and laminite. The interval at Duffys Forest (its weathered product was quarried for ceramics and is now largely built over) being recorded as up to 35 metres thick. Occasional erosional remnants of the Mittagong Formation, the sandstone/shale transitional at the top of the Hawkesbury Sandstone, are preserved at localities along the southern end of the Murrua Trail and bordering Terrey Hills. The overlying Ashfield Shale mainly occurs outside the national park on land that has been cleared and developed, but where native vegetation survives in nearby reserves such as Dalrymple-Hay Nature Reserve it supports the critically endangered Blue Gum High Forest ecological community.

There are small areas of ferricrete along the ridge tops within the national park at Terrey Hills and Ingleside. The exposed igneous intrusions at West Head, Campbells Crater and Smiths Crater have weathered to form deep red soils with a higher nutrient content than the surrounding areas.

Park waterways and foreshores

The waterways in and adjoining the national park and island nature reserves are spectacular in their natural beauty and recreational value. They support important fisheries and aquatic biodiversity and habitats, including Barrenjoey Head Aquatic Reserve (see Box 2). The national park protects tens of kilometres of shoreline, creeks, waterfalls, beaches, estuaries, coastal lagoons, secluded bays and coves. The beds of Cowan Creek, Coal and Candle Creek, Smiths Creek, Cockle Creek, Apple Tree Creek and The Basin lagoon are part of the national park.

Long Island and Spectacle Island nature reserves are surrounded by the Hawkesbury River, and Lion Island is surrounded by the waters of Broken Bay. Barrenjoey Head lies at the southern head of Broken Bay and the entrance of Pittwater. Pittwater, the Hawkesbury River and Tasman Sea adjoin the national park.

Cowan Creek, Cockle Creek, Yeomans Creek, Coal and Candle Creek, Smiths Creek Salvation Creek are the main waterways in the national park. Seagrass, saltmarsh and mangrove communities in bays and estuaries of the national park and foreshores of island nature reserves are important coastal wetland habitats. The Barrenjoey Head Aquatic Reserve surrounds Barrenjoey Head and is managed under the *Marine Estate Management Act 2014*.

Box 2: Barrenjoey Head Aquatic Reserve

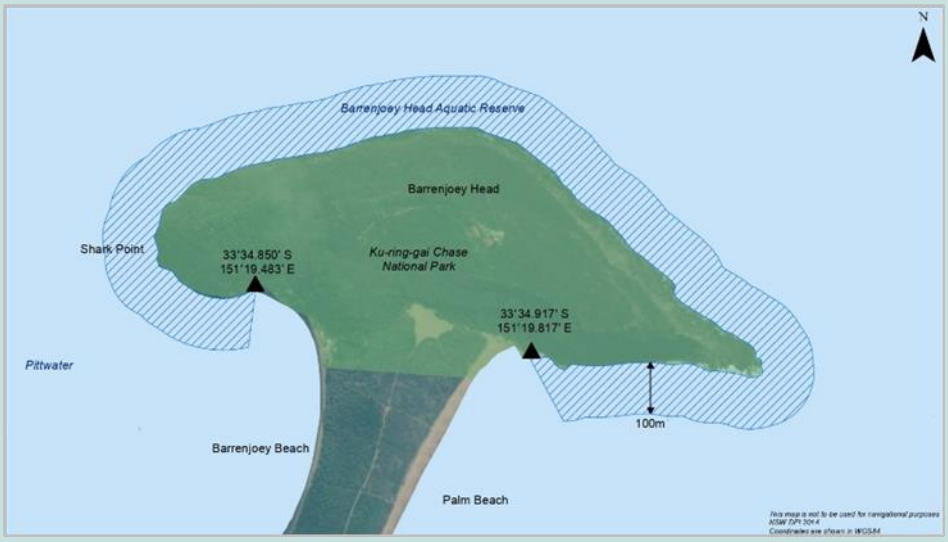
Barrenjoey Head Aquatic Reserve is managed by the NSW Department of Primary Industries (DPI) Fisheries under the Marine Estate Management Act. The aquatic reserve covers approximately 30 hectares, including the rocky shore around Barrenjoey Head, extending from the northern end of Palm Beach around the headland to the northern end of Station Beach, and 100 metres offshore.

The shore provides diverse rocky habitats, including platforms, crevices, rock pools and boulders which attract a range of marine wildlife, including seals. The reserve also includes subtidal rock walls and boulders, seagrass beds, reef systems and sandy seabed.

Management of the aquatic reserve is focused on:

- conserving the biodiversity of fish and marine vegetation
- protecting fish habitat
- supporting scientific research.

Collaboration between agencies responsible for aquatic biodiversity, marine estate and waterways helps ensure an integrated approach to protect these biodiversity values at the headland and aquatic reserve.



Management considerations and opportunities

Erosion is a naturally occurring process, however, poorly sited and maintained roads, walking tracks and management trails can accelerate erosion and siltation. This is particularly apparent on steeply or moderately sloping sections of the national park and on the edges of watercourses. In addition, threatened plant species and communities found on ridge tops with highly erodible shale or lateritic soils are also particularly vulnerable to the impacts of erosion. Predicted sea level rise also presents an increased risk of tidal inundation and erosion of foreshore areas in the parks.

Realignment of tracks and trails is sometimes required to prevent further erosion and therefore minimise impacts to the parks' natural values or cultural values. The construction and use of unauthorised tracks and trails also increases the risk of erosion and damage to vegetation and watercourses. Closure and rehabilitation of unauthorised tracks and trails is required to prevent damage to park values, especially threatened species and communities.

The predicted increased intensity and frequency of rainfall events resulting from climate change (see Box 4) may accelerate natural weathering processes and increase the risks of rock falls and land slips.

The catchments of Coal and Candle Creek, Yeomans Bay, Refuge Bay, Flint and Steel Bay, Salvation Creek and The Basin are completely within Ku-ring-gai Chase National Park. The catchments of Cowan Creek, Cockle Creek and Smiths Creek extend into neighbouring urban and industrial areas, and stormwater flows into the national park from these neighbouring lands.

Development of surrounding lands and associated increases in run-off has elevated siltation and pollution in some watercourses within the national park. Increased sediment loads are particularly noticeable in waterways downstream of developed areas after high rainfall events. Weed growth and algal blooms along some watercourses have increased due to nutrients and weed propagules carried in run-off. Run-off can also introduce other pollutants which affect water quality.

The saltmarsh communities in the parks are particularly vulnerable to sedimentation and siltation. Areas of concern for increased siltation, pollution and weed growth include:

- the Cowan Creek and Cockle Creek catchment downstream of industrial estates and golf courses at Terrey Hills, Asquith and North Turramurra
- Smiths Creek catchments downstream of horse stables in McCarrs Creek and Kierans Creek
- waterways adjacent to the Pacific Motorway (M1)
- seepage of sewage and wastewater into waterways from nearby houses.

Some coastal lagoons in the parks, such as Great Mackerel Beach and The Basin, alternate between being open or closed to the ocean. The mouths of intermittently closed and open lakes and lagoons in the national park may need to be artificially opened to maintain coastal wetland habitat and prevent localised flooding or address water quality issues in a lagoon.

Properties adjoining the national park at Great Mackerel Beach are particularly vulnerable to flooding from the small lagoon at the northern end of the beach and from very high tides. The lagoon entrance has been artificially opened as an emergency measure to release flood waters. The opening of intermittently closed and open lakes and lagoons and other foreshore rehabilitation works may be needed to maintain coastal habitats in various parts of the park. This will increase as climate change leads to sea level rise and higher levels of erosion and sedimentation in waterways. A risk assessment, including an appropriate level of environmental assessment and consultation with appropriate authorities, is required before opening intermittently closed and open lakes and lagoons or undertaking other coastal rehabilitation works.

Unauthorised discharge of sewage and wastewater, particularly in small bays not regularly flushed by tidal waters, may also affect water quality. Wastewater pump-out facilities at the Bobbin Head and Akuna Bay marinas have reduced the incidence of wastewater discharge from boats into waterways. Improved environmental management of the marinas, slipways and associated facilities has also helped to maintain water quality.

The wash from boats increases the risk of shoreline erosion. To minimise shoreline erosion, 4- and 8-knot speed zones and no-wash zones have been established in the park's tidal waterways. NPWS works closely with Transport for New South Wales (TfNSW) to monitor these speed limits and zones to protect park shorelines from wash.

NPWS maintains on-site sewerage treatment systems at Illawong Bay, Resolute Picnic Area, Akuna Bay and near the North Turramurra entrance. These facilities have been progressively upgraded to meet required environmental standards and prevent outflow into the waterways (see Section 4).

Hornsby Shire Council has monitored the water quality in local catchments outside the parks since 1994. Monitoring includes a reference site at Gunyah Point. The reference site does not receive stormwater or urban run-off. Opportunities exist to work with local councils to monitor water quality in creeks and waterways affected by stormwater and urban run-off in the park. Monitoring will help to identify areas of risk and options to prevent decline in water quality in park waterways and consequent impacts on park values. NPWS continues to consider ways to encourage and support monitoring water quality and aquatic ecosystem health of waterways in the parks (e.g. through research partnerships) according to NSW water quality guidelines.

Other government agencies have a range of roles in the management of the waterways in and adjacent to the national park. These include responsibilities for the management of recreational and commercial fishing, marine and coastal habitats, threatened aquatic species and aquatic reserves (Department of Primary Industries (DPI) Fisheries) and waterway use, navigation and safety (TfNSW).

Local councils and Sydney Water have responsibility for managing stormwater discharge and maintenance of sewerage treatment infrastructure (see Section 5). NPWS works closely with these agencies to manage potential impacts and protect park values.

Coastal zone management

The largely undeveloped foreshores, hill slopes and skylines of the parks form significant scenic values that characterise the Pittwater, Broken Bay and lower Hawkesbury River area.

The *Coastal Management Act 2016* and Coastal Management State Environmental Planning Policy 2018 (Coastal Management SEPP) guide the sustainable development of the coastal zone in New South Wales. Under the Coastal Management Act and Coastal Management SEPP the foreshores of the parks have been zoned as coastal environment areas, coastal wetlands and littoral rainforest. This zoning recognises the importance of managing and maintaining the natural environmental processes in the coastal zone and protecting coastal wetlands and littoral rainforests.

Under the Coastal Management Act and Coastal Management SEPP local councils are preparing Coastal Zone Management Plans to support sustainable development and integrate land-use planning, development and environmental protection responsibilities in the coastal zone. NPWS must comply with the provisions of the Coastal Management Act and Coastal Management SEPP where works are proposed in the parks' Coastal zone. NPWS also works closely with local councils to contribute to relevant Coastal Zone Management Plans and to manage water quality and minimise the impacts of surrounding land uses on the parks' values.

The *Sydney Regional Environmental Plan No. 20*, which covers the Hawkesbury and Nepean rivers, supports the aims of the Coastal Management SEPP. It emphasises the importance of protecting water quality and the scenic values of the river, foreshores and significant areas of vegetation and habitat values.

2.2 Native plants and animals

The parks are recognised nationally as an exceptional representation of Sydney region biota and a site of high species richness and diversity associated with Hawkesbury Sandstone landforms. More than 1,000 species of plant have been recorded in the parks representing a high species richness and diversity (Benson and Howell 1994). The parks are also important for having a diverse and complex range of vegetation communities and protecting many rare and threatened plants, animals and vegetation communities.

The parks protect 23 threatened plant species and 50 threatened animal species. Appendix D includes a full list of scientific names for species mentioned in this report, including threatened species.

Strategies for the conservation of threatened species, populations and ecological communities have been set out in the NSW Biodiversity Conservation Program (DPE 2019). Actions listed in each of these strategies are prioritised and implemented through the Saving our Species program, which aims to maximise the number of threatened species that are secured in the wild in New South Wales for 100 years. The national park and nature reserves contain priority management areas and sites for a number of threatened ecological communities, plant and animal species.

The NPWS threatened species (zero extinctions) framework (DPIE 2021) outlines a series of actions designed to secure and restore threatened species populations, specifically to prevent extinctions on the national park estate and to stabilise or improve the on-park trajectory of all threatened species. Actions that will be taken under the framework include identification of assets of intergenerational significance, acquisition of key threatened species habitat, the establishment of a network of feral predator-free areas and establishment of a world-class ecological health framework across national parks.

Many recovery plans for NSW threatened species have previously been prepared and may still provide useful information, but they no longer determine the actions required for the conservation of threatened species in New South Wales. Recovery strategies for threatened species are now prepared under the Biodiversity Conservation Program. The Australian Government prepares recovery plans for nationally listed threatened species under the *Environment Protection and Biodiversity Conservation Act 1999*. These plans do apply to nationally listed threatened species occurring in the parks (Table 2 and 3).

Vegetation communities

Ku-ring-gai Chase National Park is particularly important in conserving a large area of diverse and relatively undisturbed vegetation unique to the Sydney Basin Bioregion. It is also important for conserving vegetation types that are significant in a local and regional context. These tend to be of limited size and are associated with unusual or remnant geological and topographical features.

Surveys and mapping of plant communities in the national park have been undertaken, including a major survey by the Royal Botanic Gardens Sydney (Thomas and Benson 1985). Vegetation surveys have also been undertaken on Lion Island (Benson 1981), Spectacle Island (Webb 1981) and Long Island (Benson and Howell 1994). Lion Island, Long Island and Spectacle Island nature reserves support a similar range of vegetation types to the national park, but the diversity on the islands is more remarkable because of their small size. More recent work to update vegetation maps and descriptions across Metropolitan Sydney, including Ku-ring-gai Chase National Park, identified 33 vegetation communities in the park (OEH 2016a). A list of vegetation communities in the parks is provided in Appendix B.

The vegetation of the parks varies according to the soil type, topography, aspect and drainage. Dry heath vegetation is found on the shallow sandy soils that have formed on exposed rock outcrops of Hawkesbury Sandstone ridges, such as along the Lambert Peninsula. Typical species include banksia, dagger heath, scrub she-oak and dwarf apple.

Wet heathland and hanging swamps occur on the elevated sandstone plateaus in the national park predominantly on the Lambert Peninsula. These distinctive communities are found on damp or wet peaty soils where drainage is impeded at creek headwaters and in seepage zones. These communities are dominated by a mix of sedges, grasses and shrubs, generally with sedges occurring in the wettest areas. Common species found in these

communities include swamp banksia, pink swamp heath, prickly teatree, sedges such as sword grass and the insectivorous sundews. These swamplands are valuable for understanding changes to the environment over time as they contain palaeontological records that have been preserved for at least 6,000 years (Australian Heritage Database).

A low eucalypt woodland is found on the gentle upper slopes and protected ridgetops. This community is dominated by scribbly gums, red bloodwood and yellow bloodwood. Black she-oak and old man banksia are also present. The steeper and lower sandstone hill slopes support open forest dominated by smooth-barked apple and Sydney peppermint. Also occurring within this community are red bloodwood and Christmas bush.

On the Narrabeen shales, along the lower slopes of Western Pittwater and parts of Cowan Creek estuary, are taller open forests, which include stands of grey ironbark and forest oak. Cycads, turpentine, rough-barked apple, bangalay and grey gum are also found here. Small areas of warm temperate rainforest with water gum, coachwood, lilly pilly, Port Jackson fig and cabbage tree palms are found in the deeper protected gullies.

The mudflats at or near the tidal limit of Cowan Creek, Smiths Creek, Cockle Creek, Porto Bay and at the western end of Spectacle Island support river mangrove and grey mangrove, with swamp oak on the margins. Saltmarsh communities found at the head of Smiths Creek and Cockle Creek, in coastal lagoons near Great Mackerel Beach and Long Island and Spectacle Island nature reserves are an important part of coastal wetlands. Seagrasses are found in most of the shallow bays and tidal reaches of Cowan Creek estuary and are important estuarine habitat. Seagrasses also line the western shores of Pittwater.

Eight threatened ecological communities listed under the *Biodiversity Conservation Act 2016* have been recorded in the parks (Table 1 and Appendix C). Some of these communities are also listed as threatened under the Commonwealth Environment Protection and Biodiversity Conservation Act.

What is an ecological community?

An ecological community is a naturally occurring collection of native plants, animals and other organisms occupying a particular area. Ecological communities are threatened when they become at risk of extinction. Currently, more than 100 threatened ecological communities are recognised in New South Wales by their listing under the *Biodiversity Conservation Act 2016*.

Table 1 Threatened ecological communities in the national park and nature reserves

Threatened ecological community (vegetation formation)	Occurrence	BC Act status	EPBC Act status
Duffys Forest Ecological Community in the Sydney Basin Bioregion (dry sclerophyll forest)	On lateritic and shale derived soils on ridge tops in the Duffys Forest, Terrey Hills and St Ives area of the national park	EEC	
Pittwater and Wagstaffe Spotted Gum Forest in the Sydney Basin Bioregion (wet sclerophyll forests)	On Narrabeen shales on western edge of Pittwater from Morning Bay to Elvina Bay	EEC	
Coastal Upland Swamp in the Sydney Basin Bioregion (freshwater wetlands)	On damp and wet peaty soils on the elevated sandstone plateau of the Lambert Peninsula in the NP	EEC	E

Threatened ecological community (vegetation formation)	Occurrence	BC Act status	EPBC Act status
River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions (forested wetlands)	On Cowan Creek upstream of Bobbin Head and behind Great Mackerel Beach in the NP	EEC	
Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions (saline wetlands)	On the intertidal shores of estuaries and lagoons on the upper reaches of Cowan Creek, Smiths Creek, Apple Tree Creek and at Morning Bay and Great Mackerel Beach in the NP and on Long Island and Spectacle Island nature reserves	EEC	V
Swamp Oak Floodplain Forest in the Sydney Basin Bioregion (forested wetlands)	In the upper reaches of Cockle Creek, Smiths Creek, Jerusalem Bay and near Great Mackerel Beach, Akuna Bay and Green Point	EEC	E
Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions (rainforest)	On Barrenjoey Head	EEC	CE
Themeda Grasslands on Sea Cliffs and Headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions (grasslands)	On Barrenjoey Head in the NP and on Lion Island NR	EEC	

Notes: NP = national park; NR = nature reserve; BC Act = *Biodiversity Conservation Act 2016*; EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999*; EEC = endangered ecological community; CE = critically endangered; E = endangered; V = vulnerable.

Other rare and unusual vegetation communities in the parks include:

- diatreme vegetation communities at Campbells Crater and Smiths Crater, which include rough-barked apple, cabbage tree palms, blue stringybark and some remnant red cedars
- dyke vegetation communities at West Head, comprising species such as broad-leaved white mahogany, large-fruited red mahogany, cabbage tree palm, burrawang and grass trees
- low woodland of vulnerable Camfield's stringybark and scribbly gum association found near the start of the Elvina Trail on the Lambert Peninsula
- open forest on Wianamatta shale along Cockle Creek upstream of Gibberagong Waterholes containing uncommon species or species not found elsewhere in the park
- vegetation communities containing rainforest species along creek lines and the western edge of Pittwater.

Regionally rare or uncommon species found in the parks include drooping she-oak, broom spurge, *Angophora crassifolia*, *Blechnum ambiguum*, *Boronia fraseri*, native rose, soft boronia, Darwinia procera, brown stringybark, yellow top mallee ash, scaly bark, *Hibbertia nitida*, beard heath, tufted mat-rush, *Persoonia isophylla, Pimelea latifolia* ssp. hirsuta, Stephenson's platysace, *Commersonia hermanniifolia*, *Tetratheca neglecta* and *Xanthorrhoea macronema*.

More than 20 plant species found within the parks are listed as either endangered or vulnerable under the Biodiversity Conservation Act (see Table 2).

Under the Biodiversity Conservation Program priority management sites have been established in the parks, or are proposed, for several threatened plants. Priority management sites have also been identified for threatened ecological communities, including at Duffys Forest and Themeda grassland on sea cliffs and coastal headlands.

Populations of the critically endangered Caley's grevillea and endangered *Haloragodendron lucasii* have been declared assets of intergenerational significance under the National Parks and Wildlife Act. This declaration recognises the significant contribution of the national park in protecting these species. Conservation action plans outlining the management and monitoring requirements have been prepared for 6 sites declared in the national park consistent with the National Parks and Wildlife Regulation. In future, other assets of intergenerational significance may be declared in the parks.

