Australian Government
Department of the Environment, Water, Heritage and the Arts

Significant impact guidelines for 36 migratory shorebird species

Migratory species

Background paper to EPBC Act policy statement 3.21

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Contents

Introduction

This paper provides background to *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) policy statement 3.21—Significant impact guidelines for 36 migratory shorebird species, hereafter referred to as the policy statement. This background paper provides the biological and ecological context to the important habitat areas, significant impact thresholds, and mitigation measures outlined for the 36 migratory shorebirds in the policy statement. The information provided in this paper has been prepared based on the best available information, gathered from scientific literature, consultation with experts and an understanding of the application of the EPBC Act. Increases in knowledge will be accounted for in future policy revisions.

Conservation status

Thirty-six international migratory shorebird species regularly visit Australia each year. These species are listed as migratory under the Australian Government EPBC Act identified in Table 1. Listed migratory species are a matter of national environmental significance. Under the EPBC Act an action will require approval from the federal environment minister if the action has, will have, or is likely to have a significant impact on a matter of national environmental significance.

Australia is a signatory to a number of international agreements relating to migratory shorebird conservation, including:

- the Convention on Wetlands of International Importance (also known as the Ramsar Convention)
- bilateral agreements for the conservation of migratory birds between the Government of Australia and the Government of Japan (JAMBA), the Government of China (CAMBA) and the Government of the Republic of Korea (ROKAMBA), and
- the Convention on Conservation of Migratory Species of Wild Animals (also known as the Bonn Convention).

The EPBC Act is the key mechanism for meeting Australia's responsibilities under these agreements. In addition to the EPBC Act, all states and territories have legislation that protects biodiversity and native species. Migratory shorebirds and/or their habitat may also be protected through these various mechanisms.

Actions that affect migratory shorebirds, or their habitat, may need to be assessed by both the Australian Government and state/territory agencies, due to different laws and requirements. This policy statement deals only with actions needing referral under the EPBC Act. If you think your action may affect the species and/or its habitat you should contact the relevant agency in your area.

Table 1: The 36 migratory shorebird species

#	Scientific name	Common name
	Scolopacidae	**Sandpipers and related birds**
1.	*Gallinago hardwickii*	Latham's snipe
2.	*Gallinago stenura*	Pin-tailed snipe
3.	*Gallinago megala*	Swinhoe's snipe
4.	*Limosa limosa*	Black-tailed godwit
5.	*Limosa lapponica*	Bar-tailed godwit
6.	*Numenius minutus*	Little curlew
7.	*Numenius phaeopus*	Whimbrel
8.	*Numenius madagascariensis*	Eastern curlew
9.	*Tringa totanus*	Common redshank
10.	*Tringa stagnatilis*	Marsh sandpiper
11.	*Tringa nebularia*	Common greenshank
12.	*Tringa glareola*	Wood sandpiper
13.	*Xenus cinereus*	Terek sandpiper
14.	*Actitis hypoleucos*	Common sandpiper
15.	*Heteroscelus brevipes*	Grey-tailed tattler
16.	*Heteroscelus incanus*	Wandering tattler
17.	*Arenaria interpres*	Ruddy turnstone
18.	*Limnodromus semipalmatus*	Asian dowitcher
19.	*Calidris tenuirostris*	Great knot
20.	*Calidris canutus*	Red knot
21.	*Calidris alba*	Sanderling
22.	*Calidris ruficollis*	Red-necked stint
23.	*Calidris subminuta*	Long-toed stint
24.	*Calidris melanotos*	Pectoral sandpiper
25.	*Calidris acuminata*	Sharp-tailed sandpiper
26.	*Calidris ferruginea*	Curlew sandpiper
27.	*Limicola falcinellus*	Broad-billed sandpiper
28.	*Philomachus pugnax*	Ruff
29.	*Phalaropus lobatus*	Red-necked phalarope
	Charadriidae	**Plovers and lapwings**
30.	*Pluvialis fulva*	Golden plover
31.	*Pluvialis squatarola*	Grey plover
32.	*Charadrius bicinctus*	Double-banded plover
33.	*Charadrius mongolus*	Lesser sand plover
34.	*Charadrius leschenaultii*	Greater sand plover
35.	*Charadrius veredus*	Oriental plover
	Glareolidae	**Pratincoles**
36.	*Glareola maldivarum*	Oriental pratincole

About migratory shorebirds

East Asian-Australasian flyway

Migratory shorebirds breed in the northern hemisphere and migrate to the non-breeding grounds of Australia along the East Asian-Australasian flyway. The flyway stretches from the breeding grounds of Siberia and Alaska, southwards through east and south-east Asia, to Australia and New Zealand (see Figure 1). Fifty-five migratory species use this route which encompasses 22 countries with over 400 sites of international importance for their populations. Of these species, 36 (about 2 million birds) are known to regularly visit Australia each year (Watkins, 1993).

Over 75 per cent of the flyway populations of eight species of migratory shorebirds, and between 20-75 per cent of another 13 species, reside in Australia during the non-breeding season (Bamford et al, 2008). Compared with other countries in the flyway, this is a very high proportion of species with large populations during the non-breeding period. In addition, large proportions of the populations of species which migrate to New Zealand, including the bar-tailed godwit, red knot and ruddy turnstone, depend on Australia as a stepping-stone for their migration (Bamford et al, 2008).

Figure 1: East Asian-Australasian flyway (prepared by Wetlands International)

Migratory shorebirds depart from their breeding grounds in northern China, Mongolia, Siberia and Alaska from July to October. Birds begin arriving in Australia in late August, with most birds commonly present from October to March each year. The return migration occurs from around March to early June in time for the breeding season in the brief Arctic summer. Birds must arrive, breed and fledge offspring within six to seven weeks before heading south to avoid the harsh northern conditions.

For many species, migration involves a 25000km round trip each year. Their ability to complete these long flights depends on the availability of suitable sites across the flyway. During their migration, migratory shorebirds move through networks of wetland sites, known as staging areas, where they feed

intensively to build up fat and protein reserves to fuel their energetically demanding migration. At the end of their migration, Australia provides migratory shorebirds with essential non-breeding habitats to feed and rest.

The double-banded plover is the one exception to this pattern of north–south migration. This species breeds in New Zealand, with more than half of the population migrating west to south-eastern Australia around February for the non-breeding season every year. This species is typically present in Australia from March to September.

Not all birds return to the breeding grounds during the breeding period. Many young birds remain in the non-breeding areas, perhaps undertaking a partial migration to preferred summer habitat. Sites important to these young birds during the breeding period have been identified in several countries, particularly Australia and New Zealand (Bamford et al. 2008). These are sites that support important numbers of non-breeding birds, including immature individuals. In parts of northern Australia, there is an increase in the abundance of some species during the breeding period (Chatto 2003), due to the partial migration of non-breeding birds from southern Australia. The identification of important sites that are used during the breeding period by non-breeding birds is crucial, as these birds represent the future recruits into the breeding populations. The Roebuck Bay/Eighty Mile Beach region of north-western Australia for example, is not only a key staging site for migrating birds, but also supports large numbers of immature birds during the breeding season. Given the lack of breeding season data for non-breeding sites, it is likely that sites important for juvenile/non-breeding birds are underrepresented across the flyway (Bamford et al. 2008).

Status of shorebird populations

Migratory shorebird populations appear to be declining worldwide (Clemens et al, 2008; Howe et al, 2000; IWSG, 2003; Nebel et al, 2008). These declines are primarily thought to be a result of reduced survival rates due to habitat loss, habitat modification and hunting, rather than reduced recruitment (Gosbell and Clemens, 2006; Priest et al, 2002; Zockler et al, 2002).

