



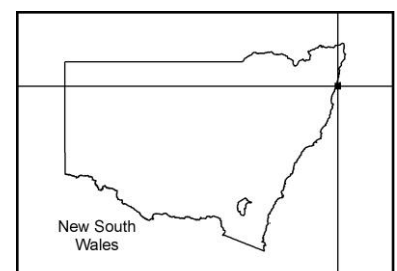
**NSW National Parks  
& Wildlife Service**  
Office of Environment & Heritage

# Plan of Management



## **Solitary Islands Reserves**

**Incorporating North Rock, North Solitary Island, North-West Solitary Island,  
South West Solitary Island and Split Solitary Island Nature Reserves and  
South Solitary Island Historic Site**



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**This plan of management was adopted by the Minister for the Environment on 27 November 2015.**

### **Acknowledgements**

The NSW National Parks and Wildlife Service (NPWS) acknowledges that the Solitary Islands are in the traditional Country of the Gumbaynggirr and Yaegl people.

This plan of management was prepared by staff of the North Coast Region of NPWS, part of the Office of Environment and Heritage.

For additional information or any inquiries about this plan of management or South Solitary Island Historic Site, Split Solitary Island Nature Reserve and South West Solitary Island Nature Reserve, contact the NPWS Coffs Coast Area Office at 32 Marina Drive (PO Box 4200), Coffs Harbour NSW 2450 or by telephone on (02) 6652 0900.

For additional information about North Solitary Island, North Rock and North-West Solitary Island nature reserves, contact the NPWS Clarence South Area Office at 49 Victoria St (PO Box 361), Grafton NSW 2460 or by telephone on (02) 6641 1500.

**Front cover image:** South Solitary Island Historic Site, with South West Solitary Island and Moonee Beach nature reserves in the background. Photo: D Nalder/NPWS

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## Foreword

The Solitary Islands reserves comprise five nature reserves and the South Solitary Island Historic Site, all of which were reserved between 1959 and 2010. Totalling an area of 46 hectares, these island reserves are located between one and 12 kilometres offshore from Coffs Harbour on the NSW north coast.

These reserves provide important nesting habitats for several species of migratory and threatened seabirds and shorebirds, including the wedge-tailed shearwater (or muttonbird). Apart from the uses associated with South Solitary Island lighthouse, the islands have been subject to very little human disturbance. The reserves form a continuum of natural habitats with the underlying reef system of the surrounding Solitary Islands Marine Park.

The South Solitary Island lighthouse, completed in 1880, is one of a series of navigational aids along the NSW coast. The lighthouse tower is one of only two relatively intact, major lighthouses in New South Wales located on an offshore island. A new site-specific conservation management and cultural tourism plan, to be prepared for the South Solitary lighthouse complex, will provide guidance on appropriate cultural tourism use and options for on- and off-site conservation and interpretation of heritage items.

The South Solitary lighthouse and the Solitary Islands have an ongoing cultural significance to the local community and are considered part of the contemporary identity of the Coffs Harbour community. The islands have mythical landscape values to the people of the Gumbaynggirr and Yaegl Aboriginal Nations.

The NSW *National Parks and Wildlife Act 1974* requires that a plan of management be prepared for each nature reserve and historic site. A draft plan of management for the Solitary Islands reserves was placed on public exhibition between 23 November 2012 and 25 February 2013. The six submissions received on the draft plan were carefully considered before adopting this plan.

This plan contains a number of actions to protect our natural environment, including protection of threatened species and communities, and to control pest plants and animals. It also seeks to foster partnerships with Aboriginal people through consultation, especially in relation to management and interpretation of Aboriginal cultural values.

This plan of management establishes the scheme of operations for the Solitary Islands reserves. In accordance with section 73B of the National Parks and Wildlife Act, this plan of management is hereby adopted.



**Mark Speakman**  
**Minister for the Environment**



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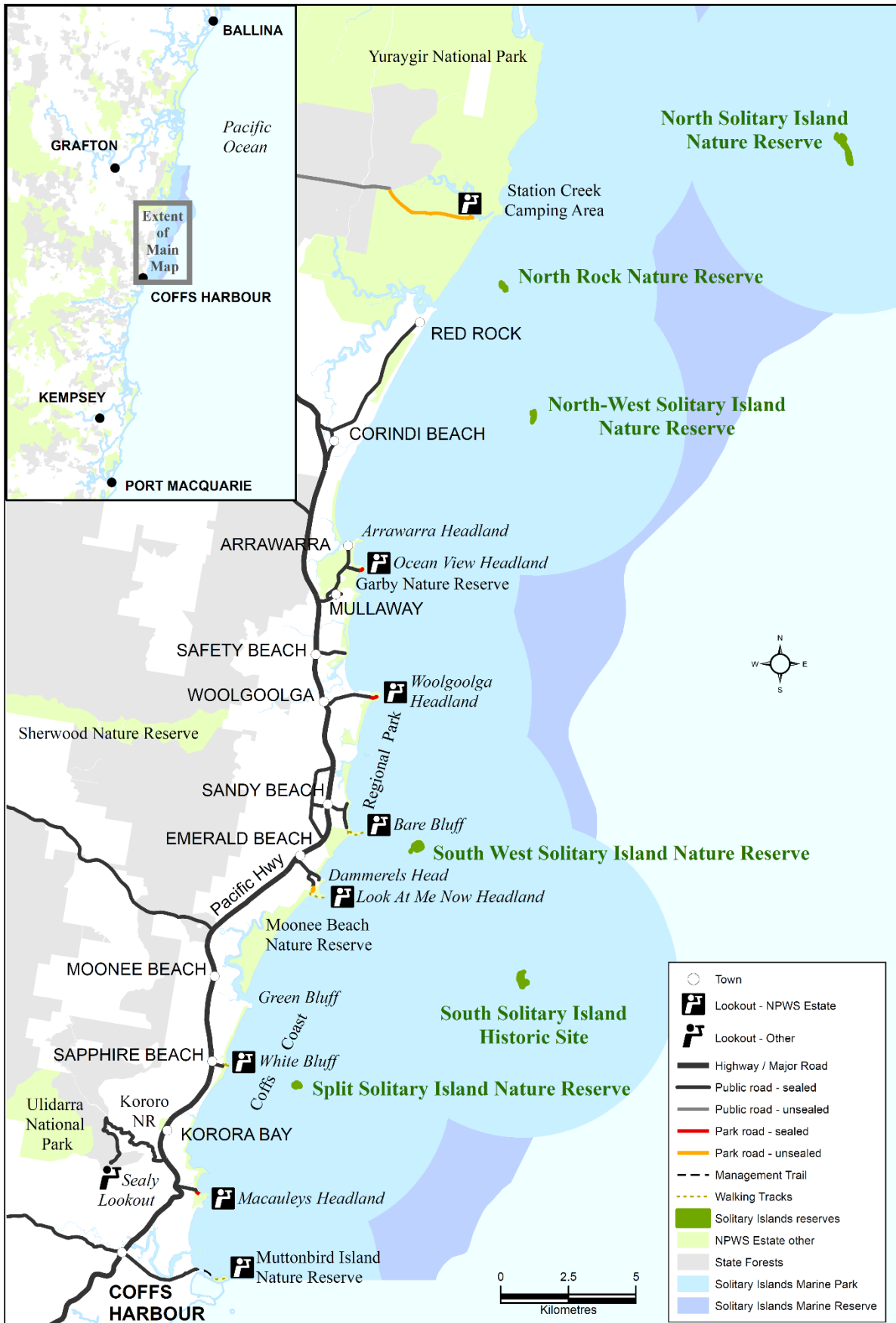
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**Map 1 Solitary Islands reserves**



# 1 Location, reservation and regional context

The Solitary Islands are a group of offshore islands scattered between 1 and 12 kilometres offshore along approximately 42 kilometres of NSW waters to the north-east of Coffs Harbour (30°18'S 153°6.6'E). The six reserves that comprise the area covered by this plan are listed in Table 1 and shown on Map 1.

**Table 1 Solitary Islands reserves**

Name	Reserved area (ha)	Year reserved
North Rock Nature Reserve	4	1959 ^
North Solitary Island Nature Reserve	20	1972
North-West Solitary Island Nature Reserve	4	1971
South Solitary Island Historic Site	11	2010
South West Solitary Island Nature Reserve	3	1961 ^
Split Solitary Island Nature Reserve	4	1961 ^

^ Initially reserved as faunal reserves under the *Fauna Protection Act 1948* and subsequently became nature reserves on the commencement of the *National Parks and Wildlife Act 1967*.

