Green turtle (Chelonian mydas) returning to the sea after nesting, English Bay, Ascension Island.

Chapter 12 Plants and animals

Background

While at a glance beaches may appear as barren stretches of sand, in reality they are diverse and productive transitional ecosystems – sometimes called "ecotones" - that serve as a critical link between marine and terrestrial environments.

The sandy beach is an unstable environment for plants and animals, largely because the surface layers of the beach are in constant motion as a result of waves and wind. This also means that organisms that live there are specially adapted to survive well in this type of environment. Many burrow in the sand for protection from waves or to prevent drying out during low tide. Others are just visitors, such as birds and fishes. While different animals are found in different zones, they often move up and down the beach with tides. Hence, zonation patterns along sandy shores are not as clearly defined as on rocky shores.

Beach ecosystems and climate change

Many of the projected impacts of climate change will adversely affect beach ecosystems, in particular sea level rise, ocean acidification and temperature increases (see Chapters 5, 6, and 8 respectively for more information). Resident and visiting species, e.g. sea turtles, migrating birds, will be affected. Rising sea levels and increased frequency of extreme events with higher waves will increase beach erosion and reduce the area of beach habitat for plants and animals. The most extreme effect would be the total loss of the beach, while alternatively in some areas the beach will be able to retreat inland thereby maintaining the beach ecosystem intact. Within decades, acidification of the oceans will negatively affect marine organisms that need calcium carbonate to form skeletons and shells, such as coral reefs, sea urchins and snails. Temperature increases will probably change the geographical distributions of some species and the assemblage composition on any shore. Species now living close to their upper thermal limit may be unable adapt and would thus become locally extinct. Survival would depend on migration to cooler areas although such migration for intertidal species may be more difficult than for oceanic species.

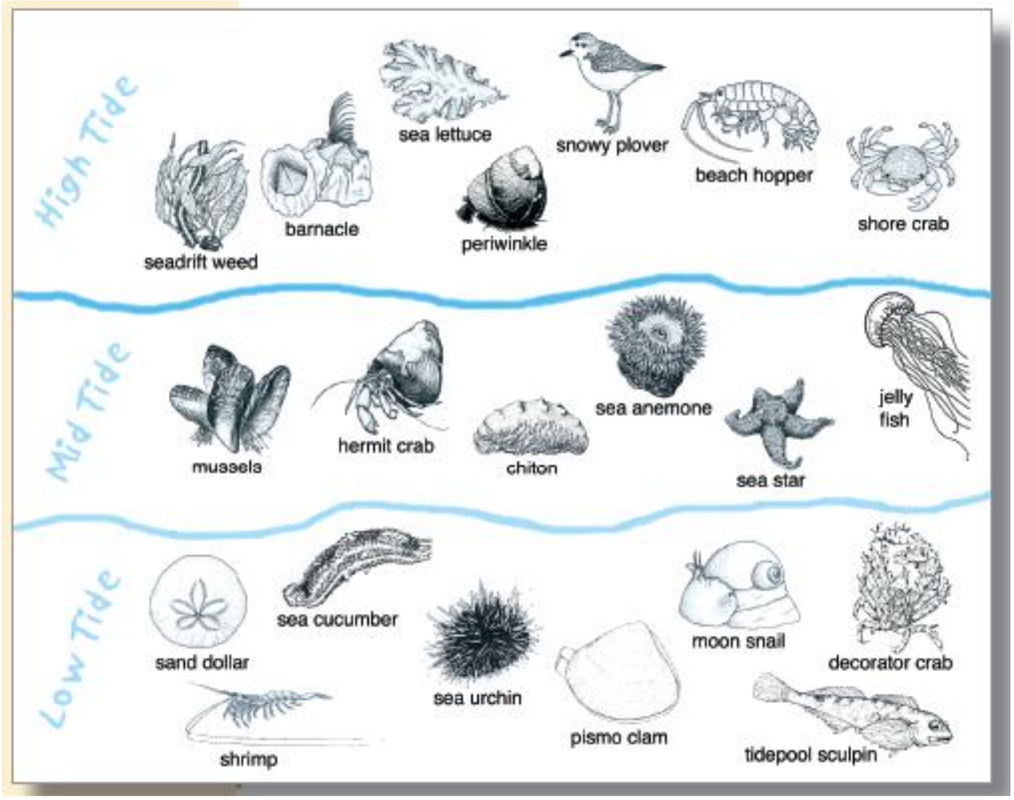

Figure 24 *Common plants and animals found between the high and low water mark. (Illustration compiled by Aurèle Clemencin)*