There are a number of conservation issues which arise from the migratory lifestyle of these birds. Migratory shorebirds demonstrate high site fidelity and often flock in large numbers at productive habitats to fuel their energetically demanding migration (Clemens et al, 2008). Loss or modification of these habitats appears to cause disproportionate declines in shorebird populations (Morrison et al, 2004; Myers et al, 1987). As the birds depend on the continued existence of well managed sites along a migratory pathway which links Australia to Alaska and Siberia, the loss or degradation of important sites anywhere along the flyway can have international repercussions. This makes a cooperative and concerted international effort an essential element of the conservation of migratory birds.

Conservation of sites tends to be in direct conflict with human use of the areas (Bamford et al, 2008). Migratory shorebirds share the flyway with more than 45 per cent of the world's human population, in countries with rapidly developing economies (Priest et al, 2002). Migratory routes through East Asia are in close proximity to some of the largest concentrations of humans

anywhere. Intertidal habitats in these areas are frequently reclaimed for human use. For instance, in China and South Korea, over 40 per cent of intertidal wetlands, particularly those of the Yellow Sea, have been destroyed by land reclamation (Barter, 2002). Today, more than 80 per cent of wetlands in east and south-east Asia are classified as threatened (Barter, 2002).

In Australia, population monitoring studies have reported declines in migratory shorebird numbers similar to those recorded globally (Gosbell and Clemens, 2006; Nebel et al, 2008; Olsen et al, 2003; Wilson, 2001). While these trends reflect the impacts of habitat loss and degradation in east and south-east Asia, a number of domestic processes are also thought to be contributing to this decline (Creed and Bailey, 1998; Minton and Whitelaw, 2000).

Habitat in Australia

Around August each year, large numbers of migratory shorebirds begin arriving in Australia. Most arrive first at staging sites in northern Australia, before dispersing throughout the country and into a wide variety of habitats.

The particular types of habitat used in Australia vary across the 36 species. Intertidal habitats, including coastal estuaries, mudflats, rocky inlets, reefs and sandy beaches are generally considered to provide the most important sites. However, recent reports also highlight the importance of inland wetlands and grassland areas to migratory shorebirds (Nebel et al, 2008; Taylor, 2003).

Inland wetlands in Australia are often ephemeral due to variability in climate and rainfall. For this reason, some inland sites may not be used for a number of years. However, when these areas receive rain they can provide extremely productive and important habitat. For example, Lake Eyre in South Australia is known to provide important habitat for migratory shorebirds when flooded (Nebel et al, 2008). The migratory shorebirds that use these inland wetlands are highly mobile, allowing them to respond to changes in conditions (Watkins, 1993). Generally, these habitats are only sporadically surveyed due to their ephemeral nature and tendency to be remote and logistically difficult to access. Consequently, there is a distinct lack of data for the vast inland and north of Australia (Clemens et al, 2008).

Habitat suitable for migratory shorebirds in Australia must provide areas rich in food with nearby roosting sites that allow the birds to rest without losing substantial energy to disturbance or extended travel (Clemens et al, 2008). Migratory shorebirds rely on these non-breeding grounds for intensive feeding to build up energy reserves to fuel their northern migration and breeding (Priest et al, 2002). These birds must find enough food to increase their body mass by 70-80 per cent in order to migrate and breed. Foraging sites vary depending on the species. Many migratory shorebirds have specialised feeding techniques that enable them to feed at specific foraging habitat. Depending on the species, factors such as sediment type and size will influence foraging habitat selection.

Migratory shorebirds that use coastal habitat tend to forage at low tide and roost together in large flocks during high tide (Phil Straw, pers. com.). Roosting sites provide areas for the birds to rest safely. The high energy demands on migratory shorebirds means that resting is a critical part of their life cycle. Optimal shorebird roosting habitat must be sufficiently open in order

to allow migratory shorebirds to detect and avoid predation (Clemens et al, 2008). During bad weather, shorebirds may temporarily move to different roosting habitats, choosing more sheltered roosts in depressions, behind low shrubs, behind sandy hummocks and even in four-wheel drive track depressions. Within estuarine environments, principal roost sites include exposed sands at the estuary mouth and on adjacent beaches, saltmarshes that are only marginally submerged during high tide, grassy areas adjacent to the estuary, nearby freshwater wetlands, claypans and occasionally rock groynes and exposed reefs (Chafer 2009).

Once in Australia, many species show a tendency to return to the same sites each year. Migratory shorebirds are also known to use networks of connected sites and will move between these sites depending on the time of day, availability of resources and environmental conditions at the site. Some habitats represent important refuge sites during extreme high tides or weather conditions at preferred sites.

More information on each species is available in Appendix 1.

Important habitat for migratory shorebirds in Australia

Under the EPBC Act, 'important habitat' is a key concept for migratory species, as identified in *EPBC Act Policy Statement 1.1 Significant Impact Guidelines—Matters of National Environmental Significance* (see text box below). Defining this term for migratory shorebirds in Australia is needed to ensure that sites necessary for the ongoing survival of the 36 species are appropriately managed.

The EPBC Act Significant impact guidelines 1.1 state that:

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

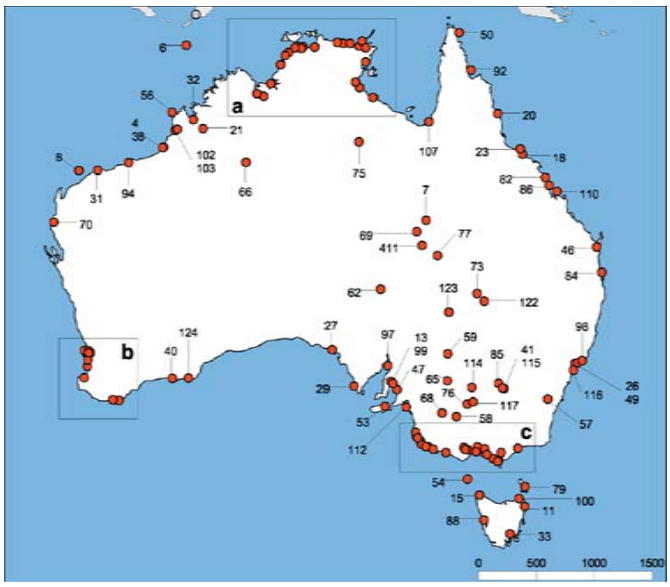
- ***substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of <u>important habitat</u> for a migratory species***
- ***result in an invasive species that is harmful to the migratory species becoming established in an area of <u>important habitat</u> for the migratory species, or***
- ***seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an <u>ecologically significant proportion</u> of the population of a migratory species.***

Important habitat for migratory shorebirds in Australia consists of both nationally and internationally important sites (see below). The widely accepted and applied approach to identifying internationally important shorebird habitat throughout the world has been through the use of criteria adopted under the Ramsar Convention on Wetlands. According to this approach, a wetland should be considered internationally important if it regularly supports:

- one per cent of the individuals in a population of one species or subspecies of waterbird, or
- a total abundance of at least 20000 waterbirds.

This approach has been used to identify 118 sites supporting internationally important numbers of migratory shorebirds in Australia. These sites are shown in Figure 2, and detailed in Bamford et al. (2008).

