

## Spatial Patterns and Dimensions:

Stockton Bight is located at the midpoint of the NSW coast, halfway between Victoria and Queensland. It is 195 km North of Sydney. The Bight extends approximately 31.8km from Stockton in the Southwest to Birubi Point (Anna Bay) in the Northeast. The approximate midpoint of the Bight has a latitude of 32° 50' S and a longitude of 151° 53' E. The average height of the dunes ranges between 15-20m above sea level, with the largest dunes reaching around 40m. The area of the Bight is 78 km<sup>2</sup> with an average width of 2-3 km. It is estimated that the sand dunes date back around 15,000 years.

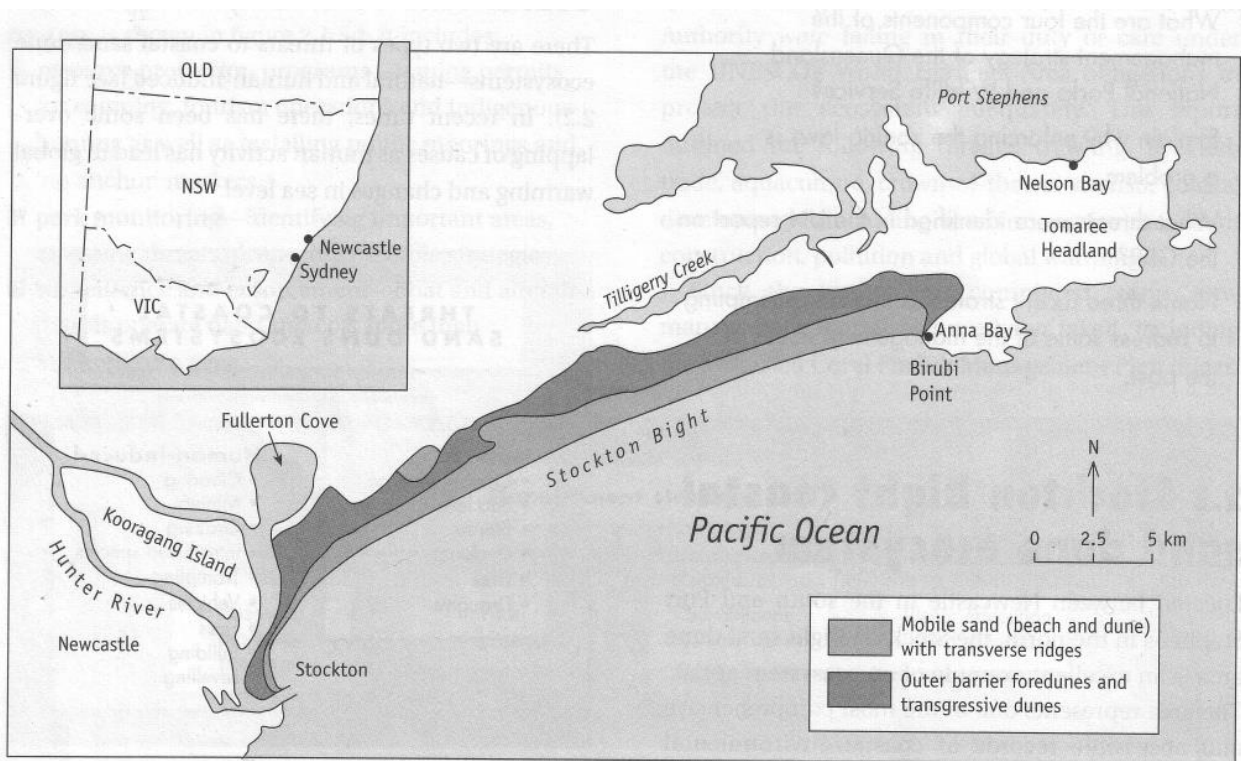
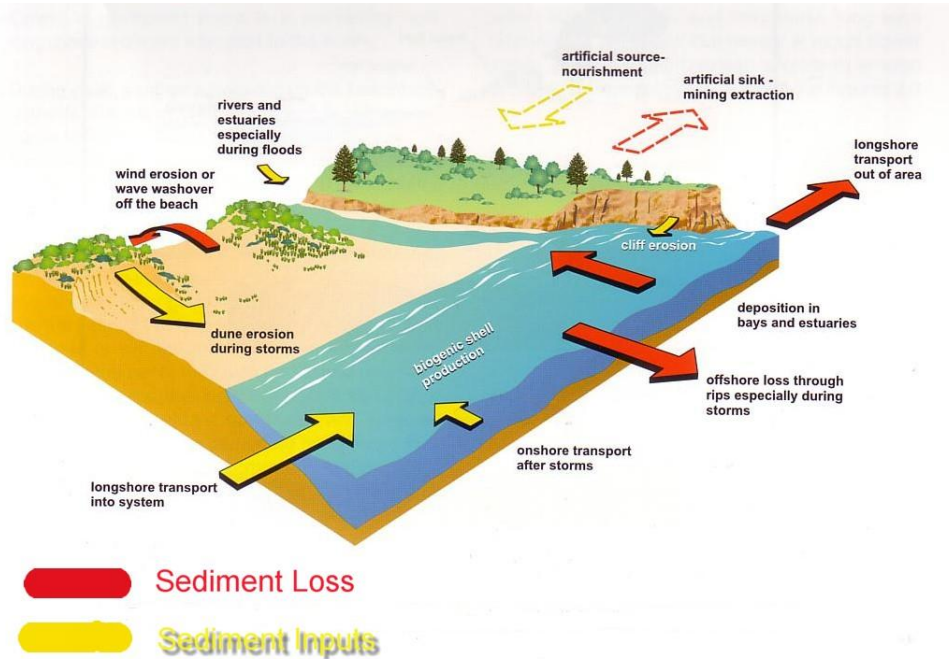


