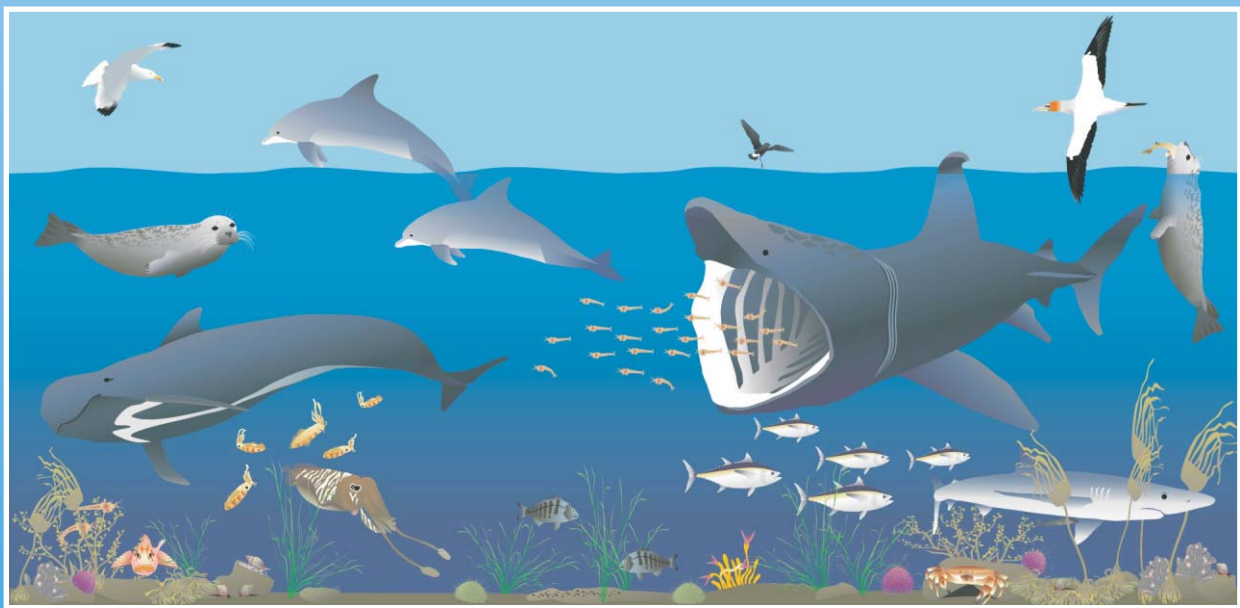# Explore the Seafloor

Biology
Teacher's Pack

What sea animals live on the seafloor?

This teacher's pack contains activities and suggestions designed to complement the teaching of a case study on marine ecological research aimed at Key Stages 3 and 4.

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Case Study

What sea animals live on the seafloor?

This teacher's pack contains activities and suggestions to complement the teaching of a case study on marine ecological research aimed at KS3 and 4. The case study aims to support the curriculum by providing a real-life application of science in the workplace. It was developed as part of the Explore the Seafloor project, funded by the Marine Aggregate Levy Sustainability Fund (MALSF).

This case study comes from the research undertaken as part of a Regional Environment Characterisation (REC) survey. In 2008, MALSF commissioned research into four main dredging regions in the United Kingdom – the Thames, South Coast, East Coast and Humber. These studies involved experts from universities, survey companies and heritage organisations investigating the archaeology, geology and ecology of the seafloor. The aim of the studies was to ensure that we use the sea sustainably, without damaging its natural or physical heritage.

Using this teacher's pack

This pack provides background information to accompany a PowerPoint presentation on the case study, which can be downloaded from web address http://ets.wessexarch.co.uk/teachers/biology/

The Explore the Seafloor project has produced an interactive website (http://ets.wessexarch.co.uk/), filled with interesting resources and more information about each REC. In addition, there are many ways to develop this lesson beyond Explore the Seafloor. Through this pack, colour-coded boxes will indicate opportunities to use our resources, where to find out more and possible discussion topics.

Blue	**Activity or resource**
Green	**Find out more**
Red	**Film**
Yellow	**Discussion**

The following resources are available to download from: http://ets.wessexarch.co.uk/teachers/biology/

E-Games

1. Be a Seafloor Explorer

Interactive Whiteboard Lessons

2. Infauna or Epifauna?
3. In the Lab
4. Food Chains

Film

5. Talk to the Scientist (films 1-5 or ALL) – Marine ecologist Bryony Pearce talks about elements of the Humber REC. The PPT and teacher pack indicate when it may be useful to use a section of the film.

PDF

6. Activity Sheet 1: In the Lab
7. Activity Sheet 2: Case Study Review KS3
8. Activity Sheet 3: Case Study Review KS4

Films are downloadable from the website or you can watch them online at YouTube or Vimeo - links to channels available on the lesson webpage.

Check out our Resources page http://ets.wessexarch.co.uk/resources/ for more material to use in your lessons.