Figure 2: Migratory shorebird sites of international importance in Australia (taken from Bamford et al, 2008)

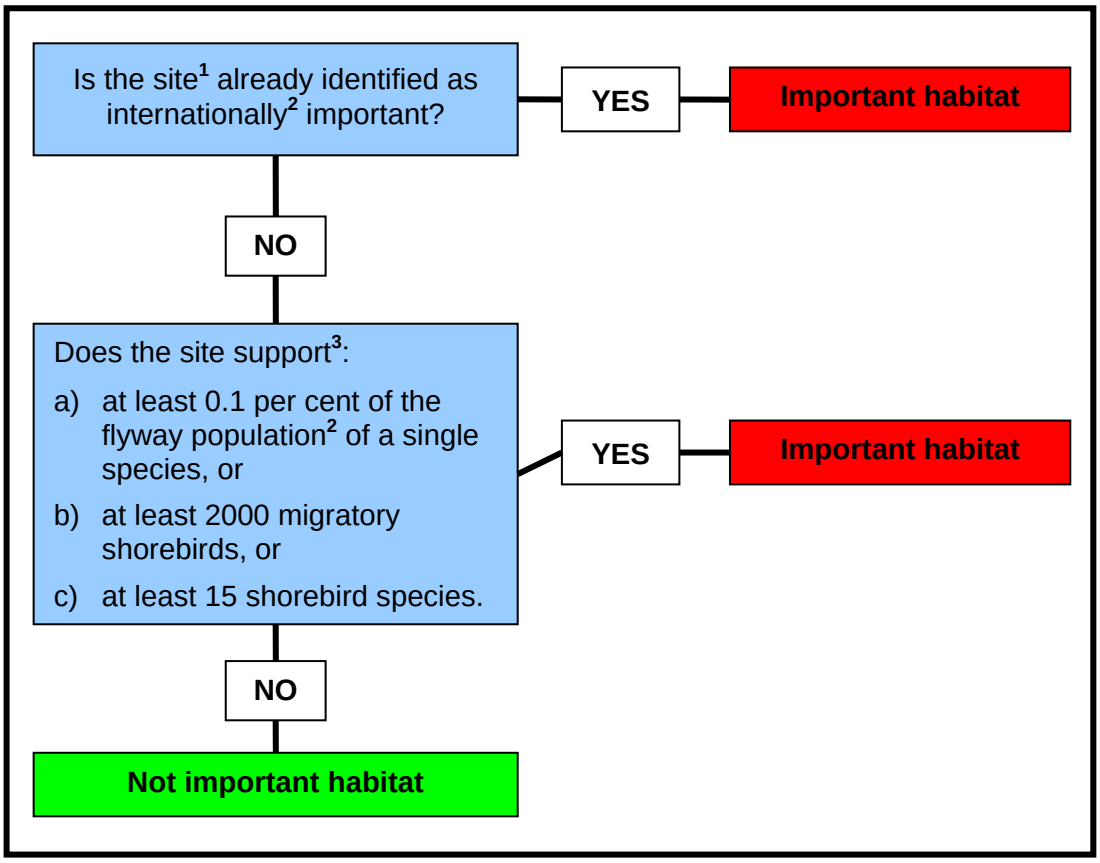


Nationally important habitat for migratory shorebirds is defined using a similar approach to these international criteria. Nationally important habitat for migratory species is defined as habitat that supports at least:

- 0.1 per cent of the flyway population of a single species
- 2000 migratory shorebirds, or
- 15 shorebird species.

Figure 3 illustrates the process for identifying important habitat for migratory shorebird under the EPBC Act. This process applies to each of the migratory shorebird species with the exception of Latham's snipe, *Gallinago hardwickii*. The basis for developing these criteria is discussed in the following chapter.

Figure 3: Process for identifying important habitat for migratory shorebirds (excluding Latham's snipe)



1. 'Site' is defined for migratory shorebirds as: *the entire (discrete) area of contiguous habitat used by the same group of migratory shorebirds, which may include multiple roosts and feeding areas*. The area covered by a migratory shorebird 'site' may extend beyond the boundaries of a property or project area, and may also extend beyond Ramsar boundaries for internationally important areas. Appropriate surveys can determine the extent of a migratory shorebird 'site'.
2. The list of internationally important sites and flyway population estimates, as at 2008, are at: www.environment.gov.au/biodiversity/migratory/publications/shorebirds-east-asia.html

   Where population estimates are presented as a population range, the lowest estimate in the range should be used to calculate the population percentage.

   Local and/or more recent information should be sought during the project planning phases to determine the likelihood of important habitat for migratory shorebirds being present within or near the proposed project site.
3. 'Support' is defined differently depending on whether the habitat is considered permanent or ephemeral.
   - For permanent wetlands, 'support' is defined as: *migratory shorebirds are recorded during surveys and/or known to have occurred at the site within the previous five years.* See below for information regarding survey methodology.
   - For ephemeral wetlands, 'support' is defined as: *habitat that migratory shorebirds have ever been recorded in, and where that habitat has not been lost permanently due to previous actions.*

Development of the criteria for identifying important habitat under the EPBC Act

The threats to migratory shorebirds, both internationally and in Australia, have led to serious declines in shorebird numbers (Nebel et al, 2008; IWSG, 2003; Gosbell and Clemens, 2006; Delany, 2003). As a contracting party to a number of international agreements relating to shorebird conservation, Australia has obligations to protect migratory shorebird habitat and maintain sustainable populations when they are in Australia. While the Ramsar criteria for identifying internationally important shorebird sites is effective in capturing large proportions of migratory shorebird populations in many countries, it does not work well in Australia (Clemens et al, *in prep*). The majority of sites identified in Australia using the Ramsar criteria are staging sites, used by huge aggregations of shorebirds where they enter and exit the country. While shorebirds typically use staging sites intensively, they may use them more intermittently and for relatively short periods compared to breeding or non-breeding sites (Bamford et al, 2008). While staging sites are extremely important for successful migration, the protection of non-breeding sites is also crucial for maintaining healthy populations of shorebirds. The dispersed nature of shorebirds in Australia means that the Ramsar criteria does not identify sufficient non-breeding sites to protect sustainable populations of migratory shorebirds.

A recent study analysed different criteria for identifying important shorebird sites in Australia and suggested an approach for identifying internationally, nationally and regionally important sites (Clemens et al, *in prep*). This study recommended that nationally important shorebird areas are those sites which regularly support at least 0.1 per cent of the flyway population of a single species, or more than 2000 migratory shorebirds. These criteria identified habitat supporting large numbers of migratory shorebirds not captured using existing international criteria, and comes closer to protecting a similar proportion of the migratory shorebirds that visit Australia when compared to the performance of existing international criteria in other countries, such as the Pacific Coast of the United States (Page et al, 1999).

This approach is consistent with that of a number of other countries, who have established a second tier for nationally important sites where international criteria are insufficient. For example, the United Kingdom identifies and protects 270 special protection areas, totalling more than 2 million hectares of habitat for migratory birds using criteria based on one per cent or more of the national population of a non-breeding species or sub-species or one per cent or more of the biogeographical population of a regularly occurring migratory species.

The identification of sites based on percentage of the national population of migratory shorebirds is not possible in Australia. There is not enough information available for each of the 36 species on the proportions of the flyway populations regularly coming to Australia, due to irregular monitoring and the remote and inaccessible locations of many of our sites. Flyway population estimates in the East Asian–Australasian flyway are more robust, and subject to more regular revision.

Consultations with migratory shorebird experts, including state and territory officers, supported the use of the national threshold criteria, in addition to a measure of species diversity. The criteria of *at least 15 shorebird species* was chosen to represent a point at which the shorebird habitat demonstrated very high biodiversity value, regardless of the numbers of birds using the site.

