

COASTAL CANTERBURY



Canterbury Coastline.

Much of Canterbury's population lives on or near the Canterbury coast, a long and diverse coastline stretching from north of Kaikoura to the Waitaki River. In between are the sandy beaches of Pegasus Bay, the rocky platforms of Kaikoura and Banks Peninsula, coastal lagoons, hapua, estuaries and shingle beaches. Each area has its own ecological processes, biodiversity, values and issues. Along a coastline as extensive as Canterbury's, the ecological values are very diverse. There are also many issues which arise from naturally occurring phenomena or from the effects of human activity.

The coastline is where the land and rivers meet the sea. People have, through time, used the sea as the eventual receiving environment of waste from the land by using the rivers and the coastline for the disposal of storm water run-off, treated sewage and other industrial wastes. This

can ultimately harm the coastal environment. People also use the coast for recreational activities like walking, swimming, surfing and fishing for fun, food, and money.

This issue of *Your environment, Canterbury* delves into everything coastal – firstly from a global perspective then focussing on us, New Zealand, and more specifically Canterbury/Waitaha. As an island country and a region with 800km of coast, the coastal ecosystems and biodiversity are important and the way we use and protect them is crucial. Three special Canterbury coastal features receive the limelight – spits, coastal lagoons and hapua. With knowledge and enthusiasm, we can discuss what you and your community can do to protect and enjoy the coast. It's one of the most special environments we have and one that often defines us as New Zealanders.

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COASTAL CANTERBURY

Did you know...?

The hydrosphere in physical geography describes the combined mass of water found on, under, and over the surface of a planet.

The blue planet

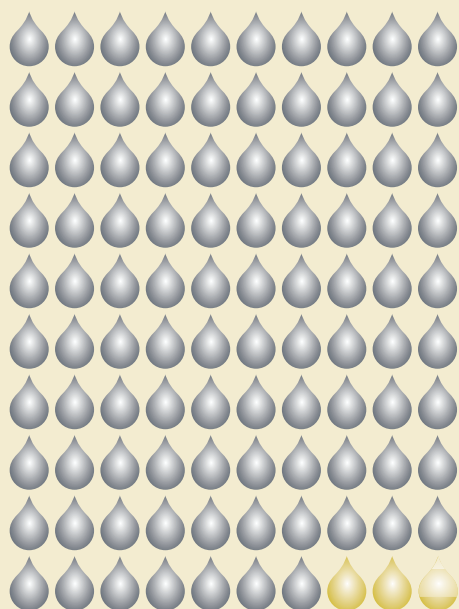


Earth is often referred to as the blue planet. With about 70% of the Earth's surface covered by salt water and the remaining 30% consisting of continents and islands, which together have many lakes and other sources of water, it's no wonder blue is our hue!

The salt water covering the Earth is divided up into five oceans – the Indian, Pacific, Arctic, Atlantic and Southern Oceans – and 103 seas. An ocean is a body of saline water that composes a large part of a planet's hydrosphere, and has no boundaries. The word 'sea' is used to mean smaller, partly landlocked sections of the ocean.

Oceans and seas moderate the Earth's climate and support an enormous diversity of marine and coastal life. Humans rely on the sea for food, trade and recreation. It has been travelled and explored since ancient times, while the scientific study of the sea (oceanography) dates broadly from the voyages of Captain James Cook who explored the Pacific Ocean between 1768 and 1779.

All the water in the world



- Salt water
- Fresh water
- Rivers & lakes
- Ground water
- Polar ice

The coast – a busy and changeable place

The coast is the narrow strip of land between the sea and an island or continent and is one place that you can guarantee change 24-7! The nonstop wave action along a coastline means nothing ever stays the same. Breakers gnaw away at cliffs, shift sand, breach barriers, build walls and sculpt bays. Even the gentlest of ripples constantly reshape coastlines in teeny, tiny ways – a few grains of sand at a time.

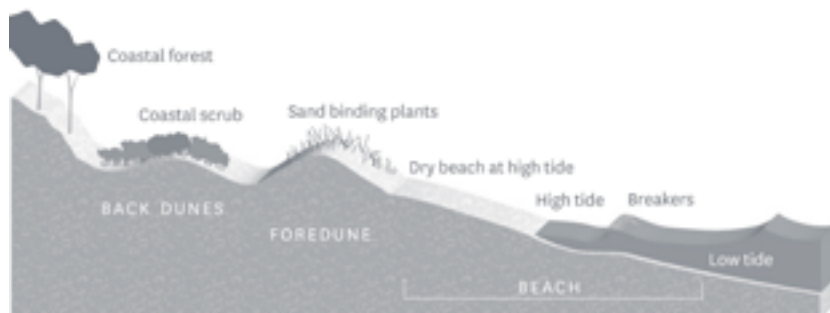
Glaciers, rivers, and streams deliver a steady supply of building material for nature's unending job. And not to be outdone, the tectonic forces that move giant pieces of Earth's crust will periodically bump the bedrock here and squeeze fresh lava out there, adding their own flourish to the coastal redesign.

Waves are the busiest sculptors on the coastline. Built up by winds both local and far out at sea, they unleash their energy and go to work when they break on the shore. The upward rush of water (called swash) delivers sand and gravel to the beach. On the return, backwash carries sand and gravel out to sea. Since waves usually hit the beach from one side or the other, but always return at a right angle to the beach, the motion drifts sand and gravel along the shore.

The ebb and flow of the tides is a partner in the dance of breaking waves and shifting sands, helping to sculpt an array of landforms for temporary display, such as narrow spits, barrier islands, and lofty dunes.

Along much of the coastline, pounding waves slowly chip away the base of cliffs, forcing chunks of rock to crumble and slide into the sea. Where a band of solid rock gives way, waves claw at weaker clays behind to sculpt a cove or a bay. Headlands form where the coastline gives way on either side, leaving a lone rocky mass to get hammered by the sea. (Source: National Geographic (science.nationalgeographic.com))

Cross-sectional diagram of the coast



Adapted from Waikato Regional Councils 'Coasts and Us' unit

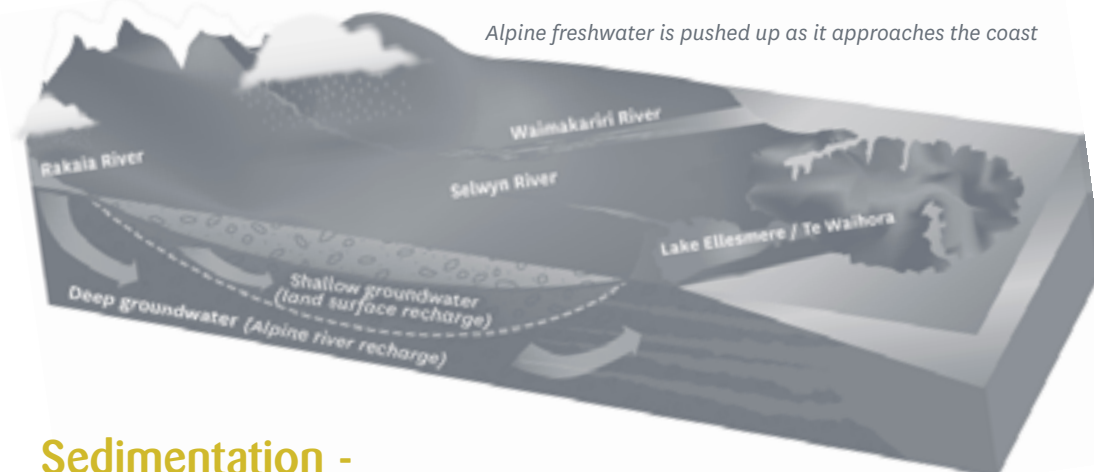
Merging of waters – freshwater and the coast

Like many things in life, it is hard to talk about one thing in isolation. Everything seems to be connected. The coast and freshwater is a great example of that.

Ngāi Tahu use the phrase 'ki uta ki tai' (from the mountains to the sea) to express their view that each part of a waterway is one element of a whole, interconnected system of land and water.

Water managers use catchments as an integrated way of studying and managing water and ecosystems. Catchments include all land from which water runs into the streams, which then in turn, run into a river. Important catchment features also include lakes, aquifers, estuaries, lagoons and wetlands. What happens in one part of the catchment affects the mauri (spirit or life force) of the waterway as a whole.

It extends beyond the river, however, to include the adjacent coastal and marine ecosystems. What we do in or on the land that affects a river may also have effects a long way downstream in the sea.



Sedimentation - An important part of the process

Sedimentation is the building up of layers of small particles like sand or soil. The easiest place to see this is the beach. A beach is made up of lots of sand which have been deposited, or left behind, by the sea.

Sand and mud are eroded from the land by rainfall and carried by rivers towards the sea. As the water slows, it can't carry as much and so sand and mud are dropped. The bigger the grain of sand, the sooner it is dropped. The smaller grains of mud drop out in sheltered waters such as upper areas of harbours or in estuaries.