Learning outcomes

- Explore different scientific methodologies used for marine research
- Understand what types of animals live on the seafloor and that they live in different habitats
- Understand the role of benthic macrofauna as part of a food web
- Develop the ability to understand and communicate scientific concepts and apply them to the real world
- Understand ecological terms used in scientific research
- Develop the ability to critically analyse and evaluate evidence from scientific research
- Identify that human activity can lead to changes in the environment
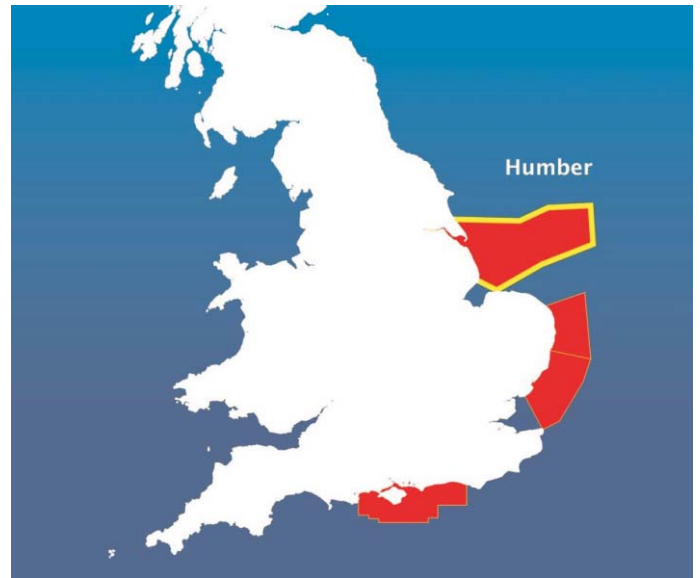
Case Study

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http://ets.wessexarch.co.uk/teachers/biology/

What is an REC? [Slide 3]

This case study comes from the research undertaken as part of a Regional Environment Characterisation (REC) survey. A REC is a regional assessment of the geology, ecology and archaeology of the seafloor using information gathered through desk based assessment, geophysical data and sampling surveys. The website http://ets.wessexarch.co.uk/ allows you to explore the results for four of the REC study areas. – South Coast, East Coast Humber and Outer Thames Estuary.

Activity - Online E-Game: Be a Seafloor Explorer

Humber REC Archaeological Research [Slide 4]

This lesson focuses on the ecological research undertaken within the wider study. The Humber REC study area has a diverse marine environment filled with amazing animals and birds. The aim of the research was to create maps showing the distribution of sea animal communities and their habitats, as well as identifying any areas of special interest, such as rare species or habitat. This will inform marine planning. When industries make applications to government authorities for licences to use an area of the sea, for example for dredging, the authorities can ensure that the work is undertaken responsibly, taking into consideration the protection and care of the marine environment.

Find out more - Useful background information
Explore the Seafloor Humber REC Summary
http://ets.wessexarch.co.uk/recs/humber/
Original Humber REC Report
http://www.cefas.defra.gov.uk/alsf/projects/natural-seabed-resources/rec-0803/final-report.aspx

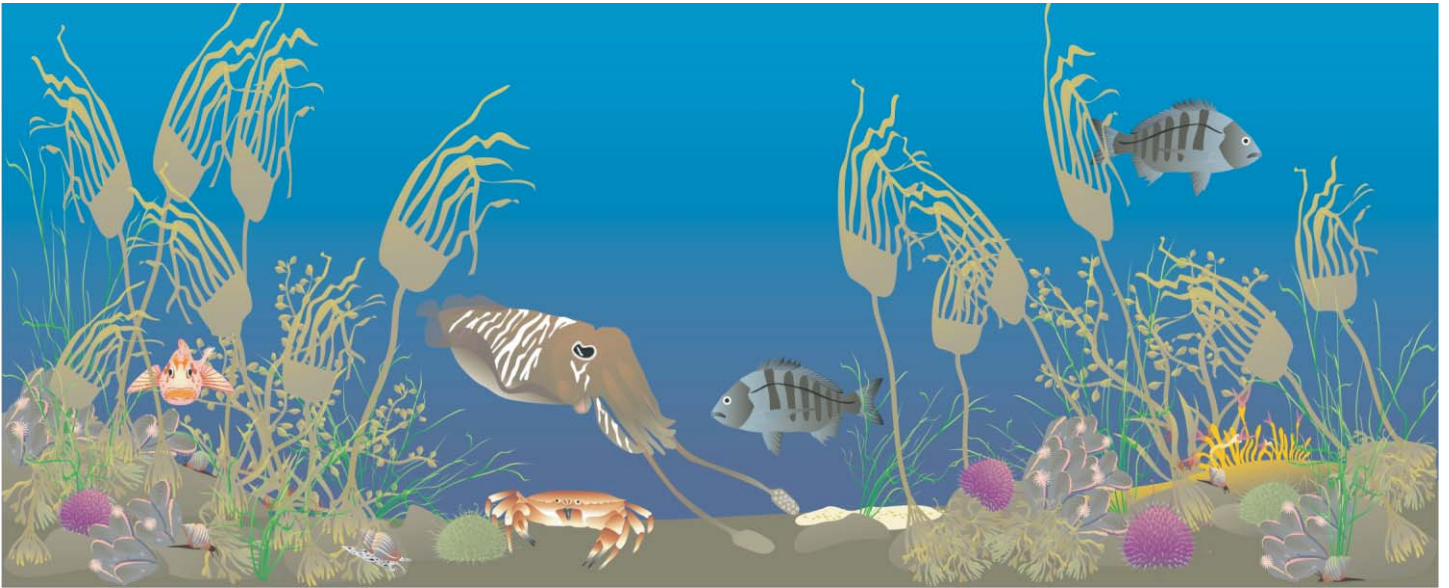**Film (part 1) -** Talk to the scientist: Marine Ecology