Table 2 Threatened plants in the national park and nature reserves

Species	BC Act status	EPBC Act status
Ancistrachne maidenii	V	
Angus's onion orchid	E	E
Bauer's midge orchid	E	E
Bynoe's wattle	E	V
Caley's grevillea	E (AIS)	CE
Camfield's stringybark	V	V
Darwinia biflora	V	V
Darwinia peduncularis	V	
Deane's paperbark	V	V
Epacris purpurascens var. *purpurascens*	V	
Hairy geebung	E	E
Haloragodendron lucasii	E (AIS)	E
Kunzea rupestris	V	V
Lasiopetalum joyceae	V	V
Leafless tongue orchid	V	V
Micromyrtus blakelyi	V	V
Narrow-leaf finger fern	E	
Netted bottle brush	V	
Persoonia mollis subsp. *maxima*	E	E
Pimelea curviflora var. *curviflora*	V	V
Rhizanthella slateri	V	E
Scrub turpentine	CE	
Sunshine wattle	E	E
Tetratheca glandulosa	V	

Notes: AIS = asset of intergenerational significance; BC Act = *Biodiversity Conservation Act 2016*; EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999*; E = endangered; V = vulnerable.

Source: NSW BioNet, accessed 2022.

Native animals

More than 209 birds, 58 native mammals, 48 reptiles and 19 amphibians have been recorded in the parks. These records are derived from several small-scale animal surveys and site observations recorded in the BioNet Atlas (NSW BioNet 2020) by individuals and researchers working in the parks. Further systematic survey may identify additional species.

Fifty animals found in the national park and nature reserves are listed as threatened under the Biodiversity Conservation Act (see Table 3). These include threatened species such as the southern brown bandicoot (see Box 3), koala, tiger quoll, bent-wing bat, southern myotis, glossy black-cockatoo, powerful owl, masked owl, swift parrot, leatherback and loggerhead turtle, Rosenberg's goanna, giant burrowing frog and red-crowned toadlet.

Box 3: Southern brown bandicoot

The endangered southern brown bandicoot is a small marsupial mammal around 28 to 36 centimetres in size and weighing up to 1.5 kilograms. It has small, rounded ears, a conical snout, short and tapered tail, yellow-brown or dark grey coat with a cream-white underbelly. They are smaller and shyer than other bandicoot species, preferring to stay sheltered in the dense heath vegetation that is their main habitat.

The southern brown bandicoot has experienced severe range contractions and population declines since European settlement. In New South Wales the bandicoot now occurs in small patchy populations mainly in coastal areas between the Hawkesbury River and Victorian border. The population in Ku-ring-gai Chase and Garigal national parks is one of 2 main populations found in New South Wales. The other main population occurs in the far south-eastern corner of the State.

The major threats to southern brown bandicoots include predation by foxes and feral cats, habitat loss and habitat degradation from too-frequent fire, death and injury by fire and motor vehicle strike.

Priority actions to conserve this species are being implemented as part of the Saving our Species program. Under this program Ku-ring-gai Chase National Park is a significant part of a priority management site. Priority actions include feral animal control, fire management and improving knowledge of population distribution and abundance.

Photo 1 Southern brown bandicoot. Ricardo Simao/DPE

Endangered populations of gang-gang cockatoo (gang-gang cockatoo population in the Hornsby and Ku-ring-gai local government areas) and koala (koala population in the Pittwater Local Government Area) may also extend into the national park.

Other mammal species found in the national park include the eastern pygmy-possum, feather-tailed glider, New Holland mouse, swamp wallaby, brush-tailed possum, ring-tailed possum, sugar glider, short-beaked echidna, long-nosed bandicoot, platypus, grey-headed flying-fox, chocolate wattled bat and Gould's wattled bat. It is notable that swamp wallabies are found on Long Island and Spectacle Island nature reserves and within Ku-ring-gai Chase National Park.

Threatened and protected species managed under the Biodiversity Conservation Act not only occur on land but can also be observed in the marine environment that borders parts of the national park and island nature reserves. New Zealand and Australian fur seals are commonly seen in the waterways adjoining the parks and at the seal haul-out sites on the northern side of Barrenjoey Headland. Lion Island is home to the largest colony of little penguins in the Sydney region. Sea turtles are regularly seen in the tidal waterways, including green, loggerhead and leatherback turtles. Both humpback and southern right whales regularly swim into Pittwater and the Hawkesbury River during their winter migration.

The *NSW Marine estate management strategy 2018–2028* (NSW Marine Estate 2018) outlines how to protect and enhance our waterways, coastline and estuaries across New South Wales over a 10-year period. NPWS plays a key role overseeing the implementation of initiative 5 of the strategy. This initiative focuses on reducing impacts to threatened and protected marine species through education and compliance, strengthening partnerships for incident response (e.g. whale entanglement or stranding), and improving knowledge of threats, habitat and our marine species.

The national park and nature reserves are nationally significant in protecting an outstanding diversity of birds notably perching birds, including scrubwrens, honeyeaters, Australasian robins, fantails, drongos and monarchs (Australia Heritage Database).

Birds found in the national park and nature reserves range from small heathlands birds, including the New Holland honeyeater and eastern spinebill, to the large wedge-tailed eagle, brown falcon, nankeen kestrel, whistling kite, eastern osprey and white-bellied sea-eagle. The eastern rosella, crimson rosella, galah, sulphur-crested cockatoo, laughing kookaburra and brush turkey are found in the parks' woodlands. Rainbow lorikeet, Lewin's honeyeater, superb blue wren and rock warbler inhabit taller forest areas. Superb lyrebirds are a common sight in the national park. The parks support several birds listed under the Japan–Australia Migratory Bird Agreement, China–Australia Migratory Bird Agreement and Republic of Korea – Australia Migratory Bird Agreement.

Reptiles present in the national park include, among others, the eastern long-necked turtle, death adder, red-bellied black snake, diamond python, eastern brown snake, eastern tiger snake, eastern water dragon, eastern blue-tongued lizard, lace monitor and other smaller lizard species. In addition, around 100 butterflies and moth species, spiders and the rare freshwater small Sydney crayfish have been recorded in the park.

The population of koalas in the national park have been impacted by fire. Ongoing monitoring will improve knowledge of the koala population. NPWS also continues to implement relevant management actions as part of the statewide recovery strategy for koalas.

Table 3 Threatened animals recorded in the national park, nature reserves and adjacent waterways

Common name	BC Act status	EPBC Act status
Amphibians		
Giant burrowing frog	V	V
Red-crowned toadlet	V	
Reptiles		
Green turtle	V	V
Hawksbill turtle		V
Leatherback turtle	E	E
Loggerhead turtle	E	E
Rosenberg's goanna	V	
Birds		
Barking owl	V	
Black-chinned honeyeater (eastern subspecies)	V	
Blue petrel		V
Broad-billed sandpiper	V	C, J, K
Bush stone-curlew	E	
Crested tern		J
Dusky woodswallow	V	
Eastern osprey	V	
Fork-tailed swift		C, J, K
Gang-gang cockatoo	V	
Gang-gang cockatoo population in the Hornsby and Ku-ring-gai local government areas	EP	
Glossy black-cockatoo	V	
Grey-tailed tattler		C, J, K
Little eagle	V	
Little lorikeet	V	
Little tern	E	C, J, K
Masked owl	V	
Pied oystercatcher	E	
Powerful owl	V	
Regent honeyeater	CE	CE
Short-tailed shearwater		C, J, K
Sooty oystercatcher	V	
Sooty shearwater		J
Sooty tern	V	
Southern giant petrel	E	E
Square-tailed kite	V	
Swift parrot	E	CE

Common name	BC Act status	EPBC Act status
Turquoise parrot	V	
Wedge-tailed shearwater		J
White-bellied sea-eagle	V	C
White-throated needletail		V, C, J, K
Mammals		
Australian fur seal	V	
Eastern pygmy-possum	V	
Grey-headed flying-fox	V	V
Humpback whale	V	V
Koala	V	E
Koala in the Pittwater Local Government Area	EP	E
Large bent-winged bat	V	
Little bent-winged bat	V	
New Zealand fur seal	V	
Southern brown bandicoot (eastern)	E	E
Southern myotis	V	
Southern right whale	E	E
Spotted-tailed quoll	V	E

Notes: BC Act = *Biodiversity Conservation Act 2016*; EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999*; CE = critically endangered; E = endangered; EP = endangered population, V = vulnerable; C = international migratory bird agreement with China; J = international migratory bird agreement with Japan; K = international migratory bird agreement with Korea.

Source: NSW BioNet, accessed 2020.

Management considerations and opportunities

Risks to native plants and animals in the parks include feral animals, weeds, fire, run-off from urban and industrial areas, unauthorised use and unmanaged recreational activities, and loss of connectivity with surrounding parks, bushland and waterways. Other significant risks include climate change leading to inundation of foreshore areas, increased erosion, changes in vegetation structure or loss of habitat.

Key threatening processes

Key threatening processes could adversely affect the survival or evolutionary development of species, populations or ecological communities. They are listed under the Biodiversity Conservation Act and include feral animals, weeds and other invasive species, fire, diseases, or processes and activities that cause habitat loss or change.

Thirty-five of the 39 threatening processes listed in New South Wales have been identified as existing or potential threats to the natural values of the national park and island nature reserves (Appendix E). The Biodiversity Conservation Program includes a range of priorities and strategies to reduce the impact of these processes on natural values. These include actions to prevent, contain, improve knowledge of the threat, implement strategic programs across multiple sites and/or develop management tools.

Fire, feral animals, weeds and climate change are the main key threatening processes requiring management in the national park and nature reserves. Emerging threats, including new feral animals, weeds or pathogens – such as Phytophthora, exotic rust fungi that

particularly effects plants from the Myrtaceae family, and amphibian chytrid fungus – are monitored and control actions undertaken as required. Control actions for Phytophthora, exotic rust fungi and amphibian chytrid fungus will be guided by the hygiene guidelines developed as part of the Saving our Species program (DPIE 2020).

Box 4: Climate Change

Human-induced climate change is listed as a key threatening process under the Biodiversity Conservation Act. Habitat loss caused by human-induced greenhouse gas emissions is listed under the Environment Protection and Biodiversity Conservation Act. The following is a snapshot of the predicted changes to climate for Metropolitan Sydney (Adapt NSW n.d.):

Projected changes 2020–2039 (near future)

- Maximum temperatures are projected to increase by 0.3–1.0°C.
- Minimum temperatures are projected to increase by 0.4–0.8°C.
- The number of hot days (i.e. >35°C) will increase.
- Rainfall is projected to decrease in spring and winter but increase in autumn.
- Severe fire weather days is projected to increase in spring.

Projected changes 2060–2079 (far future)

- Maximum temperatures are projected to increase by 1.6–2.5°C.
- Minimum temperatures are projected to increase by 1.4–2.5°C.
- The number of cold nights (i.e. <2°C) will decrease.
- Rainfall is projected to increase in autumn.
- Severe fire weather days are projected to increase in summer and spring.

The projected increases in temperature, number of hot days and severe fire weather days are likely to influence bushfire frequency and intensity across the Metropolitan Sydney region. This will result in an earlier start to the bushfire season and increase the risk of more frequent and intense fires in the park.

Higher rainfall in summer and autumn is likely to accelerate all forms of soil erosion across the region and increase run-off at these times of year. This in turn is likely to impact the stormwater system, increasing the incidence of poor water quality in park waterways and flooding of low-lying areas of the park such as Bobbin Head and foreshore communities on Pittwater (DECCW 2010b). Increased erosion may also increase the risk of rock falls and landslips in the parks.

The coastal areas of the national park and nature reserves are at risk of increased inundation and erosion from sea level rise. This includes increasing impact from storm surge, saltwater intrusion, changes in flooding regimes for intermittently closed and open lakes and lagoons, receding shorelines and consequent changes in vegetation communities in coastal wetland areas.

Climate change may change the size of populations, distribution of species, alter their geographical extent and species composition within some ecological vegetation communities. Species most at risk are those who are unable to migrate or adapt, particularly species that have small population sizes, home ranges or slow growth rates.

From a biodiversity perspective, one of the most important ways to manage impacts of climate change in the parks is to identify species or populations that may be at particular risk from a changing climate, then develop and implement strategies to reduce those risks.

Connectivity

The relatively large size of Ku-ring-gai Chase National Park and its geographical and biological connection with surrounding natural areas plays an invaluable role in maintaining genetic, species and ecosystem diversity. It also promotes resilient vegetation communities, maintains healthy plant and animal habitat, and allows the movement of native animals across the landscape. With climate change projected to affect the distribution of plant populations and the availability of fauna habitats, the intactness and connectivity of this network of parks and surrounding native vegetation will be increasingly important.

Habitat conservation and connectivity is important to prevent loss and decline in animal species. The national park forms part of an extensive area of native vegetation, but the Pacific Motorway, Pacific Highway, railway and major roads, such as Mona Vale Road, are significant barriers to the movement of animals.

Land bridges, overpasses, underpasses and adaptation of existing structures to make them more attractive to wildlife can help minimise the impact of these barriers. Land bridges being built over Mona Vale Road will connect Ku-ring-gai Chase National Park and Garigal National Park and allow for greater and safer movement of animals.

Increasing urban development also limits connectivity. The impacts of urban development may be reduced by working with local communities, councils and other land managers to support maintenance of green corridors and protect biodiversity on surrounding lands. Additions to the national park that improve connectivity with other high conservation value lands will support conservation of the parks' natural values.

Significant intertidal areas and marine or aquatic habitat occur in the Cowan Creek estuary and adjacent to the parks in the Pittwater, Hawkesbury River and Barrenjoey Head Aquatic Reserve. Maintaining the connection between the terrestrial (land) and aquatic habitat including seagrass habitat and mangroves within and adjacent to the parks is important for many species including migratory shorebirds, juvenile fish and crustaceans. It is important that species using the intertidal area can move freely between land and water, to access food, shelter and breeding habitat. Physical barriers, and damage or changes to aquatic vegetation or habitat can lead to a loss of connectivity and in some cases a decline in the presence of some species.

Disturbance caused by recreational use

Growing visitor numbers requires active management to minimise impacts and well-designed facilities that provide opportunities for visitors to participate in recreational activities while maintaining park values.

Unauthorised camping on beaches and foreshores has increased the risk of fires in remote locations in the national park. Bushfires caused by escaped campfires in remote locations are more difficult to control because they are hard to detect early and to access.

Wading and swimming in freshwater creeks in the national park is popular. Intensive recreational use of freshwater creeks can lead to trampling of vegetation and damage to creek banks. It can also lead to visitor injuries (e.g. from slipping on wet rocks). Subject to environmental assessment, more formal water access points provided at popular swimming spots along walking tracks will help to prevent damage to vegetation and creek banks.

The creation and use of unauthorised tracks has damaged vegetation, creek lines and native animal habitat in some parts of the park. For example, unauthorised tracks within the Duffys Forest endangered ecological community risk fragmenting this vegetation community and damaging habitat of the critically endangered Caley's grevillea. NPWS continues to work with the community to close and rehabilitate unauthorised tracks to help protect threatened species and vegetation communities, waterways, native plants and animals or heritage.

The provision of public (courtesy) moorings helps to reduce the risk of damage from boats anchoring in vulnerable seagrass communities. The education of boat users about minimising potential impacts to the marine environment, including appropriate approach distances for marine mammals, also plays an important role in protecting marine species and habitats.

Weeds and feral animals

The *Biosecurity Act 2015* and its Regulation provide specific legal requirements for the response, management and control of biosecurity risks, including weeds and feral animals. These requirements apply equally to public lands and private lands. Under this framework, Local Land Services (LLS) has prepared a regional strategic weed management plan (LLS 2019) and a strategic feral animal management plan (LLS 2018) for the LLS Greater Sydney region. These plans identify priority weeds and feral animals in each of the regions, and the appropriate management response for the region (i.e. prevention/alert, eradication, containment or asset protection).

The NPWS Branch pest management strategy identifies feral animals and weeds commonly found in the region and priority pest and weed control activities in the parks. The overriding objective of the pest management strategy is to minimise adverse impacts of introduced species on biodiversity and other park and community values, while complying with legislative responsibilities. The strategy also identifies where other site-specific or pest-specific plans or strategies need to be developed to provide a more detailed approach. Reactive programs may also be undertaken in cooperation with neighbouring land managers in response to emerging threats.

The NPWS Branch pest management strategy prioritises feral animal and weed species that require intervention, including species that:

- are listed in the LLS strategic pest and weed plans, including weeds of national significance, new and emerging weeds and pests
- are priorities identified in the Biodiversity Conservation Program for threatened species and communities
- pose a risk to uncommon or rare native species
- threaten the natural, and cultural heritage values of an area
- have a high potential for invading native vegetation communities
- are in riparian zones
- are part of existing control programs, including cooperative programs with neighbouring land managers.

Weed and feral animal management programs detailed in the Branch pest management strategy are implemented as part of annual operational plans. Annual weed and feral animal management actions and activities are captured and reported through the pest and weeds information system to support monitoring, evaluation and adaptive management.

More than 200 weed species have been recorded in the national park (Thomas and Benson 1985) and nature reserves. Weeds are found along watercourses, in areas adjacent to urban development (including foreshore communities), in areas of past occupation and in some areas of high public use. Probable sources of weed populations in the park include run-off from neighbouring properties and roads, weeds spreading from neighbouring bushland or gardens, and dumping of garden refuse.

Known weed infestations include Hungry Beach, Flint and Steel, around the Western Pittwater foreshore communities, the old boatshed site north of Apple Tree Bay, Barrenjoey Head, West Head Lookout and the McCarrs Creek area. Lion Island and Spectacle Island nature reserves also have known weed infestations.

Priority weed species listed as threatening processes under the Biodiversity Conservation Act and detected in the parks include bitou bush, boneseed, lantana, exotic vines and scramblers, exotic perennial grasses, escaped garden plants and introduced aquatic species. Appendix F provides a list of priority weeds from the NPWS Greater Sydney Branch pest and weed strategy and LLS *Greater Sydney regional strategic weed management plan* (LLS 2019).

Other weeds occurring in more isolated areas of the national park and nature reserves include asparagus fern on Barrenjoey Head; coral trees, camphor laurels and mother-of-millions on the Lambert Peninsula beaches; giant reed and cats claw creeper at Gibberagong Waterholes; and honeysuckle at Bobbin Head.

Native species like the Gymea lily and golden wreath wattle are not indigenous to the area and are considered to be weeds. Gymea lily is not spreading and is less of a concern, however, control is needed to prevent the spread of golden wreath wattle.

Box 5: Research and monitoring

The diversity of species and habitats combined with monitoring data collected over many years and the parks' proximity to large universities makes them an important scientific and educational resource.

Research delivered by universities and other research institutes is ongoing and continues to grow. The outcomes of research and monitoring provide valuable information to improve NPWS's understanding of the parks' values and response to management, including trialling new management techniques. NPWS continues to support research, particularly research that is aligned to NPWS research priorities and has direct benefits for park management.

NPWS also conducts research and monitoring in the parks to refine or assess management effectiveness. This varies from monitoring threatened species to understanding visitor use and opinions.

Domestic and feral cats, dogs, foxes, black rats, house mice, European honeybees and rabbits have all been recorded in the national park.

Feral cats and foxes are considered the most serious threat to native animals, including the endangered southern brown bandicoot. The diet of foxes in Ku-ring-gai Chase National Park and Garigal National Park has been found to consist of 64% mammals, 14% plant matter, 13% birds and 3% garbage waste (Kennedy 1995). The most common prey species recorded were swamp wallabies, followed by rabbits, brush-tailed possums, long-nosed bandicoots and ring-tail possums.

Foxes mainly travel along roads, fire trails and walking tracks in Ku-ring-gai Chase National Park. As a result, the fox control program implemented under the recovery strategy for the southern brown bandicoot focuses effort on these trails. Widening of tracks and creation of new trails, including unauthorised tracks, increases opportunities for foxes. The fox control program is designed to protect all native species targeted by foxes and is implemented in cooperation with surrounding land managers.

