# 9.1. Introduction

The North coast is 560km in length, running from the north-west at Cape Wrath eastwards to Duncansby Head and John O'Groats, with the Orkney Isles lying close offshore, and the Shetland Isles further into the North Sea. Its characteristics are varied with the North Sea interacting for the most part with rocky sea cliffs interspersed by small bays. As one of the least inhabited areas of Scotland there are a small number of abandoned villages and ruins and a few ports and fishing villages, which have stood the test of time, forced down to the coast by the rugged Highlands of the hinterland.

The coastline is more structured along this part, characterised by a series of headlands, small bays and sandy beaches - a product of erosion themselves - acting as a natural buffer and providing important dune habitats for flora and fauna (Mendum *et al.*, 2001<sup>1</sup>). There is a small but eclectic mix of socio-cultural development in this area, retaining a distinctive Nordic influence whilst including the resting and submission point of wartime enemies, remnants of villages created or dispersed by the Highland Clearances, a chain of fifteenth century seaside mansions and a retired nuclear reactor (Barling *et al.*, 1996<sup>2</sup>).

#### 9.1.1. Geology & Geomorphology

The structure of the coastline is relatively solid in comparison to the fragmented western coast, with 74% (416km) comprised of hard or mixed geology and only 1% (7km) of soft coastline (Fitton *et al.*, 2017<sup>3</sup>). The geology of the area runs in strikes from south-west to north-east changing along the coastline from west to east. The western coast is formed of a Lewisian Gneiss Complex with intrusions of metaphorphic rocks, representative of past magmatic events and forming the highest sea cliffs in Great Britain. The central portion of this section is characterised by a series of fault and thrust zones revealing the Moine Sequence of metamorphosed sand and mudstones with igneous intrusions at the coast in some places, which occurred during the Caledonian magmatic event (Mendum *et al.*, 2001<sup>1</sup>).

The east part is characterised by Old Red Sandstone cliffs consolidated during the Acadian orogenic event 419 million years ago (British Geological Survey, 2017<sup>4</sup>). The whole section is dominated by sea cliffs, interrupted at a number of points by small bays with sand beaches backed by dunes, relatively protected by their headlands (Barne *et al.*, 1996<sup>5</sup>). The Orkney Islands are comprised in their entirety of the same Old Red Sandstone as the adjacent mainland. The Shetland Isles are less homogenous, made up of a mixture of metamorphosed Dalradian rocks and igneous intrusions of mafic, ultra-mafic and felsic lava and tuff deposited during the Caledonian magmatic event (British Geological Survey, 2017<sup>4</sup>).

#### 9.1.2. Coastal Processes

The metamorphosed, harder geological character of the area creates more resistant coastlines, although the changing geological typologies give rise to potential lines of relative weakness, in particular when harder igneous rock has intruded softer lithologies at the coast. This is a common process involved in bay and headland formation through differential erosion rates. Although more resistant, harder rocks are not necessarily immune to erosion by wave action, often creating cave formations at the base of sea cliffs.

The presence of large sandy beaches usually indicates lateral sediment movement with wave action, however, due to the isolated pocket beaches here they act as independent units, for the most part retaining their own sediment within the bay (Barne *et al.*, 1996<sup>5</sup>). The proportion of accretion and erosion

are fairly equal and occur primarily in the soft sediment sections; this is one of the few cells where the proportion of retreat has decreased from 1960s-present, where 80% is reported to have seen no change since monitoring began in 1890 (Fitton *et al.*, 2017<sup>3</sup>).

#### 9.1.3. The Coastal Environment

The coastal environment has a variety of notable characteristics. In amongst the series of small beachbacked bays and their protective headlands Loch Eriboll and the Kyles of Durness and Tongue are the only inlets to feature along this section, together with two major estuarine rivers – the Borgie and Naver whose mudflats provide food for stop-over, migrating and native birds (Barne *et al.*, 1996<sup>5</sup>). The coastal habitat is also home to a species of rare bumblebee, and nationally significant populations of seabirds including puffins, waders, and a reintroduced species of eagle (Benson, 2018<sup>6</sup>).

Nature conservation stretches to flora including the Scottish Primrose found only in the Sunderland and Orkney regions, recreating bumblebee habitats, and private reforesting efforts along the shore of Loch Eriboll (Barling *et al.*, 1996<sup>2</sup>). Close to the shore islands - Rabbit Island, Eilean nan Ron and Coomb Island - create habitats for wildlife and marine mammals, and shelters for fishermen against the North Sea. The area contains one of the largest dune and machair systems in Scotland, the Faraid Desert Dunes, which is predicted to experience some erosion in the near future (Fitton *et al.*, 2017<sup>3</sup>).

In terms of natural heritage, the Faraid and Dunnet dune systems are a highly valued habitat, along with the small islands off the coast, in particular for the sea bird populations both native and migratory managed by the RSPB (Barling *et al.*, 1996<sup>2</sup>). Conservation designations cover a number of small but significant areas, including 9.6ha of SAC and 13.1 ha of SSSI, which are acknowledged to be at potential risk from coastal erosion by 2050, increasing to 12.8 ha and 17.1ha respectively beyond this benchmark (Fitton *et al.*, 2017<sup>3</sup>). Although some erosion is predicted for the future, a combination of the scarcity of any civilisation and the dominance of hard rock coasts means cultural heritage assets are not anticipated to be at any serious risk.

#### 9.1.4. Coastal Heritage

The heritage on this part of the coastline is most prevalent around isolated hamlets, which either still function, or are in dilapidated states of abandonment due to various events through history, including the Highland Clearances and severe depletions in wild salmon stocks. Due to the unforgiving landscape of the Highlands, settlements and, therefore, heritage assets have been forced close to the coast (SCAPE, 2012<sup>7</sup>). A variety of evidence of local industries remains, such as fishing infrastructure, and harbours renowned for the export of locally hand-quarried Caithness Limestone, wool, fish products, and even sand used as a soil fertilizer during the wartime 'Dig for Victory Campaign' (Barling *et al.*, 1996<sup>2</sup>).

Historic fortifications include the privately-owned seventeenth century Thurso Castle and the late Queen Mother's residence - the Castle of Mey and a variety of lighthouses guarding the coast from the dangers of the sea. Ancient churches including St Mary's Chapel, St Maelrubha, and St Columba grace the coastline in various states of ruin or reinvention, alongside older Viking and Bronze Age relics and evidence of civilisation, including burial sites, huts and cooking rings (SCAPE Trust, 2012<sup>7</sup>).

Aside from fishing off cliffs and piers, agriculture exists in the form of crofts - arduous subsistence farming on the hills behind the coast. As well as these historic features a range of more modern but relevant heritage exists in the story of societal development in this region, including wartime installations of antitank blocks on beaches, and The Far North Line, the most northerly train line opened to Thurso in 1844 that carried soldiers in World War I, and the UK's only Fast Prototype Nuclear Reactor (Barling *et al.,* 1996<sup>2</sup>). The archipelagos of Orkney and the Shetlands, perhaps due to their isolated character, have preserved some of the most comprehensive prehistoric heritage in the world. These include the Broch of Mousa on Shetland, an iron age round house dating from 300 BC, and Skara Brae on Orkney, a 5,000 year old Neolithic settlement (Hambley, 2017<sup>8</sup>; SCAPE, 2012<sup>7</sup>).

#### 9.1.5. Case Study Sites

The north coast is the narrowest section of the Scottish coast comprising just 3% of the total length, with a distinctive geomorphology. There is one case study site: the coast from Durness to Bettyhill. It represents an area with an eclectic cultural history - playing a key part of the wartime efforts, a rich marine habitat, a sparse population, a range of scenery, environments and artwork resources, and carrying a distinctive character different from Scotland's east and western coasts.

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# **Case Study 9.1 – Durness to Bettyhill, Scotland North Coast**

## 1. Location

The case study area lies towards the western edge of the north coast, just east from Cape Wrath and its solitary lighthouse, beginning at the headland of Durness and running east past the headland of Whiten Head to Bettyhill. Its main features include two large sandy beaches, which cover either side of a rocky peninsula, and Loch Eriboll, a deep fjord channel.