Activity 12.1 Observing and recording plants and animals on the beach

Collect, observe and record→ For this activity, give the students plastic bags and ask each of them to collect ten different objects from the beach and to record where on the beach each object was found. Remind them not to collect live animals, and if they select a live plant, then to just take a small piece or leaf from the plant. The idea is to observe and conserve the flora and fauna. If the class is large, you might wish to ask some of the students to record five different plants they see and five different animals; if they cannot identify a particular plant or animal, suggest they make a sketch.

Identify the collected items→ Back in the classroom, get the students to separate biological from non-biological items, and plants from animals. Then ask them to identify the items in their collections. Once this has been completed and discussed, ask each student to select one of the plants or animals they collected and to describe it – shape, colour, size – and draw a picture of it. As a further activity, ask the students to research its habits – diet, movement, reproduction, protection – and note any unusual or interesting features. Include ways in which it might be affected by humans and climate change and how it might be protected.

Understand the beach ecosystem→ The beach ecosystem represents the interaction between the biological organisms and the physical environment in the beach area. Thus the birds and the crabs are as much a part of the ecosystem as the sand and the waves. Learning how the different components interact and depend on each other is the study of ecology.

Use the organisms collected on the beach to build a food chain to show how the various plants and animals interact within the ecosystem and how energy passes from one organism to another. Figure 25 shows a simple food chain.

Sun	Sun
↓	↓
Plants (producers)	Algae in coral and seagrass
↓	↓
Plant eaters (herbivores)	Parrot fish, Green turtle
↓	↓
Meat eaters (carnivores)	Sharks, Barracuda

Figure 25 *Simple food chain*.

Activity 12.2 Understanding the role of coastal vegetation

What to measure→ Vegetation on the beach and behind the beach plays an important role in helping to stabilize the beach and prevent erosion.

Landward of the highest high water mark, vines and grasses predominate, which then give way to small salt-resistant shrubs, which in turn give way to trees. In tropical environments the sand runner or goat-foot (*Ipomoea pes-caprae*), a long trailing vine, is often found colonizing the sand surface. Other species of vines, herbs and shrubs may also occur depending on the location of the beach. Further inland there are coastal trees, which in tropical areas might include seagrape (*Cocoloba uvifera*), seaside mahoe (*Thespesia populnea*), coconut palms (*Cocos nucifera*), manchineel (*Hippomane mancinella*) and the West Indian almond (*Terminalia catappa*). The change from low vines and grasses to mature trees is known as a vegetation succession.

How to measure → Identify the vegetation succession at the beach. Lay out the tape measure starting at the seaward edge of the vegetation and, at 2 m (2 yd) intervals, note down the number of plant species present and identify them, or describe them if names are not known. Note particularly if any plants appear to be stressed, e.g. roots exposed or brown leaves.

When to measure→This activity may be carried out once only, or perhaps repeated after a severe storm.

What the measurements will show→Use the data collected to describe the vegetation succession. A typical coastal succession is shown in Figure 26. Discuss the environmental conditions in the different zones, e.g. the frontal zone may be subject to wave action during storms and will receive the full force of the salt spray (or sea blast), while the forest zone may be more protected from the salt spray and the wind, and the soil and nutrient conditions may be better. Ask the students to:

- forecast what will happen to the vegetation succession as sea level rises and the beach retreats inland;
- forecast what would happen to the beach environment if all the vegetation was removed for a new development project such as a 100+ room hotel complex.

