

Ecological Determinants of Birdlife on Stockton Beach

John Goswell

Hunter Bird Observers Club Special Report No. 11

© September 2025

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Ecology of the Stockton Sand Dunes

Along the beaches of Australia there is a natural progression of plant and animal life, starting at the ocean and extending inland to the coastal forests. Each stage of this progression involves plants and animals that are specialized for each micro-climate and these can affect the micro-climate of the next zone resulting in a succession of plant and animal life. The various stages differ around Australia, depending upon local conditions. In his massive 658-page book on plant succession, Clements (1916) stated that Eugen Warming¹ “was the first to give a consistent account of succession on sand-dunes”. Warming’s 1891 paper described the various stages: the initial sand deposition, then sand algae, then iron-sulphur bacteria, then sand-binding plants such as marram grass (*Ammophila arenaria*), then the shifting white dunes, then the grey sand dunes, then the dune heaths, then the dune scrub, then the dune forest. At the time, the word “succession” was commonly used to refer to temporal changes in floristics (as described by Clements in 1916) rather than the spatial separation of floristic zones as Warming described. Since then, various authors have examined succession on sandy beaches around the world. Given the fact that there are over 10,000 beaches on the Australian coast (Short, 2010), one would have expected this to be well studied in Australia, however relatively few authors have examined the unique Australian beach succession in detail². There have been even fewer publications regarding plant succession along Stockton Beach³, however Pidgeon described the succession along Stockton Beach in 1940 (Pidgeon, 1940):

- Windblown sand, then
- Grasses, then
- Mat plants, then
- Dune scrub, then
- Banksia forest, then
- Mixed eucalypt forest

As most authors on succession are botanists, few include the complex interactions with animal life that occur with each successive zonation. This article aims to discuss the botanical and zoological aspects of succession on Stockton Beach, with particular emphasis on how plant succession influences birdlife.

The Physiography of Stockton Beach

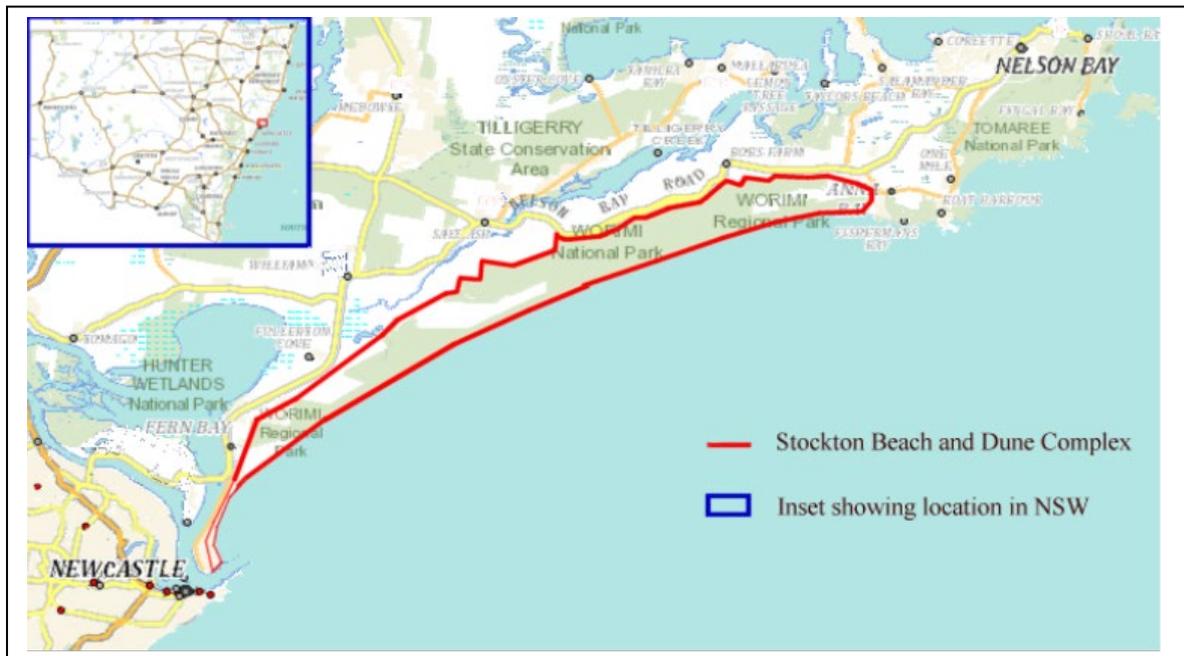
Stockton Beach, previously referred to as Stockton Bight, stretches for 32km from the port of Newcastle, NSW, to Birubi Point at Anna Bay (from latitude 32.77 deg. to 32.920 deg. south). Most of this area is owned by the Worimi Conservation Lands and is leased to the National

¹ Dr Johannes Eugenius Bülow Warming (1841-1924) was a professor of botany at the Royal Institute of Technology in Stockholm. According to Trudgill (2012) “it was Eugenius Warming, together with Buffon, Biberger and Dureau de la Malle, who played the key roles in developing the foundation for the theories of plant dynamics upon which later ecologists built”.

² Examples include Osborn and Robertson (1939), Walker et al. (1981), Sacheti and Scott (1986), Moxham et al. (2010), Patton (1934), Chladil and Kirkpatrick (1989).

³ Authors include Pidgeon (1940) and Unwin (1980) who wrote a paper on the ecology of Stockton Bight for the Environmental Studies & Coastal Branch, Department of Environment & Planning (now DECCW). Unwin’s paper, however, was not published.

Parks and Wildlife Service (NPWS). It is covered by the Worimi Conservation Lands Management Plan (Office of Environment and Heritage, 2014).



Stockton Beach is one of the longest beaches in NSW and is the largest active beach dune system in Australia. It is also one of the highest wave energy beaches in NSW (bluecoast Consultant Engineers, 2020). The most northern section of the beach faces south-east and hence directly towards the dominant wave direction. The beach tends to be “reflective” in the south, i.e. there is little protection from the full force of the waves. Here the beach is a little steeper and the sand is relatively coarser than the northern parts of this beach and less rich in microflora and micro/macro-fauna. In the northern areas, the beach is “dissipative”, i.e. the wave energy is reduced by shallow ocean sand bars and the relatively flat topology. The sand tends to be finer. Species richness and total biomass of the micro-organisms living in these sands tend to be significantly increased in dissipative beaches compared to reflective beaches (Brown and McLachlan, 2010)

The landform of Stockton Beach is dynamic. Winds generally drive sand inland, resulting in the dunes traveling westward at a rate of about 4m per year. These dunes are slowly engulfing some of the coastal forests on the western borders. The sand dunes are up to 40m above sea level and the depressions between the sand dunes (swales) can be as low as sea level. The waves are predominately from the south-east and contribute to a northerly drift of the ocean sand. The beach landform is more affected by waves than tides (Short, 2006). Storms, especially if combined with high tides, can cause erosion of the intertidal zone and foredunes. The storms can pull sand back to form sand bars in the ocean, parallel to the beach and these provide some protection by dissipating wave energy, reducing the erosive effects of the waves. In calmer weather, the waves can deposit sand onto the beach and foredunes.

Various factors affect the topography of the beach (Hesp, 1991).

- Windblown (aeolian) sand can deposit parallel to the shoreline to form an incipient foredune. Major storms sometimes erode this, but in calmer weather the sand can build up again. If the building up (accretion) is greater than the erosive effects, a foredune can form and become stabilized by colonizing plants (typically *Spinifex sericeus*). Over long periods of time this process can form multiple parallel dunes, which can advance the shoreline seaward.
- Localized breaks in the foredune (blowouts), can push sand further landward, depositing sand on the lateral sides and the most distant end, excavating a depression in the process. These are called parabolic dunes. The depressions, called swales, can go as low as sea level. As the fine sand is more easily blown away, coarse sand and calcareous material is left and can form into hard pans at the base of the swale, reducing permeability to water. If a new foredune forms, this swale becomes an isolated depression.
- Under the influence of the various wind patterns, loose sand can be blown into various forms and will slowly progress in the direction of the prevailing winds. These are transgressive dunes. Some of the lower dunes are peppered with “islands” and hummocks of remaining colonized vegetation that have resisted the erosive forces and/or burial.

The Stockton sand dunes show all the above features.

At Stockton, the northerly movement of ocean sand is interrupted by the Newcastle headland and the Newcastle and Stockton breakwaters. These reduce the ocean sand movement that would otherwise have reached the southernmost part of the beach, resulting in a net loss of sand and the encroachment of the ocean towards the man-made structures. The breakwaters also force silt from the Hunter River to be deposited further out from the original channel, meaning that the northerly ocean flow deposits this nutrient rich material further up the beach, missing the southern portion.

The net erosive effects on the southern part of the beach threatens the roads and buildings of the Stockton suburb. Rock and geotextile sandbag barriers have been created in the eroded areas in an attempt to halt this process. Dredgings from the channel are sometimes used to replenish the lost sand and nutrient.

The ocean floor for some distance out from the beach consists of soft sand, with increasing mud content towards the south. The distance from the surf to the edge of the continental shelf (if defined as occurring at 200m in depth) is greater here at 46.7km than any other part of the NSW coast (Jordan et al., 2010).

Stockton Beach has been subjected to the mining of heavy sands (rutile, zircon, monazite and ilmenite). Rehabilitation has consisted of creating similar dune shapes, but in the past included planting introduced species, such as bitou bush (*Chrysanthemoides monilifera*), to rapidly stabilize these dunes. Quarrying sand for building and construction purposes still occurs in the south of the beach, along the most western dunes, i.e. those dunes which are now encroaching and burying the hind dune forest. Quarrying also occurs in the mid-western dunes and to a limited extent in the northern dunes. Modern rehabilitation techniques use native plants for rehabilitation.

