Shorebird Conservation Action Plan

Bar-tailed Godwit (Limosa lapponica). SCC Corporate Image Library

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1 Introduction

The Sunshine Coast provides important habitat for migratory and resident shorebirds which gather in large numbers on the sandbanks and mudflats of the lower Maroochy River and northern Pumicestone Passage.

Shorebird roosts and feeding areas often overlap with recreational areas used for walking, fishing, exercising dogs, boating, jet skiing, kayaking, swimming, kite and windsurfing, and celebratory events that utilise fireworks.

Recreational use at lower Maroochy River and northern Pumicestone Passage is significant, especially during summer when migratory shorebirds are present, thus presenting high potential for disturbance of the birds in their natural habitat.

On a local level, disturbance by recreational users likely poses the biggest threat to shorebirds. Managing anthropogenic disturbance is necessary to protect the shorebirds, especially in light of the rapidly increasing population and number of beach users on the Sunshine Coast. While there are various tools available for management, the focus of this plan is to raise awareness and educate the public around shorebirds, to protect all shorebirds' habitat, and to provide management solutions for shorebird conservation.

2 Background

Migratory Shorebirds

Most shorebirds in Australia are long-distance migrants that can be found feeding and resting on swamps, tidal mudflats, sandbanks, and beaches. 37 species of migratory shorebirds visit Australia regularly each summer during their non-breeding season. All but one migrate thousands of kilometres on the East Asian-Australasian Flyway (EAAF) from the breeding grounds in the northern hemisphere to Australia. The Double-banded plover (*Charadrius bicinctus*) breeds in New Zealand and migrates to Australia during winter.

After arriving in south-eastern Australia in October, the migratory shorebirds seek out high-quality food resources in the intertidal zone of coastlines, which provide essential habitat for the birds to rest and feed, allowing them to rebuild energy reserves necessary to travel the vast distance back to their breeding grounds in the northern hemisphere. Shorebirds feed day and night during low tide, and congregate at roost sites when the incoming high tide covers their feeding areas. High tide roosts are as close to feeding areas as possible and provide essential areas where the shorebirds can rest, digest their food and preen. Migratory shorebirds need to accumulate fat and muscle to increase their body mass by up to 70 % in the months leading up to their journey north, which usually starts in February-March.

Any disturbance to the birds during this time hinders their ability to build up these critical energy reserves, compromising their return journey. While disturbances may be short in duration, the cumulative effect of daily disturbances has the potential to reduce energy levels by more than they can replenish daily. Disturbance to shorebirds frequently occurs where

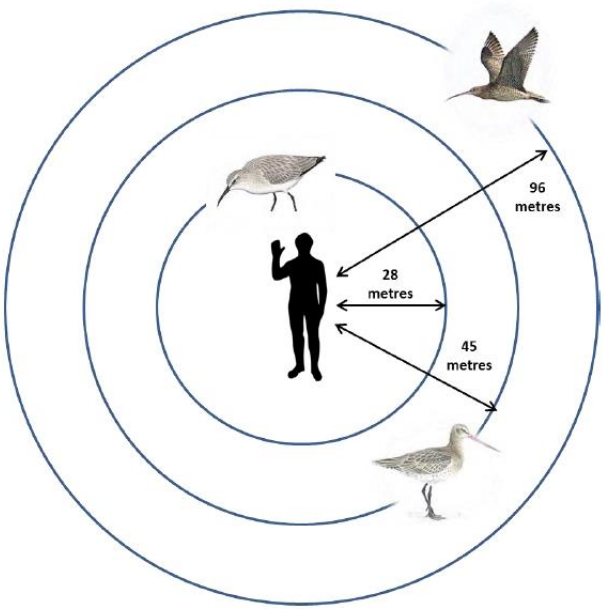


Figure 1: *Average flight-initiation distances (FIDs) for human disturbance (single walker, non-motorised, excluding dogs) for curlew sandpiper (28 m), bar-tailed godwit (45 m) and eastern curlew (96 m). (Figure based on data from Weston et al. 2012).*

humans and wildlife co-occur, in the form of walkers, fishermen, kite surfers, kayakers, dogs, boats or jet skis. Natural disturbances usually occur by birds of prey flying over the bird flocks.

In the Sunshine Coast region, migratory shorebirds mainly congregate on the banks and islands of the lower Maroochy River and in the Pumicestone Passage. The appearance of migratory shorebirds coincides with summer holidays, which regularly leads to a large increase of people using beaches and waterways around shorebird roosts, creating increased potential for disturbance.

Resident shorebirds

There are 17 species of resident shorebirds in Australia, which are year-round residents, nesting locally along coastal shorelines, wetlands and grasslands. Resident shorebirds in eastern Australia have declined significantly in the past decades (Nebel et al. 2008).

Resident shorebirds mainly breed in spring and summer, coinciding with the peak season of beach activities for humans. Many of these species lay their eggs relatively unprotected on beaches or rocky shores. Key threats relevant to the Sunshine Coast area are trampling of nests by people and animals on the beach, and disturbance by people and domestic animals passing too close to the nest. This can lead to chicks or eggs overheating or dehydrating in the summer sun while the adult birds are attempting to distract the (perceived) predators. Other threats include extreme weather, such as storms, which can inundate nests of resident shorebirds when coinciding with high tides.