These reserves, with their low growing, salt- and wind-tolerant vegetation, provide important breeding sites for several species of seabirds. Difficult access, coupled with the prohibition of unauthorised entry by the general public to all the reserves to protect nesting seabirds, has resulted in them being subject to very little human disturbance apart from the uses associated with South Solitary Island lighthouse. The lighthouse complex on South Solitary Island is historically significant. This light is still in use as part of the system of maritime navigation aids along the NSW coast. A navigational beacon is also located on North Solitary Island.

Before reservation, the islands were Crown land. South Solitary Island was under the control of the Australian Government until it was transferred to the State of New South Wales in 2000. Most of the reserves are named after the main island that they incorporate, the exception being South West Solitary Island Nature Reserve which incorporates what is officially known as Groper Islet. Several of the reserves include a number of smaller islands or rocky islets.

The reserves' gazetted boundary is the mean high water mark. The lands below this and the surrounding waters lie in the Solitary Islands Marine Park (referred to as the 'marine park' in this plan). The marine park is managed under regulations administered by the NSW Marine Estate Management Authority. This plan of management does not apply to any part of the marine park.

Solitary Islands reserves are part of a regional system of conservation reserves, including nearby Yuraygir National Park, Coffs Coast Regional Park, and Moonee Beach and Garby nature reserves. The reserves also have a biogeographical relationship with other offshore islands used by seabirds, such as nearby Muttonbird Island Nature Reserve, Cook Island Nature Reserve (near Tweed Heads) and Julian Rocks Nature Reserve (near Byron Bay).

The reserves lie offshore from areas within the Clarence Valley and Coffs Harbour City local government areas, with Coffs Harbour the largest population centre near the reserves. The administrative areas of the North Coast Local Land Services, and the Coffs Harbour and District and Grafton-Ngerrie local Aboriginal land councils include the reserves.

## 2 Management context

### 2.1 Legislative and policy framework

The management of nature reserves and historic sites in New South Wales is in the context of the legislative and policy framework of the NSW National Parks and Wildlife Service (NPWS) — primarily the *National Parks and Wildlife Act 1974*, the National Parks and Wildlife Regulation, the *Threatened Species Conservation Act 1995* and NPWS policies.

Other legislation, international agreements and charters also apply to the management of these reserves. In particular, the NSW *Environmental Planning and Assessment Act 1979* may require the assessment and mitigation of the environmental impacts of works proposed in this plan. The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* applies in relation to actions that may impact matters of national environmental significance, such as migratory species and threatened species listed under that Act. The NSW *Heritage Act 1977* may apply to the excavation of known archaeological sites or sites with potential to contain historic archaeological relics.

Migratory species listed under the Environment Protection and Biodiversity Conservation Act are those listed under the international conventions to which Australia is a signatory. These include the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention). Parties to this convention have agreed to protect migratory species, to negotiate and implement agreements for the conservation and management of migratory species with other range states, and to support research related to migratory species. Australia has also negotiated bilateral migratory bird agreements with the governments of Japan, China and the Republic of Korea (JAMBA, CAMBA and ROKAMBA respectively). These treaties apply to the management of listed migratory species that occur in the Solitary Islands reserves, particularly those species which breed in the reserves.

A plan of management is a statutory document under the National Parks and Wildlife Act. Once the Minister has adopted this plan, no operations may be undertaken within the Solitary Islands reserves except in accordance with this plan. This plan will also apply to any future additions to the reserves. Should management strategies or works be proposed for the reserves or any additions that are not consistent with this plan, an amendment to this plan or a new plan will be prepared and exhibited for public comment.

### 2.2 Management purposes and principles

#### Historic sites

Historic sites are reserved under the National Parks and Wildlife Act to protect and conserve areas associated with a person, event or historical theme; or areas containing a building, place, feature or landscape of cultural significance.

Under the National Parks and Wildlife Act (section 30F), historic sites are managed to:

- conserve places, objects, features and landscapes of cultural value
- conserve natural values
- provide for sustainable visitor or tourist use and enjoyment that is compatible with conservation of natural and cultural values
- provide for sustainable use (including adaptive re-use) of any buildings or structures or modified natural areas having regard to conservation of natural and cultural values
- promote public appreciation and understanding of the site's natural and cultural values
- provide for appropriate research and monitoring.



## **Nature reserves**

Nature reserves are reserved under the National Parks and Wildlife Act to protect and conserve areas containing outstanding, unique or representative ecosystems, species, communities or natural phenomena.

Under the Act (section 30J), nature reserves are managed to:

- conserve biodiversity, maintain ecosystem functions, and protect geological and geomorphological features and natural phenomena
- conserve places, objects, features and landscapes of cultural value
- promote public appreciation, enjoyment and understanding of the reserve's natural and cultural values
- provide for appropriate research and monitoring.

Nature reserves differ from historic sites and national parks in that they do not have the provision for visitor or tourist use as a management principle.

### **2.3 Statement of significance**

The following values contribute to the significance of the Solitary Islands reserves:

- The reserves, five of which are nature reserves, are relatively undisturbed by human impacts and provide opportunities for ongoing ecological and conservation research and monitoring.
- The reserves provide important nesting habitats for several species of migratory and threatened birds which rely on the ongoing symbiotic relationship between the birds and the islands' vegetation.
- The reserves form a continuum of natural habitats with the underlying reef system of the Solitary Islands Marine Park.
- The islands have mythical landscape values to the people of the Gumbaynggirr and Yaegl Aboriginal Nations.
- The lighthouse complex on South Solitary Island is of potential state heritage significance because of its age, design and construction.
- The South Solitary lighthouse and the Solitary Islands have an ongoing cultural significance to the local community and are considered part of the contemporary identity of the Coffs Harbour community.
- The South Solitary lighthouse is functionally significant as it continues to operate as an integral part of the network of maritime navigational lights.

### **2.4 Specific management directions**

Management of the Solitary Islands nature reserves and those parts of South Solitary Island Historic Site outside of the historic curtilage will focus on conserving important seabird habitats. This will include restricting visitor use and access.

Management of the South Solitary Island lighthouse and its curtilage (i.e. the highly modified area on South Solitary Island around the lighthouse complex) will focus on conserving and interpreting its historic heritage significance. Supervised tours, functions and events may be permitted.

Research and monitoring will be facilitated and encouraged to assist with the long-term management of the reserves, using existing baseline datasets where available.

## 3 Values

Both Aboriginal and non-Aboriginal people place values on natural areas, including resource, aesthetic, social, spiritual and recreational values. These values may be attached to the landscape as a whole or to individual components, for example, animal species used by Aboriginal people. This plan of management aims to conserve both natural and cultural values. To make the document clear and easy to use, various aspects of natural heritage, cultural heritage, threats and ongoing use are dealt with individually but their interrelationships are recognised.

### 3.1 Landscape, geology and hydrology

Groups of offshore islands are an uncommon feature along Australia's south-east coast. When viewed from the coast, the Solitary Islands are points of interest that contrast with the broad expanse of the ocean. From the water, the islands provide navigational points of reference. South Solitary Historic Site with its lighthouse complex at the apex of the island is a dramatic landmark feature with an impressive visual quality (AHD 1986).

The geology of the reserves is similar to nearby mainland headlands, formed from a sequence of marine sediments laid down in the late Carboniferous age (350–280 million years ago) (Korsch 1980). The sediments have subsequently been heated under pressure (metamorphosed) and tilted. This Coffs Harbour Sequence consists of layers of greywacke, siliceous argillite, sandstone, mudstone and a lesser amount of chert. The northern part of this sequence, which includes most of the reserves, is known as the Coramba Beds. This is differentiated from the neighbouring Brooklana Beds by the greater frequency of sandstone. However, North Solitary Island is atypical in that sandstone is virtually absent, even though it is situated in the Coramba Bed zone (Korsch 1980). South Solitary Island contains some igneous rocks, including a dyke on its western side that could be related to the Emerald Beach Adamellite on the mainland (Floyd 1984).

During a time of lower sea levels when the coastline would have been further east (approximately 15,000–20,000 years ago), the Solitary Islands would have been low hills on a coastal plain. Over time, erosion and inundation by rising sea levels has differentially removed the softer strata and led to the island formations we see today. These processes are continuing. The remaining hard, metamorphosed rock forms the 'skeleton' of the islands and islets. The islands are characterised by steep rocky edges rising to gently domed, vegetated tops.

Although generally small, most of the islands reach altitudes above 30 metres above sea level. Groper Islet in South West Solitary Island Nature Reserve is the highest of the islands, rising to approximately 50 metres above sea level. North Rock only reaches approximately 15 metres above sea level, and the western section is so low it is awash in rough seas.

The shape and exposed nature of the islands leaves them particularly influenced by the ocean and local rainfall. The area has a marked July–October dry season and a February–May wet period, with an annual average rainfall of 1759 millimetres. There is no natural freshwater storage on the islands.

