Preface

Durham's Heritage Coast has an amazing wealth of wild, natural beauty fashioned by the sea and the ice of tens of thousands of years. Its uniqueness stems from a combination of these powerful forces of nature with the Magnesian Limestone rock that they have sculpted. The result is a coastline of rocky shores, sandy beaches and dunes, cliffs topped with grasslands rich in wildflowers and teeming with insect life cut occasionally by deep gorge-like wooded valleys, damp with ferns and mosses and full of animal life.

This pack is intended to help primary teachers get the most out of this unique resource on our doorstep. It contains plenty of background information for teachers to assist with planning and understanding of the topics and a series of activity programmes for both Key Stage 1 and Key Stage 2 pupils, along with supporting resources.

The information will assist with the delivery of a structured approach to exploring the many educational opportunities presented by Durham's Heritage Coast. The pack will enable initial informing with basic key concepts followed by “hands on and minds on” activities that develop understanding, assimilation and reinforcement of the ideas, and finally the application of new-found knowledge and understandings.

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What is a Heritage Coast?

Heritage Coasts are areas of special scenic and environmental value. There are 43 defined Heritage Coasts in England and Wales. The definition is intended to protect these valued areas from undesirable development.

Durham Heritage Coast extends south from Salterfen Rocks near Sunderland to the northern boundary of Hartlepool Borough. It includes stretches of unspoilt cliffs with amazing views, wonderful sandy beaches and dunes, fantastic rockpools, majestic woodland denes, globally rare grasslands and nationally scarce or rare plants and animals.

It is managed by a partnership comprising representatives of:
Durham County Council, Easington District Council, Hartlepool Borough Council
City of Sunderland, Countryside Agency, Environment Agency, English Nature
National Trust, Durham Wildlife Trust, Groundwork East Durham, Northumbrian Water
Blackhall Regeneration Partnership, Horden Regeneration Partnership, Easington Regeneration Partnership, Ryhope Development Trust, Seaham Town Council

How to use the pack

The pack is intended for use by primary schools wishing to explore the coastal environment, its ecology, its rich animal and plant life, cultural history, landscape, geology and geography. It consists of three main sections: the first section contain teacher's background information on each of the twelve topics covered; the second section contains activity programmes for the twelve topics aimed at both KS1 and KS2; the final section contains resources to assist with the learning and exploration process. It is hoped that the pack will provide a platform from which teachers can develop further educational use of the tremendous resource that is offered by Durham Heritage Coast.

Teacher's Information (Section 1)

These information sheets give teachers sufficient information to be confident about the subject. They also signpost more detailed information to enable investigation of the subject at a deeper level.

The teachers information sheets include:

- background notes on the topic
- information for use by the teacher to introduce the pupils to the key concepts with visuals where appropriate
- national curriculum attainment targets and links to reference materials and other sources

Activity Programmes (Section 2)

These contain suggested activity programmes for both Key Stage 1 and Key Stage 2.

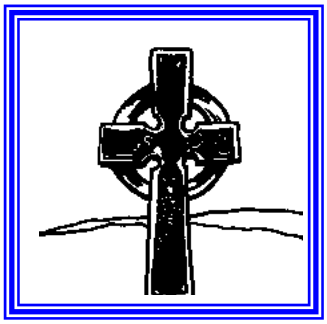
The aim of the activity programmes is to:

- inform the pupils of the key concepts (see teachers information sheets)
- allow assimilation of the concepts through the structured activities
- reinforce their knowledge by application during the activity programme or in the follow-up activities

Resources (Section 3)

This section contains diagrams, drawings and other materials to support the information presented in Section 1 or for use during the activities in Section 2. There is also a CD containing useful images and other resources. (Please request this from Durham Heritage coast)

1.1 Prehistoric to Pre-industrial



The Durham Heritage Coast has seen many changes over time, both in its geology and human occupation. Before 8,000BC the area was covered by a thick ice cap so no people inhabited the area, but as the ice cap melted people started to move in and settle.

Mesolithic and Neolithic

Little is known about the early human history of the area as later human activity has destroyed the evidence. However, it appears that the area was a centre of activity during the Mesolithic and Neolithic periods.

Numerous flint tools and weapons have been found along the coast. In fact the Durham coast is the only area in County Durham to have yielded such a large collection of flints. Key pockets have been found at Hawthorn, Seaham, Easington, Horden Blackhall Rocks and Beacon Hill. This indicates that the coast was very important to these early people as it provided food from the sea and surrounding land, shelter and protection.

Their dwellings would have been simple and easily erected as they were hunter gatherers, constantly moving around to find food. They would have been made from wood and rushes which rot easily so often nothing remains of them, or they may have used natural caves. One particularly significant find of this period is a Mesolithic hearth found at Crimdon Dene which proves they used fire to cook and keep warm.

In the latter part of the Neolithic, large areas of forest were cleared to make way for more permanent settlements. It is also believed that the people started to farm the area for the first time and build burial barrows and monuments. These barrows were oblong burial mounds which could contain many graves. The graves often included grave goods such as flints and skins etc which were to see the deceased into the afterlife.

Bronze Age

Again little evidence remains from this period in time due to later disturbance. There is no evidence of a massive disaster in the area at this time so it is safe to assume that people did live in the area then in much the same way as during the Neolithic period.

Bronze Age arrowheads have been found in Crimdon Dene not far from the Mesolithic hearth indicating continuous settlement in that area. Although metalwork and pottery have been found, evidence of buildings or large settlements is still missing. Burial barrows exist at Seaham and Peterlee which include cremations and full burials. Bronze Age barrows were different to Neolithic ones in a number of ways. Firstly they tended to be round rather than oblong and most contained only one grave or a small number indicating a possible family barrow.

These graves included Beaker pots which were a type of pottery found only at this time in history and are often used to date the barrow. This indicates a social change with the development of a social hierarchy within the settlements and the celebration of individuals rather than a group as a whole.

Iron Age

Settlement evidence from this period is again missing from the Durham coast but as settlements have been found to the north and west of the coastal strip, it is safe to assume that occupation did occur but all trace has been lost through agricultural and industrial processes.

When there is no structural evidence, archaeologists often rely on crop marks to prove people lived there. These marks show up on aerial photographs and are caused by the different soil found in post holes or wall foundations. Unfortunately the Magnesian Limestone of the area is not conducive to the formation of crop marks so making finds is very much a hit and miss affair.

The settlements would have been more substantial than those of the Bronze Age with individual farmsteads being enclosed by ditches and palisades.

Roman

Yet again finds from this period are few and far between and very few excavations have taken place to pin point Roman activity along the coast. Roman finds have been uncovered at Seaham including coins and pieces of Samian ware. This is classic Roman pottery, terracotta in colour and highly decorated with friezes showing Roman life. The pottery was imported from Gaul and was expensive so any one who had it was well-off and of high status.

Roman finds have also been made at Blackhills Gill which includes lower status blackware pottery, bowl fragments and a probable Roman knife handle.

The Roman presence in northern Britain is mainly military, supporting garrisons at Hadrian's Wall with a series of forts and staging posts the full length of the country. Beacon Hill is ideally situated to act as a signalling station being 85m above sea level; it is believed it got its name because a Roman beacon was situated on it.

Anglo Saxons and Vikings

After the Romans left, Britain went through a period of great change and invasion. The first to invade were the Angles from Denmark and the Saxons from Germany in the 5th century. Many Britons noticed little change, particularly in the North but later more invasions resulted in Britons being forced off farms and made into slaves. Christianity came to Britain during Roman times and it had taken quite a hold. With the coming of the pagan Anglo Saxons, Christians were forced to flee to Wales and the west.

Farming was very important at this time and evidence of ridge and furrow earthworks can be seen from Beacon Hill. These ridges are caused by ploughing strips of land again and again resulting in the soil piling up into ridges and are indicative of this period. Ploughing and the allocation of land was a community activity showing that these communities were socially interactive and co-operative.

By this time most of Britain was pagan again, worshiping many different gods brought over by the Anglo Saxons. An Anglo Saxon pagan cemetery has been found at Andrew's Hill at Easington which included some glass beads and brooches. Much of the area has been heavily ploughed in the past so little else remains.

In the 7th century the two kingdoms of Bernicia (N. Northumberland) and Deiria (S. Northumberland) united which led to a period of stability. The powerful kingdom soon became Christian and churches and monasteries were built all over the area. It was through monastic settlement that trade and political contact was maintained with the outside world and the monastery often became the focal point for the local market. The cemetery near St Mary's church at Seaham dates to the middle of the 7th century and was still being used up to the middle of the 9th century. The nave of the church is from the late 7th or early 8th century. 8th and 9th century carvings can also be seen in St Mary's church at Easington and St Andrews at Dalton-le-Dale.

The Kingdom's power declined in the 9th century with the coming of the Vikings from Scandinavia. They brought with them new pagan gods and settled in the north.

Despite there being little solid evidence of Anglo Saxon and Viking settlement, it is obvious they were here due to the place names. Both groups had specific words

meaning farm, village, hill etc. and they were put at the end of people's names to show who places belonged to etc. These place names still exist today. Easington is Esa's family homestead and Seaham means homestead of the sea in Anglo Saxon.

During the 10th century Christianity became the major religion of Britain. Many churches were built at this time and Anglo Saxons and Vikings united to create England.

Medieval

The Norman invasion of 1066 further united England and Christianity grew from strength to strength. Early churches were added to and made more impressive. St Mary's church at Easington dates from the 12th century but a stone cross of an earlier date has been found indicating an earlier church existed there. The church stands on a natural rise and was probably used by sailors as a landmark.

Seaton Holme was also important in the Medieval period with the remains of a late Anglo Saxon building followed by a manor house. This was used by the Bishops of Durham and it is believed to have been the home of Nicholas Breakspear who became the only English pope under the name Adrian IV in the early 12th century. Medieval evidence can also be seen at Hawthorn where traces of an early building can be seen as earthworks to the south of the modern village. It is also possible that some of the existing field boundaries in the area date to the 12th and 13th centuries.

From the 11th century onwards, northern England was dominated by wars with the Scots which continued into the 14th century. Large numbers of castles and pele towers were built at this time. Pele towers were stone defence towers with walls 1 to 3m thick and 3 storeys high. The ground floor was for storage and animals, the first floor had a kitchen and hall and the top floor was for living and sleeping. The roof was flat and had battlements for protection. The tower was designed to withstand short sieges.

There are the ruined remains of a pele tower at Dalden Tower near Seaham. In the south east corner on the first floor level there are the remains of a small niche next to the fire place decorated with 2 small shells, dating to the 14th century. There is a wall running north from the tower and a bank and ditch defence to the north and north-west. This is a Scheduled Ancient Monument protected by law. In 1349 the plague or Black Death hit England and spread rapidly through the country. Many villages were wiped out or just deserted as people tried to get away. This is probably why very little evidence exists for early settlement in the area as the settlements were probably widespread to start with. New villages started to spring up in other places, always with a church at their centre and these can be seen all over the Durham coast area.

Key Concepts

Chronological order

The past is split into periods of time starting with the oldest moving forwards to the present. Each period has a start date and finish date and is given a name to identify it. Below are the time periods covered in this section and their dates.

Mesolithic	8,000 to 4,000BC
Neolithic	4,000 to 2,000BC
Bronze Age	2,000 to 750BC
Iron Age	750BC to 75AD
Roman	55AD to 406AD
Saxon/Viking	406 to 1066AD
Medieval	1066 to 1485AD

People in each period had different houses, clothes, work and possessions etc.

Evidence of the past

Even though things happened 1,000's of years ago we can still see what they were like by the evidence left behind. The evidence can be as simple as the names of places relating to what happened there for example Beacon Hill suggests a beacon was placed here.

Also the name endings can tell which people started the village.

holm – Viking for island formed by a river
by – Viking for village
wick – Anglo Saxon for farm
aycliffe – Saxon for oak clearing
don – Anglo Saxon for hill or peak
ham – Anglo Saxon homestead
ing – Anglo Saxon for family group
ton – Anglo Saxon for farmstead

So Seaham means homestead of the sea and Easington means Esa's family farmstead.

Other evidence can be in the form of ruined buildings, bits of pottery, jewellery, bones etc. These often have to be excavated as they are usually hidden under the ground.

Each time period has different types of building and pottery so you can tell what happened in a place, and when, by which type of building or pottery you find.

Flint arrow heads – Mesolithic and Neolithic
Simple pots – Bronze Age
Round barrows– Iron Age
Samian ware – Roman
Cremation urn - Saxon
Churches – Medieval

Continuous occupation

If you find things from different time periods in the same place then it shows that it was inhabited over a long period of time without gaps. This is called continuous occupation.

For example finds in Seaham have found people have lived there for 1,000's of years:

Flint from the Mesolithic to the Bronze Age
Round burial barrow from the Iron Age
Coins from the Romans
St Mary's church from the Anglo Saxons
Headland monastery from the Medieval
Mine and harbour from the Victorians

Importance of religion

In prehistoric times people worshiped the sun, stars, moon and the earth; stone monuments were built to worship at.

The Romans too had their own gods such as Vesta, Janus and Mithras. Many Britons started to worship them as well as their gods. Christianity came to Britain in the Roman times but when the Anglo Saxons and Vikings came that changed.

The Anglo Saxons and Vikings worshiped other gods with names such as Tiw, Woden, Thunor and Frigg which give us our Tuesday, Wednesday, Thursday and Friday. And the Saxon spring goddess of Eostre was turned into the Christian Easter.

Christianity came back in the late part of the Viking time and became the main religion of the country very quickly. Many churches around today were started at this time and then built on and made bigger as time went on.

Curriculum Links

History		
KS1 AT Levels 1 - 3		
1 – 5, 6b		
KS2 AT Levels 3 - 6		
1 – 9		
Science		
KS1 AT Levels 1 - 3		
Sc1 *1,2a-c*	*Sc2* *1,2b,5b*	*Sc3* *1*
KS2 AT Levels 3 - 5		
Sc1 *1b,2bcfh*	*Sc2* *1*	
Maths		
KS1 AT Levels 1 - 3		
Ma2 *1,2ac,3a-c,5*	*Ma3* *1bcd,3ac,4ac*	
KS2 AT Levels 3 - 5		
Ma2 *1ace-h,2afhlj* *3aegj*	*Ma3* *1ae,2a,4abe*	*Ma4* *1,2bcf*
Art & Design		
KS1 AT Levels 1 - 3		
1-5		
KS2 AT Levels 3 - 5		
1-5		
Geography		
KS1 AT Levels 1 - 3		
1,2,3a-d		
KS2 AT Levels 3 - 6		
1,2a-f,3a-d,4		
English		
KS1 AT Levels 1 - 3		
En1 *1-11*	*En2* *1-7*	*En3* *1-12*
KS2 AT Levels 3 - 6		
En1 *1,2,3a-d,4-11*	*En2* *1-9*	*En3* *1-12*
ICT		
KS1 AT Levels 1 - 3		
Full curriculum		
KS2 AT Levels 3 - 6		
Full curriculum		

Places to visit

Seaham

St Mary's church

Crimdon Dene and Beach

Lime Kiln Gill
Prehistoric finds

Cold Hesledon and Dalton le Dale

Ridge and Furrow
Pele tower
Medieval buildings

Easington and Beacon Hill

Ridge and furrow
View point

Hawthorn Hive

Limestone quarry
Lime kiln
Farming

Links to other sections in this pack

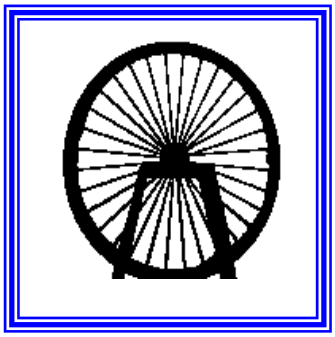
Geology and the Landscape 1.3
Geology and People 1.4

Resources

Books
History of Britain Series – Romans, Anglo Saxons and Vikings

Websites
www.durham.gov.uk
www.seaham.com/heritage/dig99
www.thenortheast.fsnet.co.uk
www.durhamheritagecoast.org
www.pastperfect.info
www.peletower.freeuk
www.4front.cw.net/Highnam/FarmingRidgeandFurrow
www.northumberland.gov.uk
www.britainexpress.com/history/Roman_Britain
www.bbc.co.uk/education/anglosaxons
www.bbc.co.uk/history/ancient/vikings

1.2 Industrial



The County of Durham is best known for its coal industry but it was not the only industry in the area through the centuries.

Lime

The first main industry to develop in the area was the lime industry which involved quarrying the rich sources of Magnesian Limestone found in the area. One notable quarry site is at Hawthorn where the exposed faces of the disused quarry can still be seen. It was started in the Medieval period but expanded in the 19th and 20th centuries. Medieval farmers discovered that lime increased the fertility of soil and made crops grow better. This was needed to feed the growing population.

The lime process is really very simple. The limestone was taken from the quarry to the lime kiln were it was heated to extract the lime or quicklime. In Medieval times lime kilns were only 3-4m high with alternate layers of brushwood fuel and limestone right to the top of the kiln. The kiln was then covered by turf and left to burn for a week. Once the quicklime had been formed it was slaked to make it into a powder for spreading. This involved adding water to the quicklime which produces a violent reaction; heat, steam and calcium hydroxide. This was a very dangerous process which could cause severe burns and blindness. The resulting lime was then used as fertiliser or added to mortar to make it stronger so larger buildings could be built. It took 21 tonnes of limestone to make 1 tonne of quicklime which would cover 2.5 acres of land.