Legal framework

Conservation of migratory shorebirds is complex as multiple stakeholders across many jurisdictions and political boundaries are involved. Australia has agreed to protect migratory shorebirds under several international conservation agreements, recognising the need to protect migratory shorebirds by cooperating across jurisdictions. Those agreements include:

- Party to international conventions including the *Convention on Migratory Species* (CMS; Bonn Convention), the *Convention on Wetlands of International Importance* (Ramsar Convention), and the *Convention on Biological Diversity* (CBD).
- Bilateral migratory bird agreements with Japan (JAMBA), China (CAMBA), and the Republic of Korea (ROKAMBA)
- The *East Asian-Australasian Flyway Partnership* (EAAFP), including relevant working groups and task forces.

As a consequence of Australia's obligations to protect migratory shorebird habitat and maintain sustainable populations, migratory shorebirds are classified as Matters of National Environmental Significance and are protected under the *Environmental Protection and Biodiversity Conservation* (EPBC) Act 1999. A *Wildlife Conservation Plan for Migratory Shorebirds* (Commonwealth of Australia, 2015) provides a framework to guide the

conservation of migratory shorebirds and their habitat in Australia. Shorebirds in Queensland are protected under the *Nature Conservation Act 1992* (Qld) and *Marine Parks (Moreton Bay) Zoning Plan 2019*

Under these regulatory frameworks, Sunshine Coast Council has the obligation to protect shorebirds and their habitats as reflected in the Environment and Liveability Strategy 2017 (ELS 2017). The following policy positions outlined in *Part A: Strategic directions (vision, guiding principles, policy positions;* ELS 2017) apply to this plan:

Biodiversity policy positions	**2.1. Natural ecosystems and the native plants and animals they support are preserved:** a. Habitat areas are ecologically functional and well connected b. Ecological functionality of habitat areas in maintained under changing environmental conditions c. Viable populations of native plants and animals are maintained e. Core and connecting habitat areas are protected
	2.3. Biodiversity is valued, respected and used sustainably to support our lifestyle, livelihoods and sense of place: c. Recreational activities and supporting infrastructure in or near conservation areas minimise impacts on biodiversity values
Coastal policy positions	**4.1. The natural values and function of coastal environments are preserved:** b. Coastal landforms, habitats and vegetation communities are protected and enhanced c. Native coastal fauna populations are maintained and enhanced
	4.2. A healthy coast and near-shore marine environment is preserved to sustain our valued coastal lifestyle and economy: a. Coastal recreational, social and economic activities have minimal impact on coastal values and natural processes

The Shorebird Conservation Action Plan contributes to the following Transformational Actions of the *ELS 2017 Five-year implementation plan (transformational actions, Sept. 2019)*:

Strategic Pathway 2. Protection and enhancement of our natural assets and distinctive landscapes.	**6. Connecting nature and people** Connecting our valued habitat areas to support our native flora and fauna and providing the community with opportunities to participate in conservation and to experience the natural environment
Strategic Pathway 3. Responsive, accessible and well managed assets and infrastructure	**13. Healthy coast** Providing a strategic and coordinated approach to the protection, sustainable use and enjoyment of our dunes, beaches, rocky shores, and near-shore marine waters

Strategic Pathway 4. Transitioning to a sustainable and affordable way of living	**21. How we live in the environment** Increasing our understanding of how people interact with the natural environment
Strategic Pathway 5. A reputation for innovation and sustainability	**24. Building our knowledge** Enabling evidence based decisions for a healthy environment and liveable Sunshine Coast

Sunshine Coast Council Context

Thousands of migratory shorebirds (order *Charadriiformes,* suborder *Charadrii*) annually visit our region over the summer, feeding on substrates in inter-tidal, shallow water, and roosting on dry high-tide sandbanks. In addition, up to 40,000 migratory terns (order *Charadriiformes,* suborder *Lari*), spend the summer within the Sunshine Coast Council Local Government Area (SCC LGA; Chan & Dening, 2005). Terns typically forage in the open sea, but roost on coastal sandbanks.