## 2. Why was the Case Study Site selected?

The region's status as one of the most uninhabited in Great Britain makes the cultural heritage that is present even more interesting, representing a changing history of lives, which clung to this isolated edge of Britain, some surviving and others falling along the way. This area is relatively more fertile than the surrounding regions, making crofting perhaps a more sustainable way of life than others, and adding an interesting element to the area's heritage. On the hilly shores of Loch Eriboll, names of ships are marked out with white stones (SCAPE, 2012<sup>1</sup>; Benson, 2018<sup>2</sup>) some of which are sinking but others are still visible, providing a historic link to users of the sea and coast. The Loch itself has a place in wartime history, used as a bombing range, rendezvous point of the Home Fleet, and where German submarines surrendered at the end of WWII (SCAPE, 2012<sup>1</sup>). A variety of natural resources made up the small-town industry, including wool and herrings exported from Rispond Harbour. Other historic features include ruins of churches and their burial sites and evidence of activity from Viking and Bronze Age settlements and invasions (Hambley, 2017<sup>3</sup>). Although small in length and isolated in location, this case study proves an area of great interest.

## 3. Summary of the Geology, Geomorphology & Coastal Processes

The area contains the oldest rocks in Britain (British Geological Survey, 2008<sup>4</sup>), pre-dating the Cambrian Period. The shore consists predominantly of sea cliffs exposing Durness Limestone containing quartzite up to the east shore of Loch Eriboll. Here it is interrupted by a belt known as the Moine Thrust Zone representing a significant tectonic event (Krabbendam, 2004<sup>5</sup>; Mendum *et al.*, 2001<sup>6</sup>). The predominant geology is a Lewisian Gniess Complex, with inlet areas characterised by Cambrian rocks of the Durness Limestone. These harder, metamorphosed rocks, although relatively impervious to erosion, are exposed to vicious climatic and oceanic forces from the North Atlantic and North Sea, which can lead to wave cut erosion especially at the base of the sea cliffs and creating features such as notches, stacks and caves (Barne *et al.*, 1996<sup>7</sup>). Geodha Smoo at Durness is the largest example of this, a three cavern cliff cave created by the power of the waves over time, when sea level was higher than present (British Geological Survey, 2008<sup>4</sup>).

The peninsula is covered by the Faraid climbing dune system; these dunes are naturally dynamic and change position over time at the mercy of the wind and waves; making accretion and deposition very common processes (Barne *et al.*, 1996<sup>7</sup>). In this case, the erosional force of the wind has helped uncover cultural heritage in the form of a Viking burial site among the dunes (Brady, 1998<sup>8</sup>). The sand is supplied from offshore glacial deposits rather than terrestrial sources due to the relative lack of erosion and enclosed beaches inhibiting longshore sediment transport.

Loch Eriboll is the only deep inlet on the North coast (Hill, 1996<sup>9</sup>), creating a unique coastal environment and opportunities for social and ecological development. Both the dunes and Loch Eriboll are protected under SSSI and Regional Landscape designations due to the presence of rare species of flora and fauna, including the Scottish Primrose *Primula scotica*, alpine-arctic plant communities, wild cat and pine marten populations (Barling *et al.*, 1996<sup>10</sup>) and in the coastal environment of the Loch and surroundings, a range of marine fauna including rare sessile inverts, seals, dolphins and commercial fish and shellfish populations (Hill, 1996<sup>9</sup>). The study area is also classified as a Preferred Conservation Zone, Area of Great Landscape Value, and possible SAC (Hill, 1996<sup>9</sup>); these designations encourage conservation above development. Within the area there are no hard coastal defences, although the beaches, coastal islands and lochs form buffers against the full force of wind and wave attack. Isostatic uplift in this area, although occurring at a slower rate than sea level rise itself creates a dampening effect on its risks, particularly in relation to flooding in comparison to the south of Britain, based on the measurements at Newlyn (*Fitton et al*, 2017). It can therefore be considered that the main threat to these habitats and the cultural value they contain is from human pressures of grazing and agriculture, before coastal erosion or flooding.

#### 4. How can the art imagery resources inform us of changes that have affected this coastal zone?

The views of the Durness site show a hard rock coastline that has experienced very little change over time, although beaches fronting Durness are much more mobile. The coastal geology and geomorphology in terms of Smoo caves and Whiten Head do not appear to have changed since depicted by William Daniell in the early nineteenth century. The Kyle of Tongue and Strathnaver sites have extensive sand deposits in the estuaries at points in time and these are evident in both Daniell's early nineteenth century aquatints and in David Addey's watercolours of the 1990s. 'Dynamic Coast' (Fitton *et al.*, 2017<sup>11</sup>) highlights significant fluctuations in terms of erosion and deposition at Durness, Bettyhill and the Kyle of Tongue and future changes, although these are unlikely to pose risks to the natural heritage.

#### 5. Key issues that can be learnt from this site.

1. The north coast of Scotland appears to have undergone relatively little change in terms of the physical landscape and its coastal development. The illustrations of beaches and estuary mouths along this frontage show healthy conditions over time, although they are affected by significant changes in terms of sediment mobility, erosion and accretion to the present day.

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Fig. CS9.1.-CS9.3. This sequence of views depicts the village of Durness on the north coast of Scotland, immediately to the north-west of Loch Eriboll. The village is located on a limestone headland and overlooks a small harbour which is sheltered by the headland to the north. The location is depicted accurately by William Daniell in his aquatint (top), which was engraved in 1820. The scene appears to have changed relatively little in David Addey's watercolour of 1997 (centre).

Whilst not visible in Daniell's view, the northern coastline contains sandy pocket beaches and to the north-west, Faraid Head is an important geomorphological site as Scotland's largest sand dune system, the force of the winds creating dunes up to 60m in height.

Images courtesy of Fig. CS9.2 David Addey; Fig. CS9.3. Sarah Charlesworth © 2008.





**Fig. CS9.4.-CS9.6.** show views of the Smoo Cave just to the east of Durness. This large cave system that can be accessed from the shore was visited by Daniell in 1820 (top). It appears to have changed little in David Addey's view of 1997 (middle). The present day view is illustrated (bottom) and shows cliff top development adjacent to the cave system.

Images courtesy of Fig. CS9.5 David Addey; Fig. CS9.6. E. H. Mackay © 2005.





Fig. CS9.7.-CS9.9. show the view looking eastwards across the mouth of Loch Eriboll to Whiten Head. William Daniell's view (top) shows the northern termination of the headland with its system of caves and sea stacks, whilst the view by Addey (middle) is more distant and shows the headland together with the island from perhaps where Daniell took his view. The present day view is remarkably similar to the coastline depicted by Daniell and shows a very slow rate of change affecting the headland of durable Durness Limestone.

Images courtesy of Fig. CS9.8 David Addey; Fig. CS9.9. David Purchase © 2016.



Fig. CS9.10.-CS9.12. show views of the Kyle of Tongue, which lies to the east of Loch Eriboll and to the west of the village of Bettyhill. Daniell's view of this remote location, engraved in 1820, shows cockle pickers on the sands gathering their harvest at ebb tide. The existence of the extensive sand flats is evident also in the watercolour by David Addey (middle) and in the present day view (bottom).

This series of views suggest that the volume of sediment appears to have increased within the Kyle since Daniell's view, although beach levels fluctuate between erosional and depositional phases continuously along this coast.

Images courtesy of Fig. CS9.11. David Addey; Fig. CS9.12. Commons Wikimedia © 2012.



Fig. CS9.13.-CS9.15. show the mouth of the River Naver at Strath Naver, which emerges into Torrisdale Bay at Bettyhill. The buildings located at the mouth of the river on the right in Daniell's view (top) were probably constructed for the purpose of salmon fishing. These were located just to the north of the jetty that now exists and which can be seen in David Addey's watercolour (middle). The present day view is illustrated in the bottom image.

As within the Kyle of Tongue the erosional and depositional processes fluctuate here, with significant changes being described since 1900.

Image courtesy of Fig. CS9.15. Bob Jones © 2002.

# 10.1. Introduction

The East Coast of Scotland includes 2,022km of coast between John O'Groats in the north and the English border town of Berwick-on-Tweed in the south (excluding estuarine inlets which significantly increase this length). It is relatively urbanised in comparison to the rest of the Scottish coast with developed industries and large settlements lying adjacent to the coast with long histories of trade. Long stretches of sandy beaches, the relative shelter within bays, and the small fetch of the North Sea made many coastal towns also popular seaside resorts; dune coasts encouraged the birth of golf in the peacetime of the Victorian era.

#### 10.1.1. Geology & Geomorphology

Where the north-west comprised the oldest rocks in Scotland and Britain, the east coast has bedrock consisting predominantly of Devonian, Carboniferous and Jurassic sedimentary rocks, with the youngest rocks in Scotland towards the south-east (British Geological Survey, 2008<sup>1</sup>). Marked changes occur at the northern terrestrial limits of the Highland Boundary and Great Glen Faults. Igneous intrusions are less extensive than in the north and west, creating islands such as the Bass Rock and important headlands such as Burghead and North Berwick where they do exist. One of the defining geological formations of the east coast are the sedimentary rocks, metamorphosed by intense folding during orogenic events, transforming into marble and granite (Merrit & Leslie, 2009<sup>2</sup>) and long stretches of sand beach and dune frontage.