The REC Methodology [Slide 5]

There are three main stages to the REC. In any research project, the methodology must suit the aims of the project, but also take into consideration schedule and budget. A REC covers a large area and therefore does not aim to provide detailed information but rather an overview of the whole area.

Stage 1	Collecting Data	• Desk Based Assessment
		• Fieldwork
		• Initial processing of data
Stage 2	Results - Using the data	• Modelling
		• Biotope maps
Stage 3	Recommendations	Highlighting what is special about the Humber REC study area

Stage 1: Collecting data

There are two main ways that the ecologists collected data, through their own fieldwork and through reviewing information already available.

What is a Desk Based Assessment (DBA)? [Slide 6]

A DBA collects and **summarises in a report** information about a defined area, in this case the REC. This includes any relevant research already undertaken and other sources of information about the marine environment for the study area. The North Sea has been the subject of extensive marine research over the last century. A DBA is useful as it brings together many individual pieces of work into one place so people can reference it easily. This information is usually created by a variety of different organisations for a variety of different reasons. The detail the DBA goes into is affected by time, money and the aims of the project. Often DBAs will tell where you can find information, with a brief summary of what it is and its significance, rather than repeat ALL the information in a new report.

Find Out More -
Example: Chapter 2 of the Humber REC Report
http://www.cefas.defra.gov.uk/alsf/projects/natural-seabed-resources/rec-0803/final-report.aspx

Film (part 2) - Talk to the scientist: Benthic macrofauna

Activity - Interactive Whiteboard Lesson: Infauna or Epifauna?

Fieldwork [Slides 7 – 13]

Fieldwork involves collecting original data for the purpose of the research aims. The overall aim of the ecological research was to understand the marine environment in this area. The information gathered will be used to monitor the seafloor for any negative impacts caused by anthropogenic (human) factors and natural factors.

The ecologists focused their fieldwork on studying **benthic macrofauna**. Benthic means 'sea bottom' and macrofauna are animals that are between 1mm and 10cm in size. It is impossible to study all the animals in the marine environment. The REC ecologists focused on these because they are easy to sample compared to smaller or larger animals, and because negative stresses on the marine environment impact on them quickly, so they are early indicators of any problems.
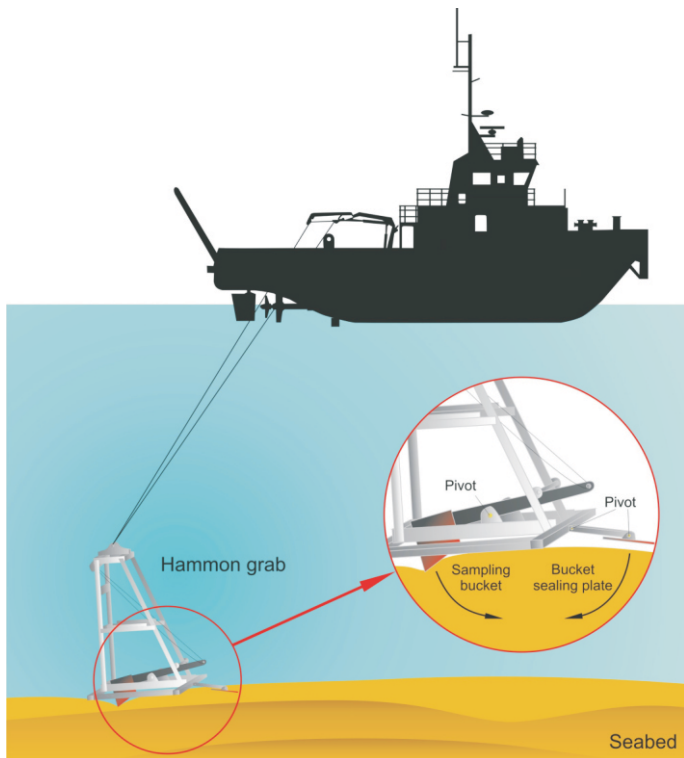
Ecologists divide the benthic macrofauna into two main groups.

- **Infauna** are animals that live in the seafloor, buried in the sediment.
- **Epifauna** live on or just above the seafloor, normally when there is gravel or rocky areas that the animals can attach to.

They also studied other larger mobile animals, like fish, which live just above the seafloor.

Ecology Sampling [Slide 8]

Working out at sea on a boat, the ecologists use three techniques to collect samples.