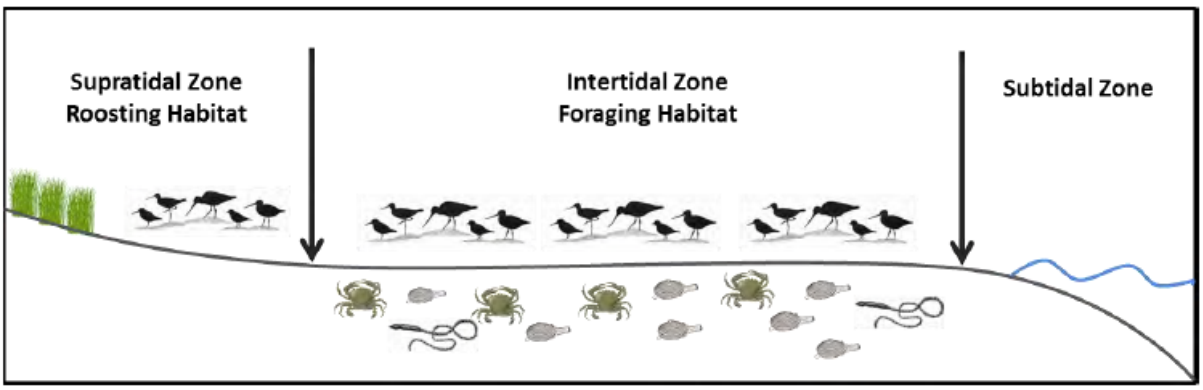
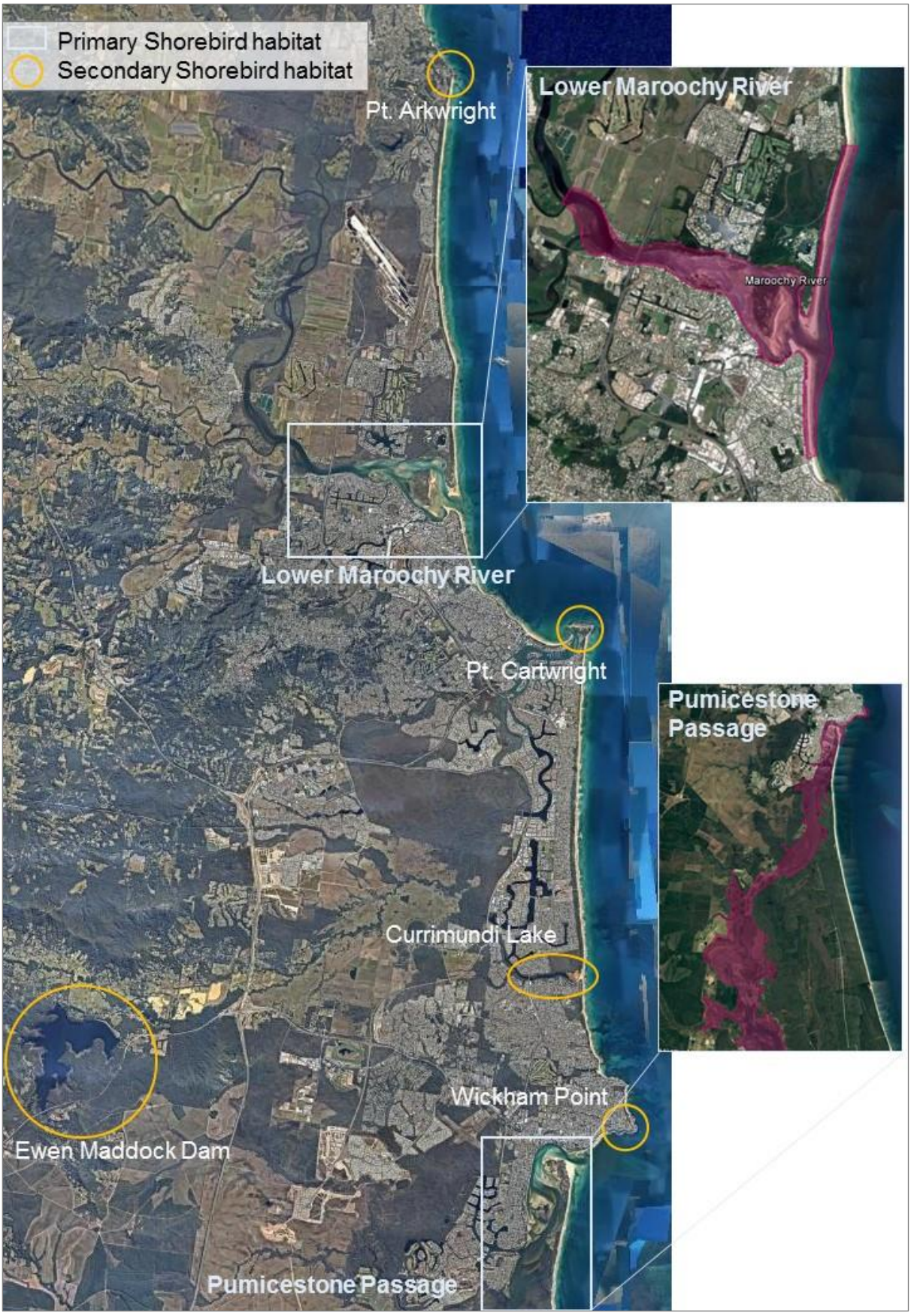


Figure 2 *Shorebird habitat use schematic diagram. (Note: Illustration not to scale; roosting habitat is not always adjacent to foraging habitat. Source: Steven 2017)*

The distribution of threatened shorebirds within the SCC LGA is highly variable and likely associated with particular intertidal habitat types and prey availability. Primary Sunshine Coast shorebird and tern roosting locations are the Pumicestone Passage and lower Maroochy River. The Pumicestone Passage as part of Moreton Bay Marine Park is declared an Area of International and National Importance (Bamford et al. 2008). Secondary roosting locations are located at Ewen Maddock Dam, Landsborough; Wickham Point, Caloundra; Currimundi Lake, Currimundi; Point Arkwright, Yaroomba; and Point Cartwright, Buddina. More research is needed for further listings in the Pumicestone passage zone. (Map 1).

Minimal research has been undertaken for migratory shorebirds on the lower Maroochy River, apart from surveys conducted by volunteers of the Queensland Wader Study Group; however, SCC does not currently have access to this data.



