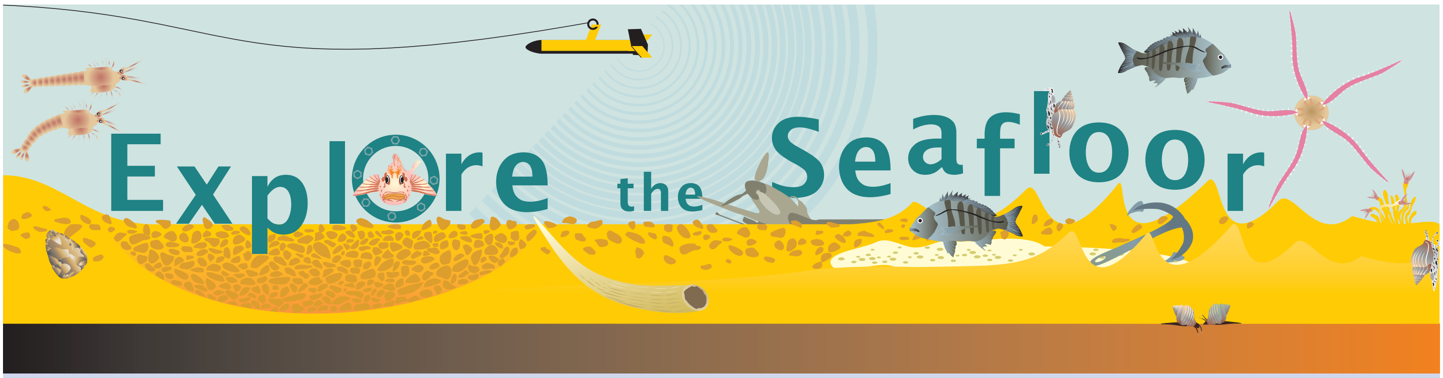
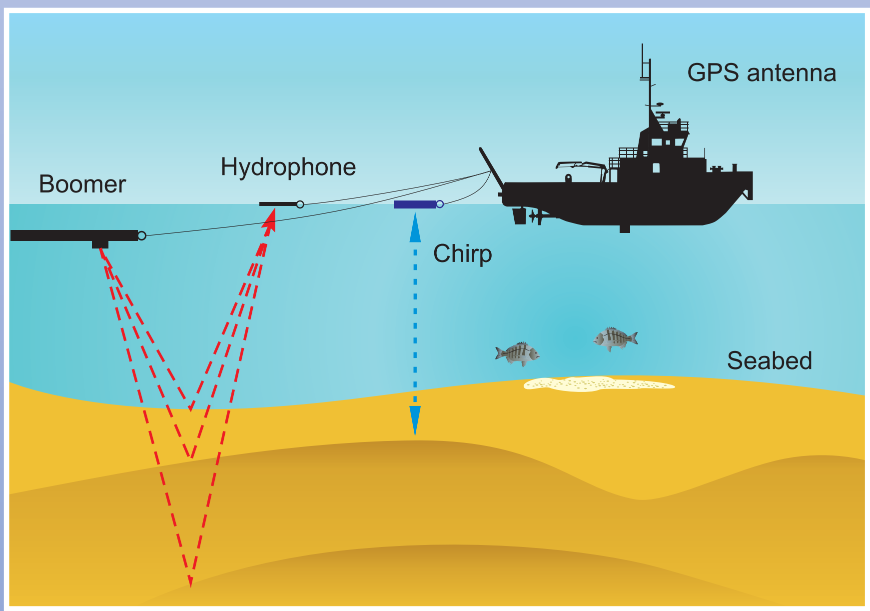


Physics
Teacher's Pack

How we map the seafloor

This teacher's pack contains activities and suggestions to complement the teaching of a case study on marine research, focusing on the techniques used to map the physical properties of the seafloor at Key Stages 3 and 4.



Marine
Aggregate Levy
Sustainability Fund
MALSF

Wessex Archaeology

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Case Study

How do we map the seafloor?