In the 19th and 20th centuries the need for lime increased dramatically for agriculture, chemical processes and iron working. This led to coal becoming the fuel for the kilns as it burns at a lot higher temperature. It also meant the kilns could be made much larger and more efficient. The best preserved lime kiln is at Hawthorn Hive. It is from the 18th century and you can see how it was built into the cliff using stone and brick arches which can still be seen. Other kilns existed in the area suggested by names such as Limekiln Gill at Crimdon and Horden.

Iron and Chemicals

Iron production started back in the Iron Age on a very small scale using fires and bellows. The need for iron during the Industrial Revolution meant that more needed to be made quickly. To produce iron you need to heat ironstone to very high temperatures to melt it and extract the iron. In the 19th century coal was used to heat the furnaces so you often find iron works close to pits. This was the case at Dawdon where an iron works was built near the Seaham pits in 1860. This way the coal could come straight from underground and into the iron works.

In 1835 before the iron works, there was a glass works at Dawdon which used sand and coal to make glass bottles. These were exported through the port at Seaham. A chemical works was built in 1865, again using the coal from the local pits.

These industries had a big impact on the local area, creating 100's of jobs but also a lot of pollution from chimney stacks and waste. It is thought that the name Blast Beach comes from the fact that clinker waste was dumped there from the iron works. It could also have derived from the

fact ships emptied their ballast here before taking on their cargoes of iron and coal at Seaham.

All these factories were serviced by the aptly named Ballast Railway and Blast Furnace Branch line which took the coal to the iron works and products to Seaham harbour for transport abroad. Much of the iron went to the ship yards at Sunderland but there were also shipyards at Seaham though on a smaller scale.

Coal

Coal has probably had the biggest impact on the Durham Heritage Coast area as it was part of the oldest intensive coal mining district in the North East.

Archaeological evidence in other parts of Britain show that the Romans mined coal as did the people in the Medieval time but these were on a very small scale and involved coal near to the surface. Mining in west Durham did exist in the 13th and 14th centuries and the Bishops of Durham controlled all mining activities there.

Coal in the east Durham area was discovered in 1811 at Haswell, but it is situated below layers of boulder clay and Magnesian limestone several thousand feet thick in places. This meant that it could not be mined until technologies had been developed to enable very deep shafts to be built, water to be pumped out of these shafts and the coal to be brought to the surface. This did not happen till steam engines were developed.

The first pit was sunk in the 1820's at Haswell but it was not until 1838 when the first large pit was opened at Murton. By 1890 this pit was producing 3,000 tonnes of coal and employing over 2,000 people. At its height in 1925 over 3,600 people worked at the mine but it closed in 1991.

Not only men worked at the mine in those days, women often worked on the surface on the spoil heaps and children as young as 6 years old often went underground. They were employed to pull small coal wagons on metal tracks through the pits to the large cages used to take the coal to the surface. They also operated the tunnel doors and bellows which circulated air round the pits. They often spent 12 hours a day 6 days a week in the pits and didn't go to school. Many of the passages were narrow and low so most miners spent 12 hours a day bent double working only by candlelight. This often led to back problems and blindness that meant they couldn't work any more. Because there was no social security in those days this meant that these people had no money at all and many lived in extreme poverty.
It wasn't only people who worked down the mines, ponies were also used to pull coal wagons. These were Shetland-like ponies bred for their small size and great strength, able to pull 1 tonne of coal each. These ponies often never saw the light of day from the moment they entered the pit until they died; as the stables were underground and when they became too old to work they were just put down. Pit ponies continued to be used well into the middle of the 20th century. Conditions for them were much improved and when they became too old to work they retired into the sunshine at special pit pony sanctuaries.

Mining was a very dangerous job due to flooding, roof falls and explosions due to gas escapes as the coal was mined. Many disasters are recorded in local churches but one of the worst happened at Seaham in 1880 when 164 people died, the youngest being only 14, as well as 181 pit ponies due to an explosion underground.

The first Seaham colliery was sunk in 1849 and was owned by the Londonderry family headed by Lord Londonderry. This pit had several local names including the Nack and Nicky Nack. At its height in 1914 over 3,000 people worked there. The Vane Tempest pits, named after Lord Londonderry's wife's family, were developed in 1923 and 1928 to get at the northern part of the Seaham measures. Most of these measures lie under the North Sea and the pit workings extended 5km out under the sea.

Most of the pits were owned by wealthy land owners and business men who built large houses for themselves and didn't treat the workers very well at all. However Vane Tempest pit was very advanced for its time as it took miners welfare very seriously. Pit head baths were built in 1937 and a canteen and medical centre added in the 1940's and 50's. This pit and the Seaham colliery were merged in 1988 before they were all closed in 1992 with the loss of 1,100 jobs.

Other pits to be developed in the area were Easington 1899 to 1993, Dawdon 1907 to 1991 and Blackhall 1909 to 1981. The last pit to be built in the area was at Hawthorn in 1960. It was built to bring coal from the Murton, Eppleton, Horden and Elenore pits and was closed in 1992.

The rapid growth in the coal industry changed land use and settlement patterns in the area. Many of the current towns were mere villages at the start of the 1800's but the need for housing for the 1,000's of miners and their families meant that these villages quickly became the mining towns we see today. One of the biggest changes was around the Seaham area where the Londonderry family built the harbour and the town purely to accommodate their coal industry needs.

Railways

The development, by George Stephenson in the 1820's, of the first passenger railway, had a dramatic effect on the Durham Heritage Coast and its ability to develop its coal industry. Steam engines had been used to bring coal to the surface and pump water from the pits for a long time but now the new generation of engines could do a lot more work and the steam trains could pull enormous weights of coal all around the country.

Most of the local railways were set up to transport coal, for example the South Hetton railway was built in 1835 and transported coal from the pit to Seaham harbour. This railway has a quite significant incline down to the harbour so it used a tandem gravity incline engine system that controlled the speed of the full coal wagons going down whilst at the same time bringing up the empty wagons making it a lot more efficient.

Many of the mine owners demonstrated their wealth by not only building railways but also building private railway stations that only they could use. Londonderry Station is very close to Seaham Hall station but whereas Seaham Hall transported coal Londonderry was only for use by the Londonderry family and their friends. The remains of another private station can be seen at Hawthorn Halt where the Pemberton family had their home. They could stop any train and get it to take them to any other station on the line.

The railway lines criss-crossed the countryside transporting miners and coal and connecting towns with the main lines enabling people to go to London and Newcastle more easily. Most of these old railway lines are now disused with many having disappeared under recent development. However you can see where some used to be as they show up as straight pathways cut down into the landscape with uniform width along their length. One such example is the South Hetton railway which is now a public walkway.

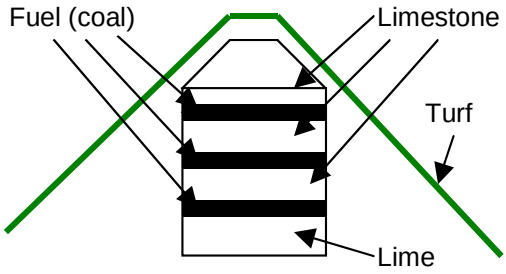
Key Concepts

Limestone

Limestone is a rock made up of tiny shells and skeletons of sea animals. These shells and skeletons sank to the bottom of a warm sea and other things settled on top of them. Eventually the weight of the things on top of them squashed them and turned them into rock. Its chemical content is calcium carbonate and it is millions of years old.

If you put an acid onto limestone it will dissolve and give off carbon dioxide and if you heat it you get lime. This is done in a lime kiln and the lime can be used as a fertiliser and to make building mortar stronger.

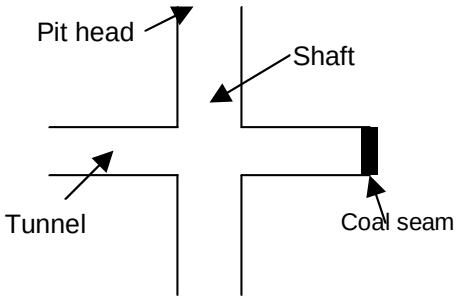
Lime Kiln



Coal

Coal is formed from plants, which died millions of years ago and other things settled on top of them. Eventually the weight of the things on top of them squashed them and turned them into rock.

In Durham coal is found deep underground. It is found in horizontal seams and to get to it vertical tunnels called shafts are sunk. Tunnels are then dug off these shafts right into the coal seams. Places where coal is taken out of the ground are called pits, mines or collieries.



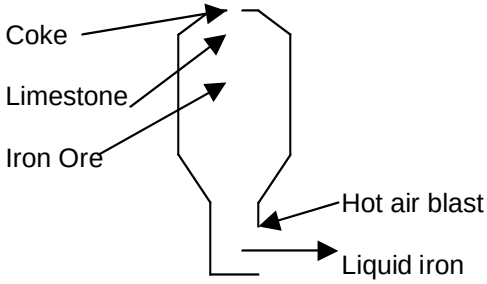
Iron

Iron is a metal which can be melted and moulded into different shapes. It is very strong and can be used for building many different things. It comes from iron ore.

Iron ore is found in certain types of rocks in small amounts and is quarried from the ground. The rocks are full of other things besides iron, which forms only part of the rock.

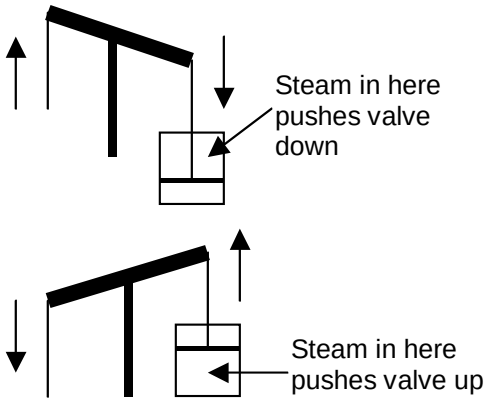
The iron is taken out of the rock by heating it to very high temperatures, using coke, and adding lime to melt it and take out all the impurities to give 98% pure iron. All this happens in a blast furnace.

Blast Furnace



Steam

It took a lot to get coal out of the ground as it was so deep and heavy. It was much easier when steam engines were developed. These machines use coal or coke to heat water into steam. This steam is then pushed through small pipes very fast so it can push levers or turn wheels easily. These are then used to pump water, wind cages or pull large loads.



Curriculum Links

History		
KS1 AT Levels 1 - 3		
1 – 5, 6b		
KS2 AT Levels 3 - 6		
1,2acd,3,4,5,7		
Science		
KS1 AT Levels 1 - 3		
Sc1 1,2abegi	*Sc2 1a*	*Sc3 1,2b*
KS2 AT Levels 3 - 5		
Sc1 1,2abcgjkl	*Sc3 1ad,2abcdf*	*Sc4 2bcd,3 abc*
Maths		
KS1 AT Levels 1 - 3		
Ma2 1ace,2bc,3ab, 4a,5ac	*Ma3 1a,3bc,4*	
KS2 AT Levels 3 - 5		
Ma2 1acek,2afhl 3bkl	*Ma3 1a,2a,3a,4a*	*Ma4 1acf,2a bcf*
Art & Design		
KS1 AT Levels 1 - 3		
1,2,3a,4ab,5abc		
KS2 AT Levels 3 - 5		
1,2,3a,4ab,5abc		
Geography		
KS1 AT Levels 1 - 3		
1c,2ace,3ac,4, 5b,7a		
KS2 AT Levels 3 - 6		
1c,2a-f,3acde,4, 5a,6a,7a		
English		
KS1 AT Levels 1 - 3		
En1 1-11	*En2 1,2,3adf,4, 6acg,7*	*En3 1-12*
KS2 AT Levels 3 - 6		
En1 1-11	*En2 1,2acd,3,4abf 5,6,8f,9*	*En3 1-12*
ICT		
KS1 AT Levels 1 - 3		
Full curriculum		
KS2 AT Levels 3 - 6		
Full curriculum		

Places to visit

Seaham

- Harbour,
- Iron works
- Railway
- Blast Beach

Crimdon Dene

- Lime Kiln Gill

Cold Hesledon and Dalton le Dale

- Railway winding engine and pumping station

Easington and Beacon Hill

- Railway
- Station
- Colliery

Hawthorn Hive

- Limestone quarry
- Lime kiln

Links to other sections in this pack

Geology and the Landscape 1.3
Geology and People 1.4
People and the Coast 1.5

Resources

Books

Durham Coastal Footpath leaflet

Websites

www.durham.gov.uk
www.thenortheast.fsnet.co.uk
www.durhamheritagecoast.org
www.keystothepast.info
www.dmm.org.uk
www.slaidburn.org.uk
www.limekilns.org.uk
www.monktoncoke.com
www.indiggroup.co.uk/durhamdialect
www.seaham.i12.com/sos/dockrailways

1.3 Geology and the Landscape

At one time or another the place that is now Co. Durham has been subjected to every climate on Earth. This has produced the landscape we now see.

The Earth is approximately 4500 million years old. For much of this time the planet's land surface was a barren, desolate, rocky landscape. The processes that operate now however were also operating then. The present is the key to the past when looking at rocks and the forces at work that have formed our landscape. The processes of erosion and deposition we see now have been operating for billions of years and have helped produce the beautiful coastal landscape of County Durham.

Types of Rock

There are three main rock types: igneous, sedimentary and metamorphic.

Igneous rock

These were the very first rocks to form on Planet Earth as it started to cool. They are formed from the cooling of molten magma from beneath the Earth's surface. Basalt and granite are examples. We have no igneous rocks near the surface on the Heritage Coast.

Sedimentary rock

These are formed when particles of weathered or eroded rocks or remains of dead plants and animals are deposited, often underwater. The layers build up over millions of years and the deeper layers become compacted eventually sticking together to form new rock. Limestone, sandstone and coal are good examples. All of the rocks on the Durham Heritage Coast are sedimentary (with the exception of some glacial erratics, loose rocks which were carried here by ice sheets).

Metamorphic Rock

When igneous rocks or sedimentary rocks are subjected to extreme heat or pressure they can change to produce rock with a new structure and appearance. Marble is a good example, formed from limestone. We have no metamorphic rock on the Heritage Coast with the exception of the above glacial erratics.

The Rock Cycle

Rocks at the surface are subjected to erosion and weathering. The rock fragments are broken down into smaller and smaller particles which when deposited as sediment will in time form sedimentary rock. In this way all rock is recycled when it reaches the surface.

The Rocks of the East Durham Coast

Over hundreds of millions of years the place that was to become County Durham has drifted upon a tectonic plate through a range of latitudes and so has been exposed to a wide range of climates. During this time the rocks we see today were created.

The Coal Measures

About 310 million years ago we lay on the equator and the landscape was very different. Huge rivers bigger than the Amazon flowed towards us depositing enormous amounts of sediment, creating a vast, flat, tropical swamp covered in forest. As the plants of the forest died they built up a thick layer of dead vegetation which was occasionally flooded and covered with muds and sands from the rivers. This period was known as the Carboniferous. The layers of vegetation became our coal seams as they were compacted by the growing weight above them.

Sandstone

As the tectonic plate we are on continued its journey north, the climate changed, where once was rich equatorial forest was now hot dry desert covered by sand dunes. The sandstone that they formed is present under the rock that now gives Durham Heritage Coast its special character, the Magnesian limestone.

Magnesian Limestone

The desert became flooded by a warm shallow sea, the Zechstein Sea. Here swam trilobites and ammonites. We even had our own barrier reef offshore made up, not of coral, but of bryozoans (moss animals) the descendants of which can still be found in the waters off our coast. Beacon Hill near Hawthorn Dene is one of these reefs. At the bottom of the sea accumulated an oozy, lime rich mud which became the Magnesian limestone we see today. The cliffs all long the Heritage Coast are made up of Magnesian limestone usually with a cap of boulder clay.

The period of the desert followed by warm tropical sea was called the Permian and lasted from 295-250 million years ago.

For the next 250 million years no new rocks were formed in East Durham. Rather land movements raised the rocks present into low hills where little or no deposition occurred and probably erosion was the main force at work. We did however continue our northward bound journey on the tectonic plate.

Ice Ages

For the last 2.5 million years Britain has been subjected to a series of ice ages. We are currently in a warm period between ice ages. At times Durham was buried beneath up to one kilometre of ice. As the glaciers melted at the end of each of these periods they left behind a deposit known as boulder clay (glacial till). This is an unstratified mix of all grades of particle size up to pieces of rock and boulders known as glacial erratics.

As the ice retreated torrents of glacial melt water carved deep valleys and gorges into the Magnesian limestone. These are our well-known coastal denes such as Castle Eden Dene and Hawthorn Dene.

The coming and going of the ice has also led to big fluctuations in sea levels. The view from the top of Beacon Hill has changed many times over the last 2.5 million years.

Sometimes as far as the eye could see to the east was forest and you would have been able to walk across to Denmark, at other times the North Sea has flooded in and waves have lashed into the Magnesian limestone to form the cliffs and caves we see on the coast, often topped by a layer of boulder clay left by the retreating glaciers. Remnants of the 8000 year old forest can be seen at very low tides at Hartlepool and Seaton Carew; the stumps are often under 15 metres of water.

The return of the plants and the building of soil

The last ice pack retreated about 12,000 years ago and very gradually as the climate warmed plants started to colonise the bare surface. Initially we would have been surrounded by Arctic tundra with mosses, lichens, some grasses and wild flowers and small ground hugging woody species such as dwarf willow and birches.