While recognised as a crude measure of "importance", threshold criteria, particularly the percentage of a population criterion, have been shown to be an effective method of identifying sites of biological and ecological significance to migratory shorebirds (Watkins, 1993; Bamford et al, 2008; Page et al, 1999). This approach also has particular merit in an impact assessment context for a number of reasons.

The approach:

- is widely accepted and applied around the world and has the support of migratory shorebird experts
- is known to achieve environmental outcomes by effectively identifying sites of importance to migratory shorebirds
- is practical, clear, straightforward and easy to apply, and
- is transparent and consistent.

While it is not currently known what number of sites or birds is needed to ensure long term viable populations, the observed declines in shorebird numbers suggest that a lower threshold that identifies a greater number of sites supporting a larger proportion of birds is warranted. Much of the habitat in Australia suitable for migratory shorebirds is under increasing pressure from human activities. Many coastal areas in Australia are under considerable pressure from development, while inland wetlands are being lost or degraded due to water extraction processes for agriculture (Nebel et al, 2008). Protecting these nationally important habitats in Australia will be critical to the ongoing survival of migratory shorebirds.

The policy statement therefore advocates a process to identify important migratory shorebird habitat that:

- uses existing information about internationally important sites
- uses the criteria (0.1 per cent or 2000 migratory shorebirds) recommended by Clemens et al. (in prep) for identifying nationally important sites
- recognises that sites that support at least 15 shorebird species are also important to protect given their species richness, and
- applies to all of the 36 species with the exception of Latham's snipe (discussed below).

Existing information

In addition to the internationally important sites for migratory shorebirds identified by Bamford et al. (2008), a number of sites supporting nationally important numbers of migratory shorebirds have been identified as part of the Shorebirds 2020 project, a collaborative enterprise between Birds Australia, the Australasian Wader Studies Group (AWSG), WWF Australia and the Australian Government's Natural Heritage Trust. These sites will be

progressively made available through the Shorebirds 2020 website and the department's protected matters search tool.

Historic and recent survey data may also be available locally, (for example bird observer groups), or through state/territory government agencies.

Analysis of the process for identifying important habitat

The process outlined above for identifying important habitat for migratory shorebirds under the EPBC Act does not perform equally across the 36 species. This is due to variations in the species habitat use, behaviour and population numbers. Following is an analysis of the process based on the work of Clemens et al (2008).

It is likely that the threshold criteria will successfully identify important habitat for 28 of the 36 species. These species tend to use coastal habitats, aggregate in larger flocks, and/or co-locate with other shorebird species more likely to trigger the designation of important habitat. These 28 species are:

Bar-tailed godwit	Great knot	Red-necked stint
Black-tailed godwit	Greater sand plover	Ruddy turnstone
Broad-billed sandpiper	Grey-tailed tattler	Sanderling
Common greenshank	Lesser sand plover	Sharp-tailed sandpiper
Marsh sandpiper	Red-necked phalarope	Terek sandpiper
Curlew sandpiper	Pacific golden plover	Whimbrel
Double-banded plover	Red knot	Grey plover
Eastern curlew	Asian dowitcher	Ruff
Common redshank	Pectoral sandpiper	Long-toed stint
Wandering tattler		

It is likely that important habitat may not be regularly identified for four of the species. This is because they either occur in inland areas in the north of the country that are infrequently visited or surveyed, or only a small proportion of their population is thought to visit Australia. It is unlikely for these species to be regularly considered under the EPBC Act given their distribution and population numbers. Consequently, specific criteria for identifying habitat important to the species have not been developed. The four species are:

Pin-tailed snipe	Swinhoe's snipe	Wood sandpiper
Common sandpiper		

There are three species for which little is known about their population numbers and use of habitat because they occur in inland grassland areas of the country. For these species it is difficult to assess the performance of the criteria. Again, it is unlikely for these species to be regularly considered under the EPBC Act given their distribution and population numbers. The three species are:

Little curlew	Oriental plover	Oriental pratincole

The process for identifying important habitat is not appropriate for Latham's snipe for a number of reasons. Similar to some other species, Latham's snipe does not commonly aggregate in large numbers or co-occur with other species in identified important habitat. However, unlike these species, Latham's snipe occurs in coastal and near coastal areas that are subject to pressures from development and the entire flyway population uses habitat in Australia during the non-breeding season. Consequently, a different approach is needed to identify important habitat for this species.

Criteria for identifying important habitat for Latham's snipe

There are three criteria that have been developed to identify important habitat for Latham's snipe under the EPBC Act. These criteria have been developed with advice from experts relating to the number of individuals of Latham's snipe that signals important habitat for the species and a description of their preferred natural habitat.

Important habitat for Latham's snipe occurs at those sites that are identified as internationally important for the species, or those sites:

- that support at least 18 individuals of the species, and
- that have the following characteristics: a naturally occurring freshwater wetland with vegetation cover nearby (for example tussock grasslands, sedges, lignum and reeds).

The same definitions for **site** and **support** apply to the process for identifying important habitat for Latham's snipe as for the general process (Figure 3).

Key threats and recovery priorities

While a range of threats operate across the East Asia–Australasian flyway, the following is focused on those threats that are likely to occur within Australia and which are relevant within the context of impact assessment.

There are four principal threats most relevant to judgements on significance. These include:

- habitat loss
- habitat degradation
- disturbance, and
- direct mortality.

Habitat loss

Direct habitat loss is a serious threat to migratory shorebirds. In Australia, the loss of important habitat reduces the availability of foraging and roosting sites, affecting the ability of birds to build up the energy stores necessary for successful migration and breeding. Some sites are also important year-round for juvenile birds, with loss of these habitats affecting the future breeding populations of these species.

Their tendency towards high site fidelity and to congregate in large numbers at productive habitats appears to cause disproportionate declines in shorebird populations when important habitat is lost (Morrison et al, 2004; Myers et al, 1987). For example, in Australia, loss of shorebird habitat around Botany Bay

is thought to have led to significant population declines in the area (Clemens et al, 2008).

Habitat may be lost due to a range of activities that make the habitat unavailable to shorebirds. These may include direct loss through clearing, inundation, infilling or draining (for example for buildings, dams or marine services such as harbours, marinas, ports and oil terminals) or indirect loss through changes to hydrology (for example changing flood patterns), water quality or structural changes near some roosting sites (for example increased cover, encroachment of buildings, solid fences).

Habitat degradation

Degradation of shorebird habitat has a similar effect on populations as direct habitat loss. Many migratory shorebirds have specialised feeding techniques, making them susceptible to slight changes to prey sources and their foraging environments. Habitat degradation is associated with activities such as invasion of intertidal mudflats by exotic species. For example, invasion of exotic rice grass (*Spartina anglica*) is thought to have led to the loss of both roosting and foraging habitats for migratory shorebirds in America (Stralberg et al, 2004). Similar impacts from this species have been observed in parts of Australia (Minton and Whitelaw, 2000).

Other examples of activities that may cause degradation to shorebird habitats include water pollution and changes to the water regime; loss of marine or estuarine vegetation which helps stabilise mudflats and provides organic matter to support the invertebrates on which migratory shorebirds feed; expansion of mangroves; artificial changes to hydrological regimes that affect the productivity of the feeding environment; and exposure of acid sulphate soils.

Habitat degradation may also be caused by impacts which are indirect, or not directly associated with a particular activity. For example, nutrient runoff from a construction or development site may compromise the quality of water at a wetland downstream of the development.