Succession of Life Along Stockton Beach

A similar pattern to Warming's original description of succession is seen on Stockton Beach and dune complex. Moving inland from the ocean, there are a number of stages or zones that can be identified, although many mitigating factors (both natural and anthropogenic) prevent this from being a simple linear progression. Each stage provides a different habitat for different bird species.

- The ocean close to the beach
- The tidal zone
- The foredune
- The swales
- The hind dunes
- The coastal forest

The Ocean Close to the Beach

At first glance, what one can see of the ocean close to the surf looks as though it only contains saltwater and sand, but it is incredibly biologically active. Ninety percent of the ocean biomass is made up of bacteria, archaea and microbial eukarya assemblages. These life forms are not visible to the naked eye. Brown and others (Brown M. et alia, 2018) have identified over 150,000 species of these micro-organisms off the Australian coastline using DNA fingerprinting. As waves approach the shore they have increasing effects on the ocean sediments, stirring nutrients into suspension. This is accentuated as the waves break. Nutrients, microflora and microfauna are thoroughly mixed. There is adequate light for photosynthesis by phytoplankton. These are the primary producers and they take basic chemicals and convert them into organic matter and release oxygen. The action of the surf also provides rich oxygenation in the water for the zooplankton. The zooplankton feed on bacteria and phytoplankton. Both phytoplankton and zooplankton become food for the filter feeders such as shellfish and crabs. Storms can break macro-algae (seaweed and kelp)⁴ from their seabed and drive them to the surf zone. As they float freely through the water, they attract invertebrates to the food and shelter. Floating macro-algae also provides protection for small fish, who gain the added advantage of increased food from the co-habiting invertebrates (Baring, 2014). As the macro-algae decays it becomes food for bristle worms (Polychaeta), amphipods, isopods⁵ and other crustaceans⁶. All these, in turn, become food for small fish. This shallow, sandy, subtidal area is an important breeding and nursery area for many fish species, including eastern Australian salmon (*Arripis trutta*), sea mullet (*Mugil cephalus*), sand whiting (*Sillago ciliata*), yellowfin bream (*Acanthopagrus*

⁴ Local species include ascidians (*Pyuria spinifera* and *Sigillina* sp.), green macroalgae (*Caulerpa filiformis*, *Caulerpa geminate*, *Codium platyclados*, *Codium spongiosum*, *Codium fragile*), brown macroalgae (*Eklonia radiata*, *Hormosira banksia*, *Phyllospora* sp., *Dictyota bartayresiana*, *Sagassum* sp.) and red macroalgae (*Cryptonemia* sp.)

⁵ Bruce (Bruce N L, 1986) records the following isopod genera in Australian subtidal zones: Eurydice, Pseudolana, Metacirolana, Bathynomus, Girolana, Neocirolana, Booralana, Orphelana, Natatolana, Dolicholana, and Cartetolana

⁶ Crustaceans expected to be in the near shore at Stockton Beach include opossum shrimp (Mysinae), the three-pronged sea-spider (*Halicarcinus ovatus*), isopoda (*Exophaeroma*), copepods and tanaids (*Tanaidacea*) [Source iNaturalist].

australis), Cerapus, tailor (*Pomatomus saltatrix*) and several flathead and stingray species (Jordan and Creese, 2015). A number of birds specialize in feeding on the fish and macrofauna.

Birds of the ocean close to the beach

Common Name	Scientific Name	Occurrence	Diet	Nest
Great Cormorant	<i>Phalacrocorax carbo</i>	Common resident	Fish caught underwater	W
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>	Common resident	Fish caught underwater, crustaceans and also insects	W
Little Pied Cormorant	<i>Microcarbo melanoleucos</i>	Common resident	Fish caught underwater, crustaceans and also insects	W
Great Pied Cormorant	<i>Phalacrocorax varius</i>	Common resident	Fish caught underwater and also on crustaceans (such as prawns and shrimp), molluscs and cephalopods.	W
Silver Gull	<i>Larus novaehollandiae</i>	Common resident	Surface fish, worms, insects and crustaceans	I
Greater Crested Tern	<i>Thalasseus bergii</i>	Common resident	Dive for small surface fish	I
Australasian Gannet	<i>Morus serrator</i>	Common resident	Fish which they catch and swallow whilst underwater	E
Wedge-tailed Shearwater	<i>Puffinus pacificus</i>	Common migrant August to April	Fish, squid and crustaceans	I
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	Common resident	Fish, turtles and sea snakes	T

Key: W – typically nest in wetland areas
 I – nest on nearby offshore islands
 E - nest on islands not local to the Hunter.
 T - nest in tall Eucalypts

The Intertidal Zone

This is the section of the beach covered by water at high tide and uncovered at low tide and here will include the splash (swash) zone above. Again, one would initially think that there was no life in this zone. It is a harsh environment with complete saltwater immersion at times and any fresh water from rain or underground sources is quickly mixed with salt water from the ocean. The “soil” is almost pure siliceous sand with a small amount of calcium carbonate from shell fragments and hence it is, by its own nature, nutrient poor. This zone has full sun exposure and becomes very hot at times in the upper few centimetres although beneath this, temperatures are similar to the ocean temperatures. The wind can be harsh, with nothing to stop its effect. However, the surface of this zone is rich in oxygen, and water with dissolved oxygen (enhanced by the action of the waves) can travel well beneath the surface of the sand, providing conditions which are crucial to the availability of the scant nutrients and hence microbiological activity (McLachlan and Defeo, 2017). In high energy beaches, such as Stockton Beach, the oxygenation can reach down to more than 100cm. Below the level of oxidation, the biochemistry changes to reductive processes.

The intertidal zone is a massive filter. Waves deposit saltwater with organic compounds, which are filtered through the sand. The organic compounds originate from the micro-organisms in the seawater and from the breakdown of macro-algae (seaweed) which at times become detached

from the sand beds and move into the surf zone. A rich array of micro-organisms in the near shore ocean breaks this seaweed down. The wet sands and water of the intertidal zone contain bacteria (including cyanobacteria), phytoplankton, flagellates, diatoms (e.g. *Anaulus australis*), and other micro-algae, and some of these process inorganic material via photosynthesis and release significant amounts of oxygen into their environment. The limited penetration of light (5-6mm) limits the zone of photosynthesis to the uppermost layer of the sand. This intertidal zone is also significant in its ability to remove carbon dioxide (Mandal et al., 2014). Medium to coarse grain sands enable greater seawater movement through them than finer sands, however the finer sands provide a significantly greater surface area for the attachment of micro-organisms⁷. On Stockton Beach, wave activity has resulted in finer sand to the north and coarser sand to the south of the beach.

Despite the apparent paucity of life in this zone, it is rich in biological forms. A study in California, using modern DNA fingerprinting techniques, logged almost one thousand different life-forms (taxa) in the intertidal zone (Boehm et al., 2014).



Flat wet areas in the norther section of Stockton Beach – a prime zone for pied oystercatchers to feed on pipis

Feeding on the microscopic life forms are various invertebrates such as shellfish (e.g. pipis [*Donax deltoides*] and *Neverita incei*) and surf crabs (*Ovalipes australiensis*). Bristle worms (Polychaeta) and ribbon worms (Nemertea), crustaceans (Isopoda, Amphipoda, Stomatopoda, Mysidae) also live here and feed on micro-organisms and detritus. Beach worms (e.g. *Onuphidae spp.*) also inhabit the wet sand and feed on seaweed and decaying organic matter. Many of these various animals then become food sources for those birds foraging in this zone.

James (1996), whilst studying the macrofauna on Catherine Hill Bay Beach, noted a further zonation of life forms even within the upper intertidal zone. The zone 10m below the upper drift line had a dominance of certain small crustaceans (isopods), with the zone below this, to the swash zone, dominated by bloodworms (glycerid polychaetes) and the swash zone was dominated by certain crustacea (amphipods, cumaceans), glycerids, and bivalves.

Birds of the Intertidal Zone

The birds living in this zone, the shorebirds, have three basic habitat requirements: roosting areas, foraging areas, and nesting areas (Northern Rivers CMA, 2010). Many shorebirds will

⁷ Sands with 0.1mm grain size provide a thousand times more surface area compared with sands of 2mm grain size (see McLachlan, 2006, page 56)

forage day and night because their preferred foraging zones are available at low tides, which occur at night as well as during the day. Roosting, therefore, will follow the inverse pattern. Some birds use more than one type of roost area, e.g. pied oystercatchers may roost on intertidal flats near their food or move to the rock platforms at Newcastle. Some shorebirds are resident all year round. Some migrate vast distances to nesting or feeding grounds on the other side of the globe.

The list below includes those seen with an incidence of 10% or more on regular surveys undertaken by members of the Hunter Bird Observers Club (HBOC) and the nation parks and Wildlife Service (NPWS)⁸.

Common Name	Scientific Name	Occurrence	Diet	Nest
Silver Gull ^P	<i>Larus novaehollandiae</i>	Common residents	Fish, worms, insects and crustaceans.	Offshore islands †
Australian Pied Oystercatcher ^P	<i>Haematopus longirostris</i>	Common resident	Pipis, worms, crabs and small fish	Swales
Greater Crested Tern ^P	<i>Thalasseus bergii</i>	Common resident	Fsh but will eat crustaceans and insects	Offshore islands †
White-fronted Tern ^P	<i>Sterna striata</i>	Uncommon winter migrant	Fish, typically just beyond the surf zone.	New Zealand
Little Tern ^P	<i>Sternula alibfrons</i>	Aug. to March	Small fish, crustaceans, insects, worms and molluscs	Swales and foredunes
Gull-billed Tern ^P	<i>Gelochelidon nilotica</i>	Partial migration to inland	Small fish, crustaceans, insects, reptiles, amphibians, and small mammals	Inland
Red-capped Plover ^P	<i>Charadrius ruficapillus</i>	Common resident	Molluscs, small crustaceans, worms and some vegetation	Swales and foredunes
Double-banded Plover ^P	<i>Charadrius bicinctus</i>	Feb. to Sept.	Molluscs, crustaceans, insects, seeds and fruit	New Zealand
Ruddy Turnstone	<i>Arenaria interpres</i>	Uncommon on beach, migrant	Insects, crustaceans, molluscs & spiders. Wrack and/or associated detritivores (Kirkman and Kendrick, 1997).	Northern hemisphere
Red-necked Stint	<i>Calidris ruficollis</i>	Uncommon migrant	Small invertebrates and small insects	Eurasian tundra
Bar-tailed Godwit ^P	<i>Limosa lapponica</i>	Aug. to Oct. Uncommon on the beach	Molluscs, worms and aquatic insects	Northern hemisphere
Sanderling	<i>Calidris alba</i>	Uncommon on beach Sept. - April	Invertebrates in the sand.	Arctic tundra

† These nest on nearby offshore islands such as Broughton Island and Moon Island

^P The superscript ^P denotes personal observation.