What's the issue? When sedimentation turns bad

Sedimentation is a natural process. However, too much sedimentation can be harmful to the coastal environment. Floods and storms can cause excess sediment to wash off the land via building sites, farms, recently harvested forestry blocks and through the stormwater network to name a few. The sediment then enters waterways and flows into the sea. This sediment:

- Reduces water clarity and interferes with the vision, breathing and feeding of marine animals
- Fills the gaps between rocks in which some animals live
- Covers rocks and the seabed, which smothers the plants and animals that live there
- Affects the growth of plants, which can disrupt the food chain



Avon-Heathcote/Ihuta estuary at low tide.

Stormwater and the coastal environment

When water falls onto a hard, sealed 'impermeable' surface such as roofs, roads and driveways, it cannot soak into the ground. Instead, it runs off the surface. This runoff is called **stormwater**. It flows overland via gutters and drains, into a network of pipes and open waterways. From here it flows, mostly untreated, into our streams and rivers and eventually into estuaries and the sea.

Urban stormwater is a major concern for New Zealand. Because the stormwater system collects rainfall through drains, it also carries away hazardous substances such as metals off the roof of buildings, and petrol, rubber, oil, and metals left behind on our busy roads by vehicles. On its journey to the sea, stormwater can also pick up rubbish such as cigarette butts, fertiliser, plastic, leaves and animal excrement. All of these contaminate stormwater and ultimately the sea. Drains should only drain rain!

Using too many fertilisers and pesticides on lawns and gardens can also result in toxic chemicals being washed into the stormwater system.

All these substances gradually build up in our streams, rivers, estuaries and the sea and can become a hazard for plant and animal life in these environments.

Want to know more?

Please refer to our coastal education resources on our website www.ecan.govt.nz/education



In the classroom: Every drop counts

How's your maths? Try these for size.

- There are 17 cars parked in a school car park. Each car leaves 5 drops of oil each day. When it rains heavily this oil will be washed down a stormwater drain into the waterways and out to sea.
- What is the total number of drops of oil each day from these cars?
- What is the total number of drops of oil in one week?
- If there are 197 days in the school year how many drops of oil will have been left in the car park?
- Work out how many litres of oil this might be.

Cooling down in Canterbury

Contaminated stormwater can pollute the many swimming sites around the region. However, it is not the only source of contamination posing a health risk to bathers. Some of the more common sources of faecal contaminants are **sewage**, **rural run-off** and **birds**.

- **Sewage** from many communities is collected via a network of pipes and pumped to a central facility, where it is treated before being discharged to the environment. Sewage consists mostly of water, but also contains organic material and micro-organisms including pathogens. There are a number of factors that can cause sewage to get into the water before it is fully treated. The main ones include broken or leaky pipes, overflows due to heavy rainfalls, and emergency overflows.
- **Rural run-off** can add significantly to the contamination of waterways. Apart from farm oxidation ponds that have been shown to contain high levels of pathogens, a large amount of animal waste ends up on the paddock. Depending on a number of factors (including distance to the nearest stream, rainfall intensity and stock numbers) faecal material ends up in waterways. Where stock has access to streams and rivers for drinking water, excrement may be deposited directly into the water.
- **Birds** In some water bodies, birds can accumulate in very large numbers because of food supply and breeding needs. Bird faeces can contain pathogens that can be harmful to humans.



Pollutants

Pollutants such as metals, oil, toxic substances, plastic and rubbish reach the sea via:

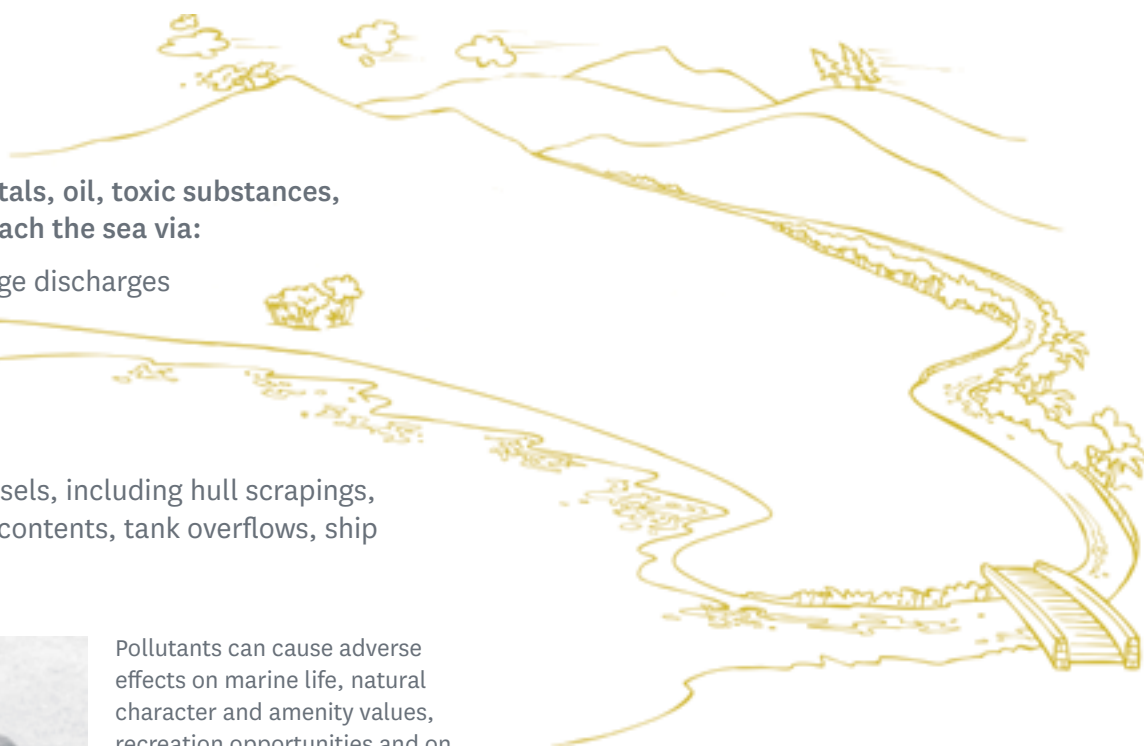
- industrial and sewage discharges
- general runoff
- careless humans
- stormwater
- discharges from vessels, including hull scrapings, ballast water, bilge contents, tank overflows, ship waste and sewage



Pollutants can cause adverse effects on marine life, natural character and amenity values, recreation opportunities and on commercial undertakings such as tourism, fishing and aquaculture.

The many values our coastal environment provides are affected by waste, in all its many forms.

Contaminant discharges, especially sewage, are particularly abhorrent to the values of Ngāi Tahu. The issue is also of importance to Ngāi Tahu as tangata whenua because of the effects on the mauri (life force, special nature) of the coastal environment and on mahinga kai.



Did you know?

Coastal lagoons and estuaries are not the same thing.

Lagoons are shallow, often elongated bodies of water separated from a larger body of water (in this case, the sea) by a shallow or exposed shoal, or similar feature. They often occur on mixed-sand and gravel coastlines.

An estuary is a partly enclosed coastal body of brackish water, with one or more rivers or streams flowing into it and with an opening to the sea.

The main difference between the two is that a lagoon is a body of water with little tidal, saltwater inflow, whereas estuaries receive a regular flow of fresh and saltwater.

In the classroom: Settling down - sediment



What you need:

A cup of gravel
A cup of soil
A cup of sand
Three paper cups
Water
A two litre plastic bottle
A funnel

What to do:

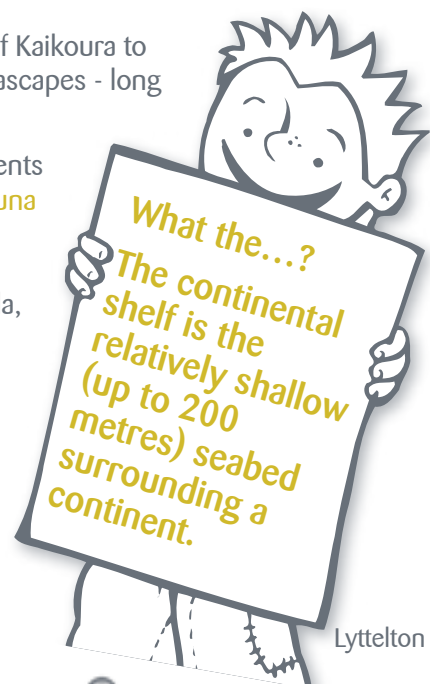
1. Fill one cup with soil, one with sand, one with gravel.
2. With the funnel, pour the soil, sand and gravel into the bottle.
3. Now pour water into the bottle. Pour until the bottle is almost full. Close the cap lightly.
4. Shake the bottle thoroughly so that everything is mixed well.
5. Place the bottle on a table. Record your observations. Check the bottle after 15-20 minutes and check again after 24 hours. Note what you see.