Disturbance

Disturbance is emerging as a major conservation issue for migratory shorebirds. The high energy demands of their migratory lifestyle means that disturbance that either reduces their feeding rate or does not allow the birds to rest properly can have a considerable impact on behaviour and energetic fitness (Davidson and Rothwell, 1993; Paton et al, 2000).

Disturbance from human recreation activities such as dog walking, 4WDs, power boating, jet skiing may force migratory shorebirds to increase time devoted to vigilance and anti-predator behaviour or may compel the birds to move to alternative, less favourable feeding areas (Goss-Custard and Verboven, 1993). At high and sustained levels, these activities can prevent shorebirds from using all or part of the habitat and therefore have a significant impact on migratory shorebirds. Other types of continuous disturbance, such as excessive lighting, can cause roosting habitats to be permanently lost as the birds are made more vulnerable to predators (van de Kam et al, 2004). Similarly, many migratory shorebird species are sensitive to changes in the

structural characteristics around roosting sites. The introduction of unsuitable vegetation or solid structures can inhibit the bird's ability to detect and avoid predators, thereby increasing vigilance (nervousness) and potentially rendering the habitat unsuitable.

Direct mortality

Finally, direct mortality of migratory shorebirds may occur due to a variety of reasons and can seriously threaten shorebird populations. Activities that may result in direct mortality include placement of wind farms in migration or movement pathways, chemical or oil spills, and bird strike by aeroplanes.

Conservation objectives

The Wildlife Conservation Plan for migratory shorebirds outlines the overarching objectives for migratory shorebird conservation in Australia. These are to:

1. increase international cooperation for the protection of migratory shorebirds and ensure that countries of the East Asian – Australasian Flyway work together to conserve migratory shorebirds and their habitat
2. identify, protect and sustainably manage a network of important habitat for migratory shorebirds across Australia to ensure that healthy populations remain viable into the future
3. increase biological and ecological knowledge of migratory shorebirds, their populations, habitats and threats in Australia to better inform management and support the long term survival of these species, and
4. raise awareness of migratory shorebirds and the importance of conserving them, and increase engagement of decision makers and the community in Australia in activities to conserve and protect migratory shorebirds and their habitats.

Australia's involvement also includes regional cooperative action through the East Asian–Australasian Flyway Partnership. The partnership, which was launched in November 2006, builds on the achievements of the Asia-Pacific Migratory Waterbird Conservation Strategy and its action plans for Anatidae (swans, geese and ducks), cranes and migratory shorebirds, which guided the international conservation of migratory waterbirds from 1996 to 2006.

Significant impact assessment

Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted and upon the intensity, duration, magnitude and geographic extent of the impacts. The potential for an action to have a significant impact will therefore vary from case to case. However, having had consideration for the threats to migratory shorebirds and their habitats across Australia, the Department of the Environment, Water, Heritage and the Arts has developed the following guidance for the assessment of significant impacts (Table 3).

The elements and thresholds in Table 3 were developed in consultation with experts on migratory shorebirds and their habitats. They are not intended to

be exhaustive or prescriptive, but rather to highlight the need to maintain the ecological function of important habitat and minimise impacts to migratory shorebirds across Australia.

The impact thresholds use the qualitative measure of ***substantial reduction*** to assess the level of significance associated with degradation, disturbance and direct mortality. Reduction in shorebird numbers cannot be quantified in these thresholds due to the many possible variables relating to the type of action and its likely impacts, the habitat involved and the species and number of birds present. Consequently, defining ***substantial reduction*** will need to be made on a case-by-case basis. Factors to consider will include:

- the number of migratory shorebirds historically using a site (based on surveys and historical data)
- likely resultant changes in bird numbers and species diversity
- alterations to the value, quality, and/or geographic extent of the site (for example will the site still be classed as important habitat?)
- the function and role of the site (roosting, foraging) and likely changes in ecology and hydrology
- the regional and local context of the site, and
- the nature, extent and/or duration of impacts; their likelihood and consequence.

Table 3: Significant impact assessment for migratory shorebirds

Ecological element affected	**Impact threshold**	**Comment**
Important habitat	***Loss*** of important habitat	The loss (for example, clearing, infilling or draining) of important habitat areas is likely to have a significant impact on migratory shorebirds when it results in a reduction in the capacity of the habitat to support migratory shorebirds. The magnitude of the impact may increase with the number of shorebirds using the area, the regional significance of the site and/or the extent to which the loss reduces carrying capacity.
	Degradation of important habitat leading to a *substantial reduction* in migratory shorebirds using the site	See above for a discussion about the term *substantial reduction.*
	Increased ***disturbance*** leading to a *substantial reduction* in migratory shorebirds using important habitat	
	Direct mortality of birds leading to a *substantial reduction* in migratory shorebirds using important habitat	

Where there is a possibility of a significant impact on a matter of national environmental significance, a referral under the EPBC Act should be considered.

Mitigation measures

Mitigation activities are measures undertaken on the site of the development to avoid or reduce impacts. Where possible and practicable it is best to avoid impacts, particularly on sensitive environments such as wetlands. If impacts cannot be avoided then they should be minimised or mitigated as much as possible. Effective mitigation measures should be incorporated into the design of a development at the planning stages so that significant impacts on migratory shorebirds, and other matters of national environmental significance, can be avoided. Careful and early planning of the action can avoid, or reduce, the likelihood of a significant impact and when properly integrated into the project design may qualify the proposal for a 20-day *not-controlled action, particular manner* decision under the EPBC Act.

The following are a general set of measures which may assist in minimising impacts on migratory shorebirds associated with important habitat loss, important habitat degradation, disturbance and direct mortality of birds using important habitat. A referral (including all proposed avoidance and mitigation measures) to the federal environment minister may still be required if a real chance or possibility of a significant impact on migratory shorebirds remains, of if legal certainty for the taking of the action is desired.

Habitat loss

Given the serious threats associated with loss of migratory shorebird habitat, proposed developments should be designed to avoid any loss of habitat, including the riparian/wetland fringe and the floodplain system surrounding the habitat. Careful planning through choice of site and project design can avoid or minimise habitat loss. Projects that do not result in habitat loss for migratory shorebirds may not have a significant impact and not need to be referred under the EPBC Act (please note that impacts on other matters of national environmental significance may need to be referred).

Habitat degradation

Efforts should be made to avoid the degradation of migratory shorebird habitat. Both shorebirds and their wetland habitats can be very sensitive to changes to hydrology or water quality (including toxic inflows), fragmentation of sites and exposure to acid sulphate soils. Actions should be designed to avoid reducing the capacity of the important habitat to support migratory shorebirds by implementing measures to manage issues such as runoff, water pollution, water table changes and invasive species. For example, residential developments should incorporate water sensitive urban design features, best practice xtate methodologies for managing contaminated soils and acid sulfate soils and weed management plans.

Disturbance

The impacts of disturbance on migratory shorebirds are a major concern for the sustainable use of their habitat. Disturbance due to human recreation activities as well as other disturbances such as lighting and noise may render both roosting and foraging habitat unsuitable. The design of a development should consider its potential to cause disturbance to migratory shorebirds during both construction and operation phases (and shut down if applicable) and have mechanisms in place to avoid or reduce any impacts. While some activities may result in only low-levels of disturbance, it is important to consider the combined effects of disturbance with other threats when assessing the likely impact.

Different types of disturbance may vary in intensity, frequency, duration, coverage and predictability. For instance, the level of disturbance may differ depending on whether the activities involve encroachment from the water, are land-based or are airborne. There is also variation among the 36 species in their response to disturbance (for example Rodgers and Schwikert (2003); Paton et al, 2000; Weston et al, 2009). Measures to mitigate against these impacts will therefore need to be determined based on which species of shorebird is likely to be present, and the type and intensity of the disturbance.