There is a variation from south to north in this zone along Stockton Beach, most likely because of the differing wave exposure discussed above. In the south, the beachfront tends to be narrower and steeper with coarser sand. This limits the zone in which pipis and beach worms can grow. Further north, the shallower ocean dissipates the wave energy further out from the beach, and the flat sands result in broad wet areas at low tide. The finer sands in the north drain more slowly. These factors produce large areas for pipis and beach worms. Consequently, this

⁸ HBOC members, in conjunction with National Parks and Wildlife Service personnel, have undertaken monthly surveys of Stockton beach since 2009 (Neil Fraser, personal communication).

becomes a favoured area for pied oystercatchers to feed and breed. During the breeding season (August to December), breeding pairs become territorial and drive away non-breeding pairs. Their territories are about a kilometre apart (1.2 +/- 0.5km) along the northern section (Fraser 2023).

Key threatening processes for these shorebirds along Stockton Beach include human activities, the European red fox (*Vulpes vulpes*), dogs (*Canis familiaris*), alterations to natural ecosystems (e.g. from climate change) and pollution (including entanglement from discarded fishing lines).

The Foredune

Above the intertidal zone is the foredune: a rise of sand deposited by wind and waves. It is sometimes preceded by an incipient dune; however, the incipient dune may come and go depending upon erosive and accretive surf conditions. In south-eastern Australia, foredunes form because the colonizing vegetation on the foredune slows the wind and traps the wind-blown (aeolian) sand (Hesp, 1988). Wrack (washed up seaweed and kelp) and other debris⁹ washed up and blown above the swash zone, can also trap aeolian sand and contribute to sand deposition.

The foredune looks bare and barren. It is exposed to the full sun and becomes very hot during summer. The sun and the wind dry this sand, making it hard for anything to live here. There is little capacity to hold water in this sand and it is above the water table. The dry sand is more easily moved by wind and this can cause relatively rapid shifts in dune topography, burying any plant life that has tried to get a foothold. Any rainfall is quickly lost through the sand and there is essentially no humus to retain moisture. The sand is nutrient deficient. This region does get a little organic matter washed up by the waves, but this is limited. Few plants can tolerate these conditions. The prime colonizer is spinifex grass (*Spinifex sericeus*).



The beach and foredune. Note the 4WD activity as evidenced by the multiple tyre tracks.

Spinifex leaves are covered in dense fine hairs which help protect against dehydration and abrasion from sandblasting. The plants are salt tolerant and form long “runners” with long roots that hold the sand together, effectively stabilizing the dune. Male spinifex plants are separate to the female plants. Even though it is a grass (family Poaceae), little appears to eat it along this

⁹ Debris can be considerable following flooding events in the Hunter River.

beach (no kangaroos or wallabies on Stockton Beach). The runners (rhizomes) can be metres in length. This feature, combined with the ability to grow rapidly, helps spinifex survive the shifting sands. It does not appear to survive 4WD traffic very well, which is a significant problem in parts of Stockton Beach. Spinifex roots are prone to rot in wet conditions, which may explain why this grass does not persist beyond the dunes or in the wetter parts of the swales. The tough leaves reduce the wind flow along the surface of the dune, resulting in the deposition of sand and building up of the foredune. Reduced wind flow allows for the accumulation of some humus. This sets up conditions for other plants to grow.

Given that there are large areas covered by spinifex, one would expect that this would result in the massive production of seed, however spinifex seed heads do not always contain seeds or may have a few seeds. Significant seed production can occur in favourable seasonal conditions. The process of variable seed production is described by Hesp (1991) as an adaptive process in areas of poor nutrient and variable fresh water supply.



Spinifex and other early colonizers reduce the wind flow and allows humus to accumulate.

Spinifex flowers in summer. The seeds have been observed to be eaten by galahs (*Eolophus roseicapilla*) (Gosper, 1999) and so one would expect other birds to be using this food resource. Australasian pipits eat seeds as well as insects and so may well eat spinifex seeds as well as seeds from other plants growing in this zone (pennywort [*Hydrocotyle bonariensis*] and beach primrose [*Oenothera drumondii*]), although published documentation of this has not been found by the author.



This photo shows how spinifex grass binds the sand dunes with its long roots. The brown band to the right of the central tack comprises only of exposed spinifex roots, giving an indication of how deep and how matted they can be. The photo also shows some of the damage to the dunes that off-road vehicles can cause.

Unseen to the naked eye, endomycorrhizal fungal hyphae can spread in the sand, helping to bind it and stabilize the dune (Jehne and Thompson, 1981). These fungi form symbiotic relationships with the dune plants and provide nutrients in these nutrient poor conditions.

Hanlon (2020) noted different species of endomycorrhizal fungi in the incipient dunes compared with established dunes, showing zonation at this level as well.

This zone is important as it provides nesting sites for some birds. According to the National Parks and Wildlife Service (NPWS), only six species of birds are known to nest along beaches. These are

- Little tern (*Sternula albifrons*)*
- Australian pied oystercatcher (*Haematopus longirostris*)*
- Red-capped plover (*Anarhynchus ruficapillus*)*
- Sooty oystercatcher (*Haematopus fuliginosus*)
- Beach stone-curlew (beach thick-knee, *Esacus magnirostris*)
- Hooded plover (*Thinornis cucullatus*)

* These birds have been observed to nest on Stockton Beach.

Australian pied oystercatchers would normally nest on the ocean side of the foredune but on Stockton Beach this is frequented by 4WDs. The birds have learned to nest on the west side of these dunes which adds extra work and stress for the birds when feeding their chicks (Fraser 2023).

Of interest Spinifex has been observed to be essential in the survival of the hooded plover¹⁰ in South Australia.

A frequently encountered plant in this zone is the beach pennywort (*Hydrocotyle bonariensis*), also known as Kurnell curse. It is an introduced species from the Americas and sub-Saharan Africa. It has distinctive round, flat leaves. This plant commonly spreads via rhizomes. It also produces seeds, which are potentially edible by birds.

Another early colonizer of the dunes is pigface (*Carpobrotus glaucescens*). Pigface stores water in its fleshy leaves, enabling it to survive in dry conditions. It also survives burial by sending up new shoots. It has extensive roots, which help it to find water and help to stabilise the dunes.

Other plants on and behind the foredune include the beach primrose (*Oenothera drummondii*) and sea holly (*Eryngium maritimum*). Beach primrose is an introduced species from the Americas. It forms pretty, yellow flowers and, in some areas, such as the broad, flat northern swales, it is widespread. It also helps stabilise the dunes. Sea holly is an exotic plant from the United Kingdom and Europe. It has tough, grey-green leaves with distinct sharp points and a waxy coating, no doubt limiting water loss. It has deep roots which help stabilise the sand. It can form clumps, creating small protected “islands” of sand.

There is not much shelter in this zone for animals. Crabs can find protection by burrowing deep into the foredune sands. These include the ghost crab (*Ocypode cordimana*) and the horn-eyed ghost crab (*Ocypode ceratophthalmia*). On the lower and shore side of the dunes wrack (mostly seaweed and kelp washed up by the waves) can provide food and shelter for other organisms, which would otherwise need to hide in the sand. Wrack is rapidly degraded¹¹ by bacteria and invertebrates such as roly polies (isopods), beach hoppers (talitrid

¹⁰ Landscape South Australia, Our Plover Coast, <https://www.landscape.sa.gov.au/hf/our-priorities/nature/our-plover-coast>. (Note that *S. hirsutus* is an earlier name for *S. sericeus*)

¹¹ A study in South Africa showed that 80% of the wrack biomass was gone in 14 days (Griffiths and Stenton-Dozey, 1980).

and oniscid amphipods), insects (Brown and McLachlan, 1990), kelp flies (Coelopidae), and beetles such as the rove beetle (*Thinopinus pictus*) (James and Fairweather, 1996). These invertebrates are potential food for birds in this zone. Ruddy turnstones and silver gulls are known to associate with wrack collections (Kirkman and Kendrick, 1997)¹². The breakdown of the wrack by detritivores brings nutrients back into the intertidal zone and also back into the ocean. There is some evidence that deposition of wrack can help trap sand and promote the formation and/or the building up of foredunes (Kirkman and Kendrick, 1997) and that commercial removal of wrack can lead to loss of foredunes (Columbini and Chalazzi, 2003).

Organic material on the beach can also include carrion from washed up dead birds and fish. Whilst this carrion is normally only in small amounts, a combination of exhaustion from migration and severe weather events can result in large numbers of short-tailed shearwaters (*Ardenna tenuirostris*) dying and being washed ashore. Such events occurred in November 2008 (~8,000 dead birds) and November 2010 (~5,000 dead birds) (Lindsey and Newman, 2010). The bodies of these birds are decomposed by a progression of feeding by bacteria and macrofauna: first the dipteran flies and ants, and then later arthropods (Columbini and Chalazzi, 2003). These invertebrates are also potential food sources for birds.