As these plants died they added organic matter to the mineral particles left by the ice sheets. Slowly soils developed as the climate continued to warm. They supported the growth of trees such as the pine and birch we still see in northern Scotland. The tree composition of the forest gradually changed with the continually warming climate and the trees we see today along the Heritage Coast such as ash, oak and hazel became the dominant trees.

Deep rich forest soils developed under this tree cover, which once covered the entire area. These rich forest soils are the ones that allowed our early ancestors to settle down in County Durham and start to farm the land rather than simply hunt and gather food from the forest.

Key Concepts

Erosion

Rocks can be worn away by water and by being rubbed by other materials such as sand and pebbles carried in water, wind or ice. This process of wearing away is called erosion and results in pieces being broken off the surface of the rock. By being knocked together and also off the surface of rock, these pieces are made smaller and smaller eventually becoming gravels, sands and muds.

Deposition

Eventually the water or air that is carrying the eroded bits of rock, slows down or stops and when this happens the fragments (sand etc) are dropped. This is called deposition. It is how the sand gets on to a sandy beach or the mud gathers at the bottom of a slow-moving river.

Stratification

When, for example, sand is dropped onto the bottom of a river, it will form a layer. Later on finer mud may come down the river and get laid down on top of the sand. This will form a different layer. You may get more sand laid on top of this, or if a volcano erupts nearby it may be covered with lava. Rocks are formed in different layers like this; the oldest ones are found on the bottom and the youngest on the top.

Soil

Soil is made up of a mixture of eroded rock (mineral) particles, like sand and silt, mixed up with the remains of plants and sometimes animals. As the plant and animal remains breakdown they release plant food. The plant remains also help hold water in the soil if it is sandy. Soil that is good for plant growth has a balanced mixture of both mineral particles and plant remains. *(See also the section under "Wooded Denes" titled "Nutrients Cycles")*

Curriculum Links

<table>
<tr><th colspan="3">Science</th></tr>
<tr><td colspan="3">KS2 AT Levels 3 - 5</td></tr>
<tr><td></td><td>Sc3
1d</td><td></td></tr>
<tr><th colspan="3">Geography</th></tr>
<tr><td colspan="3">KS2 AT Levels 3 - 6</td></tr>
<tr><td colspan="3">1abc,2a-f,3a-e,4b,6c,7abc</td></tr>
</table>

This topic also has strong links to the National Curriculum in English and ICT

Places to visit

Nose's Point and Hawthorn Dene

Castle Eden Dene

Blackhall

Links to other sections in this pack

Geology and people 1.4
Magnesian limestone grassland 1.9
The Wooded Denes 1.10

Resources

Books

An Adventure In Time - by Brian Young and Gen Batty - Easington District Council Booklet

Robson’s Geology of North East England - G. A. L.l Johnson - Northumbria Natural History Society

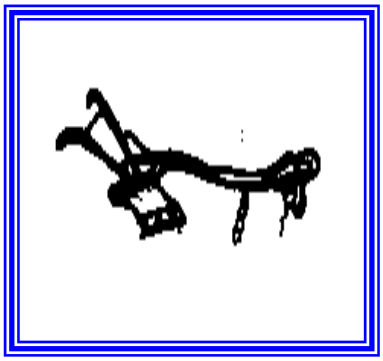
Minerals, Rocks and Fossils- Bishop, Woolley and Hamilton - Philips

Websites

www.talkorigins/origins/geo_timeline.html

www.dur.ac.uk follow links to Dept of Earth Sciences (see geology of Durham field trip; also has links to a geological glossary and other information)

1.4 Geology and People



When people think of the geology of County Durham they generally think of coal mining, however, other aspects of the geology of the area have had an influence on human settlement patterns over many thousands of years

Early Settlement

Over 12,000 years ago the whole of the North East was covered by a giant ice sheet up to 1km thick in places. The weight of the ice pushed the land downwards below the normal sea level but as the ice melted this weight was removed and the land surface rose slowly to the position it is in today.

The melting ice also caused rivers and streams to flow with large amounts of water which cut deep down into the boulder clay and limestone to form gorges or Denes. These Denes created shelters from severe weather and provided food for people so evidence of the first prehistoric settlements in the area is often found in the Denes. Mesolithic and Neolithic flint shards and possible hearths have been found at Crimdon, Easington, Ryhope and Castle Eden Denes.

The fact that the area has a coastline also attracted early settlers who were hunter gathers who didn't stop in one place for long but moved around to find food. On the Durham coast they could fish in the shallows and get crabs and mussels from the rock-pools. The coastline also acted as a boundary which did not need defending as sea travel was very uncommon at that time and therefore one side of a settlement was protected.

The weathering of the different deposits at different rates has also left a number of raised areas inland from the coast. The best of these is at Beacon Hill which is an outcrop of a barrier reef laid down in the tropical seas which existed in the area millions of years ago. The hill stands 85m above sea level and acts as an excellent viewing point from which you can see miles on a good day. Also people coming to the area could see the hill from a long way off.

The name Beacon Hill suggests that there was possibly a beacon on this site, possibly built by the Romans. They often used hills of this type to site signalling beacons on their way to Hadrian's Wall but no real archaeological evidence has been found to support this theory. The area was also important during the Anglo Saxon and Viking incursions as ships approaching the coast from Scandinavia could be seen easily from the hill and early warnings given.

Farming

During the Bronze Age and later, people started to settle more permanently in one place. They started to build proper shelters and took up farming rather than travel around hunting for food and taking their shelters with them. The boulder clay and limestone under the surface of the area provided good conditions for small scale farming and many towns existing today started off as small farming communities in the Iron Age and Roman times.

These farming communities developed further in the Medieval period under the

feudal system. Here each village was governed by a baron who lived in a manor house and owned the land.

The peasants were the people who worked on the land for the baron but they also had small areas they could work for themselves. Each village had 2 or 3 large fields bounded by hedges and divided up into narrow strips. Each peasant had strips in different parts of the fields so that good and bad soil was divided fairly between all the peasants. Every other year one of the fields was left without crops or laid fallow. This allowed the soil fertility to recover and give better crops the following year.

People grew crops such as rye, oats, peas and barley and kept sheep, cows and pigs which grazed on the meadow land and unwanted crop leaves etc. In some areas ploughing the fields was difficult due to the way the land undulates due to the underlying boulder clay but despite their limited machinery Medieval farmers coped very well with the conditions. Signs of the strip fields, hedge boundaries and ridge and furrow ploughing can still be seen today if you look hard enough at places like Beacon Hill, Hawthorn Hive, Cold Hesledon and Dalton le Dale.

In the 18th century the population of the area grew rapidly and so did the need for food, farming needed to change and become more efficient. Fields were made bigger and oxen and horses were used to pull larger ploughs. A new crop rotation system came from Holland which stopped the need to leave a whole field fallow for a year. In each field the farmer grew wheat in year 1, turnips in year 2, barley in year 3 and clover for animals in year 4. This system kept the soil fertile all the time and provided food for animals in the winter.

Though the soil was suitable for small scale farming, it was not very good for the large scale now needed. Farmers discovered that if you added lime to the soil crops would grow better. Luckily limestone lies under the whole area so limestone quarries and limekilns sprang up all over east Durham. The resulting lime was then put straight onto the local fields, often only a few hundred metres from the kiln and quarry. Farming and lime working were the main uses of the local geology right into the 19th century when another geological formation took over; coal.

Coal

Coal is made from plants and trees which died about 300 million years ago. As time passed these deposits were compressed under deposits thereby forming the coal seams. Coal is 60-65% carbon but it also contains sulphur, chlorine and volatile matter such as gas and tar. It burns very well giving off a lot of heat which can be used for a lot of things.

Coal had been mined in West Durham and other parts of the North East since the 18th century but in East Durham the coal is found under thick layers of boulder clay and limestone, up to 500m deep. It wasn't until steam engines that could get the coal to the surface had been developed, that the rich coal seams here could be exploited.

One of the most difficult pits to sink was at Murton. Here the limestone layer is very thick and there are pockets of shifting sands which make it difficult to maintain the shafts. The pit was begun in 1838 but it took 5 years before coal could be extracted from 3 shafts. Besides getting coal out of the pits another problem was getting air deep down so the miners at the seams could work. Other shafts had to be dug alongside the mine shafts as air vents with sophisticated bellows and pumps installed at the surface. Another problem for East Durham miners was the fact that the limestone is very porous so flooding often occurred. Again steam came into its own with the invention of water pumps to pump the water to the surface.

So valuable was coal that all this effort was put into extracting coal from seams that were often only a few feet thick. In fact the biggest seam was at South Hetton and it was only 2m thick and some seams were less than 1foot thick. The seams might not have been thick but they were long, some

up to 6km. Some even went out under the sea as at Seaham where coal was mined up to 5km from the coast.

It was discovered that if you burned coal without oxygen, the resulting coke was 90-95% carbon and would burn at a lot higher temperatures making it more efficient. This is called carbonisation and it drives off all the impurities normally found in the coal. It took 1000kg of coal to produce 750kg of coke. When used in iron and steel making it improved the quality of the metal and so became a very valuable resource.

Coal was vital to the industrial development of the country as it was needed to fuel the steam engines that operated the machinery; when it was discovered in East Durham it changed the area for ever. It allowed villages to develop into towns and new industries to flourish, such as iron and chemical works.

However, the use of coal also had a negative impact on the area. Huge amounts of colliery waste were dumped straight onto the land or the beaches causing massive local pollution. In fact the area looked so bad the Blast Beach was used to film alien planet scenes for Alien 3. The Turning The Tide project in the 1990's did a lot of work removing the waste and trying to return the area to its pre-industrial beauty.

This in itself caused different problems to the geology of the area. The waste on the beaches had piled up against the cliffs bottoms and protected them from erosion by the sea. Removing the waste has meant that these cliffs are now eroding away and the beaches are drifting. Also the closing of the mines has meant that water is flooding the old shafts and tunnels, causing them to collapse. This in turn causes the land above them to sink or subside. This can cause a lot of problems to roads and building foundations and millions needs to be spent on remedial works.

Wartime

Due to the importance of the ports along the coast the area needed to be protected in wartime. There are many WW2 pillboxes along the coast set into cliff bottoms or on high points. These contained large guns designed to attack enemy ships and were often made out of converted lime kilns. The cliffs provided protection and camouflage for the placements and a good vantage point. In WW1 because some of the Dene areas looked like France and Germany they were used to practice trench building and defending.

Sand

Another geological feature of the Durham Heritage Coast used by people were the sandy beaches found along the coast but particularly between Blackhall and Hartlepool.

Sand was needed for the glass making industry at Seaham but also for use in the moulds in the iron industry. In the early days this sand was taken from the local beaches to the factory where coke, made from coal from the local pits, was added together with lime, made from local limestone, to make iron which was then transported out of Seaham harbour.

Before WW1 not many people visited the coast for pleasure, people didn't take holidays, they couldn't afford them and often their employers didn't give them any. The war made people realise that life should be lived and the great British seaside holiday came into fashion. The flat sandy beaches at Crimdon became very popular with day trippers in the early 1920's, particularly with miner's families from the nearby villages of Murton and Easington. In the late 1920's the miners were given 2 weeks annual holiday and many spent this relaxing and playing on Crimdon beach.

Key Concepts

All settlements need food, water and shelter

For early people water came from rivers, streams and rain. Food came from plants and animals found nearby and in the sea

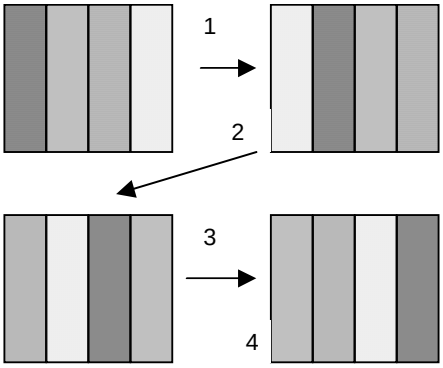
which the people hunted and gathered. Shelter was as simple as trees and caves. They moved around and didn't settle in any one place for long. All these things were found in the Denes.

Later people settled in one place and food came from growing crops and rearing animals. Shelters were built of wood and stone and small settlements grew and developed into larger villages and towns.

Farming has changed over the centuries

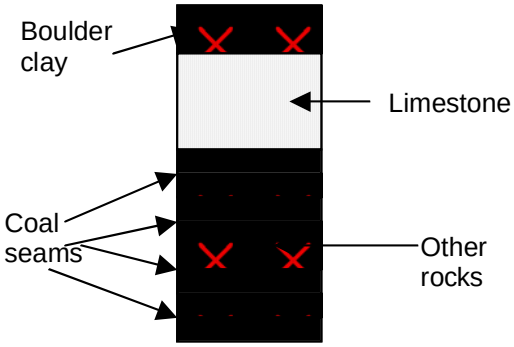
Once people settled in one place they needed to be able to grow their own food and so started farming. As the population grew so did the need for food. Lime was used to make the fields more fertile.

Fields were split into strips for people to work and bounded by hedges. The fields were worked using ploughs drawn by oxen and then later by steam engines and tractors. The 18th century 4 year crop rotation meant that more crops could be grown in the fields. The four crops that were rotated were wheat, barley turnips and clover.



Coal mining was vitally important in the 19th and 20th centuries

Coal is laid down in narrow strips called seams in between layers of other rocks. In East Durham it lies under thick layers of boulder clay and limestone.



There are no working mines left in East Durham and virtually all signs have been removed.

Sand

Sand was used to make glass and in the iron industry. Now it is mostly used for leisure for day trips to the beach and summer holidays.

Curriculum Links

History		
KS1 AT Levels 1 - 3		
1 – 5, 6abc		
KS2 AT Levels 3 - 6		
1,2acd,3,4,5,7,8 9,11a		
Science		
KS1 AT Levels 1 - 3		

Sc1 *1,2abegi*	*Sc2* *1a*	*Sc3* *1,2b*	*Sc4* *2,3ab*
KS2 AT Levels 3 - 5			
Sc1 *1,2abcgjkl*		*Sc3* *1ad,2abcdf*	*Sc4* *2bcd* *3abc*
Maths			
KS1 AT Levels 1 - 3			
Ma2 *1a-g,2,3ab,* *4a,5a*			
KS2 AT Levels 3 - 5			
Ma2 *1acek,2afh* *3bkl,4af*			*Ma4* *1acdf* *2abcf*
Art & Design			
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KS2 AT Levels 3 - 5			
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Geography			
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1c,2acd,3abce *4,5b,7a*			
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1ac,2aeg,3a-eg *4,5a,6acd,7a*			
English			
KS1 AT Levels 1 - 3			
En1 *1-11*		*En2* *1,2,3adf,4,* *6acg,7*	*En3* *1-12*
KS2 AT Levels 3 - 6			
En1 *1-11*		*En2* *1,2acd,3,4aef* *l,5,6,8,9*	*En3* *1-12*
ICT			
KS1 AT Levels 1 - 3			
Full curriculum			
KS2 AT Levels 3 - 6			
Full curriculum			

Places to visit

Seaham and Dawdon

- Harbour
- Colliery sites
- Dawdon Iron works area
- Blast Beach
- Pillbox

Crimdon Dene and Beach

- Lime Kiln Gill
- Prehistoric finds

Easington and Beacon Hill

- Ridge and furrow
- View point
- Colliery

Hawthorn Hive

- Landing stage
- Limestone quarry and kiln
- Pillbox
- WW1 trench system

Links to other sections in this pack

Prehistoric to Pre-Industrial 1.1
Industrial Heritage 1.2
Geology and the Landscape 1.3

Resources

Books

History of Britain Series – Romans, Anglo Saxons and Vikings, Medieval and Victorian

Durham Coastal Footpath leaflet

Websites

www.durham.gov.uk
www.thenortheast.fsnet.co.uk
www.durhamheritagecoast.org
www.seaham.com/heritage
www.keystothepast.info
www.dmm.org.uk
www.sunderlandonline.com/seaham
www.georesources.co.uk/coastman

Sea-trade and Commerce

The sea has always played an important part in the lives of people of the Durham Heritage Coast for food, trade and defence

Fishing

The North Sea has traditionally been one of the most productive fishing areas in the world, with 3% of the worlds total fish catch coming from it. There are major summer and autumn spawning grounds for many fish species off the North East coastline due to the deep water and abundance of plankton brought into the area on the prevailing sea currents.

Commercial fish are those which are caught for food or as animal feed or fertiliser and are split into two types; pelagic and demersal. Pelagic fish live in the upper layers of the sea where there is a lot of food and include herring, mackerel and sardines. Demersal fish live on or near the bottom of the sea and include cod, haddock, whiting and flat fish such as skate and lemon sole. Lobsters and crabs are also caught closer to the shore.

Because different fish live in different parts of the sea, different methods are needed to catch them.

Drift nets

These are very long and very fine nets which hang in the water like giant curtains up to 30km long. These are designed to catch pelagic fish but they also trap non commercial fish and dolphins which drown in the nets. The nets can also break free from their moorings and float away on the currents and are called ghost nets. Fish get caught in them and cause them to sink to the sea bed. When the fish start to decompose the weight is reduced so the nets rise again. More fish get caught in them so they sink and the cycle starts again.

Purse seine trawl net

These are bag shaped nets pulled behind a boat to catch pelagic fish. The fish go into the net and as the weight increases the two ends of the net are brought together trapping the fish inside.

Bottom trawlers

These are virtually the same as purse seine nets but are dragged along the sea bed to catch demersal fish.