Hammon grab

Pivot

Pivot

Sampling bucket

Bucket sealing plate

Seabed

• **The Hamon Grab** is primarily used to collect infauna samples, using a sample bucket to scoop up a sample of the seafloor. This also provides samples of the seafloor sediments for geologists to examine, which helps determine sea animal habitats.

• **The Beam Trawl** is a large net that is dragged along the surface of the seafloor. Ecologists use this technique to collect epifauna samples.

• **Underwater photography** takes images of the habitat and also how sea animals are arranged on the seafloor – they provide the setting or context.

No technique is exact, and sometimes the Hamon Grab will collect epifauna samples and vice versa.

Film (part 3) - Talk to the scientist: Ecology Fieldwork
Note: This film covers all the material up to Slide 13.

Where they sampled? [Slide 9]

Ecologists cannot sample the entire area, so they attempt to cover a representative proportion of the REC study area. This slide shows the route of the boat and the locations where the ecologists took Hamon Grab and photographs. It also shows where Clamshell Grabs were collected; these are seafloor sediment samples taken by geologists to assess what the seafloor is made of. The geologists information will help the ecologists identify habitat types across the area. The ecologists took 135 Hamon Grab samples and 30 Beam Trawl samples.
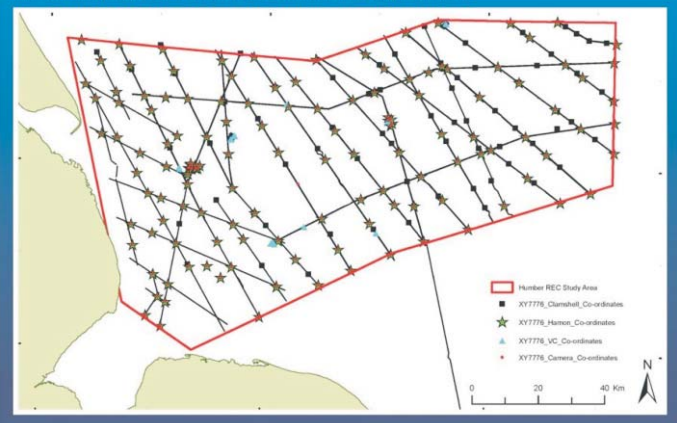
Discussion - Will this sampling strategy provide representative data for the Humber REC study area?

Humber Ecology Samples
Ecologists take different types of samples by a variety of methods across the study area. These include:
• Hamon Grab
• Beam Trawl
• Video or Camera
This map shows the locations of both ecological and geological sample stations in the Humber study area. The stars show the Hamon Grab sample stations.

Underwater Photography [Slide 10]

Images of the seafloor are important to put the information collected through the samples into context. The scientists used a range of cameras for a variety of different reasons and this fed back into the geological and ecological research. **Geophysics survey** is a technique used to take images of large areas of the seafloor, you can find out more about this technique from our Physics Lesson: How do we map the seafloor?

Find Out More - Download our Physics Lesson: How do we map the seafloor?
http://ets.wessexarch.co.uk/teachers/physics/
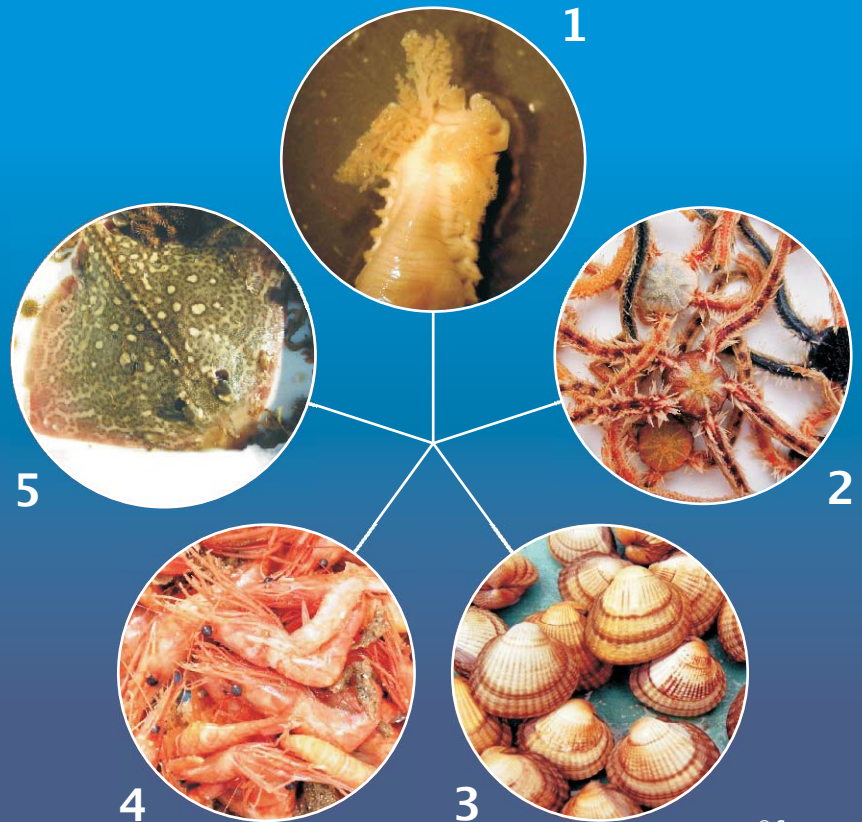
Animal Group Types