Birds found in the foredune include:

Common Name	Scientific Name	Occurrence	Diet	Nesting
Australian Magpie ^P	<i>Gymnorhina tibicen</i>	Common resident	Small insects, frogs and seeds	In trees from August to January
Australian Raven ^P	<i>Corvus coronoides</i>	Common resident	Small birds and will eat insects, and seeds Wrack invertebrates*	In tall trees from July to September
Silver Gull ^P	<i>Larus novaehollandiae</i>	Common resident	Mostly fish, also worms, insects and crustaceans	On nearby islands
Australian Pipit ^P	<i>Anthus novaeseelandiae</i>	Common resident	Insects and seeds	In spring on the ground
Australian Pied Oystercatcher ^P	<i>Haematopus longirostris</i>	Common resident	Pipis, but also eat worms, crabs and small fish	On the ground
Little Tern	<i>Sternula alibfrons</i>	Aug. to March	Mainly fish but also on crustaceans, insects, worms and molluscs.	On the ground
Pacific Golden Plover	<i>Pluvialis fulva</i>	Uncommon Sept. to May	Insects, crabs and other invertebrates	In Alaska
Gull-billed Terns ^P	<i>Gelochelidon nilotica</i>	Common resident, March to Dec. †	Insects taken in flight, amphibians, crustaceans and small mammals	On the ground

* Known to eat wrack and/or invertebrates feeding on wrack (Kirkman and Kendrick, 1997).

^P The superscript ^P denotes personal observation.

NB. Australian ravens have been identified as a threat to eggs and chicks for beach nesting birds (Maguire, 2008).

¹² As well as the hooded plover (*Charadrius rubicollis*) in the southern shores of Australia

The Swales

In many places behind the foredunes and between sandhills, are depressions which can go down to sea level. These accumulate rainwater and because they are close to the groundwater level or in fact at times below (Woolley et al., 1995), they can hold exposed water for periods of time. One would expect the presence of fresh water to be important for birds as a source of drinking water. Various factors contribute to the level of the water in these swales. Rainfall can raise the water level in the swales, particularly because some have developed a



semi-permeable pan of sand, salts and organic matter which reduces drainage. Water in the swales can also be an outflow from the extensive water in the sand beds further inland, for example the Tomago sand beds. Between two HBOC surveys (16th February 2025 to 11th July 2025), the region had 1009 mm of rain (Bureau of Meteorology, data for Williamtown), resulting in a rise in water levels of perhaps a metre at the time of the second survey, with a marked increase in the surface area of the water in each swale. This presence of fresh water enables different plants to grow. Being depressed means that dead vegetative material is unlikely to be blown away, allowing humus to build up in the soil. On rare occasions such as late March 2025 and early April 2025, combinations of king tides, strong onshore winds and east coast low pressure systems, can result in water over-topping the lowest of the foredunes, bringing floating debris into the swales.

The swales support an increased diversity of life compared to the surrounding (mostly) bare dunes. The vegetated swales, more correctly called beach wetlands (Bell and Driscoll, 2010), occur along most of Stockton Beach and vary in size and type, tending to be small in the south and broad and flat in the north. Between the Lavis Lane entry point and Cox's Lane, the water in these swales has helped form an accreted sand/salt layer, which is relatively

impermeable to water. This enables water to stay longer but not permanently (Woolley et al.,1995).

These swales also demonstrate a succession of plant life to some degree. Some swales have just water. More developed swales have colonizing vegetation such as spinifex. Further developed swales have sedges and so on.

It would be worthy of study to determine whether the vegetation in the swales represents temporal succession, i.e. bare sand is colonized and stabilized by spinifex then by rushes and reeds then by wattles and bitou bush then tea tree and banksias, etc. or whether the apparent zonation occurs because of the physical factors already present. These factors could allow certain species to grow in the habitats for which they are best adapted. A swale with water and no plants might be covered in seeds from numerous plants, but the spinifex would only grow in the drier, more saline sands. The rushes and reeds would only grow in and around the water. Both processes, of course, may be happening at the same time. In the second example, wattles and bitou bush might only start to grow once the colonizers had altered the humus content in the soil. It is also possible that each stage reflects the persistence of water throughout the year and/or the age of the swale, given that wind and sand movement might alter these swales considerably over time.

A brief description of the plants and animals in the swales follows:

- 1 - Water only. No surrounding vegetation.



The swale in this photo was dry a few weeks later. There was no visible humus to hold water or provide nutrients. The surrounding area had been frequented by 4-wheel drive vehicles, which would have damaged any plants trying to colonize. There are no visible plants in or around the water.

- 2 - Spinifex (*Spinifex sericeus*), pennywort (*Hydrocotyle bonariensis*) and beach primrose (*Oenothera drumondii*). There is the occasional searocket (*Cakile maritima*), an introduced species from Europe, North Africa and western Asia. All these colonizer plants can tolerate salty conditions and dry periods. Spinifex does not survive wet conditions as the roots rot, hence is not present in the centre of the swale where water accumulates. Surface insects on these shallow waters can provide food for red-capped plovers. Pipits also forage around these swales, being hard to see in the spinifex.



Spinifex is seen around the wet parts of this swale.

- 3 - An outer circle of spinifex, pennywort and beach primrose, then club rush (*Ficinia nodosa*) and sometimes stalked brooklime (*Gratiola pedunculata*), spreading nutweed (*Sphaeromorphaea australis*), and blown grass (*Lachnagrostis filiformis*), with, in the centre, rushes/sedges (*Juncus acutus*, *Cyperus* spp.). In some swales the introduced plant, spiny rush (*Juncus acutus*) is dominant. The sedges and club rushes have to be able to tolerate wet sandy soil for short periods of time and dry conditions at times. Humus can collect in these lower areas, improving nutrients, shading the sand and increasing water holding capacity. Outside this area, spinifex and pennywort have to survive in dry and hot conditions with little nutrient in the soil. Small insects (crickets, flies, ants, grasshoppers) survive in these swales.



A thick cover of *Spinifex sericeus* leading up to a dense covering of *Juncus acutus*.



Spinifex acutus and *Hydrocotyle bonariensis* surrounding exposed water with *Juncus acutus*.

- 4 - Outer circles of the above plants with an inner area of rushes (*Typha orientalis* and/or *Typha domingensis* and/or *Phragmites australis*) in the centre. Bull-rushes and phragmites tolerate standing in water for long periods and survive dry conditions for short periods of time. They tend to grow thickly, shading the soil and stopping surface winds, and trapping humus for the soil. The conditions are suitable for aquatic life: snails, tadpoles, frogs and insects, which also include moths and butterflies. Superb fairy-wrens can obtain enough shelter from raptors and can forage here.



Spinifex sericeus and *Hydrocotyle bonariensis* on the outer margins with *Ficinia nodosa* and then *Typha domingensis* in the wetter areas

- 5 - Outer circles of the above plants with some emerging taller species: Bitou Bush (*Chrysanthemoides monilifera*), she-oak (*Casuarina glauca*), narrow-leaved tea tree (*Gaudium laevigatum*¹³), and/or broad-leaved paperbark (*Melaleuca quinquinerva*). These are normally short (young and/or stunted in growth) in these swales. These bushes provide shelter for small birds such as superb fairy-wrens and white-fronted chats. These chats feed on the ground for insects and occasionally seeds (Lindsey and Fraser, 2024). This zone includes flies, dragonflies, butterflies, moths, mosquitoes, grasshoppers, crickets, ants, lizards (such as the copper-tailed skinks, *Ctenotus taeniolatus*), water snails, tadpoles,

¹³ Previously known as *Leptospermum laevigatum*

frogs (such as the common eastern froglet, *Crinia signifera*). This increase in fauna allows insectivorous and carnivorous birds to forage here.

Of note, the coastal groundsell (*Senecio spathulatus*) was thought to no longer occur in the Newcastle area until re-discovered by Stephen Bell in 2010 (Bell and Driscoll, 2020). It is listed as endangered under the TSC Act.

Bird species in the swales include:

Common Name	Scientific Name	Occurrence	Diet
Superb Fairy-wren ^P	<i>Malurus cyaneus</i>	Common resident	Small insects and small arthropods but will also eat a small quantity of seed and fruit.
Australian Pipit ^P	<i>Anthus novaeseelandiae</i>	Common resident	Insects and their larvae as well as seeds
White-fronted Chat ^P	<i>Ephianura albifrons</i> *	Common resident	Small insects and acacia seeds
Australian Raven ^P	<i>Corvus coronoides</i>	Common resident	Small birds and will eat insects, and seeds
Australian Magpie ^P	<i>Gymnorhina tibicen</i>	Common resident	Small insects, frogs and seeds
Pacific Golden plover	<i>Pluvialis fulva</i>	Occasional September to April†	Insects, spiders, crustaceans, small lizards and seeds
Double-banded Plover ^P	<i>Charadrius bicinctus</i>	February to September†	Molluscs, insects (both on land and in water), crustaceans and seeds
Little Tern	<i>Sternula albifrons</i> *	August to March	Mainly fish but also on crustaceans, insects, worms and molluscs.

* listed as vulnerable under the TSC Act

^P personal observation

Some birds may come to the swales when water is present:

Common Name	Scientific name	Occurrence	Diet
White-faced Heron ^P	<i>Egretta novaehollandiae</i>	Common	Fish, frogs, small reptiles and insects
Red-capped Plover ^P	<i>Charadrius ruficapillus</i>	Common	Worms, snails, crustaceans, isopods, small crabs, insects, beetles, insects, insects, flies, bees and wasps
Masked Lapwing ^P	<i>Vanellus miles</i>	Common	Insects, earthworms, snails, centipedes and plants
Black-fronted Dotterel ^P	<i>Elsyornis melanops</i>	Uncommon	Small molluscs, aquatic and terrestrial insects
Gull-billed Tern ^P	<i>Gelochelidon nilotica</i>	Common	Insects taken in flight, amphibians, crustaceans and small mammals
Welcome Swallow ^P	<i>Hirundo neoxena</i>	Common	Insects in flight.