Pots

These are used to catch crabs and lobsters and are special basket like traps baited with fish. The lobsters and crabs can crawl in through a net ‘sleeve’ but can’t get out. The pots are collected the following day and the animals are brought ashore to be sold at the fish market still alive.

Fishing boats

The deep sea boats are called trawlers and are large with powerful engines to cope with the large waves and storms out at sea. They also have sophisticated radar and satellite equipment which help them to find ever diminishing fish shoals. The sea inshore is not so rough so smaller boats can be used for lobster fishing etc. and these are called cobles. They are traditionally made of wood

and brightly coloured with a distinctive curved shape. Some have a small cabin or just a bright tent like cover called a dodger to keep the waves out of the boat.

Over fishing

The fishing industry has declined greatly over the years due to over fishing, pollution and fish quotas and many fishermen are having to adapt to catching different fish from the traditional ones. In 1929 236,000 hundred weight of herring was caught off the Durham coast but in 1979 this was down to just 227 hundred weight. In fact in 1995 herring fishing was banned to let the stocks recover.

Fishing from Seaham

There is a small commercial fishing fleet based at Seaham which usually uses drift nets in the summer to catch salmon and sea trout and pots in the winter to catch lobster and crab. The boats are usually cobles as the fishing grounds are only up to 10km off shore. There are a few trawlers including the Why Not which fishes for cod, haddock, monkfish and large prawns. It uses a trawl net in winter and a drift net in summer for salmon as they swim up the coast towards the river mouths to spawn.

Trade and Seaham Harbour

The Durham coast has seen many changes in the type of trade occurring over the years. As far back as the Medieval period, goods were coming across the North Sea from the continent including Denmark, Holland and Germany. In the 18th and 19th centuries smuggling was common at the Blackhall rocks area. The rocks did make landing the contraband of spirits and silk difficult but the caves acted as natural stores and the inaccessibility of the site made it difficult for the authorities to find the smugglers.

Trade became official and diversified with the building of Seaham Harbour by Lord Londonderry in 1828. It was built to transport coal from the Londonderry pits to London and beyond. It was a privately owned and on an almost totally artificial harbour with 2 docks; the south dock for fishing boats and the north dock for coal and other cargo boats. The harbour is 2.1m deep with a 85m entrance between two breakwaters. The northern breakwater has a lighthouse and clock tower on it to guide sailors and show the time for the tides etc.

When work began on the harbour there were only 300 inhabitants but by 1914 the population was 15,000. Goods including grain and timber came into the harbour from all over the continent, from the Baltic to the Mediterranean. The chief export in the early days of the port was coal from the local pits but later steel, fertiliser, bottles, limestone, chemicals and anthracite were exported. At one point the small harbour handled more tonnage of cargo than the neighbouring port of Sunderland. Fishing and timber shipping continue the commercial heritage of the area.

Wrecks

For many the term shipwreck conjures up images of pirate treasure or sunken gold but very few wrecks are like this. The North East coast is littered with thousands of wrecks from every century, many due to the treacherous weather in the North Sea and the jagged rocks and cliffs which line the coast. However, many of the wrecks off the Durham Heritage Coast were not the result of bad weather or hitting rocks but were due to collisions or deliberate sinking in wartime. Here are details of some of them:

Storms

On the 17th December 1872 a terrible storm hit the Durham coast with waves up to 20m tall pounding the coast. In total six ships were lost in that one storm ranging from small fishing boats to a large cargo ship. Over forty people lost their lives that night. Heavy seas and thick fog caused the H.A. Brightman to become stranded on Blackhall rocks on the 17th June 1879. She was a three mast steamer registered in North Shields and carrying coal and twenty one crew to Alexandria in Egypt. Gale force winds were responsible for the Spanish steamship Abasota getting stuck on the

Whitstones Reef south east of Sunderland on October 19th 1908. She was carrying iron ore to the Tyne from Algiers.

On the 10th June 1881 a south-south east gale and heavy seas caused the full rigged steamship, the Norman, carrying wheat to Stockton, to become stranded at Ryhope Dene. The ship was seen by the coastguard and chief officer at Seaham who called out the emergency services at 2pm, the Seaham Volunteer Life-Brigade arriving shortly afterwards. At their second attempt they managed to fire the rocket apparatus over the ship and prepared to take off the crew by breeches buoy. The seventeen crew and two passengers chose to be taken off by the Seaham lifeboat, the Sisters' Carter of Harrogate. The lifeboat took ten men; the captains' wife, a female passenger, and one man were taken off using the Bosun's chair. The rest of the crew were taken off in the lifeboat's second trip, the captain staying on board until she started to break up.

Collision

The sea off the Durham coast was a very busy trade route for shipping from the 18th century onwards, with ships travelling between the North East and continental Europe and beyond.

On the 14th September 1883 the steamship Monica was carrying a cargo of coal to Germany on a fine calm day. Just east of Seaham harbour she hit the steamship the John McIntyre and sank after all her crew were rescued. On the 25th of March 1884 the fishing trawler Adherent was travelling to the fishing grounds when she collided with the steamship Dunelm and sank just east of Seaham harbour. Luckily all her crew were taken on board the Dunelm and landed at Sunderland. A similar fate hit the steamship Meredith when she hit another steamship the Longnewton on the 31st March 1891 and the steamship Eident carrying iron ore sank on 24th October 1902 after hitting the Norwegian steamship GMB.

The fact that so many collisions occurred in the area shows how busy the shipping lanes around Seaham were. The cargoes the vessels were carrying and where they were from also indicate the wide variety of the trade. Many of the collisions occurred with Scandinavian ships indicating a very large trade with these countries. Seaham exported a lot of coal to them and in turn they traded timber for pit props into Seaham.

Wartime

The fact that Seaham and Sunderland were important industrial and trading ports made them targets during wartime. If the ships going to and from the ports could be sunk with their cargoes then it would have an effect on Britain's ability to fight a war. Many people think German U-boats were only used in WW2 but they were first effective in WW1 in the North Sea.

On 29th April 1916 the steamship Teal was carrying a general cargo to London when she was attacked by the German submarine UB 27 east of Seaham harbour. The sub came out of a fog bank and fired a torpedo which missed but the sub then fired on them with their deck gun and the Teal's captain decided to abandon ship. It took the sub several attempts and two torpedoes to sink the Teal before leaving the crew to be picked up and taken to Hartlepool. The steam trawler Helvetia was also attacked by a German sub in August 1916, as was the Norwegian steamship the Azira in September 1917 when the ship's carpenter was killed.

Subs didn't just torpedo ships they also laid mines which would explode when a ship hit them. On 23rd May 1917 the Norwegian steamship the Gran hit a mine east of Ryhope and the explosion cut the ship in half, each sinking 200m apart.

Key Concepts

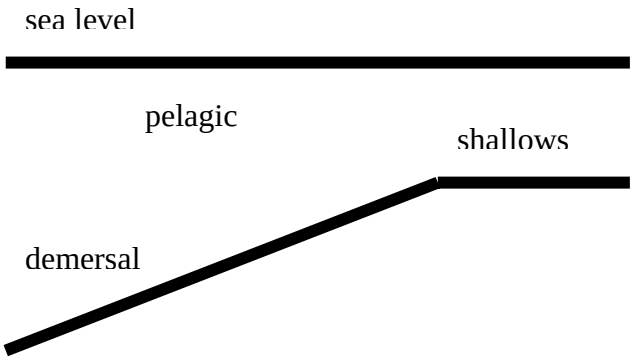
The sea is a source of food for people

Hundreds of different species of fish live in the sea; some of these are caught for food. Different fish live in different parts of the sea and different methods are used to catch them.

Pelagic – live near the surface and are caught by drift nets or purse seine trawler nets.

Demersal – live on or near the bottom and are caught using bottom trawler nets.

Lobsters and crabs – live in shallow water and are caught by basket-like traps called pots.



If too many fish are caught there are not enough to breed so fishermen can only catch a certain number each year. These are called Quotas and are set by the government.

The sea links countries through trade

Britain is an island; it is completely surrounded by sea. The sea off the Durham coast is the North Sea which is up to 75m deep in places. If you go east across the sea you will reach European countries such as Holland, Denmark, Germany, Norway and Sweden. Ships can use the North Sea to transport heavy cargoes such as steel, coal and wood.

Dangers at sea

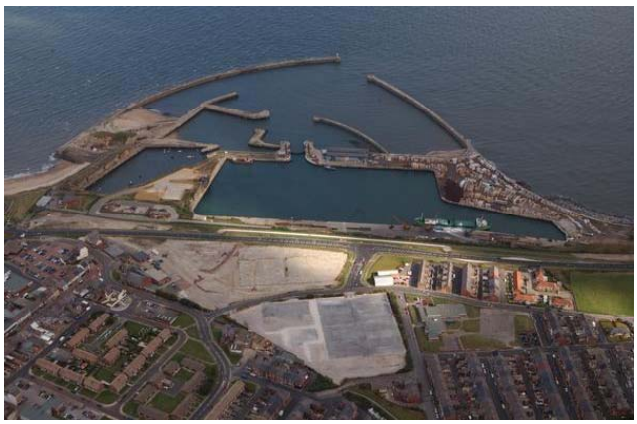
The sea is a dangerous place. Storms and strong winds can cause waves 20m, high pushing boats over or onto rocks. In wartime submarines and mines can sink ships easily from below the surface of the sea.

To help ships, lighthouses are built at danger points such as rocks, cliffs and harbours to guide ships safely.

Seaham – the purpose built harbour

Natural harbours are where the coast curves into the land, often at the mouth of rivers to create a sheltered bay with deep water that boats can use.

Seaham is a man-made harbour where walls have been built to protect the boats when they load and unload their cargo. The walls themselves are protected by large rocks. A lighthouse guides boats to the harbour.



Curriculum Links

History		
KS1 AT Levels 1 - 3		
1 – 5, 6bcd		
KS2 AT Levels 3 - 6		
1 - 9,11a		
Science		
KS1 AT Levels 1 - 3		
Sc1 1,2ab	*Sc2 1acd*	*Sc3 1,2abc*
KS2 AT Levels 3 - 5		
Sc1 1b,2bcfh	*Sc3*	*Sc4 2d*
Maths		
KS1 AT Levels 1 - 3		
Ma2 1,2,3abe, 4a,5a		
KS2 AT Levels 3 - 5		
Ma2 1acfi,2adfhi 3ij,4ab		*Ma4 1,2acf*
Art & Design		
KS1 AT Levels 1 - 3		
1,2,4ab,5abc		
KS2 AT Levels 3 - 5		
1,2,3a,4ab,5abc		
Geography		
KS1 AT Levels 1 - 3		
1,2,3abe 4,6b		
KS2 AT Levels 3 - 6		
1ace,2abcdf, 3abcdeg 4,6acd		
English		
KS1 AT Levels 1 - 3		
En1	*En2 1,2,3bdf,4, 6acfg*	*En3 1-12*
KS2 AT Levels 3 - 6		
En1	*En2 1,2acd,3,4ab efi,5,6,8f,9*	*En3 1-12*
ICT		
KS1 AT Levels 1 - 3		
Full curriculum		
KS2 AT Levels 3 - 6		
Full curriculum		

Places to visit

Seaham

- Harbour
- Iron works
- Railway

Blackhall Rocks

- Caves and stacks
- Railway station
- Colliery

Links to other sections in this pack

Industrial Heritage 1.2
Geology and the Landscape 1.3
Geology and People 1.4

Resources

Books

The Comprehensive Guide to Shipwrecks of the North East Coast Volume 1 1740 to 1917 by Ron Young
Durham Coastal Footpath leaflet

Websites

www.durham.gov.uk
www.thenortheast.fsnet.co.uk
www.durhamheritagecoast.org
www.seaham.com/heritage
www.seaham.i12.com/sos
www.keystothepast.info

1.6 People and the Coast

Sustainability and the Future

People have, for thousands of years, used the sea and coastal areas to supply their needs in different and changing ways. Up until the Industrial Revolution our impact upon the coast and the sea itself had been small and localised. As our population expanded and industrialisation increased, our impact upon the Durham coast and the North Sea became more and more profound.

Past misuse

The sea became a place to dump waste from factories and from homes. The biggest single most obvious impact upon the Durham coast was the effect of mining on the quality of coastal waters. For over a hundred years spoil from the coastal mines was routinely dumped into the sea, for example at Dawdon.

The result of this was the destruction, through burial, of many of the inshore communities of sublittoral sands and gravels (see section 1.11 "Life Beneath the Waves").

Many of our beaches became black with a thick layer of sea coal. Although this was unsightly it did provide a source of cheap coal and the basis for employment for a number of people, sea-coalers, who gathered the coal after each high tide and then bagged it up for sale. Sea coaling was common on many of the beaches and still continues today to a much more limited extent than in the past.

Turning the Tide

With the big decline in mining and the closure of the pits came the opportunity for real change. The Turning the Tide project set out to clean up the effects of 100 years of industry and mining. With the help of the sea, the coastline is now much more attractive and cleaner. The natural beauty that was just beneath the surface now shows through. Out at sea, divers are reporting a big improvement in wildlife with lobsters, octopuses, spider crabs and a whole range of other sea creatures now being seen where, not long ago, there was very little sea life.

Present problems and threats in the North Sea

Although the Turning the Tide project did a huge amount to improve the coastline there are many factors that influence the sea off our shores that the project could have little effect upon. They are all related to the growing human populations, both in the countries that fringe the North Sea, and also globally.

This is obviously a large many-faceted subject so here the problems are simply introduced and sources for more detailed information are indicated.

Water pollution

There are two main source of water pollution in the North Sea:

Industrial
Domestic

The North Sea basin has a poor exchange of water with the North Atlantic and is fringed with highly industrialised countries most of whose industrial effluent flows down the major rivers such as the Tees and the Rhine, and into the sea. As a result it is unfortunately one of the most polluted seas in the world.

Domestic sewage again finds its way into the North Sea eventually. Strict legislation has been put in place to control treatment and quality of discharges into the sea. This has led to significant improvement in water quality and many of our beaches are now of good bathing quality.

Although there have been significant improvements due to legislation much still needs to be done. Each home can make a difference simply by reducing their use of household cleaning products that are harmful, replacing them with environmentally less damaging alternatives.

Over-fishing

There are serious and well-founded concerns that traditional British fish and chips may become a thing of the past. The reason for this is seriously reducing commercial fish stocks in the North Sea.

Over fishing threatens the whole ecosystem. The modern methods developed in the 20th century which include the use of very efficient nets and sonar to locate shoals, has meant more fish have been caught for less effort. This led to the crash of mackerel and herring stocks in the 1960's and 1970's. Mackerel have never recovered to commercially exploitable levels. The stock of cod is now only one third of what ecologists believe to be a minimum safe population. Stocks of haddock, saithe and plaice are also in an unsafe condition with whiting heading that way. Since the start of the 1990's virtually all commercial fish for human food has become endangered.

In addition industrial fishing for fishmeal and oil takes an enormous tonnage of fish each year. They are now targeting species important for seabirds such as sand eels. In addition they catch small immature fish such as haddock and herring which are already endangered.

The management of fishing has been very poor and has failed to address the problems being caused.

Apart from the impact on the fish the by-catch of harbour porpoise alone is estimated at 7000 deaths each year, just in the North Sea.

Beam trawling damages the sea bed so badly that the ecosystems present are devastated. It is estimated, as it is being trawled, that up to 55 per cent of the animals present on the seabed are killed. This includes brittle stars, shellfish, worms and starfish. In some places the same piece of seabed can be trawled for fish up to four times a year!

A further problem for cod recovery and possibly other species as well is that global warming is raising the temperature of the North Sea causing a change in the timing of mass growth of the plankton. Young larval cod feed on this mass growth but are now out of synchrony with it. This lack of food will make cod recovery much more difficult.

Marine litter

This is much more harmful than the unsightly litter we see in our towns and cities; marine litter is deadly. It kills millions of birds, fish, whales, dolphins, turtles and many other marine creatures each year worldwide. Carried on ocean currents, marine litter is found everywhere even in the most remote places on Earth. It consists of many things, in particular plastics, which do not break down very easily and so can persist for decades and even centuries.

The main sources are land-based but there is also a significant amount of litter dumped out at sea by shipping.

Discarded or lost nets from fishing vessels are a major source of deaths as fish, birds and sea mammals become tangled and die, sometimes very painfully.

Some of our whale species and turtles eat plastic bags thinking they are jellyfish. The plastic becomes compacted in their intestines, eventually killing them.

The litter can also damage or destroy coastal fish "nurseries" as plastic litter can be a source of persistent toxic substances.

Bioaccumulation in marine organisms

Chemical pollutants can enter the marine environment in a number of ways:

Direct discharges from industrial plants and sewage treatment works

Indirectly for example from agricultural sources e.g. pesticides and herbicides

Atmospheric deposition for example from waste incineration plants e.g. dioxins

Toxic compounds present in the water can be absorbed by plants. These are then passed on to animals feeding on the plants. Animals vary in their ability to regulate toxins, and certain toxins tend to build up in body tissue. When the animal is eaten by a predator, the toxins from its prey build up in its body tissue. The effect is magnified by the number of prey animals it eats that have the toxic compounds in their tissue.

The higher up the food chain the more the toxins accumulate; this can have serious effects on the ability to reproduce and defend against disease. Some of the compounds cause diseases such as cancer.

The future

Pollution

As individuals, the cause of much of our contribution to marine pollution is related to our consumption of manufactured products and the use of chemical products around the home. This is the area where we can each, as individuals, make an impact.