Map 1: *Sunshine Coast Council LGA Shorebird habitats*

Threats to shorebirds in SCC waterways

Shorebirds face many threats throughout their global range, which can be broadly categorised as (Sutherland et al. 2012):

- Natural events (e.g. storms, cyclones)
- Gradual drivers (e.g. climate change, algal blooms, altered sediment flow)
- Current anthropogenic factors (e.g. habitat loss and degradation, tidal habitat reclamation, pollution, disturbance)
- Future issues (e.g. microplastics, changing primary productivity in key habitats)

Habitat loss and degradation within the East Asian-Australasian Flyway remains one of the leading causes of shorebird declines (MacKinnon et al. 2012). While most of these drivers are outside of Australia's jurisdiction, any local threats to the birds need to be considered in the context of the heightened vulnerability to these species, and the effective management of Australian shorebird habitat remains important.

The threats faced by shorebirds in Sunshine Coast waterways are likely similar to those faced along other developed coastlines in Australia (Glover et al. 2012, Weston et al. 2012). Disturbance by human recreational activities and free-roaming dogs are probably the biggest local threats to foraging and roosting migratory shorebirds, which may lead to excessive energy expenditure of the birds and in turn negatively affects their ability to successfully migrate back north to reproduce. The effect of introduced predators such as cats and foxes has not been studied locally, however, the intertidal islands and sand banks are likely free of these species.

The main sources of disturbances to shorebirds in the Sunshine Coast waterways are likely similar to other places like the Gold Coast waterways and include (Steven et al., 2017):

- People on foot
- Fisherman and bait collecting
- People with dogs
- Boat and personal watercraft (PWC, such as jet skis)
- Kitesurfing and windsurfing
- Kayaking, SUP-boarding

The type and impact of local recreational disturbance is largely unquantified and this aims to be addressed through this plan.

3 Conservation Project Objectives

The primary objective of this project is to raise the profile and increase awareness of migratory shorebirds and provide safe roosting areas to improve conservation outcomes for these protected species.

The project aims to:

- Identify current migratory and resident shorebird habitats within the SCC LGA.
- Identify species and abundance of migratory and resident shorebirds in those habitats.
- Increase community awareness around shorebirds and shorebird conservation.
    - Social media campaign
    - Interpretative signage
    - Binoculars and bird hides at strategic locations
    - External exhibit for the Coastal Discovery Van
    - Interpretative trail incorporating cultural heritage
- Determine main threats to migratory and resident shorebirds in the SCC LGA and incorporate site management needs and recommendations
- Raise awareness around shorebird disturbance.
    - Small volunteer group to provide education – dog beaches, summer holiday
    - Information signage
    - Engaging a well-known person as an 'ambassador'
    - Billboard advertising before summer holidays
    - Signage at key entrance areas, e.g. North Shore car park
    - Shorebird BioBlitz
- Trial new 'artificial' habitat areas for migratory shorebirds where they can rest undisturbed
    - Floating roosts http://geum.birdlife.org.au/floating-roost-trial
    - Artificial roost site (similar to Kakadu Beach in southern Pumicestone Passage, Fig. 3)
- Monitor the impacts of the effects of the New Year's Eve Fireworks on shorebirds.
- Research project to investigate the effects of artificial light at night on shorebirds.
- Research project to investigate the interconnectedness of Sunshine Coast roosts for migratory shorebirds.

Figure 3: *Kakadu Beach on Bribie Island. Artificial high tide roost for migratory shorebirds, closed to the public.*

4 Implementation and Actions

Shorebird surveys

Shorebird surveys will be undertaken by a qualified shorebird expert to determine current distribution and habitat, identify which species are present, and determine the type and extent of disturbance. Surveys will be conducted when most migratory shorebirds are present during December-February and will investigate roosting shorebirds during high tide, and foraging shorebirds during low tide. During the months of June to August, it is also suggested to undertake a secondary shorebird survey to capture young waders and the start of breeding season for resident shorebird species.

The surveys will aim to address the following:

- Shorebird statistics
    - Total abundance
    - Species observed
    - Species abundance
- Shorebird behaviour
    - Activity (roosting/foraging)
    - Spatial data of foraging locations
- Frequency and type of disturbance observed

Surveys should be conducted no more than two hours either side of the high (roosting) or low tide (foraging), and should not be undertaken during periods of high rainfall or strong winds. Surveys within 2km proximity to known firework locations should aim to establish tidal heights when birds are present/not present and therefore when firework events can occur without shorebird disturbance. It is recommended to undertake roosting and foraging surveys in December or January (during school holidays), and repeat these surveys in February for the

main shorebird roosting areas in the Pumicestone Passage and lower Maroochy River to get a better understanding of the amount of disturbance associated with school holidays.

It is recommended to survey the secondary locations (see Map 1) at least once per season.

Month	Location	Tide	Behaviour	Comments
Dec/Jan	Pumicestone Passage	High	Roosting	School holidays
Dec/Jan	Pumicestone Passage	Low	Foraging	School holidays
Dec/Jan	Maroochy River	High	Roosting	School holidays
Dec/Jan	Maroochy River	Low	Foraging	School holidays
Feb	Pumicestone Passage	High	Roosting	
Feb	Pumicestone Passage	Low	Foraging	
Feb	Maroochy River	High	Roosting	
Feb	Maroochy River	Low	Foraging	

A contractor will be engaged to undertake these surveys, if possible with assistance from SCC and the Queensland Wader Study Group.