COASTAL CANTERBURY

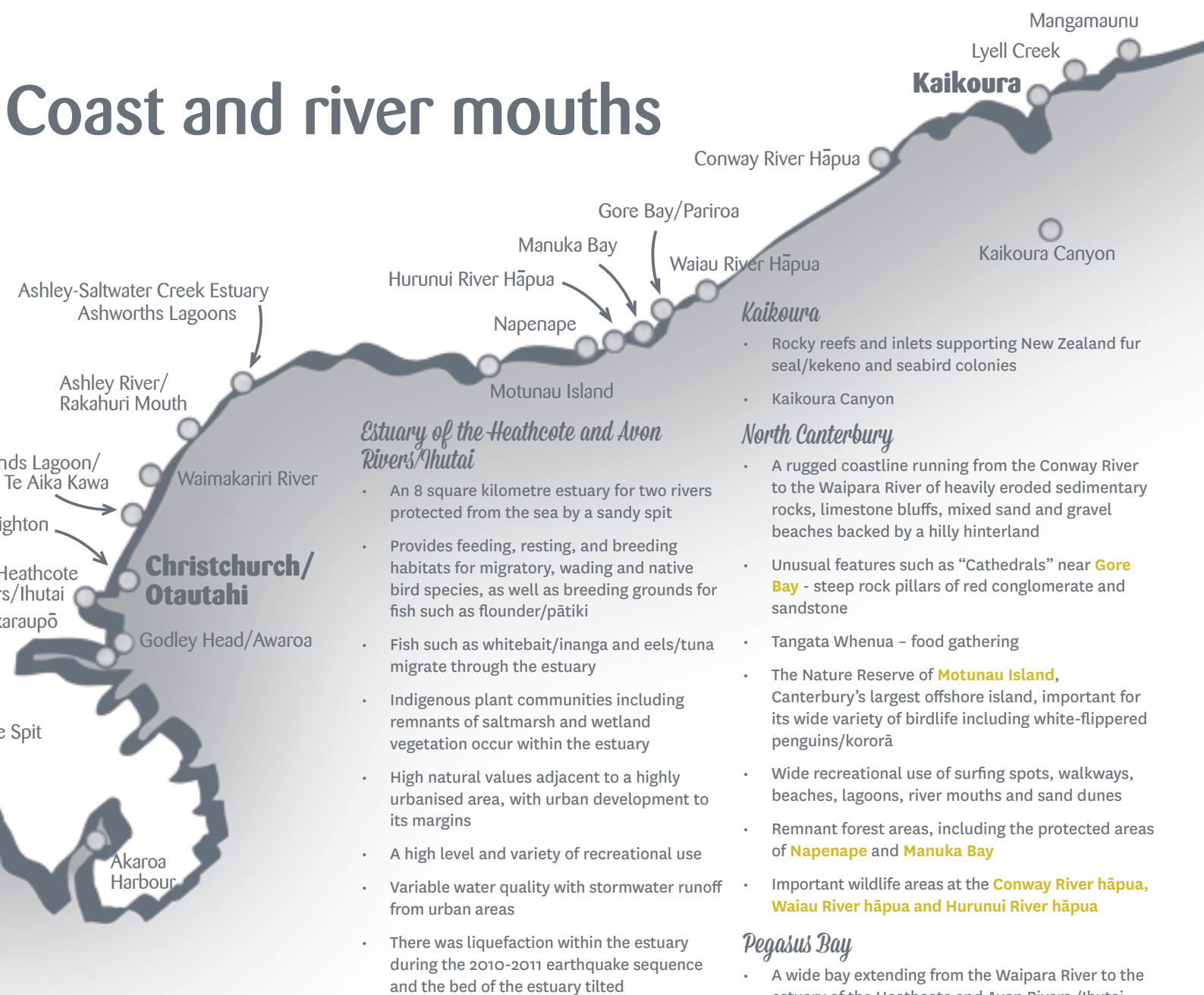
Te Waitaha takutai – The Canterbury

The Canterbury region has a long and diverse coastline stretching from north of Kaikoura to the Waitaki River. At 800 km long there is a considerable variety of land and seascapes - long sand and shingle beaches, mudflats and rocky shores.

Three major coastal currents affect Canterbury's coastal waters, carrying nutrients to support the food chain allowing a diversity of marine **flora** (plant life) and **fauna** (animal life). Beneath these rich waters lies a large **continental shelf**, ranging in width from a few hundred metres off Kaikoura to nearly 100 km off the Canterbury Bight. It narrows between Haumuri Bluff and the Kaikoura Peninsula, where undersea canyons provide deep inshore feeding grounds for marine mammals, particularly whales.



Coast and river mouths



Estuary of the Heathcote and Avon Rivers/Ihuta

- An 8 square kilometre estuary for two rivers protected from the sea by a sandy spit
- Provides feeding, resting, and breeding habitats for migratory, wading and native bird species, as well as breeding grounds for fish such as flounder/pātiki
- Fish such as whitebait/inanga and eels/tuna migrate through the estuary
- Indigenous plant communities including remnants of saltmarsh and wetland vegetation occur within the estuary
- High natural values adjacent to a highly urbanised area, with urban development to its margins
- A high level and variety of recreational use
- Variable water quality with stormwater runoff from urban areas
- There was liquefaction within the estuary during the 2010-2011 earthquake sequence and the bed of the estuary tilted

Banks Peninsula/Horomaka

- Highly distinctive landform featuring the water-filled craters of two extinct volcanoes with steep valleys and a rugged and remote indented coastline extending from the mouth of the **estuary of the Heathcote and Avon Rivers /Ihuta** to the eastern end of the Kaitorete Spit
- Two large natural harbours, **Lyttelton Harbour /Whakaraupō** and **Akaroa Harbour** with many bays suitable for boat moorings and safe anchorage
- Numerous rocky shore platforms, sandy beaches, stone and boulder beaches, mudflats and sea caves
- Close proximity to Christchurch and high usage for water recreation and also important as a recreational fishery and mahinga kai
- The commercial Port of Lyttelton services vessels with a variety of cargo handling equipment, storage facilities and wharves. It is the principal commercial port in the region and the largest in the South Island
- There is aquaculture in some bays
- A large range of habitats supporting many wildlife species, including Hector's dolphins/upokohue, seals, sooty shearwaters/tītī and penguins/kororā

Kaikoura

- Rocky reefs and inlets supporting New Zealand fur seal/kekeno and seabird colonies
- Kaikoura Canyon

North Canterbury

- A rugged coastline running from the Conway River to the Waipara River of heavily eroded sedimentary rocks, limestone bluffs, mixed sand and gravel beaches backed by a hilly hinterland
- Unusual features such as "Cathedrals" near **Gore Bay** - steep rock pillars of red conglomerate and sandstone
- Tangata Whenua - food gathering
- The Nature Reserve of **Motunau Island**, Canterbury's largest offshore island, important for its wide variety of birdlife including white-flipped penguins/kororā
- Wide recreational use of surfing spots, walkways, beaches, lagoons, river mouths and sand dunes
- Remnant forest areas, including the protected areas of **Napenape** and **Manuka Bay**
- Important wildlife areas at the **Conway River hāpua**, **Waiau River hāpua** and **Hurunui River hāpua**

Pegasus Bay

- A wide bay extending from the Waipara River to the estuary of the Heathcote and Avon Rivers /Ihuta
- North of Leithfield Beach, low-lying and generally stable sand and gravel beaches. South of Leithfield Beach the beaches are sandy and backed by extensive sand dune systems
- Ponds, lagoons, hāpua and estuaries, such as Brooklands Lagoon
- Ashley/Saltwater Creek Estuary and Waipara River hapua providing fresh and brackish water and saltmarsh areas supporting a variety of indigenous plants
- The mouths of the braided rivers the estuary, lagoon and hapua are important ecosystems. They provide feeding, resting, and breeding habitats for migratory, wading and native bird species, as well as breeding grounds for fish such as flounder/pātiki and whitebait/inanga
- High recreational use, with significant holiday and retirement settlements adjacent to the coast
- Mahinga kai - eg the shellfish tuatua



Tangata Whenua and the Coastal

In Te Wai Pounamu (the South Island), one tribe, **Ngāi Tahu** occupies all but the most northern part of the island. The entire Canterbury region lies within the **rohe** (area) of Ngāi Tahu.

Mana whenua

Ngāi Tahu Whānui is Tangata Whenua within the rohe of Ngāi Tahu. The iwi is made up of whanau and hapū (family groups) who hold traditional authority – mana whenua, over particular areas. Mana whenua is determined by whakapapa - genealogical ties, and confers traditional political authority over an area. Once acquired, manawhenua is secured by ahi kā - continued occupation and resource use. Environment Canterbury recognises mana whenua through its relationship and consultation with Papatipu Rūnanga and Te Rūnanga o Ngāi Tahu.

Te Rūnanga o Ngāi Tahu

Te Rūnanga o Ngāi Tahu represents the tribal collective of Ngāi Tahu Whānui. It was established by the Te Rūnanga o Ngāi Tahu Act 1996 to give a legal identity to the tribe.

Ngāi Tahu claims settlement

In 1998 the Ngāi Tahu Claims Settlement Act was passed to achieve full and final settlement of historical Ngāi Tahu claims against the Crown. This Act, amongst other things, identifies taonga (treasured) species and establishes tōpuni, statutory acknowledgements and nohoanga sites. These instruments recognise the special association of Ngāi Tahu with these areas and species for the purpose of improving the effectiveness of Ngāi Tahu participation in resource management. The location of these areas in the Canterbury region is shown in Figure 4.1 of the Coastal Environment regional plan which can be found at www.ecan.govt.nz/rcep.