Although there is little variation in the average monthly wave height throughout the year, large waves of more than 4 metres high are more common in winter in the ocean surrounding the reserves, with wave direction usually from the south-east through to the east (MPA 2008). Occasionally a large north-east swell can result from intense low pressure systems known as east coast lows. There are anecdotal reports from former residents of South Solitary Island that during extreme storms waves have washed over the top of the island which stands 41 metres high.

Shallow soils have formed on the less exposed and less steep vegetated domes of the islands. Salt-spray has added nutrients to the soil (e.g. magnesium, potassium and sodium), and bird droppings and shells have contributed phosphorous, calcium and nitrogen. These

nutrients are soluble in water and prone to leaching if the organic matter is removed, but can accumulate in the absence of fire (Floyd 1984).

### Desired outcomes

- Scenic amenity of the reserves is maintained.
- Soil erosion is minimised.

### Management response

3.1.1 Consider scenic amenity of the park's landscape in all proposed works.

3.1.2 Undertake all works and activities in a manner that minimises erosion.

## 3.2 Native plants and animals

### Native plants

The flora of the reserves was surveyed comprehensively in the 1970s and early 1980s (Floyd 1984), and more recently by NPWS staff in 1996 and 2010. More than 70 native plant species have been recorded on the islands, the majority of which are herbs, grasses and vines that form dense ground cover in two distinct habitats: cliffs to steep slopes and gentle elevated slopes. Exposure to waves and salt from ocean spray predominantly determines the islands' vegetation zones. All the reserves have similar native vegetation, with some additional species supported by the different geology of North Solitary Island. The vegetation in the reserves is predominantly undisturbed, except on South Solitary Island.

The vegetation is mainly dense herb fields and grassland, with pockets of low shrubs. On cliffs and steep slopes, common species include sea purslane (*Sesuvium portulacastrum*), ruby saltbush (*Enchylaena tomentosa*), shore spleenwort (*Asplenium difforme*), beach daisy (*Melanthera biflora*) and pig face (*Carpobrotus glaucescens*). Prickly couch (*Zoysia macrantha*), dune bean (*Vigna marina*) and coastal jack bean (*Canavalia rosea*) occur on gentle slopes on shallow soils. On deeper soils, blue flax-lily (*Dianella caerulea*), weeping grass (*Microlaena stipoides*), native commelina (*Commelina cyanea*), variable groundsel (*Senecio pinnatifolius* var. *pinnatifolius*), warrigal greens (*Tetragonia tetragonioides*) and pennywort (*Hydrocotyle peduncularis*) form a very dense cover.

Tuckeroo (*Cupaniopsis anacardioides*) forms a small dense thicket on South West Solitary Island, which can be considered a littoral rainforest association (Floyd 1984). Other patches of littoral rainforest association occur on sheltered parts of North Solitary Island, some of which are little more than vine thickets dominated by coastal vitex (*Vitex trifolia*) and caustic vine (*Sarcostemma australe*) (Floyd 1984). Littoral rainforest is listed as an endangered ecological community under the Threatened Species Conservation Act and is listed as critically endangered under the Environment Protection and Biodiversity Conservation Act.

A number of significant plant species are currently known to occur in the reserves:

- scrambling clerodendrum (*Clerodendrum inerme*), a straggling low shrub which grows in the littoral rainforest community on North Solitary Island at its southern limit of distribution
- *Plectranthus cremnus*, a rare herb which grows on South Solitary Island
- *Vitex trifolia* var. *trifolia*, a species that is rare in New South Wales and is found on North Solitary Island.

The herbaceous vegetation of the reserves has a symbiotic relationship with the seabirds that nest on the islands, particularly wedge-tailed shearwaters (*Ardenna pacifica*). The burrows of the shearwaters are quite shallow, sheltered by a thin layer of vegetation and soft soil above the burrow, and are sometimes lined with plants. The roots of the native commelina and blue flax-lily give the soil strength and make ideal burrow areas, while the variable groundsel stabilises the exposed burrow entrance areas without blocking access for

the birds. The plants thrive on the nutrients from bird droppings and food scraps, along with the mixing of the soil by digging birds.

Transitory patches of dead vegetation or dieback have been observed on all of the islands, and appear to only last a single season. They are thought to be caused by natural cycles of insect attack, varying bird nesting intensity and environmental conditions (Floyd 1984).

The most significant threats to the native vegetation of the reserves are competition from introduced weeds (particularly on South Solitary Island), fires, occasional drought periods and human-induced climate change (see Sections 4.1, 4.2 and 4.3). The introduction of domestic animals and rabbits together with garden plants onto South Solitary Island in the early 1900s impacted heavily on the native vegetation of that island (see Section 4.1). Visitor access to the reserves is restricted (see Section 3.5).

### Native animals

Fauna surveys and formal observations of seabirds on the islands date back to the early 1900s (Lane 1972; Floyd 1984). These records demonstrate the reserves' importance as habitat for migratory birds, and as nesting sites for seabirds and shorebirds. In addition, many birds visit from the tropics (e.g. lesser frigatebird [*Fregata ariel*] and white-tailed tropicbird [*Phaethon lepturus*]) or from temperate waters (e.g. black-browed albatross [*Thalassarche melanophris*] and southern giant-petrel [*Macronectes giganteus*]). This importance was recognised through the reservation of three of the islands as faunal reserves (see Section 1) and the listing of the five nature reserves on the Australian Heritage Database (formerly the Register of the National Estate) in 1978 (AHD 1978a–e).

Many of the migratory bird species that frequent the reserves are protected under international agreements. The reserves also provide habitat for a number of threatened species, including black-winged petrel (*Pterodroma nigripennis*) and eastern osprey (*Pandion cristatus*). Significant species (i.e. listed migratory or threatened species) likely to nest on the islands are listed in Table 2.

**Table 2: Significant bird species likely to nest on the Solitary Islands**

Common name	Scientific name	Legal Status*	Reserves present
Flesh-footed shearwater	<i>Ardenna carneipes</i>	Vulnerable # ^	NS, SWS, SS
Sooty shearwater	<i>Ardenna grisea</i>	^	NS, SWS, SS
Wedge-tailed shearwater	<i>Ardenna pacifica</i>	^	NS, NR, NWS, SS, SWS, SpS
Sooty oystercatcher	<i>Haematopus fuliginosus</i>	Vulnerable	NR, NS, NWS, SWS, SpS
White-bellied sea-eagle	<i>Haliaeetus leucogaster</i>	^	NS, NWS, SS, SWS, SpS
Eastern osprey	<i>Pandion cristatus</i>	Vulnerable	NWS, SS
Black-winged petrel	<i>Pterodroma nigripennis</i>	Vulnerable	NS
Fluttering shearwater	<i>Puffinus gavia</i>	^	NS, SWS
Common tern	<i>Sterna hirundo</i>	^	NS, NWS

\* Status under TSC Act.

# Species also listed as nationally threatened under the EPBC Act.

^ Migratory species listed under EPBC Act.

Reserves: NR = North Rock Nature Reserve, NS = North Solitary Island Nature Reserve, NWS = North-West Solitary Island Nature Reserve, SS = South Solitary Island Historic Site, SWS = South West Solitary Island Nature Reserve, SpS = Split Solitary Island Nature Reserve.

Sources: Lane 1972, 1974, 1975; NPWS 2010a.

Shearwaters are 'true' seabirds, spending most of their life at sea and only returning to land for breeding. Four types of shearwater are likely to breed on the Solitary Islands (see Table 2), with another, the short-tailed shearwater (*Ardenna tenuirostris*), recorded as visiting. The wedge-tailed shearwater, also known as the muttonbird, is the only one of these known to nest on all of the Solitary Islands as well as on nearby Muttonbird Island.

Based on observations at Muttonbird Island, the wedge-tailed shearwater's breeding cycle is extraordinarily reliable (Swanson & Merritt 1974). They return, usually to the same burrow, to breed in August each year with egg-laying at the end of November. The chicks hatch in the latter half of January and leave the islands by early May.

Shearwater burrows (number, density, length and depth) vary greatly on different islands in the group in response to varying soil types and vegetation. Generally speaking, depending on habitat quality, there can be up to one burrow every square metre on the Solitary Islands, however, much less than half of the area of these islands supports habitat suitable for shearwater burrows. Up to 3000 breeding pairs were recorded on North Solitary in 1971 (Lane 1974).

Shearwaters are not always the most prolific bird species on the islands. Vast numbers of crested terns (*Thalasseus bergii*) use North, North-West and South Solitary islands for nesting in the summer months in most years. About 8000 breeding pairs were observed on North Solitary Island in 1971, however their breeding is irregular (Lane 1974, 1975).