Disturbance

Human disturbance is a major threat to migratory shorebirds 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 level and frequency of disturbance and analyse any combined impacts of disturbance that may result in a significant impact on the shorebirds.

Community Engagement

Increase community awareness around shorebirds, conservation, and shorebird disturbances using the following tools:

- Social media campaign
- Information pamphlets
- Interpretative signage
- Binoculars and bird hides at strategic locations
- External exhibit for the Coastal Discovery Van
- Annual photo competition
- Interpretative trail incorporating cultural heritage
- Shorebird volunteers
- Library talks
- Engaging a well-known person as an 'ambassador'
- Billboard advertising before summer holidays
- Signage at key entrance areas e.g. North Shore car park

Shorebird community engagement and education is targeted at all users (local and tourists) of the areas where the shorebirds forage, roost, and breed. Sunshine Coast Council's key messages will be formulated around the following points:

- Our recreational beaches provide important habitat for migratory shorebirds
- The birds roosting on sandbanks are not just sea gulls, they're special summer visitors that have travelled thousands of kilometres without a break and need their rest.
- Migratory shorebirds live their lives in an endless summer – breeding in Alaska or Siberia during northern summer, enjoying Australia during austral summer.
- Migratory shorebirds are the endurance athletes of all animals, some fly nonstop for 8 days, without food or water
- Migratory shorebirds have been making their annual journey of over 24,000 km for thousands of years
- Migratory shorebirds sleep with only half their brain while migrating
- Observe quietly from a distance, use the binoculars provided
- Do not disturb the birds. This disturbance is causing them to take flight, which is energy expensive. If disturbed, shorebirds may not have the strength needed for their long migration
- Prevent surf kites from flying over roosting and feeding birds
- If going ashore at a bird site, land well away from them
- Keep dogs under control so that resting and feeding birds are not disturbed
- Initial messaging will focus on educating the public about shorebirds, their migration and life history, and the conservation issues they are facing. At a later time point, once the surveys have identified major sources of disturbances, messaging will include raising awareness about disturbance factors and their negative impact on shorebirds.

Social media campaign

Use SCC's social media portals to raise awareness about migratory shorebirds and their need for undisturbed rest and foraging opportunities. Use emotive bird photos and short key messages in posts, in the lead up and during spring and summer, which coincides with the season for migratory shorebirds and nesting time for resident shorebirds. Evaluate success of campaign in March and repeat similar campaign in the following summer.

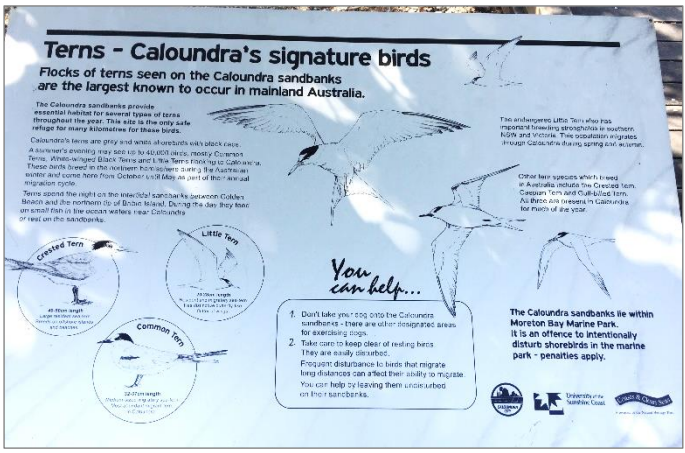
Month	**Message**	**Pictures**
October	Our special summer visitors are arriving	Flock of flying birds
November	Grab your binoculars and see if you can spot those migratory shorebirds	4 different shorebirds
November	Can you spot the oystercatcher's eggs? Resident shorebirds lay their eggs in relatively unprotected locations, so watch out for them	Oystercatcher nest
December (school holidays)	You're not the only one needing a holiday! Migratory shorebirds travelled here all the way from the arctic, they need their well-deserved rest – please don't disturb	Flock of roosting shorebirds

January	Did you know that shorebirds have to double their weight in two weeks?	Photo after arrival, before departure
February	Migratory shorebirds are the endurance athletes among the animals. They fly up to 8 days without a break to return to their arctic breeding grounds. To be able to migrate that far, they need plenty of food and rest. Do not disturb	Flock of flying birds

Interpretative signage

Design and install interpretive signage along Pumicestone Passage (Golden Beach, Caloundra) and the lower Maroochy River (North Shore, Cotton Tree, Maroochydore). The aim of the signage is to inform the public of the presence, migration and life history of shorebirds. At a later time point, utilise results from shorebird surveys to inform about disturbances and their impacts (i.e. dogs, people, and activities).

Figure 4: *Current signage (Pumicestone Passage)*



Signs are to catch the public's interest and attention, while requiring little energy to read and understand it. The following principles should be considered:

1. Provoke the attention and curiosity of the public. Grab interest quickly and keep it.
2. Relate the message to the everyday life of the audience. Why should it matter to them personally?
3. Address the whole. Show the connection of an object to a theme or storyline.
4. Don't tell everything. Leave something for the visitor to discover.

Liaise with communications team and graphic design to come up with effective signage. See examples below for ideas.