Options for mitigating impacts from disturbance include:

- the use of buffer zones around areas important for the migratory shorebirds. A number of studies investigating the impact of disturbance pressures on migratory shorebirds have determined appropriate buffer distances (Collins et al, 2000; Davidson and Rothwell, 1993; Fitzpatrick and Bouchez, 1998; James et al, 2003; Paton et al, 2000). For example, James et al. (2003) recommended buffer zones ranging from 165m to 255m. The appropriate buffer will depend on the nature of the individual circumstances, including the species present, habitat type, location and surrounding land use (Weston et al, 2009). As described in Weston et al. (2009) and references therein, the determination of buffer widths should also account for the specific objective of a buffer and for fluctuating water levels. A discussion of buffer design, including guidelines for determining the buffer requirements, is given in the Western Australian Planning Commission (2005).
- Construction of appropriate barriers, such as fences around important habitat, to restricting access. Ideally, there should be no access (by humans and/or domestic animals) to areas identified as important to migratory shorebirds. Where this is not feasible, particular recreational activities may need to be excluded from the area or it may be necessary to limit the number of people using an area at one time or the period in which they can access it. For example, most migratory shorebirds are present between October and March (non-breeding birds may use some habitats during the rest of the year).
- Landscape and urban design, including sympathetic lighting strategies and sound attenuation.
- Community education through mechanisms such as interpretive signs at access points to shorebird habitats.

Direct mortality

A number of developments may lead to direct mortality of migratory shorebirds, including toxic chemical release and attack by domestic pets. Consideration should be given to the location and design of these developments to avoid the potential for direct mortality. For example, wind turbines should not be placed in flight paths of migratory shorebirds. Surveys at the site will assist in determining how migratory shorebirds move through the area.

Survey guidelines

Important habitat is the key element of the process outlined above to assess the likely impacts on migratory shorebirds. Surveys for migratory shorebirds should be conducted at sites where either:

- no suitable survey records exist,
- records are too old to be considered reliable, or
- the site characteristics have changed.

Where accurate data on the site is lacking, site assessment should include surveys to establish the presence and number of migratory shorebirds, as well as the habitat characteristics (for example type, quality, size and availability) and the context of the site within the local region (for example how many other similar sites occur and are these used by shorebirds?).

While some non-breeding individuals may remain in Australia throughout the year, the majority of migratory shorebirds are present during the non-breeding season (peak October-March). The window of time in which count surveys can be conducted for most migratory shorebird species is therefore quite narrow. While count surveys are preferable, there may be cases where it is not possible to survey the site during this window.

Where it is not possible to conduct surveys for migratory shorebirds in the manner recommended, a thorough habitat assessment must be done to identify potential habitat. The characteristics of the site (landform, hydrology, flood levels etc.) should be assessed and used to predict the limits of migratory shorebird habitat. Areas of potential habitat for migratory shorebirds (including both the riparian/wetland fringe and the floodplain system surrounding the habitat) should be treated in a precautionary manner, with potential habitat assumed to be important habitat for the purposes of significant impact assessment. The action should then be designed to avoid significant impacts on birds (including disturbance and direct mortality) and all areas of potential habitat (including loss, degradation etc.).

A guide to conducting count surveys for migratory shorebirds is provided below. These survey guidelines were developed based on a range of existing methodologies for surveying migratory shorebirds. There is significant expertise in surveying migratory shorebirds in Australia, and in some cases, areas known to provide habitat for migratory shorebirds will have been the subject of past or ongoing migratory shorebird monitoring. In such cases there may be a large body of existing data concerning shorebird usage of the site and established survey methods for monitoring migratory shorebirds. Where possible, survey methodologies should be consistent with any pre-existing

survey protocols in order to allow for ease of comparison between data sets. For example, the Australasian Wader Studies Group has been surveying migratory shorebirds for over 20 years and the Shorebirds 2020 project aims to coordinate shorebird monitoring across the country. More information on the Shorebirds 2020 project is available at: www.shorebirds.org.au.

The guide below outlines the survey principles and minimum recommended efforts for the survey of migratory shorebirds in a particular area to support environmental impact assessment. Given that the majority of migratory shorebirds are only present in Australia for a certain period each year, surveys must be conducted at the recommended period. Local knowledge will often be useful to determine the optimal time within these recommended periods to survey.

Survey recommendations for tidal areas

Survey coverage

At a minimum survey coverage should include:

- all of the habitat thought to be used by the same population of shorebirds, and
- the entire area of contiguous habitat where shorebirds may occur.

This will require consideration of the regional context of the wetland and may include multiple discrete roosts and feeding areas.

Survey timing

- Surveys should be conducted during:
    - the period when the majority of migratory shorebirds are present in the area to obtain data on the total population using the site. This period will vary across Australia. For instance, key staging sites often in the north of the country that are used by shorebirds during inbound and outbound migration should be surveyed at the beginning or end of the non-breeding season. Local knowledge should be sought to determine the appropriate time period, and
    - the northern hemisphere breeding season (mid-April to mid-August) to obtain data on non-breeding, non-migrating immature populations of migratory shorebirds at the site, as well as double-banded plover.
- Surveys for roosting shorebirds should be conducted as close to the time of high tide as practicable and at a maximum of no more than two hours either side of high tide (unless local knowledge indicates a more suitable time).
- Surveys for foraging shorebirds should be conducted as close to the time of low tide as practicable and at a maximum of no more than two hours either side of low tide (unless local knowledge indicates a more suitable time).
- Surveys should not be undertaken during periods of high rainfall or strong winds.
- Surveys should not be undertaken when activities are taking place which cause disturbance to the birds.

Survey effort

- Minimum of four surveys for roosting shorebirds during the period when the majority of shorebirds are present in the area. Replicate surveys over this period are important in obtaining adequate data. For example one survey in December, two surveys in January, and one survey in February.
- Minimum of four surveys for foraging shorebirds including two surveys at spring low tide and two surveys at neap low tide.
- Minimum of one survey during the northern hemisphere breeding season to capture birds that remain in Australia during the breeding season as well as the double-banded plover (mid-May to mid-September).
- For large sites or for sites where large numbers of birds are expected, it is recommended that at least two people undertake the counts and agree on the number of birds and the number of species present.

Minimum data requirements

The following should be included in the survey report:

- Shorebird statistics relating to roosting sites:
    - total abundance – total number of birds present across all species
    - species richness – number of species observed, and
    - species abundance – number of birds of each species present.
- Shorebird behaviour:
    - activity at site – roosting only, foraging only, roosting and foraging, and
    - foraging location – spatial data of the area used by shorebirds for feeding to enable mapping of foraging habitat
- Survey conditions:
    - date, time of day
    - tide height, and
    - weather conditions:
        - Temperature
        - Precipitation
        - Wind Speed, and
        - Wind Direction.
- Number of observers and experience level.
- Habitat Characteristics:
    - dominant landform type
    - site hydrology
    - dominant terrestrial and aquatic vegetation types
    - intertidal substrate characteristics
    - invasive species
    - current disturbance regime (see below), and
    - presence of suitable nocturnal roost sites (see below).
- Method used to conduct the survey.

Survey recommendations for non-tidal areas

Surveys of non-tidal wetlands may provide a greater challenge than coastal tidal wetlands as the roosting and foraging behaviour of the birds is less predictable and there is no need for the shorebirds to group together at roosting sites during high tide. In addition, many of the non-tidal areas used by migratory shorebirds in Australia are ephemeral. Where practicable, surveys of these areas should be conducted during optimal conditions for the shorebirds.