The vast exposed areas along the beach and sand dunes give good visibility for raptors to find food:

Common Name	Scientific Name	Diet
White-bellied Sea-eagle ^P	<i>Haliaeetus leucogaster</i>	Fish, turtles, sea snakes and small mammals and birds
Swamp Harrier ^P	<i>Circus approximans</i>	Birds, eggs, large insects, rabbits and other small animals, reptiles, frogs, and fish
Australian Hobby ^P	<i>Falco longipennis</i>	Small birds and large insects
Osprey ^P	<i>Pandion haliaetus</i>	Fish, sea snakes, molluscs, crustaceans, reptiles, insects, birds and mammals
Whistling Kite ^P	<i>Haliastur sphenurus</i>	Small mammals, birds, fish, reptiles, amphibians, crustaceans, insects and carrion
Black-shouldered Kite	<i>Elanus axillaris</i>	Rodents, small reptiles, small birds and insects
Nankeen Kestrel ^P	<i>Falco cenchroides</i>	Mice and rats and other small mammals, reptiles, small birds and a variety of insects
Brown Falcon	<i>Falco berigora</i>	Mice and small mammals, small birds, lizards, snakes, caterpillars, grasshoppers, crickets, and beetles

^P Personal observation. Other species also listed as per Lindsey and Newman (Lindsey and Newman, 2010).

Note that the small birds need to have a means of escaping predation. Pipits are well camouflaged even amongst the spinifex. Fairy wrens need some raised vegetation, for example reeds. Chats seem to like small bushes in which to hide such as the bitou bush. When disturbed they may land on a “lookout post” on a small bush to watch what is happening.

Nesting colonies of little terns have been observed in a small number of locations on the upper beach and the swales from 2012 to 2023. Breeding success in 2023 was estimated to be 5.6% (6 fledglings from 53 nests and 107 eggs), reflecting a high rate of predation at the time the chicks hatch (Fraser 2023). In 2023 the main predator was thought to be ghost crabs (*Ocypode cordimana*). Other potential predators included red fox, Australian raven, silver gulls, gull-billed terns, domestic dogs, feral cats, black rats, goannas, and raptors. Ghost crabs live in deep burrows in the sand and come out at night to feed. Many crab burrows occur in the foredunes on both eastern and western facing slopes.

Appendix 1 shows details of many of the swales on Stockton Beach.

The Hind Dune

In a simple system, particularly with a steep beach front, the foredune might merge with the hind-dune, however in older, more established dune systems like at Stockton Beach, they can be separated by other, mostly bare, sand dunes. The eastern face of the hind-dune has some degree of protection from the harsher elements by the spinifex-stabilized foredune. Being further from the surf means no exposure to salt water, although exposure to salty sea mists can still occur. Forests to the west sometimes provide shade from the hot afternoon sun. The eastern side of the hind dune is usually colonized by wattles (*Acacia longifolia*) and bitou bush (*Chrysanthemoides monilifera*), which reduce the sunshine reaching the ground and hence

reduce ground temperatures and increase humidity. These two plants have the ability to survive partial burial and can strike new roots from branches that have been covered in sand. These plants also reduce wind speeds further, reducing evaporation. They enable larger plants to grow to the west of them such as the coastal tea tree (*Gaudium laevigatum*), coastal banksias (*Banksia integrifolia*) and black she-oak (*Allocasuarina littoralis*). The tea tree can grow in dense stands and become a very effective wind barrier. Specimens are often sculptured by the prevailing wind patterns.. In the southernmost extent of Stockton Beach, tuckeroo (*Cupaniopsis anarcardioides*)¹⁴ is also present in this zone.

The soil in this zone is starting to develop a profile (eSpade)

- The surface is grey (A1 horizon)
- beneath is whitish sand (A2 horizon)
- overlying an orange to brown sand (B1 horizon)

In many parts of Stockton Beach this zone has been overtaken by the westward march of sand dunes and exists only as islands of remnant vegetation. The plants of the hind dune can become a dense barrier and provide protection from aerial predators for small birds such as fairywrens and white-cheeked honeyeaters. Surprisingly, even the bare westward marching dunes provide protection for the vegetation from the onshore winds, having reached the same height as the forests to their west, or higher. However, where there is no colonizing vegetation, the dunes continue to bury the forest.



The hind dune encroaching the coastal forest in the Bobs Farm district.

¹⁴ Its presence only above Little Park Beach, raises the question of whether it was planted here, however it does occur in this zone on other nearby coastal beaches.

Birds of the hind dunes:

Common Name	Scientific name	Occurrence	Diet
Superb Fairy-wren ^P	<i>Malurus cyaneus</i>	Common resident	Insects and arthropods, small quantities of seeds
Variegated Fairy-wren ^P	<i>Malurus lamberti</i>	Common resident	Insects, small quantities of seeds
White-cheeked Honeyeater ^P	<i>Phylidonyris niger</i>	Common in January to June†	Nectar but will sometimes eat insects
Yellow-faced Honeyeater ^P	<i>Caligavis chrysops</i>	Common resident	Nectar, pollen, fruit, seeds, arthropods, insects, and their products
Silvereye ^P	<i>Zosterops lateralis</i>	Common resident	Small insects, spiders, fruit and nectar
Little Wattlebird ^P	<i>Anthochaera chrysoptera</i>	Common in January to June†	Nectar, insects, flowers, berries and some seeds
Brown Thornbill ^P	<i>Acanthiza pusilla</i>	Common resident	Spiders, beetles, lerp insects, ants and grasshoppers. Sometimes seeds, fruit, or nectar.
Eastern Spinebill ^P	<i>Acanthorhynchus tenuirostri</i>	Common resident	Nectar supplemented with small insects and other invertebrates
Eastern Whipbird ^P	<i>Psophodes olivaceus</i>	Common resident	Insects and other small invertebrates usually caught on the ground
Red-browed Finch ^P	<i>Neochmia temporalis</i>	Common resident	Seeds and insects on the ground

^P Personal observation.

The Coastal Forest

Once protected from the harsh beach conditions by both the foredune and its colonizing plants, and also the wind-stopping cover of the hind dunes, conditions become suitable for trees to grow. Along Stockton Beach these include banksias (*Banksia integrifolia* and *Banksia serrata*), the coastal red gum (*Angophora costata*), blackbutt (*Eucalyptus pilularis*) and swamp mahogany (*Eucalyptus robusta*). There is significant coverage of the soil with leaves and bark (e.g. 5cm thick in places). The closed forest shades the soil and surface temperatures are much lower, reducing evaporation. The surface soil has a dark grey appearance, with leached, whiter sand beneath (a podzol soil).

The soil has a more defined profile (Outline Planning Consultants, 1991):

- A1 horizon - Surface to 30cm, is grey with variable amounts of organic material
- A2 horizon – 30cm up to 2m, is a whitish, leached sand
- B1 horizon - 2 – 2.5m, is a brown sand
- B2 horizon - up to 12m is a pale amber sand

The soil has better water holding abilities, enabling young trees to survive until they can get their roots to the water table. It has been determined that some of the Eucalypts have extended their roots 50m to obtain water from the groundwater beneath (Woolley et al., 1995). The trees provide shade and shelter from the winds, providing a suitable climate for smaller plants in the understory. These include species such as prickly moses (*Acacia ulicifolia*), broad-leaved

geebung (*Persoonia levis*), bracken fern (*Pteridium esculentum*), blady grass (*Imperata cylindrica*), kangaroo grass (*Themeda triandra*), burrawang (*Macrozamia communis*), lance beard heath (*Leucopogon lanceolatus*), guinea flower (*Hibbertia scandens*), spiny matt rush (*Lomandra longifolia*), blue flax lily (*Dianella caerulea*), purple coral pea (*Hardenbergia violacea*), dusky coral pea (*Kennedia rubicunda*), common hop bush (*Dodonaea triquetra*), slender devil's twine (*Cassytha glabella*)¹⁵.

In the northern forested areas of Stockton Beach, some rare orchids occur: the sand doubletail orchid (*Diuris arenaria*), listed as endangered under the TSC Act and the EPBC Act and the Newcastle doubletail orchid (*Diuris praecox*), listed as vulnerable under both acts.

Within this forest there are some low-lying forests which become inundated after rains or have persistent standing water. These cause variations in the vegetation (Bell and Driscoll, 2010):

- paperbark-mahogany sedge swamp forest - broad-leaved paperbark (*Melaleuca quinquenervia*) and swamp mahogany (*Eucalyptus robusta*)
- paperbark-mahogany dry swamp forest - broad-leaved paperbark (*Melaleuca quinquenervia*) and swamp mahogany (*Eucalyptus robusta*)
- mahogany-baloskion swamp forest - prickly-leaved paperbark (*Melaleuca nodosa*) and lemon-scented tea-tree (*Leptospermum polygalifolium*) with plume rush (*Baloskion tetraphyllum*), lomandra (*Lomandra longifolia*) and a hybrid tree (*Eucalyptus robusta* x *Eucalyptus parramattensis* subsp. *decadens*).
- depression banksia woodland – coastal banksia (*Banksia integrifolia*, hybrid *E. robusta* x *E. parramattensis* subsp. *decadens*).

As researched by Ecotone Ecological Consultants (2008) the animals living in this coastal forest include

- possums [common brushtail possum (*Trichosurus vulpecula*), common ringtail possum (*Pseudocheirus peregrinus*) and the squirrel glider (*Petaurus norfolcensis*)]
- New Holland mouse (*Pseudomys novaehollandiae*)
- northern brown bandicoot (*Isodon macrourus*)
- brown antechinus (*Antechinus stuartii*)
- insectivorous bats (*Nyctophilus geoffroyi*, *N. gouldi*, *Chalinolobus morio*, *Vespadelus vulturnus*, and *Miniopterus australis*)
- wallabies [swamp wallaby (*Wallabia bicolor*) and red-necked wallaby (*Macropus rufogriseus*)]
- echidna (*Tachyglossus aculeatus*)
- two species of snake have been recorded in this forest: diamond python (*Morelia spilota*) and black-bellied swamp snake (*Hemiaspis signata*)
- numerous species of lizard
- eight species of frog were recorded in this zone: the most common being the brown toadlet (*Pseudophryne bibroni*) and common eastern toadlet (*Crinia signifera*).