Figure 5: *Great drawings of the birds on mudflat. Text too small and too much.*

Figure 6: *Appealing sign and good messaging*

Binoculars and bird hide at strategic locations

Install two robust binoculars alongside signs focussing on bird IDs (Figs. 7, 8). Suggested locations below:

Figure 7: *Proposed binocular location at Golden Beach to observe migratory shorebirds on Caloundra banks.*

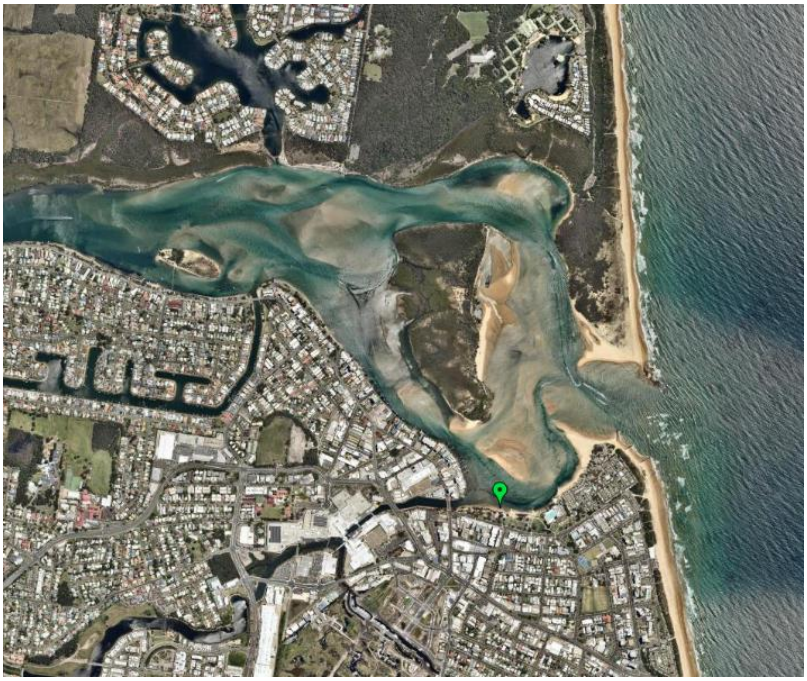


Figure 8: *Proposed binocular locations at Cotton Tree to observe migratory shorebirds on the sandbanks and Goat Island.*

Build a bird hide (best location to be determined) to observe birds on the sand banks or artificial roosts. The location should consider access by the public and ensure access is well away from the shorebird roosts.

External exhibit for the Coastal Discovery Van

Develop external educational exhibit suitable for age 9 and higher. Visit shorebird exhibit at Boondall Wetland Environmental Centre (launching 8 December 2019, contact Lisa Hughes) for ideas. Incorporate interactive activities into exhibit, e.g. different beak designs to catch different prey.

Annual photo competition

Launch an annual shorebird photo competition, either stand-alone or tied in with the ELS photo competition. A photo competition would increase the reach of the community engagement. To avoid adding a further disturbance factor, the competition would have to follow strict guidelines about how to best photograph shorebirds.

Interpretative trail incorporating cultural heritage

In collaboration with the Kabi Kabi, develop an interpretative trail along Pumicestone Passage (Golden Beach), integrating aboriginal stories about migratory shorebirds with recent learnings, fascinating facts and our key messages.

Shorebird council volunteers and ambassadors

Establish a small group of volunteers to provide education on the beaches during the summer holidays (mid-December – end of January). Volunteers could either have a small stall or walk on the beach and talk to members of the public about the impacts of disturbance on shorebirds. Suggested locations are North Shore (dog beach), Cotton Tree and Golden Beach.

This would also offer a council volunteer program for wildlife additional to the TurtleCare program, which has been at capacity for the past few years. A shorebird volunteering program offers an opportunity for passionate people to get involved without needing specialised knowledge and skills.

Training provided to the volunteers would include two components:

- Basic knowledge about migratory shorebird biology, legislation, as well as types and impact of disturbances (to be delivered by Birdlife Australia or the QWSG)
- Training on interaction and communication with people.

Explore the option of engaging a well-known person not affiliated with Council (e.g. Dr Harry) to act as an ambassador for shorebirds, e.g. on billboard advertising (see below).

Library talks

Library talks in the lead-up to and during the migratory shorebird season can be used to educate the community about resident and migratory shorebirds, their migration and life histories.

Billboard advertising and or Shorebird murals

Explore possibility of raising awareness about migratory shorebirds on a billboard during the summer months (similar to Redland City Council's Koala campaign, Fig. 9). Additional advertising mediums such as airport or hotel advertising or travel magazines could be considered.

Figure 9: *Redland City Council Koala awareness campaign*

Signage at key entrance areas e.g. North Shore car park

Install signage at key entrances to shorebird habitat, such as North Shore car park, Cotton Tree, and Golden Beach/Pelican Waters. The goal of the signage is to remind visitors of the presence of migratory and nesting shorebirds. It may be permanent, or a mobile road sign that is placed in those locations during summer.

Creation of Refuge Area

Disturbance is one of the main threats to migratory shorebirds which spend their non-breeding season in Australia. The lack of undisturbed roosting sites negatively affects the shorebirds' fitness, and consequently, their ability to successfully migrate and reproduce.

Safe and undisturbed roosts, in particular high tide roosts, are critical for migratory shorebirds. While not a replacement for natural habitat, artificial supratidal habitats have been shown to provide attractive high tide roosts for migratory shorebirds, especially when shielded from disturbance and made inaccessible to the public.