The old adage of repair, re-use and recycle, cuts down on the amount of pollution we each produce by consuming less newly manufactured products. Basically don't throw it away if you can help it.

Household cleaners, washing powders etc all contain harmful substances that can persist in the environment and eventually cause problems to marine animals. By using environmentally less damaging ("friendly") products we can substantially reduce our individual impacts.

Energy

Most of the energy we use comes from fossil fuels such as oil. Transportation of oil in bulk tankers is one of the causes of oil pollution in our seas. If we used more renewable energy this would reduce the amount of oil transported and so the incidence of accidents.

Use of fossil fuels is causing global warming which is already affecting life in the North Sea. Cod breeding cycles are now out of synchrony with the flush of phytoplankton that used to feed their larvae. This is making it much less likely that North Sea cod will ever recover to former levels.

There is about 15 per cent less phytoplankton than there used to be in the North Sea. This provides less food for important food chain species such as sand eels and so has a knock-on effect on populations of seabirds.

If we could use more non-polluting renewable energy we would reduce the problem.

Renewable energy

The sea and the wind along our coast are a source of energy that if harnessed can produce electricity.

Tidal barrages

Around 20 per cent of Britain's energy could be produced from tidal power stations. There are only a few sites suitable for large-scale production around the British coast. Often there is significant risk of damage to important wildlife areas if tidal barrages are built.

Offshore tidal turbines

These are a bit like underwater wind turbines and if developed would be placed where tidal flows are high. They would have the advantage of much reduced impact on wildlife compared to barrages

Wave power

The Heritage Coast in Durham is fairly sheltered compared with the coastlines on the west of the country exposed to the Atlantic Ocean. This means we receive less energy through wave power. Scotland is the world leader in developing wave power turbines. It is estimated that around three times our current energy needs could be provided from wave powered turbines with the right technology.

Wind power

The winds are stronger out at sea so turbines placed in offshore wind farms collect more energy, more reliably. On land wind turbines are placed on high ground such as clifftops again where winds are stronger.

Fishing policies that work!

Key Concepts

Pollution

Pollution is something that causes harm to plants and animals including people. Pollutants are the substances that cause this pollution. They can be carried in water or the air or can be deposited in the soil. They can be liquids, gases or solids. They are usually released into the environment by humans often during manufacturing processes or while we carry out our daily lives (for example driving a car, cleaning the floor etc)

Bioaccumulation

Pollutants can be thought of specks of poison floating around in the air, water or soil. These poison specks can be taken in by plants while they are growing. When the plant is eaten by an animal they are passed on and if that animal eats a lot of these plants they can get quite a lot of poison specks stuck in them. When another animal eats the animal with the poison specks it also gets all the poison specks. If it eats a lot of animals with the poison specks in them it may become quite ill and sometimes die.

Tides and currents

Water in the sea is never still; it is always moving. Tides come in and wash things up on the shore and they then go out again, carrying things away. As well as this there are currents in the sea which are a bit like rivers flowing through the slow-moving waters. These currents can carry things for thousands of miles. They are often used by migrating sea animals to help them move from one place to another.

Energy for electricity

Our electricity is made by using the energy from things that are moving. Steam that comes from water can be made to move pistons which then make electricity in a generator.

Fossil fuels

To heat water and make steam and so electricity, we often use coal, oil or gas. These are called fossil fuels because they were made and trapped in the Earth's rocks hundreds of millions of years ago. When we burn them they cause a lot of pollution by releasing poisonous gases into the air we breathe.

Renewable energy

Electricity can be made using the movement of water or wind or by trapping sunshine energy directly. Electricity made in this way doesn't cause any pollution. It is called renewable because unlike coal and oil in the ground it will never run out; it keeps on being renewed.

Curriculum Links

Science		
KS1 AT Levels 1 - 3		
Sc1 *1,2abefghj*	*Sc2* *5c*	*Sc3* *1ac*
KS2 AT Levels 3 - 5		
Sc1 *2abc*	*Sc2* *4,5a*	
Geography		
KS1 AT Levels 1 - 3		
1abcd,2abcd,5ab,6b,7ab		
KS2 AT Levels 3 - 6		
1abcde,2abcdf,3abcdeg,5ab,6ae,7ac		

This topic also has strong links to the National Curriculum in English and ICT

Places to visit

Crimdon
Seaham

Links to other sections in this pack

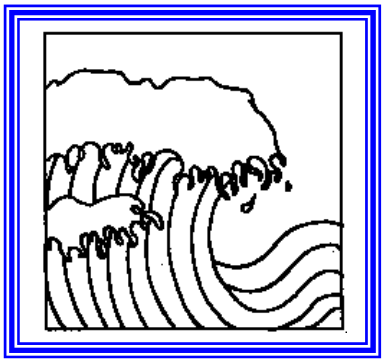
Industrial 1.2
The sea as a force of nature 1.7
Life on the seashore and cliffs 1.8
Life beneath the waves 1.11

Resources

Websites

www.greenpeace.org.uk
www.foe.org.uk
www.est.org.uk (Energy Saving Trust)
www.cat.org.uk (Centre for Alternative Technology)
www.greenfutures.org.uk
www.wwf.org.uk
www.wavegen.com
www.britishwindenergy.co.uk
www.mcsuk.org (Marine Conservation Society – marine litter and much more besides)
www.wwflearning.co.uk (some good activity resources)

1.7 The Sea as a Force of Nature



Water is vital for life on Earth, in fact two thirds of the Earth's surface is covered by water, most of it in the seas and oceans.

Water is constantly on the move and being recycled through evaporation and condensation in the form of rain. This cycle is closed which means that the water around today has always been around, even at the time of the dinosaurs. Without this precious liquid there would be no life on Earth.

Waves

The surface of the sea is in constant motion due to the action of the wind which causes waves to form. The faster and stronger the wind, the larger the waves and the more powerful they are. Waves coming from the Atlantic and hitting the British Isles can be as much as 15m high.

These huge waves don't affect the open sea dwellers much, as the swell, or the movement up and down of the waves is relatively controlled and gentle, it is a different matter when the waves reach the shore. Wave action stores up large amounts of mechanical energy and when the waves reach the relatively immovable land this energy is released.

The effect of this energy release can be very destructive, moving material from the beaches and destroying cliffs, but it can also be constructive by depositing sand and pebbles in new areas where new plants etc. can colonise. Depending on the force and nature of the waves these changes can be gradual over many decades or in some cases immediate with some beaches changing shape overnight.

The amount and size of waves can also affect the numbers and types of plants and animals found on the shore. Many species aren't adapted to cope with the force of large waves so don't fair well on rocky shores, whilst others such as the barnacle has adapted to withstand these forces so is found there in large numbers.

The direction of the wind also plays a part in the effect waves have on the coast. The waves follow the direction of the wind and rarely break at right angles to the beach, instead they hit the coast at an angle. The waves carry pebbles and sand grains in with them as they break on to the beach and deposit them at the top. The wave then retreats back to the sea, called the backwash, which does travel at right angles to the beach. This backwash carries the sand grains back down the beach to the sea to be picked up by the next angles wave. This continues along the length of the beach, the waves moving the pebbles and sand grains in a zig-zag pattern along the beach and is called longshore drift.

The movement of sand down the length of a beach can be quite serious, resulting in whole areas of sand disappearing and large areas of sand build up further along the coast which can block river estuaries. Longshore drift can be reduced by building defences called groynes. These are wooden fences built at right angles to the beach, higher at the wave break area and decreasing in size as you go down to the sea. These act as barriers to stop the sand travelling long distances. These barriers are also good at stopping sand being blown off beaches in strong winds at low tide and

collecting other rubbish blown against them such as litter.

Tides

Life on the seashore is dominated by the twice daily rise and fall of the tides. Tides are caused by the pulling effect of the Sun and Moon's gravity. Most of this pulling force comes from the Moon as it is closer to Earth than the Sun, so tides follow the Moon's cycle. When the Moon is overhead at any place on Earth, it pulls the water beneath it outwards into a bulge. Another bulge is seen on the opposite side of the Earth caused by the water being thrown outwards by the planets spin. It is these two bulges travelling round the Earth which cause the 2 High tides a day. Therefore the time of each high and low tide moves forwards about 35minutes every day. Also the Earth is not a smooth, pure sphere so the times and heights of the tides vary from place to place.

The tides are very regular; high tides occur twice every 24 hours and 50 minutes which is one complete orbit of the Moon round the Earth. The size of the bulges varies as the Moon and Sun move in relation to each other during the course of a Lunar month.

When the Moon is new or full, the Sun and Moon are in line with each other and so the gravitational pull is greatest at this time. This makes the high tides higher and the low tides lower and they are called spring tides. The difference in height between high and low tides at this time can be over 5m. Spring tides happen every two weeks and are biggest in March and September.

When there is a half Moon, the Sun and Moon are at right angles to each other so they pull the Earth's seas in different directions. This produces smaller differences in high and low tides and they are called neap tides. The difference between high and low tide here can be as little as 2m.

Knowing the times of the high and low tides is very important for people working on and near the sea and for those wanting to visit the coast. For example fishermen need to know when high tide is so they can get in and out of the harbour easily otherwise they might get grounded. People wanting to visit rock-pools and the beach, need to know that the tide isn't in, or going to come in soon, before they get there so they don't get trapped by the incoming sea.

For this reason tide tables are published which give the times of the high and low tides and often their heights. These tables are individual to the area they cover and are different for every day of the year. They are often published in the newspapers or found on the internet. They should always be consulted before any trip to the coast.

Erosion

Longshore drift is a form of coastal erosion, but one that is considered slow acting with less dramatic or visible effects on the whole. It is particularly evident along the Durham coast due to the effect of man and the mining industry.

Colliery waste used to be dumped straight onto Durham beaches from Victorian times to the 1990's. In the 1970's 2.4 million tonnes of coal waste per year was dumped. Some of this waste was cleared from the beaches during the Turning the Tide project but plenty still remains. The strong Northerly and North Westerly winds have caused a lot of the waste to be transported down the coast, as far as Seaton Carew. Not all the spoil washed from the beach is re-deposited, some is lost out at sea where it sinks in deep water. It is thought that in a couple of decades most of the spoil will have totally gone from Durham beaches.

In some places longshore drift is reversed and this results in sand being deposited in large areas. This is called accretion and forms dunes. Accretion and groynes can be seen at Crimdon beach where dunes have formed from sand transported from further up the coast where it is now more rocky than sandy. Dunes can also be seen at North Sands.

There are five main types of land erosion caused by the sea.

Hydraulic pressure – where a wave hits a cliff with great force squashing air into cracks in the rock. As the wave retreats the air is released in a tiny explosion which makes the crack bigger. Finally the crack is so big pieces of rock fall off the cliff.

Corrosion or Solution – salt in the sea reacts with certain rocks such as limestone and chalk effectively melting them away.

Abrasion – this is caused when sand grains and pebbles are thrown against the rock by the force of the waves. This blasts bits of rock from the cliff and is the basis for sand blasting to clean buildings etc.

Weathering – there are two types of weathering action. The first is a bit like corrosion where rain water mixes with pollutants in the air to make an acid which then reacts with the rock to dissolve it away. The other involves rain water getting into cracks in the rock and freezing in cold weather. When water freezes it expands so the ice makes the cracks bigger until they cause bits to break off the cliff.

Mass Movement – this is what happens if waves wear rocks at the base of a cliff so that an over-hang develops which is unstable. Eventually gravity will prevail and the overhang will collapse.

All these methods have combined to make the Durham coast look the way it does today. One of the best places to see coastal erosion is at Blackhall Rocks.

The rocks are made of limestone which is easily worn away and reacts with acid rain and salt water. Huge waves have caused the rocks to wear away at the base of the cliffs to leave overhangs. These have collapsed to leave steep limestone cliffs. Some of the layers are softer than others and these have been eroded faster making cracks which have turned into caves. Sometimes two caves meet back to back and an arch is formed. With time the arches collapse forming a single column of rock called a stack. Most of the stacks at Blackhall have been eroded away but new ones will form from the arches and caves there now.

Defence

Because many people depend on the coast for their livelihoods and homes, protecting it is very important. There are many different forms of coastal defence available with different methods being better for some places rather than others.

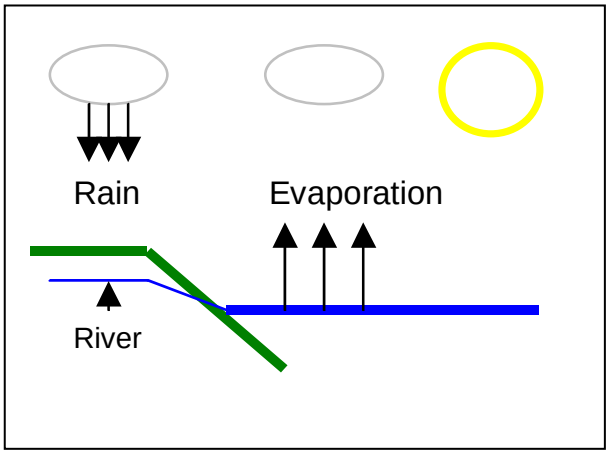
Sea walls are built to form a solid barrier to protect low-lying land at the coast. They used to be built as vertical walls but they undergo the same erosion problems as cliffs so now they are usually sloped to reduce the force of the waves hitting them and the amount of sand lost at the base.

More recently boulders have been used which reduce the wave force but the waves can go round them more so they aren't eroded as much. Gabions are mesh cubes filled with boulders placed at the base of cliffs and do a similar job. Despite these measures the sea continues to erode the land at the coast and many people face the possibility of having to move to escape the sea.

Key Concepts

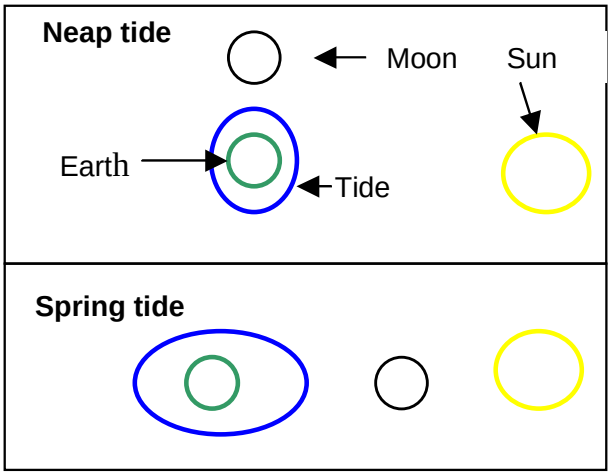
Water Cycle

Water is constantly on the move and being recycled. The sun causes it to evaporate into the air from the surface of the sea and land. It rises into the atmosphere where it cools and condenses to make clouds. Eventually the water falls back to Earth as rain or snow. It flows into the rivers and seas and the cycle starts again. This cycle has been going on for millions of years and today's rain is the same as the rain the dinosaurs saw.



Tides

Life on the seashore is dominated by the tides, the twice daily rise and fall of the sea. Tides are caused by the gravity of the Sun and Moon pulling the water on the planet towards them. There are two types of tide.

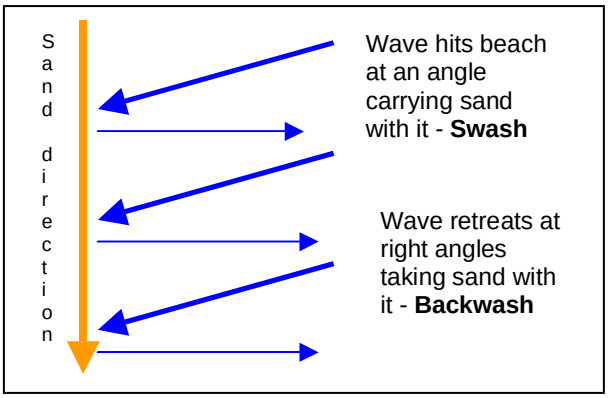


Spring tides are when the Sun and Moon are in line so the pull is stronger and high tides higher and low tides lower. They happen at full and new moon.

Neap tides are when the Sun and Moon are at right angles to each other the pull is not as strong so the tides are not as big. They happen at the time of the half moon.

Erosion

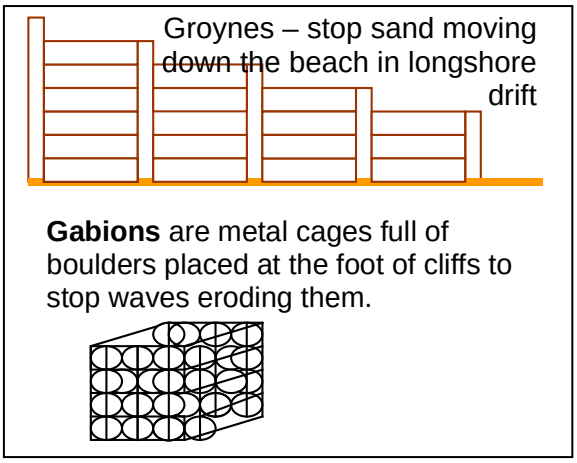
The force of the sea crashing onto the coast twice a day causes the sand and rocks to be swept away and deposited elsewhere. Even gentle waves can make sand move down a beach by longshore drift.



Powerful waves can cause greater damage to soft limestone cliff faces by making cracks bigger which turn into caves. These can join to form arches and collapse to form stacks.

Defence

To stop this erosion people build defences at the coast.