Survey coverage

As for tidal areas described above.

Survey timing

- Surveys should be conducted during:
    - the period when the majority of migratory shorebirds are present in the area to obtain data on the total population using the site. This period will vary across Australia. For instance, key staging sites often in the north of the country that are used by shorebirds during inbound and outbound migration should be surveyed at the beginning or end of the non-breeding season. Local knowledge should be sought to determine the appropriate time period, and
    - the northern hemisphere breeding season (mid-April to mid-August) to obtain data on non-breeding, non-migrating immature populations at the site, as well as double-banded plover.
- Surveys should be conducted when habitat conditions are suitable for migratory shorebirds. Typically, non-tidal habitat will be suitable for migratory shorebird use when water is present with a minimally vegetated, exposed margin.
- Surveys should not be undertaken during periods of high rainfall or strong winds.
- Surveys should not be undertaken when activities are taking place which cause disturbance to the birds.

Survey effort

As for tidal areas described above

Minimum data requirements

As for tidal areas described above.

Additional considerations

Levels of human disturbance

Human disturbance is a major threat to migratory shorebirds in some areas and can have a significant impact on the quality of habitat available to migratory shorebirds. As such, it is important that shorebird surveys adequately assess the current disturbance regime at a site. This will allow for an analysis of whether the cumulative disturbance regime of the site (for example existing disturbance plus expected disturbance from the proposal) is likely to result in a significant impact on migratory shorebirds.

Refuge sites

Some sites may provide only marginal habitat for migratory shorebirds under normal conditions but may act as refuge for migratory shorebirds when disturbed at preferred roosting or feeding sites, or when there are extreme conditions at these sites, such as extreme high tides or very strong winds. Surveys should therefore make note of any shorebird habitats outside the study site and attempt to place the study site in the context of the larger wetland environment. Some questions that may help place the site in the broader context include:

- Is the site in close proximity to known shorebird roosting and feeding sites?
- Does similar habitat appear widely available within the region?
- What is the level of connectivity of the site to other areas of known or potential shorebird habitat, or how much movement exists between adjacent sites?
- Are birds known to fly to the site when disturbed at other known sites or during unfavourable conditions at other known sites and if so how long do birds spend at the site before returning to preferred habitat?
- Is the site available during extreme high tides?

Nocturnal roosts

Migratory shorebirds may use different roost sites during the hours of darkness. The most commonly used nocturnal roost sites by shorebirds (other than species that often perch in mangroves such as Whimbrel and tattlers), are shallow pools such as flooded saltmarshes that are free from wave action. These sites apparently offer increased security from predation, as predators must walk through water and wide-open areas to get to the birds.

Surveying nocturnal roost sites can be difficult and may not be practicable during short term assessments of areas. However areas of flooded saltmarsh, coastal lagoons and wet grassland should be noted during surveys as potential nocturnal roost sites and visited where possible during nocturnal spring high tides (the two tides in a day vary greatly and the larger of the two tides may not be at night).

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Appendix

Appendix 1: Migratory shorebirds in Australia – the following table is an amended version of Table A from the Wildlife Conservation Plan for
Migratory shorebirds using up to date data from Bamford et al (2008) and Clemens et al (2008). See http://www.wetlands.org/WatchRead/tabid/56/mod/1570/articleType/ArticleView/articleId/2012/Default.aspx for maximum counts of species at internationally important sites in Australia.

Scientific Name	Common Name	Breeding Area	Habitat preference in Australia	Characteristics	Estimated Flyway Population	Estimated number visiting Australia	0.1% threshold	Internationally important habitat in Australia
Gallinago hardwickii	Latham's snipe	Japan and adjacent parts of Siberia	Freshwater wetlands. Inland, upland and Coastal Plains Soft moist ground or shallow flooded areas	Birds tend not to gather in large flocks. Singularly or in small loose groups	36,000	36,000	Not applicable (see page 11).	1 site of international importance identified
Gallinago stenura	Pin-tailed snipe	Arctic Tundra	Freshwater wetlands, usually grass/sedge swamps or damp to wet grasslands	Mainly seen in North West Western Australia Birds migrate in small flocks of 5 – 10, but are rarely seen in flocks in Australia	25,000 – 1,000,000	Distribution poorly understood in Australia.	25 - 1000	No sites identified as internationally important
Gallinago megala	Swinhoe's snipe	Central Siberia, Mongolia	Freshwater wetlands, usually grass/sedge swamps or damp to wet grasslands	Usually singularly or in small loose groups <25. Mainly seen in Northern Australia	25,000 – 100,000	Poorly counted species as the habitat it favours are not well surveyed	25 - 100	No sites identified as internationally important

Scientific Name	Common Name	Breeding Area	Habitat preference in Australia	Characteristics	Estimated Flyway Population	Estimated number visiting Australia	0.1% threshold	Internationally important habitat in Australia
Limosa limosa	Black-tailed godwit	Iceland, Nth Atlantic, Europe, Russian and China	Mainly coastal, usually sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats. Often found inland in small numbers	Gregarious, small to large groups, numbering hundreds at favourable roosting sites. .	160,000	70,000	160	14 sites of international importance identified
Limosa lapponica	Bar-tailed godwit	Northern Russia, Scandinavia, NW Alaska	Mainly coastal, usually sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats	Gregarious, small to large groups, numbering up to a 1000 at favourable roosting sites	325,000	180,000	325	9 sites of international importance
Numenius minutus	Little curlew	Siberia	Coastal plains, grasslands, often recreational areas such as sports ovals; may forage in dry habitat, but congregate at freshwater eg. Shallow inland pools	Forage in dispersed flocks, congregate to drink and bathe	180,000	175,000	180	8 sites of international importance
Numenius phaeopus	Whimbrel	Siberia, Alaska	Intertidal coastal mudflats, river deltas and mangroves, occasionally sandy beaches	Forage singularly or small groups, congregate in small to large flocks to roost	100,000	30,000	100	7 sites of international importance
Numenius madagascariensis	Eastern curlew	Russia, NE China	Intertidal coastal mudflats, coastal lagoons, sandy spits	Forage singly or in small groups, congregate in large flocks to roost	38,000	28,000	38	18 sites of international importance

Scientific Name	Common Name	Breeding Area	Habitat preference in Australia	Characteristics	Estimated Flyway Population	Estimated number visiting Australia	0.1% threshold	Internationally important habitat in Australia
Tringa totanus	Common redshank	Western Europe	Rare but regular visitor. Not known to visit Australia in significant numbers (<200)	Sheltered coastal wetlands	75,000	Insufficient data	75	No sites identified as internationally important
Tringa stagnatilis	Marsh sandpiper	Eastern Europe to Eastern Siberia	Coastal - permanent or ephemeral wetlands of varying degrees of salinity, commonly inland	Occur singularly or in small to large groups	100,000 – 1,000,000	9,000	100 – 1000	4 sites of international importance
Tringa nebularia	Common greenshank	Arctic Circle, Siberia	Wide variety of inland and sheltered coastal wetlands - mudflats, saltmarshes, mangroves	Occur singularly or in small to large groups	60,000	18,000	60	8 sites of international importance
Tringa glareola	Wood sandpiper	Eurasia, mostly Scandinavia, N China, Siberia	Freshwater wetlands	Singly, pairs or small flocks, occasionally larger flocks of 100s - in North Western Australia	100,000 – 1,000,000	6,000	100 – 1000	No sites identified as internationally important
Xenus cinereus	Terek sandpiper	Russia, eastern Europe	Intertidal coastal, - mainly saline mudflats, lagoons and sandbanks	Singly, pairs or small flocks, roost in small groups with other waders	60,000	22,000	60	11 sites of international importance
Actitis hypoleucos	Common sandpiper	Western Europe, Eastern Russia	Wide variety of inland and coastal wetlands - varying levels of salinity - muddy margins or rocky shores	Singly or in small groups	25,000 – 100,000	3,000	25	2 sites of international importance