This teacher's pack contains activities and suggestions to complement the teaching of a case study on marine research, focusing on the techniques used to map the physical properties of the seafloor at KS3 and KS4. The case study aims to support the curriculum by providing a real-life example of the application of these techniques 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/physics/

The Explore the Seafloor project has produced an interactive website (http://ets.wessexarch.co.uk/), full of 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 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/physics/

E-Games

1. Be a Seafloor Explorer

Interactive Whiteboard Lessons

2. Using sound waves
3. Interpreting Geophysics (2)
4. Studying Environmental Remains

Film

5. Prehistoric Climate Change
6. Exploring an aircraft wreck
7. Fly-through: 3-D model of the South Coast seafloor
8. Fly-through: palaeo-Arun prehistoric reconstruction
9. Talk to the scientist: why do we map the seafloor (ecology)

PDF

10. Activity Sheet 1: Prehistoric Climate Timechart
11. Activity Sheet 2: Interpreting Geophysics

Films are downloadable from the website or you can watch them online at YouTube and 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

- Understand that sound waves reflect, and that these reflections can be used to produce images
- Understand the methods scientists use to map the physical properties of the seafloor
- Explore how scientific ideas are being used in current technology
- Use and understand scientific terminology
- Develop the ability to critically analyse, evaluate and communicate evidence from scientific research
- Be able to discuss the reasons for mapping the seafloor and using the sea sustainably

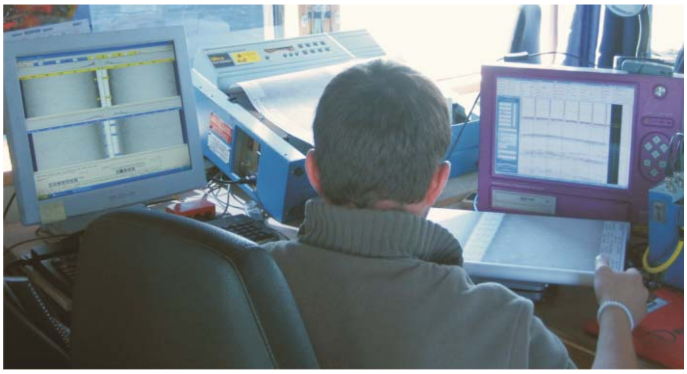
Case Study

How do we map the seafloor?

This provides background information to support a PowerPoint presentation or case study PDF, which you can download from
http://ets.wessexarch.co.uk/teachers/physics/

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

South Coast REC Research [Slide 4]

This lesson focuses on the South Coast REC results, however through the lesson there will be examples from the other REC studies. It explores the techniques used by scientists to collect information about the physical properties of the seafloor and create different types of maps. These maps 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 our underwater resources, including sea animals habitats and archaeology.

- The **geologists** aimed to produce maps showing the morphology and sediment distribution, which in other words means they mapped what the seafloor looks like and what it is made of. These maps also formed the basis for the work undertaken by the archaeologists and ecologists.

- The **ecologists** aimed to produce maps showing the location of different sea animal communities and their habitats.

- The **archaeologists** aimed to produce maps showing the potential location of areas of prehistoric material, and the actual locations of ship and aircraft wrecks.

Find Out More - Background information
Explore the Seafloor South Coast REC Summary
http://ets.wessexarch.co.uk/recs/southcoast/

Original South Coast REC Report
http://www.cefas.defra.gov.uk/alsf/projects/natural-seabed-resources/rec-0802/final-report.aspx

Mapping the Seafloor [Slide 5]

Over time the seafloor has formed through a variety of geological processes. For this lesson, it is important to know that it was not always under water but was once dry land, at times when the sea level was much lower than it is today.

Film - Prehistoric Climate Change

18,000 Before Present (BP)

10,000 Before Present (BP)

The Pleistocene

During the last 2.5 million years (known on the geological timescale as the Pleistocene, followed around 10,000 BP by the Holocene), there have been numerous cold periods called '**glacials**', separated by warmer periods, called '**interglacials**'.