Rabbit control programs in the park and adjoining lands can increase fox predation on native animals (prey switching). Alternatively, fox control programs may encourage growth in rabbit numbers on neighbouring lands. NPWS coordinates with surrounding land managers to ensure rabbit and fox control programs are effective.

The large number of residential properties bordering the national park increases the risk of domestic and stray cats and dogs adversely impacting native wildlife. Predation of native wildlife by feral cats is identified as a key threatening process in the parks.

Remote cameras set-up to monitor foxes and endangered southern brown bandicoot also record the presence of feral cats and help to identify where feral predator control activities may be needed. Education and trapping programs run by local councils also helps to reduce the risk posed by domestic, feral and stray cats and dogs in the park.

Fire

Inappropriate fire regimes is one of the main threats to vegetation communities and native plants and animal species in the parks including threatened species and ecological communities. Fire management activities like controlled burning, hazard reduction burning and fire suppression are one of the most important tools for maintaining and protecting the parks' vegetation communities and animal habitats.

Under the *Rural Fires Act 1997* NPWS also has an obligation to act to prevent bushfires in the parks, stop any bushfires spreading outside the parks and to work cooperatively with other fire agencies.

NPWS manages fire to protect life, property, community assets, cultural heritage and biodiversity from the adverse impacts of fire. This needs to be balanced against managing fire regimes to maintain and enhance the parks' biodiversity. Strategies to achieve this are described in the park fire management strategy and included in bushfire risk management plans.

Ongoing research examining the response of plant and animal communities to fires over time is used to inform and refine the parks' fire management strategy and bushfire risk planning. High frequency fire is listed as a key threatening process for threatened Caley's grevillea, southern brown bandicoot, Duffy's Forest and Pittwater Spotted Gum Forest ecological communities.

Fire management strategies are implemented cooperatively and in coordination with other fire authorities, neighbours and the community. Cross-tenure fire management priorities are described in the relevant district bushfire risk management plans prepared by the bush fire management committees under the Rural Fires Act. Ku-ring-gai Chase National Park and Long Island Nature Reserve are in the Northern Beaches and Hornsby/Ku-ring-gai Rural Fire Districts. Lion Island and Spectacle Island nature reserves are in the Central Coast Rural Fire District. NPWS is a member of these bush fire management committees.

Fire trails are maintained and upgraded by NPWS in accordance with prescribed standards and consistent with fire access and fire trail plans prepared by the relevant Rural Fire Service bush fire management committees.

Box 6: Fire history

Aboriginal people used fire as a tool for hunting and for managing food resources. It is believed that Aboriginal people burnt sections of the ridges within the Sydney area frequently (about every 1–5 years), while the hill slopes and valleys were less frequently burnt (Conroy 1996).

Ku-ring-gai Chase National Park

Available records show that over the last 50 years most of Ku-ring-gai Chase National Park has been subject to a fire frequency of 10–15 years, particularly on ridges and upper slopes.

Over the past 10 years most fires in the park have been planned hazard reduction burns. Over the same period of time there have been on average 1–2 wildfires in the national park each year. The last large wildfire was in January 1994 when 7,110 hectares or almost half the park was burnt. After the 1994 fires it was estimated that only about 1% of the park contained vegetation which was older than 21 years (Conroy 1996).

Lion Island, Long Island and Spectacle Island nature reserves

Before August 2018, most of Lion Island had been unaffected by fire for more than 30 years. In August 2018, a lightning strike started a bushfire on Lion Island, which burnt most of the island and severely damaged the habitat of the island's little penguin population. Artificial fireproof nesting burrows were installed on the island to provide little penguin habitat while the vegetation communities recovered. Spectacle Island Nature Reserve has not been affected by bushfires for 30 years. Records show 2 fires have occurred on Long Island in the past 30 years.

Photo 2 Hazard reduction burning. David Croft/DPE

3. Looking after our culture and heritage

Australia has one of the oldest records of human existence on the planet, with records dating back more than 60,000 years. Many places today have particular significance to Aboriginal people. Other places hold significant history to both Aboriginal and non-Aboriginal people, and very often, this history is a shared one.

Both Aboriginal and non-Aboriginal people place values on cultural and natural landscapes. These values may be attached to the whole landscape, or to parts of the landscape (e.g. a particular plant, animal or place). All landscapes contain the imprint of human use. On any given area of land some historical activity will have taken place. Much of the Australian environment has been influenced by past Aboriginal and non-Aboriginal land-use practices, and people continue to influence the land through recreational use, cultural practices and the presence of introduced plants and animals.

History since European settlement is represented through our historic heritage, which includes places and items that may have historic, scientific, cultural, social, archaeological, architectural, landscape or aesthetic significance.

3.1 Aboriginal culture and heritage

Aboriginal communities have an association with and connection to the land. Aboriginal communities associate natural resources with the use and enjoyment of foods and medicines, caring for the land, passing on cultural knowledge, kinship systems and strengthening social bonds. Aboriginal heritage and connection to nature are inseparable from each other and need to be managed in an integrated manner across the landscape.

What is 'Country'?

To Aboriginal people, the landscape is made up of many features that are interrelated. These include land, water, plants and animals, places and stories, historical and current uses, and people and their interactions with each other and place. These features are central to Aboriginal spirituality and contribute to Aboriginal identity. They are inseparable and make up what is known as 'Country'.

Aboriginal sites are places with evidence of Aboriginal occupation or places that are related to other aspects of Aboriginal culture. They are important as evidence of Aboriginal history and as part of the culture of local Aboriginal people. Country is a place of birth, a place of tribal or clan connections, a place where you belong to.

Connection to Country

The parks are part of an ancient landscape that includes Aboriginal people. Aboriginal people have a deep spiritual and cultural connection to this Country. Their ancestors have lived here for thousands of years and form part of the living landscape.

The arrival of the First Fleet in 1788 had devastating consequences for Aboriginal people in the Hawkesbury and Broken Bay area. By 1790, just 2 years after the arrival of the First Fleet, over half the Aboriginal population in the area is believed to have been killed by smallpox. Many Aboriginal people had moved away from Pittwater by the 1840s as traditional lands were taken and occupied by Europeans. Despite this, Aboriginal people continued to visit and live in the area and have maintained their connection to Country, traditional knowledge and obligations to care for Country.

The national park and nature reserves have deep spiritual significance for Aboriginal people, and they are important for the continuation of cultural practices and traditions. Aboriginal people continue to visit the national park and nature reserves to connect and care for Country, pass on knowledge, maintain sites and share culture among their communities and the wider public.

Other less visible Aboriginal connections to the national park and nature reserves include traditional knowledge of the landscapes, waterways, sites, plants and animals and traditional land management practices. This knowledge and spiritual connections are embodied in personal and community stories, memories and oral traditions.

Aboriginal sites

More than 800 Aboriginal sites have been recorded across the national park and island nature reserves and are listed in the Aboriginal Heritage Information Management System. These Aboriginal sites are significant to Aboriginal people as a tangible link to their culture and ancestors, and for the education of their children.

The park contains one of the largest collections of Aboriginal art in the Sydney region. More than 170 rock engraving sites have been recorded in the national park and nature reserves. The engravings depict emus, echidna, fish, kangaroos, boomerangs, shields, footprints, people and ancestral spiritual figures. These sites also contain and convey important cultural information.

Shell middens are the most common type of site recorded in the park and are mainly found along the foreshores. These middens are evidence of the rich resources of the coastal area and their importance to Aboriginal people. Other sites include rock shelters, art sites including hand stencils, grinding grooves, stone arrangements, burials and occupation sites. The variety and extent of sites are evidence of a thriving culture in the Greater Sydney coastal zone thousands of years before the arrival of Europeans.

Management considerations and opportunities

The community is continuing discussions on identifying traditional and custodial connections to lands including these parks. The role of Aboriginal people in undertaking and leading these processes is recognised and respected. When the outcomes of these processes are known NPWS will ensure that the traditional custodial families are appropriately acknowledged.

Although the NSW Government has legal responsibility for the protection of Aboriginal sites and places, Aboriginal people's spiritual and cultural connection to the parks is respected. There is recognition of the importance of incorporating local Aboriginal knowledge into the ongoing management of the park and reserves.

Aboriginal people will continue to make decisions about their own heritage with support as appropriate from NPWS. NPWS will work with and involve Aboriginal communities in the management of Aboriginal sites, places and related issues, and in the promotion and presentation of Aboriginal culture and history.

Knowledge of sites and the transfer of this knowledge to younger generations is an important way for the Aboriginal community to maintain connection to Country and fulfil their obligations to care for Country. Aboriginal sites are also important to encourage broader community understanding and appreciation of Aboriginal culture.

Access to Country is important for Aboriginal people to maintain, renew and develop cultural connections and practices, including access for non-commercial cultural use of resources. The Aboriginal community are also keen to share in the economic benefits derived from their Country through taking up business and employment opportunities.

Ku-ring-gai Chase National Park and Long Island Nature Reserve fall within the Metropolitan Local Aboriginal Land Council area. Lion Island Nature Reserve and Spectacle Island Nature Reserve are within the Darkinjung Local Aboriginal Land Council area. NPWS works closely with these land councils to manage and conserve Aboriginal sites in the national park and nature reserves. Protection of these sites is also prioritised in the NPWS Branch pest and weed management strategy and park fire management strategy.

Opportunities exist to engage with the land councils and the broader Aboriginal community that have interests in the national park and nature reserves to develop a range of mechanisms to support Aboriginal community involvement in management of the parks. Supporting on-Country visits, incorporating traditional knowledge and practices in management programs, including integrating cultural burning into the parks where appropriate, supporting Aboriginal tourism and other businesses, and working on Country are some of the opportunities.

Some Aboriginal sites have been damaged through vandalism and graffiti. Ongoing monitoring of sites is being undertaken by NPWS and local Aboriginal land councils.

There has been no systematic archaeological survey of the national park and nature reserves. It is likely there are sites that have not yet been recorded. Recorded and unrecorded Aboriginal sites are protected under legislation. This legislation requires NPWS to exercise due diligence in ensuring that management activities and other works do not damage sites and artefacts. The *Due diligence code of practice for the protection of Aboriginal objects in New South Wales* (DECCW 2010a) guides individuals and organisations considering undertaking activities that could harm Aboriginal objects.

Recording and maintaining up-to-date records of site locations assists with monitoring and helps ensure sites are not damaged during management operations. The location of recorded sites is confirmed and updated on an opportunistic basis when management activities are planned. However, a more systematic program for updating existing records in cooperation with the Aboriginal community may help to improve knowledge of sites and culturally appropriate site management practices. This will be particularly important for sites close to the foreshores at risk of inundation from sea level rise.

Many park visitors are interested in learning about Aboriginal culture. Opportunities exist to work with the Aboriginal community to develop programs that promote greater understanding of Aboriginal culture and ensure that this information is developed and shared in a culturally appropriate way.

Only a small number of Aboriginal sites in the national park and reserves are promoted for public viewing. This includes Aboriginal sites near the Gibberagong Track, Elvina Trail, the Basin Trail and Resolute Track and at Red Hands Cave near the Resolute Picnic Area.

Protective structures have been built at some sites, including The Basin engravings and Red Hands Cave. Other sites receive regular visitation because they are located close to roads or walking tracks. Monitoring these sites and their protective structures is required to prevent damage, especially where vandalism and graffiti is a problem. NPWS works with the Aboriginal community in monitoring sites and in deciding where new protective measures may be needed.

3.2 Historic heritage

Heritage places and landscapes are made up of living stories as well as connections to the past which can include natural resources, objects, customs and traditions that individuals and communities have inherited and wish to conserve for current and future generations, and can include natural resources, objects, customs and traditions.

Social history

Established in 1894, Ku-ring-gai Chase National Park is the second oldest national park in New South Wales. The national park and nature reserves retain important sites and historical associations with colonial expansion and the social history of the Broken Bay, Pittwater and lower Hawkesbury River area.

In the early days of the colony, the Broken Bay, Pittwater and lower Hawkesbury River area were important for transport and trade along the Hawkesbury River. This included transporting resources to support early extractive industries such as timber-getting, soda ash, shell lime and salt production. The area was also well known for smuggling activities. Coasters Retreat got its name from this period when it provided a refuge for coastal traders and their vessels resting and sheltering from storms.

From 1834 onwards, several land grants were made, and small villages were established along the foreshores of Pittwater, Cowan Water and the lower Hawkesbury River.

As development of Pittwater and the Hawkesbury River area expanded, coastal navigation and regulation of trade became a focus, with navigation lights and a Customs House built on Barrenjoey Head. The navigation lights were later replaced with Stewart Towers and then the Barrenjoey Lighthouse in 1881. The lighthouse still operates today, guiding boats and ships along the NSW coast and around the heads of Broken Bay.

The area became a popular destination for recreation. Cottages, boatsheds and fishing shacks sprang up along the foreshores and islands. With few roads established in the area, boats remained the main means of transport and access. Although the area was later connected by road and rail, boating stayed an important means of access and transport and plays an integral part of the lifestyle and history of the Pittwater, Broken Bay and lower Hawkesbury River communities today.

The establishment of Ku-ring-gai Chase in 1894 and the management of the Chase by the Trust began an era of expanding recreational use and recognition of the significant natural and cultural values of the area. Several walking tracks and lookouts were established by the Trust as well as the development of access roads to Bobbin Head and later, land reclamation to establish the picnic areas. The more recent historical significance of the area has been defined by development of road access, increasing recreational use, depression-era building projects (roads, tracks and visitor facilities), military uses and the evolving approach to conservation management.

Early land grants

Most of the land that is now part of the national park and nature reserves remained undeveloped due to its rugged and steep terrain and low agricultural value, however, small areas on the foreshore and headlands were developed.

William Lawson, the Blue Mountains explorer, was granted 260 hectares at West Head on the Lambert Peninsula in 1834. Over the following years, further land grants were made at The Basin, Little Mackerel and Great Mackerel Beaches and Soldiers Point. In 1882 Beechwood Cottage was built as a holiday cottage at The Basin by Frederick Jackson, who also allowed the public to camp and picnic at The Basin. In 1885 James Terrey was granted land at Cottage Point. By the 1880s there were also several boatsheds along Cowan Creek, including a boatshed at Bobbin Head and Windybank's boatshed at Waratah Bay. None of these original boatsheds remain.

The land at The Basin, West Head and part of the original land grant at Cottage Point eventually became part of the national park.

Barrenjoey Lighthouse complex and coastal navigation

Boats were the main means of transport and trade in the Broken Bay and Hawkesbury area in the early days of the colony. The treacherous journey between Sydney and the Hawkesbury was made easier by the navigation light built on Barrenjoey Head in 1855. The navigation light was eventually replaced by the Stewart Towers in 1868 and then by the present lighthouse in 1881. The lighthouse was automated in 1932 and continues to operate. The location of the Stewart Towers is marked by a memorial cairn that was erected in honour of local historian PW Gledhill.

The historic heritage buildings at the Barrenjoey Lighthouse complex are the oldest remaining structures in Pittwater associated with coastal shipping in Broken Bay, the Hawkesbury River and along the coast. They are a significant intact example of a late Victorian lighthouse designed by James Barnet, the NSW Colonial Architect in the period 1862 to 1890.

The customs station was erected at the base of Barrenjoey Head in 1843 to monitor trade, smuggling and other illegal activities in Broken Bay and along the coast. Customs operations continued in this area until 1904. Photos and documented heritage are all that remain of the Customs House building and operation. The large cottage at the base of Barrenjoey Head, known as Boatman's Cottage, was constructed in the 1920s and has been retained as staff accommodation. The red boatshed and other fishermen's cottages were built much later.

The lighthouse and associated historic heritage buildings and surrounding landscape were listed on the State Heritage Register (No. 00979 Heritage NSW, accessed 2023) in 1999. The site of the Customs House, Boatman's Cottage and fishermen's cottages are included in the boundary of the registered heritage site. A conservation management plan for the site was prepared in 2012 (OEH 2012a).

The historic Barrenjoey Head Lighthouse buildings continue to be restored and are being considered for adaptive reuse for community uses, including visitor tours consistent with the conservation management plan, and subject to heritage assessment and community consultation.

Establishing Ku-ring-gai Chase

By the early 1890s, a number of people were becoming concerned about the increasing development and degradation of the area. Eccleston Du Faur, a resident of Turramurra, convinced the government that a park was necessary 'to prevent the reckless destruction of native flowers' and because of the 'rapidly increasing neighbourhood' (letter from Du Faur to Henry Copeland 1892). As a result of Du Faur's efforts, 13,500 hectares, including most of the current national park, were dedicated as Ku-ring-gai Chase in 1894 and placed under the care of trustees.

At the time of dedication, several regulations were passed to protect the native plants, animals and cultural heritage (*Government Gazette* No. 843 14 December 1894). The Trust placed a priority on nature conservation and did not permit logging and other extractive industries in the park, unlike the trustees of The National Park (now Royal National Park) south of Sydney. They also actively promoted the park to visitors as a means of raising revenue for park management.

In 1895 a wharf was constructed at Lovett Bay, and a walking track was built up the hill to Flagstaff (or Perrys) Lookout, which became one of the most popular early picnic spots on Pittwater. In 1901 Du Faur contributed some of his own money to the construction of a road from North Turramurra to Bobbin Head. In 1903 another road was built from Mount Colah railway station to join the Bobbin Head Road via a causeway, creating a circular drive through this section of the national park. Part of the Bobbin Head management trail follows the alignment of the first road constructed by Du Faur, and the Birrawanna Track follows part

of the old carriage track from Mount Colah to Apple Tree Flat. Seawalls were also constructed at this time as part of a major reclamation project.

In 1915 the Trust purchased The Basin on Pittwater, which was then the most popular recreation area adjoining the park. They repaired Beechwood Cottage and built a jetty, boatshed, swimming enclosure and dressing sheds for visitors (Lunnon 1987).

Between 1924 and 1926 Private William T Shirley, an ex-serviceman and tuberculosis patient at the nearby Lady Davidson Home in Turramurra, carved a small 1.5-metre sandstone replica of the Great Sphinx in Egypt. The monument is flanked by 2 small pyramids and inscribed 'Lest We Forget' in memory of his Australian Imperial Force comrades during the First World War. The area around the Sphinx was restored in 1995.

Most of the facilities at Bobbin Head were constructed during the 1930s, including additional seawalls, most of the shelter sheds, the sandstone toilets and bus shelter, parts of the current boatshed and the road to Apple Tree Bay. This construction was funded mainly from government unemployment relief grants. The Bobbin Inn and a road to Illawong Bay were also constructed at this time, as was the landscaping of Orchard Park (named after the president of the Trust at that time), planting of Norfolk Island pines at The Basin and the construction of the brick monuments near the bridge at Bobbin Head. In 1940 a stone ambulance room/rangers office was constructed near the bus shelter on the eastern side of the Bobbin Head bridge. This building has been used for a range of purposes, including as a temporary kiosk and a base for Coast Alive Discovery program activities.

During the 1950s, further building work was undertaken at Bobbin Head, including the construction of a workshop, additional picnic shelters and a kiosk. At this time, the old coach house was converted to garages, a concrete bridge was provided across the creek, and Bobbin Inn was extended and modified. A koala sanctuary was developed on the ridge above Bobbin Head (now Kalkari). Facilities were also constructed at Illawong Bay and Akuna Bay, however, today only the seawalls remain.

Over the years there have been many changes to the developed areas of the national park, with new facilities being constructed while others were modified or removed. Similarly, the landscaped areas at Bobbin Head have changed from a bush setting in the early 1900s, to a formal landscape in the 1930s, then back to a more informal and native landscape in the 1950s through to the present day.

One of the few consistent landscape features throughout the park has been the planting of Norfolk Island pines in the main visitor areas. In 1994 major works were undertaken at Bobbin Head for the centenary of Ku-ring-gai Chase National Park. This included restoration of the remaining picnic shelters, conversion of the old sandstone garages to a picnic shelter, removal of the old boat ramp and some trees overshadowing the picnic pavilion, and other landscaping works. More recent work includes upgrading the playground, installation of new picnic shelters and alteration of heritage picnic shelters for current visitor use.