There are also other sites of significance that are important to local Rūnanga, but are not included in the statutory areas.

Kaitiakitanga

Kaitiakitanga is the expression of Māori authority, mana, ethics and guardianship. Tangata Whenua are the keepers and caretakers of knowledge relating to natural resources and the protectors of those resources.

Kaitiakitanga is fundamental to the relationship of Tangata Whenua and the environment.

Kaitiakitanga in relation to a particular resource can only be exercised by the particular Tangata Whenua who are the **Kaitiaki** (guardian) for the area.

Kaitiakitanga is an environmental decision-making system, which has been developed by Tangata Whenua, and in this case Ngāi Tahu, to fulfil their responsibility towards the environment. The responsibility of Kaitiaki is twofold: first, there is the ultimate aim of protecting **mauri**, secondly, there is the duty to pass the environment to future generations in a state which is as good as, or better than, the current state.

Kaitiakitanga is a broad notion which includes the following ideas:

- Guardianship
- care
- wise management
- resource indicators, where resources themselves indicate the state of their own mauri

Kaitiakitanga may be practised through:

- The maintenance of **wahi tapu**, **wahi tipuna** and other sites of importance
- the management of fishing grounds (**mahinga mātaihai**, **taiāpure**)
- protecting the environment from degradation and mitigating adverse effects
- observing the **māramatanga** (lunar calendar)
- observing the **tikanga** (custom) of sowing and harvesting
- designing settlements in keeping with the environment; and
- customary techniques such as **rāhui**, **tapu**, and **mana**



Environment

(Source: Coastal Environment Regional Plan)

Tangata Whenua Values

Ngā Wai (water), **Te Moana** (sea), **Mahinga Kai** (traditional food) and **Tauranga Waka** (landing sites for canoes) are all examples of taonga (treasured elements of a tribe's existence). Ngāi Tahu therefore has specific concerns regarding protection of these.

Concerns include:

(a) Water Quality

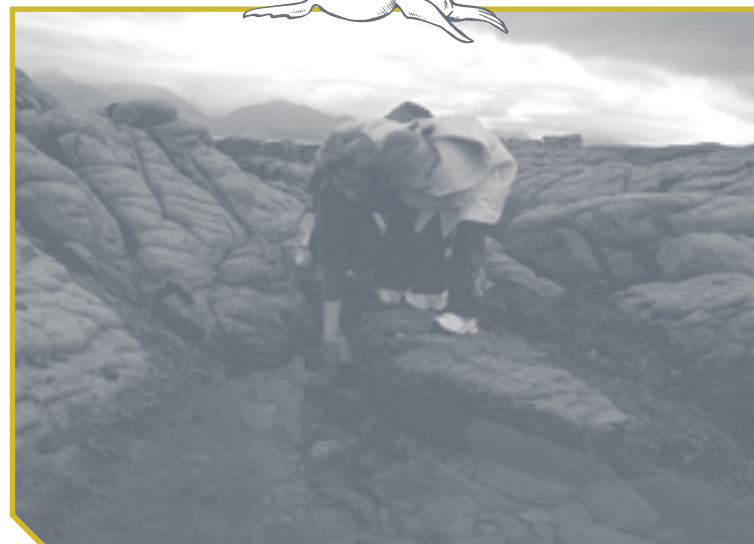
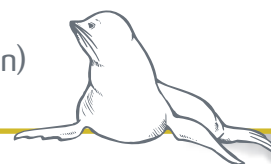
The general concern of Ngāi Tahu is that the water quality of the Canterbury region should be suitable for cultural purposes. The quality of the water should not be altered in a way that affects the cultural use of water as the environment that embodies the culture and nourishes kaimoana (sea food).

Specific concerns include:

- Amenity value, the ability to swim in water
- the discharge of human excrement into water bodies
- dairy shed and other agricultural/industrial run-off
- riparian land use that has downstream effects
- facilities such as sewage outlets that are constructed without consultation with, and approval of, the Rūnanga
- risk to kaimoana from discharges into water
- discharge of chemicals and other potentially hazardous waste; and
- dumping of waste into the sea

Kaitiakitanga is a proactive and preventative approach to environmental management.

However, this traditional management system rarely has the opportunity to address large scale environmental degradation. For example, the mauri (life principle) of places experiencing long-term sewage discharges, have been adversely affected. Ngāi Tahu feels that if Kaitiakitanga had been recognised, such degradation would not have occurred.



(b) Mahinga Kai

- Effects on the habitat of traditional fish species
- protection of spawning sites
- access to rivers and beaches where mahinga kai is gathered
- guaranteed access to areas such as **wāhi tapu** and mahinga kai; and
- consultation with Ngāi Tahu regarding general access to cultural sites

Rūnanga also have issues in relation to resource management within their individual rohe, for example:

- Water quality in Akaroa Harbour and Lyttelton Harbour /Whakaraupō
- the effects of dredging of the channel for commercial shipping in Lyttelton Harbour/Whakaraupō
- sewage and other discharges affecting shellfish beds
- the future of hāpua or coastal lagoons
- sedimentation affecting shellfish beds and the abundance of other seafood
- access and fishing easements

Ngāi Tahu has advanced a range of measures to address these matters.



COASTAL CANTERBURY

Nothing like home

New Zealand is an island country situated in the South western Pacific Ocean. It consists of two main land masses (North and South Islands) and numerous smaller islands, all surrounded by sea. In fact, there is no location in New Zealand that is more than 130km from the sea. We take it for granted because, well, that is just the way we are. However, from a global perspective, we are quite isolated. Australia is quite close, but the rest of the world is a long plane and even longer boat ride away!



The regional issues include:

- Damaging effects of human activities and discharges of contaminants on the life-supporting capacity of coastal ecosystems
- The need to provide for use and development of coastal resources while maintaining the natural character of the coastal environment
- Adverse effects of activities on cultural and heritage values including those values important to Tangata Whenua
- The effects of natural hazards such as coastal erosion and inundation

Issues specific to a certain area include:

- Sand dune protection and vehicle access in northern Pegasus Bay
- Flooding of coastal land on the South Canterbury coast
- Sedimentation in Lyttelton Harbour/Whakaraupō
- Marine farming around Banks Peninsula



Under pressure

The coast provides many things – kaimoana, recreation and trade opportunities, amazing vistas, and unique flora and fauna. However, the pressures placed on the coast and the seas and oceans beyond are many.

With its extensive diversity, the Canterbury coast not only has region-wide coastal issues but also issues specific to a certain area.

The New Zealand coast is very long, estimated at between 15,000 km – 18,000 km long, the 10th longest in the world! The exact length is concealed by the countless twists and turns around inlets, headlands, spits, harbours, fiords, sounds and estuaries. Two thirds of the coastline is hard rocky shore, with the rest soft shores of sand and gravel cover.

New Zealand's coastal marine area is more than 15 times larger than its terrestrial area, and our **Exclusive Economic Zone** is the fourth largest in the world. However, only a small percentage of this environment is currently protected.

New Zealand's Changing Coastline



(Image adapted from Nic Bishop's "Natural History of NZ")

Did you know?

Coastal marine area:

The marine and coastal area is the 'wet' part of the beach that is covered by the ebb and flow of the tide. It does not include the dry part of the beach. The marine and coastal area is the area between the line of mean high water springs and the outer limits of the territorial sea (12 nautical miles from shore).

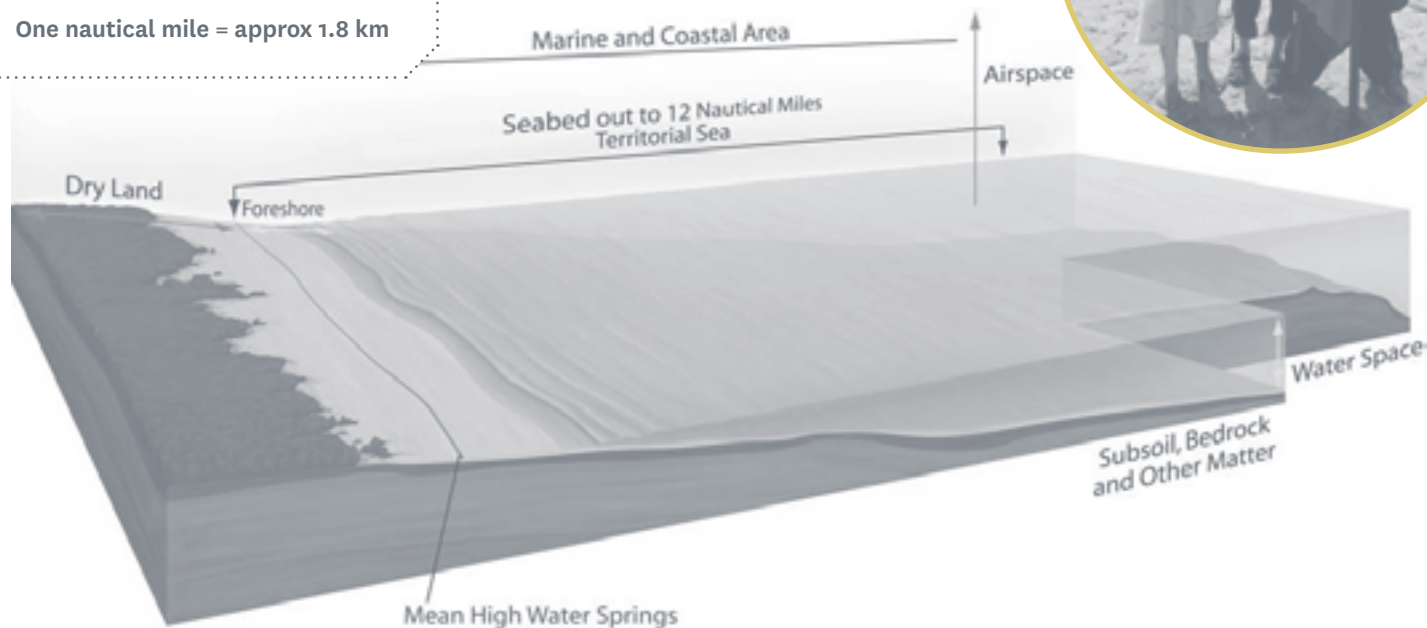
The management of the environmental resources of the coastal marine area in Canterbury is carried out by Environment Canterbury. We prepare regional coastal plans and approve coastal consents under the Resource Management Act.