During the **cold phases**, large continental ice sheets covered much of Britain and most of the north-west European peninsula. During cooler periods, when water was locked up in ice sheets, the sea-level was lower than today. Britain was not an island, but a peninsula, joined to continental Europe.

During **warm periods**, the sea levels were similar to those today and Britain was an island.

The transition phases in-between, when it was not too cold and the sea levels were low, our early ancestors were able to occupy large parts of the land, now submerged beneath the sea.

This means that geologists studying the seafloor need to understand how the planet's surface formed and changed before, during and after the Ice Age. For archaeologists it means that people could have lived on what is now the seafloor, so there are places where they will look for evidence for prehistoric people. Both geologists and archaeologists want to understand what the landscape looked like in the past, before it was submerged.

Film - Prehistoric Climate Change

Activity - Activity Sheet 1: Prehistoric Climate Change Timechart. Use the timechart and film to explore the sea level changes.

Note: Before Present (BP) = Before **1950**

The REC Methodology [Slide 6]
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 survey 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	• Fieldwork • Desk Based Assessment
Stage 2	Results - Using the data	• Creating maps • Final report
Stage 3	Recommendations	Highlighting what is special about the South Coast REC study area.

Stage 1: Collecting data [Slide 7]
There are two main ways that the archaeologists collected data, through their own fieldwork and through reviewing information already available, which is called a desk based assessment.

Fieldwork
Fieldwork involves collecting original data for the purpose of the research aims. Fieldwork for the REC is multidisciplinary, involving a range of different scientific specialities. Geologists and archaeologists, working with marine geophysicists, lead the majority of the fieldwork for finding out about the physical properties of the seafloor. Ecologists use this information about the physical properties of the seafloor to map different sea animal habitats. They also do their own fieldwork looking at a different element of the marine research - they collect ecological samples to find out what animals live there.

These are the principal techniques used during the fieldwork for collecting information about the physical properties of the seafloor; further explanation of each technique follows later in the lesson.

Geophysical survey is an important element of marine research undertaken by marine geophysicists, who work for both archaeology and geology organisations, as well as independently. Geophysical survey creates images of the seafloor by collecting information about its physical properties. There are a variety of techniques.

A Vibrocorer takes samples (cores) from beneath the surface of the seafloor. This collects information about the layers below the seafloor's surface. It can tell us how the seafloor was made, and what it is made of. In these samples, scientists also find preserved environmental remains, for example seeds or tiny animals like snails, which can tell us about past climates and environments.

Grab samples are samples of surface seafloor sediment. Geologists collect samples of the seafloor sediments, using a Clamshell grab. The ecologists use a Hamon Grab to collect sea animals that live in and on the seafloor. When doing this, they also collect seafloor sediments, which they give to the geologists to study. These samples can tell us what the seafloor is made of.

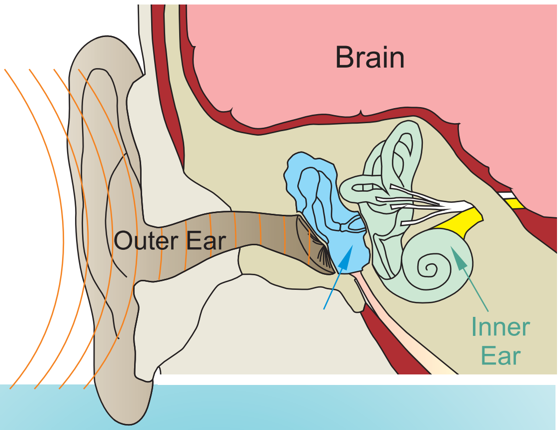
Underwater Photography takes images of the seafloor. These images allow scientists to see their seafloor sediment samples in their context i.e. in their location on the seafloor. This can help describe what the seafloor is made of, as well as identify habitats that sea animals live in.