#### 10.1.2. Coastal Processes

The isostatic uplift of land associated with deglaciation is one of the dominant processes along this coast. Whilst formations are more dramatic in the north more muted glacial influence reaches down the entirety of the east coast in the form of raised beaches and glacial till deposits (Merritt & Leslie, 2009<sup>2</sup>). As with the north and west coasts the sediment dynamics, erosion and depositional processes are complex and reasonably self-contained within sediment cells, although the structured coastal geomorphology allows for more influence from longshore drift processes, creating depositional structures not seen in the north or west coasts. In the firths, localised tide and wind patterns influence a wide variety of landscapes and habitats. In the northern section from Cairnbulg to Duncansby Head almost 60% of the coastline is described as soft sediments, whereas on the section south of this area hard rock dominates with a relatively large portion of artificial coastline (331km), particularly towards the south (Hansom *et al.*, 2017a<sup>3</sup>; Hansom *et al.*, 2017b<sup>4</sup>). Rather than promoting erosion the soft sediments contribute to accretionary processes, which dominate along the whole east coast creating a hugely dynamic coast. Whilst since 1970 erosion rates have increased in extent and rate, and stability has decreased; shoreline advance still currently dominates with rates increasing to match erosion, although this could be the beginning of a transition towards increased erosion.

#### 10.1.3. The Coastal Environment

Moving from north to south the coastline leaves behind the dramatic, isolated and volcanic character of the Northern Highlands, shifting to lower cliffs and gentle hills carved by glacial retraction. Along this frontage larger settlements gradually developed. Finer grained sediments associated with sedimentary

rocks, sourced from fluvial and offshore glacial deposits, and the products of erosion have built up to form wide sandy beaches, reedbeds, mudflats and rare saltmarsh habitats, which are of national and international importance under Natura conservation legislation, including National Nature Reserve Status and SSSI, SPA, and SAC designations (Hansom, 2003<sup>5</sup>). The coastline is broken up by several extensive and well-established estuarine environments, rather than the sea lochs of the north or the fragmented inlets of the west coast. The relatively sheltered nature of this coast due to the smaller North Sea fetch and orientation of much of the coast lends itself to creating large areas of deposition (Scottish Natural Heritage, 2017<sup>6</sup>).

#### 10.1.4. Coastal Heritage

The northern east coast was an area affected deeply by Highland Clearances, and was home to some of the main instigators of this upheaval. Replacement villages, including Wick, designed by Thomas Telford to be the herring capital of Europe within twenty years welcomed former land tenants (National Library of Scotland; Smith 2001<sup>7</sup>). For a large area with a low population density rocked by upheavals throughout history, the industrious nature of its inhabitants has left a significant mark on this coastline; characterised by many fishing harbours – in particular herring and lobster – the remains of a once thriving textile industry in Dundee, coastal mines, ship-building as well as the omnipresence of strong religious links with churches, chapels and cathedrals in various states of ruin and repair. The presence of more recent conflicts can also be felt; the large sandy beaches allowed practice for the D-Day Landings of 1943 at Culbin Sands, Nairn, where buried tanks and submarines still lie, and Wick commemorates the location of the first daylight air-raid of World War II (Smith, 2001<sup>7</sup>). Although the Highland Clearances created a large agricultural presence, where crofting was a main industry for the north and west, the natural resources of the east coast allowed a diversification of industries, including strong fishing areas, coal and granite mining, textile production, grain exportation and coastal holiday resorts. Towards the south of the coastal section, in part related to the industrial variety, a shift to a higher level of societal affluence is felt reflected in the presence of Victorian hotels and many coastal golf courses, still popular today.

#### 10.1.5. Case Study Sites

- Wick Helmsdale
- Brora- Tarbat Ness
- Nairn Burghead
- Peterhead Aberdeen
- Broughty Ferry St Andrews
- Wemyss Coast
- Musselburgh Tantallon Castle

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Fig. CS10.1. 'Rose Hearty, Aberdeenshire' by Robert Weir Allen. Oil. 1909. Image Courtesy: Aberdeen Art Gallery.

# Case Study 10.1 – Wick to Helmsdale, Scotland East Coast

# 1. Location

Wick is a small village with Viking origins situated just south of the headland of John O'Groats; this case study section runs southwards to Helmsdale along a south-east orientated coastline over a length of approximately 60km.

## 2. Why was the Case Study Site selected?

This section of coast has some uncommon geological formations, including a coal-bearing seam, which in turn has determined the industry and settlement types. Wick developed as a fishing village born from the Highland Clearances in an area of Viking influence (Aitken, 2005<sup>1</sup>) Along the coast are remnants of Neolithic life and death in burial chambers and standing stones, villages based on the herring and salmon industries, golf courses and castles. The coast at Helmsdale is a designated SSSI, with a coastal rail link in exceptionally close proximity to the coastline (Aitken, 2005<sup>1</sup>). These characteristics make for interesting cultural history and artistic inspiration, as well as the potential requirement for management to protect assets from future erosion.

## 3. Summary of the Geology, Geomorphology & Coastal Processes

The geology of this coastline is dominated by the Old Red Sandstone Supergroup laid down during the Acadian orogenic event of the Devonian Period, intruded by felsic lava deposits of granite and granodiorite. The Helmsdale Fault begins offshore in this section before cutting through the land in a NE-SW orientation (British Geological Survey, 2017<sup>2</sup>). Directly behind the coastal frontage lies a large section of Moine sequence. Although predominantly sedimentary in nature these rocks have been folded at high pressure and their metamorphosed nature makes them more resistant to the erosive forces at the coast (Merritt & Leslie, 2009<sup>3</sup>).

The coastal character type is defined as Rocky Coast, dominated by sheer sea cliffs and open sea views (Scottish Natural Heritage, 2017<sup>4</sup>). In the few places where beaches are present, they are formed of coarse gravel, consistent with the products of erosion of resistant rock types. Due to the hard bedrock and steep cliffs, the coastal processes at work are limited to those caused by weathering and wave action; creating arches, stacks, and caves and the potential for reefs offshore (Hansom *et al.*, 2017<sup>5</sup>). The sediment cell (3g) is contained within this section of coast, suggesting no exchange with adjacent regions takes place via transfer processes such as longshore drift (May & Hansom, 2003<sup>6</sup>).

## 4. How can the art imagery resources inform us of changes that have affected this coastal zone?

The historical imagery along this frontage illustrates the developmental changes that have affected the port of Wick and the coastal town of Helmsdale. The artworks also describe important heritage sites, including Wick Castle and Dunbeath Castle, and show how they have been altered since the second decade of the nineteenth century. The images also illustrate very little change to the physical coastline, with both the clifflines and beaches, such as the beach at Berrydale, showing insignificant change.

## 5. Key issues that can be learnt from this site.

- 1. Art imagery suggests that the physical coastline has changed very little since 1818. This accords with the conclusions of 'Dynamic Coast' (Hansom *et al.*, 20175) that the frontage "is dominated by rocky cliffs that are high and resistant to erosion".
- 2. The architectural heritage has been accurately recorded through the artworks by William Daniell and David Addey. Such images should be added to the Historic Environment Records to provide full colour records of changes affecting major coastal properties (castles and coastal mansions).

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Fig. CS10.2. 'The Herring Fleet of Wick entering the Harbour' by Robert L. Anderson ARSA RSW. 1884. Watercolour. Private Collection.



Fig. CS10.3.-CS10.5. These views show the town of
Wick, the north-eastern end of this case study site. Fig.
CS10.3. (top) shows a view engraved by William Daniell on his 'Voyage Round Great Britain' in 1821. From this

elevated vantage point Daniell looks out across the harbour to the mouth of the port beyond. At the time of

Daniell's visit Wick was prospering on account of its herring fishery with nearly 600 fishing boats at work.

Following a major storm in 1848, work commenced on improving the harbour arms and various phases of improvement continued until the early twentieth century. David Addey's view (middle) shows the view in 2001. The view over the harbour appears to have changed little, although the huge herring fleet, which employed over 1,100 boats in the 1860s, has since declined dramatically. David Addey's view includes the monument on the left, which was erected in honour of James Bremner, a naval architect and harbour builder who died in 1856.

The present day view (bottom) shows the port greatly expanded with a wide range of waterfront buildings and infrastructure.

Images courtesy of Fig. CS10.4. David Addey; Fig. CS10.5. © Dorcas Sinclair/Geograph.org.uk.