In 1967, following 73 years of Trust management, the park was gazetted as a national park under the management of the newly formed NPWS. NPWS took over the recently completed park office and visitors centre on the hill above Bobbin Head, converted the koala sanctuary built in the 1950s to a visitor information centre (Kalkari) and removed the prefabricated holiday cottages built at The Basin in the 1950s and early 1960s.

Brooklyn Dam

Brooklyn Dam was added to Ku-ring-gai Chase National Park in 1989. The Dam was built in 1884 to provide water for steam trains using the railway line between Sydney and the Hawkesbury River. The dam was enlarged 6 times between 1884 and 1924 as use of the line increased. The dam is maintained for its heritage value and part of the aging

dam wall has been removed to limit the capacity of the dam and prevent collapse of the remaining wall.

Military occupation

West Head was occupied for military purposes in 1941. A military battery was constructed on the headland during the Second World War and included gun emplacements, an observation post, searchlight stations, a trolley way, huts and other structures (Gojak 1993). The gun emplacements and trolley way are still visible today and information about the battery is provided in signage.

In September 1942 during the second world war a special camp was established at Refuge Bay near West Head for members of the Navy Z Force who spent three months here training for a secret mission, code named Jaywick, to attack Japanese forces in Singapore Harbour.

After the Second World War a National Fitness Camp was established using the military buildings near the point, while other areas previously occupied by the military were added to Ku-ring-gai Chase. Throughout the 1950s and 1960s military exercises continued to be conducted on the peninsula under the land transfer agreement. In 1964 the land was added to Ku-ring-gai Chase after the fitness camp closed and the Trust developed the West Head Lookout.

Historic heritage in the island nature reserves

Eighteen fishing shacks were built on Spectacle Island, and a dam of about 5 metres in diameter constructed out of sandstone blocks. The foundations of some of the fishing shacks can still be seen. There are no known historic sites on Lion Island Nature Reserve or within Long Island Nature Reserve. Historic heritage sites associated with the railway on Long Island are outside the nature reserve.

Built historic heritage

Historic heritage buildings in Ku-ring-gai Chase National Park can be found at Bobbin Head, Barrenjoey Head, West Head and The Basin. The most significant of these is the Barrenjoey Head Lighthouse complex, which is listed on the State Heritage Register and discussed earlier in this section.

The buildings at Bobbin Head date from the 1930s and represent the early establishment of visitor facilities in the park. The Bobbin Head Marina was originally the site of the famous Halvorsen boat building family's boat hire business.

The army track and battery at the base of West Head are associated with the defence of Sydney during the Second World War.

Beechwood Cottage at The Basin was built in 1882 when coastal traders and smugglers lived and worked in the area. The cottage has been restored and is available as a function centre.

Cottages built during the era of Ku-ring-gai Chase Trust's management of the park are located at Mount Colah (Mount Colah Lodge) and North Turramurra (Turramurra Lodge). These cottages were used as staff residences and are of local historical importance. NPWS plans to continue to use these as staff accommodation or find alternate use, subject to heritage assessment and completion of repairs.

West Head Lookout was built in the early 1960s and designed by renowned landscape architect Bruce MacKenzie. The lookout is considered a seminal work in the development of the Sydney Bush School approach to landscape architecture and design. Bruce MacKenzie

also collaborated with architect Russell Smith in the 1960s to design the sandstone building, which is now the NPWS Ku-ring-gai Chase office. The sandstone NPWS office building and landscape design at West Head Lookout respond to the natural landscape and provide a reference point for the design of future building and landscape works in the park.

Management considerations and opportunities

Historic heritage buildings and landscapes in the park are subject to a range of threats to their integrity and heritage value, including wildfire, vandalism, erosion, weed and pest invasion and rising sea levels.

Inappropriate restoration techniques or works, deterioration from natural weathering processes and loss of documentation or knowledge about the historical significance of an object or a place also threaten the heritage values of the parks.

Heritage legislation and conservation management plans

In New South Wales, historic heritage values are protected and managed under the *Heritage Act 1977*. NPWS manages places of heritage significance in parks in accordance with the Heritage Act, the National Parks and Wildlife Act and the principles detailed in the Burra Charter. Where necessary, conservation management plans are prepared to guide restoration works and the management of significant historic heritage places.

The significance and condition of many historic heritage items in the parks have not been formally assessed. Conservation management plans or a statement of heritage impact are prepared where required, including when new works and adaptive reuse of buildings or sites are proposed. NPWS may recommend listing significant sites in the State Heritage Register consistent with the outcomes of heritage significance assessments.

The state heritage listed Barrenjoey Head Lighthouse precinct is managed consistent with a conservation management plan prepared under the Heritage Act.

NPWS works closely with Heritage NSW in listing and protecting historic heritage values in the parks. Protection of these values is also prioritised in the NPWS Branch pest and weed management strategy and the parks' fire management strategy.

Historic heritage sites and items

Barrenjoey Lighthouse and associated buildings and the site of the Customs House at Barrenjoey Head are listed on the State Heritage Register and managed under a conservation management plan prepared under the Heritage Act (OEH 2012a).

Fifty-six historic heritage sites of local significance recorded in the park, are listed under section 170 of the Heritage Act and recorded in the NPWS Historic Heritage Information Management System. These sites are associated with early land use and development and the management of Ku-ring-gai Chase National Park. Sites include recreation areas and facilities, early road and carriage transport routes, monuments, cottages and houses, ruins of foreshore cottages and fishing shacks, grave sites,
sites of military use and survey points. The trig stations of Pittwater are associated with the first trigonometric survey of New South Wales in 1867. Some of these sites are also listed in local environmental plans. A further 96 historic heritage items and places in the parks have been identified as potential sites of local historic heritage significance and recorded in the Historic Heritage Information Management System.

A collection of items associated with the management history of the park is housed and displayed in the Kalkari Discovery Centre. Items include early Trust minutes and correspondence, historic photographs, artwork and a tea service set with the monogram of the Ku-ring-gai Trustees. Other records of historic heritage importance are stored in the

NPWS Ku-ring-gai Chase office, while several objects of significance to Barrenjoey Lighthouse are on display in the lighthouse. Care is required to record, store, display and professionally manage this collection so it is accessible to the community. NPWS collections are recorded and catalogued on the NPWS Ehive Collections Management online database (search for Ku-ring-gai Chase).

A portrait of Ecclestone Du Faur painted in 1911 by Violet Teague, previously displayed in the NPWS Ku-ring-gai Chase office, was donated to the National Portrait Gallery in 2020.

NPWS is committed to identifying, conserving, displaying and sharing the rich history and historic heritage of the parks. As many of the historic heritage sites and items in the parks have not been formally assessed for significance and condition, an assessment is required before decisions are made about future management of these sites and items. Consideration also needs to be given to the appropriate storage of heritage information and documents held in the NPWS Ku-ring-gai Chase office.

Adaptive reuse of historic heritage buildings

Adaptation or adaptive reuse means the modification of a heritage place to a new use that conserves its heritage values. Where a building can no longer function with its original use, a new use through adaptation is a legitimate way to preserve its heritage significance.

Adaptive reuse of historic heritage buildings and structures may mean a simple change in use, or alterations and additions to the buildings or structures to give them new purpose. Work to historic heritage buildings should conserve what is important about them and provide the opportunity to reveal and interpret their history, while also providing sustainable long-term uses (Heritage Office 2008)

The adaptive reuse of historic heritage buildings can enhance conservation through refurbishment and restoration works and provide funding for ongoing maintenance. The new uses for buildings and places must be compatible with protecting their significance and enabling their history to be interpreted and shared. Table 4 describes existing uses of heritage buildings within the national park.

Table 4 Heritage buildings and existing uses in the national park

Building	Existing use
Barrenjoey Head	
Barrenjoey Lighthouse	Guided tours
Lighthouse Keeper’s Cottage	Unoccupied
Assistant Lighthouse Keeper’s Cottage	Unoccupied
Boatman’s Cottage	Staff accommodation
Fishermen’s cottages	Unoccupied
Red Shed	Unused
The Basin	
Beechwood Cottage	Group function venue
Park entrances	
Turramurra Lodge	Unoccupied
Mount Colah Lodge	Staff accommodation
Bobbin Head	
Bobbin Inn	Visitor information and cafe
The Pavilion picnic shelter	Bookable picnic shelter

Building	Existing use
The Station picnic shelter	Bookable picnic shelter
Small sandstone kiosk	Unoccupied
Small sandstone amenities building	Public facilities
Heritage picnic shelters	Picnic shelters
Bus shelter	Shelter
NPWS Ku-ring-gai Chase office	NPWS office
Superintendent's house	Unoccupied
Morning Bay	
Grosvenor's house	Unoccupied

Note: NPWS = NSW National Parks and Wildlife Service

4. Providing for visitor use and enjoyment

The national park and island nature reserves are set among densely populated suburbs of northern Sydney. Large numbers of people (more than 500,000) live within 15 kilometres of the park, and many people visit the park on a regular basis. Visitation to the national park has increased considerably over the past 12 years, from 2.2 million visits in 2008 to 4.4 million visits in 2022 (Roy Morgan 2023). Increased visitation is expected due to the proximity of the park to these growing areas, increasing demand for open space and opportunities to experience natural landscapes and waterways.

Lion Island Nature Reserve, Long Island Nature Reserve and Spectacle Island Nature Reserve are managed for conservation of their natural and cultural heritage values. Access to the nature reserves is only allowed by consent for research, and for park management activities relating to the protection of natural and cultural values. Visitor access is not permitted.

4.1 Visitor access to the national park

The main access to the national park is along public roads, including Bobbin Head Road and Ku-ring-gai Chase Road on the western side of the park; and McCarrs Creek Road, Cottage Point Road, West Head Road and Liberator General San Martin Drive on the eastern side of the park (Figure 1). Vehicle entry fees are collected at vehicle entry stations or park and pay stations in selected carparks. A landing fee is also applied at The Basin. Visitors can also access the park on foot from railway stations at Mount Ku-ring-gai, Berowra, Cowan, Mount Colah and Hawkesbury River (Brooklyn) as well as from neighbouring suburbs.

Public and private ferry services provide access to the national park and beaches along the western side of Pittwater at Coasters Retreat, The Basin, Elvina Bay, Lovett Bay and Morning Bay. Tourist ferries also bring visitors to the park, stopping at Cottage Point and Bobbin Head wharves.

Sailing boats, cruising yachts, house boats, and other watercraft access the waterways and foreshores of the national park from Pittwater and the Hawkesbury River and from marinas and boat ramps at Bobbin Head and Akuna Bay. The park is closed at night, however, public roads remain open.

4.2 Visitor destinations

Ku-ring-gai Chase National Park is one of the most visited parks in New South Wales. Visitors come to picnic, bushwalk, bike ride, camp and undertake a variety of water-based recreational activities including boating, sailing, swimming, kayaking and canoeing.

The main visitor precincts are located at Bobbin Head, Apple Tree Bay and Kalkari in the western side of the park; and West Head, The Basin, Illawong, Akuna Bay and Barrenjoey Head in the eastern side of the park (Figure 2).

These visitor precincts are designed to cater for moderate to high levels of visitor use. Visitor facilities such as sealed carparking areas, toilets, barbecues, picnic shelters and open space for picnicking are provided. Visitor activities in these precincts include picnicking, land-based fishing, sightseeing and scenic viewing and camping. Many visitors access the track and trail network and Cowan Creek waterway from the main precincts.

Smaller visitor use sites, or visitor nodes, include Duckholes Creek Picnic Area, Salvation Creek Picnic Area, the Sphinx Memorial and Brooklyn Dam. These areas are less-modified environments with low to moderate visitation and basic facilities.

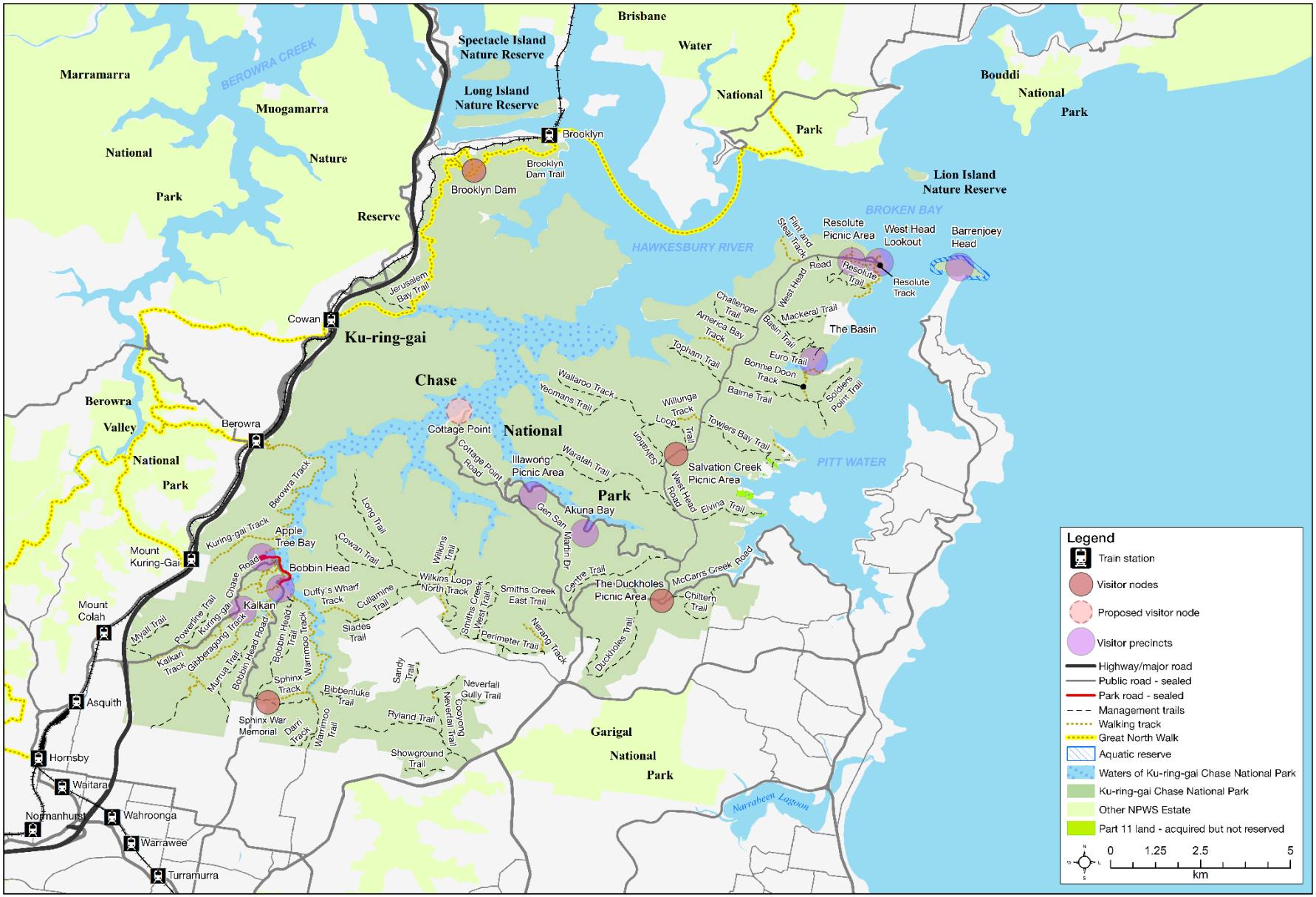


Figure 2 Visitor use Ku-ring-gai Chase National Park

Bobbin Head and Apple Tree Bay precincts

Bobbin Head and Apple Tree Bay visitor precincts on the foreshores of Cowan Creek are the most visited precincts in the park. These areas were developed as a 'pleasure ground' for public recreation in the earliest days of the establishment of the park (DEC 2006a). The 1930s heritage character is maintained in the sandstone buildings, including Bobbin Inn, heritage picnic shelters and plantings of Norfolk pines. This heritage character is a major feature of the site.

The picnic areas at Bobbin Head are the most popular sites for picnicking in the national park and are especially popular for family and group gatherings. A range of day use facilities are provided, including barbecues, picnic shelters, a children's nature play area and picnic tables. The Station picnic shelter and the Pavilion picnic shelter can be booked for larger groups. The picnic areas at Bobbin Head are used for a range of events (see Section 4.8).

The Gibberagong Environmental Education Centre, owned and managed by the NSW Department of Education, is located at Bobbin Head and provides environmental education activities for schools throughout the park. Other popular activities in this precinct include land-based fishing, kayaking, canoeing and paddleboating.

The historic Bobbin Inn houses the main visitor information centre for the national park and a cafe with outdoor seating leased to an operator. The inn building also has an upstairs multi-use space that is being considered for lease, which could include a restaurant, function area or other community uses. Other services at Bobbin Head include the marina complex, which is leased to an operator that provides 200 wet berths, 10 swing moorings, a slipway, cafe and offers small boat hire and boat servicing to the public.

The mangrove boardwalk and playground are popular facilities at Bobbin Head. The playground has been redeveloped as a nature play area, and new picnic shelters have been built. Additional improvements in the Bobbin Head precinct include upgrading the sandstone amenities building to improve accessibility and upgrading existing heritage shelters. These works have been guided by the Bobbin Head and Apple Tree Bay masterplan and associated conservation management plans (DEC 2006a). The plan requires raising the level of reclaimed land and repairs or upgrades to the seawalls to prevent inundation.

Apple Tree Bay is popular for picnics and launching boats, kayaks, canoes, paddleboards and jet skis on Cowan Creek. Visitor facilities include a boat ramp, canoe and kayak launch area, barbecues, picnic shelters and an open area for picnicking. Launching boats and other watercraft is the primary activity in the precinct. However, picnicking is becoming more popular as visitor numbers increase and the picnic areas at Bobbin Head become crowded. Other activities include land-based fishing and walking.

A small kiosk leased to an operator is also located at Apple Tree Bay. The kiosk building also houses public amenities and a storage area. The storage area may be suitable to be leased for a water sports equipment hire operator, small shop or similar use. There are also several licensed moorings in Apple Tree Bay (see Section 6.4).

Bobbin Head and Apple Tree Bay precincts are well connected to the track and trail network in the western section of the park.

The Kalkari precinct

The Kalkari precinct is located on Ku-ring-gai Chase Road about 3 kilometres from Bobbin Head. This area was a koala sanctuary and small zoo in the 1950s. Around 1970 the area was named Kalkari, an Aboriginal word meaning 'to wait', and redesigned to display live animals of the Hawkesbury Sandstone region. At this time, the zoo cages were replaced by larger open and less intrusive enclosures, and ponds and feed trays were installed to attract

native birds and animals. The Kalkari Discovery Centre was also constructed at this time. The area is no longer used to display animals, and most enclosures have been removed.

Today Kalkari is the base for the Chase Alive Discovery volunteer program and Chase Alive volunteers staff the Discovery Centre. The Kalkari Discovery Centre is the main interpretive centre for the parks, supporting environmental education and activities associated with the Discovery Ranger program. The centre also houses and displays a collection of Aboriginal cultural heritage and historic heritage items associated with the 73 years the Ku-ring-gai Chase Trust managed the park. The Kalkari precinct is linked to Bobbin Head and Apple Tree Bay precincts via walking tracks.

Illawong and Akuna Bay precincts

Illawong precinct is located along Liberator General San Martin Drive in a secluded area beside Coal and Candle Creek. Facilities in this precinct include picnic shelters, barbecues and toilets. Popular activities include land-based fishing and picnicking.

Akuna Bay precinct is located beside Coal and Candle Creek approximately 2 kilometres from Illawong Picnic Area. The Akuna Bay precinct, which includes a marina, associated buildings and carparking area, is leased to a business operator. The marina has 219 wet births and 160 dry storage spaces for boats, jetskis and kayaks, a cafe and offers small boat hire and boat servicing. The marina also has function rooms.

Other facilities at Akuna Bay include a public boat ramp and trailer parking. Barbecues and picnic tables are provided adjacent to the marina and boat ramp. Most visitors to the precinct use the facilities at the marina or launch boats and other watercraft from the boat ramp. Other activities in this precinct include land-based fishing.

