3.1 Coasts as natural systems

In this section you will learn about the concept of systems and their application to coastal landscapes

The coast as an open system

The coast is an example of an open system. This means that it has inputs that originate from outside the system (such as sediment carried into the coastal zone by rivers) and outputs to other natural systems (such as eroded rock material transported offshore to the ocean). In Figure **1**, a small stream discharges water and inputs sediment into the sea at Selwicks Bay. The waves that affect this stretch of coastline are often driven by North Atlantic storms that pass into the northern North Sea. Sediment eroded from cliffs is transported southwards along the coast and deposited in parts of the southern North Sea – an output from the system.

As an open system, the coast has important links with other natural systems such as the atmosphere (consider the importance of wind, for example, in generating waves), tectonics, ecosystems and oceanic systems. These natural systems are linked together by flows of energy and by the transfer of material. In Figure **1**, the chalk cliffs are vulnerable to the process of carbonation, which is an important aspect of the carbon cycle. Dissolved salts can be carried into the deep ocean well away from the coast.

Figure 1 *Selwicks Bay, Flamborough Head, UK*

The coastal system

In common with other natural systems it is useful to apply systems terminology to help us to understand the connections between processes and landforms (Figure **3**). You will come across elements of the coastal system throughout this chapter, in particular the flows of energy and the transfers of sediment from place to place. A really clear example of the application of systems concepts to the coast is the sediment cell (see 3.3). There are eleven major sediment cells in England and Wales, which form the basis for coastal management (Figure **2**). Here, there are very clear inputs of sediment (e.g. from rivers and cliff erosion), transfers of sediment (e.g. longshore drift), stores (e.g. beaches and spits) and outputs (e.g. transfer to the deep ocean). This is probably the clearest and most straightforward way of understanding the coast using systems terminology.

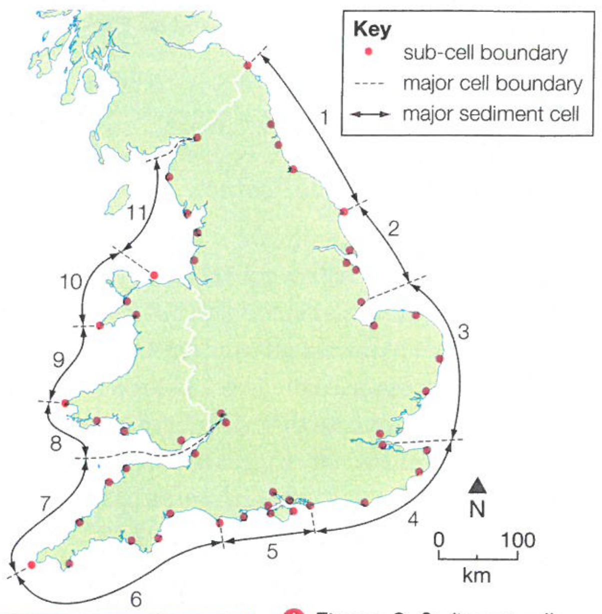


Figure 2 *Sediment cells in England and Wales*

Figure 3 *The coastal system*

Systems term	Definition	Coastal example
Input	Material or energy moving into the system from outside	Precipitation, wind
Output	Material or energy moving from the system to the outside	Ocean currents, rip tides, sediment transfer, evaporation
Energy	Power or driving force	Energy associated with flowing water, the effects of gravity on cliffs and moving air (wind energy transferred to wave energy)
Stores/ components	The individual elements or parts of a system	Beach, sand dunes, nearshore sediment
Flows/transfers	The links or relationships between the components	Wind-blown sand, mass movement processes, longshore drift
Positive feedback	Where a flow/ transfer leads to increase or growth	Coastal management can inadvertently lead to an increase in erosion elsewhere along the coast. Groynes trap sediment, depriving areas further down-drift of beach replenishment and this can exacerbate erosion. Seawalls can have the same effect by transferring high energy waves elsewhere along the coast.
Negative feedback	Where a flow/ transfer leads to decrease or decline	When the rate of weathering and mass movement exceeds the rate of cliff-foot erosion a scree slope is formed. Over time, this apron of material extends up the cliff face protecting the cliff face from subaerial processes. This leads to a reduction in the effectiveness of weathering and mass movement.
Dynamic equilibrium	This represents a state of balance within a constantly changing system	Constructive waves build up a beach, making it steeper. This encourages the formation of destructive waves that plunge rather than surge. Redistribution of sediment offshore by destructive waves reduces the beach gradient which, in turn, encourages the waves to become more constructive. This is a state of constant dynamic equilibrium between the type of wave and the angle of the beach (see 3.2).