Exclusive Economic Zone:

The exclusive economic zone is where a country has special rights over the exploration and use of marine resources including energy production from wind, water and oil. It stretches from the shoreline out to 200 nautical miles from the coast.

Did you know?

One nautical mile = approx 1.8 km



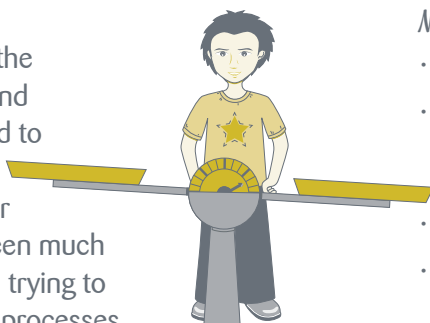
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The key is finding a balance

The right balance fits between the needs of the natural environment, and human desire and need to use natural resources for work and play. Over the years, there has been much human activity, both in trying to control natural coastal processes, and solving coastal problems that have arisen from human activity.

Decisions about how we use natural resources are never easy. Weighing up the pros and cons of an activity takes critical thinking and appreciation of the social, political, economic and natural environment (biophysical). How will all these things be affected by a particular activity?

A good example of this is to consider what happens when coastal land in South Canterbury floods during a big coastal storm.



Natural Environment (biophysical)

- natural process that has always occurred
- part of the way environments change and renew themselves, i.e. create new habitats like new lagoons for plants, invertebrates, birds and fish
- sediment
- flood protection structures prevent the coastal environment from changing and evolving

Political

- when natural disasters happen who pays for the repairs?
- whose fault is it? Who or what organisation is responsible? Is anybody responsible?
- who makes the decision about what will happen?
- does Civil Defence need to be involved? How much will it cost to have them involved?

Social

- effect of the flooding on the family. How do they feel?
- effect of the flooding on the community, emotionally and financially
- loss of work for farm workers and income for their families
- how does it make people involved feel to see crops ruined and animals dead?

Economic

- coastal land being used for farming (animals or crops) is ruined by salty flood waters, sand and soil
- cost of replacing fences that have been broken or washed away
- loss of money for the farmers and families as they can't use the land
- loss of food and money for the local and national economy because the farmers are unable to use the land to grow crops and animals to sell
- cost of repairing the land more quickly than it would naturally take so farmers can start producing from the land again
- funding spent on flood protection measures wasted



In the classroom: So many users, so little time!



How you value and use the coast can be very different to other people. Sometimes, when these differences collide, things can become difficult. Understanding and working through these differences is very important, not only for relationships with others but also for the overall health and sustainability of the coast and the many ways it gifts us.

Divide the class into small groups and give each group one of the roles outlined below. The group discusses their position on a coastal issue in Canterbury. It may require doing further research. One person from each group then takes part in the class role play. You will have to decide what the scenario is, e.g. they could all be at a demonstration, at a council meeting or a community gathering.

Weighing up the pros and cons and considering social, political, cultural, economic and natural environment (biophysical) of each, how will all these things be affected by a particular activity? Examples of coastal issues are Lyttelton Port and/or Port of Timaru, coastal tourism and marine farms. Can you come up with some of your own?



Timaru Port

Councillors and politicians

You have a responsibility to answer the concerns of local citizens, who are worried about the sustainable use of the coastline and the impact on marine and coastal life. Some also depend on resources from the coast for their livelihood. You are also aware that some people don't want to change their ways, especially if it is going to cost them money.

Coastal Care Group

You are against any activities that adversely affect the coastline and would like to see more marine sanctuaries along the Canterbury coastline. You would like sustainable fishing limits to be set to ensure an abundance of fish life while still ensuring recreational fishers, iwi and local businesses are able to continue to fish and make a living.

Concerned community

You would like Canterbury's coastline to continue to provide recreation opportunities such as surfing, fishing and swimming and habitats for the many animals and plant species. You also recognise that landowners and the marine industry in Canterbury contribute a lot of economic growth to the region.

Land user

You are aware that some of your land use practices have the potential to harm waterways and impact on coastal wetlands, and the coastline. You own a large farm close to the coast and rely on reliable access to fresh water to irrigate and provide drinking water for your stock. You believe it is the right of the land owner to have access to waterways for irrigation and stock and would like to learn how you could manage this without having adverse effects on the local coastline.

Fishing charter

Fishing has been part of your life for years and you now own a small fleet of vessels servicing local restaurants and markets with regional fish varieties. The Quota Management Systems (QMS) helps your business as it ensures there is enough fish to go round while leaving enough to ensure species are protected and the industry is sustainable. You do, however, have some concern around increased signs of pollution of the coastline and over fishing.

Local hapū

You believe the discharge of contaminants into local rivers is deeply offensive as it threatens the Mauri (life force) of the waterway and the ability to collect mahinga kai from the local estuaries, hāpua, lagoons and sea. Te Moana (sea), Mahinga Kai (traditional food) and Tauranga Waka (landing sites for canoes) are all examples of taonga (treasured elements of a tribe's existence) and you are particular concerned about their protection and sustainable management.

Tourism operator

You run a successful local sea bird watching business and rely on the clean green image that New Zealand is known for. There have been times where you have noticed an increase of pollution along the shoreline and especially after heavy rain events. Occasionally you have observed birds with artificial debris stuck to the necks and body.

Scientists

You monitor the coastline including animal and plant species and coastal processes and water quality. Your main job is to ensure that everyone knows what is happening to the Canterbury coastline and why.



COASTAL CANTERBURY

Living here – coastal features in

The Canterbury coast has many special features – some would say we are spoilt for choice! However, not wanting to make this book the size of Aoraki, let's look at three interesting coastal features; spits, lagoons and hāpua and look at examples of each of these in Canterbury – Kaitorete Spit, Wainono Lagoon and the Rakaia River Mouth (a hāpua).



Case study

National case study:

Farewell Spit

At 32 km, Farewell Spit, in the NW corner of the South Island, is one of the longest in the world. It is bordered to the north by Cook Strait, to the west by the Tasman Sea, to the south and east by the Pacific Ocean. It is believed to be caused by the strong prevailing winds and currents bringing sand eroded from the Southern Alps and depositing these into Golden Bay.



(Source: Wikipedia)

Canterbury case study:

Kaitorete Spit:

The name 'Kaitorete Spit' is actually a misnomer, coastal scientists refer to the 'spit' as the Kaitorete 'bar' or 'barrier'. The permanent beach bar or barrier was formed about 6000 years ago by gravels from the Rakaia River and pushed into place by the Pacific Ocean. It is a good example of the interplay between marine and river processes. It separates Te Waihora from the sea. A northward drift from southern rivers such as the Rakaia transports most of the sand and shingle that forms the spit.



It was once an important route for Māori travelling from Horomaka/Banks Peninsula to settlements such as Kaiapoi and Kaikoura. The remains of camps, ovens and middens can still be found along the spit (source: Te Ara – The Encyclopaedia of New Zealand). The spit provided ease of travel when compared to the swampy route inland around the edges of Te Waihora.

Kaitorete is flanked by Taumutu at its south western shore and the site of Waikākahi pā in the north.

It remains an important mahinga kai for foods such as bird eggs and tuna and is an important source of weaving materials such as pīngao.

The area is steeped in the histories of Ngāi Tahu, Ngāti Māmoe and Waitaha. It's the largest remaining area in New Zealand of native sand binder/pīngao, a bright-orange plant prized for weaving. (DOC)

Did you know?

A longshore drift is when sediments are moved along the coast. This is caused by currents that are made by continuous waves.

Quick activity – when a spit isn't a spit

Compare the image of Farewell spit and Kaitorete spit. How are they the same? How are they different?