Silver gulls (*Chroicocephalus novaehollandiae*) nest en masse in the dense modified vegetation around the South Solitary Island lighthouse complex, and are known to have nested on North Solitary Island. Morris (1971) suggested that this species was competing with crested terns for island nest sites, with abnormally high numbers possibly due to the food resources available to gulls in the nearby urban areas.

There are also a number of other birds that use the islands, including reef heron, cormorants and herons. Land birds that frequent the islands include Australasian pipit (*Anthus novaeseelandiae*), willie wagtail (*Rhipidura leucophrys*), kingfishers and flycatchers.

The rocky shores of the islands, including the intertidal zone below high water mark, are zones of transition between marine and terrestrial environments. Invertebrates living on these shores (including crabs, molluscs, gastropods and cunjevoi) are an important food source for many species that frequent the reserves, such as sooty oystercatchers.

In contrast, the importance and composition of the islands' terrestrial invertebrates are not as well known. Opportunistic observations suggest that the dominant herbivore on the islands is an undescribed blue millipede and an undescribed species of land snail has also been recorded. Mites, spiders, ants, flies, mosquitoes, moths and beetles are the most commonly recorded groups. A species of large centipede (up to 30 centimetres long) inhabits South Solitary Island. As centipedes are carnivorous (primarily eating other invertebrates), this species may be a significant predator on the island.

The only known non-avian native vertebrates present on the islands are Burton's snake-lizard (*Lialis burtonis*) and two species of skink (*Egernia frerei* and *Lampropholis delicata*). Several classes of animals have few or no native representatives on the reserves, including amphibians and mammals (Egan 2010).

The most significant threats to animals in the reserves are loss of habitat from introduced weeds or fire, entanglement in weeds, predation by birds of prey and introduced pests, human trampling of the fragile burrows, entanglement in or ingestion of debris in marine environments, and climate change (see Section 4). A national threat abatement plan is in place for the risk posed by marine debris (TSSC 2003).

Strategies for the recovery of threatened species, populations and ecological communities have been set out in a statewide *Threatened Species Priorities Action Statement* (DECC 2007). These actions are currently prioritised and implemented through the *Saving our Species* program which aims to maximise the number of threatened species that can be secured in the wild in New South Wales for 100 years (OEH 2013b). Individual recovery

plans may also be prepared for threatened species to consider management needs in more detail.

The Priorities Action Statement currently contains strategies for each of the threatened bird species recorded in the park and the endangered littoral rainforest community. Actions include weed control and fire protection (see Sections 4.1 and 4.2). Such management may improve the resilience of species to other threats, such as climate change, but it may be necessary to identify and promote ways to increase habitat for seabirds on the mainland.

### **Desired outcomes**

- The natural values of the reserves are maintained.
- Negative impacts on significant migratory or threatened species are stable or diminishing.
- Management of the reserves contributes to the resilience of native species to the negative effects of climate change.

### **Management response**

- 3.2.1 Implement relevant recovery actions for threatened species and communities in accordance with the Priorities Action Statement, recovery plans and threat abatement plans.
- 3.2.2 Regenerate previously disturbed areas outside the historic heritage curtilage to consolidate the populations of significant plants on South Solitary Island.
- 3.2.3 Continue to record observations of plants and animals (including weeds and pests), and vegetation condition during management visits to the islands.

### **3.3 Aboriginal heritage**

Aboriginal communities have an association and connection to the land and life-giving water resources. The land and water within a landscape are central to Aboriginal spirituality and contribute to Aboriginal people's identity. 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.

In the Gumbaynggirr and Yaegl traditional lands, the offshore islands are not necessarily viewed as being separate from other parts of their Country. Indeed, there is geological evidence that the Solitary Islands were part of the mainland, probably low hills on a coastal plain, when the coastline was further east. This was during a time of lower sea levels (approximately 15,000–20,000 years ago) which is within the period of occupation by Aboriginal people. While there have been no investigations on the islands which would reveal any prehistoric sites, it is possible that the islands were regularly visited by Gumbaynggirr or Yaegl people until recent times. While no archaeological sites are known on the islands, the Solitary Islands are of mythological and symbolic importance to local Aboriginal people. Morelli (2008) gives the name of South Solitary Island as *Bunyun.gudi* and the name of North Solitary Island as possibly *Ngarunda*. These islands were believed to be supported by single pillars, which never could be loosened although the islands swayed in stormy seas.

NPWS fosters an ongoing relationship with the Aboriginal community via regular meetings with the Southern Yuraygir Aboriginal Consultative Committee, the Garby Elders and other relevant Gumbaynggirr tribal elders groups. Relevant matters are also referred to the Coffs Harbour and District and Grafton-Ngerrie local Aboriginal land councils. This consultation contributes to the management direction of the reserves.

## **Desired outcome**

- The Aboriginal community is involved in the management and interpretation of the reserves' Aboriginal values.

## **Management response**

3.3.1 Consult and involve relevant Aboriginal community members and organisations in the management of Aboriginal values associated with the reserves.

## **3.4 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. Cultural heritage comprises places and items that may have historic, scientific, cultural, social, archaeological, architectural, natural or aesthetic significance. NPWS conserves the significant heritage features of the parks and reserves that it manages.

The Solitary Islands were named by James Cook as he sailed up the east coast of Australia in 1770, the name being chosen due to their isolated nature. They were charted by Matthew Flinders in 1799.

Due to the number of shipwrecks on the northern NSW coast, the construction of a series of lighthouses became a priority for the colonial government of New South Wales. The construction of the South Solitary Island lighthouse complex was completed in 1880. The complex (see Map 2) comprises the lighthouse tower, a stores annex, residential quarters used by the lighthouse keeper and assistant lighthouse keepers, and the ruins of a high-level loading jetty. The shore end of the jetty was removed in 1986 due to its unsafe condition, and the remainder collapsed in 2003. Water storage wells sunk in the rock are still fed by run-off from the roofs.

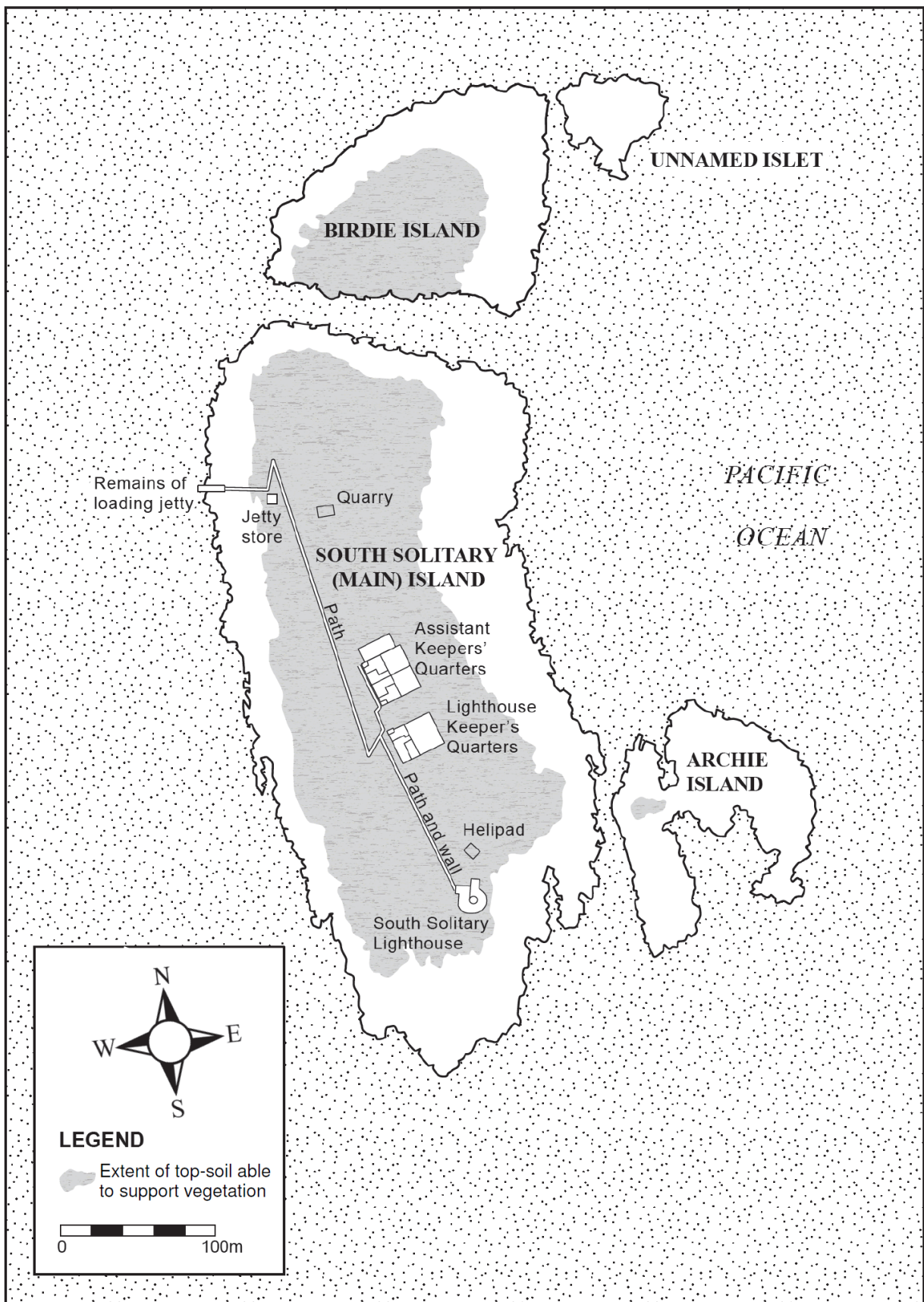
The light tower is 12 metres high from the ground to the lantern and has a curved external wall. Situated at the apex of the island, it is an impressive landmark clearly visible from the Coffs Harbour marina breakwall and from several vantage points and headlands north of Coffs Harbour. Dammerels Head at Emerald Beach has historical links with the lighthouse as it was the site of the signal station which provided early communications between the lighthouse keepers on South Solitary Island and the mainland.