The visitor precincts at Illawong and Akuna Bay are not accessible from the track and trail network. Access to these precincts is along public roads.

West Head and Resolute precincts

The West Head Lookout at the end of West Head Road is the most accessible and popular viewing point in the park. The lookout offers spectacular views over Broken Bay to Lion Island and the Central Coast and across Pittwater to Barrenjoey Head, Palm Beach and the Tasman Sea.

The nearby Resolute Picnic Area provides space for picnicking away from the busy West Head Lookout. It also provides access to Red Hands Cave, Resolute Beach and Koolewong walking track.

Over the past 10 to 15 years, improvements have been made to visitor facilities in this precinct. This includes new toilets at Resolute Picnic Area, new directional and interpretation signs, upgrades to the parking areas and West Head Lookout, and construction of the West Head Army track. Further upgrades to West Head Lookout are needed. These upgrades will be in keeping with the site's heritage significance and subject to heritage and environmental assessment.

Barrenjoey Head precinct

Barrenjoey Head and the lighthouse are prominent landmarks with high historic heritage importance. The headland and lighthouse complex is listed on the State Heritage Register. Visitors come to see the heritage buildings and enjoy scenic views over the coastal waterways of Pittwater, the Hawkesbury River and Broken Bay. Other popular activities include fishing on the rocky shoreline.

The headland is highly valued by the local community and other visitors. The precinct is only accessible by foot from the council-managed Governor Phillip Park and Palm Beach carpark.

The lighthouse is the only building open to the public for volunteer-led guided tours. Other facilities and services that support visitor use at Barrenjoey Head are currently provided by council (carpark and toilets) or private businesses located nearby (cafes and restaurant).

The Basin precinct

The Basin precinct is a popular camping and day use site on the Western Pittwater foreshore in the national park. The Basin can be accessed by public ferry, private boat or by foot along Basin Trail from West Head Road.

The main visitor activities include picnicking, camping, fishing, swimming and wildlife viewing. Visitor facilities in this precinct include tent-based camping sites, toilets and showers, picnic tables and shelters, gas and wood barbecues.

The swimming area located next to The Basin Picnic Area provides a separate space for swimming away from areas used by boats, yachts and public ferries. From time to time excess sand is removed from the swimming area to maintain a suitable depth. Other visitor facilities include Beechwood Cottage, which was built in 1885 as a holiday cottage.

Cottage Point

Cottage Point is located on the foreshore of Cowan Creek. Access to Cottage Point is via boat from Cowan Creek or by vehicle along Cottage Point Road. Most people visiting Cottage Point are accessing or visiting private properties, using Ku-ring-gai Motor Yacht Club facilities and hiring boats, or patronising the local cafe and restaurant.

Ku-ring-gai Motor Yacht Club provides moorings for club members, and some Cottage Point residents have licensed moorings in the park (see Section 6.4). These moorings are managed consistent with the National Parks and Wildlife Regulation.

Other visitor destinations

Duckholes Picnic Area, Salvation Creek Picnic Area, Brooklyn Dam and the Sphinx Memorial are smaller, less-modified visitor areas that provide opportunities to experience the park away from the high-use visitor precincts. Basic picnic facilities are provided at Duckholes Picnic Area, Salvation Creek Picnic Area and Sphinx Memorial. Walk-in camp sites are provided at Brooklyn Dam for people using the Great North Walk. The Sphinx Memorial is a popular site for walkers and trail runners using the track and trail network around Bobbin Head.

Management considerations and opportunities

The park's rugged, steep landscape and the importance of protecting the significant natural and cultural values limit opportunities for the expansion of existing visitor destinations or the creation of new visitor destinations.

There is more than 120 kilometres of shoreline in the park, and about 1.5 kilometres has been developed for picnicking and other activities. The rest of the park foreshore is not capable of supporting visitor facilities without major modification. Furthermore, the foreshores are at high risk from future sea level rise, which make further development in these areas impractical. Redesign of existing visitor destinations, including parking facilities and new traffic management approaches, are needed to address the challenges posed by increasing visitation.

Precinct utilisations and site capacity

During school holiday periods, on most public holidays and on sunny weekends demand for carparking spaces often exceeds availability at Bobbin Head, Apple Tree Bay, the Sphinx Memorial and West Head. NPWS observations suggest the number of days these precincts reach capacity has increased each year, and this increase is expected to continue.

During peak visitation carparks are full and services are strained, which reduces visitor enjoyment and may create risks. Some carparking improvements have been made in high-use precincts, but further works and traffic management options may be necessary to address capacity issues.

Other options to manage peak visitation in high-use precincts include introducing 'park and ride' style services at peak times, timed parking, promoting improved public transport options and establishing effective communication methods to alert visitors before they travel about congestion and encourage them to visit during quieter sites. Some precincts that are quieter during peak periods could be developed as an overflow.

Precinct planning and design

Precinct planning may be necessary to address site capacity, facility design and traffic management options. These opportunities could be realised by linking visitor destinations and providing additional facilities and services. This could include resting places or potable water and toilet facilities for bushwalkers, trail runners, boat users, cyclists and scenic drivers as they move around the park.

Visitor precincts at Bobbin Head, Apple Tree Bay, Illawong, Akuna Bay, The Basin and park foreshore will be increasingly affected by tidal inundation due to sea level rise. Tidal inundation already affects picnic areas at Bobbin Head, impacting the presentation and appeal of the precinct and vehicle access during high tides. Sea level rise projections is considered in precinct planning, infrastructure and trail maintenance programs.

Occasionally the Bobbin Head Marina berths are impacted by flooding due to the build-up of sediments from increased erosion, urban run-off and rising tides in Cowan Creek upstream of Bobbin Head. Removal of sediment may be required to prevent flooding of these facilities.

Improvements to the Bobbin Head and Apple Tree Bay precinct have been guided by the precinct master plan prepared in 2006. NPWS has implemented most of the masterplan proposals, however, some proposals have been deferred until measures to address tidal inundation are implemented. NPWS may review the master plan and prepare a new precinct plan (or plans) to accommodate growing visitor demands, address risks associated with tidal inundation and consider connections with the Kalkari Discovery Centre precinct.

Camping and accommodation

The Basin Camping Area offers tent-based camping overlooking the picturesque waterways of Pittwater. Public access is by foot along a steep management trail or by private boat, water taxi or ferry. Opportunities exist to redesign The Basin campground to attract a broader range of visitors, for example, by providing a range of camping styles, including serviced camping and group camping facilities.

Bush camping catering for self-sufficient walkers hiking the Great North Walk is provided at Brooklyn Dam. The campsites are designed for a single night's stay, and the level of use is generally low. Groups may also camp overnight as part of organised walks.

Other forms of overnight accommodation in the park include house boats and private boats using NPWS courtesy moorings. The use of the moorings is subject to the National Parks and Wildlife Regulation.

4.3 Tracks, trails and roads

The public roads, walking tracks and management trails in the park provide opportunities for some of the most popular visitor activities, including scenic driving, bushwalking, trail running, road cycling, mountain biking and horse riding.

Along with the 40 kilometres of public roads, there are more than 150 kilometres of walking tracks and management trails in the park. Many management trails are multipurpose and used for walking, mountain biking and horse riding, as well as park management activities. The public roads are managed and maintained by TfNSW.

NPWS aims to provide walking tracks and management trails that are properly designed, sited and constructed to support a range of recreational uses, while also protecting natural and cultural values.

Scenic driving

Spectacular views of the park, waterways, islands and Northern Beaches suburbs can be seen from many of the roads within the national park. Picturesque bush-lined roads in the park are popular for scenic drives. West Head and Bobbin Head are the most popular destinations on scenic drives. A roadside viewing area is provided on the Cottage Point Road and on West Head Road north of the Challenger Trail to allow visitors to pull over and appreciate the views of the national park and the Hawkesbury River.

Bushwalking

Bushwalking is one of the most popular activities in Ku-ring-gai Chase National Park. There are currently more than 50 kilometres of designated walking tracks within the national park in addition to the park management trail system, which is also available for walking. Walking tracks provide access to many outstanding features within the national park and encourage a close appreciation of its natural and cultural values.

Popular walks on the Lambert Peninsula near West Head include Red Hands Cave walk, the Resolute loop walk, Flint and Steel track, The Basin engravings walk and America Bay track. Many of the bushwalking experiences on the Lambert Peninsula are along management trails that provide access to the Pittwater foreshores or scenic views over the coastal waterways surrounding the parks.

Most designated walking tracks are located in the western section of the park and are accessible for visitors using public transport. The most popular walks in the Bobbin Head area include the mangrove boardwalk and rainforest walk along the Gibberagong Track, the Berowra track from Apple Tree Bay to Waratah Bay, and the Sphinx track and Bobbin Head trail loop.

Some tracks and trails in the park are also part of the Great North Walk (Sydney to Newcastle) managed by Crown Lands and the Harbour to Hawkesbury walking track routes (Manly to Berowra Waters).

The park’s extensive track and trail network varies from longer bush tracks across rugged terrain for more experienced walkers, to short all-abilities access trails providing a range of bushwalking opportunities with varying degrees of physical challenge.

Walking tracks in the national park are classified according to the Australian Walking Track Grade System which identifies maintenance standards and a track's suitability for different user groups as follows:

- Grade 1 – No bushwalking experience required. Suitable for wheelchair users who have someone to assist them (sealed path).
- Grade 2 – No bushwalking experience required. Tracks are compacted surfaces and may have gentle slopes. Walks are generally less than 10 kilometres in length (generally formed tracks).
- Grade 3 – Suitable for most ages and fitness levels. Some bushwalking experience recommended (generally formed tracks with some steep sections).
- Grade 4 – Experienced bushwalkers (generally rough, long tracks, limited directional signage).
- Grade 5 – Very experienced bushwalkers with specialised skills (generally very rough tracks, no directional signage).

The track network is designed to provide a range of bushwalking experiences. Most walking trails have been graded as 3 or 4. Paths and tracks graded as 1 and 2 are mainly within visitor precincts.

Road cycling

With its proximity to Sydney's northern suburbs, scenic environment, challenging hill climbs, connection to other routes and relatively low traffic volumes, Ku-ring-gai Chase National Park is a popular place for road cycling. Most roads used by cyclists are managed by TfNSW. This includes Bobbin Head Road and Ku-ring-gai Chase Road in the western section of the park; and McCarrs Creek Road, Liberator General San Martin Drive, West Head Road and Cottage Point Road in the eastern section. Cyclists on these public roads use the visitor facilities and services in the national park.

The public roads in the national park are also used for annual road cycling events, such as the Bobbin Head Classic Bike Tour. These events occur on TfNSW-managed roads and are approved by TfNSW. Consent from NPWS is required where parts of the park are used to support event activities.

Mountain biking

The popularity of mountain biking has grown considerably since the last plan of management was prepared in 2002. The scenic and natural features and accessible metropolitan location make the national park popular with mountain bikers. Ku-ring-gai Chase National Park has more than 100 kilometres of management trails that can be used for mountain biking.

Similar mountain biking opportunities on management trails are offered in Berowra Valley National Park, Lane Cove National Park and Garigal National Park. Additionally, the Gahnia and Serrata mountain biking tracks in Garigal National Park provide 6.5 kilometres of purpose-built single-track. The NPWS Cycling Strategy recognises that these parks will not be able to meet all the desired opportunities for mountain biking. NPWS works closely with the local council and other land managers to support a strategic approach to delivering mountain biking opportunities in northern Sydney consistent with the NPWS Cycling Strategy.

Other mountain biking opportunities in the surrounding area include the Manly Dam mountain bike track, a dedicated mountain bike trail at Hornsby quarry and the Bare Creek Bike Park at Belrose. The Bare Creek facility caters for a range of mountain bike riding experiences that are not suited to a national park setting.

Horse riding

Horse riding is permitted in Ku-ring-gai Chase National Park on designated management trails and walking tracks shown in Figure 3.

Most horse riding occurs along authorised horse trails, both inside and outside of the national park, near the semi-rural areas of Ingleside, Duffys Forest and Terrey Hills. There are also authorised trails in Garigal National Park near Belrose, St Ives and Frenchs Forest.

The trails in the national park allow horse riders access to scenic locations in the bush. Horse riders also desire to undertake loop rides and ride from home to horse riding centres, such as the St Ives Showground, without needing to ride beside major roads.

Management considerations and opportunities

Walking tracks and management trails improvements program

NPWS continues to assess the walking track and management trail network in Ku-ring-gai Chase National Park and has developed a prioritised program of improvements to the track and trail network.

Development of any new tracks and trails is subject to the outcomes of environmental, heritage and sustainability assessment processes consistent with the National Parks and Wildlife Act and relevant NPWS policy and procedures.

New tracks may be preferred-use (e.g. primary use cycling but other uses allowed) or multi-use trails (i.e. trails used for management vehicles, walkers, horse riders and cyclists). A range of strategies to enhance the visitor experience and minimise environmental harm are considered, including:

- installation of raised boardwalks or other protective measures to reduce erosion
- assessment of existing unauthorised and informal tracks for inclusion in the park's walking track and management trail network.
- rerouting, closure or construction of new tracks and trails
- installation of wayfinding, interpretation and track head facilities
- promotion of longer routes such as the Harbour to Hawkesbury and Great North Walk route
- potential reopening of historic walking tracks such as the flagstaff lookout track.

Scenic driving

The narrow winding roads, increased vehicle and bicycle use (especially during peak visitor use periods), causes congestion on the roads within the national park. This is particularly apparent along West Head Road and Liberator General San Martin Drive. Options to disperse visitors along the road and enhance the scenic drive experience include:

- promoting scenic drives with stop-off points rather than a single destination
- upgrading existing precincts to encourage short stops along scenic routes
- promoting short walk options to lookout points along existing walking tracks and trails.

In future, NPWS may consider strategies such as timed entry, timed parking and 'park and ride' options to scenic destinations to address traffic congestion along roads and at key visitor destinations in the national park.

Bushwalking

Proposals for new walking routes in the park have been suggested. These proposals range from short loop or linking tracks to longer multi-day walks. Some of these proposals include substantial expansion of the walking track network into currently undeveloped areas with high natural and cultural heritage significance. These more extensive proposals need to be considered in the context of regional tourism initiatives, existing walking opportunities inside and outside the national park, and to be balanced with the resources required to manage and upgrade the existing extensive track and trail network. Proposals for short walking tracks in existing precincts and linking tracks and trails may be considered consistent with precinct plans or as part of the tracks and trails improvement program. Proposals for a more extensive expansion of the walking track network would require further detailed planning consideration and may require an amendment to the plan of management.

NPWS may undertake an assessment of the Bonnie Doon track to determine whether it can be upgraded to an appropriate standard or if it will be closed and rehabilitated if upgrading the track is not feasible. A small section of this track between Bonnie Doon Wharf and the beach west of this wharf may be retained as an extension to the existing track between Bonnie Doon Wharf and Bennets Wharf at Coasters Retreat.

Existing tracks may be upgraded and rerouted to minimise environmental impacts and improve visitor experience. Management trails no longer required for park management purposes, including fire management, may be reclassified as walking tracks.

The Cowan to Brooklyn section of the Great North Walk passes through the national park. Walk-in camp sites have been established at Brooklyn Dam for people on the Great North Walk and a composting toilet is being installed to improve visitor experience and sustainability. The Great North Walk is managed by NSW Crown Lands.

Mountain biking

The construction of unauthorised mountain bike tracks by members of the public remains an issue in some parts of the park. Often these tracks have resulted in negative impacts on the natural and cultural values in the park.

Suitable locations for sustainable track construction in the park are limited by the park's steep terrain, highly erodible soils, vegetation of high conservation significance and significant Aboriginal heritage sites. Currently, the network of management trails available for mountain bikers in the park is shared with walkers, horse riders and trail runners.

NPWS has conducted a preliminary review of mountain biking opportunities in the park, including an assessment of existing and unauthorised tracks, and has identified 2 areas for further assessment (see Figures 3 and 4). Mountain biking experiences may be developed in these assessment areas by constructing new links or by modifying existing tracks or trails. These tracks may be preferred-use (e.g. primary use cycling but other uses allowed) or multi-use trails (i.e. trails used for management vehicles, walkers, horse riders and cyclists). Some tracks and trails in these areas may need to be closed and rehabilitated.

The assessment of these areas and any new tracks and trails will consider:

- Aboriginal heritage
- ecological sustainability
- the quality of the experience for cyclists
- improving linkages between existing trails
- the need to balance competing visitor demands
- existing opportunities in the park and elsewhere

- linking mountain biking opportunities across the region, including on other tenures where practical
- visitor safety
- the availability of resources to provide and maintain the experience.

Road cycling

The number of cyclists using roads through the park is increasing. These roads are isolated, narrow, winding, tree-lined and slippery in wet conditions. Some road sections have rock walls or steep drop-offs, and native animals regularly cross the roads. These road conditions significantly contribute to the risk of accidents. Poor or risky motor vehicle driving behaviour, risky cycling behaviours and high pedestrian traffic near key visitor precincts also increases the risks for cyclists, pedestrians and people traveling in vehicles.

Information relating to road cycling trends, incidents and safety matters is mostly anecdotal. More robust information and data are required to support decision-making to improve road cycling conditions and safety. NPWS works with TfNSW to identify appropriate options to address road and traffic management issues.

Horse riding

Ku-ring-gai Chase National Park is part of a priority region identified for improved horse-riding opportunities in NSW national parks under the Strategic directions for horse riding in NSW national parks (OEH 2012b). The regional horse-riding consultative group set-up to investigate these opportunities identified connectivity between trails, suburbs and horse riding facilities, and longer riding experiences as key issues within Ku-ring-gai Chase National Park. As a result of consultation and environmental assessment, the number of trails available for horse riding in the park was expanded, and potential new link trails were identified.

Most of the identified priorities and trails have been established. Some link tracks are still pending agreement with surrounding land managers, environmental assessment and the availability of funding to upgrade tracks to an appropriate standard (Figure 3).

Part of the Perimeter Trail, the Long Trail and parts of the Wilkins Loop South Track pass through Duffys Forest endangered ecological community. Perimeter Trail and Long Trail have been hardened to allow management vehicle access and prevent damage to this community. If riders keep to the trails, the impact of horse riding on surrounding vegetation is minimised. After consultation, the southern section of the Wilkins Track was closed to horse riding and bike riders but retained as a walking track (Figure 3).

Two causeways have been installed at creek crossings on the Perimeter Trail to prevent damage to creek banks and provide access across creeks for horse riders near the Terrey Hills Golf Club.

Trails may need to be realigned to minimise erosion or temporarily closed during and after rainfall events to avoid damage. The condition of trails needs to be monitored, and where negative impacts are identified tracks may be temporarily closed to horse riders and other users, until repairs are undertaken and the risk of further damage is minimised. Occasionally riders use trails not authorised for horse riding. Rider education and signage may help to prevent the use of unauthorised trails.