¹⁵ This list is made from personal observation. A much more detailed list for each beach coast forest type is described by Bell and Driscoll (2010).

The coastal forest provides food and shelter for a much-increased number of bird species compared to the zones more seaward (see table below). There is a greater variety of blossoms, seeds, and increased numbers of insects and arthropods. Dense foliage provides nesting sites for the small birds. The larger trees provide nesting sites for the larger birds. These include tree hollows and arboreal termite nests (for kookaburras).

Commonly encountered birds include:

Common Name	Scientific Name	Occurrence	Diet
Laughing Kookaburra ^P	<i>Dacelo novaeguineae</i>	Common resident	Insects, worms, crustaceans, small snakes, mammals, frogs and birds
Superb Fairy-wren ^P	<i>Malurus cyaneus</i>	Common resident	Small insects and small arthropods but will also eat a small quantity of seed and fruit
Variegated Fairy-wren ^P	<i>Malurus lamberti</i>	Common resident	Insects, small quantities of seeds
Australian Magpie ^P	<i>Gymnorhina tibicen</i>	Common resident	Small insects and small arthropods but will also eat a small quantity of seed and fruit
Little Lorikeet ^P	<i>Parvipsitta pusilla</i>	†	Nectar and pollen, sometimes mistletoe
Yellow-tailed Black-cockatoo ^P	<i>Zanda funerea</i>	†	Seeds and insects
Eastern Rosella ^P	<i>Platycercus eximius</i>	Common	Seeds, fruits, buds, flowers, nectar and insects
Sulphur-crested Cockatoo ^P	<i>Cacatua galerita</i>	†	Berries, seeds, nuts and roots
Brown Thornbill ^P	<i>Acanthiza pusilla</i>	Common resident	Spiders, beetles, lerp insects, ants and grasshoppers. Sometimes seeds, fruit, or nectar
Rainbow Lorikeet ^P	<i>Trichoglossus moluccanus</i>	†	Nectar and pollen, but also eats fruits, seeds and some insects
White-throated Treecreeper ^P	<i>Cormobates leucophaea</i>	Common resident	Insectivorous (mainly ants) although will eat also nectar
Eastern Spinebill ^P	<i>Acanthorhynchus tenuirostris</i>	Common resident partial migration	Insects and nectar
Golden Whistler ^P	<i>Pachycephala pectoralis</i>	Common resident	Insects, spiders, small arthropods, sometimes berries
Yellow-faced Honeyeater ^P	<i>Caligavis chrysops</i>	Common resident and migratory	Nectar, pollen, fruit, seeds, arthropods, insects, and their products
Rufous Whistlers ^P	<i>Pachycephala rufiventris</i>	Common in spring & summer	Insects, sometimes seeds, fruit or leaves
White-cheeked Honeyeaters ^P	<i>Phylidonyris niger</i>	†	Nectar but will sometimes eat insects
White-browed Scrubwren ^P	<i>Sericornis frontalis</i>	Common resident	Insects and other small arthropods. Occasionally seeds.
Yellow-throated Scrubwren ^P	<i>Sericornis citreogularis</i>	Common resident	Seeds, insects, small invertebrates
Willie Wagtail ^P	<i>Rhipidura leucophrys</i>	Common resident	Insects

Australian Raven ^P	<i>Corvus coronoides</i>	Common resident	Small birds and will eat insects, and seeds
Welcome Swallow ^P	<i>Hirundo neoxena</i>	Common resident	Insects in flight
Pallid Cuckoo	<i>Heteroscenes pallidus</i>	Summer	Insects and their larvae
Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>	Resident	Insects and their larvae
Eastern Whipbird ^P	<i>Psophodes olivaceus</i>	Common resident	Insects and other small invertebrates usually caught on the ground
Rock Dove	<i>Columba livia</i>	Common Introduced	Seeds
Noisy Miner ^P	<i>Manorina melanocephala</i>	Common resident	Nectar, fruits and insects
Spotted Dove ^P	<i>Spilopelia chinensis</i>	Common introduced	Seeds
Crested Pigeon	<i>Ocyphaps lophotes</i>		Seeds, leaves, insects
Grey Fantail ^P	<i>Rhipidura albiscapa</i>	Common resident	Flying insects
Magpie Lark ^P	<i>Grallina cyanoleuca</i>	Common resident	Insects and their larvae, earthworms and freshwater invertebrates.
Pied Currawong ^P	<i>Strepera graculina</i>	Common resident	Small lizards, insects, caterpillars, berries and small birds
Black-faced Cuckoo-shrike ^P	<i>Coracina novaehollandiae</i>	Common resident	Insects and other invertebrates, sometimes seeds and fruits
Rufous Fantail ^P	<i>Rhipidura rufifrons</i>	Uncommon October to March	Small insects

^PThe superscript ^P denotes personal observation. Other entries are birds listed in Birdata.

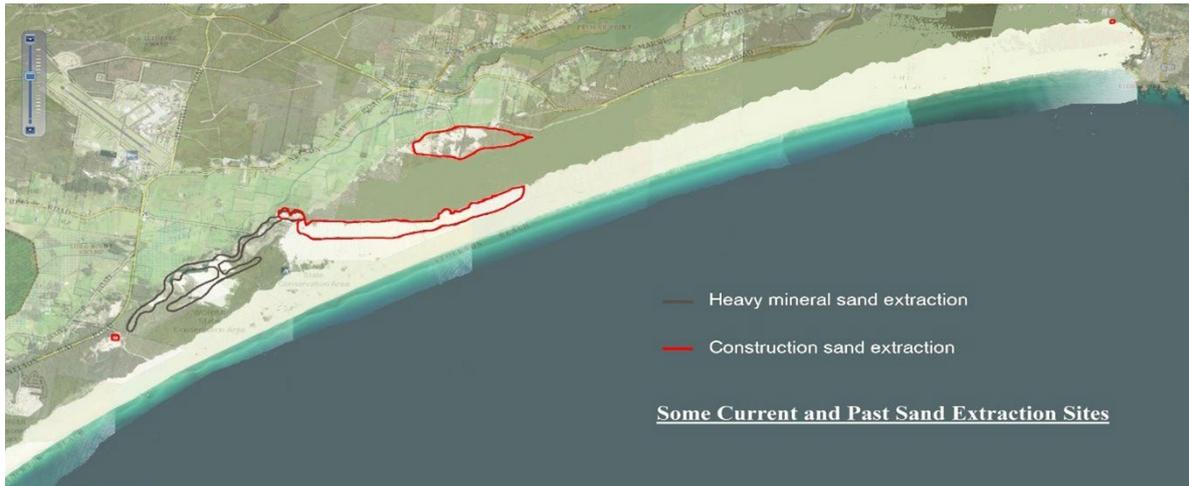
Changes over time

The Stockton Beach topology and vegetation have been complicated by multiple factors. These include

- changed ocean levels over eons of time.
- Foredune blowouts resulting in sand being blown further westward
- 4WD and quad bikes damaging the dunes
- The creation of the Newcastle breakwaters, changing he movements of ocean sand and nutrients
- Severe storms causing massive erosive events
- The westward progression of the sand at a rate of about 4 to 5m per year, burying the coastal forest.
- The introduction of exotic flora and fauna. Note that for over 200 years ships have emptied their ballast near the entry to the Newcastle harbour, potentially bringing in

new plant and animal species¹⁶. For example, the Australian distribution of the South African species flag slugwort (*Hebenstretia dentata*), which is essentially only found in Australia from Newcastle harbour to Anna Bay, is highly suggestive of its arrival on a ship. Hamilton, in 2014, in discussing plants arriving in ships' ballasts stated that Stockton Beach, Geelong and Port Phillip were "well known nurseries for alien weeds".

- Past mining for heavy mineral sands. Parts of Stockton Beach were mined for rutile, zircon, ilmenite and monazite in the past, disrupting the natural patterns in dune formation and ecology¹⁷.
- Quarrying of sand. A number of sand quarrying licenses have been permitted to enable sand to be taken where it is encroaching on the forests.



The vegetation of Stockton Beach has changed over time but there is little documentation of this. A good description of the flora was preserved in a report by Pidgeon (1940). She describes the succession of plant life along the sand dunes as follows, noting that that the taxonomic names that she used have been changed to the modern-day equivalents:

- Windblown (aeolian) sand
- Beach fescue (*Poa billardierei*), spinifex (*Spinifex sericeus*). Occasional *Senecio* spp. and *Sonchus* spp..
- Dune fan flower (*Scaevola calendulacea*), climbing guinea flower (*Hibbertia scandens*), and pigface (*Carpobrotus aequilaterus*)¹⁸
- Leptospermum - Acacia scrub
- Banksia - Leptospermum thicket
- Banksia forest
- Mixed eucalyptus forest

¹⁶ Petrus Heyligers (2007) documented the spread of exotic species along the Australian coast and states that the most likely site of introduction into Australia is via the ports.

¹⁷ Brewer and Whelan (2003) studied changes in vegetation after heavy mineral extraction of the sand dunes in the nearby Bennet's Beach. They noted the loss of zonation and the appearance of numerous weed species as well as some unexpected native plant species following the sand mining.

¹⁸ A southern African plant not normally found on this beach. Most likely Pidgeon mistook this with pigface *Carpobrotus glaucescens* which is commonly found on NSW coastal sand dunes.

Notable differences are the presence of the grass, beach fescue, on the sand dunes and the presence of *Scaevola* and *Hibbertia* in the next zone. Notable absences include bitou bush and pennywort and beach evening primrose (all introduced species).