Figure 2.2.1 Location map of Stockton Bight

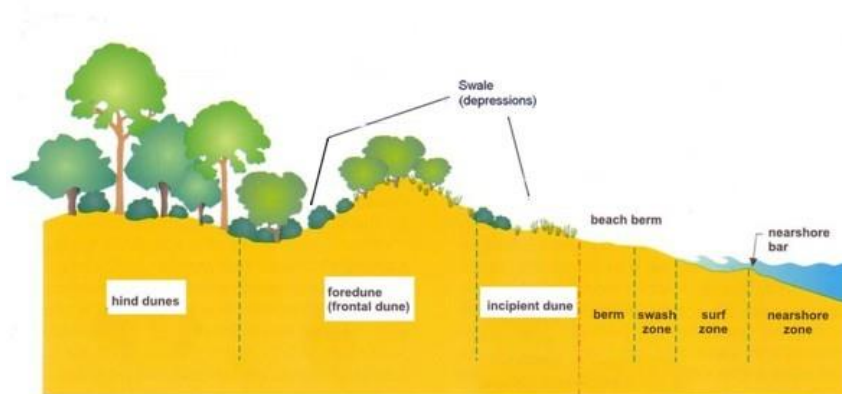
## Biophysical Interactions

### ***Accretion cycle***

The accretion cycle is a complex process whereby the lithosphere, hydrosphere, atmosphere and biosphere create, build up, store and remove sand in the dune system in a constant cycle. The cycle begins with eroded sand transported onto the shore by waves (fluvial), the sand dries and is blown to the back of the beach (aeolian) where it is stored with the help of vegetation. Destructive waves then take the sand back out to sea and store it offshore, however it is then slowly deposited back to the beach by constructive waves.



## Geomorphic Processes



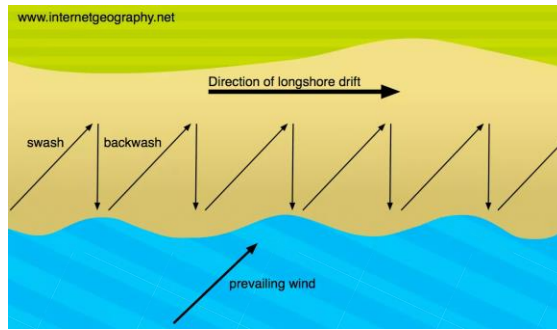
The Geomorphological zones of a coastal dune system

The Hunter Catchment area has provided the Stockton Bight Dunes with much of its sediment. The bedrock from mountain ranges around the area eventually are transported by the Hunter River and deposited. The cliffs around Tomaree have also been eroded and transported by longshore drift. This process of erosion is called fluvial (water) erosion.