Find Out More - Marine Careers
http://ets.wessexarch.co.uk/resources/marinecareers/

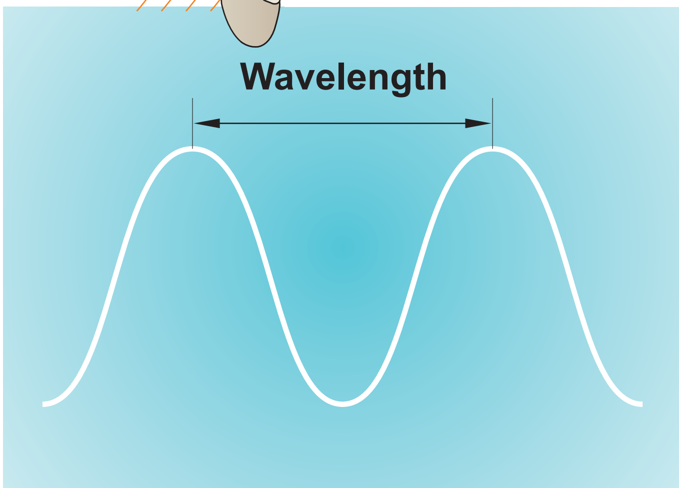
Fieldwork: Geophysics Survey [Slides 8 – 18]
The REC used a variety of survey techniques. They used three different acoustic geophysical survey techniques, which are:-

- **Sidescan sonar**
- **Multibeam Bathymetry sonar**
- **Sub-bottom Profiler**

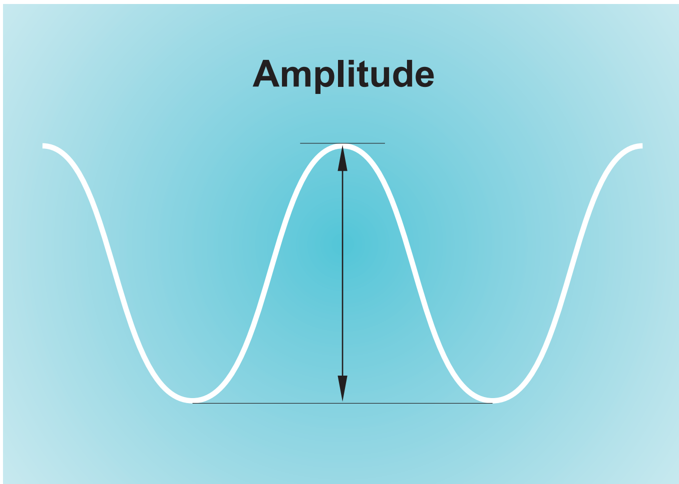
They also used **Magnetometry** survey, which measures **magnetic** changes.



A combination of these techniques builds up a bank of information about the physical properties of the seafloor, which the scientists used to achieve their individual research aims.



Acoustic geophysical techniques: the principles [Slide 9]
Acoustic geophysical techniques use sound waves. Slides 12 to 16 cover how each of the three acoustic techniques work, but first we will review some of the principles of sound waves, and their behaviour in water.



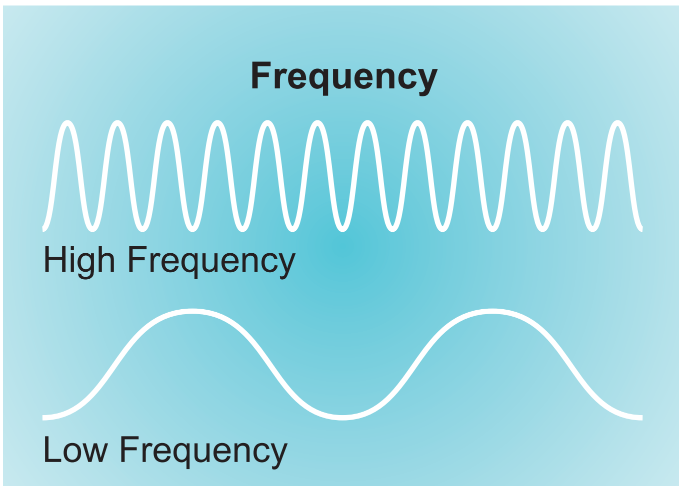
Sound waves are changes in pressure. To create a sound wave, first an object must vibrate. This vibration causes the pressure to change in a medium such as air or water, and then that pressure is transferred to the human eardrum, creating the sound we hear.