Pidgeon also describes the “swamps in sands” in “undulating areas of stabilized wind-blown sands” just north of the Hunter River at Port Stephens. The lack of swales behind Bennet’s Beach north of Port Stephens, means that she must have been referring to the swales along Stockton Beach. She describes a succession from

- bare water to submerged plants (not named) to
- amphibious reeds [the rushes *Machaerina teretifolia*, *Machaerina articulata*, and arrowgrasses (*Triglochin* spp.), frogmouth (*Philydrum lanuginosum*), grey sedge (*Lepironia articulata*)] to the emerged stage [grey sedge (*Lepironia articulata*), broad-leaved paperbark (*Melaleuca leucodendra*) seedlings] to
- tea tree forest [broad-leaved paperbark (*Melaleuca leucodendra*)] to
- Eucalyptus and tea tree forest (*Melaleuca leucodendra* and *E. robusta*) to
- the “climax” vegetation type (*E. pilularis*, *Angophora costata*).

It would seem that the last three stages are no longer in the swales and the succession listed follows the theme presented in Pidgeon’s paper that various plant assemblages in the Central Coast of NSW follow different paths of succession until they reach the same climax vegetation type (*Eucalyptus pilularis*, *Angophora costata*). The plant assemblages that she describes for the second zone are quite different to what is seen today, but the plants in this zone have an approximate functional equivalence. It seems likely that for the broad leaved paperbark, *Melaleuca quinqueria*, she has given the taxonomic name of the similar *M. leucodendra*, which mostly occurs in northern Australia and has not recently been described as occurring in the Stockton Beach associated coastal forests (Atlas of Living Australia).

Osborn and Robertson in 1939 described in detail the succession of plants along the coast at Myall Lakes, not far north of Stockton Beach. This is an important description because at the time it was in its natural state before any apparent anthropogenic changes. They described the following zones¹⁹

- the first colonizer – sea rocket (*Cakile maritima*).
- The foredune was vegetated with coast fescue (*Austrofestuca littoralis*), coast groundsel (*Senecio spathulatus*), and spinifex (*Spinifex hirsutus*).
- Vegetation on the “fixed dunes” consisting of the following “mat plants”: ice plant (*Mesembryanthemum aequilaterale*)²⁰, dune fan flower (*Scaevola calendulacea*), and coast stackhousia (*Stackhousia spathulata*), white correa (*Correa alba*) and coast beard-heath (*Leucopogon parviflorus*).
- The next zone consisted of banksias (*Banksia integrifolia* and *B. serrata*) and coast tea tree (*Gaudium laevigatum*)²¹, native coffee bush (*Breynia oblongifolia*), Sydney red gum (*Angophora costata*), and others.
- The next zone was described as the banksia–angophora forest (*Angophora costata* and *Banksia serrata* and/or *B. integrifolia*) with a variety of undergrowth plants.

¹⁹ The older taxonomic names have here been changed to the modern equivalent.

²⁰ Probably pigface (*Carpobrotus glaucescens*)

²¹ Until recently was *Leptospermum laevigatum*.

- The final zone was listed as having the dominant trees – blackbut (*Eucalyptus pilularis*) and red bloodwood (*Corymbia gummifera*) with some Sydney red gum (*Angophora costata*) and banksia (*Banksia serrata*) with an extensive variety of plants in the understory.

DISCUSSION

During this study, many conservation issues became apparent.

1. The importance of protecting the foredunes. Any damage to the foredunes, e.g. from 4-wheel drive activity, can lead to blowouts in the dune and exacerbate the movement of sand inland.
2. Some foredunes are quite low and have lost their Spinifex protection, allowing waves to over-top them under certain conditions. This could potentially result in the erosion of these foredunes leading to significant blow-outs.
3. Human activity, particularly in the north-east section of the beach might considerably affect the activities of the shorebirds.
4. More study is needed regarding the breeding activity of birds in the swales
5. Little information appears to be available regarding what some birds in the swales eat.
6. There appears to be little information on the effects of exotic plants on the ecology of Stockton Beach and dune complex. For example, Bitou Bush *Chrysanthemoides monilifera* may have replaced some of the native plants, however removal without establishing a suitable native replacement, may have deleterious effects on the stability of the dunes.

Many of these issues are addressed under the Worimi Conservation Lands Management Plan (Office of Environment and Heritage, 2014).

CONCLUSIONS

The study area: Stockton Beach, with its associated sand dunes and coastal forests, provides a number of distinctly different habitats. In each of these, the physical environment determines what plants will grow and hence what animals will live there. Every bird species has its own requirements in terms of food and water, nesting and roosting sites and protection from predators. This means that there are distinct differences in terms of what species are found in each zone. This study has examined these zones and the factors determining what plants (from phytoplankton to large eucalypts) grow in each zone.

This study was temporally limited. Ideally the study should be extended over all seasons of the year and over many years to account for seasonal and longer-term changes. As such, this study provides a snapshot for future comparisons.

The ecology of the Stockton Beach and dune complex has not been well studied, perhaps because of the difficulty of access. Members of the Hunter Bird Observers Club, in conjunction with the National Parks and Wildlife Service have extensive data on the birds of the foreshore and are now seeking to extend the observations into the swales behind the foredunes. Further studies of the birds, animals and plants are needed to better understand the intricate relationships amongst life forms in this dynamic landform.

ACKNOWLEDGEMENTS

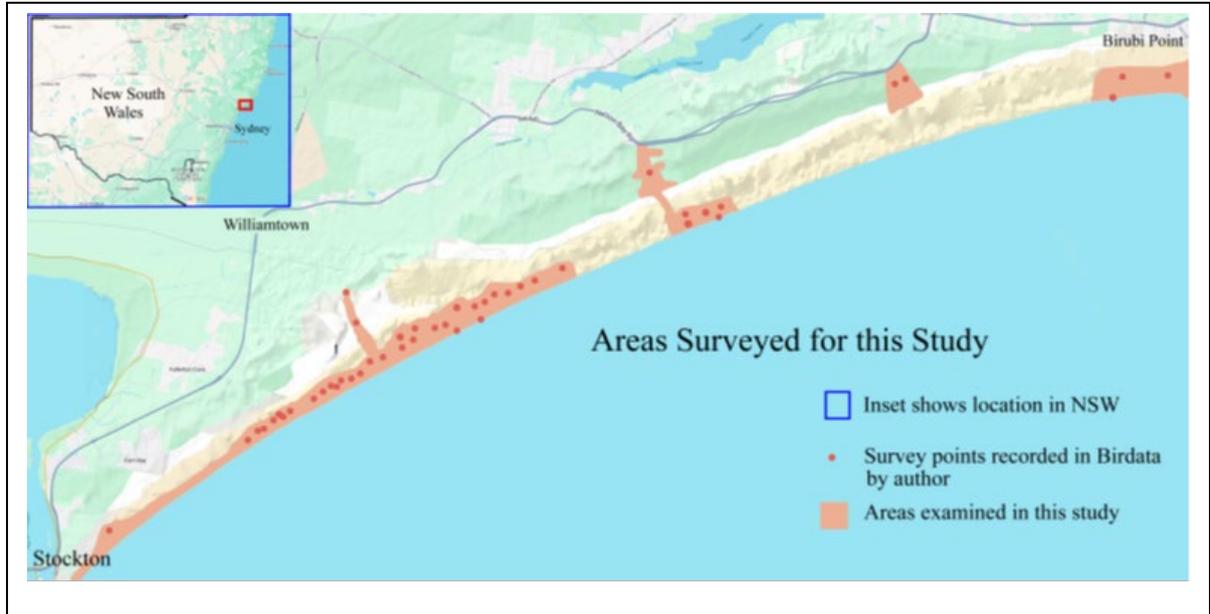
Many thanks to Andrew McIntyre and Neil Fraser, who through the Hunter Bird Observers Club, organized two surveys with the aim of simultaneously examining the birdlife along all 32km of Stockton Beach and the adjacent swales on 16th February 2025 and 11th July 2025. These expeditions enabled the author to examine, not only the birds, but also the plants and other animal life. The author was initially partnered with Greg Little, who was kind enough to put up with the logging of plants as well as birds and was able to assist in identifying plants. On the second survey, the author was partnered with Archie Brennan, also of the Hunter Bird Observers Club, who managed to spot a Hooded Plover (*Thinornis cucullatus*) during the survey. This was a rare and important observation.

Many thanks, also to Stephen Bell for reviewing this article and correcting some errors, particularly relating to the plants. Similarly, my thanks to Neil Fraser and Lou Stanton (from NPWS) for their review of this article.

Many thanks to Alan Stuart (editor of *The Whistler*) and Kristy Peters (HBOC member) for their editing of the related article that was published in *The Whistler*, the journal publication of the HBOC.