1 **Annelida: segmented worms**
e.g. Sand Mason Worm

2 **Echinodermata mostly five fold
symmetrical shapes, e.g. starfish,
sea anemones and sea cucumbers**

3 **Mollusca: bilaterally symmetrical
invertebrates, e.g. cockles, mussels
and clams**

4 **Crustacea: invertebrates with two
parted limbs, e.g. prawns, crabs
and lobsters**

5 **Miscellania: animals from all
other animal groups including fish,
anemones and seamats.**

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Phyla Classification Group

On the boat: sorting the samples [Slide 11]
Once a sample is collected it is processed on the boat. This process differs depending on whether a sample was collected by Hamon Grab or Beam Trawl.

Hamon Grab samples
First, the Hamon Grab sample is photographed. A sub-sample of the seafloor sediments is then taken, which is given to geologists to study. The rest of the sample is sieved and all the fauna is collected, fixed in chemicals and sent to the laboratory.

Beam Trawl samples
Again, they are photographed and the volume of the sample is measured. On the boat the ecologists sort the catch into '**phyla**' (explained above) and identify each species where possible. Any animals too small to identify on the boat are fixed with chemicals and taken back to the lab.
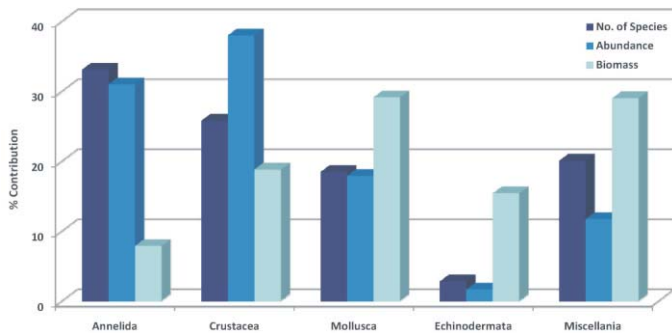
In the Lab [Slides 12 – 13]
Back in the lab, the Hamon Grab sample and any remaining unidentified animals from the Beam Trawl samples are studied. First, the REC ecologists divided the samples by '**phyla**', which is a type of biological classification. The types are **Annelida**, **Echinodermata**, **Mollusca**, **Crustacea** and anything else goes into Miscellania. The animals in each phyla are then sorted into each individual animal species and counted; this is the job of a taxonomist. They found 684 different species of benthic macrofauna through the Hamon Grab samples and 125 different species of benthic macrofauna from the Beam Trawl samples.

Activity - Interactive Whiteboard Lesson or Activity Sheet 1: In the Lab
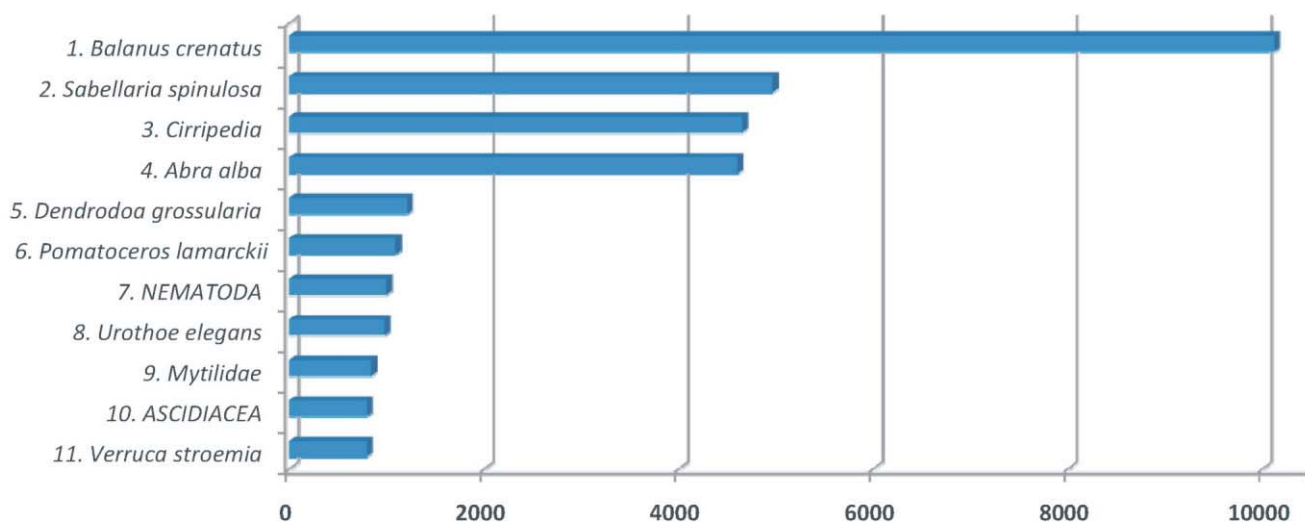
Initial Results [Slides 14 – 18]

These slides show the initial results from the lab work, for animals collected by the Hamon Grab [Slides 14 - 16] and animals collected by the Beam Trawl [Slides 17 and 18].