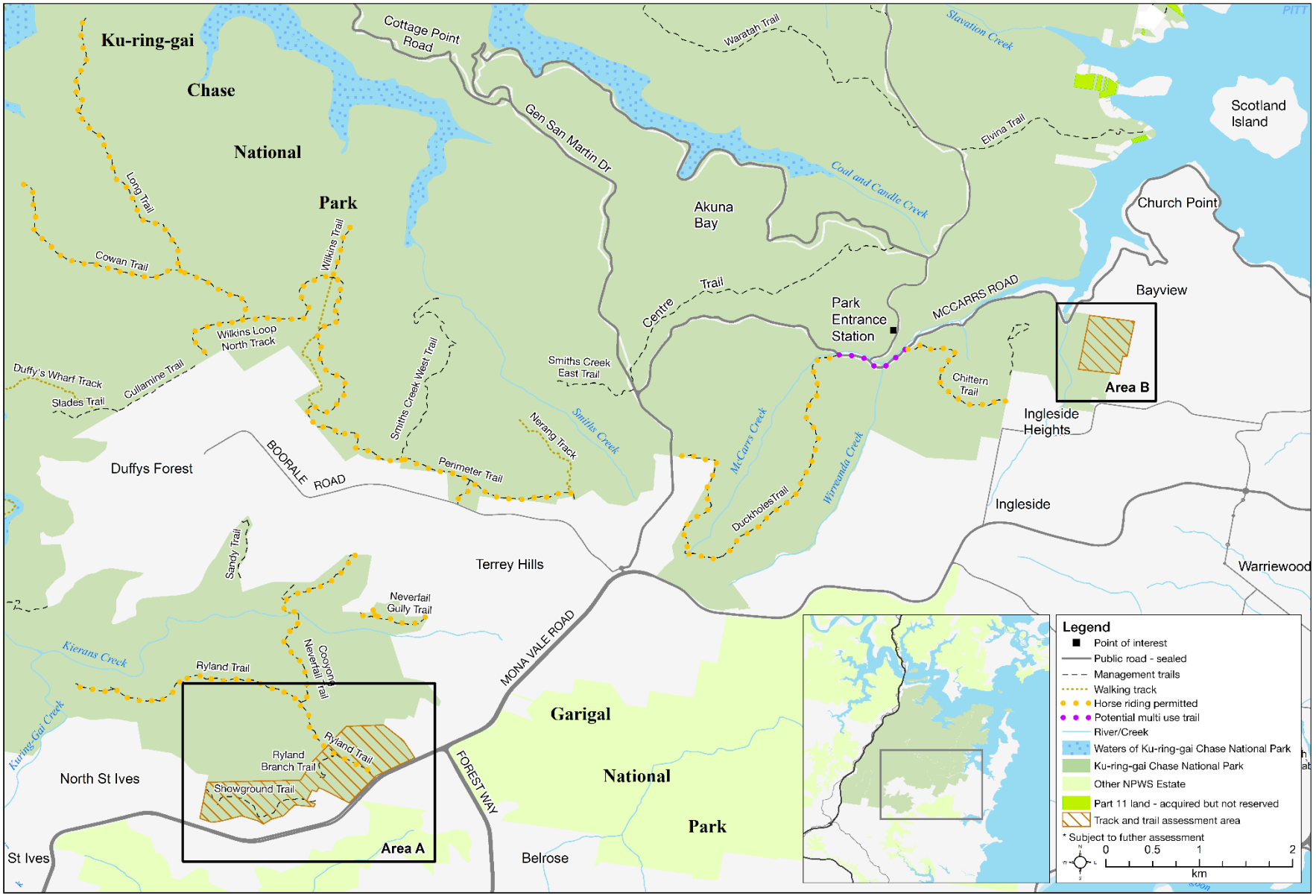


Figure 3 Ku-ring-gai Chase National Park existing and potential new tracks and trail recreational experiences

Figure 4 Tracks and trails assessment areas A and B

4.4 Tidal waterways

Ku-ring-gai Chase National Park includes the beds of Cowan Creek and its tributaries, including Coal and Candle Creek, Apple Tree Creek, Smiths Creek, McCarrs Creek and The Basin lagoon. The waterways in and around Ku-ring-gai Chase National Park provide major water-based recreational opportunities for boating, sailing, fishing, swimming, canoeing and kayaking in natural waterways.

The waterways in the park are accessed from marinas, boat ramps and launch facilities at Bobbin Head, Apple Tree Bay and Akuna Bay. Visitors also access the park waterways in boats from Pittwater and Hawkesbury River. Canoeing, kayaking and paddleboarding are also popular activities in the park, and launch facilities are provided at Apple Tree Bay and Bobbin Head.

Public and private ferries provide access to the park at The Basin, Coasters Retreat, Great Mackerel Beach, Morning Bay, Lovett Beach and Elvina Bay on Pittwater, and at Cottage Point and Bobbin Head in Cowan Creek. The public wharves in Pittwater and Cottage Point are maintained by TfNSW. Seaplanes also bring visitors to the park, landing on the water at Cottage Point.

The marina at Akuna Bay has wet berths, hire boats and a dry stack area for boats, jetskis and kayaks. The complex also includes a cafe and function room. The marina at Bobbin Head has hire boats, wet berths, swing moorings, a slipway and a cafe. The Ku-ring-gai Motor Yacht Club at Cottage Point has licences for a jetty, slipway and moorings within the park.

NPWS manages and maintains 54 courtesy moorings in the national park. These moorings are provided to enhance public safety and visitor experience. They also reduce environmental impacts caused by tying boats to trees and prevent anchoring in seagrass habitat.

The popularity of boating is increasing, and the size of vessels using park waterways is also increasing. Speed restrictions and no-wash zones have been established to minimise impacts of wash on the park foreshores.

Recreational fishing from boats and foreshore locations such as Bobbin Head, Apple Tree Bay, Illawong Point and Barrenjoey Head is a popular activity in the park.

Management considerations and opportunities

The management of recreational and commercial fisheries is the responsibility of DPI Fisheries under the *Fisheries Management Act 1994*. Commercial fishers sometimes use boat ramps to access surrounding waterways. NPWS works closely with DPI Fisheries to manage commercial fishing access and recreational fishing activities in the park.

Navigation, maritime safety and regulation of watercraft is the responsibility of TfNSW. NPWS works closely with waterway management agencies regarding sailing and boating activities that may impact park values and visitor safety.

The waterways can become congested near boat ramps and popular bays in Cowan Creek and destinations like Cottage Point. Conflicts sometimes arise between waterway users about rules and responsibilities. Improved education of all waterway users regarding safety, appropriate behaviour and boating rules may help to reduce conflicts.

Boat ramps and popular waterway destinations will be managed in cooperation with TfNSW to foster visitor safety, including reducing conflicts between recreational boating, jetskiing, waterskiing and non-motorised recreational activities (e.g. kayaking, canoeing and paddleboarding).

Under the National Parks and Wildlife Regulation the use of NPWS courtesy moorings is limited to one boat per mooring for a maximum of 24 hours. This is to allow equitable use of moorings and prevent moorings from being dragged by boats. There is currently no charge or booking system for their use. The type, location and conditions of use for courtesy moorings is subject to periodic review to maintain visitor experience and sustainable use.

In addition to the moorings managed by the Ku-ring-gai Motor Yacht Club, NPWS also manages mooring licences issued to individuals and lessees at Apple Tree Bay and Cottage Point. All these moorings are managed under a licensing system (see Section 5.4).

Options to assist NPWS in managing and maintaining courtesy moorings include:

- outsourcing mooring maintenance to TfNSW
- working cooperatively with DPI Fisheries and TfNSW to investigate the use of more environmentally friendly moorings
- investigating options to licence the management of courtesy moorings.

The existing courtesy moorings managed by NPWS will be retained. The location and type of moorings may change over time after consultation with DPI Fisheries, TfNSW and the community.

Kayak and canoe launch facilities at Bobbin Head and Apple Tree Bay help to reduce risks to visitors by separating paddle craft from motorboat and jetski launching areas.

Dredging may be required to maintain suitable water depth for continued ferry access to the wharf at The Basin, to maintain tidal flow in The Basin lagoon and access to the Marina at Bobbin Head. The wharf structure is owned and maintained by NPWS, however, dredging activities would need to be approved by other agencies. NPWS will work with other agencies to maintain park access.

Some beaches and sand flats along the park foreshores are accessible only by boat, while others are accessible from both the water and walking tracks. The most popular foreshore areas are on Western Pittwater and beaches close to West Head, including West Head Beach, Resolute Beach, Flint and Steel Beach, White Horse Beach and Hungry Beach. These foreshore areas are maintained as undeveloped natural areas, and no facilities are provided. Camping and use of wood fires are not permitted in these areas.

Speed limits and no-wash zones have been established within the park waterways by the waterway management agency. These limits and zones may be reviewed and changed depending on waterway conditions and changing use. NPWS works with the relevant waterways management agency to regulate activities on waterways in the park to maintain recreational opportunities while also managing impacts on marine wildlife, and natural and cultural values. This includes supporting efforts to educate boat users about appropriate approach distances for marine mammals.

Power boats and watercraft are not permitted to operate upstream of the Bobbin Head Marina on Cowan Creek, upstream of the road bridge at Bobbin Head on Cockle Creek or upstream of the footbridge on Apple Tree Creek. These narrow channels and shallow areas are more suited to unpowered boats, kayaks, canoes and paddleboats.

4.5 Other recreation

Rock climbing and abseiling are not allowed in parks unless a written consent is provided, or provision is made for these activities in the plan of management. The plan of management makes provision for rock climbing and abseiling in the national park within a designated area at Barrenjoey Head. The plan also enables additional sites to be considered subject to further assessments.

Drones (and similar devices) are increasingly used within national parks. They are primarily used to take aerial images, but also as a form of recreation. Drones can adversely impact natural values and other park users (Vas et al. 2015; Lyons et al. 2017). They have also stopped park management operations such as hazard reduction burns and associated helicopter operations. The use of drones within national parks is guided by the NPWS Drones in parks policy and relevant aviation safety regulations.

Geocaching and virtual geocaching occasionally occur in some areas of the park. Geocaching is an activity where participants use a global positioning satellite receiver to find the location of the cache. Written consent from NPWS is required to place a physical cache in the national park.

The foreshore, beaches and rock platforms are popular for fishing. Fishing is permitted in the park subject to licensing requirements under the Fisheries Management Act and requirements under the *Rock Fishing Safety Act 2016*.

Management considerations and opportunities

Suitable locations for rock climbing, abseiling and bouldering is constrained by the presence of vegetation and species of high conservation significance and Aboriginal heritage sites. This includes the presence of recorded and unrecorded Aboriginal cultural heritage sites. Unstable geology may also make some locations unsuitable.

Specialist emergency services training activities that include abseiling and rock climbing are allowed with written consent from NPWS consistent with the National Parks and Wildlife Regulation and relevant NPWS policy.

The use of drones is controlled by the Australian Government under Civil Aviation Safety Authority Regulations. In the national park drones are used for commercial filming and photography and park management purposes. Utility providers also use drones to inspect powerlines and other infrastructure for maintenance purposes.

Under current Civil Aviation Safety Authority Regulations, drones must not fly within 30 metres of people, and they must not be flown over or above people. There is no suitable location in the park for the recreational use of drones due to high visitation and restrictions placed on the use of drones near uncontrolled airports and essential infrastructure like powerlines.

4.6 Information, interpretation and education

Promoting public awareness of park values, recreational opportunities and NPWS conservation responsibilities assists visitors to support protection of national parks while also increasing their enjoyment of these landscapes.

Information, interpretation and education programs in the parks are delivered through:

- interpretive signs about the parks' natural and cultural heritage values
- guided activities as part of Discovery program and Chase Alive Discovery activities
- directional, regulatory and risk signage
- printed brochures
- app and web-based information for trip planning, safety, visitor experiences and understanding park values.

A priority for park information is visitor safety. On-site signs identify site-specific risks and provide information on how to avoid risks and what to do in case of an emergency. Safety information is regularly reviewed as part of the parks' risk management program to ensure essential safety messages are communicated and appropriate treatments are in place.

Visitor information is provided at Bobbin Inn and Kalkari Discovery Centre. Information and interpretive signs are also located at major visitor destinations in the park.

Volunteers provide information and lead guided walks, children's programs and other activities as part of the Chase Alive Discovery program. Approximately 15,000 people attend these activities each year. These guided activities provide opportunities for visitors to learn more about Ku-ring-gai Chase National Park and promote appreciation of conservation more generally.

The Gibberagong Environmental Education Centre at Bobbin Head delivers environmental education for schools in New South Wales and is managed by the NSW Department of Education. The centre is a teaching facility with a science laboratory, library and overnight accommodation for 30 students. It provides a range of environmental education activities in several locations in the national park. Tour operators licensed under the Parks Eco Pass program also deliver environmental education activities in the national park.

Management considerations and opportunities

Information provided about the parks through signage, printed material, social media and online promote an appreciation of the parks' values and inform visitors about recreational opportunities, risks and minimal impact behaviours.

Interpretation and directional signage are progressively being updated in the national park when sites and facilities are upgraded. Opportunities exist to improve interpretation of the parks' natural and cultural values through a range of media, including app-based and web-based technology, guided activities, displays, signs and printed material.

4.7 Volunteering

Volunteers participate in a range of activities in the park and nature reserves. These programs and activities build connections between NPWS, communities and individuals and contribute to the ongoing management of the national park and island nature reserves.

Volunteer activities include providing guided tours, operating visitor centres, meeting and greeting visitors on site, maintaining and championing heritage sites and a range of bush regeneration and environmental management activities.

Several organised volunteer groups run these services, including the Chase Alive Discovery program (managed in partnership with NPWS), West Head Awareness Team, Pittwater bush regeneration and Floating Landcare.

Volunteers provide valuable and important assistance to NPWS in controlling weeds, undertaking bush regeneration and restoring degraded areas. As well as working in many locations in the parks, volunteer Bushcare groups work on adjoining lands helping to maintain vegetation corridors that support the movement of wildlife.

Volunteer bushfire brigades are located at Cottage Point, Mackerel Beach, Coasters Retreat and Western Pittwater foreshore communities. These volunteer brigades participate in fire management activities as part of the Rural Fire Service. NSW Volunteer Marine Rescue based at Cottage Point provides marine rescue, boating safety and education services.

Management considerations and opportunities

Opportunities exist to expand volunteer services to include campground hosts track and trail maintenance and corporate volunteering. Horse riding, walking and mountain bike groups have expressed interest in contributing to the maintenance of tracks and trails.

All volunteers in the park are covered under volunteer agreements and registrations. Activities undertaken by volunteers must be consistent with the plan of management and the regional operations plan. Bush regeneration activities are aligned with priorities identified in pest management strategies and other relevant park management programs. NPWS supports the Chase Alive Discovery program and other volunteer groups, encouraging a proactive and self-reliant approach to volunteer activities.

4.8 Visitor services, group activities and events

Most visitor services are located at Bobbin Head, Apple Tree Bay and Akuna Bay, including marina complexes at Bobbin Head and Akuna Bay, which provide mooring and other boating services.

Commercial and non-commercial events and group activities provide increased opportunities for public participation in nature-based activities and promotion of the parks' natural and cultural values. Activities involving professional instruction help visitors undertake these activities safely and minimise impacts on park values.

Recreational and guided tours form a small but growing component of public use of Ku-ring-gai Chase National Park and include bus, car and boat tours, guided walks, wildlife and wildflower viewing, boat hire, fishing trips, educational tours, commercial filming, photographic instruction and viewing of Aboriginal sites.

The size and frequency of organised events has grown in recent years. Activities involving large numbers of participants include long-distance bushwalking, rogaining, orienteering and cycling events and organised picnics in major precincts such as Bobbin Head. Large events including competitive sporting or fundraising events are managed to minimise impacts on natural and cultural values and other visitors, consistent with NPWS events management policy and guidelines.

Group recreational activities are popular in Ku-ring-gai Chase National Park. Group activities may be commercial, where people pay an organiser to participate, or non-commercial, organised by private individuals, not-for-profit community groups, incorporated associations or clubs.

Unregulated group activities can lead to unacceptable impacts to park values or adversely affect the experience of other visitors. Large groups can make it difficult for other visitors to use the park's facilities or can produce high noise levels that disturbs other visitors. NPWS manages group activities to ensure negative impacts on natural and cultural values and other park users are minimised by limiting the size and location, among other conditions.

The public can book The Station and The Pavilion picnic shelters at Bobbin Head and Beechwood Cottage at The Basin for group activities and organised events.

Orienteering or rogaining events or training activities may be permitted on existing tracks only. The number of participants for approved orienteering or rogaining events and activities may also be limited to protect park values.

Management considerations and opportunities

All businesses providing recreational and guided tour activities require consent from NPWS regardless of the number of participants. In 2020 more than 50 Eco Pass licence holders were registered to operate in the national park.

NPWS consent is also required for the following non-commercial group activities:

- rock climbing and abseiling group activities including groups of 10 or more people at Barrenjoey Head

- group activities of more than 20 people at West Head and 40 people elsewhere in the national park
- sporting events or tournaments
- school/educational visits
- weddings and other private functions.

Businesses providing services such as entertainment, catering, photography and celebrant services for non-commercial group functions also require consent.

Businesses operating in the park must hold a lease, licence or consent. Leases, licences and consents ensure that activities, levels of use and behaviour are appropriate for the park and specific locations and are compatible with general recreational use. Leases and licences also require businesses to make a financial contribution to park management and protect park values (see Section 6.4).

NPWS continues to consider options for a range visitor services to be provided by businesses operating in the national park under a lease or licence. Any lease or licence issued to a business are subject to heritage, environmental and sustainability assessments.

Leases and licences are also monitored and reviewed to ensure:

- the operators comply with lease or licence conditions
- the operations are appropriate in terms of the objectives of the park
- the operators are providing a valuable service to park visitors
- information provided by operators is accurate
- the operations are not having an unacceptable impact on park values or other visitors.

5. National park infrastructure and services

5.1 Infrastructure in the park

NPWS manages and maintains a range of visitor and management facilities in Ku-ring-gai National Park, including gates, fencing, housing, office and depot buildings, historic heritage buildings, seawalls, bushfire response infrastructure, water supply infrastructure, sewerage treatment facilities and infrastructure, walking tracks, management trails, sealed roads and visitor facilities.

Assets no longer necessary for park management or visitor use may be decommissioned or removed and the site rehabilitated after relevant heritage and environmental impact assessments and approvals. There is currently no NPWS infrastructure on any of the island nature reserves.

Public roads and access

Vehicle access to the park is along public roads, including Bobbin Head Road, Ku-ring-gai Chase Road, McCarrs Creek Road, Liberator General San Martin Drive, West Head Road and Cottage Point Road. These roads are managed by TfNSW. The park is open between sunrise and sunset, however, public roads can be accessed at all times.

Park waterways are accessed from boat ramps in the national park at Apple Tree Bay and Akuna Bay, and from canoe and kayak launching ramps at Bobbin Head and Apple Tree Bay. Boats and other watercraft access the park foreshores from waterways that are part of the national park, and from Pittwater and the Hawkesbury River.

Private and public ferry services provide access to the foreshores of the national park from wharves at The Basin, Coasters Retreat, Great Mackerel Beach, Lovett Beach, Morning Bay and Elvina Bay on Pittwater, and Cottage Point and Bobbin Head on Cowan Creek.

Management trails

There are approximately 100 kilometres of management trails within the national park. There are no management trails on Lion Island, Long Island or Spectacle Island nature reserves.

Management trails provide access for essential management operations such as fire management, weed control, feral animal control, maintenance of park facilities and services, and search and rescue activities.

Many management trails in the park are multipurpose trails, also providing recreation opportunities for visitors (see Figure 2 and Section 4.3).

Some management trails and park access roads extend across adjacent lands owned and managed by other authorities or private individuals. Preparation of a reserve access strategy will help to secure park access for management purposes and recreational use through establishing formal agreements or other legal instruments where appropriate and required.

The management trails in the park are an important fire management asset, and most are identified as strategic or tactical fire trails. Under the Rural Fires Act, the relevant bush fire management committees' fire access and fire trail plans identify access requirements for fire suppression and management purposes, including on land managed by NPWS.

Park management facilities

There are several houses within the park which were previously used as staff residences. Most of these houses are close to major visitor use areas or management facilities such as the works depot.

The 2 houses at Bobbin Head and the house at Morning Bay are no longer required for operations, and the 2 fishermen's cottages at Barrenjoey Head contain hazardous material and are deemed unsuitable for visitor use.

The Mount Colah and Turramurra lodges and Boatman's Cottage have historic heritage significance and have been retained for staff accommodation or other potential future use such as visitor accommodation. The house near the Kalkari Discovery Centre (west Kalkari house) has been retained for staff or potential future use as visitor accommodation.

Mount Colah works depot services Ku-ring-gai Chase National Park and other parks in northern Sydney. The depot includes offices, storage for boats, NPWS firefighting vehicles, equipment and chemical stores. The depot is also an important operations site during bushfire response or planned burn operations. Helicopter pads are located at Mount Colah works depot and near the Resolute Picnic Area to support fire and search and rescue operations.