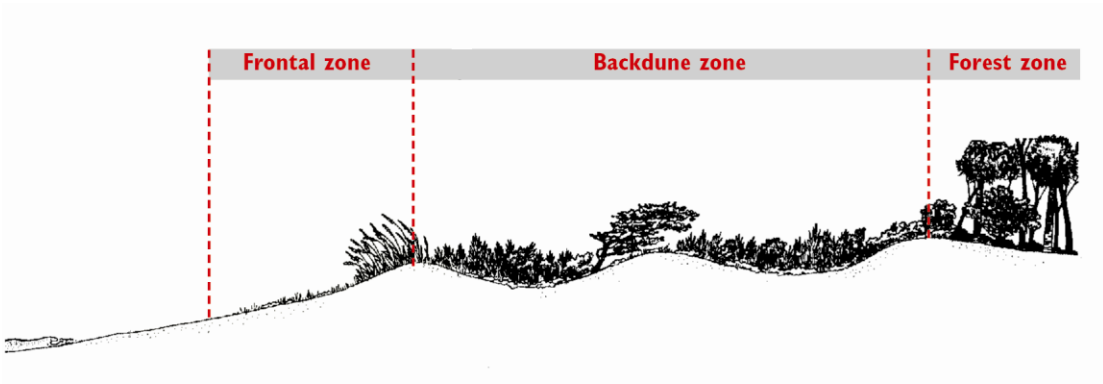

Figure 26 Vegetation succession*: The frontal zone is covered with grasses and vines, which gives way to shrubs and herbaceous plants and eventually the coastal woodland (adapted from Craig, 1984).*

Coastal forest in Puerto Rico – palm trees and almond trees

Sea purslane, a low succulent vine colonising the sand surface

Activity 12.3 Increasing beach resilience to climate change

While coastal forests help increase the resilience of most beaches, they do not work in every location – generally they will only work in sandy areas that are not inundated by the sea. Very strong predominant winds will also limit the existence of a coastal forest. On coastlines where there are wetlands it may be more appropriate to investigate other measures e.g. planting mangroves.

What to measure→Record the type of vegetation behind your beach and investigate the potential to strengthen or create a coastal forest. A coastal forest may be a single line of trees, one tree deep, or it may be an extensive forest several trees deep, or it may be part of a coastal wetland. Well established, mature coastal trees will help make the beach more resilient, since the roots naturally trap sand and slow down erosion (although tree roots do **not** stop erosion). The trees enhance the biodiversity by providing additional habitat for animals and birds. They also provide shade for beach users and generally improve the aesthetics of the beach.

- record the type of vegetation behind the beach;

- investigate who owns the land immediately behind the beach.

Determine if a coastal forest is feasible →Consult with the owners or managers of the land as to whether they agree to the idea of planting more trees on the land. You will have to explain how trees will help the beach cope with climate change. Be aware that in some places people may not be in favour of planting more trees since they wish to have an uninterrupted view of the sea. Also be sure to plant native species since these will be more resilient to climate change than species imported from other regions.

Design, implement and monitor your tree planting project →

- look for partners to help with your project, e.g. Agriculture Department, community group, environmental non-governmental organisation;
- design your planting plan (native tree species, numbers of seedlings, space between seedlings, fertilizer needs), this must include a follow-up plan to care for the plants while they are small;
- plant the trees and publicise the activity;
- monitor carefully how many of the seedlings survive over the first 6 months, and care for the trees, particularly providing them with water since the beach is a very harsh environment for new plants.

Activity 12.4 Monitoring beaches for nesting turtles

What to measure→Many tropical sandy beaches are used for nesting by sea turtles. There are seven species of marine turtles:

Leatherback turtle (*Dermochelys coriacea*)
Hawksbill turtle (*Eretmochelys imbricata*)
Green turtle (*Chelonia mydas*)
Loggerhead turtle (*Caretta caretta*)
Kemp's Ridley turtle (Lepidochelys kempii)
Olive Ridley turtle (Lepidochelys olivacea)
Flatback turtle (*Natator depressus)*

At night-time, female turtles crawl up onto the beach, dig their nests at the back of the beach or in the vegetation behind the beach and lay their eggs in the sand. The period for nesting differs according to the species and the geographical area of the world, e.g. in the Caribbean, most nesting takes place between April and September. After the eggs have been laid, the female covers the nest with sand and returns to the sea. Between 55 and 72 days later the hatchlings emerge and make their perilous journey down the beach to the sea.