## Hydrologic Processes

Hydrological is a fancy way of saying hydrosphere. It is mainly through the flow of water in the hydrosphere through rivers, currents, waves, and rain that helps in the depositing and removal of sediment in the accretion cycle.

- River discharge
  - River discharge from the Hunter River provides sediment from eroded cliffs. The climate determines how much sediment is delivered (climate sediment yield) as higher rainfall leads to a faster flowing river and therefore higher discharge amount.
- Longshore drift
  - Longshore drift transports sediment up to places quite far from the source through the movement of the ebb (flow back) and swash (flow on) of the waves. On Australia's East coast, sand moves northward along the beach.



- Waves destructive)

- The waves

onto a beach (constructive) or remove sand from a beach (destructive)

(constructive and

movement of water via

can either deposit sand

- Rainfall

- Rainfall increases the surface tension of sand, reducing aeolian transport. It also allows for plant growth, stabilising and trapping sediment, allowing dune formation.

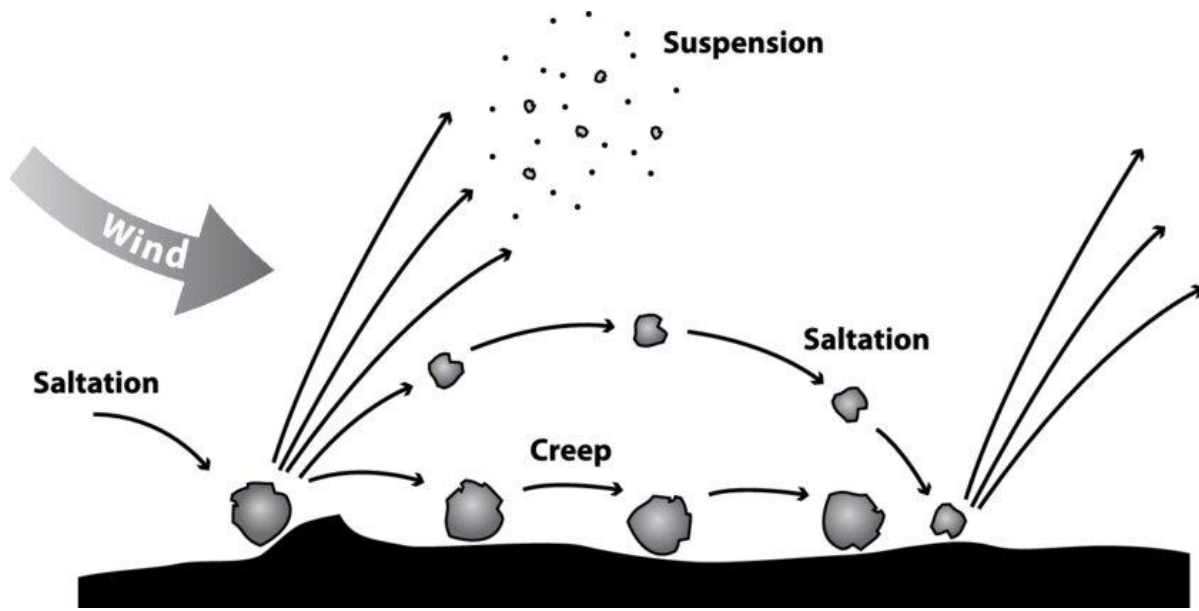
### ***Weather and Climate (atmosphere)***

The atmosphere is a very important biophysical component in Coastal Dune Ecosystems. Wind, temperature and precipitation are key climatic factors that play a significant role in the moving of sand particles in the accretion cycle on Coastal Dunes and in providing the conditions for vegetation growth.

Temperate climates are ideal for the formation of sand dunes as they allow sand to dry faster, making aeolian transport easier. Also, they allow dense vegetation to grow, stabilising dunes.