The NPWS Ku-ring-gai Chase office is located near Bobbin Head and was commissioned by the Ku-ring-gai Chase Trust and completed shortly before NPWS assumed management responsibility for the park. This building has historic heritage significance and continues to operate as an NPWS office.

The picnic areas at Bobbin Head, Apple Tree Bay and Illawong Bay are on reclaimed land that was created by constructing seawalls and dumping fill onto mud flats. Over time the seawalls have been undermined, and the fill has sunk below the level of the highest tides. As a result cracks have developed in carparks, buildings and pipes which require ongoing repairs. Repairs and maintenance to seawalls and ongoing foreshore restoration works are required to prevent further erosion and maintain picnic areas. Other works required include raising the ground levels to prevent inundation at high tides.

Several quarries and gravel pits were created in the park to provide material for construction of roads and buildings. Stone extracted from the quarry off Bobbin Head Road was used to construct the first road to Bobbin Head and some of the sandstone buildings within the national park. This quarry is maintained for its historic value. Two other quarry sites are maintained to stockpile sandstone and soil used for maintenance of management trails and walking tracks. Sediment control measures are in place at these sites. The gravel pit near the start of the Bobbin Head Trail and other roadside gravel pits have been rehabilitated. Other disturbed land in the park is programmed for rehabilitation where no other use has been identified.

NPWS-managed utilities and services

NPWS is responsible for maintaining and operating several powerlines, water pipelines and sewerage infrastructure within the national park that service public facilities (including the marinas and leased buildings) and management facilities within the park. NPWS also maintains information technology infrastructure that services park operations, including the office and depot.

NPWS owns and maintains two 11 kilovolt (kV) overhead powerlines servicing Bobbin Head (North Turramurra to Bobbin Head) and Apple Tree Bay (Mount Colah to Apple Tree Bay).

NPWS also owns and maintains a range of sewerage infrastructure including sewer lines and site-based sewerage treatment facilities.

The small dam near Resolute Picnic Area is used to provide non-potable water for public amenities. Water from the dam near The Basin is treated and used to supply the campground and day use area. Brooklyn Dam and another small dam associated with the development of the northern railway line are maintained as locally significant heritage sites. The small dams off Bobbin Head Road and at Illawong Bay are no longer used and are not actively maintained. The dam off Towlers Bay Trail is maintained for management purposes.

Public vehicle access to the park is along public roads managed by TfNSW or local councils. Other public access is provided along management trails and walking tracks managed by NPWS. The wharves at The Basin and Morning Bay, and the pontoons at Bobbin Head and Apple Tree Bay are owned and maintained by NPWS. Other public wharves that provide access to the park from foreshore communities are managed by TfNSW.

Management considerations and opportunities

Due to their proximity to large population centres, infrastructure in the park is vulnerable to vandalism and other illegal activities, particularly rubbish dumping and anti-social activities. The national park is closed at night, but public roads are still open and night-time access increases the risk of vandalism and illegal dumping.

Vehicle entry fees are currently collected at vehicle entry stations at Mount Colah and North Turramurra entrances and near Duckholes Picnic Area and Illawong Picnic Area. There is potential to use other technologies and locations to collect vehicle entry fees and modify or remove these stations. Vehicle entry stations may need to remain to support visitor use and safety, including management of visitor access during peak times, fire management operations and emergencies.

Many management trails are multiple-use trails used for park management, including emergency bushfire response and for recreation activities. Some of these management trails cross Crown lands or private lands. Not all sections of these access trails have been secured by formal access agreements.

The maintenance of tracks and trails in the national park is a major ongoing commitment. Realignment of tracks and trails may be required to prevent erosion and to minimise environmental impacts. Management trails no longer required for fire management or other park purposes could be reduced in width and designated solely for recreation or closed and rehabilitated if they are not suitable for recreational use.

Fire access and fire trail plans prepared under the Rural Fires Act may identify the need for new fire trails in the park. Construction of new fire trails requires an appropriate level of heritage and environmental assessment and will be subject to the requirements of the National Parks and Wildlife Act.

NPWS provides access to potable water at Bobbin Head and Apple Tree Bay, The Basin and the Akuna Bay visitor precincts. Barrenjoey Head has been connected to water and sewer mains.

Ku-ring-gai Chase National Park has significant infrastructure and assets that are at risk from foreshore erosion and sea level rise associated with climate change, including walking tracks and visitor precincts. The risk of foreshore erosion and sea level rise is assessed and considered when planning new facilities and as part of the repair and maintenance programs under the asset management system.

Buildings no longer required for park operations or deemed unsuitable for visitor use are scheduled for removal after appropriate heritage and environmental impact assessment.

6. Non-park infrastructure and services

6.1 Infrastructure managed by other agencies

Several state and regional authorities, including energy providers, Sydney Water and Transport for New South Wales, occupy or use land in Ku-ring-gai Chase National Park for public utilities. Infrastructure managed by these authorities include powerlines, a water main, sewerage and telecommunications infrastructure. Access trails have been established in the national park to service this infrastructure and major road and rail corridors, including the Pacific Motorway (M1), Pacific Highway and the main northern railway line. Other non-NPWS infrastructure includes a radio tower on Barrenjoey Head used for surf rescue operations and Cottage Point Rural Fire Service Volunteer Fire Brigade facilities at Cottage Point.

Transgrid owns and maintains 3 overhead powerlines crossing the southern section of the park between Terrey Hills and Mount Colah, including two 330 kV lines and one 132 kV line. NPWS has entered into an agreement with Transgrid to standardise the processes for undertaking maintenance and minimising environmental impact.

Ausgrid owns and maintains powerlines servicing Cottage Point, Illawong Bay and Akuna Bay from a 132 kV powerline that runs beside the road corridor between Terrey Hills and Cottage Point, with extensions to Illawong Bay and Akuna Bay. The use and maintenance of these powerlines are covered by a consent under the National Parks and Wildlife Regulation enabling inspection, maintenance and emergency works consistent with an agreed protocol. Ausgrid also has easements for access to the Murrua Road substation and transmission lines crossing park lands at McCarrs Creek and Elvina Bay.

The Transport Asset Holding Entity (part of Transport for NSW) owns and maintains powerlines running through the park alongside the railway corridor on the western boundary of the park. These powerlines are not covered by a formal access easement or maintenance agreement.

Sydney Water Corporation owns and operates sewerage infrastructure in the park. Easements have been established for access and maintenance for some of this infrastructure, including a pump station and sewer lines. Other Sydney Water Corporation owned infrastructure is covered by a consent under the National Parks and Wildlife Regulation enabling inspection, maintenance and emergency works consistent with an agreed protocol. Under the protocol environmental impact assessment may be required for some works.

There are more than 30 trigonometric (trig) stations throughout the park. These stations are part of the geodetic survey network in New South Wales and are maintained by NSW Surveyor General. Under the *Surveying and Spatial Information Act 2002* the Surveyor General or authorised persons may access the park to maintain, repair or replace survey marks.

Table 5 Easements and right of way access in the parks

Description	Purpose	Management
Murrua Rd sewer line easement	Sewerage easement – Sydney Water Corporation	Registered easement
Electricity substation	Electricity substation access easement – Ausgrid	Registered easement
RoW access easement	Right of way (RoW) to private property	Registered easement
King and Church St sewer line easement	Sewer line access easement – Sydney Water Corporation	Registered easement
Myall Rd pump station easement	Sewerage pump station access easement – Sydney Water Corporation	Registered easement
McCarrs Creek and Elvina Bay easement	Transmission line access easement – Ausgrid	Registered easement
Akuna Bay telecommunications licence	Telecommunications cable	Licence
National Broadband Network cable licence	Telecommunications cable	Licence

Management considerations and opportunities

Agencies external to NPWS own, operate and manage infrastructure and services in the national park, including power, water and sewerage infrastructure. The maintenance and operation of these services and facilities are guided by protocols and agreements where established, in some circumstances formal easements have been established.

Under the *Electricity Supply Act 1995* operators can use existing powerlines not covered by a formal easement or agreement, however, operators must comply with the National Parks and Wildlife Act and Regulation when carrying out any maintenance or replacement work. Some works carried out by these agencies are subject to NPWS consent, environmental and cultural heritage impact assessments.

Additional high-tension powerlines are not allowed to cross the park unless they are required for park management purposes or have been identified as an essential service consistent with relevant legislation.

Proposals for new telecommunications facilities, including additional antennae on existing towers, require NPWS consent. New users or providers also require a licence under the National Parks and Wildlife Act and new infrastructure is subject to environmental impact assessment.

A right of way easement has been established to allow access to private property. This easement will continue to be managed consistent with the National Parks and Wildlife Act and NPWS policy allowing access through park lands where no other practical alternative is available.

6.2 Neighbouring communities

Ku-ring-gai Chase National Park is surrounded by residential suburbs of Brooklyn, Cowan, Berowra, Mount Kuring-Gai, Mount Colah, North Wahroonga, North Turramurra, St Ives, Duffys Forest, Terrey Hills, Ingleside, Bayview and Palm Beach.

The remote foreshore communities of Coasters Retreat, Currawong Beach, Elvina Bay, Lovett Bay, Morning Bay and Great Mackerel Beach are located on the western shores of

Pittwater and surrounded by the national park. These communities are generally only accessible by boat. Cottage Point community is surrounded by the national park and is accessible by vehicle along public roads and by boat from Cowan Water.

Management considerations and opportunities

As neighbours and frequent visitors of the national park, members of these neighbouring communities have a strong connection to the national park and nature reserves. Many people from these local communities volunteer with the Rural Fire Service and Bushcare groups. NPWS works in cooperation with local communities, volunteer rural fire brigades and Bushcare groups to support emergency fire response, control weeds and undertake bush regeneration in the parks.

Cooperative arrangements with local councils, rural fire brigades, Local Land Services and neighbours are also essential to maintain a coordinated response to fire, weed and feral animal management activities.

6.3 Existing interests

There are several structures and buildings in the national park that are occupied or used by individuals or families and are not required for park management purposes. These include wharves, jetties, pontoons, boatsheds, water pipes and other buildings. Most of these are located at Cottage Point and were permitted by agreement with the Trust before the national park was reserved in 1967.

Management considerations and opportunities

The provisions of the National Parks and Wildlife Act do not allow private use of park lands where existing use rights have not been established and where there is no benefit to the public or park management.

Permissive occupancies and other licences have been issued for structures and uses where existing use rights have been established consistent with the National Parks and Wildlife Act. The management of these structures, which occupy a very limited area between properties and the park, are a considerable administrative burden to residents and NPWS with little or no environmental or community benefit. While the licences will continue to be managed consistent with the National Parks and Wildlife Act and NPWS policy and procedures, a longer-term solution is required to improve management of these historical uses. This could include proposing changes to park boundaries consistent with National Parks and Wildlife Act and relevant NPWS policy.

6.4 Licensed moorings

Several individual and club moorings have been established in the national park waterways to allow public access and access for residents at Cottage Point. Club moorings and individual moorings are located at Cottage Point and in Apple Tree Bay.

Management considerations and opportunities

Boats are an important means of transport for residents in foreshore communities and a popular way for people to experience the parks. Most residents at Cottage Point have been issued with licences to moor their boats in the park. This allows residents to access the national park and their properties from the water and provides alternative options for evacuation during emergencies such as bushfires. Not all residents at Cottage Point have access to a mooring, and NPWS is considering proposals for new moorings for

Cottage Point residents based on the availability of space within the established mooring area. The number, type and location of moorings is subject to NPWS policy and agreement with TfNSW and DPI Fisheries.

Appendices

Appendix A Legislation and policy

The following laws and policies apply to how we manage our parks (this is not a complete list):

NSW legislation

- *National Parks and Wildlife Act 1974* and Regulation
- *Environmental Planning and Assessment Act 1979*
- *Heritage Act 1977*
- *Biodiversity Conservation Act 2016*
- *Biosecurity Act 2015*
- *Filming Approval Act 2004*
- *Electricity Supply Act 1995*.

Other NSW laws may also apply to park management:

- *Work Health and Safety Act 2011*
- *Marine Estate Management Act 2014*
- *Due diligence code of practice for the protection of Aboriginal objects in New South Wales*.

Commonwealth legislation and policy

- *Environment Protection and Biodiversity Conservation Act 1999*
- *Disability Discrimination Act 1992*
- Building Code of Australia.

NPWS policies and strategies

A range of NPWS policies and strategies may also apply to park management, including:

- park management policies
- regional pest management strategies
- fire management strategies.

Other laws, policies and strategies may also apply. Please contact NPWS for advice.

Appendix B Vegetation classes and communities in the park

Formation	NSW vegetation class	NSW plant community type (PCT ID)	Threatened ecological community
Dry sclerophyll forests	Sydney Coastal Dry Sclerophyll Forests	Coastal Sandstone Foreshores Forest (1778)	
		Coastal Sandstone Riparian Forest (1780)	
		Coastal Sandstone Gully Forest (1250)	
		Sydney North Exposed Sandstone Woodland (1783)	
		Sydney Ironstone Bloodwood – Silvertop Ash Forest (1786)	Duffys Forest Ecological Community in the Sydney Basin Bioregion
	Sydney Hinterland Dry Sclerophyll Forests	Hawkesbury River Escarpment Dry Forest (1912)	
Heathlands	Sydney Coastal Heaths	Coastal Foredune Wattle Scrub (772)	
		Coastal Headland Banksia Heath (1822)	
		Coastal Sandstone Heath-Mallee (1824)	
		Coastal Sandstone Rock Plate Heath (881)	
	Coastal Headland Heaths	Coastal Headland Clay Heath (1817)	
		Coastal Sand Tea-tree-Banksia Scrub (771)	
Wet sclerophyll forests	North Hinterland Wet Sclerophyll Forests	Central Coast Escarpment Moist Forest (1565)	
		Central Coast Escarpment Dry Forest (1557)	
		Coastal Shale-Sandstone Forest (1845)	
	North Coast Wet Sclerophyll Forests	Coastal Enriched Sandstone Moist Forest (1841)	
		Coastal Diatreme Forest (1914)	
	Southern Lowland Wet Sclerophyll Forests	Pittwater Spotted Gum Forest (1214)	Pittwater and Wagstaff Spotted Gum Forest in the Sydney Basin Bioregion

Formation	NSW vegetation class	NSW plant community type (PCT ID)	Threatened ecological community
Rainforests	Northern Warm Temperate Rainforests	Coastal Sandstone Gallery Rainforest (1828)	
		Coastal Warm Temperate Rainforest (905)	
		Coastal Escarpment Littoral Rainforest (1833)	Littoral Rainforest in the Sydney Basin Bioregion
	Littoral Rainforests	Coastal Headland Littoral Thicket (910)	
Saline wetlands	Seagrass Meadows	Seagrass Meadows (1913)	
	Saltmarshes	Estuarine Saltmarsh (1126)	Coastal Saltmarsh in the Sydney Basin Bioregion
	Mangrove Swamps	Estuarine Mangrove Forest (920)	
Freshwater wetlands	Coastal Heath Swamp	Coastal Upland Damp Heath Swamp (1803)	Coastal Upland Swamp in the Sydney Basin Bioregion
		Coastal Upland Wet Heath Swamp (1804)	Coastal Upland Swamp in the Sydney Basin Bioregion
Forested wetlands	Eastern Riverine Coastal Floodplain Wetlands	Coastal Alluvial Bangalay Forest (1794)	River-flat Eucalypt Forest on Coastal Floodplains of the Sydney Basin Bioregion
		Estuarine Swamp Oak Forest (1234)	Swamp Oak Floodplain Forest of the Sydney Basin Bioregion
		Hinterland Riverflat Eucalypt Forest (941)	
		Sandstone Cliff-face Soak (1127)	
Grasslands	Maritime Grasslands	Beach Spinifex Grassland (1204)	
		Coastal Headland Grassland (898)	Themeda Grassland on Seacliffs and Coastal Headlands in the Sydney Basin Bioregion

Note: PCT ID = plant community type number.

Source: Native Vegetation of the Sydney Metropolitan Area – version 3.1, 2016 (VIS_ID 4489).

Appendix C Description of threatened ecological communities in the park

The following are listed as endangered ecological communities under the Biodiversity Conservation Act.

Duffys Forest Ecological Community in the Sydney Basin Bioregion

Known as Duffys Forest in some vegetation classifications this community forms a component of the shrubby forests and woodlands of coastal Sydney sandstone environments. This community is closely associated with rust-coloured ironstone mantles layered above sandstone ridgelines, with mean annual rainfall above 1,100 millimetres. It features a low to moderately tall eucalypt cover of red bloodwood (*Corymbia gummifera*), silvertop ash (*Eucalyptus sieberi*) and stringybark (*E. capitellata*/*E. oblonga*) on flat to gently sloping terrain. Broad-leaved scribbly gum (*E. haemastoma*) and smooth-barked apple (*Angophora costata*) are not uncommon at sites although they rarely dominate. The Proteaceae family is particularly diverse in the shrub layer; there are often multiple species of banksias, hakeas, persoonias and grevilleas present at a site. A moderate cover of grasses and forbs is found on the forest floor. Elevation for the community ranges between 100 and 300 metres above sea level. The thickness of the ironstone mantle varies considerably across sites and in some instances may be completely eroded. Sites typically have no outcropping sandstone.

Ironstone mantles are likely to have been preferentially cleared for orchards and smaller agricultural pursuits during early settlement where arable, flat lands with good rainfall were sought after. Significant areas have since been removed for urban development and road building. Localised impacts include numerous gravel pits exploiting the laterite for road building. Remaining areas are highly fragmented and threatened by ongoing clearing, weed invasion, rubbish dumping, high fire frequency and erosion.

Pittwater and Wagstaff Spotted Gum Forest in the Sydney Basin Bioregion

Stands of spotted gum (*Corymbia maculata*) mark this distinctive forest on the foreshores and escarpments of the Pittwater peninsula. These trees form a tall open forest that may also include grey ironbark (*Eucalyptus paniculata*) and broad-leaved white mahogany (*E. umbra*). At the lower heights of the eucalypt stratum, it is common to find an open cover of forest oak (*Allocasuarina torulosa*). The middle storey usually comprises a mixed layer of mesic and dry shrub species and occasional palms. Shrub species include blueberry ash (*Elaeocarpus reticulatus*), scentless rosewood (*Synoum glandulosum* subsp. *glandulosum*), narrow-leaved geebung (*Persoonia linearis*) and mountain holly (*Podolobium ilicifolium*). Like many spotted gum forests along coastal New South Wales, burrawang (*Macrozamia communis*) can assume a prominent component of the ground layer above a scatter of grasses, ferns and small vines. At times the ground layer appears very grassy, with an abundance of blady grass (*Imperata cylindrica* var. *major*) notable where there is a history of frequent fire.

Pittwater Spotted Gum Forest has a close association with Narrabeen sediments exposed on rises, escarpments and foot slopes throughout northern Pittwater Local Government Area. It is estimated that 75% of its pre-European distribution has been cleared in the Pittwater and Gosford urban areas, with some remaining stands impacted by the encroachment of urban weeds.

Pittwater Spotted Gum Forest is threatened by clearing for urban development, urban run-off, rubbish dumping, garden refuse, weed invasion and inappropriate fire regimes.

Coastal Upland Swamp in the Sydney Basin Bioregion

Coastal upland swamp is endemic to New South Wales and confined to the Sydney Basin Bioregion. The community includes open graminoid heath, sedgeland and tall scrub associated with periodically waterlogged soils.

The community occurs primarily on impermeable sandstone plateaus with shallow groundwater aquifers in the headwaters and impeded drainage lines of streams, and on sandstone benches with abundant seepage moisture.

Threats to this community include altered fire regimes (frequent burning).

Coastal Upland Swamp in the Sydney Basin Bioregion is also listed as endangered under the Environment Protection and Biodiversity Conservation Act.

Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions

Saltmarshes consist of low succulent herbs and rushes on tidally inundated land. These marshes form plains that adjoin open water and mangroves. Throughout the marsh, salinity varies greatly according to tidal influence, evaporation and freshwater accumulation. Some of the areas are flooded regularly, while at slightly higher elevations flooding is rare. After rain, fresh water accumulates and adds extra water to the marsh, leaving pools of standing water when the tide recedes. Chenopod species dominate areas more frequently inundated by the tides, while sea rush (*Juncus kraussii*) occupies the more elevated terrestrial margin. Local scalds occur in small depressions where intensely saline deposits accumulate from the evaporation of tidal waters preventing the growth of any plants at all.