The **vertical bar graphs** show information collected about the different phyla.
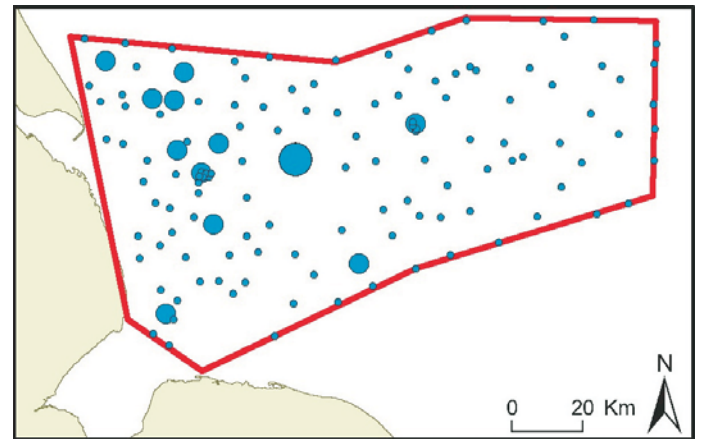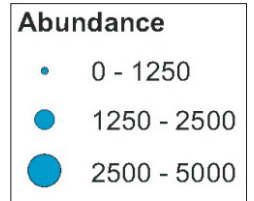
- **The number of species** indicated the biodiversity of that animal type.

- **Abundance** refers to how many animals for that phyla were found

- **Biomass** refers to the total weight of the animals found.

The **horizontal bar graphs** indicate the top ten species collected by each type of sampling method. The animal names are in Latin, but in most cases they will also have a common name in English.

The **maps** indicate how the results can be shown geographically. Slide 16 plots the abundance of animals found in Hammon Grab samples across the study area.

Abundance
- 0 - 1250
- 1250 - 2500
- 2500 - 5000

Discussion -
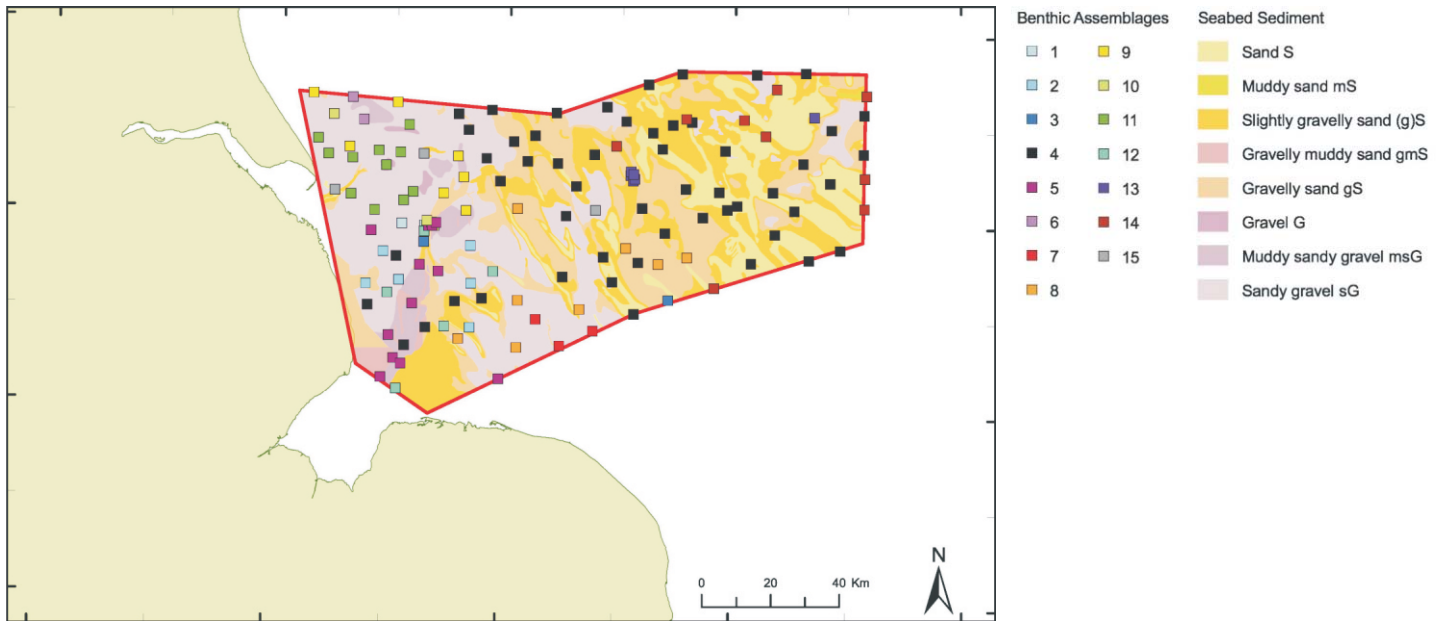**[Slide 14] -** What does this graph tell us about the Hamon Grab samples?