Fig. CS10.6.-CS10.8. depict Old Wick Castle, which is located on a headland to the south of the town, and, having been constructed in the twelfth century, is one of the oldest of Scotland's castles. Daniell's view of 1821 (top) shows the castle located precariously adjacent to the sea cliff, whilst David Addey's watercolour shows a building of reduced size, with the outer wall having fallen away. The present day image (bottom) appears to show very little change to this site over the centuries.

Images courtesy of Fig. CS10.7. David Addey; Fig. CS10.8. Craig Brown © 2009.



architect, David Addey, painted mainly between 1990 and 2000, and making a comparison with present day views, the chronology of change both physical and human that have affected these important buildings is comprehensively recorded.

Images courtesy of Fig. CS10.10. David Addey; Fig. CS10.11. Wikipedia.





Fig. CS10.12.-CS10.14. show the castle at Berrydale and the adjacent shoreline. In Daniell's view (top) the Berrydale Water can be seen emerging at this point, and there is an active fisheries industry taking place on the sandy beach. In David Addey's watercolour (c.2001) the beach seems relatively unchanged in its extent and compares with the contemporary view (bottom).

Images courtesy of Fig: CS10.13. David Addey; Fig. CS10.14. Sarah Egan © 2007.



Fig. CS10.15.-CS10.17. show the former fishing village of Helmsdale, located at the mouth of this salmon river. In Daniell's view (top) the ruined castle is located in a commanding position overlooking the river and harbour. The watercolour painted by David Addey of a similar location shows that a road has passed alongside the site of the former castle, whilst the harbour depicted by Daniell has now been replaced and is connected across the mouth of the river by a new bridge. Thomas Telford's two arch bridge, which was constructed in 1811 and is visible in the foreground of Daniell's engraving, is still in use.

Images courtesy of Fig. CS10.16. David Addey; Fig. CS10.17. © Phil Williams/Geograph.org.uk.



# Case Study 10.2 – Brora to Tarbet Ness, Scotland East Coast

# 1. Location

This section includes Dornoch Firth, the most northern estuary on the east coast, with the coastal town of Brora at its northern limit. The southern extent is delineated by the Tarbat Ness headland, which encloses the estuary area and Morrich More, also forming the northern terrestrial boundary of the Great Glen Fault.

# 2. Why was the Case Study Site selected?

As an estuary the Dornoch Firth is at greater risk from the effects of erosion and inundation. It is also a relatively undeveloped estuary compared to the other firths present on the east coast, thus creating a different focus to its history as well as its present day management. It is a heavily designated area, with Special Protected Areas, a Special Area of Conservation, Site of Special Scientific Interest and National Nature Reserve status, as well as cultural heritage designations of conservation areas, scheduled monuments, castles, and many Grade A-C listed buildings (Hansom, 2003<sup>1</sup>; JNCC, 2001<sup>2</sup>). With mystic Iron Age standing stones, large mudflats, and important wading bird populations the range of artistic vistas proved popular among painters in the past and indeed today.

# 3. Summary of the Geology, Geomorphology & Coastal Processes

The bedrock geology at Brora is a small outcrop of Jurassic rocks laid down between 201 and 145 million years ago. Behind this and forming the dominant rock type of the Dornoch Firth is Old Red Sandstone from the Acadian Orogeny (419 million years ago), a continuation of those found further north along the Sutherland coast. Intersecting the back of the Firth is the Helmsdale Fault running in a NE-SW direction, causing a change in geology to Mortar and Tarskaviag groups of metamorphosed sandstone (British Geological Survey, 2017<sup>3</sup>) - the oldest of the Moine Sequence intruded with igneous granite and folding, which reveals the Lewisian Gneiss Complex, the oldest rock type in Britain (British Geological Survey, 2008<sup>4</sup>).

The coastal character is varied; at Brora it is defined as a deposition coastline with open views (Scottish Natural Heritage, 2017<sup>5</sup>) with a narrow coastal shelf to the north, briefly interrupted by a section of rocky coast before the outer and inner less developed Dornoch Firth.

The Dornoch Firth is the most northern estuary in Britain, large and complex in nature and internationally renowned for its unique geomorphology, which comprehensively depicts the last 7,000 years of marine transgression through gravel cliff and dune succession sequences and other emergent landforms associated with isostatic rebound (Hansom, 2003<sup>1</sup>). What makes this coastline unusual is the dominance of accretion in all but the most northern section of the study area, and the north-western edge of the Morrich More, exposed to a larger fetch, which has been supplying the inner firth and causing a net gain of 3.1 ha/year for the past 34 years (Dargie, 2017<sup>6</sup>).

Golspie, Dornoch, and Tarbat are designated Potentially Vulnerable Areas (SEPA, 2016<sup>7</sup>), due to their lowlying proximity to the coast, and risk of coastal flooding as well as fluvial, mainly to residential houses, golf courses, and some Listed Buildings and Scheduled Monuments including Dunrobin Castle, and Castle Haven Dun (Historic Scotland, 2015<sup>8</sup>). Some areas already benefit from coastal defences dating from the 1960s which slow the minor erosion on the frontages whilst a large portion is buffered naturally by sand beaches. In future the presence of natural and engineered coastal defences should maintain stability in the majority of this area (Hansom *et al.*, 2017<sup>9</sup>), with changes classed as natural rather than erosion, and not significant enough to cause damage to heritage assets.

# 4. How can the art imagery resources inform us of changes that have affected this coastal zone?

Although generally low-lying coasts were less frequently painted by artists, there are a number of watercolours and oil paintings showing the town of Dornoch, often viewed across the sand dunes and marshes from the sea. These images illustrate relatively little overall change along the coastal frontage, although processes of erosion and deposition may be active along the immediate coastal frontage (see **Fig. CS10.18.-CS10.20.** overleaf). There are numerous views illustrating the frontage of Dunrobin Castle

and coastal change along this frontage appears modest. More detailed views of the castle itself illustrate the significant changes that have taken place to the building since first painted by William Daniell in the early nineteenth century.

#### 5. Key issues that can be learnt from this site.

- 1. Low-lying coasts are less frequently painted than more elevated and dramatic coastlines.
- 2. Where coastal mansions or castles exist such as Dunrobin there are significantly more images and these often depict not just the subject itself, but also the hinterland including, importantly, the shoreline (see Fig. CS20.21.-CS10.26. overleaf).

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Fig. CS10.18.-CS10.20. show views in the vicinity of the town of Dornoch on the coastal frontage between Brora in the north and the spit of Tarbet Ness on the south side of the Dornoch Firth. This location was not depicted by Daniell in his coastal voyage as is often the case, low-lying coasts – dunes and saltmarshes did not attract the attention of artists in the same way as the cliffed coastlines.

**Fig. 10.18 (top)** shows the dunes of Dornoch painted in watercolour by the artist, William Beattie Brown, in 1884. Erosion and accretion rates have fluctuated along this low-lying coast over the last century, and although there has been some recent erosion adjacent to the golf links, elsewhere there has been substantial accretion (Hansom *et al.*, 2017<sup>9</sup>).

Images courtesy of Fig. CS10.18 the Royal Scottish Academy, Edinburgh; Fig. CS10.19. & CS10.20. Commons Wikimedia.





Fig. CS10.21.-CS10.24. (and CS10.25-CS10.27 overleaf) show views of the coastline in the vicinity of Dunrobin Castle, which is located close to the village of Golspie to the north of Dornoch. William Daniell produced two views of the castle in 1821, the first (top) shows a view looking along the coastal frontage from the north-east and shows the estate protected by a substantial seawall. The watercolour (middle) by James William Giles was painted in 1851 and shows the more natural shoreline in the foreground, with the protected frontage and the mansion beyond. David Addey's watercolour, painted in about c.2001, shows a view of the estate from the beach to the north of the castle, which is undefended. This compares with the present day view showing an extensive shingle beach (below).

Images courtesy of Fig. CS10.22. The Royal Collection Trust/© Her Majesty Queen Elizabeth II 2018; Fig. CS10.23. David Addey; Fig. CS2.24. Geograph.org.uk.





two fine architectural views of Dunrobin Castle by William Daniell (top) and David Addey (middle). The quality of William Daniell's aquatint engravings that contain castles and stately homes is particularly fine, as well as the detail provided of the seawall and the jetty in the centre of his view. The seawall can also be seen at low water in David Addey's highly detailed depiction. The castle has been extended and altered since Daniell's view based on designs by Sir Charles Barry. The timber pier, illustrated in Daniell's view, existed until the 1990s. A present day view of the castle is provided in the photograph (bottom).

Images courtesy of Fig. CS10.26. David Addey; Fig.CS10.27. Geograph.org.uk.