The South Solitary Island lighthouse complex is historically significant for its age, design and construction. It is one of only two relatively intact, major lighthouses in New South Wales located on offshore islands. The complex was the first of three major NSW coastal installations by Colonial Architect James Barnet in which local rock was used as an aggregate for the concrete used to make the tower and the walls of the keepers' cottages (AHD 1986). The resulting architectural expression and functional consistency is of a very high standard (Graham Brooks & Assoc. 2001) with an impressive visual quality in a harsh clifftop setting (AHD 1986).

The lighthouses along the eastern Australian coastline have added cultural significance as a group or collection. Their interdependent role as navigational aids spanning the NSW shipping routes makes the total collection important. Other lighthouses in this collection (e.g. the Smoky Cape lighthouse complex in Hat Head National Park) have been listed on the State Heritage Register, but the South Solitary Island lighthouse group has not been listed. It was, however, listed on the Australian Heritage Database (formerly the Register of the National Estate), and places in New South Wales listed on this database are being considered for listing on the State Heritage Register.

## Map 2 South Solitary Island Historic Site

Source: After Graham Brooks & Assoc. (2001)





The buildings that make up the complex are the oldest still standing in the Coffs Harbour Local Government Area. The complex was occupied by lighthouse keepers and their families for nearly a century until 1975. Members of the keepers' families still live in the local area. This living link to the local community adds to the ongoing significance of the site.

It is likely that remnants of gardens and the subsurface of the historic precinct contain evidence from the period of construction and operation.

When the tower light was automated in 1975, the lightkeepers and their families were removed from the island. A conservation management plan for South Solitary Island was prepared for the Australian Government 20 years later (JRC Planning Services 1996). However, by this time the residential quarters were in a state of disrepair and the island was only accessible by helicopter — the situation that existed when the island was transferred to the NSW Government in 2000.

Management of the complex by NPWS since 2001 has been guided by the *Conservation Management and Cultural Tourism Plan, NPWS Lighthouses* (Graham Brooks & Assoc. 2001). Works have included emergency stabilisation works on the residential quarters that were completed in 2004, and the progressive reinstatement of historic fabric and utilities.

The current condition of the tower is good. Sometime before 2000, photovoltaic panels were installed to charge the batteries that provide power to the lighthouse. These are mounted on the external rails of the tower as well as on an adjacent stand, and the installation did not damage the fabric of the tower.

Following the emergency stabilisation works completed in 2004, the cottages are presently stable and, following some additional recent work on the roofs, weather resistant. The standard of the interior of the cottages is variable, with only parts of the Lighthouse Keeper's Quarters currently suitable for use.

Part of the heritage value of the South Solitary lighthouse complex includes movable heritage items associated with the operation of the lighthouse and the life of the lighthouse keepers on the island. Some of these items have been moved to the mainland and are in a mixture of private and public ownership, including local museums. NPWS supports and encourages public access to these items and considers that the display of some of these items on South Solitary Island may enhance the on-site interpretation of the island's heritage value.

The South Solitary lighthouse complex has the potential for adaptive re-use for staff accommodation (see Section 3.6), for the display and keeping of items associated with the heritage of the island, and for tourist accommodation (see Section 3.5), although the last of these is limited by the island's isolation and difficult access.

Under the National Parks and Wildlife Act, adaptive re-use of a building or structure means the modification of the building or structure and its curtilage to suit an existing or proposed use. This is permitted, subject to assessment and approval, but only if:

- (a) the modification and use is carried out in a sustainable manner,
- (b) the modification and use are not inconsistent with the conservation of the natural and cultural values of the land,
- (c) in the case of a building or structure of cultural significance, the modification is compatible with the retention of the cultural significance of the building or structure.

A new site-specific conservation management and cultural tourism plan is required to guide any future expansion in the use of the historic site and any upgrading or other major works on buildings. It will also need to provide guidance on the conservation and interpretation of movable heritage items. This plan can also formally delineate the historic curtilage, and guide the management of vegetation around the buildings.

### **Desired outcomes**

- The cultural significance of historic features is conserved.

- The curtilage of the lighthouse complex is maintained as a cultural landscape.
- Negative impacts on cultural heritage values are stable or diminishing.

### **Management response**

- 3.4.1 Prepare and implement cyclical maintenance schedules to ensure an appropriate level of maintenance and stabilisation of the lighthouse complex continues.
- 3.4.2 Ensure potential listing of the South Solitary Island lighthouse complex on the State Heritage Register is considered as part of the NSW review of sites on the former Register of the National Estate.
- 3.4.3 Prepare and implement a site-specific conservation management and cultural tourism plan for the South Solitary Island lighthouse complex, including guidelines for cultural tourism use, options for on- and off-site conservation and interpretation of moveable heritage, and delineation of the historic curtilage to be retained in a modified condition.

### **3.5 Visitor use, community programs and education**

Use of the reserves must be carefully managed since they are relatively small and support fragile ecosystems and species which are vulnerable to disturbance. In particular, the seabird nest burrows can easily collapse under foot traffic. There are also difficulties with safe access to most of the islands. Therefore public access to the reserves is not permitted, other than as part of supervised tours to South Solitary Island or as part of authorised research activities. The prohibition of unauthorised visitor access is assisted by the exposed rocky nature of the reserves which, combined with frequently rough sea conditions, does not allow easy access for visitors. Few of the islands offer sites for safe landing in emergencies. There are no visitor facilities in the reserves.

The reserves can be easily seen from the Coffs Harbour breakwater and nearby coastal headlands, and it would be appropriate to provide off-site interpretative signage to promote public appreciation of the reserves' values and awareness of restrictions on visitor access.

School education programs and resource kits on local maritime history, island wildlife and the cultural significance of the islands have been prepared with support from NPWS.

Since 2007, NPWS has worked with stakeholders and the local tourism industry to hold an 'open week' each year to provide opportunities for the public to visit the lighthouse complex on South Solitary Island, and to learn about its history and the lifestyle of the isolated lighthouse keepers. Tours of the island are conducted on a commercial basis and have generated revenue that has been allocated to heritage asset maintenance.

There is demand for the supervised tours to South Solitary Island to include access to the lighthouse tower. NPWS has negotiated a tourism access licence with Australian Maritime Safety Authority (AMSA) which permits NPWS staff to conduct tours of the lighthouse tower once they have been appropriately trained.

Subject to the new conservation management and cultural tourism plan (see Section 3.5), these tours may include overnight stays if it is financially viable to adapt and manage the cottages for tourist accommodation. These may be leased as a commercial operation.

The historic curtilage on South Solitary Island is considered to be a modified natural area, not appropriate for or capable of restoration, which may be leased or licensed for functions and/or events. This does not preclude control of weeds such as kikuyu grass within the curtilage (see Section 4.1).

While use of the islands is limited, and landing on the islands is not permitted except for NPWS approved activities or in emergencies, the waters of the surrounding marine park are popular for a range of recreational activities, including swimming, boating, whale watching, fishing and diving, as well as commercial fishing (subject to the use being permissible at the

relevant location under the marine park zones). A number of moorings have been installed in the marine park at popular diving locations around the islands.