- Wind

- Aeolian transport = wind movement
- The prevailing wind on the Bight is South-East
- The three types of aeolian transport are:
  - Suspension - high off the ground, tiny particles
  - Saltation - particles jump on sand moved by wind
  - Creep - heavier particles are dislodged by impact from saltation



- Temperature
  - Warm weather dries the sand at an ideal rate for aeolian transport, not too quick nor too slow, and allows the right vegetation to grow in order to anchor the sand.
- Precipitation
  - Precipitation determines how wet the sand gets and assists in the ability for vegetation to grow. It plays a role in the storage of sand as the density of precipitation anchors the sand also.
  - The precipitation is not constant and heavy enough to make the sand on the Bight constantly wet. Thus, precipitation levels allow vegetation to grow whilst allowing the accretion cycle to function properly.

### ***Biogeographical Processes***

Biogeographical is a fancy way of saying biosphere and therefore involves all of the biotic features of an ecosystem.

Vegetation is crucial for the formation and protection of dunes from wind. Vegetation anchors sand and stabilises the dune ecosystem, allowing it to accumulate and grow larger.

- Colonisation
  - Colonisation refers to the first organisms to inhabit a bare patch of land (lithosphere) such as spinifex and marram grass
- Succession
  - Succession refers to the sequence of organisms that succeed after each other in an ecosystem until it reaches a climax community.

Firstly, mini dunes are created by colonisation whereby fluvial transportation brings seeds which act as a small catchment for sand. From there bird droppings deposit nutrients into the sand, allowing them to grow and catch tumbleweeds which carry pioneer colonisers such as spinifex seeds. These then grow and catch more tumbleweeds, growing more dense and connecting other small dunes. Saltation builds these up and creates an environment for pigface and the goats foot vine, stabilising the dunes. Over time the prevailing SE winds transport more sand and create walls, allowing the incipient dune and foredune to form. These dunes are more nutrient rich and lend to larger, more sophisticated vegetation such as banksias. The hind dunes are then formed with the most complex soil and vegetation, protected by the foredune and incipient dune.

## **Nature and Rate of Change**

Stockton Bight is a state of dynamic equilibrium. Changes occur because of:

- Natural Induced change
- Human impacts / human induced modifications

The rate of change varies from rapid to gradual.

Natural induced changes are often exacerbated by human impacts.

## ***Natural Stresses***

Natural stresses include:

- Storm activity
    - Blowouts - erosion and removal of dunes
    - Washovers
  - Bushfires
- Storm damage
    - A blowout is when high winds blow sand into the secondary and tertiary vegetation zones, smothering the dune vegetation.
    - Sand dunes adjust to blowouts through vegetation succession which refers to the process of organisms succeeding one another, eventually creating a new community.
      - The Stockton Bight has two blowouts, the largest being the Tongue at 5.5km long and 1.9km inland. The second is the Bowl, originated due to careless land practices in recent times.
    - A washover is when heavy storms bring large waves that travel up the swash zone and over the incipient and foredune area, eroding the dunes and bringing sand back into the ocean.
      - The Sygna storm in 1974 and the Pasha Bulker storm in 2007 both brought large waves and eroded the dune ecosystem through washover.

## ***Human Impacts***

Human impacts can be divided into two groups:

- Traditional impacts (Indigenous Australians)
- Modern use

Indigenous Australians have lived in the Bight for thousands of years. The clan that live there is called the Worimi group. They lived a nomadic lifestyle following seasonal foods. It is believed that they used firestick burning as a way of encouraging biodiversity and plant regrowth.

Modern human impacts include:

- Introduced species
- Disruption of sediment/accretion cycle
- Recreational use
- Sand mining

### ***Introduced species***

- Bitou Bush
  - The Bitou Bush was introduced as a plant to stabilise dunes however, over time it has turned into a weed and overrun the ecosystem, causing a disruption to other stabilising plant species. The Bitou Bush interrupts the natural regrowth of plants throughout the dunes, leading to the possibility of destabilisation and more vegetation to fuel bushfires.
- Rabbits
  - Rabbits were introduced into Australia during the arrival of ships and immediately spread and adapted to living conditions. They were introduced in order to eradicate certain vegetation but instead overpopulated. These rabbits eat the grasses and other vegetation on dunes, reducing ground cover and exposing the sand to wind erosion. The burrows also destabilise the dune structure.