# Case Study 10.3 – Nairn to Burghead, Scotland East Coast

## 1. Location

Located on the outer reaches of the Moray Firth this north-facing section of coast runs from the coastal town of Nairn eastwards, including Findhorn and Burghead Bays and reaches its eastern limit at the headland of Burghead.

## 2. Why was the Case Study Site selected?

The study area lies on the outer shore of the Moray Firth and boasts some the most spectacular geomorphological features on the British Coast. The history of the area integrates Bronze and Iron Age forts with nineteenth century health resorts, a Royal charter town, with herring and grain ports, a battle field, buried tanks and villages washed away by sand.

# 3. Summary of the Geology, Geomorphology & Coastal Processes

The bedrock geology is fairly homogeneous along this section of coast, made almost entirely of Devonian Old Red Sandstone. Only at the headland of Burghead is there a small outcrop of younger New Red Sandstone from the Permian-Triassic Period 299-201 million years ago (British Geological Survey, 2017<sup>1</sup>). Beneath this lies metamorphosed Grampian Group sandstones and magmatic intrusions and above, superficial glacial till deposits.

The coastal character is defined simply as outer firth, as it lies on the eastern edge of the Moray estuary (Scottish Natural Heritage, 2017<sup>2</sup>). The majority of the coast is fronted by long curved sandy beaches with impressive spit and bar formations, 5,000 ha of stabilised dune, and coastal forest planted by the Forestry Commission in 1920 (Hansom *et al.*, 2017<sup>3</sup>). At Findhorn Bay expanses of mudflats are revealed by the tide creating important habitat for overwintering and migratory birds, and saltmarsh formed by fluvial deposition of fine sediments and are designated SSSI and SPA (Comber *et al.*, 1994<sup>4</sup>). Raised beds of gravel associated with isostatic relative sea level fall provide the basement for extensive dune systems (Firth, 1989<sup>5</sup>). This section falls into its own sediment cell (3c) as Burghead headland prevents sediment input from further afield (May & Hansom, 2003<sup>3</sup>).

This study site is recognised as the most dynamic coast in Scotland (Hansom *et al*, 2017<sup>6</sup>), due to a combination of high sediment load in river discharge, a large wind-blown sand component particularly during storms, and the longshore drift process currently moving the spits westwards by erosion and deposition at opposite ends of the spit (Hansom, 2003<sup>7</sup>). The River Findhorn discharges an average estimate of 76,000 t/year of fine and coarse sediments from glacial till deposits inland, and erosion of the gravel cliffs provide sediment to the spit formations (Brew, 2001<sup>8</sup>). Although erosion is most prolific in front of RAF Base Kinloss and Burghead (0.6m/yr) this sediment is fuelling accretion on the westward side of the case study area, and no built assets should be at major risk by 2100. It is predicted that in 113 years the bars will sit in front of Nairn at the western edge of the study area (Hansom *et al.*, 2017<sup>6</sup>), which will have implications for the eastern coast formerly sheltered by this formation, as well as altering the shoreline significantly at Nairn.

## 4. How can the art imagery resources inform us of changes that have affected this coastal zone?

Although a coastline of outstanding beauty and natural importance here, again, the main focus by artists has proved to be architectural subjects rather than the natural environment. Heritage features such as Nelson's Tower at Forres and the harbour at Burghead proved to be of greatest interest to artists. These artworks describe changes that may have affected architectural subjects but also, in the case of Burghead, can illustrate the chronology of coastal and harbour defences over time.

## 5. Key issues that can be learnt from this site.

- 1. Sites of natural or environmental significance and highly regarded today do not necessarily feature in the art record.
- 2. Architectural and harbour and the coastal built environment, including seawalls and defences, are often well illustrated.

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Fig. CS10.28. 'Nairn' By William Daniell. Aquatint. 1821.



Fig. CS10.29.-CS10.31. The dynamic and richly diverse coastline between Nairn and Burghead to the east was not painted by William Daniell on his coastal voyage or by many of the leading nineteenth century Scottish artists, probably on account of its open and low-lying topography. However, the number of important historic buildings along this coast did attract their attention. These included Nelson's Tower at Forres (Fig. CS10.29), which shows in Daniell's view Findhorn Bay in the distance.
 Commemorating the victory of Trafalgar, the tower was opened in 1812, the tower was painted by David Addey in c.2001. the present day view (bottom right) shows the well-maintained structure today.

Images courtesy of Fig. CS10.30. David Addey; Fig. CS10.31. G. Laird 2018 © Creative Commons Licence.







show views of the harbour wall at Burghead at the eastern end of this frontage. The harbour arm traps sediment in the wide Burghead Bay, to its south-west. The view by Daniell (top), engraved in 1821, shows construction work underway on the harbour; a further timber landing stage is being added on the inner side of the harbour arm. The arm provides improved levels of protection for the town from severe easterly storm waves. The present day views (middle and bottom) show a recent view of Burghead looking towards the breakwater. Images courtesy of CS10.33. Andrew Wood ©

Fig. CS10.32.-CS10.34.

CS10.33. Andrew Wood © 2015; Fig. CS10.34. Anne Burgess © 2015/Geograph.org.uk.

# Case Study 10.4 – Peterhead to Aberdeen

#### 1. Location

This lengthy frontage of east facing North Sea coastline begins at the coastal town of Peterhead running almost due south down the coast to the historic "Granite" city of Aberdeen.

#### 2. Why was the Case Study Site selected?

Peterhead and Aberdeen are both very important as major fishing and trading ports (Hastings, 2010<sup>1</sup>), and historically for whaling. Aberdeen also provides ferry transport to continental Europe. The granite mined from Peterhead and Aberdeen is particularly distinctive in colour and so the locations grew into important quarry areas, exporting globally. Geomorphologically it is an interesting mix of hard and softer sediments with a large uninterrupted beach front and areas of European conservation importance, which in the past have experienced serious erosion.

#### 3. Summary of the Geology, Geomorphology & Coastal Processes

Dalradian metamorphosed sedimentary rocks dominate this coastline exposing the oldest rocks in northeast Scotland. Deposited during the mountain building events of the Caledonian Orogeny, and representing the Scottish coast of the prehistoric Lapetus Ocean, these rocks have experienced folding, burial, extreme heating and compression transforming sedimentary into hard, resistant rocks -particularly granite (Merritt & Leslie, 2009<sup>2</sup>). Intrusive and extrusive magmatic formations of the Ordovician-Devonian Periods are scattered throughout. Towards the southern edge of the section around Aberdeen, small outcrops of Old Red Sandstone are visible on the coast (British Geological Survey, 2017<sup>3</sup>); formed by fluvial deposits originating in the Caledonian Mountains. Superficial glacial Logie-Buchan Drift deposits are also present, particularly at Peterhead (Merritt *et al.*, 2003<sup>4</sup>).

Although the underlying bedrock is predominantly resistant to erosion, the area has been exposed above sea level for most of the last 400 million years. The coastal character is a combination of rocky coastline in the northern half, and depositional coast in the southern half (Scottish Natural Heritage, 2017<sup>5</sup>). Features of the rocky section include sea stacks, rocky reefs, and erosive fractures creating blowholes; at Slanes a glacial remnant gravel ridge is prominent (Merrit & Leslie, 2009<sup>2</sup>). Cruden Bay contains an extensive, healthy dune system, signifying the start of the depositional coastline, and an extensive 21km beach front from south of Colliston to Aberdeen completes the section (JNCC, 2001<sup>6</sup>). Two sections – *Hill of Longhaven* and *Bullers of Buchan* - are designated SSSI due to their geological and biological interest, including the wide variety of granitic erosion features, heathland and wildlife habitats (JNCC, 1972<sup>7</sup>, 1984<sup>8</sup>).

At Peterhead the hard rock prevents major erosion or flood risks, and the sheltered Cruden Bay area is only affected by heavy storms, and is currently experiencing accretion. However, the soft nature of the open coastline of Aberdeen Bay, dominated by longshore drift driving sediment north, is experiencing erosion (University of Aberdeen, 2010<sup>9</sup>). The Potentially Vulnerable Area of Don mouth (SEPA, 2016<sup>10</sup>) is currently retreating at 2m/year, the Sands of Forvie National Nature Reserve and SSSI at 0.5m/year, and erosion of the coastal golf course frontage has led to coastal protection schemes (Fitton *et al.*, 2017<sup>11</sup>). In future erosional dominance is expected to continue to shift sediment north, with effects exacerbated by engineered defences interrupting the natural flow.