The islands assist in orientating marine park users with the boundaries of marine park zones, and this has required the placing of markers on some of the islands. In addition, a navigational beacon on North Solitary Island and the lighthouse on South Solitary Island provide important navigational lights used by local boats as well as large ships travelling along the east coast.

The reserves are part of the Coffs Coast setting and are visually prominent from the Coffs Coast and inshore waterways. Education programs are needed to foster community support and compliance with the conservation management of the reserves.

Due to the difficult access and limited capacity of the lighthouse complex, off-site interpretation options will be utilised (e.g. interpretative displays on the mainland, media releases, educational material and contact with community groups). Subject to the new conservation management and cultural tourism plan (see Section 3.5), part of the lighthouse complex may be used for the purposes of a small exhibition and keeping space to enhance on-site interpretation.

Signs prohibiting unauthorised landing have been erected on some, but not all, of the reserves.

### **Desired outcomes**

- Negative impacts of visitors on the reserves' values are stable or diminishing.
- Opportunities for guided historic tours on South Solitary Island continue.
- Appropriate cultural tourism opportunities are provided on South Solitary Island.
- The local community is aware of the significance of the reserves and of management programs.

### **Management response**

- 3.5.1 Investigate options for the adaptive re-use of the historic complex on South Solitary Island for the purposes of cultural tourism, including visitor accommodation and leasing options, subject to the recommendations of the new conservation management and cultural tourism plan.
- 3.5.2 Seek to maintain a cooperative approach with the Marine Park Authority regarding the enforcement of visitor access restrictions.
- 3.5.3 Establish baseline data on the level of use (including illegal use) and associated impact on the reserves.
- 3.5.4 Audit existing regulatory and informational signage on the reserves. Maintain existing signs and install additional signage if required to deter illegal access and use. Where possible, incorporate regulatory symbols on existing signs.
- 3.5.5 Liaise with local volunteer marine rescue groups, fishing clubs and other marine park users to ensure they understand restrictions on access and lighting of open fires, and are aware of safe emergency landing locations on the islands.
- 3.5.6 Subject to funding and the permission of the relevant land manager, install interpretative signage on the values of the reserves in the vicinity of Coffs Marina or other appropriate vantage points.

## **3.6 Research and monitoring**

The Solitary Islands are relatively undisturbed by humans, surrounded by marine park, and have been the focus of various research and monitoring programs since the late 1960s. A

number of vegetation and bird surveys have been conducted and provide a great deal of baseline and other information for managing the reserves. Opportunities to repeat these surveys or undertake other relevant research on the islands should be encouraged and facilitated.

Baseline surveys of the island seabird populations — most notably breeding populations of wedge-tailed shearwater — were conducted on all of the reserves during the late 1960s and early 1970s (see *Seabird Islands* series). These surveys involved banding adults and nestlings (wedge-tailed shearwaters mostly, but also silver gulls); determining the status of breeding seabirds on each of the islands; and mapping the extent of each breeding population. The *Seabird Islands* papers also documented the ornithological history of each island and other seabirds recorded during researchers' visits. These surveys provide important baseline information on the status and extent of breeding seabirds on the reserves. Follow-up surveys in more recent years have involved further bird banding and identification of breeding areas on North, South West and South Solitary islands.

A fire was lit by stranded fishermen on South West Solitary Island in 1973. The fire killed possibly half of the wedge-tailed shearwater population that was present at the time and had a significant impact on the island's vegetation. A 10-year research and monitoring program provided an opportunity to assess the recovery of the island's vegetation and shearwater population after the fire. Annual surveys were conducted over an eight-year period and more recent follow-up surveys have been conducted (in 1997–98 and 2008).

The demise of rabbits on South Solitary Island provided an opportunity to study the recovery of vegetation on the main island using adjacent Birdie Island as a comparison. Annual measurements were made over a 10-year period.

Future research — whether new studies or replicates of previous surveys — may be permitted where they have a clear nexus with the values and purpose of the reserves, and where environmental impacts are not significant.

### **Desired outcomes**

- Research and monitoring assists in the long-term management of the islands.
- Research and monitoring have minimal impact on the islands' values.

### **Management response**

- 3.6.1 Encourage ongoing monitoring and research of the islands' vegetation and seabird populations using established methodologies and survey sites.
- 3.6.2 Encourage other research and monitoring (e.g. impacts of climate change) to assist with long-term management of the reserves.
- 3.6.3 Encourage community monitoring as appropriate.
- 3.6.4 Compile all existing research papers and data and create a centralised storage system for this information and knowledge. Ensure any new information is incorporated.

## 4 Threats

### 4.1 Pests

Pest species are plants and animals that have negative environmental, economic and social impacts and are most commonly introduced species. Pests can have impacts across the range of park values, including impacts on biodiversity, cultural heritage, catchment and scenic values.

NPWS prepares regional pest management strategies which identify pest species across that region's parks and priorities for control, including actions listed in the Priorities Action Statement (see Sections 3.2 and 3.3), threat abatement plans, and other strategies such as the NSW *Biodiversity Priorities for Widespread Weeds* (NSW DPI & OEH 2011) and the *NSW Biosecurity Strategy 2013–2021* (DPI 2013).

The NPWS *Regional Pest Management Strategy 2012–17, North Coast Region – A new approach for reducing impacts on native species and park neighbours* (OEH 2012) identifies pest species and priority programs for these reserves. 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- or pest-specific plans or strategies need to be developed to provide a more detailed approach.

A separate weed management strategy has been prepared for South Solitary Island (NPWS 2012) which identifies high priority weeds for control, mostly exotic grasses and vines. Planning of control work and use of herbicides must take into consideration potential impacts on nesting birds, significant plant communities and species (such as *Plectranthus cremnus* which is threatened by weed invasion on South Solitary Island) and cultural heritage values.

Introduced animals are not present in the five Solitary Islands nature reserves, and introduced plants, although present in these reserves, are not considered a major issue. In contrast, the introduction of domestic animals (goats, mice and rabbits) together with garden plants onto South Solitary Island in the late 19th century has had significant impacts on that island's ecosystems. The natural vegetation was denuded and some of the topsoil eroded away on the main island, although there was little impact on nearby Birdie and Archie islands.

The goats did not survive long but the rabbits persisted until 1975. The house mouse (*Mus musculus*) still occurs on South Solitary Island. Impacts of mice include predation of bird eggs and hatchlings, invertebrates and skinks; damage to historical buildings; and significant consumption of native seeds and seedlings. The national threat abatement plan to reduce the impacts of exotic rodents on biodiversity on offshore islands (DEWHA 2009a) sets out actions relevant to the management of feral mice on South Solitary Island.

A list of the priority weed species in the reserves is given in Table 3. Many weeds occur only on South Solitary Island due to its history of human use. Groundsel bush (*Baccharis halimifolia*) has been effectively controlled on South Solitary Island by NPWS since 2000 but a population of this noxious weed survives in South West Solitary Island Nature Reserve.

The upper part of South Solitary Island is still dominated by introduced plants such as kikuyu grass (*Pennisetum clandestinum*). On other parts of the island the vegetation has recovered somewhat, probably assisted by the seed source of the adjacent Birdie Island, however, it is likely to take many decades for the friable, humus-rich topsoil to build up again.

Invasion of native plant communities by exotic perennial grasses is a key threatening process under the Threatened Species Conservation Act (NSW SC 2003). Kikuyu grass is included in this threat as it can form dense mats across the surface of the ground displacing native plant species and blocking access by burrowing birds. A seabird habitat restoration project on Montague Island, off the far south coast of New South Wales, has developed a successful methodology for kikuyu grass control on offshore islands using a combination of

burning, spraying and assisted revegetation (DECCW 2009a). This technique may be suitable for use on South Solitary Island.

Invasion and establishment of exotic vines and scramblers is another key threatening process under the Threatened Species Conservation Act (NSW SC 2006). Madeira vine (*Anredera cordifolia*) and coastal morning glory (*Ipomoea cairica*) are part of this threat on South Solitary Island.