Sea turtles are classified as endangered because of over-harvesting in the past; today, many countries have programmes to conserve and protect them.

Monitoring may consist of night-time watches at key nesting beaches, checking beaches early in the morning for evidence of turtle tracks, and watching nest sites for emerging hatchlings. Some turtle conservation programmes, with appropriate training and permission, tag the flippers of sea turtles during nesting. When the turtle is seen again later, her new location, growth rate, etc. provide valuable information to natural resource managers.

Left: Turtle tracks at Long Beach, Ascension Island; right: Safeguarding a turtle nest on a busy tourist beach, Bayibe, Dominican Republic.

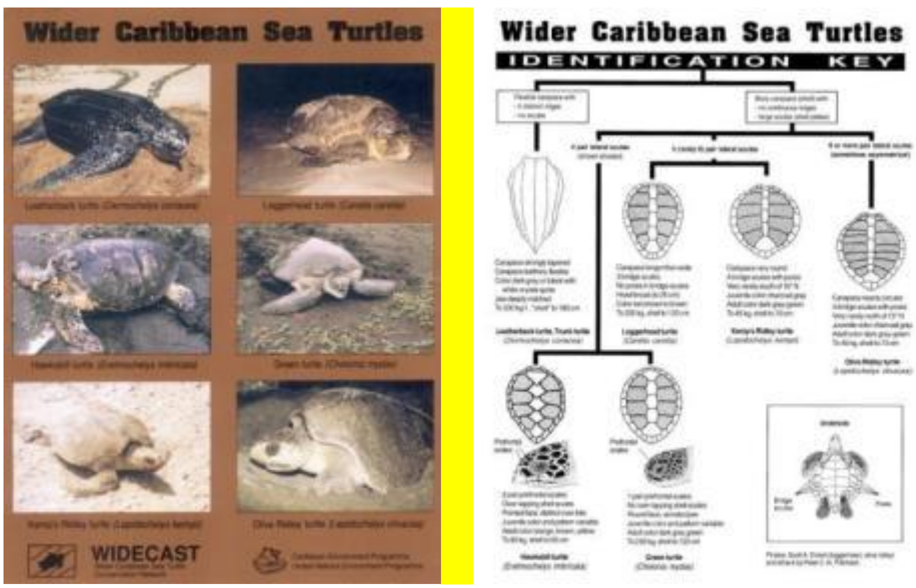

Figure 27 *Sea turtle identification (Source: WIDECAST, 1991) (See also Annex 4, to reproduce for classroom purposes.)*

A Sea Turtle Beach Toolkit has been designed to inform and educate coastal communities about how beach dynamics and climate change affect beaches and biodiversity, with a focus on endangered Hawksbill sea turtles[1]. This well-designed and well-illustrated toolkit, available on the Sandwatch (www.sandwatch.org) and WIDECAST (www.widecast.org) websites, is particularly useful for groups who are primarily interested in sea turtles and who wish to understand the characteristics of their nesting habitat. The toolkit describes easy-to-use methods to measure beach characterization parameters:

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[1] Varela-Acevedo, Elda, Karen L. Eckert, Scott A. Eckert, Gillian Cambers and Julia A. Horrocks. 2009. **Sea Turtle Nesting Beach Characterization Manual**, p.46-97. In: Examining the Effects of Changing Coastline Processes on Hawksbill Sea Turtle (*Eretmochelys imbricata*) Nesting Habitat, Master's Project, Nicholas School of the Environment and Earth Sciences, Duke University. Beaufort, N. Carolina USA. 97 pp.

- beach profile;
- beach elevation;
- beach width;
- boundary parameter;
- sand softness;
- sand composition;
- sea defences;
- vegetation;
- predation risk;
- beachfront lighting;
- general observations.

Many of the methods used in the Toolkit are the same as described in this manual. The study of sea turtle nesting habitats is a complex undertaking, so care must be taken to ensure that nests are not damaged or disturbed. Contact local sea turtle experts and/or marine biologists for further information.

The two activities described below: sand softness and predation risk have been adapted directly from the Sea Turtle Beach Toolkit.