Kaitorete is home to other threatened plants and animals, some of which are unique to this location, such as woolly head Craspedia 'Kaitorete', and a flightless moth!

It is a fantastic place to spot katipō spiders and lizards too.



n Canterbury



Spits

A spit is a depositional (a process where something is added) landform made up of beach material that extends out from the main coastline into the sea.

It is formed over long periods of time by wave action and when the prevailing (most predominant) wind blows at an angle to the coastline, resulting in longshore drift.

So what's going on?

The Kaitorete coastal dunes are a scientific reserve and the spit is a conservation area. The ecological sequence of habitats on Kaitorete is unique and incredibly valuable. It ranges from native dune vegetation along the coast, to 'semi-natural' dryland habitats inland, to native saltmarsh vegetation on the shores of Te Waihora. A number of rare/threatened species are found here, including the largest population of the threatened shrub *Muelenbeckia astonii*.

Both animal and plant threaten the spit. Domestic stock, rabbits and hares can harm the fragile plants and habitats they provide. Exotic plants such as marram grass, broom and gorse can also overtake native plants such as pīngao and disrupt the largely unmodified dune system. Inappropriate recreation such as motorbike scrambling and four wheel driving use can also damage the fragile flora and destroy the habitats of birds and other fauna.

EXTRA:

There are a number of weed and animal control initiatives currently underway to protect the area. Do some research and find who, what and how. Maybe you could join a local group!

1. Longshore drift moves material along the coastline
2. A spit forms when the material is deposited
3. Over time, the spit grows and many develop a hook or curved end if wind direction changes further out
4. Waves cannot get past a spit, which creates a sheltered area where silt is deposited and mud flats or salt marshes form

(Source: BBC)



Quick facts – Kaitorete:

- It is the largest unmodified dune system in Canterbury
- It has the largest population of pīngao in New Zealand
- It contains the large mix of sand gravel with associated dune system. This is both rare nationally and internationally
- It is the breeding site for the New Zealand pipit/pūhoihoi, banded dotterel/pohowera, southern black fronted gull/karoro, red billed gull, white fronted tern/tara and Caspian tern
- It is home to two rare species of moth endemic to Kaitorete Spit, plus the rare Canterbury darkling beetles



COASTAL CANTERBURY

Nature's filters – Coastal lagoons

Coastal lagoons are water bodies that have limited openings to the sea. They are found at the mouths of rivers or streams behind shingle or sand bars. They receive limited inputs of salt water from wave overtopping, infiltration through the shingle or sand bar, or an artificial opening. The water in a lagoon is often brackish (a mixture of sea water and fresh water).

Hāpua are a type of lagoon that usually form at the mouths of braided, gravel rivers and form as long narrow water bodies parallel to the shore. They are predominantly fresh water with no significant tidal inflows or outflows and have a single semi-stable opening to the sea.

For more information on Hāpua refer to pages 18-19.



A Canterbury case study – Wainono Lagoon

The Wainono Lagoon is a wetland of national importance owing to its biodiversity and size. It is considered the most significant wetland between Te Waihora/Lake Ellesmere and the Karitane Estuary in Otago.

Wainono Lagoon fills a relatively flat shallow basin, so the area of the lagoon varies considerably depending on its water level. It is a 335 hectare brackish coastal lagoon 1 metre above sea level, separated from the sea by a shingle bar. It is an important site for native birds, fish and plants and is of high importance to Tangata Whenua. It is also popular with hunters during the game bird season.

Adjoining the lagoon are salt marsh and salt turf wetlands and one of the best remaining carex and flax-dominated wetlands in Canterbury. While stop banks protect farm land in some areas, the natural fluctuation of lake levels causes periodic flooding of low lying paddocks.

Quick facts – Wainono:

- Fifty-seven bird species have been recorded with 15 breeding species
- Fish include long-finned and short-finned eels (tuna), brown trout and flounder/pātiki. Whitebait/inanga, smelt and yellow eyed mullet also visit the lagoon in season
- Lampreys/korokoro frequents the outlet stream
- Game bird species include Canada geese, black swans, mallard and grey ducks, and paradise/shel ducks
- Threatened species occur here like the native swamp nettle/onga onga *Urtica lineafolia* and the threatened ground cover plant *Meuhlenbeckia ephedroides*



Wainono Lagoon hosts an amazing diversity of bird and fish life due to its many habitats.

History

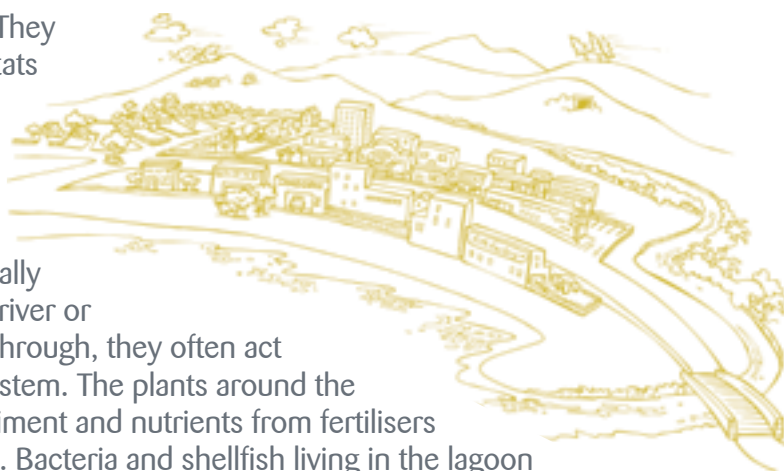
Wainono Restoration Project



The lagoons' water quality has been steadily declining. Because of this, a project to restore the quality of the lagoon was started in 2010. The Wainono Restoration Project seeks to improve water quality in feeder tributaries to Wainono, thus improving water quality and preserving habitats and amenity values in the lagoon. The primary focus is helping farmers identify and manage sediment and nutrient inputs from their farming operations. Other activities include weed control and wetland management.

Te Rūnanga O Waihao, adjoining landowners, QEII Trust, DOC, Waimate District Council and Waimate Trackways are all collaborating to make sure Wainono Lagoon remains as a functioning habitat and an important community asset.

Coastal lagoons are both beautiful and very important. They are the meeting place of land and sea and provide habitats for many plants and animals. They protect land from damage during coastal storms. They can also act like big filters by trapping nutrients and sediment that are washed off the land during floods.



Lagoons provide wild areas, often within highly modified, farmed or urban environments. They are also valued for boating, fishing and game-bird shooting

Regionally, coastal lagoons areas hold significant cultural value to Ngāi Tahu. All have important mahinga kai and wāhi tapu sites, particularly Wainono Lagoon.

As they are usually the last place a river or stream passes through, they often act as a filtration system. The plants around the edges filter sediment and nutrients from fertilisers or animal waste. Bacteria and shellfish living in the lagoon can also help break down nutrients. When the nutrient levels reaching a lagoon from the land are too great, the lagoon can't function properly. It becomes like a fully saturated sponge, as if the filter is blocked. This means that nutrients and chemicals harm the lagoon and this in turn harms the sea and coastal environment.

In the classroom: Making the links - web of life

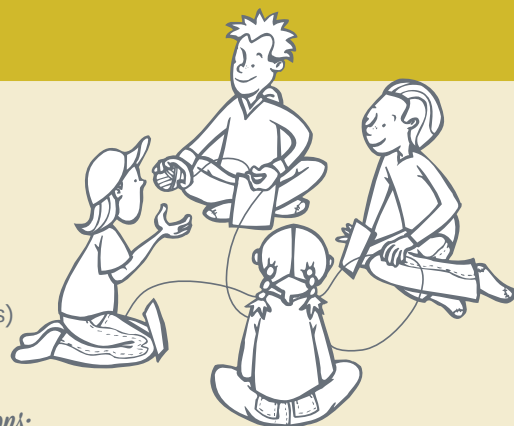
This is an activity that graphically demonstrates the inter-connectedness of ecosystems and, in this case, wetland ecosystems.

You will need:

- A ball of coloured wool/string
- Cards (make up your own of the plants, insects and birds that live in wetlands)
- Pegs (optional)

Instructions:

1. Sit the students in a circle, facing inwards.
2. Give each student a card which identifies who or what they are representing, ie. cabbage tree, paradise shelduck, midge, dragonfly, which they peg to their front, or hold where others can see it.
3. Explain to the students that the idea of the activity is to find relationships between their card, and the cards of other students. Discuss what these possible relationships could be, for example, cabbage tree - fantail - cabbage tree moth.
4. Give one student the ball of wool, ask them to hold securely to the end of the wool, and gently pass or throw the ball over to a student that has a card that has a relationship with theirs. Let the wool unravel as it is passed so a visual connection is made. Make sure that the wool connections are taut.
5. Each student who receives the wool does the same until all students have made a connection with another student. Some students will have many connections, others only one or two.



Reflective questions:

Discuss with the students how to describe what the circle now looks like (a web) and ask:

- Why does it look like that?
- Why do some students have links to many cards and others only one or two?
- Is everything connected (whether directly or indirectly)? Why is that?

Gently pull one of the strands of wool to demonstrate and discuss who can feel the pull.