#### 4. How can the art imagery resources inform us of changes that have affected this coastal zone?

Important harbours and sea ports, such as Peterhead and Aberdeen, along this case study frontage, the information that can be gained from historical artworks more relates to patterns of development change rather than physical processes. The views, therefore, of both these sites show extensive waterfront development rather than details of shorelines and any natural hinterland. Again, the views of Slanes Castle illustrate particularly well changes that have affected this historic site over time.

## 5. Key issues that can be learnt from this site.

1. The case study locations illustrate development change over time rather than informing us of

coastal processes or environmental changes.

- 2. The imagery provides important records of the transition from coastal fishing ports to major industrial centres over time.
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Fig. CS10.35.-CS10.37. This sequence of views illustrates the coastal frontage at Peterhead on the north-east coast. The aquatint engraving (top) by William Daniell RA was produced in 1822 as he continued his 'Voyage Round Great Britain', down the eastern coast of Scotland. The sandy and shingle shore is visible in Daniell's view, backed by retaining walls of granite which protect the distinctive granite architecture of the city. The watercolour by David Addey (middle) (2001) shows how the waterfront has since become intensively developed, Addey's vantage point being from the cemetery, looking northwards across the bay. The two distinctive church spires can be seen, although the waterfront is now obscured by industrial buildings. The present day view (bottom) is taken from further to the south, but shows the sand and shingle foreshore with the two church spires visible in the distance.

Images courtesy of Fig. CS10.36. David Addey; Fig. CS10.37. © EN.Wikipedia.org.







Fig. CS10.38.-CS10.40. At the southern end of this frontage is the city of Aberdeen, which was visited by William Daniell in 1822. His view (top) shows the harbour busy with shipping and contrasts with the watercolour by David Addey (middle) (1999), which shows the intensive development of the waterfront with port and industrial buildings. The lighthouse on the right is on the site of the earlier building shown in Daniell's view. The present day view (bottom) shows, again, a view looking across the harbour mouth with the lighthouse structure (centre left) and the range of granite buildings occupying the waterfront. There is little to see of the existing shoreline, which, at the time of Daniell's visit, was the subject of continuously shifting sandbanks; the problem being remedied by the construction of Smeaton's Pier.

Images courtesy of Fig. CS10.39. David Addey; Fig. CS10.40. Anne Burgess © 2018. CC-by-SA/2 Geograph.org.uk.



Fig. CS10.41.-CS10.43. show views of Slanes Castle located on this rugged coast near Cruden Bay to the south of Peterhead. Constructed close to the high cliffline, the architectural depiction shown in Daniell's view (top) is guite different from the later structure painted in watercolour by David Addey (middle). The castle was extensively altered in the late seventeenth century and partially rebuilt in 1836. A large part of the castle was subsequently demolished in 1925. The sequence of images illustrates the changing fate of some of Scotland's coastal historical properties over the last 200 years, and form important records to support understanding of the changing coastal heritage of this coastline.

Images courtesy of Fig. CS10.42. David Addey; Fig. CS10.45. Bob Embleton © 2007.

# Case Study 10.5 – Broughty Ferry to St Andrews

## 1. Location

Broughty Ferry is a coastal town on the outer Firth of Tay, one of the few large estuarine inlets on the east coast. The section encompasses the Firth of Tay, inland of the coastline of the city of Dundee, and south as far as St Andrews lying in the bay sheltered by Fife Ness headland.

#### 2. Why was the Case Study Site selected?

The Firth of Tay is a partially urbanised large estuary, with Dundee and the small town of Broughty Ferry along its banks, built and populated by wealthy Victorians, giving it an affluent history. A succession of incidents involving the ferry and Tay bridges add tragedy to the history of the area (Barling *et al.*, 1996<sup>1</sup>). This coast has many designations including several SSSI, SPA and SAC sites, highlighting its value for native and migratory bird populations (JNCC, 2000a<sup>2</sup>) but also the unique prograding geomorphology of the coastline (Hansom, 2003<sup>3</sup>). It also includes National and Local Nature Reserves, and a wealth of listed buildings and scheduled monuments and densely populated towns located close to the shore. The Victorian history, bridges, large sandy expanses and reedbeds and the associated wildlife of international and national importance create a variety of potential artistic subjects.

#### 3. Summary of the Geology, Geomorphology & Coastal Processes

The study area lies south of the Highland Boundary Fault with bedrock characterised predominantly by Old Red Sandstone, intruded by large formations of extrusive lava and tuff, particularly on the southern bank of the Firth of Tay; some smaller intrusions of Gabbro can also be found on the northern bank (Hansom, 2003<sup>3</sup>). At the most inland point of the Firth, an outcrop of Carboniferous rocks lines the shore. At St Andrews Bay the dominant bedrock changes to Border and Strathclyde Groups, indicative of a change in the region's geology to Carboniferous groups (British Geological Survey, 2017<sup>4</sup>).

The north and southern coastlines of the outer firth are lined by sandy beaches up to St Andrews lying in a bay overlooked by Fife Ness headland. St Andrews is backed by the semi-enclosed Eden Estuary, and combined with the inner Tay estuary has some of the largest reedbeds in Britain, mud and sand dunes and saltmash areas (JNCC, 2000b) protected by SSSI and SPA designation. These features are indicative of a sheltered, low lying area of high deposition.

The majority of this coastline is stable or accreting in what is a dynamic area with large seawards advances occurring in the inner Firth encouraged by resistant geology on the southern shore and large sediment loads. The fastest accretion rates in Scotland occur in the Tentmuir area, building out extensively over the last 5,000 years (Hansom, 2003<sup>3</sup>) by the same post-glacial processes responsible for Culbin Sands at Nairn. The sediment supply is a combination of large river discharge load, offshore glacial sediments and longshore drift pushing up sediment from the south of the area, through the combined forces of wind and wave action. In future the small areas of erosion are expected to increase (Fitton *et al.*, 2017<sup>6</sup>). This may enhance the vulnerability of some flood risk areas such as natural heritage sites and golf courses, although accretion will remain dominant and the presence of coastal defences in populated areas reduces risk of inundation. The use of landfill waste in artificial claim areas has created additional contamination risks associated with any future erosional processes within the estuary (Mott MacDonald, 2011<sup>7</sup>).

#### 4. How can the art imagery resources inform us of changes that have affected this coastal zone?

The rich architectural heritage of the Dundee to St Andrews frontage is well illustrated through this case study, particularly showing images of the town of St Andrews from the harbour. Beach views of St Andrews from the mid-nineteenth century to the present day demonstrate that healthy beaches have existed at this location for the last 150 years.

#### 5. Key issues that can be learnt from this site.

1. Art imagery resources from this case study site provide a comprehensive record of coastal heritage sites including Broughty Castle and locations on the St Andrews frontage.

2. Images illustrate the maintenance of healthy beaches at St Andrews since the middle of the nineteenth century. Such records provide a baseline for studies examining coastal change and support the findings of '*Dynamic Coast*' (Fitton *et al.*, 2017<sup>6</sup>) in terms of only minor fluctuations in beach extent and volumes since the 1890s.

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Fig. CS10.44.-CS10.46.

illustrate Broughty Castle, a fifteenth century fortress, located at Broughty Ferry to the east of Dundee, at the mouth of the Firth of Tay. The view by William Daniell (1822) carefully depicts the architecture of the ruined building on its grassy mound. For many years an important coastal stronghold, the castle was improved in the middle of the nineteenth century and now stands in splendid isolation on its defended promontory.

Images courtesy of Fig. CS10.45. David Addey; Fig. CS10.46. Karen Vernon © 2009/Geograph.org.uk.



views of the coastal frontage in the vicinity of the city of Dundee. In July 1822 William Daniell passed along this coast and produced a detailed aquatint engraving (top) looking along the Firth of Tay. The 1822 watercolour (middle) by James Kinnear shows a more distant view of Dundee from Tayport, which lies on the south side of the Firth, with the city in the distance. The coastline here is much less developed in contrast to the north shore, which is developed intensively between Broughty Ferry to the east and Invergarrie to the west. The photograph (bottom) again shows a view looking along the Firth of Tay, this view is taken from the shore at Tayport, near the lighthouse, looking northwards across the Firth.

Fig. CS10.47.-CS10.49. show

Images courtesy of Fig. CS10.48. Lion & Turnbull; Fig. CS10.49. James Allen © 2012.



**Fig. CS10.50. (above) & Fig. CS10.51. (below)** show two contrasting views of the old pier at St Andrews. The view by William Daniell (1822) is taken from the end of the pier, with a range of historic buildings dramatically outlined on the skyline. The view by Myles Birket Foster shows the old pier from its landward end and was painted in watercolour in 1892. The contrasting views (overleaf) by David Addey and the present day photograph show the prospect from the end of the pier has changed little since Daniell visited there in 1822.