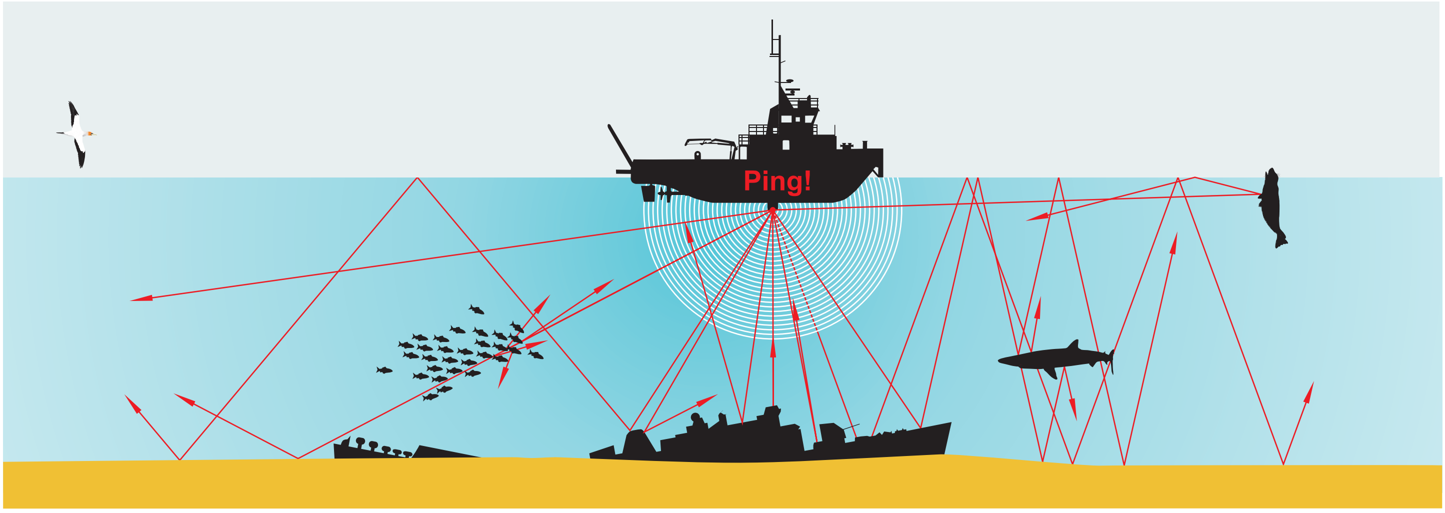
Here are some common terms:-

- **Wavelength:** The length of a wave, or the distance between a point on a wave and the same point on the next wave.

- **Amplitude:** The power of the wave, or the height when viewed on a graph

- **Frequency:** The number of times a wavelength occurs in a unit of time. This is usually over one second and is measured in hertz (Hz). A high frequency means the sound source is vibrating very fast.





Using sound in water [Slides 10]

Sound cannot exist without something to carry it. It can travel through gas, liquid and solids; however, it cannot travel in outer space, as it is a vacuum and there is nothing there to carry the sound. While sound in air travels at 334 metres per second, sound underwater travels at around 1560 metres per second, making it much faster.

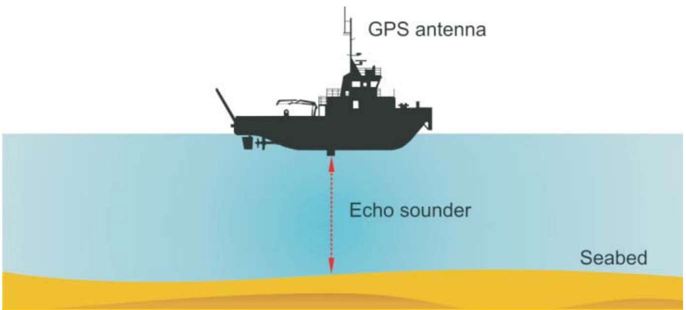
The basics: echo sounders [Slide 11]

Sonar systems emit sound waves, which travel through the water and reflect back up when they meet either an obstruction or the seafloor surface. In this slide you can see how we can calculate the depth of the seafloor, by using a sonar system to emit a sound wave, and then measure the time it took to travel to the seafloor and back again.