**Table 3: Main weed species on the Solitary Islands**

Common name	Scientific name	Reserves present
Madeira vine ~ *	<i>Anredera cordifolia</i>	SS
Narrow-leaved carpet grass	<i>Axonopus fissifolius</i> (prev. <i>affinis</i> )	SS, SpS
Groundsel bush <sup>N</sup>	<i>Baccharis halimifolia</i>	SWS
Prairie grass	<i>Bromus cartharticus</i>	SS, SWS
Mother-of-millions *	<i>Bryophyllum delagoense</i>	SS
Large-flower purslane	<i>Calandrinia menziesii</i>	NS, SS
Flaxleaf fleabane	<i>Conyza bonariensis</i>	SS, SWS
Summer grass	<i>Digitaria ciliaris</i>	NS, SS, SpS, SWS
Crowsfoot grass ~	<i>Eleusine indica</i>	NS, SS
Common barb-grass	<i>Hainardia cylindrica</i>	NWS, SS
Coastal morning glory ~ *	<i>Ipomoea cairica</i>	NS, NWS, SS, SWS
Makarikari grass	<i>Panicum coloratum</i> var. <i>makarikiense</i>	SS, SWS
Vasey grass ~ *	<i>Paspalum urvillei</i>	SS
Kikuyu grass ~ *	<i>Pennisetum clandestinum</i>	SS
Common sowthistle	<i>Sonchus oleraceus</i>	NR, NS, NWS, SS, SWS

Reserves: NR = North Rock Nature Reserve, NS = North Solitary Island Nature Reserve, NWS = North-West Solitary Island Nature Reserve, SS = South Solitary Island Historic Site, SWS = South West Solitary Island Nature Reserve, SpS = Split Solitary Island Nature Reserve.

~ species considered part of a key threatening process.

<sup>N</sup> noxious weed in Coffs Harbour City Local Government Area.

\* identified as a high priority for control (NPWS 2012).

### Desired outcomes

- Negative impacts of introduced species are controlled and where possible eliminated.
- Control programs have minimal impact on the reserves' values.

### Management response

- 4.1.1 Manage introduced species in accordance with the priorities outlined in the NPWS regional pest management strategy, other relevant pest strategies and threat abatement plans, and the Priorities Action Statement.
- 4.1.2 Plan pest management works to minimise the impact on sensitive plants and animals, particularly during nesting times.
- 4.1.3 Prepare and implement a quarantine protocol to minimise the chances of introducing pest species and other problems to the reserves. AMSA will be consulted during the preparation of the protocol.

## 4.2 Fire

The primary objectives of NPWS fire management are to protect life, property, community assets and cultural heritage from the adverse impacts of fire, while also managing fire regimes in parks to maintain and enhance biodiversity and protect cultural heritage. The built assets that are vulnerable to fire in the reserves are the historic structures on South Solitary Island and the navigational beacon on North Solitary Island. NPWS also assists in developing fire management practices that contribute to conserving biodiversity and cultural heritage across the landscape, and implements cooperative and coordinated fire management arrangements with other fire authorities, neighbours and the community (OEH 2013a).

Fire is a natural feature of many environments, however, offshore islands are an exception. Fires have the potential to have a devastating impact on the islands' vegetation communities and burrowing habitat for shearwaters and can cause severe erosion. Ignition sources are limited to rare lightning strikes or human activity.

Although rare, the catastrophic nature of such an event became evident after a fire started by stranded fishermen on South West Solitary Island Nature Reserve in January 1973 burnt part of the island, killing many nesting birds and their eggs (Floyd 1984). This single fire event caused long-term removal of nesting habitat and recovery of the vegetation to pre-fire levels has still not occurred. As such, open fires are prohibited within the reserves. Due to the very rare occurrence of unauthorised fires and the prohibition of unauthorised access to the islands, installation of regulatory signage is not warranted.

Frequent fires would lead to loss of most of the plant and animal species from the affected island and high frequency fires have been listed as a key threatening process under the Threatened Species Conservation Act (NSW SC 2000b).

A fire management strategy has been prepared for the reserves (NPWS 2010b). The strategy sets out the fire management zones of the reserves and procedures for wildfire response. The reserves are land management zones to conserve biodiversity, with a mown area surrounding the historic buildings on South Solitary Island designated as an area of reduced fuel. The overall risk of wildfires on the Solitary Islands reserves is considered low due to their isolation from human-induced ignition sources, the low growing vegetation on the islands and the humid maritime climatic conditions. Fire management for the reserves focuses on conservation of biodiversity and cultural heritage through exclusion of unplanned fire and suppression of all wildfires. However, care is needed during fire suppression operations as the nesting burrows of shearwaters could be easily damaged by foot traffic or water bombing. As discussed in Section 4.1, prescribed burning may be useful to control kikuyu grass on South Solitary Island but no other prescribed burns are planned.

Contingency planning and preparation is necessary for quick and effective management responses to individual disaster events, such as loss of seabird nesting habitat from a fire on an island. A number of logistical issues, including access restrictions and lack of facilities, would need to be addressed (see Section 5). Similarly, development of post-fire vegetation restoration strategies would assist management.

### Desired outcomes

- Life, property and natural and cultural values are protected from fire.
- Fire control activities have minimal impact on the reserves' values.

### Management response

- 4.2.1 Implement the reserves' fire management strategy and update as necessary.
- 4.2.2 Suppress all unplanned fires in the reserves as quickly as possible. During suppression operations include measures to protect shearwater burrows.

4.2.3 Prepare a contingency plan for effective and timely restoration of habitat after wildfire.

### **4.3 Climate change**

Climate is a fundamental part of the natural environment that affects the distribution of species and their habitats. The global climate has changed over a geological time scale, however, the rate of this change has accelerated recently due to atmospheric pollution by humans in conjunction with rapid clearing of forests. Human-induced climate change is listed as a key threatening process under the Threatened Species Conservation Act (NSW SC 2000a) and the associated loss of habitat is listed under the Environment Protection and Biodiversity Conservation Act (TSSC 2001).

The NSW climate is highly variable over both space and time, however, projections of changes in future climate include seasonally higher average air temperatures along with more extreme maximum and minimum monthly temperatures by 2050 (DECCW 2010a). Associated global changes are likely to include rising sea levels, as well as changes in the flow and influence of major ocean currents. The yearly average sea level for New South Wales is projected to rise 90 centimetres by 2100 relative to 1990 levels (DECCW 2009b), and it is likely to continue to rise beyond then. The flow of the East Australian Current is already changing (DECCW 2010a).

Projected changes in regional climate on the NSW North Coast include a more extreme influence of the El Niño – Southern Oscillation on rainfall patterns, leading to increased rainfall during summer–autumn and reduced rainfall in winter, with possibly an overall reduction in annual average rainfall (DECCW 2010a). This, coupled with higher evaporative demand, is likely to lead to increased drought severity. The frequency as well as the intensity of storm events may also increase and, as a consequence, the frequency of large swells and waves.

Impacts on the reserves are likely to include: increased erosion; reduced availability of fresh water; shifts in the distribution of plant and animal communities; and changes in the nearby marine food resources available to the reserves' birdlife. Seabirds in particular are considered to be more sensitive to climate change than land birds due to their typically low reproductive potential combined with their high fidelity to breeding sites (Wormworth & Sekercioglu 2011). Direct impacts on the birds nesting in the reserves will include reduction in available habitat and possibly a trend of decreasing numbers of surviving offspring. Migratory birds may be present on the reserves for longer, arriving a few days earlier and leaving several days later with each passing decade (Beaumont et al. 2006). As discussed in Sections 3.2 and 3.6, the recorded information on seabird breeding on the reserves (Lane 1974, 1975) can be used as baseline data to detect significant biological changes as the climate changes.

Structures, in particular the heritage buildings on South Solitary Island, are likely to be damaged more frequently during storm events. Low-lying parts of the reserves are likely to become submerged in the long term.

In response to accelerated climate change, management programs to reduce the pressures arising from other or associated threats, such as invasive species, fire, human disturbance and litter in the marine environment, will help to improve the resilience of the bird populations (Baron et al. 2009). However, increased frequency and intensity of extreme storm events will make conservation management difficult (DECCW 2010b).

#### **Desired outcome**

- The effects of climate change on natural systems are reduced.

#### **Management response**

4.3.1 Continue existing fire, pest and weed management programs to increase the reserves' ability to cope with future disturbances, including climate change.



#### **4.4 Marine pollution**

Litter in marine environments poses a threat to the reserves' seabird populations when they are foraging in the waters surrounding the reserves. Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments is listed as a key threatening process under both the Threatened Species Conservation Act (NSW SC 2004) and the Environment Protection and Biodiversity Conservation Act (TSSC 2003). A national threat abatement plan (DEWHA 2009b) sets out Australia-wide actions, some of which are relevant to the management of the Solitary Islands.

##### **Desired outcome**

- Negative impacts of visitors on the surrounding marine park are stable or diminishing.

##### **Management response**

- 4.4.1 Support appropriate programs to raise public awareness of the need to prevent litter entering the marine environment and to clean up the local marine environment.

## 5 Management access and infrastructure

Given their isolated and windswept location, access to the reserves for management is problematic and expensive, involving a range of complex planning and logistical issues. NPWS staff managing the reserves access South Solitary Island occasionally and the other islands only very infrequently. This is mainly due to the limited need for access but is also due to the lack of facilities to land vessels. Access by boats typically involves wet landings (i.e. swimming ashore from boats held offshore).