### ***Disruption of sediment/accretion cycle***

The sea wall at the mouth of the Hunter River was built to prevent sand from building up in the shipping channel, ensuring the depth was always enough for any ships entering.

The sea wall however, has led to sand and sediment bypassing the southern end of Stockton during longshore drift, leading to a thinner, more vulnerable ecosystem to storms.

### ***Recreational Use***

Recreational use leads to a loss of plant life through trampling and greater soil compaction, ultimately destabilising the dunes and leading to vulnerability to storms, as well as exposing sand leading to unwanted aeolian transport.

### ***Sand Mining***

Sand mining is one of the most disruptive and controversial land uses of dunes because it involves the destruction of all vegetation, leading to destabilisation and wind exposure, ultimately increased vulnerability.

## Traditional Management

The traditional owners of the Stockton Bight region are the Maaiangal Clan of the Worimi Nation. The Aboriginals from Port Stephens were sedentary (stayed in one area), different from the nomadic lifestyle of the Worimi people.

- Totems
  - Refers to a strategy whereby each family is assigned a specific plant or animal to protect.
  - Totems were an effective management strategy to prevent the overhunting and overharvesting of certain animals and plants.
- Setting size limits
  - Size limits on animals ensured the natural process of breeding to occur, leaving smaller animals to grow and reproduce before consumption.
- Seasonal hunting and harvesting
  - Seasonal hunting and harvesting ensured that plant and animal species could recover and maintain their numbers (biomass).
- Middens
  - Middens kept major events and camping spots localised, preventing any major disruption of the dunes and providing the clans with freshwater and shelter, both of which were always nearby.
  - Middens were also used to show clan boundaries.
- Firestick farming
  - Firestick farming, whilst it could have contributed to the destabilisation of the dunes by burning all vegetation, also provided the ecosystem with opportunities to increase biodiversity, improving resilience to other stresses. This was only meant to be performed during cool periods when dew was present on the ground.

## **Contemporary Management**

Joint agreement between government and Worimi people.

2007 - NSW government granted land at Stockton to the Worimi Local Aboriginal Land Council.

The land is now co-managed by the NSW government and the Aboriginal owners.

This created the Worimi Conservation Lands.

### ***Worimi National Park***

- Area of land protected for its unspoiled landscapes, outstanding or representative ecosystems, native plant and animal species and places of natural or cultural significance.
- Used for scientific research, sustainable visitor use, and public appreciation and enjoyment.

### ***Worimi State Conservation Area***

- Lands reserved to protect their significance whilst also providing opportunities for sustainable visitation, enjoyment, use of buildings and research
- Mineral and petroleum exploration may be permitted

### ***Regional Park***

- Lands reserved to protect and conserve areas in natural or modified landscapes
- Offer open spaces for cultural and recreational use

<p><b>Land Use controls</b></p> <p>Controlling what activities take place on what areas of the dunes</p>	<p>Used to prevent destructive recreational use</p>
<p><b>Fencing</b></p> <p>Fencing off certain areas of the dunes</p>	<p>Prevents trampling of dunes from recreational use</p>
<p><b>Fenced access ways and Board and chain paths</b></p> <p>Paths constructed through the dunes</p> <p>Boardwalks above the sand</p>	<p>Links car parks and open areas, prevents trampling</p> <p>Prevents trampling and sand compaction</p>
<p><b>Mats and netting</b></p> <p>Nets placed on loose sand</p>	<p>Protects and stabilises vulnerable sand and vegetation areas</p>
<p><b>Signage</b></p> <p>Placing signs to make users aware of protection activities</p>	<p>Controls public movement and behaviour</p>
<p><b>Dune reconstruction</b></p> <p>Reshaping dunes into a more dynamic shape</p>	<p>Prevents aeolian erosion if well vegetated</p>
<p><b>Revegetation</b></p> <p>Develop a plant succession to revegetate the dunes</p>	<p>Restabilises dunes and protects from aeolian erosion as well as helping to recover from sand mining</p>
<p><b>Dealing with weeds</b></p> <p>Physical - removing weeds</p> <p>Chemical - killing weeds</p> <p>Biological - prevents and outgrows weeds</p>	<p>Helps remove any unwanted introduced species of plant or even animal. Can destabilise dunes in the short term</p>