Appendix 1

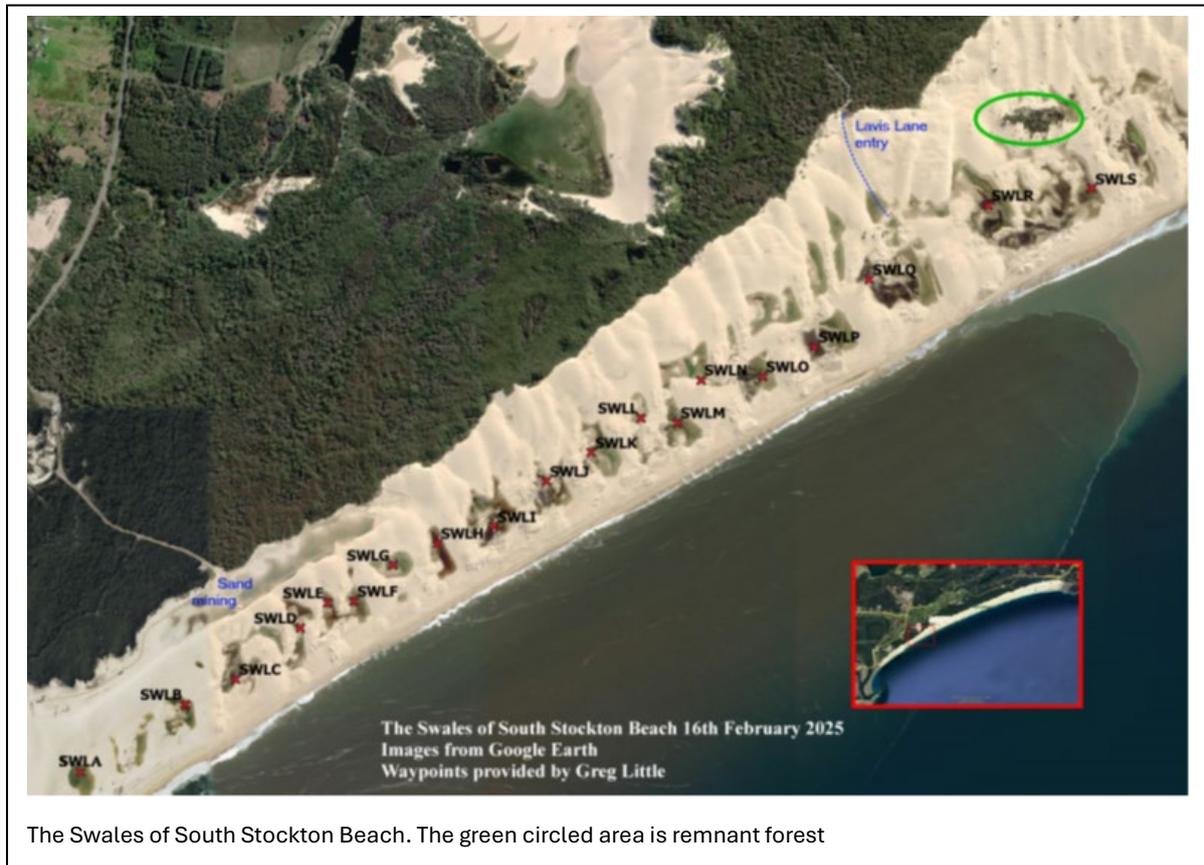
Survey points used in this study



Appendix 2

Some details regarding the swales of Stockton Beach. Note that number for the type of swale relates to the description in the main text. Subscript “a” denotes no visible/open water and “w” means visible/open water present.

The Southern Swales



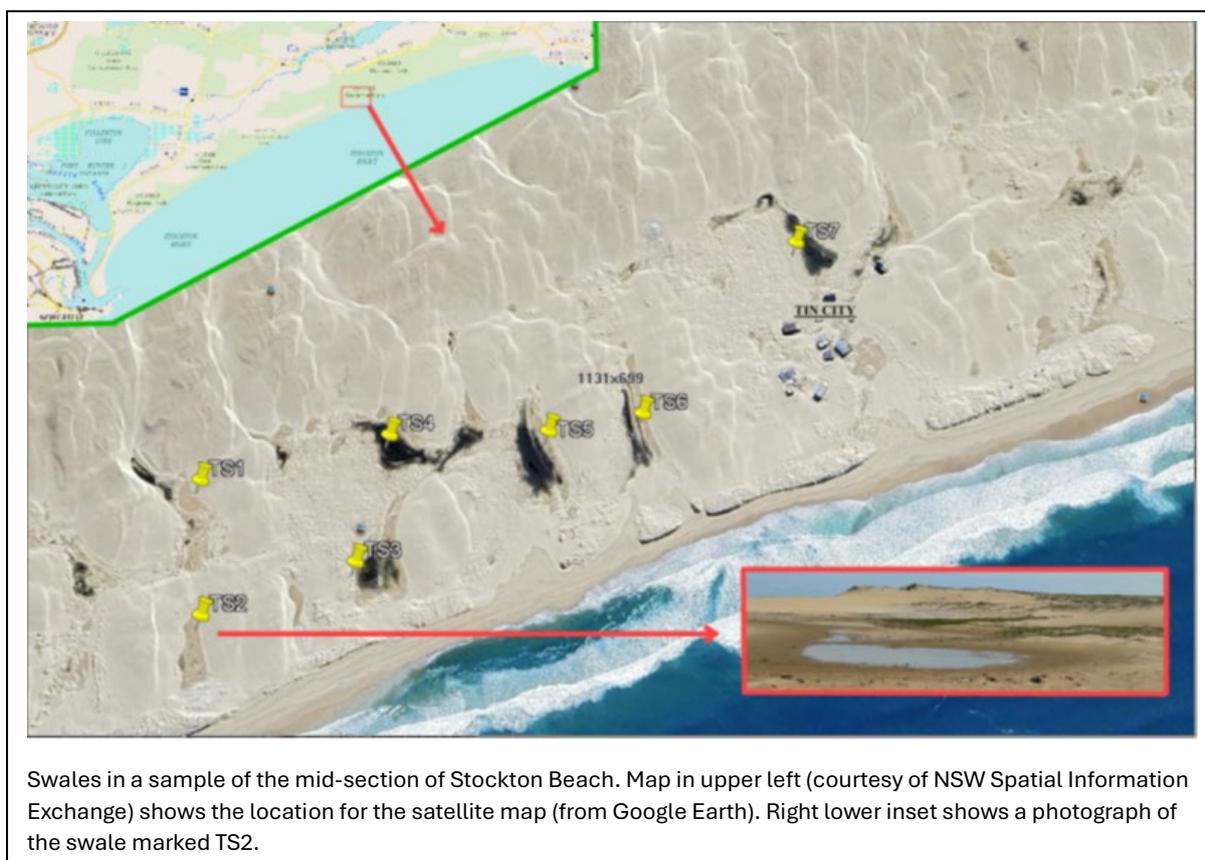
The Swales of South Stockton Beach. The green circled area is remnant forest

Swale	Type	Water	Spinifex, pennywort, pigface and/or primrose	Sedges and/or knotweed	Typha and/or Phragmites	Acacia and/or Bitou	Melaleuca Gaudium. and/or Casuarina.	Approx. size In metres
A	1w	Y						285x150
B	4a		Y	Y	Y			175x150
C	4w	Y		Y	Y			190x110
D	2a		Y					260x160
E	4a		Y		Y			115x140
F	5w	Y	Y	Y	Y		M	100x50
G	5w	Y	Y	Y	Y		M	100x100
H	4w	Y	Y	Y	Y			80x 40
I	5a		Y	Y	Y		A, M	220x170
J	4a		Y	Y	Y			220x160
K	4w	Y	Y	Y	Y			210x120
L	3a		Y	Y				230x60

M	5a		Y	Y	Y	A		200x120
N	5w	Y	Y	Y	Y	B		220x185
O	4w	Y	Y	Y	Y			230x150
P	4a		Y	Y	Y			225x220
Q	4a		Y	Y	Y			320x280
R	5a		Y	Y	Y	A		410x320
S	5a		Y	Y	Y	A		300x284

The Swales near Tin City

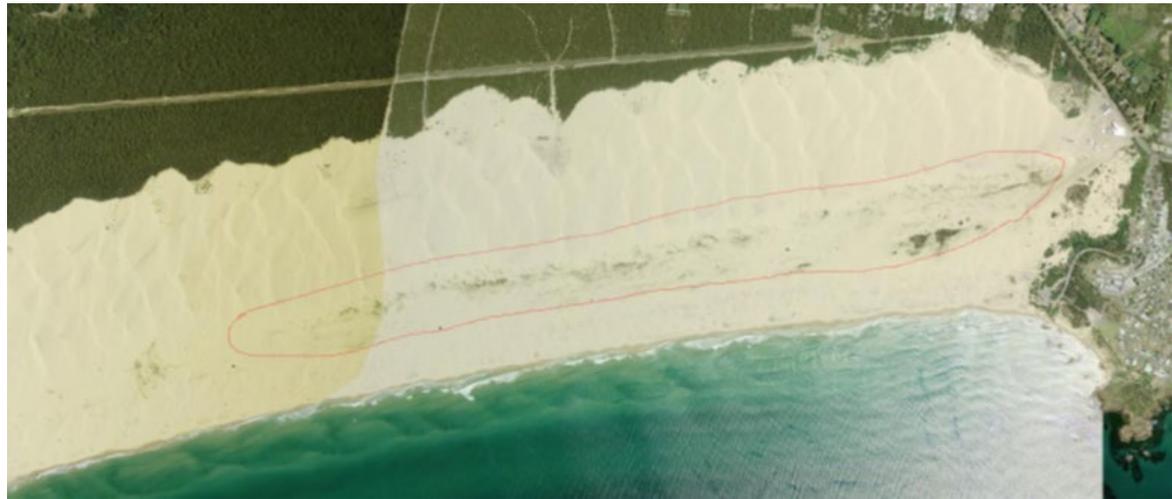
These swales are examples of those found in the mid-section of the beach. They are near “Tin City”, which is approximately 10km south of Birubi Point.



Swales in a sample of the mid-section of Stockton Beach. Map in upper left (courtesy of NSW Spatial Information Exchange) shows the location for the satellite map (from Google Earth). Right lower inset shows a photograph of the swale marked TS2.

Swale	Type	Water	Spinifex, pennywort, pigface and/or primrose	Sedges and/or knotweed	Typha and/or Phragmites	Acacia and/or Bitou	Melaleuca Gaudium. and/or Casuarina.	Approx. size In metres
TS1	2w	Y	Y					170 x 40
TS2	2w	Y	Y					100 x 40
TS3/4	2w	Y	Y					270 X 220
TS6	3a		Y	Y	Y			170 x 120

The Northern Swale



The large Birubi Point swale outlined in red

Swale	Exposed water	Spinifex, pennywort, pigface and/or primrose	Sedges and/or knotweed	Typha Phragmites	Acacia or Bitou	Mel. Gaud. or Allo.	Approx. size In metres
Birubi Point		Y	Y	Y	Bitou		3,600x400

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