[Slide 16] - What does this map tell us about the diversity of Hamon Grab samples in the Humber REC? What does this mean?

Find out More [Slide 18] - Use the internet to find the common names of the Top 10 Beam Trawl species.

Benthic Assemblages		Seabed Sediment
1	9	Sand S
2	10	Muddy sand mS
3	11	Slightly gravelly sand (g)S
4	12	Gravelly muddy sand gmS
5	13	Gravelly sand gS
6	14	Gravel G
7	15	Muddy sandy gravel msG
8		Sandy gravel sG

Working with geologists – identifying habitats [Slides 19 and 20]

In the sea, there are many different types of habitats and hundreds of different animals. For example, the seafloor may be rocky or it may consist of a particular combination of sand, gravel and mud. Different groups or assemblages of animals will live in the wide variety of habitats in the marine environment.

The REC geologists studied the seafloor sediments collected and geophysical survey images of the seafloor. They created maps of what the seafloor looked like and what the seafloor is made of. This provides important information for ecologists about the types of seafloor habitats that sea animals live in and is vital for Stage 3 of the REC methodology.

The ecologists identified groups or assemblages of animals living together from the information they collected from the Hamon Grab and Beam Trawl. They combined this data with the geologists' map of the distribution of seafloor sediments for the REC study area. They discovered 15 different groups that like to live in different environments, and were able to plot these on a map. On Slide 20, you can see that the benthic assemblage No. 11 is mostly found in the north-west corner of the REC study area, in sandy gravel seafloor habitats.

Note: The Slide 20 map is included as an activity in the Case Study Review worksheets.

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Find Out More [Slide 19] - Download Explore the Seafloor Physics Lesson: How do we map the seafloor?
http://ets.wessexarch.co.uk/teachers/physics/

Discussion [Slide 20] - What habitats do benthic assemblage 11 live in?

Stage 2: Results [Slides 21 and 22]
Biotopes, Biotope Maps and EUNIS Biotopes
Classification System

The marine environment is extremely complex and ecologists use the **EUNIS classification** system to describe it. Ecologists need a clear, standardised way of describing what lives on the sea floor and they do this by describing groups of similar habitats and animals. EUNIS, which stands for the European Nature Information System, holds a list of such groups of habitats and associated animals. These groups are called '**biotopes**' - a biotope is a mixture of the habitat, such as rock or sand, and the animals that live there. Each biotope has its own code and description.

Example: Biotope A4D.9 is 'Moderate energy, deep circalittoral rock and thin sediment'. Circalittoral is a biological word that describes parts of the seafloor where only a small amount of light can reach and so few plants grow; it is usually animal-dominated. This classification only provides information about the physical environment of the habitat.

The system is hierarchical, so it has divisions in its descriptions and then sub-divisions. The longer the biotope name, the more detail about the habitat and animal community you are getting. So Biotope **A4D.9211** is even more detailed than **A4D.921** (mapped on Slide 22), and identifies areas within the more general classification which have deeper layers of sediment (sand), and these areas are characterised by dense populations of two types of bivalves (*Abra Alba* and *Mysella Bidentata*).

There are limitations to this system of classification as it still often generalises the information. In both the Humber and East Coast RECs, they tried other ways of mapping seafloor communities and their habitats. However, the EUNIS biotopes classification system is a useful way to describe areas of the marine environment because it is a classification scheme that can be understood by marine scientists all over Europe.

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Modelling data

Once the ecologists have analysed and classified their samples into EUNIS biotope categories they can produce the map to show where these categories are located in the study area.

However, it is impossible to sample every bit of the seafloor in the REC study areas, so producing a useful map involves a process called '**modelling**'. This process makes an estimation about which biotope is likely to belong to the un-sampled areas. It fills in the gaps.

Ecologists use a wide range of data to calculate the most likely biotope present. This includes data such as the water depth and tidal currents. They also use geophysical images and data to suggest what the seafloor is like, which helps identify the possible habitat type.

Based on these informed estimates, the REC produced detailed biotope maps for the whole of each study area. These maps can be understood by many people, not just the ecologists and biologists that created them, and can be used to help decide which areas need to be protected.

Note: The Slide 22 biotope map with legend is included in the KS4 Case Study Review worksheet.

Discussion - Can you locate Biotope A4D.921 on the map? What does it tell us about the extent and location of this biotope?

Film (part 4) - Talk to the scientist: Biotopes

Stage 3: Recommendations [Slides 23 – 26]

The aim of the REC was to produce maps of the resources of the REC Humber study area. Sea activities such as wind farms, dredging, conservation and fishing all have conflicting needs. These maps will be used in the future by the government to decide the best places for each activity in the Humber REC, while ensuring that they have a minimal impact of the marine environment.

The ecologists recommended **Features of Special Interest** in the Humber REC study area. This included **marine habitats and rare species** in the area that may require protection by law. They also highlighted **alien species**, sea animals that are not originally from United Kingdom, whose presence may have an impact on the marine environment.