- Is the pull the same strength for all the students? Why?

Carefully break one of the strands (to make it more dramatic choose a student who has multiple connections).

- What happened? Why?

Discuss this in relation to the plants and animals that live in a wetland (students' cards). Ecosystems are all about the relationship between the different elements of the wetland; if one is removed, it affects more than one thing, rather like the domino effect!

COASTAL CANTERBURY

Hāpua

River mouth lagoons on mixed sand and gravel beaches form at the river-coast edge where typically, a braided river meets a beach significantly affected by long shore drift and exposed to high energy waves. Lagoons such as this are common on the east coast of the South Island and are called 'hāpua'.

Did you know?

Long shore drift is the transportation of sediments along the coast at an angle to the shoreline. Hapua are located in areas dominated by long shore drift because it aids the formation of the barrier behind which the hapua is sited.



Hāpua are often located where there is a low level of coastal development and minimal population density. They are formed as the river carves out an elongated area which runs parallel to the coast, separated from the sea by a mixed sand and gravel barrier. The barrier constantly alters its shape and volume due to long shore drift. Water flows from the river through the hapua then to the sea via an outlet channel, the location of which is constantly changing. River water also seeps through the mixed sand and gravel barrier to the sea due to its high levels of porosity.

Quick facts:

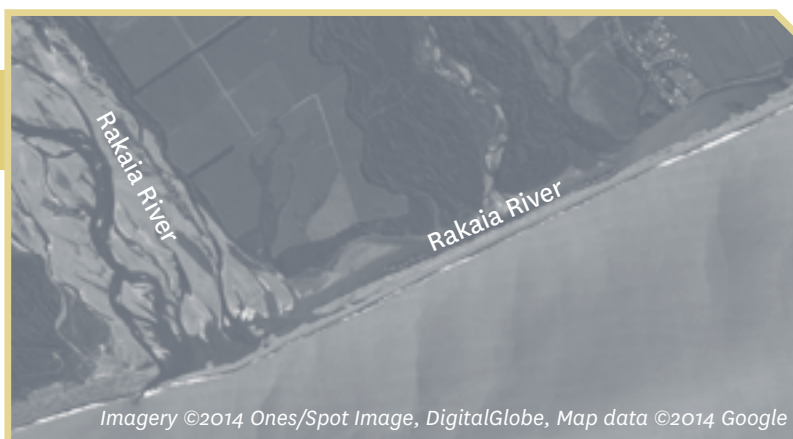
- Hāpua have a steep foreshore, often referred to as the 'engine room' of the beach profile. In this zone, swash and backwash are dominating processes alongside long shore transport
- Mixed sand and gravel beaches do not have a surf zone; instead a single line of breakers is visible in all sea conditions
- Hāpua form in micro-tidal environments. A micro-tidal environment is where the tidal range (distance between low tide and high tide) is less than two metres
- Water in a hāpua is predominately freshwater originating from the associated river
- Canterbury hāpua include the Rakaia, Ashburton and Hurunui river-mouths.



A Canterbury case study – Hāpua

The Rakaia River begins in the Southern Alps, providing approximately 8 million cubic metres of sediment to the sea. It is a braided river with a catchment area of 3,105 squared kilometres and a mean flow of 221 cubic metres per second. The mouth of the Rakaia River reaches the coast south of Banks Peninsula/Horomaka. As the river reaches the coast, it diverges into two channels with the main channel flowing to the south. As the hāpua is located in the Canterbury Bight, it is in a state of constant physical change due to the prevailing southerly sea swells and resultant northwards long shore drift.

The hāpua located at the mouth of the Rakaia River can stretch approximately three kilometres north from where the river channel nears the coast. The average width of the hāpua between 1952 and 2004 was approximately



50 metres, whilst the surface area has stabilised at approximately 600,000 square metres since 1966. The coastal surroundings are composed of erodible cliffs and a low-lying area known as the Rakaia Huts. This area has changed notably since European settlement with the drainage of ecologically-significant wetlands and development of the small bach community.

EXTRA:

Can you spot any other coastal wetlands on the map that we haven't listed?

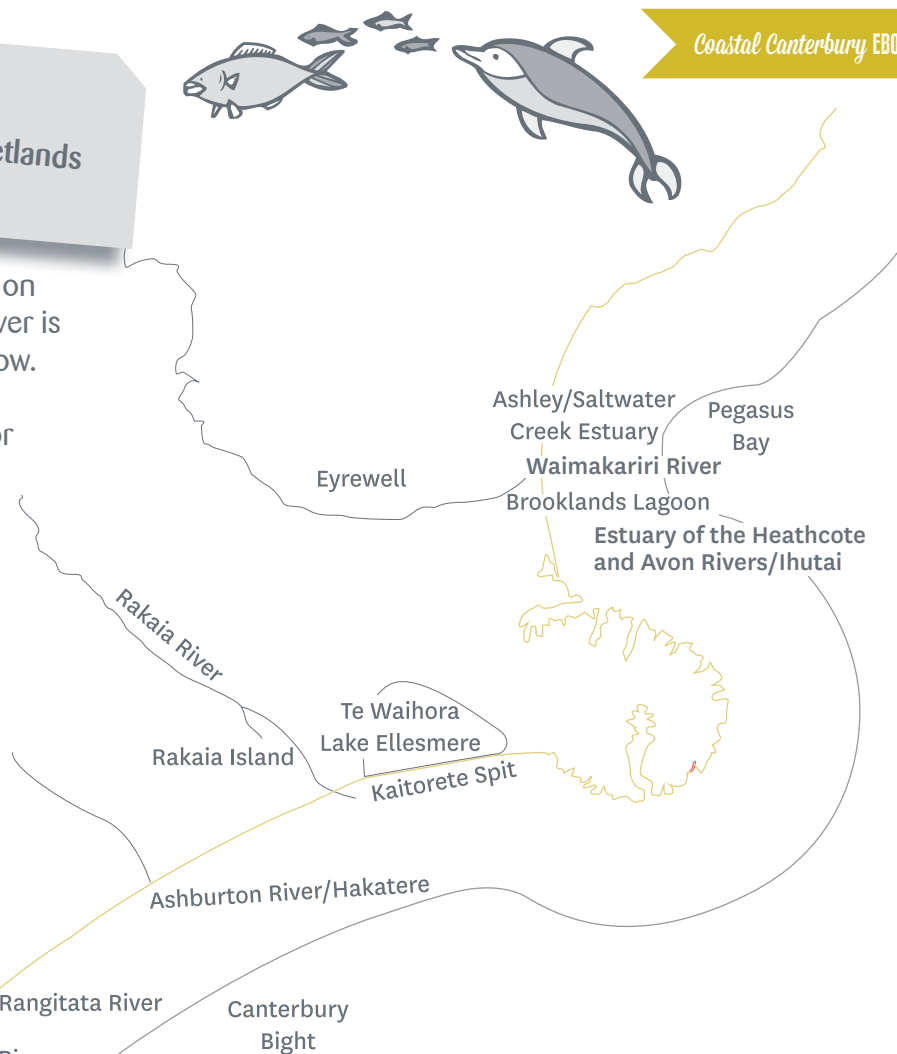
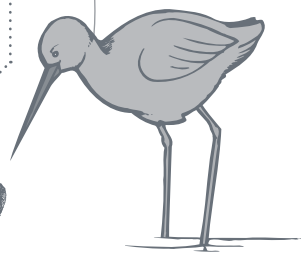
The water flow in the river has a big impact on the hāpua. When the flow of water in the river is low, the water level in the hāpua also gets low. When this happens, the channel from the hāpua to the sea can close. The potential for closure varies between hāpua, depending on whether long shore drift (linked to the sea) or fluvial (linked to the river), is the bigger driver of the closure. A high flow event such as a flood, can breach the barrier directly opposite the main river channel. This causes an immediate decrease in the water level of the hāpua, as well as transporting previously deposited sediments into the ocean. Flood events are important for eroding lagoon back shores, allowing hāpua to retreat landward and therefore remain coastal landforms.

Did you know?

A wetland is exactly that! Wet land. Wetlands are areas that are permanently or temporarily wet. They support plants and animals that are especially adapted to wet conditions. Coastal wetlands include estuaries, lagoons and hāpua.

Why so special?

Hāpua are extremely important for a number of reasons. They provide a link between the river and sea for migrating fish, as well as a corridor for migratory birds. To lose this link via closure of the hāpua outlet could result in losing entire generations of specific species, as they may need to migrate to the ocean or the river as a vital part of their lifecycle. Hāpua are a source of mahinga kai (food gathering).



In the classroom: Where in Canterbury?

Use the interactive virtual trip of coastal wetlands on our education website www.ecan.govt.nz/education - Interactive Games and Movies - Coastal Wetlands

Important wetlands in Canterbury include:

- Rakaia River mouth/hāpua
- Ashley-Saltwater Creek Estuary
- Brooklands Lagoon
- Estuary of the Heathcote and Avon Rivers/Ihutai
- Te Waihora/Lake Ellesmere
- Washdyke Lagoon/Waitarakao
- Opihi River
- Wainono Lagoon
- Waitaki River Delta

Your task: Decide on different categories of coastal wetlands in Canterbury e.g. estuary, lagoon, and hāpua. Place the name of the above coastal wetlands into the correct category. Locate and label these wetlands around mid and South Canterbury on the map outline.