Like many estuarine vegetation communities, large areas have been reclaimed for industrial, recreational and urban land use. Many examples that remain in Sydney are small in size, highly fragmented and patchy in distribution. Historical photographs taken in 1943 across much of the Sydney area clearly indicates that some former saltmarshes and mud flats are now colonised by dense stands of mangroves.

Reclamation has altered the landscape of estuarine environments. Heavy recreational pressure, rubbish dumping, invasion by weeds and sedimentation are ongoing threats to this community (Keith 2004). Sea level rise associated with climate change presents the greatest threat to the long-term persistence of this community; small rises will permanently inundate these intertidal zones.

Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions

This community is found on the coastal floodplains of New South Wales. It has a dense to sparse tree layer in which swamp oak (*Casuarina glauca*) is the dominant species. The structure of the community may vary from open forests to low woodlands, scrubs or reedlands with scattered trees.

It is found where the groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains.

Threats to this community include weed invasion, such as lantana, and altered fire regimes (frequent burning).

River-flat Eucalypt Forest on Coastal Floodplains of the Sydney Basin

River-flat eucalypt forest is found on the river flats of the coastal floodplains. It has a tall open tree layer of eucalypts, which may exceed 40 metres in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality. While the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include forest red gum (*Eucalyptus tereticornis*), cabbage gum (*E. amplifolia*), rough-barked apple (*Angophora floribunda*) and broad-leaved apple (*A. subvelutina*). Blue box (*E. baueriana*), bangalay (*E. botryoides*) and river peppermint (*E. elata*) may be common south from Sydney, swamp gum (*E. ovata*) occurs on the far south coast, Sydney blue gum (*E. saligna*) and flooded gum (*E. grandis*) may occur north of Sydney, while *E. benthamii* is restricted to the Hawkesbury floodplain.

A layer of small trees may be present, including Melaleuca decora, prickly-leaved teatree (*M. styphelioides*), grey myrtle (*Backhousia myrtifolia*), white cedar (*Melia azaderach*), river oak (*Casuarina cunninghamiana*) and swamp oak (*C. glauca*).

River-flat eucalypt forest on coastal floodplains provides habitat for a broad range of animals, including many that are dependent on trees for food, nesting or roosting. These include cormorants and egrets, the osprey (*Pandion cristatus*), whistling kite (*Haliastur sphenurus*), white-bellied sea-eagle (*Haliaeetus leucogaster*), as well as the brush-tailed phascogale (*Phascogale tapoatafa*), yellow-bellied glider (*Petaurus australis*), squirrel glider (*Petaurus norfolcensis*), sugar glider (*Petaurus breviceps*) and grey-headed flying-fox (*Pteropus poliocephalus*).

Threats to this community include weed invasion, changes to drainage and flooding regimes, changes to water quality, altered fire regimes (frequent fire) and disturbance from unauthorised recreation activities.

Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions

This community is generally a closed forest, the structure and composition of which is strongly influenced by proximity to the ocean. The plant species in this ecological community are predominantly rainforest species with evergreen mesic or coriaceous leaves. Several species have compound leaves, and vines may be a major component of the canopy. These features differentiate littoral rainforest from sclerophyll forest or scrub, but while the canopy is dominated by rainforest species, scattered emergent individuals of sclerophyll species, such as *Angophora costata, Banksia* integrifolia, *Eucalyptus botryoides* and *E. tereticornis* occur in many stands.

Littoral rainforest occurs on both sand dunes and on soils derived from underlying rocks. Stands on headlands exposed to strong wind action may take the form of dense wind-pruned thickets. In more sheltered sites, and in hind dunes, the community is generally taller, although still with wind pruning on the windward side of stands. Floristically there is a high degree of similarity between stands on different substrates. Most stands of littoral rainforest occur within 2 kilometres of the sea, but may occasionally be found further inland, but within reach of maritime influence.

Littoral rainforest is very rare and occurs in many small stands. In total, it comprises less than 1% of the total area of rainforest in New South Wales.

Threats to this community include weed invasion and disturbance from unauthorised recreation activities.

Themeda Grassland on Seacliffs and Coastal Headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions

In the park, this community is found above cliffs at Barrenjoey Headland. Kangaroo grass (*Themeda australis*) and spiny-headed mat-rush (*Lomandra longifolia*) are the dominant species.

Themeda australis is an extremely widespread species, but in this community, it may have a distinctive appearance, being prostrate and having glaucous leaves. These features are retained in cultivation and the form is believed to be genetically distinct.

Threats to this community include weeds and invasion by native shrubs. Although native shrubs are a feature of the community, invasion and conversion to dense shrubland may threaten the persistence of grassland elements in the community.

Appendix D Scientific plant and animal names

The following tables list the common and scientific name for plant and animal species mentioned in this plan.

Common name	Scientific name
Plants	
Angus's onion orchid	*Microtis angusii*
Bangalay	*Eucalyptus botryoides*
Bauer's midge orchid	*Genoplesium baueri*
Beard heath	*Leucopogon amplexicaulis*
Black she-oak	*Allocasuarina littoralis*
Blue stringybark	*Eucalyptus agglomerata*
Broad-leaved white mahogany	*Eucalyptus umbra*
Broom spurge	*Amperea xiphoclada*
Brown stringybark	*Eucalyptus capitellata*
Burrawang	*Macrozamia communis*
Bynoe's wattle	*Acacia bynoeana*
Cabbage tree palm	*Livistona australis*
Caley's grevillea	*Grevillea caleyi*
Camfield's stringybark	*Eucalyptus camfieldii*
Christmas bush	*Ceratopetalum gummiferum*
Coachwood	*Ceratopetalum apetalum*
Dagger heath	*Hakea teretifolia*
Deane's paperbark	*Melaleuca deanei*
Drooping she-oak	*Allocasuarina verticillata*
Dwarf apple	*Angophora hispida*
Eastern Australian underground orchid	*Rhizanthella slateri*
Forest oak	*Allocasuarina torulosa*
Grey gum	*Eucalyptus punctata*
Grey ironbark	*Eucalyptus paniculata*
Grey mangrove	*Avicennia marina*
Hairy geebung	*Persoonia hirsuta*
Kangaroo grass	*Themeda triandra*
Large-fruited red mahogany	*Eucalyptus scias*
Leafless tongue orchid	*Cryptostylis hunteriana*
Lilly pilly	*Acmena smithii*
Narrow-leaf finger fern	*Grammitis stenophylla*
Native rose	*Boronia serrulata*
Netted bottle brush	*Callistemon linearifolius*
Norfolk Island pine	*Araucaria heterophylla*
Old man banksia	*Banksia serrata*

Common name	Scientific name
Pink swamp heath	*Sprengelia incarnata*
Port Jackson fig	*Ficus rubiginosa*
Prickly teatree	*Leptospermum juniperinum*
Red bloodwood	*Corymbia gummifera*
Red cedars	*Toona ciliata*
River mangrove	*Aegiceras corniculatum*
Rough-barked apple	*Angophora floribunda*
Scaly bark	*Eucalyptus squamosa*
Scribbly gum	*Eucalyptus haemastoma*
Scrub she-oak	*Allocasuarina distyla*
Scrub turpentine	*Rhodamnia rubescens*
Seagrass	*Posidonia australis*
Silvertop ash	*Eucalyptus sieberi*
Smooth scrub turpentine	*Rhodamnia rubescens*
Smooth-barked apple	*Angophora costata*
Soft boronia	*Boronia mollis*
Spiny-headed mat-rush	*Lomandra longifolia*
Spotted gum	*Eucalyptus maculata*
Stephenson's platysace	*Platysace stephensonii*
Sundews	*Drosera species*
Sunshine wattle	*Acacia terminalis* ssp. *Eastern Sydney*
Swamp banksia	*Banksia robur*
Swamp oak	*Casuarina glauca*
Sword grass	*Gahnia sieberana*
Sydney blue gum	*Eucalyptus saligna*
Sydney peppermint	*Eucalyptus piperita*
Tufted mat-rush	*Lomandra brevis*
Turpentine	*Syncarpia glomulifera*
Water gum	*Tristaniopsis laurina*
Yellow bloodwood	*Corymbia eximia*
Yellow top mallee ash	*Eucalyptus leuhmanniana*
	Angophora crassifolia
	Blechnum ambiguum
	Boronia fraseri
	Commersonia hermanniifolia
	Darwinia procera
	Hibbertia nitida
	Persoonia isophylla
	Persoonia mollis subsp. *maxima*
	Pimelea latifolia subsp. *hirsuta*

Common name	Scientific name
	Tetratheca neglecta
	Xanthorrhoea arborea
	Xanthorrhoea macronema

Source: Common plant names from PlantNET (The NSW Plant Information Network System), Royal Botanic Gardens and Domain Trust, Sydney, http://plantnet.rbgsyd.nsw.gov.au.

Common name	Scientific name
Animals	
Amphibians	
Giant burrowing frog	*Heleioporus australiacus*
Red-crowned toadlet	*Pseudophryne australis*
Reptiles	
Death adder	*Acanthopis antarcticus*
Diamond python	*Morelia spilota*
Eastern blue-tongued lizard	*Tiliqua scincoides*
Eastern brown snake	*Pseudonaja textilis*
Eastern tiger snake	*Notechis scutatus*
Eastern water dragon	*Physignathus lesueurii*
Green turtle	*Chelonia mydas*
Hawksbill turtle	*Eretmochelys imbricata*
Lace monitor	*Varanus varius*
Leatherback turtle	*Dermochelys coriace*
Loggerhead turtle	*Caretta caretta*
Red-bellied black snake	*Pseudechis porphyriacus*
Rosenberg's goanna	*Varanus rosenbergi*
Birds	
Barking owl	*Nixon connivens*
Black-chinned honeyeater (eastern subspecies)	*Melithreptus gularis gularis*
Blue petrel	*Halobaena caerulea*
Broad-billed sandpiper	*Limicola falcinellus*
Brown falcon	*Falco berigora*
Brush turkey	*Alectura lathami*
Bush stone-curlew	*Burhinus grallarius*
Crested tern	*Thalasseus bergii*
Crimson rosella	*Platycercus elegans,*
Dusky woodswallow	*Artamus cyanopterus cyanopterus*
Eastern osprey	*Pandion cristatus*
Eastern rosella	*Platycercus eximius,*
Eastern spinebill	*Acanthorhynchus tenuirostris*
Fork-tailed swift	*Apus pacificus*

Common name	Scientific name
Galah	*Cacatua roseicapilla*
Gang-gang cockatoo	*Callocephalon fimbriatum*
Glossy black-cockatoo	*Calyptorhynchus lathami*
Grey-tailed tattler	*Tringa brevipes*
Laughing kookaburra	*Dacelo novaeguineae*
Lewin's honeyeater	*Meliphaga lewinii*
Little eagle	*Hieraaetus morphnoides*
Little lorikeet	*Glossopsitta pusilla*
Little penguins	*Eudyptula minor*
Little tern	*Sternula albifrons*
Masked owl	*Tyto novaehollindiae*
Nankeen kestrel	*Falco cenchroides*
New holland honeyeater	*Phylidonyris novaehollandiae*
Pied oystercatcher	*Haematopus longirostris*
Powerful owl	*Nixon strenua*
Rainbow lorikeet	*Trichoglossus haematodus*
Regent honeyeater	*Anthochaera phrygia*
Rock warbler	*Origma solitaria*
Short-tailed shearwater	*Ardenna tenuirostris*
Sooty oystercatcher	*Haematopus fuliginosus*
Sooty shearwater	*Ardenna grisea*
Sooty tern	*Onychoprion fuscata*
Southern giant petrel	*Macronectes giganteus*
Square-tailed kite	*Lophoictinia isura*
Sulphur-crested cockatoo	*Cacatua galerita*
Superb blue wren	*Malarus cyaneus*
Superb lyrebird	*Menura novaehollandiae*
Swift parrot	*Lathamus discolor*
Turquoise parrot	*Neophema pulchella*
Wedge-tailed eagle	*Aquila audax*
Wedge-tailed shearwater	*Ardenna pacifica*
Whistling kite	*Milvus sphenurus*
White-bellied sea-eagle	*Haliaeetus leucogaster*
White-throated needletail	*Hirundapus caudacutus*
Mammals	
Koala	*Phascolarctos cinereus*
Large bent-winged bat	*Miniopterus orianae oceanensis*
Little bent-winged bat	*Miniopterus australis*
Southern brown bandicoot (eastern)	*Isoodon obesulus obesulus*
Southern myotis	*Myotis macropus*

Common name	Scientific name
Spotted-tailed quoll	*Dasyurus maculatus*
Australian fur seal	*Arctocephalus pusillus doriferus*
Brush-tailed possum	*Trichosurus vulpecula*
Ring-tailed possum	*Psudocheirus peregrinus*
Chocolate wattled bat	*Chalinolobus morio*
Eastern pygmy-possum	*Cercatetus nanus*
Feather-tailed glider Appen	*Acrobates pygmaeus*
Gould's wattled bat	*Chalinolobus gouldii*
Grey-headed flying-fox	*Pteropus poliocephalus*
Humpback whale	*Megaptera novaeangliae*
Long-nosed bandicoot	*Perameles nasuta*
New holland mouse	*Pseudomys novaehollandiae*
New Zealand fur seal	*Arctocephalus forsteri*
Platypus	*Ornithorhynchus anatinus*
Southern right whale	*Eubalaena australis*
Swamp wallaby	*Wallabia bicolor*
Other	
Small Sydney crayfish	*Euastacus australasiensis*

Appendix E Key threatening processes in the park

Key threatening processes (*Biodiversity Conservation Act 2016*)
Aggressive exclusion of birds from woodland and forest habitat by abundant noisy miners
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
Anthropogenic climate change
Bush rock removal
Clearing of native vegetation
Competition and grazing by the feral European rabbit
Competition and habitat degradation by feral goats
Competition from feral honey bees
Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments
Forest eucalypt dieback associated with overabundant psyllids and bell miners
Herbivory and environmental degradation caused by feral deer
High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
Importation of red imported fire ants
Infection by Psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis
Infection of native plants by *Phytophthora cinnamomi*
Introduction and establishment of exotic rust fungi pathogenic on plants of the family Myrtaceae
Introduction of the large earth bumblebee
Invasion and establishment of exotic vines and scramblers
Invasion and establishment of Scotch broom
Invasion and establishment of the cane toad
Invasion of native plant communities by African olive (*Olea europaea* subsp. *cuspidata*)
Invasion of native plant communities by *Chrysanthemoides monilifera*
Invasion of native plant communities by exotic perennial grasses
Invasion of the yellow crazy ant
Invasion, establishment and spread of lantana
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
Loss of hollow-bearing trees
Loss or degradation (or both) of sites used for hill-topping by butterflies
Predation and hybridisation by feral dogs
Predation by *Gambusia holbrooki* Girard, 1859 (plague minnow or mosquito fish)
Predation by the European red fox
Predation by the feral cat
Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)
Removal of dead wood and dead trees

Appendix F Feral animals and weeds in the park

The following table summarises key information on feral animals in the park at the time of publication of this plan. Current information on the status of feral animals and whether they have a threat abatement plan can be found on the department's website. Further feral animal information on the park is also available in the relevant NPWS Pest Management Strategy. The Local Land Service Act declares certain animals to be pests.

Feral animals

Common name	Scientific name	KTP	TAP	LLS
Black rat	*Rattus rattus*			
Feral cat	*Felis catus*	Y	Y	
Deer	*Cervus* spp.	Y		
European red fox	*Vulpes vulpes*	Y	Y	Y
European honeybee	*Apis mellifera*	Y		
Wild dog	*Canis lupus familiaris*	Y		Y
House mouse	*Mus musculus*			Y
Rabbit	*Oryctolagus cuniculus*	Y	Y	Y

Notes: KTP = key threatening process listed under the Biodiversity Conservation Act and Environment Protection 1999 and Biodiversity Conservation Act 2016; LLS = Local Land Services; TAP = threat abatement plan prepared under the Biodiversity Conservation Act.

Priority weeds

Common name	Scientific name	WoNS	LLS	KTP
African lovegrass	*Eragrostis curvala*			Y
Agave	*Agave* sp.			
Arrowhead	*Sagittaria platyphylla*	Y	Y	
Asthma weed	*Parietaria judaica*			
Bamboo	*Phyllostachys* spp.			
Bitou bush	*Chrysanthemoides monilifera* subsp. *rotundata*	Y	Y	Y
Boneseed	*Chrysanthemoides monilifera* subsp. *monilifera*	Y	Y	Y
Buffalo grass	*Stenotaphrum secundatum*			
Camphor laurel	*Cinnamomum camphora*		Y	
Cape ivy	*Delairea odorata*			Y
Castor oil plant	*Ricinus communis*			
Cats claw creeper	*Dolichandra unguis-cati*	Y		Y
Climbing asparagus fern	*Asparagus africanus*	Y	Y	Y
Coolatai grass	*Hyparrhenia hirta*			Y
Cockspur coral tree	*Erythrina crista-galli*			
Coral tree	*Erythrina x sykesii*			
Cotoneaster	*Cotoneaster glaucophyllus*			
Crofton weed	*Ageratina adenophora*			

Common name	Scientific name	WoNS	LLS	KTP
Elodea	*Elodea Canadensis*			
Fishbone fern	*Nephrolepis cordifolia*			
Giant reed	*Arundo donax*		Y	
Golden wreath wattle	*Acacia saligna*			
Green cestrum	*Cestrum parqui*		Y	
Ground asparagus fern	*Asparagus aethiopicus*	Y	Y	Y
Gymea lily	*Doryanthes excelsa*			
Kidney-leaf mud plantain	*Heteranthera reniformis*		Y	
Lantana	*Lantana camara*	Y	Y	Y
Ludwigia	*Ludwigia longifolia, L. peruviana*		Y	
Morning glory	*Ipomea indica*			Y
Mossman River grass	*Cenchrus echinatus*			
Mother-of-millions	*Bryophyllum delagoense*			
Mickey Mouse plant	*Ochna serrulata*			
Pampas grass	*Cortaderia selloana*		Y	Y
Panic veldtgrass	*Ehrharta erecta*			
Privet	*Ligustrum lucidum, L. sinense*			
Fishpole bamboo	*Phyllostachys aurea*			
Senecio	*Senecio petasitis*			
Senna	*Senna pendula* var. *glabrata, S. septemtrionalis*			
Small leaf privet	*Ligustrum sinense*			
Tree of heaven	*Ailanthus altissima*			
Turkey rhubarb	*Acetosa sagittata*			
Tussock paspalum	*Paspalum quadrifarium*			
Whisky grass	*Andropogon virginicus*			
Wild tobacco	*Solanum mauritianum*			

Notes: KTP = key threatening process listed under the Biodiversity Conservation Act 2016 and Commonwealth Environment Protection and Biodiversity Conservation Act 1999; LLS = Local Land Services Greater Sydney regional strategic weed management plan 2017–2022; WoNS = Weeds of National Significance.

Acronyms

Acronym	Meaning
DPI	Department of Primary Industries
LLS	Local Land Services
NPWS	NSW National Parks and Wildlife Service
NSW	New South Wales
SEPP	State Environmental Planning Policy
TfNSW	Transport for New South Wales

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More information

- Australian Heritage Database
- Environment and Heritage website
- Department of Climate Change, Energy, the Environment and Water's privacy and security webpage
- Key threatening processes
- Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island nature reserves plan of management
- Local Land Services Act 2013
- National heritage listed area in national parks – see Australian National Heritage
- NSW National Parks and Wildlife Service website
- NPWS park policies:
  - *Pets in parks policy*
  - *Fossicking policy*
  - *Cycling policy*
  - *Horse riding policy*
  - *Visitor safety policy*
  - *Drones in parks policy*
- Ehive Collections Management online database (search for Ku-ring-gai Chase)
- Regional pest management strategies
- NSW BioNet website