Scientific Name	Common Name	Breeding Area	Habitat preference in Australia	Characteristics	Estimated Flyway Population	Estimated number visiting Australia	0.1% threshold	Internationally important habitat in Australia
Heteroscelus brevipes	Grey-tailed tattler	Siberia	Sheltered coasts with reef or rock platforms or intertidal mudflats	Usually in small flocks and roost in large numbers with other waders	50,000	40,000	50	16 sites of international importance
Heteroscelus incanus	Wandering tattler	Siberia, NW Canada	Rocky coasts - not commonly seen in Australia. East coast and islands	Solitary or in small groups, will roost communally, often with Grey-tailed Tattlers	Insufficient data	Insufficient data		No sites identified as internationally important
Arenaria interpres	Ruddy turnstone	Northern Siberia, Alaska	Wide variety of habitats - generally mudflats or rocky coastline - rarely inland waters	Usually in loose flocks of 20 - 100	35,000	17,000	35	16 sites of international importance
Limnodromus semipalmatus	Asian dowitcher	Siberia, N China, Russia, Mongolia	Usually intertidal sheltered coastal wetlands, mudflats, sandflats and estuaries	Gregarious, usually in pairs or small groups - occasionally in groups >100 at a few favourable feeding and roosting sites	24,000	insufficient data	24	1 site of international importance
Calidris tenuirostris	Great knot	N Siberia	Coastal habitats, intertidal mudflats, estuaries, lagoons and sandflats	Gregarious, in small to large flocks often in hundreds or thousands at favoured sites	375,000	360,000	375	8 sites of international importance
Calidris canutus	Red knot	Nth Siberia, Alaska	Intertidal mudflats, sandflats, estuaries, sandy beaches of sheltered coasts	Highly gregarious, small to large flocks, in thousands at favoured sites	220,000	135,000	220	8 sites of international importance

Scientific Name	Common Name	Breeding Area	Habitat preference in Australia	Characteristics	Estimated Flyway Population	Estimated number visiting Australia	0.1% threshold	Internationally important habitat in Australia
Calidris alba	Sanderling	High Arctic regions - Alaska, Greenland, Russia	Mostly open sandy beaches	Gregarious, small to large flocks - in hundreds at favoured sites	22,000	10,000	22	17 sites of international importance
Calidris ruficollis	Red-necked stint	N Siberia, Alaska	Mostly coastal sheltered inlets and estuaries with intertidal mudflats - occasionally on ocean beaches, commonly on inland lakes	Gregarious, often in dense flocks of hundreds to thousands	325,000	260,000	325	32 sites of international importance
Calidris subminuta	Long-toed stint	Siberia	Terrestrial wetlands, shallow freshwater or brackish wetlands with muddy or vegetated shoreline	Usually singly or in pairs, sometimes in small flocks at favoured sites, mainly in Western and central Australia.	25,000	1,000	25	No sites identified as internationally important
Calidris melanotos	Pectoral sandpiper	N Russia, N America	Shallow fresh to saline wetlands; usually in coastal regions, but often inland	Usually solitary, in pairs or in small loose groups	Insufficient data	Insufficient data		No sites identified as internationally important
Calidris acuminata	Sharp-tailed sandpiper	NE Siberia	Muddy edges of shallow fresh or brackish water. Common both on intertidal and inland waters	Gregarious, small groups to large dense flocks (100s -1000s) – the most frequently encountered species in inland Australia.	160,000	141,000	160	39 sites of international importance

Scientific Name	Common Name	Breeding Area	Habitat preference in Australia	Characteristics	Estimated Flyway Population	Estimated number visiting Australia	0.1% threshold	Internationally important habitat in Australia
Calidris ferruginea	Curlew sandpiper	Arctic Tundra	Intertidal mudflats of sheltered coastal areas, coastal lakes, estuaries, bays - occasionally inland wetlands	Gregarious, often in large flocks, mixes freely with other small waders	180,000	115,000	180	24 sites of international importance
Limicola falcinellus	Broad-billed sandpiper	Scandinavia, Russia	Sheltered coastal wetlands, mudflats, estuaries	Usually seen singly or in small loose groups, occasionally in large groups at favoured sites in North Western Australia	25,000	10,000	25	1 site of international importance
Philomachus pugnax	Ruff	N Europe, Russia	Usually terrestrial wetlands with exposed mudflats at edges	Rare but regular visitor, mainly seen singly, in pairs or small groups, associate with other small waders	Insufficient data	Insufficient data		No sites identified as internationally important
Phalaropus lobatus	Red-necked phalarope	Arctic and sub Arctic Nth America and Europe and Russia	Usually pelagic outside of breeding season, occasionally coastal wetlands	Gregarious, mainly in tropical seas. Usually singly or small groups in Australia; largest numbers in North Western Australia	100,000 – 1,000,000	Insufficient data	100 – 1000	No sites identified as internationally important

Scientific Name	Common Name	Breeding Area	Habitat preference in Australia	Characteristics	Estimated Flyway Population	Estimated number visiting Australia	0.1% threshold	Internationally important habitat in Australia
Pluvialis fulva	Pacific golden plover	N Siberia, Alaska	Mainly coastal, beaches, mudflats and sandflats and other open areas such as recreational playing fields	Usually small to large loose groups	100,000	9,000	100	1 site of international importance
Pluvialis squatarola	Grey plover	Arctic tundras, Siberia, Alaska, Canada	Coastal, intertidal mudflats, sandflats, sandy beaches, rocky coastline	Usually solitary or small groups, roost in large groups often with other waders	125,000	12,000	125	6 sites of international importance
Charadrius bicinctus	Double-banded plover	New Zealand	Littoral, estuarine and fresh or saline terrestrial wetlands, grasslands and pasture	Gregarious, small loose groups and roost in large flocks rarely with other waders	50,000	30,000	50	9 sites of international importance
Charadrius mongolus	Lesser Sand plover	Central and NE Asia	Usually coastal, estuaries and littoral environments - sandflats and mudflats,	Gregarious, small to large flocks - in hundreds at favoured sites in Northern Australia	140,000	24,000	140	6 sites of international importance
Charadrius leschenaultii	Greater Sand plover	Siberia	Coastal wetlands, intertidal mudflats or sandflats, sheltered sandy beaches	Gregarious, often forming flocks with Lesser Sand Plover	110,000	73,000	110	5 sites of international importance
Charadrius veredus	Oriental plover	Mongolia, E China	Inland - grasslands, roost on beaches or muddy margins of terrestrial wetlands	Gregarious, small to large flocks mainly in North Western Australia	70,000	70,000	70	6 sites of international importance

Scientific Name	Common Name	Breeding Area	Habitat preference in Australia	Characteristics	Estimated Flyway Population	Estimated number visiting Australia	0.1% threshold	Internationally important habitat in Australia
Glareola maldivarum	Oriental pratincole	China, Pakistan and Indian subcontinent, Indonesia and Malay peninsula.	Open country often near water, grassy flats and mudflats	Gregarious in small to large flocks (sometimes thousands) in many islands; an aerial feeder that often follows thunderstorms	2,880,000	2,880,000	2880	2 sites of international importance