Access to the islands by boat is greatly assisted by the cooperative working relationships between NPWS, the Marine Park Authority (MPA) and Fisheries NSW (a division of the Department of Primary Industries (DPI), which allow use of MPA and DPI boats and suitably skilled staff. Wet landings are safe for most of the islands except South Solitary and Split Solitary where rugged and steep rocky shores prevent access. As such, access to these islands (and the others when wet landing is not appropriate) requires the use of helicopters. Formal helipads have been established on South Solitary and North Solitary islands.

The historic cottages on South Solitary Island are progressively being repaired to permit their use as a base for management works and associated short-term accommodation consistent with the *Conservation Management and Cultural Tourism Plan for NPWS Lighthouses* (Graham Brooks & Assoc. 2001). Minor building works have been undertaken to the visiting technical officers' quarters (an outbuilding of the Lighthouse Keeper's quarters). These works reinstated ablution and minor accommodation facilities, and allow for an enhanced on-site management presence on the island. They have also mitigated visitor and workplace safety risks associated with disrupted helicopter services (e.g. due to inclement weather or mechanical difficulties) which could force visitors or staff to remain on the island for an extended time.

Another constraint on management is the need to time works to avoid disturbing nesting seabirds.

Infrastructure in the reserves includes the South Solitary Island lighthouse and the navigational beacon on North Solitary Island. These automated lights are managed under a licence agreement between NPWS and AMSA. AMSA is authorised to carry out routine maintenance and works without the need for prior approval, as long as NPWS is notified on each occasion. Formal helipads have been constructed close to both lights.

Other infrastructure on the islands is limited to signage and zone boundary markers for the surrounding marine park (managed by the Marine Estate Management Authority) and trig stations on North Solitary and South Solitary islands. An agreement between the former Central Mapping Authority (now Land and Property Information, part of the Office of Finance and Services) governs the management of trig stations within lands managed by NPWS.

### Desired outcomes

- Management facilities and operations adequately serve management needs and have minimal impact.
- Existing non-park infrastructure is managed to minimise impacts on natural and cultural values.

### Management response

- 5.1.1 Brief staff and contractors regarding seabird nesting habitat protection prior to accessing and working in the reserves.
- 5.1.2 Maintain regular contact with AMSA to ensure licensed activities associated with the operation and maintenance of the lighthouse and navigation beacon do not significantly adversely impact the reserves' values.
- 5.1.3 In accordance with the agreement between NSW Land and Property Information and NPWS, ensure that any access or vegetation management associated with the trig

stations on North Solitary and South Solitary islands only occur following a full assessment of the environmental impacts.

## 6 Implementation

This plan of management establishes a scheme of operations for North Rock, North Solitary Island, North-West Solitary Island, South West Solitary Island and Split Solitary Island Nature Reserves and South Solitary Island Historic Site.

Activities identified in the plan are listed in the table below. Relative priorities are allocated against each activity as follows:

- **High** priority activities are those imperative to achieve the plan's objectives and desired outcomes and must be undertaken in the near future to avoid significant deterioration in natural, cultural or management resources.
- **Medium** priority activities are those that are necessary to achieve the objectives and desired outcomes but are not urgent.
- **Low** priority activities are desirable to achieve management objectives and desired outcomes but can wait until resources become available.
- **Ongoing** is for activities that are undertaken on an annual basis or statements of management intent that will direct the management response if an issue that arises.

This plan of management does not have a specific term and will stay in force until amended or replaced in accordance with the National Parks and Wildlife Act.

Plan reference	Management response	Priority*
<b>3.1 Geology, landforms and hydrology</b>		
3.1.1	Consider scenic amenity of the park's landscape in all proposed works.	Ongoing
3.1.2	Undertake all works and activities in a manner that minimises erosion.	Ongoing
<b>3.1 Native plants and animals</b>		
3.2.1	Implement relevant recovery actions for threatened species and communities in accordance with the Priorities Action Statement, recovery plans and threat abatement plans.	Ongoing
3.2.2	Regenerate previously disturbed areas outside the historic heritage curtilage to consolidate the populations of significant plants on South Solitary Island.	Medium
3.2.3	Continue to record observations of plants and animals (including weeds and pests), and vegetation condition during management visits to the islands.	Ongoing
<b>3.3 Aboriginal heritage</b>		
3.3.1	Consult and involve relevant Aboriginal community members and organisations in the management of Aboriginal values associated with the reserves.	Ongoing
<b>3.4 Historic heritage</b>		
3.4.1	Prepare and implement cyclical maintenance schedules to ensure an appropriate level of maintenance and stabilisation of the lighthouse complex continues.	Ongoing

<b>Plan reference</b>	<b>Management response</b>	<b>Priority*</b>
3.4.2	Ensure potential listing of the South Solitary Island lighthouse complex on the State Heritage Register is considered as part of the NSW review of sites on the former Register of the National Estate.	Medium
3.4.3	Prepare and implement a site-specific conservation management and cultural tourism plan for the South Solitary Island lighthouse complex, including guidelines for cultural tourism use, options for on- and off-site conservation and interpretation of moveable heritage, and delineation of the historic curtilage to be retained in a modified condition.	Medium
<b>3.5 Visitor use, community programs and education</b>		
3.5.1	Investigate options for the adaptive re-use of the historic complex on South Solitary Island for the purposes of cultural tourism, including visitor accommodation and leasing options, subject to the recommendations of the new conservation management and cultural tourism plan.	Low
3.5.2	Seek to maintain a cooperative approach with the Marine Park Authority regarding the enforcement of visitor access restrictions.	Ongoing
3.5.3	Establish baseline data on the level of use (including illegal use) and associated impact on the reserves.	Low
3.5.4	Audit existing regulatory and informational signage on the reserves. Maintain existing signs and install additional signage if required to deter illegal access and use. Where possible, incorporate regulatory symbols on existing signs.	Medium
3.5.5	Liaise with local volunteer marine rescue groups, fishing clubs and other marine park users to ensure they understand restrictions on access and lighting of open fires, and are aware of safe emergency landing locations on the islands.	Ongoing
3.5.6	Subject to funding and the permission of the relevant land manager, install interpretative signage on the values of the reserves in the vicinity of Coffs Marina or other appropriate vantage points.	Low
<b>3.6 Research and monitoring</b>		
3.6.1	Encourage ongoing monitoring and research of the islands' vegetation and seabird populations using established methodologies and survey sites.	Ongoing
3.6.2	Encourage other research and monitoring (e.g. impacts of climate change) to assist with long-term management of the reserves.	Ongoing
3.6.3	Encourage community monitoring as appropriate.	Ongoing
3.6.4	Compile all existing research papers and data and create a centralised storage system for this information and knowledge. Ensure any new information is incorporated.	Medium / Ongoing

<b>Plan reference</b>	<b>Management response</b>	<b>Priority*</b>
<b>4.1 Pests</b>		
4.1.1	Manage introduced species in accordance with the priorities outlined in the NPWS regional Pest management strategy, other relevant pest strategies and threat abatement plans, and the Priorities Action Statement.	Ongoing
4.1.2	Plan pest management works to minimise the impact on sensitive plants and animals, particularly during nesting times.	Ongoing
4.1.3	Prepare and implement a quarantine protocol to minimise the chances of introducing pest species and other problems to the reserves. Australian Maritime Safety Authority will be consulted during the preparation of the protocol.	High
<b>4.2 Fire</b>		
4.2.1	Implement the reserves' fire management strategy and update as necessary.	Ongoing
4.2.2	Suppress all unplanned fires in the reserves as quickly as possible. During suppression operations include measures to protect shearwater burrows.	High
4.2.3	Prepare a contingency plan for effective and timely restoration of habitat after wildfire.	Medium
<b>4.3 Climate change</b>		
4.3.1	Continue existing fire, pest and weed management programs to increase the reserves' ability to cope with future disturbances, including climate change.	
<b>4.4 Marine pollution</b>		
4.4.1	Support appropriate programs to raise public awareness of the need to prevent litter entering the marine environment and to clean up the local marine environment.	Ongoing
<b>5 Management access and infrastructure</b>		
5.1.1	Brief staff and contractors regarding seabird nesting habitat protection prior to accessing and working in the reserves.	Ongoing
5.1.2	Maintain regular contact with AMSA to ensure licensed activities associated with the operation and maintenance of the lighthouse and navigation beacon do not significantly adversely impact the reserves' values.	Ongoing
5.1.3	In accordance with the agreement between the Land and Property Information and NPWS, ensure that any access or vegetation management associated with the trig stations on North Solitary and South Solitary islands only occur following a full assessment of the environmental impacts.	Ongoing

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