The construction of artificial roosts traditionally involved significant construction works to create static, permanent structures. While these constructed artificial roosts are often successful, they come at significant cost for both construction and maintenance, and are susceptible to degradation due to the intertidal nature of their location.

Floating roosts, in comparison, provide a refuge area for migratory shorebirds throughout the tidal cycle, are unaffected by climate change induced sea level rise, are inaccessible to terrestrial predators, and can be relocated if necessary. The complex relief of the oyster shells become colonised by intertidal and marine invertebrate communities, providing a food source for birds.

BirdLife Australia has commenced a trial of artificial roosts modelled on floating, long-line oyster bags along two sites in south-eastern Australia, and in the Geum Estuary in South Korea. A collaboration between BirdLife Australia and Sunshine Coast Council could facilitate the construction of artificial floating roosts in the lower Maroochy River and Pumicestone Passage, while contributing to data collection about usage by migratory shorebirds and other birds.

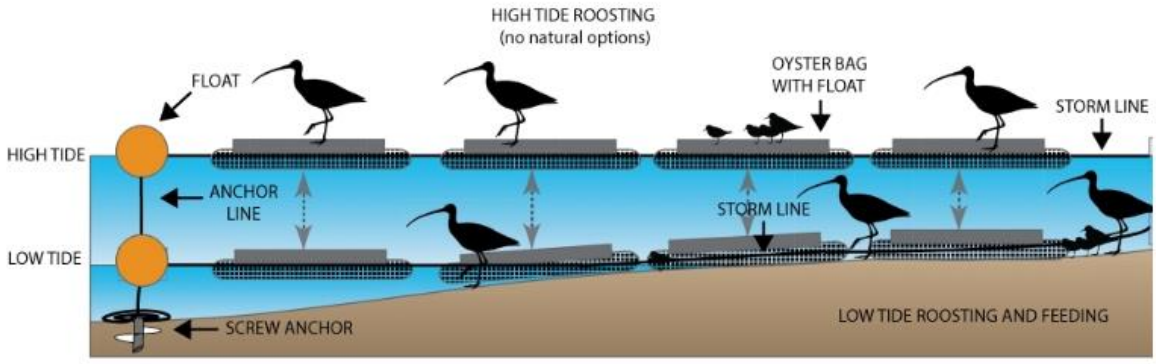


Figure 10: *Floating roosts rise and fall with the tide. Either sitting in shallow water or on the tidal flat at low tide and providing an option for roosting on high tides when other natural roosts may be inappropriate (submerged, disturbed). Source: http://geum.birdlife.org.au/floating-roost-trial*

Investigate the effects of the New Year's Eve Fireworks on shorebirds

Council currently allows New Year's Eve fireworks in close vicinity of a main migratory shorebird habitat in the lower Maroochy River, requiring a buffer zone of 300 m. The effect of fireworks on shorebirds specifically is poorly researched, as behavioural responses to fireworks are challenging to study at night. Therefore, little is known about the negative effects fireworks may have on wildlife. However, one research study used a weather radar to monitor the reaction of birds in response to fireworks for 3 consecutive years. They observed thousands of birds taking flight just after midnight, with the highest densities observed over grasslands and wetlands (Shamoun-Baranes et al. 2011). This is corroborated by anecdotal reports such as one reporting thousands of birds dying after fireworks in the USA, which scared them into flying away and caused them to crash into objects such as cars and houses (https://www.npr.org/2019/06/29/737001802/this-4th-of-july-think-of-your-feathered-friends-as-you-plan-for-fireworks).

It is reasonable to assume that both the migratory and resident shorebirds which spend the summer in the SCC LGA are susceptible to negative effects of fireworks. To fully understand the effects on our local shorebirds, it is recommended to place several observers at distances up to 2km away with night vision equipment in a suitable location to observe the shorebirds in the lower Maroochy River and Pumicestone Passage region during fireworks.

If the fireworks repeatedly cause them to take flight, it would significantly affect their ability to rest or feed, effectively impacting their survival by compromising their migration abilities. In this case, it is recommended the SCC reconsiders their conditions around fireworks.

Investigate the effects of artificial light at night on shorebirds

The effects of artificial night at light on shorebirds are complex and not very well researched.

During migration, artificial light can disorient flying birds, leading to disorientation and even causing their death through collision with build infrastructure. The disorientation may be as a result of being blinded by the light, or due to interference with the internal compass the birds use for navigation during their migration (Verheijen FJ, 1985; Poot H. et al., 2008). A review into interactions between offshore oil and gas platforms and birds in the North Sea found light to be the likely cause for hundreds of thousands of birds killed each year (Ronconi et al., 2015).

Artificial light at feeding grounds has been shown to affect foraging behaviour in different ways. Shorebirds use two main strategies of foraging, visual and tactile, with some shorebirds able to switch between the strategies. Visual feeders have high density photoreceptors, allowing them to rely on their eyes even during low light conditions (McNeil et al., 1993; Rojas et al., 1999). Tactile feeders use specialised sensory organs in their beak to detect prey in the substrate at night, but often switch to visual foraging strategies during the day, likely due to higher efficiency (McNeil et al., 1993). Research has shown certain bird species to take advantage of brightly lit foraging areas, as the artificial illumination improved their foraging success by extending the time where they can use visual foraging strategies (Dwyer et al., 2013; Santos et al., 2010). However, artificial light at nocturnal roosting sites has been found to displace birds, likely because of the increased (perceived) risk of predation (Rogers et al., 2006).