Links between the coastal system and other natural systems

Coastal systems do not operate in isolation. They are interlinked with other physical and human systems, both affecting and being affected by change. Consider the impact of natural and also human-induced climate change.

During the Quaternary glacial and interglacial periods, sea levels rose and fell several times (as did the land) in response to changes in the global water cycle. The changing level of the sea affected the precise location of coastal processes at the edges of the land masses – several landforms owe their development to changes in the sea level. Recent changes in the global carbon cycle are indirectly affecting sea levels by causing global warming and this, in turn, is affecting coastal (and terrestrial) ecosystems. Consider the impacts of these changes on human systems, with coastal regions suffering more severe flooding and being at greater risk from storm surges. You can see, therefore, how the world's natural and human systems are inextricably linked together – if one changes, they are all subject to change.

Figure **4** shows the estuarine and coastal system in New Zealand, with particular reference to fisheries. It helps to show the linkages between various marine and terrestrial systems and between physical and human systems.

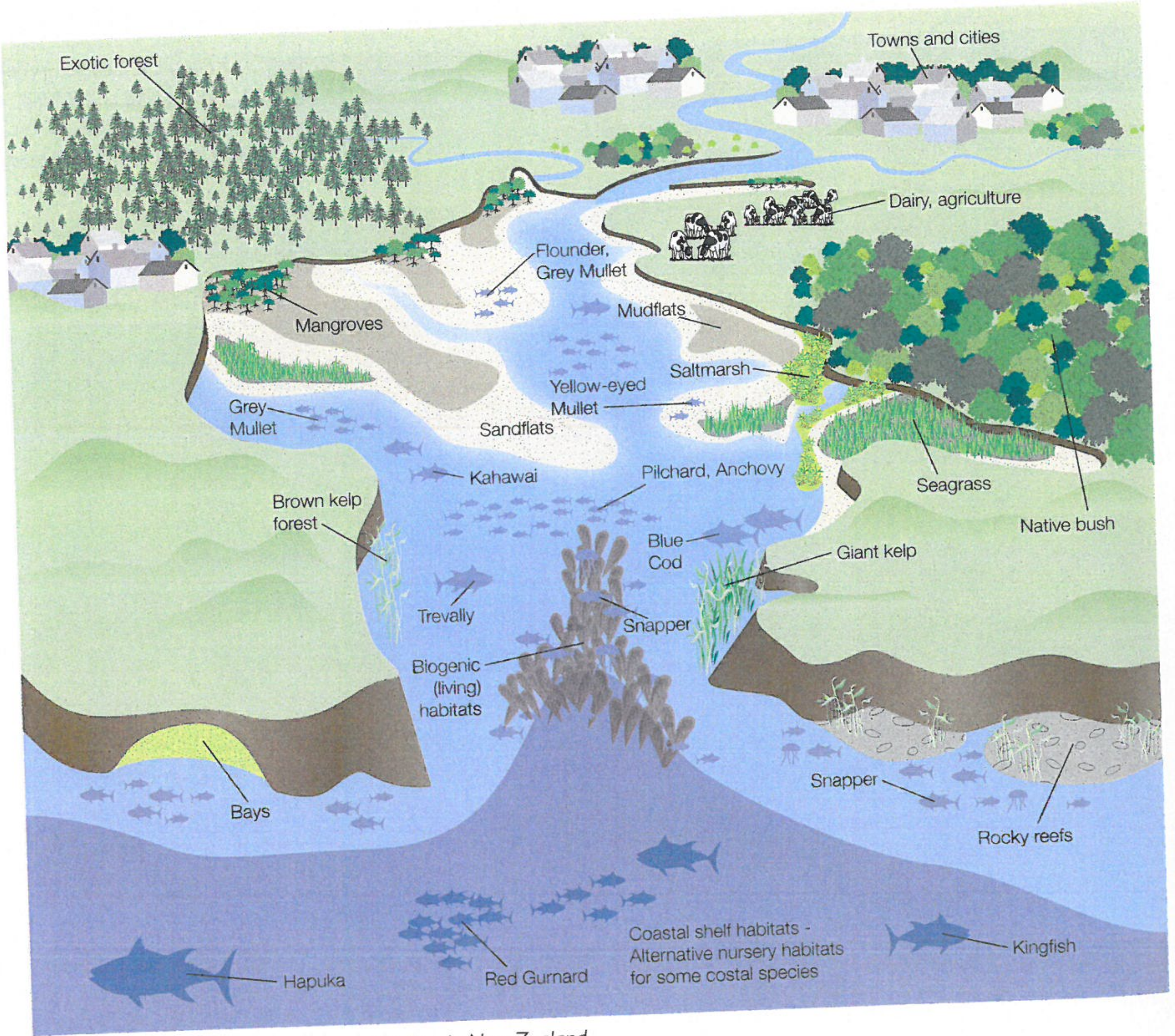


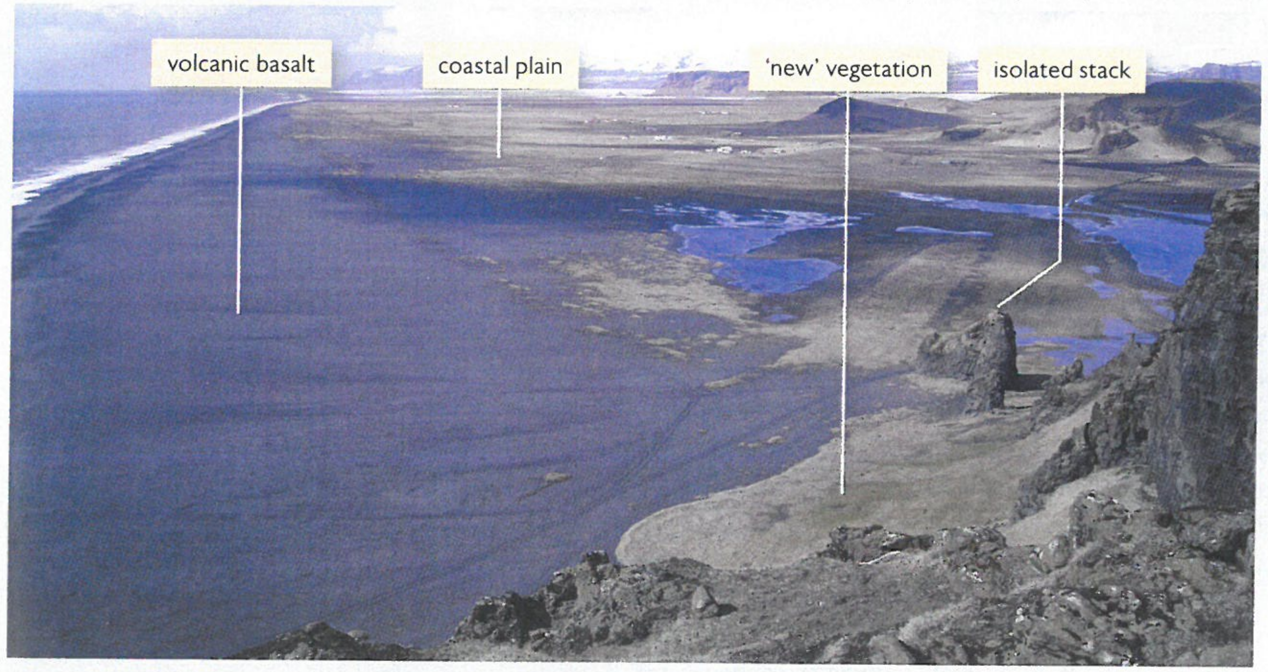
Figure 4 *The estuarine and coastal system in New Zealand*

Dyrhólaey, Iceland

Dyrhólaey is a small peninsula on the south coast of Iceland famous for its dramatic coastal landscape and its puffins in the summer. Looking south, the next land mass is Antarctica! Waves driven over this vast area of ocean transfer a great deal of energy into the coastal system of southern Iceland and they are responsible for extremely active erosion and significant transfers of sediment. The landforms of erosion and deposition combine to create this very distinctive coastal landscape.