Curriculum Links

History		
KS1 AT Levels 1 - 3		
1a,4a,6a		
KS2 AT Levels 3 - 6		
1a,5ac		

Science		
KS1 AT Levels 1 - 3		
Sc1 *1,2abcf*	*Sc2* *1acd*	*Sc3* *1abc,2a*
KS2 AT Levels 3 - 5		
Sc1 *1,2abcfh jl*	*Sc2* *1c*	*Sc3* *1ade,2a ef,3b*	*Sc4* *2b,4ad*

Maths	
KS1 AT Levels 1 - 3	
Ma2 *1ac,2ac,3abc,5*	*Ma3* *1bcd,3ac,4ac*
KS2 AT Levels 3 - 5	
Ma2 *1ac,2bc 3a,4a,5a*	*Ma3* *1b,3ac*

Art & Design
KS1 AT Levels 1 - 3
1,2bc,3,4ab,5cd
KS2 AT Levels 3 - 5
1,2bc,3a,4ac

Geography
KS1 AT Levels 1 - 3
1acd,2a-f,3abcdg,4,5a
KS2 AT Levels 3 - 6
1acd,2a-f,3a-e,4,5a,6ce,7c

English		
KS1 AT Levels 1 - 3		
En1 *1 -11*	*En2* *1 - 7*	*En3* *1-12*
KS2 AT Levels 3 - 6		
En1 *1,2,3a-d,4 - 11*	*En2* *1-9*	*En3* *1-12*

ICT
KS1 AT Levels 1 - 3
Full curriculum
KS2 AT Levels 3 - 6
Full curriculum

Places to visit

Crimdon Dene and Beach

- Dune system
- Sandy beach
- Cliff

Blackhall Rocks

- Caves
- Cliffs
- Pebble beach

Seaham Beach and Featherbed Rocks

- Sandy/pebble beach
- Cliffs
- Caves
- Rock-pools
- Sea defences

Links to other sections in this pack

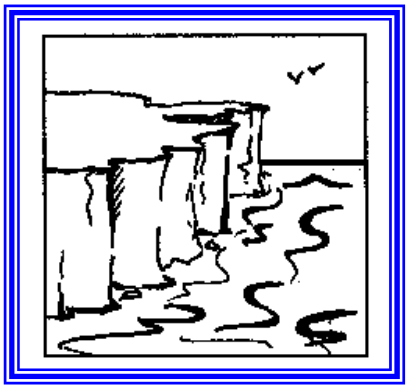
Geology and the Landscape 1.3
Geology and People 1.4
People and the Coast 1.5
Life on the Seashore 1.8

Resources

Websites

www.durham.gov.uk
www.durhamheritagecoast.org
www.naturaltrust.org.uk/coastline
www.dur.ac.uk/dorothy.riley
www.waterinschools.com/challenge/watercycle
www.dcs.ex.ac.uk/ne-lincs.sch.uk/seadefences
www.dcs.ex.ac.uk/water/cycle.htm

1.8 Life on the seashore



The seashore is a rich and varied habitat with distinct areas with specific plants and animals

Tidal Zonation

The area of the seashore which is sometimes covered by the sea is called the Tidal Zone. Gently sloping shores such as at Seaham and Crimdon have very large tidal zones but where there are steep cliffs such as at Blackhall, it is only small. Because the tidal zone is sometimes covered by sea and sometimes exposed it is a very special place and the plants and animals found on it are often not found elsewhere. The shore line can be described by the substrate: rocky or sandy.

Rocky shore

These shores are split into several zones depending on how much the zone is submerged.

Splash Zone – closest to the cliffs and only covered during very high spring tides once or twice a year but does get a lot of salt spray, inhabited by lichens and small plants and very occasionally small periwinkles.

Upper shore – long periods out of the water as even during spring tides the high tide may not reach this level. Limpets can be found on rocks, as well as barnacles and wrack seaweeds, as they can withstand a lot of drying out thanks to their shells or waxy fronds.

Mid shore – covered by the sea twice a day so animals only need to survive without water for a few hours. Lots of animals survive in rock-pools found in this area such as anemones, prawns, hermit crab, dog whelk and seaweeds.

Lower shore – usually covered by water for most of the time except during particularly low tides. The animals here need to be able to cope with being submerged for days at a time. Again rock-pools hold more life such as starfish, sponges, mussels etc. and when the tide is in, fish visit to find food.

Sub tidal – only uncovered during extremely low spring tides two or three times a year and usually only seen by divers. Animals such as edible crab and fish live here as well as kelp and red seaweeds.

Seashore Animals

Most seashore animals need sea water at some time in their life in order to breed as the eggs and sperm are usually released into the water where fertilisation takes place. These larvae are very different from the adults and they often go through several different forms before becoming adults.

The first larva of the anemone is called a planula larva and looks a bit like a furry skittle. This turns into a balloon shaped larva which then sticks to a rock to become an adult. Barnacle larva look like spiders but after moulting several times they stick to a rock on their backs and build their shell around themselves, their legs sticking out.

The first larva of the mussel looks like a toadstool and a crab zoea larva looks like an alien from outer space. See section 3 for diagram of crab life cycle. The larvae form the plankton which many fish eat so many are lost before they can become adults.

Seashore plants

Lichens

Above the splash zone the dominant plants are lichens. They can be different colours with each type liking a particular area. The grey lichen Lecanora is found highest on the shore then the orange Xanthoria, of which there are two species found on the Durham Heritage Coast, and finally four species of the black tar like Verrucaria are found nearest the shore. Lichens provide homes for land invertebrates and they start the process of rock breakdown and soil formation. They are also a good indicator of reduced air pollution with more of the orange Xanthoria appearing as the coal pollution is removed.

Seaweeds

There are many different types of seaweed, divided into groups based on colour and they prefer to live at different points on the shore. This preference is called zonation.

Brown – usually the biggest seaweeds including kelp, saw wrack, bladderwrack and channel wrack. Channel wrack is found on the upper shore, bladder wrack on mid to lower shore, saw wrack on the lower and kelp in the sub tidal zone.

Green – softer more feathery leaves such as sea lettuce and Enteromorpha found on most areas of the shore apart from the splash zone.

Red – can't tolerate drying out so are found on lower shore and sub tidal zones-flat or branching leaves or crusty patches over rocks.

Most seaweeds attach themselves to rocks using a holdfast. This is a bit like a root but is used for sticking rather than gaining nutrients. Animals such as mini-shrimps often live in the holdfast and the stems of large seaweeds often have smaller ones stuck to them.

Common Rocky Shore animals of the Durham Coast

Barnacle – Semibalanus balanoides
Limpet- Patella vulgaris
Mussel – Mytilus edulis
Winkle – Littorina sp.
Bladderwrack – Fucus vesiculosus
Coral weed – Corallina officinalis
Dahlia anemone – Actinia equine
Starfish – Asterias rubens

Cliffs

Most of the cliffs on Durham's coast are less than 50m high and are not generally vertical due to being made of Magnesian limestone which is easily weathered. The cliff faces are home to kittiwakes, fulmars and occasionally razorbill and guillemot. Much of the grassland on the cliff top is Magnesian limestone grassland. (See Section 1.9)

Sandy Shore

Not all shores are rocky, many are made up of sand and have distinct plant and animal life.

Dunes

These are scarce on the Durham coast with the most well developed being at Crimdon. Dunes are formed by the wind blowing free sand around high above the high water mark. The dune starts by sand piling up against a small barrier such as a clump of rotting seaweed to form an embryo or fore-dune. Organic debris also blows into the dune. Plants such as sea rocket and sea beet can use to grow in. These mobile dunes are constantly changing with the wind. As more sand builds up marram grass starts to grow, trapping sand so the dunes become more stable. Eventually soil forms turning the dune into fixed dune grassland.

Sandy beach

You may not think a lot lives here as you don't often see anything. However you can sometimes see sand squiggles and small round depressions which indicate there are lugworms or razor shells living in the sand. Some crabs also live in the sand as do cockles and thin tellins. These provide food for lots of coastal birds.

Strandline

This marks the edge of the sea and is shown by a line of seaweed and other debris at the high water mark. The strandline moves up and down the beach depending on the height of the tide and a lot of invertebrates use it for food as do marine birds.

Adaptations

All plants and animals are adapted to make the most of where they live. Here are just some of the adaptations found in animals on the seashore.

Living out of water

Limpet shells clamp down onto the rocks when the tide goes out and the molluscs foot sticks it firmly to the rock so it can't be swept away by the waves. Periwinkles have a trapdoor at the mouth of their snail like shell which shuts firm when the tide is out. Barnacles also have a trapdoor to their shell which is closed when the tide is out. They open them occasionally to let air in and this makes a popping sound. Sea anemones draw their tentacles inside their body which squats down and seals firmly with a small amount of water trapped inside.

Channel wrack spends 90% of its time out of water. It is made up of 65% water and rolls up like a tube to conserve water. Bladder wrack has waxy fronds which don't dry out quickly.

Feeding techniques

Grazing

Limpets are herbivores feeding on algae on rocks. Their tongue or radula is like sandpaper and they use it to scrape off the algae. It is very strong and can even make marks on the rocks themselves. Periwinkles have a similar method but they feed on larger plants. Sea urchins have five sharp teeth on the underside of their shell which they use to bite chunks off seaweeds. Velvet crabs use their delicate claws to pull seaweed to their mouth where they nibble it daintily.

Hunting

Anemones wave their tentacles, which have stings on them, harpooning shrimps and small fish. Dog whelks use their radula to burrow a hole into the shells of bivalves after first secreting digestive juices to soften it. This can take up to 14 hours. Edible crabs use their large claws to catch and cut up prey such as fish and they are very powerful. Starfish open bivalve shells using their arms and then turn their stomach inside out and push it into the shells to digest the mollusc inside.

Filtering

There are lots of small particles of detritus and plankton floating in the sea which is a valuable source of food. Barnacles lie on their backs in their shells with their feathery legs sticking out to catch things floating by. Mussels also have feathery bits at the mouth of their shells which they use to filter the water.

Birds

Many marine birds have bills adapted to reaching particular food. For example oystercatchers have long strong bills to get at buried bivalves and turn stones for small crabs. Plovers have short bills to look for bivalves just under the surface and the turnstone has a medium length strong beak for turning stones and seaweed. The curved beak of the curlew can go deep into the

sand to find worms etc. Terns have sharp beaks for catching fish and the black backed gull has a hooked bill for grasping and tearing food.

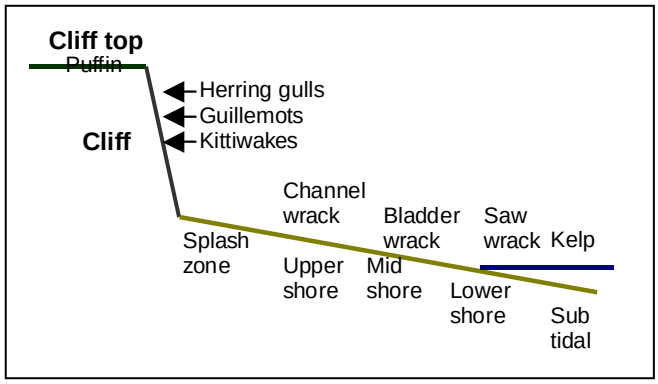
Marine birds also like particular areas of the coast including cliffs and sandy beaches. Puffins make burrows on the tops of cliffs whilst herring gulls make nests on shelves in the middle of cliffs and guillemots and shags on lower shelves. Kittiwakes prefer the bottom of cliffs and terns make their nests in sand dunes. Curlews prefer sand and shingle beaches, oystercatchers like sandy shores and sanderlings like running along the wave break line.

Key Concepts

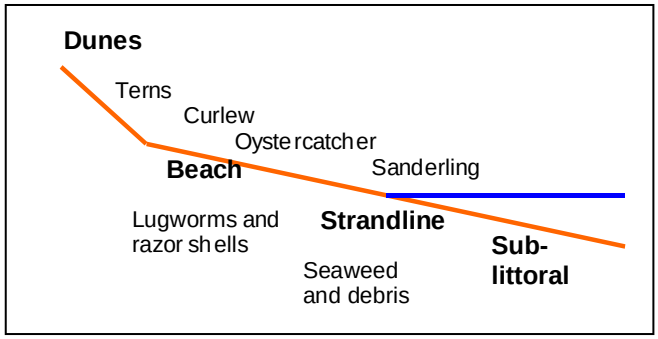
Zonation

The seashore is made up of different zones with different plants and animals in them.

Rocky Shore



Sandy Shore



Adaptation

Plants and animals are adapted to be able to live where they do.

Those living where the tide goes in and out, need to find a way to stop drying out on exposure. These animals have shells which they can shut to keep them moist or soft bodies they can squash down and trap water. Seaweeds often have waxy fronds or curl up holding water inside them.

Animals are also adapted for the way they feed. Some crabs have large claws to tear and crush prey, limpets and periwinkles have rough tongues to scrap off algae and plants and barnacles have feathery legs to trap tiny particles floating in the sea.

Seabird bills are shaped to reach different food in the sand. Puffins are large to hold a lot of sand eels, oystercatchers long and strong to turn stones and prod in the sand and curlews are long and curved to go deep into the sand for worms.

Food chains and webs

Different animals eat different things.

Herbivores eat plants
Carnivores eat other animals
Omnivores eat both plants and animals
Detritivores eat dead matter

All the plants and animals in a habitat are dependent on each other for food and shelter.

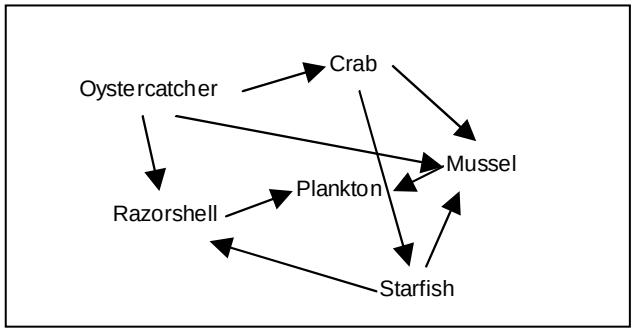
Seashore Food Chain

Zooplankton → Mussel → Dog whelk → Gull

(Also see diagram in Section 3)

Seashore food web

Things are not as simple as this as most animals eat a lot of different things not just one, and a lot of different animals eat them.

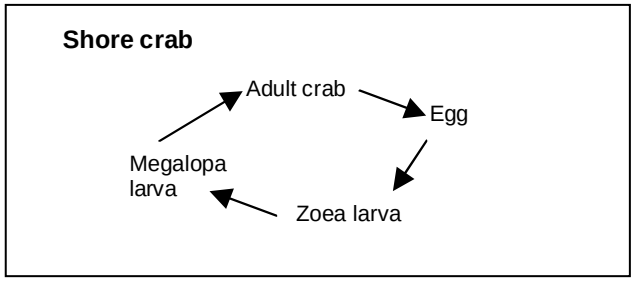


There are animals which will eat animal faeces and dead animals so the nutrients are constantly being recycled in the food web.

Life Cycles

All marine animals need the sea for breeding. Their eggs are laid in the water and float around in its currents and often become food for bigger animals.

These eggs hatch into what are called larvae which usually look nothing like the adult animals. These larvae can change several times before they finally become adults.



See diagram in Section 3

Curriculum Links

Science		
KS1 AT Levels 1 - 3		
Sc1 1,2abefgh	*Sc2 1,2abef,3a,4b,5ab*	
KS2 AT Levels 3 - 5		
Sc1 1a,2abefgh	*Sc2 1,2be,4abc*	
Maths		
KS1 AT Levels 1 - 3		
Ma2 1acfg,2ac,3abe, 4a,5a	*Ma4 1,2abc*	
KS2 AT Levels 3 - 5		
Ma2 1acf,2ad 3a	*Ma4 1,2abc*	
Art & Design		
KS1 AT Levels 1 - 3		
1ab,2ade,3b,4a		
KS2 AT Levels 3 - 5		
1a,2abde		
Geography		
KS1 AT Levels 1 - 3		
1ab,2abde,3abc,4b,5a		
KS2 AT Levels 3 - 6		
1ab,2abdf,3a-e,4ab		
English		
KS1 AT Levels 1 - 3		
En1 1 -11	*En2 1 - 7*	*En3 1-12*
KS2 AT Levels 3 - 6		
En1 1,2bde,3a-d,4ab,5 6 -11	*En2 1-3,5,6,9*	*En3 1-12*
ICT		
KS1 AT Levels 1 - 3		
Full curriculum		
KS2 AT Levels 3 - 6		
Full curriculum		

Places to visit

Seaham

- Beach
- Cliffs and rock pools

Crimdon Dene and Beach

- Dune system
- Sandy beach

Blackhall Rocks

- Cliffs
- Rockpools
- Pebble beach

Hawthorn Hive

- Beach

Links to other sections in this pack

Geology and the Landscape 1.3
People and the Coast - sustainability and the future 1.6
The Sea as a Force of Nature 1.7
Life beneath the Waves 1.11

Resources

Books

Fascinating Facts about the Seashore – J. Walker
Read and Learn – Sealife Series
By the Seashore – Tessa Paul
Seashore of Britain and Europe - Hayward, Nelson, Smith and Shields - Collins
Complete British Wildlife - Sterry - Collins
Field Guide to the Waterlife of Britain - Reader's Digest

Websites

www.durham.gov.uk
www.durhamheritagecoast.org
www.glaucus.org.uk
www.pembrokeshireoutdoors.org.uk
www.riverocean.org.uk
www.yptenc.org.uk

1.9 Magnesian Limestone Grassland

In the northeast of England we are lucky enough to have one of the rarest grassland types not only in Britain but also worldwide

The type of vegetation found in any one place is governed by a range of factors including climate, geology and soil as well as levels of human interference. Here in the northeast of England we are lucky enough to have one of the rarest grassland types not only in Britain but also globally; para-maritime Magnesian limestone grassland.