In conclusion, the effects of artificial light seem specific to certain locations and affect different bird species differently. As the coast line of the Sunshine Coast is heavily developed, light pollution is relatively high (Bell et al., 2017) and expected to increase, especially at the lower Maroochy River with the development of the new CBD.

It is therefore recommended to initiate a collaborative research project to investigate the effects of artificial light on the shorebirds of the Sunshine Coast. Suggested research partners include Professor Richard Fuller (School of Biological Sciences, University of Queensland) and Dr Rob Clemens (Birdlife Australia).

Investigate the interconnectivity of Sunshine Coast roosts

In 2019 the University of Queensland in partnership with Healthy Land and Water produced a document "Managing Threats to Migratory Shorebirds in Moreton Bay". One aspect of this report investigated the movement within Moreton Bay and interconnectedness of roost locations with the Bay and further afield. As part of this Action Plan a satellite tracking program of a significant spceies would be beneficial to understand the movement of the migratory birds while they are roosting within the SCC LGA and to investigate whether there is a connection with Moreton Bay. This may lead to a collaborative approach with neighbouring Council's to develop management strategies to address key impacts and threats to the shorebirds across their range in SEQ.

Undertake a Shorebird BioBlitz

Capitalising on the education and awareness campaign that will have been underway for three years throughout the project, a Shorebird BioBlitz is anticipated to be undertaken in the summer of the final year of the project. Citizen scientists will be joined by shorebird experts to identify and count the species of shorebirds, both migratory and resident, that are roosting on the Sunshine Coast in a specific time period. Comprehensive details of this event will be developed using the data about primary and secondary roost locations that has been gained throughout the early years of this project.

5 Implementation timeline

Budget estimate $: <$5000 | $$: $5000-20,000 | $$$: >$20,000

Date	Action	Budget	
Year 1	Get action plan approved		EO and Councillors
Year 1	Draft and design shorebird signs – education, migration, life history, ID	$	EO Comms Officer, GD
Year 1	Update SCC Shorebird website		ESP & EO
Year 1	Communication plan	$	EO Comms Officer
Year 1	Request data from Birdlife Australia	$550	Birdlife Australia
Year 1 Oct	Draft social media campaign year 1		EO Comms Officer
Year 1 Oct – Feb	Social media campaign year 1	$2000	EO Comms Officer
Year 1 Oct – Feb	Shorebird surveys Pumicestone Passage, Maroochy River, secondary sites	TBC $$	QWSG?
Year 1 Dec	Observe and evaluate effects of NYE fireworks on migratory and resident shorebirds	$	Council officer, QWSG
Year 2	Develop site management needs and recommendations for these threats	$	
Year 2	Develop a interpretative trail with associated bird hide and binoculars at identified locations adjacent to primary roosts	$	Coastal and Constructed Water Bodies Team, QWSG, Birdlife Australia
Year 2	Obtain permits for bird hide	TBC $	Coastal and Constructed Water Bodies Team, QWSG, Birdlife Australia
First half of Year 2	Get shorebird signs made & installed	TBC $$	External contractor e. g. Brandi Projects or Focus Productions
First half of Year 2	Purchase and install binoculars	TBC $$ ($7,000-9,000 per unit)	Coastal Project Officer
First half of Year 2	Evaluate social media campaign – focus on disturbance now	$	EO Comms Officer
First half of Year 2	Develop a citizen science volunteer program for monitoring migratory and resident shorebirds		Coastal Project Officer
First half of Year 2	Explore potential for small volunteer group	TBC	QWSG?

Before Sept Year 2	If volunteer group goes ahead – find volunteers, organise training, prepare necessary documents	$	Coastal Project Officer
Sept Year 2	Prepare social media campaign based on evaluation of year 1	$2000	Comms Officer
Year 2 Oct – Feb	Shorebird surveys Pumicestone Passage, Maroochy River, secondary sites	TBC $	QWSG?
Year 2 Oct -– Feb3	Instigate a research project for the creation of "artificial" habitat areas for migratory shorebirds	$	Birdlife Australia
Year 3	Plan and obtain permits for artificial roosts	TBC $	Coastal and Constructed Water Bodies Team, QWSG, Birdlife Australia
Year 3	Initiate satellite tracking to investigate the interconnectivity of the migratory shorebird roosting sites in the Maroochy River and Pumicestone passage	$$	UQ and Birdlife Australia
After March Year 3	Evaluate success of volunteer program, if implemented	$	
Year 3	Draft and design shorebird signs – disturbances	TBC $	EO Comms Officer
After March Year 3	Build artificial roosts	TBC $$$	Coastal and Constructed Water Bodies Team, QWSG, Birdlife Australia
Year 3	Get disturbance shorebird signs made & installed	TBC $$	External contractor e. g. Brandi Projects or Focus Productions
Year 3	Implement interpretative trail	TBC $	External contractor e. g. Brandi Projects or Focus Productions
Year 3	Plan and deliver a region wide collaborative Shorebird BioBlitz	$$	UQ, USC?, local artists
Year 4	Evaluate program	$	

6 References

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