Image courtesy of Fig. CS10.51. Fine Art Photographic Library.





**Fig. CS10.52. (above) & CS10.53. (below)** show the same views of St Andrews from the pier by David Addey painted in watercolour in 1999 and the present day photograph (2012). The character of this part of St Andrews is well illustrated and provides an interesting chronology of the harbour and waterfront over the last two centuries.

Images courtesy of Fig. CS10.52. David Addey; Fig. CS10.53. Rob Farrow © 2012/Geograph.org.uk.









**Fig. CS10.54.-CS10.56.** show three further views of St Andrews but this time showing the extensive beach with the town behind. The view above was painted in watercolour in about 1890 by T. Hodge and shows the healthy state of the foreshore at low water. The watercolour by Brian Gerald (middle) was painted c.1930 and shows groups of holidaymakers picnicking amongst the sand dunes and on the beach, looking across the river mouth towards the town. The waterway divides two

extensive beaches, the West Sands to the north-west of the town and East Sands immediately to its east. The present day view (bottom) is also taken from a very similar location to fig. CS10.56. and appears to show relatively little change over the last 150 years.

Image Courtesy: Fig. CS10.54. © Bridgeman Images; Fig. CS10.55. Private Collection; Fig. CS10.56. Mike Pennington © 2014.



Fig. CS10.57. (above) & CS10.58. (below) show the ruins of St Andrews Castle which was constructed c.1200 and which occupied a commanding position on a rocky headland overlooking the waterfront. The painting by Brian Gerald (c.1920) (top) compares with the present day view (below) with the coastal ruins appearing to show comparatively little change.

Image Courtesy: Fig. CS10.58. G. Lord © 2017.



# Case Study 10.6 – Fife Ness to Wemyss

## 1. Location

The Fife Ness to Wemyss Coast is a short section of south-east orientated coastline to the north of Edinburgh, including settlements at East Wemyss, Coaltown of Wemyss, West Wemyss, Largo, St Monan's, Pittenweem, Anstruther and Crail. This was one of the most frequently painted sections of the Scottish coast on account of the many picturesque fishing villages.

## 2. Why was the Case Study Site selected?

Settlements along this coast were built around the natural resources of coal, fish and lobsters, fuelling historic mining and fishing harbours. This section of coast stands out in the way significant human activity has affected it over the centuries; in the traditional sense with sea defence walls and boulder revetments, but also from years of dumping colliery waste on the foreshore (Barne *et al.*, 1997<sup>7</sup>), causing significant but temporary accretion.

# 3. Summary of the Geology, Geomorphology & Coastal Processes

This relatively small section of coast is dominated by an outcrop of Carboniferous Coal Measures along the entire frontage. At Kirkcaldy this is replaced by Millstone Grit, a non-coal-bearing carboniferous sedimentary deposit forming 15m steep cliffs (Maritime Fife, 1997<sup>2</sup>).

This is predominantly a coastline of softer geology, in comparison to the more northerly case study sites, making it less resistant to erosive forces of the North Sea. Superficial Boulder Clays and glacial drift deposits also contribute to this less resilient coastline. The area includes the Firth of Forth SSSI, and East Wemyss is part of an Interest Location for Geological Conservation (Aberdeen Institute for Coastal Science and Management, 2004<sup>3</sup>). Human activity, specifically coal mining, has had significant effects on the geomorphology of the coastline.

Land subsidence of between 1-5m caused by mining (Gordon *et al.*, 2002<sup>4</sup>) and land filling with colliery waste from the Francis and Dysart Mines artificially advanced the shoreline between 86 and 50m at West and East Wemyss respectively (Maritime Fife, 1997<sup>2</sup>). Erosion has since removed much of this artificial accretion, requiring seawalls and revetments to be placed at points along this section of coast particularly at East Wemyss and Buckhaven (Hansom *et al.*, 2017<sup>5</sup>). The rapid removal of artificial deposits from the shore suggests erosion is the dominant process, assisted by the erodability of the unconsolidated sediments along the undeveloped and unprotected sections, which in future could put several heritage assets at risk, including Ravenscraig Castle and Garden, Designed Landscape, and the Listed remnants from the era of coal mining (Maritime Fife, 1997<sup>2</sup>). The section is also a designated Potentially Vulnerable Area partially due to the risk of coastal flooding (SEPA, 2016<sup>6</sup>).

# 4. How can the art imagery resources inform us of changes that have affected this coastal zone?

This part of the east coast of Scotland has a particularly rich art record illustrating changes that have affected the harbours and fishing villages since the mid-nineteenth century in particular. In practice many of these historic sites have changed very little over time, such as Crail, St Monans and Weymss Castle frontage. There are also a large number of beach scenes, which depict the nature of the beaches, the backshore and existing historical coastal defences and harbour walls, which provide a rich source of information for those examining long-term coastal change.

## 5. Key issues that can be learnt from this site.

- 1. The art record can provide a very valuable resource for those wishing to understand the coastal heritage of the many historic towns and villages along this coast.
- 2. The detailed depictions provided by nineteenth and early twentieth century artists provide a benchmark for the examination of coastal conditions and can support understanding of long-term coastal change by providing images in full colour, often extending back long before the days of black and white and, indeed, colour photography.

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Fig. CS10.59. 'Pitten Weem, Fifeshire' by Samuel Bough. Watercolour. 1874. Image courtesy of V. & A. Images © 2019.



**Fig. CS10.60. (above) & CS10.61. (below)** show the historic fishing harbour of Crail on the Fife coast, a short distance to the south-east of Fife Ness headland. The watercolour (above) was painted by Ernest William Haslehust RBA, who produced a number of illustrated guides for the publishers, Blackie & Son Ltd, including *'The Shores of Fife'*. There appears to be very little change to the nature of the harbour when the watercolour is compared with the present day view below.

Images courtesy of Fig. CS10.60. Private Collection; Fig. CS10.61. Ken Bagnall © 2009/Geograph.org.uk.





Fig. CS10.62. (above) & CS10.63. (below) show views of the coastline at St Monans which is located a short distance to the northeast of the village of Elie on the Fife coast. Once an important centre for boat building, the detailed oil painting by J. B.
MacDonald shows the coastal frontage in 1884. The painting depicts the rocky coastline and foreshore surmounted by a range of stone walls, which provide protection for the coastal properties, as well as for the church (on the left). The present day view (below) taken from an almost identical location, appears to show very little change along this shoreline, although there is evidence of some scour in front of the churchyard's seaward boundary wall compared with the 1884 painting. Works in oils, such as this by MacDonald, show the detail that could be achieved through this medium by the best artists, and which offer an exact illustration of change or lack of change over the last 140 years.

Images courtesy of Fig. CS10.62 © 1992 Christie's Images Ltd; Fig. CS10.63. John Allan © 2012/Geograph.org.uk.





Fig. CS10.64.-CS10.66. show further views of the church at St Monans. The view bottom left is, again, painted by Ernest William Haslehust RBA in about 1920 and shows the low boundary wall, which offers protection for the churchyard from coastal erosion. Despite its exposed position facing east, there appears to be relatively little change to the coastline over time, as illustrated in the two more recent photographs.

Images courtesy of Fig. CS10.64. Jim Bain © 2008/Geograph.org.uk; Fig. CS10.65. Private Collection; Fig. CS10.66. Derek Harper © 2008/Geograph.org.uk.







**Fig. CS10.67 (above)** shows a view of the old harbour at Largo, painted in 1891 by Alexander Young. Fishing was a vital part of the economy of the east coast of Scotland and there are numerous depictions of fishing fleets both at sea and in harbour, and these artworks collectively form a very important record of this important part of the country's coastal heritage. In its more sheltered position facing south, across the mouth of the Firth of Forth, Largo developed as a popular resort with the Victorians who built seaside villas along the coastal frontage. The present day view shows part of the beach which is backed by cottages and villas.

Images courtesy of Fig. CS10.67. Lion & Turnbull; Fig. CS10.68. Jerzy Hawkins © 2017.





**Fig. CS10.69. (above) & CS10.70. (below)** show the coastal frontage at Buckhaven on the Fife coast. The watercolour is by Ernest William Haslehust (c.1920) and shows the nature of the virtually unprotected shoreline with cottages lining the back of the beach. The view contrasts dramatically with the present day photograph, which shows substantial rock armour protection for the coastal frontage.

Images courtesy of Fig. CS10.69. Private Collection; Fig. CS10.70. William Starkey © 2014/Geograph.org.uk.