Magnesian limestone - what is it?

Magnesian limestone rock formed during the Permian era about 255 million years ago. At that time what is now Britain lay at the bottom of a shallow tropical sea. As well as the larger animals present there were smaller organisms floating in the water much like plankton does now. As these organisms died their remains settled on the bottom of the sea to form an oozy mud. As the layer built up it gradually formed the rock we know today as Magnesian limestone.

Magnesian limestone grassland

There are only 255 hectares of Magnesian limestone grassland in Durham. This occurs where the Magnesian limestone is exposed or is very close to the surface. The rock raises the pH of the soil making it less acid. This encourages a whole community of lime-loving plants, such as salad burnet, to grow.

This type of grassland occurs mainly in central to eastern Durham and southeast Tyne and Wear. Where it occurs on the coast, the local climatic effect changes the composition of the community to give a unique combination of species (para-maritime Magnesian limestone grassland).

Why is it important?

The important areas are unimproved by agriculture and are species rich, with particular importance for the plant and invertebrate content. There are 13 nationally scarce plant species such as blue moor grass and bird's-eye primrose, and 84 nationally scarce invertebrate species such as the northern brown argus and the glow-worm, recorded in our Magnesian limestone grasslands. Much of the Magnesian limestone grassland in the area is protected by the designation of Site of Special Scientific Interest (SSSI)

Due to agricultural "improvements" such as ploughing and reseeding with more productive grass mixes, and the application of artificial fertilisers, there has been a sharp decline over the last 50 years in the area covered by this form of grassland. This makes protecting and managing what is left an important task.

Important species found in Durham's Magnesian limestone grassland include:

Brown hare
Grey partridge
Song thrush
Skylark
Northern brown argus butterfly
Glow worm
Dark red helleborine
Blue moor grass
Bee orchid

Looking after it

The most important meadows are managed by English Nature, Durham Wildlife Trust, the National Trust and the local authorities. They are protected by law from any potentially damaging operations such as ploughing or top-dressing with inorganic fertilisers. The main risks to Magnesian limestone grassland include:

Agricultural intensification(see above)
Overgrazing
Under grazing
Grazing at the wrong time of year
Building and development

Succession

There is a constant process of directional change in most habitats in Britain. This is related to factors such as competition between plants, interactions with animals, like grazing and browsing and changing localised conditions such as shading or soil changes brought about by the plants present. (see illustration in Section 3)

A patch of bare earth will soon be colonised by "weed" species, which have light mobile seeds and can take advantage of the open, light conditions without any competition for water, sunlight and other essentials for growth, from other plants. These plants are soon replaced by more competitive plants which soon out-compete the original colonisers and grassland develops.

Gradually tree and shrub seeds find their way into the grassland and many of the grassland species can no longer grow due to the low light levels under the developing scrub; a scrubland develops.

Finally tree species come to dominate and a woodland has grown up where once there was bare earth.

Throughout this succession the community of plants and animals changes so that the woodland community at the end is very different from the early communities, with very few species in common. Woodland is the end point for most succession in Britain. The only thing that gives us the wide range of habitats we value so much is if the process is halted, for example by grazing to retain as grassland.

Succession in Magnesian Limestone Grassland

The natural process of vegetation succession is controlled by correct grazing. If grazing is stopped, scrub will colonise the grassland and gradually replace rich grassland communities with poorer, scrubby vegetation. Some widely scattered scrub within the grassland however is valuable. A major task therefore is to ensure that scrub doesn't take over. This is done by cutting and removing scrub.

Other important management is to ensure the levels of grazing stock, cows or sheep not horses, are not so high that everything is grazed bare or so low that a few coarse grass species start to dominate and out-compete more valuable plants present. Grazing is best done in autumn and never between June and August when the plants are in flower and setting seed.

If grazing isn't possible then the grass is cut instead of grazed and the cuttings are removed so they don't rot back into the soil and enrich it. This enrichment would encourage a few coarse grasses and other species to dominate, reducing the rich diversity of the grassland.

A Grassland Community

An ecological community consists of all the organisms found living together in a given place. Usually the most obvious organisms are the plants. The species of plants found are determined by a range of environmental factors including climate, soil, hydrology and often complex interactions with other species of both plant and animal. In general the plants in the community are the beginning of the food chain as they fix energy from sunlight. (See diagram of grassland food chain)

As well as this simple relationship between plants and animals there are more complex

ones. For example many invertebrates require a particular food plant for their offspring. In Magnesian limestone grassland a good example is the northern brown argus butterfly which lays its eggs on common rockrose. A very closely-knit community with many complex interactions between the organisms present, exists in most ecosystems. The loss of one organism can lead to the loss of many others.

Key Concepts

Food chains

For more information on food chains see the text relating to food chains in section 1.10 Wooded Denes.

Examples of grassland food chains

Grass → field vole → kestrel

Nectar → fly → spider → meadow pipit

Plant sap → greenfly → ground beetle → shrew → weasel

Adaptations

For more information on adaptation see the text relating to this in Section 1.10 Wooded Denes.

A good example of an adaptation in grasslands is the grasses themselves. If you mow the lawn the grass grows back again very quickly. If you did the same thing to a lot of other plants you would probably kill them especially if you do it every week. Grass has become adapted over millions of years to being eaten down to ground level by many different animals such as deer, rabbits, horses, cattle, sheep etc. All of its growing shoots start off really close to the ground where the grazing animals don't reach.

Habitats

For more information on habitats see the text relating to this in Section 1.10 Wooded Denes.

A grassland habitat is an open, sunny place often exposed to the wind and rain. There is no shortage of light, and so energy for making seeds during the summer, so flowers can appear when the soil is warm and there is most sunlight. There are many wild flowers producing pollen and nectar and so grasslands are home to many different flying insects that can travel easily from flower to flower.

Some insects need the sunny conditions to warm themselves in the morning before they can become active. Others need to nest and raise their young in open bare patches that are warmed by the sun, for example several types of bees, wasps and ants.

The grass stalks and flower stems provide an excellent structure for spiders to build their webs and so take advantage of all the "fast" (flying) food on offer.

The dense mat of grass and vegetation allows voles to run around unseen in grassy tunnels, hidden from their predators - fox, stoat, weasel, kestrels, owls etc.

Classification

For several hundred million years, plants and animals have slowly changed (adapted) to suit and use their surroundings to their best advantage. Really good adaptations that helped find more food or allowed them to survive were passed on to offspring and became more common.

The result of this was that we now have an amazing variety of different plants and animals, many of which look very different from each other. Plants and animals that look similar to each other possibly have the same ancestors; humans, gorillas, chimpanzees, orang-utans all have similar features that show we are related.

Everything around us can be grouped in similar ways according to what they look like, how they live and how they produce offspring. Grouping the living things around us like this can help us to understand them better. It helps us to predict for example

what a newly found plant or animal may need or how it may live.

One way that we split things up into groups is by deciding if animals have a backbone or not. Then we may count how many body sections it has or how many legs it has got. The more information we can gather, the closer we can get to the group it belongs to.

Insects are easy, they all have six legs, we can then look to see if it has wings and if so, how many. Eventually we can give the insect a species name like cabbage white butterfly, all of which look the same, have the same needs and can produce offspring together.

Grasslands and woodlands are good places to look for minibeasts that can be grouped together like this.

Curriculum Links

Science	
KS1 AT Levels 1 - 3	
Sc1 *all*	*Sc2* *1,2,4,5*
KS2 AT Levels 3 - 5	
Sc1 *all*	*Sc2* *4,5*
Geography	
KS1 AT Levels 1 - 3	
1,3,4,5,6,7	
KS2 AT Levels 3 - 6	
1,2,3,5,7	

This topic also has strong links to the National Curriculum in Maths, English and ICT.

Places to visit

Nose's Point

Dene Mouth

Hawthorn Meadow
(adjacent to Hawthorn Hive)

Links to other sections in this pack

Geology and the landscape 1.3
The wooded denes 1.10

Resources

Books

The Wildflower Key Francis Rose - Warne
Grasses, Rushes, Sedges and Ferns - Fitter, Fitter and Farrer
Collins Field Guide to Insects Michael Chinery
Complete British Wildlife Photoguide Paul Sterry - Collins
Field Guide to the Wild Flowers of Britain - Reader's Digest
Butterflies and Moths of Britain and Europe - Hoffman and Mark Tanner
DK Pocket Nature Insects and Spiders McGavin
Field Guide to the Butterflies and other Insects of Britain - Reader's Digest

Web sites

www.ukbap.org.uk (follow the link to access habitats and local action plans)
www.wildlifetrust.org.uk (includes a good image library under "UK wildlife" link)

1.10 The Wooded Denes

Our wooded denes are wildlife havens and green oases which are real natural treasures along the Heritage Coast

Development of the Denes

The denes are the product of erosion caused by the melt water from a succession of ice ages. The last Ice Age finished approximately 12,000 years ago. The torrents of melt water carved deep into the underlying rock leaving a very bare and desolate looking landscape.

Gradually as the ice retreated with the warming climate the denes were colonised by lichens, mosses, tussock grasses and ground-hugging shrubs. Soils slowly developed with the changing climate and the denes and surrounding countryside gradually became wooded. The trees and plants here now represent the climax vegetation for the denes under the present climatic conditions, with some changes in species due to human interference.

The denes are influenced by the underlying Magnesian limestone which makes the soil less acidic. Plants that like acidic soil cannot grow well here and are out-competed by those more tolerant of the limey conditions. The typical trees and shrubs you will find in the denes are ash, wych elm, yew (particularly in Castle Eden Dene), english oak, hazel and hawthorn. There are also a number of introduced trees such as sycamore, larch and spruce.

Plants on the woodland floor vary with changing soils; typical are dog's mercury and wood anemone, some striking plants such as herb paris and a range of woodland grasses such as tufted hair grass and creeping soft grass.

The structure of a woodland

The best woodlands for wildlife have four layers of vegetation (see illustration in Section 3):

The canopy - trees such as ash, elm and yew

The under storey - shrubs such as hazel and hawthorn plus sapling trees

The field layer - plants such as dogs mercury, wood anemones and bluebells

The ground layer - mosses, fungi, dead leaves and dead wood

The more layered the woodland, the more varied the wildlife it can support, as some animals need several layers to feed, breed and find shelter. For example several species of birds will feed in the ground layer and nest in the shrub layer or canopy. Some species of butterflies for example the white-letter hairstreak will lay eggs only on a particular tree species (elm) but feed in the field layer itself on the nectar of various woodland flowers.

Nutrient cycles and the woodland recycling centre

Woodland plants require the plant nutrients present in solution in the soil in order to grow. These must be in an inorganic form in order to be taken up by the roots. Dead plant and animal material is full of plant nutrients but in an organic form which roots are unable to absorb. The woodland floor is a recycling station for these nutrients. Many of the invertebrates present in leaf litter are involved with shredding and breaking down plant material thereby assisting the fungi and bacteria present to convert the organic compounds present back into inorganic compounds which can then be taken up by the roots. If it wasn't for the activity of the fungi, bacteria and detritivores in the leaf litter, very soon the soil would have no more nutrients left and the woodland would die. This process occurs in all natural systems and without it all life on earth would cease to exist. (see illustration in Section 3)

Interactions and adaptations in a woodland

Food chains and energy flow

The vast majority of ecosystems including woodlands have sunlight as their energy source. Plants fix the energy present in sunlight in a form that can be passed along the food chain often as sugars. Plants are the primary producers within the woodland ecosystem.

Food chains are structured in levels. The next level after primary producers are the primary consumers, the plant-eaters or herbivores. In woodlands these animals could be plant-eating insects such as caterpillars, seed-eating animals such as wood mice or grazers such as roe deer.

Animals that eat the primary consumers are the carnivores and omnivores. There can be several levels of consumers ending with the top predator at the end of the food chain, which in the case of woodlands could be a badger, fox, stoat, weasel, tawny owl, sparrowhawk etc. (See ‘food chain’ under key concepts)

Inter-relationships

There are many examples of inter-relationships in a wood. A good example of an inter-relationship in woodland is given by the white-letter hairstreak butterfly described above.

Several species of gall forming wasp lay their eggs in the buds or leaves of oak trees. The tree then produces a layer of plant material around the developing larva both protecting it and feeding it.

Jays gather and bury acorns often forgetting where some have been buried. These continue to grow. Jays are one of the key distributors of oak trees allowing a much wider distribution from an individual parent tree than would otherwise be possible.

Management

There are no woodlands left in Britain that have not been altered by human activities to a greater or lesser extent. Woodlands are classified as ancient or recent, primary or secondary. Ancient woodland is that which has existed since at least 1600 and usually much longer. Often these places have been continuously wooded since trees first grew after the last ice age.

Usually the older a woodland the better it is for wildlife. All of our denes are ancient woodland but vary in their wildlife value. Castle Eden Dene is the most valuable and is a National Nature Reserve. The more natural the tree cover the better.

The denes vary in the extent of interference by humans. They have all suffered from planting of non-native trees such as spruce and larch or colonisation by non-natives such as sycamore.

Native trees support a rich variety of wildlife. They crossed the land bridge from Europe into Britain and spread north as the climate warmed. The whole woodland ecosystem came with them including the animals that feed on them and shelter in them and the plants that thrive under them.

Non-natives were introduced by humans and came without their ecosystems. They have been introduced into a different type of woodland to the one that they developed with.

Fewer of our native animals and plants can feed on these non-natives needing or preferring native trees such as ash and hazel.

Usually the best form of management for our denes is to encourage our native trees and gradually remove the non-native species. This helps to preserve the plants and animals belonging in the woodland, providing the right growing conditions for the plants and the right food and shelter for the animals.

Woodlands provide a wider range of habitats if they contain a varied structure. Among the structural features that make a woodland more valuable for wildlife are open sunny glades and tracks with wild flowers, old trees with plenty of rot holes and dead wood and branches, ponds, streams and rocky outcrops. This is an addition to the four layers previously mentioned.

History

Humans have long used woodlands to meet many of their needs including a source of food, medicine, firewood and building materials.

Management methods developed to exploit the woodlands to their full. Many trees grow back multi-stemmed if cut down. This practice, called coppicing, provides a quick crop of stems for weaving fences called hurdles, the wattle in wattle-and-daub walls, fodder for cattle and faggots for burning. Larger trees provided the timber for buildings, carts and ships. Some coppice trees were left to grow thicker stems and cut to make charcoal for use in iron smelting. Coppiced oak was stripped of its bark for tannin to be used during the leather tanning process.

With the arrival of the Industrial Revolution many woodlands started to fall into decline and the strong links between local communities and their woodlands started to breakdown. Woodlands once vital in supplying the needs of local people have now become more important to them as a recreational resource.

Key Concepts

Habitats

A habitat is the place where animals and plants live and that supplies all of the things they need to live and have young. Habitats vary a lot according to physical factors such as temperature, amount of water or rainfall, amount of light, depth of soil, how windy it is and many other factors besides.

A habitat can change due to the effects of the living things present. If trees grow in a grassland habitat for example, it becomes more sheltered and moist; it also becomes more shady. It gradually becomes a woodland habitat. The animals and plants present change as the habitat changes. Most prefer to live in just one habitat although some can live in more than one.

A woodland habitat is made up of a mixture of layers of vegetation starting with trees, below which is a layer of bushes, below which are growing grasses, ferns and woodland flowers and finally right at the bottom is a layer of dead leaves, fallen branches, fungi and mosses. These layers provide a variety of places for animals to live, for example a woodpecker nesting in a hole in a tree or a wood mouse nesting under a fallen log and feeding on nuts and berries from the shrub layer. (see diagram of woodland structure in Section 3)

All things are best suited to live in certain places and in certain ways. They are adapted to live in the habitat in which they are found and to a certain way of life.

Adaptations

Adaptations can take many different forms. Some may be physical, such as the wings on a butterfly and its long tube like mouth for sucking up nectar. Others may be

behavioural, for example woodlice need to be in damp places and if you expose them to light (possible drying-out) they scurry away to hide in the dark and damp again.

Squirrels

Squirrels are rodents that learned to live in trees. The primary adaptation to an arboreal life was the development of strong hook-like claws on the back feet at an angle that allows the squirrel to attach into the bark and hang and move facing down the trunk of the tree. The tail has developed as an excellent tool to assist with maintaining balance.

Woodpeckers

The woodpecker is able to cling to bark because it has two backward pointing toes as well as two forward pointing ones on each foot; other birds have only one backward pointing toe. This allows it to get a firm grip and cling onto and under branches. Its chisel like beak, with built-in shock absorber, allows it to hammer into bark and dead wood looking for minibeasts. In addition to this it has a very long tongue which it uses to collect minibeasts from inside the wood.

Wood anemones

Wood anemones, like many woodland plants, flower early in the year before the leaves on the trees block out the light. In this way the leaves of wood anemone can capture enough sunlight to allow it to make seeds.