What are Annex I habitats? [Slide 23]

Annex I of the European Commission's Habitats Directive lists habitats that are subject to special requirements for conservation under European Union law. As a member of the European Union, the Habitats Directive must also be applied in the United Kingdom law.

The habitat categories on this list represent key environments that are important to the health and productivity of marine ecosystems. Some habitats play an important role in a sea animal's life, for example by providing breeding or nursery grounds, while others are homes for fragile or rare seafloor communities. Many marine habitats are under threat from humans' use of the sea and so require protection.
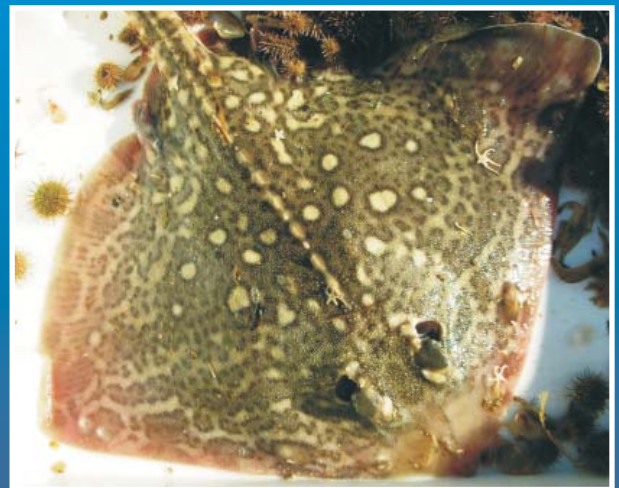
Marine Conservation Zones

The government selects a representative proportion of habitats to protect, taken from each habitat category on the Habitats Directive list. The new name for these areas will be **Marine Conservation Zones**, set up under the government's Marine and Coastal Act 2009.

Scientists will monitor these Marine Conservation Zones and many activities that might damage these areas will not be allowed. Ecologists identified a number of habitats that fit two of the Annex 1 habitat categories, in different places across the Humber study area. These categories were sandbanks and biogenic reefs. Biogenic reefs are reefs made by animals.

Under Threat

The Convention for the Protection of the Marine Environment of the North–East Atlantic (OSPAR) created the OSPAR List of Threatened and/or Declining Species and Habitats.

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REC scientists found two of these species within the Humber REC Study Area:

- **Thornback Ray** (*Raja clavata*)
- **Slow growing bivalve** (*Artica islandica*)

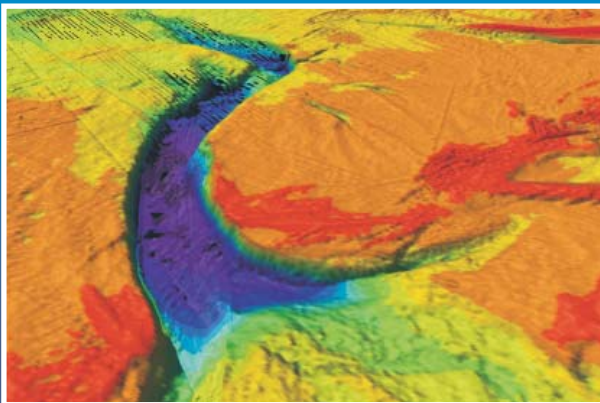**Film (part 5)**- Talk to the Scientist: Humber REC Results

Find out More - Explore the seafloor Humber REC Sustainability webpage http://ets.wessexarch.co.uk/recs/humber/sustainability/

**Feature of Special Interest: the Silver Pit
[Slides 24 - 26]**
The Humber REC study area is an important area for commercial fishing, for species like cod, whiting and sea bass. These fish rely on smaller sea animals for food.

The Silver Pit
This is a geophysical image of this geological seafloor feature.

Many of the sea animals living in and on the seafloor are an important food source for birds, fish and mammal predators. Ecologists recognise that many species identified in the Humber REC research have 'trophic significance'. This means they play an important role in the marine food chain.

For example, pink shrimp are an important food source for fish and birds. The REC identified some habitats that were particularly good places for pink shrimp to live and breed. These places may be an important link in the food chain that provides us with the fish that we eat.

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The Silver Pit is a deep tunnel valley on the Humber seafloor. On the west side of this valley there are Ross Worm reefs (biogenic reefs) and on its east side live lots of pink shrimp. There is also a high level of diversity of other sea animals living here. It is very deep, so sea animals have good protection from any potentially negative human impacts on their environment.

It is important to monitor places like the Silver Pit, which have important sources of food for other marine animals and birds. Without one element of the food chain, the rest will suffer and may not survive. We need to look after these environments so that there is enough food for fish, and then we can fish sustainably.

Activity [Slide 25] - Interactive Whiteboard Lesson: Food Chains

Discussion [Slide 27]

• What animals live on the seafloor?

• Name the different methods the ecologists used to find out about sea animals and their habitats

• What is a biotope map? How do you make one?

• How will the maps be useful in the future?

• Why is the Silver Pit an important habitat?

• Should we protect our marine life? Why?

Activity - Worksheets:
KS3 and KS4 Case Study Review

Explore the Seafloor