Fig. CS10.71.-CS10.73. & Fig. CS10.74.-CS10.76. (overleaf) show a sequence of views of the coastline in the vicinity of Wemyss Castle on the Fife coast. Fig. CS10.71 (top) shows the imposing castle with its view across the mouth of the Firth of Forth. The shoreline appears relatively stable and along the frontage in the foreground there appears to be a form of coastal defences. Fig. CS10.72. (middle) shows a similar view but painted from the shore by David Addey in 1999. Here the defences appear to have been

lost and some cottages are visible at the headland beyond the castle.

Along parts of the frontage stand boundary walls with elaborate architectural detail offered some degree of protection by rock armour defences (Fig. CS10.73 bottom).

Images courtesy of Fig. CS10.72. David Addey; Fig. CS10.73. William Starkey © 2014.





Fig. CS10.74.-CS10.76. offer three further views of the castle, this time the façade from the beach. Daniell's view of July 1822 (top) shows the frontage largely protected by a substantial stone wall, although this has been lost by the time David Addey painted the same scene in watercolour in 1999 (middle). The present day photograph (bottom) shows the wooded coastal slope and backshore today.

Images courtesy of Fig. CS10.75. David Addey; Fig. CS10.76. Jim Bains.



# Case Study 10.7 – Gullane to Tantallon Castle

## 1. Location

Gullane lies on the coast to the east of Edinburgh, on the outer reaches of the southern coast of the Firth of Forth. The study area follows the coast eastwards until the far edge of the headland after North Berwick where Tantallon Castle stands.

#### 2. Why was the Case Study Site selected?

Both the landscape and the cultural heritage along this coast to the east of Edinburgh are full of history. Coal measures, saltpans and herring harbours created bustling trade. North Berwick has seen sieges and battles over centuries – nearby Tantallon Castle was a Clan Douglas stronghold – and the town developed into a Victorian holiday resort with coastal golf courses. The coast to the west from Musselburgh to Luffness is designated a Potentially Vulnerable Area, with 380 properties in Musselburgh at medium risk from flooding, reflecting the changes being felt on this coastal frontage and the effects these changes could have. The case study site falls within the Firth of Forth SSSI and Special Protected Area. Scattered along the coast are remnants of World War II anti-tank defences and wrecked submarines, many eighteenth and nineteenth century Listed Buildings, churches, a dovecot and ruins. This diversity of cultural and natural heritage along a relatively short coastal section lent itself well to artists' brushstrokes from the late eighteenth century onwards.

#### 3. Summary of the Geology, Geomorphology & Coastal Processes

The bedrock of this region was laid down during the Carboniferous Period, running in a changing sequence from west to east. Musselburgh to the west sits on a bed of Coal Measures, emplaced in a wider area of Millstone Grit which continues to Aberlady at the eastern side of Gosford Bay, where it is replaced by a thin section of Border and Strathclyde Group of similar sedimentary compilation. The headland from Gullane Point to North Berwick consists of felsic and mafic extrusive igneous rocks formed during the Variscan magmatic period. East of North Berwick a small outcrop of Basal Carboniferous rocks reappears in a continuation of the previous sequence (British Geological Survey, 2017<sup>1</sup>).

This coast straddles the developed Inner Firth and partially the Outer Firth, marked by the change in orientation of the coast from north-west to north and north-east (Scottish Natural Heritage, 2017<sup>2</sup>). The coastline is made up of rocky shores interspersed regularly with pocket bays with wide sandy beaches set between headlands.

On the shore of a large estuarine area, there are many interconnected processes at work. The tidal current flows west to east parallel to the southern coast of the Firth, concurrent with the prevailing wind direction, influencing the direction of sediment transfer (James, 1996<sup>3</sup>). Aberlady Bay is one of the only areas of significant deposition accreting at 15m/year between 1990-present, in part due to the onshore wind direction; whereas Gullane and east of North Berwick are identified as erosion hotspots due to greater exposure and offshore winds removing sand sediments; North Berwick itself has maintained a stable position (Hansom *et al.*, 2017<sup>4</sup>).

## 4. How can the art imagery resources inform us of changes that have affected this coastal zone?

There are numerous artworks for the Gullane to Tantallon Castle frontage, which illustrate the nature of both the rocky open coastlines and beach conditions, such as those at Gullane and North Berwick. These images describe both the nature of the shoreline over time as well as its coastal heritage. The rocky coast with views looking out towards the Bass rock was a favoured subject for topographical artists, whilst others painted ancient ruins such as the chapel on the beach at North Berwick (**Fig. CS10.81. overleaf**). The dramatically located Tantallon Castle was one of the most painted Scottish coastal buildings (see **Fig. CS10.86.-CS10.88. overleaf**).

#### 5. Key issues that can be learnt from this site.

The art imagery along this study site coast tends to depict a rocky shoreline with views out towards the Bass Rock. Golfing views can provide more information as they often show the links and adjacent

beaches as a backdrop (e.g. Fig. CS10.79.).

Historical imagery such as those of the ruined chapel on the beach at North Berwick and of Tantallon Castle provide possibly the only records of some structures or changes to those structures such as deterioration as a result of weathering and erosion. Tantallon Castle was painted by many artists and their artworks illustrate the gradual weathering of this structure since the early nineteenth century.

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Fig. CS10.77. 'The Bass Rock from Canty Bay' by Michael Bouquet. Lithograph. 1849.



Fig. CS10.78.-CS10.80. (overleaf) show views of the coastline between Gullane Bay and Tantallon Castle to the east of north Berwick. This coastal frontage, is bounded on the west by the Aberlady Bay Nature Reserve and in the east by the Tantallon Castle ruins. This part of the Scottish coast was painted extensively both on account of the dramatic rocky coastline with the Bass Rock offshore and also because of the popularity of golfing, and many artworks show the sport taking place immediately adjacent to the coast. Fig. CS10.78. (top) shows a view of the Bass Rock with fishermen or seaweed gatherers working along the shore and was painted by David Farquharson ARA ARSA RSW in 1884. It is typical of the popular coastal scene paintings of this period. Fig. CS10.79. (middle) shows a view from the North Berwick Golf Course looking eastwards towards the town and painted in watercolour by J. Michael Brown, who was renowned for this type of subject. Probably painted c.1900, the view shows the extensive beach at North Berwick, with the town and Bass Rock beyond. The photograph (bottom) shows a view of North Berwick East Beach at Low Water looking towards the harbour.

Images courtesy of Fig. CS10.79. Sotheby's; Fig. CS10.80. Private Collection.



**Fig. CS10.81. (above)** shows the ruined chapel on the beach at North Berwick painted in watercolour by the artist, Francis Grose (1731-1791). Grose travelled extensively around the British coast producing views of topographical and architectural subjects in watercolour. Works such as this provide valuable records of lost heritage and may provide the only records available long predating the introduction of photography. **Fig. 10.82. (below)** shows a further view of the west beach at North Berwick, which has experienced periodic depletion and recovery in its relatively exposed position facing northwards out across the Firth of Forth.

Fig CS10.81 image courtesy of the Royal Scottish Academy, Edinburgh.







**Fig. CS10.83.-CS10.85.** show three views of the Bass Rock located a short distance off the coast at Tantallon Castle.

Fig. CS10.83. (top) was engraved by William Daniell RA on his coastal voyage in 1822. It shows fishermen at work on the shore in the

foreground, with the dramatic rock beyond. The core of this ancient volcano, with its perpendicular cliffs, is most famous for its gannetry and habitat of a wide range of other sea birds. The view of the Bass Rock was captured by David Addey in watercolour in 1999 (middle). The photograph (bottom) shows the view of the Bass Rock taken from the ramparts of the ruined Tantallon Castle and shows no apparent change to the nature of the Bass Rock over time.

Image courtesy of Fig. CS10.84. David Addey.





#### Fig. CS10.86.-CS10.88.

shows Tantallon Castle, which was commenced in the fourteenth century and is perched precariously adjacent to the cliff edge. William Daniell's view (top) was engraved in 1822 and shows the castle from the north-west. David Addey's view (middle) is taken from the shoreline to the northeast of the castle. Compared with Daniell's view the castle

is now in a ruinous state, although open to the general public. The present day view (bottom) is also taken from the shore, replicating David Addey's watercolour.

There are numerous views of Tantallon Castle on account of its majestic appearance and, collectively, these provide a record of the changes affecting this historic building since the late eighteenth century.

Images courtesy of Fig. CS10.86. David Addey; Fig. CS10.88. Mike Pennington © 2016/Geograph.org.uk.

Fig. 5.1. (overleaf) 'Tintagel Castle' by William Trost Richards. C.1880. Watercolour.

Image courtesy of Bridgeman Images.