Nutrients Cycles and decomposition

Plants need plant food (nutrients) in the soil in order to grow. When a plant dies it is still full of these plant foods. If they aren't released back into the soil other plants will not be able to use them to grow. When a plant, or an animal, decomposes in the soil it releases all the plant food it contains back into the soil. The fungi (many of them produce toadstools) and the bacteria that live in the soil do this important job of recycling plant nutrients. They are helped by many of the animals that live in the soil and leaf litter such as earthworms and springtails. (see illustration in Section 3)

Food chains

All living things need energy to help them grow, move and reproduce. This energy comes from the Sun. Plants, for example grass, can catch the energy in a beam of sunlight and turn it into sugars. Sugars are stored sunshine energy. An animal that eats that plant, for example a rabbit, gets all the stored sunshine energy in that plant and can use it to grow and produce muscle, bone and baby rabbits. If that animal is eaten by another animal, for example a fox, the fox will get all the stored sunshine energy in the animal that is eaten.

Plants (e.g. grass)

↓

Plant-eating animal - a herbivore (e.g.rabbit)

↓

Animal-eating animal -a carnivore (e.g. fox)

This is a simple food chain. All food chains start with sunshine energy trapped by plants.

Examples of woodland food chains

hazel nuts → wood mouse → tawny owl

oak leaf → caterpillar → blue tit → sparrowhawk

dead leaf → earthworm → blackbird → fox

Inter-relationships

All living things are connected to all other living things in some way or other. This could be through a food chain, air cycle, the soil cycle or one living thing that may rely on another completely different living thing in some other way; for example woodpeckers need holes in trees to make their nests; oak trees need Jays to spread their acorns far and wide and so help the trees to grow in new places.

Curriculum Links

Science	
KS1 AT Levels 1 - 3	
Sc1 *1,2*	*Sc2* *1,2abdefg,4,5*
KS2 AT Levels 3 - 5	
Sc1 *1,4,5bcdef*	*Sc2*
Geography	
KS1 AT Levels 1 - 3	
1abd,3ab,5a,7ab	
KS2 AT Levels 3 - 6	
1abc,2abd,3abe,7abc	

This topic also has strong links to the National Curriculum in English and ICT

Places to visit

Castle Eden Dene

Hawthorn Dene

Crimdon Dene (less suitable)

Links to other sections in this pack

Geology and the landscape 1.3
Magnesian limestone grassland 1.9

Resources

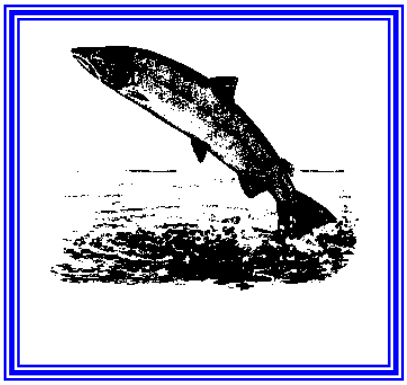
Books

Grasses, rushes, sedges and ferns - Fitter, Fitter and Farrer Collins
Woodland Nature guide - Cloudsly Thompson Crowood
The ever changing woodlands - Readers Digest
Collins Field Guide to Insects - Michael Chinery
The Wildflower Key - Francis Rose - Warne
Field Guide to the Trees and Shrubs of Britain - Reader's Digest
Field Guide to the Animals of Britain - Reader's Digest
RSPB Handbook of British Birds Holden and Cleeves
DK Pocket Nature Fungi - Evans and Kibby
See also invertebrate and flower books in Section 1.9

Websites

www.the-woodland-trust.org.uk
www.smallwoods.org.uk
www.communityforest.org.uk
www.wildlifetrust.org.uk
www.ukbap.org.uk/habitats (follow link to access habitat and local action plans)

1.11 Life Beneath the Waves



Beneath the waves off the Durham Heritage Coast there is a vast underwater world full of life which can be amazing, intriguing and sometimes awe-inspiring

The Seabed

The seabed itself consists of a number of quite distinct communities which vary with the substrate, the depth of the water and the level of disturbance from water flow and human interference.

Kelp beds

Where rocks are exposed and the water is not too deep or cloudy to filter out too much light, forests of kelp can develop. If wave action is severe, kelp is often sparse.

Kelp forest can sometimes be seen at low tides, a particularly good a place is Featherbed Rocks near Seaham. After storms kelp can often be found washed up. North of Seaham is the only place where there are currently extensive kelp beds.

Kelp forests are very important for wildlife; they provide food and shelter for a rich variety of plants and animals. In the shelter of the forest the rocks themselves are colonised by barnacles, tube worms, seaweed and sea mats as well as many other animals. Attached to the holdfasts are other sea weeds, sea anemones, bryozoa, sponges and sea squirts. Down amongst the holdfasts lobsters, crabs and small fish shelter and feed. (see diagram in Section 3)

The forest is a nursery for many sea creatures. Young fish such as herring and mackerel swim in the protection of the canopy. In fact the kelp forests are very important for maintaining fish stocks, with an estimated 220,000 juveniles in a hectare of forest.

Wrecks

Any hard substrate soon becomes colonised by the free-floating larvae of many different species of sea animals. Wrecks can soon become an underwater wildlife haven acting as an artificial reef covered in a mat of animal life.

Wrecks are colonised by a wide range of animals including the soft coral called dead man's fingers, hydroids, hornwrack and other bryozoans, sea anemone, solitary and colonial ascidians (sea squirt), spider crabs, sea slugs and brittle stars. This rich accumulation of life attracts more mobile marine animals to feed on the animals present and to shelter. Wrecks act as an important nursery area for many species of fish.

Sublittoral sand and gravels

These are the sediments that occur below the low-tide mark. They may extend well offshore and are our commonest marine habitat. They can be made up of a range of particle sizes from mainly sand and mud to mainly gravel. (see drawing ‘life beneath the waves’ in Section 3)

Although common they are internationally important because of the high number of animal species they support. They have a very important place in the marine ecosystem. In particular, from a human point of view, they are crucial nursery areas for commercial fish species such as flat fish and bass. Sand eels are another very important species of fish present. These are vital prey for several of our important and threatened sea bird species such as little terns.
The range of animal species present is large and varied and includes:

Polychaete worms
Molluscs
Starfish
Crustaceans e.g. crabs and lobsters
Sea anemones
Whelks
Sea urchins

The less disturbed areas further offshore are the most diverse although with the cessation of the dumping of colliery waste into the sea more animals are now colonising the deposits closer to shore. The most common substrate is muddy sand.

The area of water above sublittoral sediments is an important part of the habitat. Some of the larger animals use these areas for feeding, shelter and living space. These include seals, harbour porpoises, bottle-nosed dolphins and sea birds such as terns and cormorants, which feed here on fish such as sand eels, herrings and sprats.

The open water - a vertical habitat

In addition to these fixed habitats the water itself is a varying habitat for a wide range of free-floating organisms as well as mobile animals. (see drawing 'Life beneath the waves' in Section 3)

A common reproductive strategy in marine organisms, both plant and animal, is for individuals to produce many thousands, even millions of offspring that spend the first phase of their life as small microscopic organisms floating and drifting with the currents and tides. The cumulative name of these organisms is plankton and it floats in the water column. (See crab life-cycle diagram in Section 3)

The plankton can be divided into two: phytoplankton which consists of the plants and zooplankton which consists of the animal species. The phytoplankton is always found near the surface where the light is strongest. The zooplankton moves lower down in the water column during the day and rises closer to the surface at night. The fish that feed on the zooplankton such as basking sharks and fish that prey on the fish that feed in the zooplankton, such as mackerel, follow the plankton so that at night these fish are generally closer to the surface than during the day.

Niches, Competition, Predation and Evolution

A niche can be viewed as part of a habitat that offers an opportunity to avoid competition. If a species can find a way of exploiting a resource that other species cannot access than it reduces competition and increases its reproductive success. The community of animals that live on or in sublittoral sands and gravels provides some good examples of how a limited resource has been divided up and used through the process of evolutionary change.

The benthic (bottom dwelling) communities can be divided by way of life into three categories:

Infauna - those animals that literally live in the sediments egg. some polychaete worms, bivalve molluscs, sea urchins and amphipods

Epifauna - those that live on the surface e.g. starfish

Highly mobile predatory fauna e.g. octopus, fish species such as cod etc

They can also be divided by the way they feed:

Suspension feeders which filter the food out of the water

Deposit feeders which sieve food out of the mud and sand

Predators for example sea urchins and fish

Scavengers for example crabs

In adapting and using different parts of the habitat for feeding, shelter, avoidance of predation etc the animals have developed forms that best suit them to the task. Many strikingly different forms have evolved to cope with the demands of feeding on the varying food sources or ways of avoiding being eaten. The slimline torpedo shape of the sand eel that allows it to dart head first into sand and "swim" through it to hide, is a good example of this, as are the feeding tentacles of some tube dwelling worms, or the siphon tubes of burrowing bivalve molluscs that suck sediment in and digest the organic part of it.

Key Concepts

Food chains

All living things need energy to help them grow, move and reproduce. This energy comes from the Sun. Plants, for example grass, can catch the energy in a beam of sunlight and turn it into sugars. Sugars are stored sunshine energy. An animal that eats that plant, for example a rabbit, gets all the stored sunshine energy in that plant and can use it to grow and produce muscle, bone and baby rabbits. If that animal is eaten by another animal, for example a fox, the fox will get all the stored sunshine energy in the animal that is eaten.

Plants (e.g. grass)

↓

Plant-eating animal-herbivore (e.g.rabbit)

↓

Animal-eating animal-carnivore (e.g. fox)

This is a simple food chain. All food chains start with sunshine energy trapped by plants.

(For examples of marine food chains see diagrams in Section 3)

Adaptations

All things are best suited to live in certain places and in certain ways. They are adapted to live in the habitat in which they are found and to a certain way of life.

Adaptations can take many different forms. Some may be physical, such as the wings on a butterfly and its long tube like mouth for sucking up nectar. Others may be behavioural, for example woodlice need to be in damp places and if you expose them to light (possible drying-out) they scurry away to hide in the dark and damp again.

Most sea animals get the oxygen they need from the water around them. Often this is done through gills. These may be like those that fish have or they may be feathery looking like on some sea slugs. Adaptations to swimming include streamlining; this is what helps fish slip effortlessly through the water.

Animals have also adapted ways of getting at the different foot sources around them. Some, like barnacles, sieve food out from water. Others like cockles suck up sediments and digest out the food that that is in it. Others may have waving tentacle like projections that catch unwary passers-by, for example sea anemones and jellyfish.

Habitats

A habitat is the place where animals and plants live and that supplies all of the things they need to live and produce young. Habitats vary a lot according to physical factors such as temperature, amount of water or rainfall, amount of light, depth of soil, how windy it is and many other factors besides.

A habitat can change due to the effects of the living things present. If trees grow in a

grassland habitat for example, it becomes more sheltered and moist; it also becomes shadier. It gradually becomes a woodland habitat. The animals and plants present change as the habitat changes. Most prefer to live in just one habitat although some can live in more than one.

In the sea there are many different habitats. Have a look at the drawing of life beneath the waves in Section 3. Some animals live at or on the bottom of the sea and some even hide in the muds and sands found there. Others prefer rocky or hard surfaces like wrecks. Here you will find animals that cling on or attach themselves to the rocks, often filtering food out of the water. Other animals live in the open water moving around freely sometimes feeding near the surface sometimes lower down.

Life Cycles

Most of the plants and animals that live in the sea (except for mammals like seals, dolphins and whales) produce hundreds, thousands and even millions of tiny offspring that look nothing like the adults. These float off and join the plankton, lots of tiny plants and animals that float in the water often very close to the surface. Eventually they will grow and change to become adults and start the whole cycle again. The vast majority never make it to adulthood being eaten by the many predators in the sea. The crab is a good example of an animal that goes through a life cycle like this, living the early part of its life in the plankton before settling on the seabed as an adult.(see the diagram of a crab life cycle in Section 3)

Curriculum Links

Science	
KS1 AT Levels 1 - 3	
Sc1 *1,2*	*Sc2* *1,2abdefg,4,5*
KS2 AT Levels 3 - 5	
Sc1 *1,4,5bcdef*	*Sc2*
Geography	
KS1 AT Levels 1 - 3	
1abd,3ab,5a,7ab	
KS2 AT Levels 3 - 6	
1abc,2abd,3abe,7abc	

This topic also has strong links to the National Curriculum in English and ICT

Places to visit

Featherbed Rocks to see kelp beds at very low tide.

The Sea Life Centre at Tynemouth

Links to other sections in this pack

People and the coast - sustainability and the future 1.6
The sea as a force of nature 1.7
Life on the seashore 1.8

Resources

Books

Field Guide to the Waterlife of Britain - Reader's Digest

Coast and shore – a nature guide Brian Brookes Crowood

Secrets of the Seashore Reader's Digest

See also books in Section 1.8

Websites

www.wildlifetrust.org.uk (includes a good image library under "UK wildlife" link)
www.mcsuk.org (Marine Conservation Society)
www.wwf.org.uk

1.12 Get Close to the Coast

An easy to lead, carefully structured and crafted approach to getting in close touch with the wonders of the natural world

There is more to learning about the natural world around us than can ever be taught; part of the learning comes from within the individual not from a book or a lesson.

Our relationship with the natural world and the way we treat it comes in large part from the way we feel about it. Like all relationships our feelings develop and change through direct contact; we become more comfortable and at one with it: we come to a better understanding and heightened awareness.

This section aims to assist the process of personally getting to know the natural world. It contains a photocopy-able booklet that can be used in any natural environment to immerse the children in their surroundings, making direct one-to-one contact.

Immersers and Earth Education

The activities used are called immersers and this describes very precisely what they are designed to do; a process of total immersion into a natural environment to enjoy it, see it and sense it in new ways and come to a respect, understanding and appreciation of it.

Immersers are part of an approach called Earth Education. This approach aims to help people to care for and appreciate the natural world (using immersing experiences), to develop a clear understanding of the ecological processes that support all life on the planet and finally to encourage individuals to reduce their impact on the environment.

There are several Earth Education books available through the Institute for Earth Education (see address at the end of the section). They offer a wide range of immersing experiences to use, as well as excellent, hands on and minds on, captivating activities which enthuse the learners and develop clear understandings of processes such as energy flow, photosynthesis, adaptations, community, the soil cycle, water cycle, inter-relationships and so on (see the resource list).

Joseph Cornell

Joseph Cornell has also produced a range of immersing experience activities which are well worth using (see resource list). His books also contain many good games for reinforcing understandings of the natural world.

Use this section as an "off the peg" immerser but please explore the other activities in print. There is a huge range of activities that will entrance and captivate your pupils.

Resouce List

Earth Education

Earthwalks
Sunship Earth
Earthkeepers

All published by the Institute for Earth Education at Ringsfield EcoStudy Centre, Ringsfield Hall, Beccles, Suffolk, NR34 8JR
Tel: 0845 4583017 office@earthed.org.uk

Joseph Cornell

Sharing Nature with Children
Sharing the Joy of Nature

Guidelines for use of the booklet

You will need:

A booklet and pencil each
A few pairs of scissors
A "post box"
A sit-upon for each person (small waterproof mats about 40cm x 40cm)
A clipboard and paper for the poets
A selection of natural objects from the area
Blindfolds (optional)

The class should be split up into four groups with about 8 children to one adult during this activity. The groups are given an area each to use; these areas should be contiguous between the groups.

Each group goes to its allotted area; each child is given a spot of their own at least 15 metres from their nearest neighbour but within sight of their group's adult. The spot should be interesting, with plenty of variety, and comfortable. Care should be taken to ensure that children who could potentially interact disruptively are well separated from each other possibly with the adult between them.

The booklet is self explanatory however please note the following points:

Sharing

After about 30 to 45 minutes, depending on the group, gather the whole class back together. Half of the class "post" their post cards into a box, the other half then draw one out each. In these pairs they first share one special place and then the other exchanging post cards at the end of the visit to the first special place. During the sharing see if the "visitor" can find the postcard view, show each other nature's treasures and other special things discovered and share the haiku if one has been written. Allow about 15 minutes in total for the sharing sessions depending on the class. The group's adult should stay in their group's original location to oversee the activity.

A class poem

From each pupil collect the one word that they have chosen that best reminds them of their special place. Choose two poets from the class who will use all of the words to produce the classes very own poem about the natural place you are visiting. Allow about 10-15 minutes for the poets to produce the poem. Some really effective and striking poems have often been produced by simply arranging the words in an order that makes sense or paints a picture of the place and its atmosphere. Only allow the poets to introduce conjunctions etc. not new adjectives or nouns etc.

You will need a fill in activity while the poets are at work. A useful activity is to get the smaller groups back together sitting in their circles with an adult; the adult then produces a series of natural objects to pass around the group. Each person in the circle describes or says one thing about the object as it is passed round. Depending on the group you could also try to build a story about the object. The adult starts with the first line of the story and as it is passed from one person to the next, one sentence of the story is added by each person, each one picking up where the last left off.

A variation is to have all the children in the circle blindfolded, give one child an object and ask them to describe it and then pass it round the rest of the group so they can feel it and decide if it was what they expected from the description. Ask them to guess what it is when they have all handled it. A new object is introduced to the left of the first child and so it continues till they have all had a turn with a mystery object.

Performance

When the poets are happy with their work gather the whole class back together in a large circle, get them to turn around and face outwards from the circle and sit down on their sit-upons. When they are settled the teacher sitting in the middle of the circle reads the poem out slowly while the class looks outwards viewing the subject of the poem, the natural place they are visiting. Encourage a round of applause for the poets and the class itself and then tell them that it was so good that it deserves an encore. Read it again so that they can soak up the atmosphere of the place conveyed to them in the words that they themselves chose.