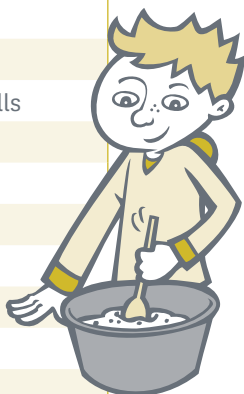
In the classroom: Who dirtied the water? Adapted from 'Coasts and Us', Waikato Regional Council

This is a story that allows students to explore how our rivers, harbours, estuaries, lagoons and oceans have deteriorated as a result of human activities.

You will need:

1. Clear glass or plastic wide-mouthed jar (4 litre capacity). Fill $\frac{3}{4}$ full with water
2. 14 empty film canisters or similar containers
3. 14 label stickers for canister
4. Permanent marker pen
5. Stirring stick or spoon
6. Fill and label the canisters with the ingredients below:

Label canister	Fill with (ingredients)
RIVER	sand
SALT MARSHES	dry grass
SHELLFISH	crushed seashells
NGĀI TAHU	flax
SETTLERS	organic rubbish
FARMERS	soil
HOUSES	toilet paper
RUN-OFF	soil
FISHERS	nylon line
BOATERS	plastic pieces
CAMPGROUND	dish-washing detergent
CLEANING	baking soda
SUNBATHERS	paper and plastic
FACTORIES	vinegar



With the class:

1. Set the scene by putting the jar ($\frac{3}{4}$ filled with water) in a place where all the students can see it.
2. Hand out the canisters to students or pairs of students, instructing them to look carefully at the label, but not inside the canister.
3. Explain that they are about to become characters in a story. When they hear their character's name (label on the canister) read out, they are to come forward and empty the contents of their canister into the jar. Let the students describe to the class what they are emptying into the jar.
4. Read the story, stopping at times to ask the students what they think.

Story

Once upon a time there was a beautiful bay. It was surrounded by lush land and dotted with green islands. The water was clear and sparkling. **FISH** lived in the water, and the land was covered with trees. Both the water and the land teemed with wildlife.

A **RIVER** ran along one side of the land, carrying sediment and sand with it as it flowed into the bay. On the other side there was an **ESTUARY**. Grasses and plant material from the estuary washed into the bay and became food for the fish. **SHELLFISH** grew in the shallower water, including cockles and pipi.

A small group of people lived on the land near the bay. The people called themselves **NGĀI TAHU**. Ngāi Tahu fished for food and shellfish in the bay. The left over shells were left near the bay. In fact we can still find the piles of shells they left behind. These are called middens.



Ask questions

Would you like to live in this bay?

Would you like to swim in this bay?

Would you like to eat fish and shellfish caught in this bay?





After many years **SETTLERS** from Europe came to live on the land around the bay. The settlers built a town much larger than the Māori villages. Some of the town's waste was also put directly into the bay. As the town grew, the settlers cleared the native bush to provide more land on which to build. **FARMERS** cut down trees to clear the land for grazing. They also allowed their stock to graze around the estuary. Without the trees and estuary plants, rain carried soil into the bay. More and more **HOUSES** and shops were built and the town grew. Sewer pipes were constructed to remove the waste from houses and bathrooms. The sewage flowed through the pipes and into the bay. With the estuary plants gone, **RUN-OFF** water washed pollution like petrol, detergents and litter from the streets, directly into the bay.

Ask questions

- Would you like to live in this bay?
- Would you swim in this bay?
- Would you eat fish and shellfish caught in this bay?



FISHERS and other **BOATERS** sometimes threw waste overboard and emptied their boat toilets into the bay. The town continued to grow. As tourists began to visit the harbour a **CAMPGROUND** was developed. Campers used kitchens and laundries to wash their dishes and clothes. The detergents went down the drains and sewage pipes and into the bay. Even swimmers and **SUNBATHERS** going to the beach sometimes left rubbish on the beaches.

FACTORIES built along the water's edge to process fish often dumped their wastes into the water.

Ask questions

- Would you like to live in this bay?
- Who dirtied the water?
- Who is responsible for cleaning it up?



COASTAL CANTERBURY

What do we know about *land use* and its impacts on waterways?

Ki uta ki tai – From

Are the ecosystems the same in the *mountains* as in the *ocean*?

What *actions* can we take to ensure the sustainable use and development of our land, water, and coasts?

What are some *human impacts* on freshwater such as rivers, groundwater and drinking water?

Explore where water comes from and where it goes. What happens to it in between?

How *connected* are we to the wai in our area? How do we show it?

How can we *make a difference* on land and in our oceans?

What *animals* and *plants* are found here where the freshwater meets the ocean?

What different *ecosystems* are found along the journey to the ocean?

What are some of the *human* impacts on our water?

What do we *use* the coast and oceans for?

(Diagram adapted from Waikato Regional Council 'Free the Sea' unit)

the Mountains to the Sea

Exploring how everything is connected including you!

Using the information from this EBox and other sources, let's take a journey from the mountains to the sea – ki uta ki tai.

Explore traditions and Māori perspectives around water and oceans in your area.

Who can you ask to *find out more*?

Environment Canterbury, the Department of Conservation, Avon-Heathcote Estuary Ihutai Trust, Christchurch City Council etc.

Explore how what happens on the land and in the waterways impacts on the coast and oceans

What *activities* impact on land, waterways and the coast?

What are the *waterways* like here?

What *impacts* the ocean's biodiversity?

Curriculum Links (Level 4)

These suggested links are just a selection

- Principals – Foundations of curriculum decision making
- Future Focus
- Environmental Education

Key concepts: interdependence, sustainability, biodiversity, personal and social responsibility for action

Social Sciences

- Understand how formal and informal groups make decisions that impact on communities
- Understand how people participate individually and collectively in response to community challenges

Science

Participating and contributing

- Use their growing science knowledge when considering issues of concern to them
- Explore various aspects of an issue and make decisions about possible actions

Living World

- Ecology
- Evolution

Health and Physical Education

Healthy communities and Environment

- Rights, responsibilities, and laws
- People and the environment

Technology

- Nature of Technology
- Characteristics of technology

COASTAL CANTERBURY

We welcome
your comments
or suggestions for
what you would like
to see in future
issues.

mountain beech/tawhairauriki

From the editor

Up to 90% of New Zealanders live within 40 kilometres of the sea — an unusual statistic in world terms. The coast provides a source of kai moana (sea food) and the water provides spiritual fulfilment to all Tangata Whenua. They, like many other people in the region, see the coast as an integral part of the whole environment reaching from the mountains to the sea and do not look at coastal issues in isolation from other environmental issues.

For Tangata Whenua the coast has always played a significant role in the lives of their ancestors and the present generation, and will continue to be important for future generations. Their system of traditional rights to, and attitudes towards, natural resource management has evolved over time. For Tangata Whenua, the natural resources of their area or rohe are a statement of identity and mana.

Environment Canterbury, the City Council and the Department of Conservation all work together to protect the coastline. In this region, Environment Canterbury has responsibility for the “Coastal Marine Area”, which is the foreshore, seabed, coastal water and the air space above the water between the outer limits of the territorial sea (12 nautical miles) and generally the area of the average of the highest tides. The City and District Councils administer the area from this point landwards, but as the coast and land are so closely linked, the city, district and regional councils work together. The coastal environment as a whole is part of the Regional Coastal Plan. The Department of Conservation is responsible for native animals and plants at any location, including coastal and marine areas.

Extra: For more detailed resources about the Canterbury coast, including curriculum-linked programmes on the rocky shore, coastal wetlands and dunes, please refer to our coastal education page www.ecan.govt.nz/education

As always, your thoughts and comments are welcome. Please contact us for further information. Our contact details are below.

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PO Box 345, Christchurch Phone: (03) 365 3828
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www.ecan.govt.nz/education

Visit us on facebook: Environment Canterbury Education for Sustainability

If you are not on the mailing list for Your Environment Canterbury, or you would like to receive extra copies of this resource, please contact Environment Canterbury Youth Engagement Team at the Christchurch office.

Resources and education services

We offer a range of facilitated school programmes and environmental education resources on natural resources and their sustainable management. Environment Canterbury also produce general information and resource material such as pamphlets, brochures and booklets, many of which are free.

If you would like to receive more information on any of our resources, please contact:
Environment Canterbury Youth
Engagement Team on (03) 365 3828
or customer services on 0800 EC INFO (0800 324 636).

Environment Canterbury: what we do

Environment Canterbury is your regional council.

We manage 14 activities for the Canterbury region.

- Air quality
- Biodiversity & biosecurity
- Canterbury Water Management Strategy
- Coastal environment
- Consents & compliance
- Emergency management
- Flood protection & control works
- Land
- Natural Hazards investigations & information
- Navigation safety
- Public passenger transport
- Regional land transport
- Regional leadership
- Waste, hazardous substances & contaminated sites



canterbury mudfish/kowaro

FSC Logo
here

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