The black sand and pebbles in Figure **5** are volcanic basalt formed by tectonic activity over millions of years and transported to the coast by rivers, glaciers and the wind. Some has been eroded directly by the sea. The presence of this material clearly illustrates the linkages with other physical systems. Much of the landscape in Figure **5** is the result of sea level change triggered by long-term changes in the water cycle. In recent times, relative sea level has dropped, creating vast coastal plains and isolated remnants of coastal landforms (an isolated stack is shown in the photo). Vegetation has developed on these newly exposed surfaces and much of this area is renowned for its wildlife, in particular birds. This demonstrates the important connections between coastal systems and ecosystems, just one of many connections between natural systems illustrated at Dyrhólaey.

Figure 5 *The coastal system at Dyrhólaey, southern Iceland*



ACTIVITIES

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1 Draw a sketch of Figure **1** and use annotated labels to identify components of the coastal system. Use Figure **2** to help you.

2 Study Figure **4**.
   - **a** Describe and suggest reasons for the diverse range of fisheries at the coast.
   - **b** Identify the physical and human systems (other than the coastal system) illustrated by Figure **4**.
   - **c** Suggest how changes to one or more of these systems could impact on the coastal system.
   - **d** Why is it important to understand the connections between natural and human systems in the management of coastal fisheries?

3 With reference to Figure **5** and your own knowledge, consider to what extent the coastal system is affected by the operation of other natural systems.