Measuring sand softness →This can be measured on the flat/gently sloping section of the beach above the high water mark, and again at the vegetation line. Sand softness has been observed to be an important variable in that it may facilitate (or hinder) the digging of a nest chamber. Beaches characterized by very wet or very dry sand can create difficult digging conditions for a female sea turtle, and successful hatchling emergence has been correlated with nest depth and sand compaction. Sometimes what appears to be a wide, vegetated and attractive nesting beach may be nothing more than a veneer of sand overlaying rubble or cement.

Digging a hole 50 cm deep at the back of the beach to see if the sand is soft enough for sea turtle nesting

Dig a hole 50 cm deep and with a 10 cm diameter. Note whether it is easy or difficult to dig the hole using the following scale of difficulty:

- high difficulty: cannot dig a 50 cm depth hole due to the tough nature of the substrate or obstacles such as gravel, cement or rock;
- medium difficulty: can dig to 50 cm, but struggle to do so;
- low difficulty: can dig to 50 cm with relative ease.

Note any obstacles found while digging, e.g. tree roots, rocks or buried trash.

Measuring predation risk (crab holes per square metre) →Beach crabs (e.g. *Ocypode quadratus*) prey on sea turtle hatchlings and can be a hindrance as the hatchlings journey from the nest to the sea. Other predators could include feral dogs and mongoose. Counting the number of crabs per m^2, and using that number to estimate crab density, can provide an indicator for the number of predators a hatchling might face. Other species may be used in areas where crabs are not a major predator.

How to measure→Make a PVC metre square quadrant by cutting a 5 m length of PVC pipe into four 1 m length pieces. In a well-ventilated area, use PVC glue to attach the PVC elbows to make a square. Randomly toss the quadrant close to a sea turtle nest on the beach. As crabs tend to hide in holes when there is human activity on the beach, proceed to count the number of crab holes within the quadrant in order to estimate crab density in the area. Repeat up to three times and average the number of holes counted. Monitor crab density early and late in the sea turtle hatching season, determine whether it changes and discuss how any changes might affect hatchling survival.

A PVC metre square quadrant

Crab holes on a beach in Barbados

How to get involved in monitoring sea turtles →If sea turtle nesting occurs in your area, contact your environmental agency or local conservation organization and ask whether there are programmes that monitor and conserve turtles.

Observing turtle nesting at night, from a safe distance so as not to disturb the female turtle, can be a very interesting and exciting experience. The same is true for monitoring the nest to see the hatchlings emerge and make their journey to the sea.

In some areas, key turtle nesting beaches are monitored during the turtle nesting season to observe and record turtle tracks and evidence of successful nesting. Often these programmes need volunteers, and your family, school, Sandwatch group or organization could play a role in ensuring the survival of these gentle marine animals.

Follow-up activities→ If students take part in any aspect of turtle monitoring, there are many areas where they can conduct further work and research; here are just a few ideas:

- conduct research to find out which turtle species nest in your country and how many successful nests are laid. Compare these figures with historical information;

- create a map of sea turtle nesting beaches in your country;
- investigate why sea turtles are endangered and what threats they face;
- discuss within your class or school why sea turtle populations have declined (or increased) in your area. Have threats to their survival increased or decreased?
- interview a Fisheries or Wildlife Officer to find out more about what is being done to protect sea turtles in your country;
- determine what you, your family and your Sandwatch group can do to help conserve sea turtles.

Sea turtles and climate change→ Because sea turtles use both marine and terrestrial habitats during their life cycles, the effects of climate change are likely to have a serious impact on these endangered species. Sea turtles return to the beach where they hatched, and as beaches get smaller or even disappear with rising sea levels and increased storms, turtle reproduction will come under threat. Another impact is an increase in the temperature of beach sand. The gender of sea turtles is determined by the temperature at which the eggs incubate. With increasing nest temperatures, scientists predict that there will be more female than male hatchlings, creating a potential threat to both reproductive success and genetic diversity. Finally, warmer sea surface temperatures and changing current patterns may change the distribution and abundance of important food sources and this, in turn, may confuse and confound sea turtles as they migrate to feeding grounds that can no longer support them.