Example: So a soundwave takes 0.05 secs to reach the seafloor and return. The equation is:

Speed = distance/time $\frac{1560 \times 0.05 = 39}{2}$

The seafloor is 39m deep.

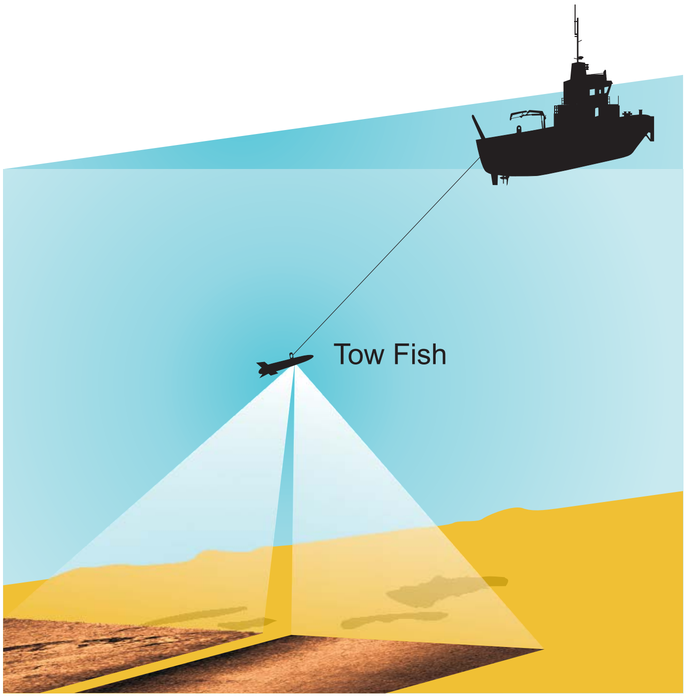


Discussion - Why do we divide the equation by two?

Sidescan sonar [Slide 12 and 13]

What is sidescan sonar?

A boat tows a sonar device called a 'tow-fish' to record images of the seafloor. The tow-fish emits regular sound waves from transducers on the side of the tow-fish, hence the name sidescan. The **transducers** convert one sort of energy into another. They are made of ceramic material, which vibrates when an electrical current is applied to them, generating an acoustic signal. These acoustic signals are reflected back to the transducers when they encounter an obstruction in their path, for example the seafloor or a shipwreck. The reflected signal causes the transducers to vibrate, producing an electrical signal, which is recorded by computers on board the vessel.



What does it measure?

This technique measures the intensity of the reflection (rather than the time it takes the sound waves to get there and back). This can illustrate characteristics of the seafloor. A colour-graded image displays the results, with changes in the shade of the colour indicating the varying intensity of the reflection. Areas of 'no return', where there is no reflection, are shown as shadows, which are very useful for interpreting images as they indicate where something rises up from the seafloor, e.g. as a shipwreck.

What does it tell us?

The different scientists working on the REC can use these images to help them understand the physical environment of the seafloor. So, for example, geologists use this method to identify seafloor sediment types, and formations. Fine sediments such as muds and silts will often absorb some sound, so the intensity of the sound wave reflection is low and on the image the area appears darker. Harder sediments such as coarse gravels or bedrock will reflect the sound back, so the intensity of the reflection is strong and so appears lighter in shade.

Sidescan sonar image examples [Slide 12]

- **Dornier 17 German bomber** – this shows a World War Two aircraft wreck on the seafloor; you can see it is lying on its back with the bomb hatch open. This wreck is not in the South Coast REC study area, but is a good example of a sidescan sonar image.

- **Sand ripples** – this image shows a geological feature and allows geologists to map where sand ripples are located in the South Coast REC study area

Discussion - Why is there a white line down the middle of the sidescan images?

Frequency [Slide 13]

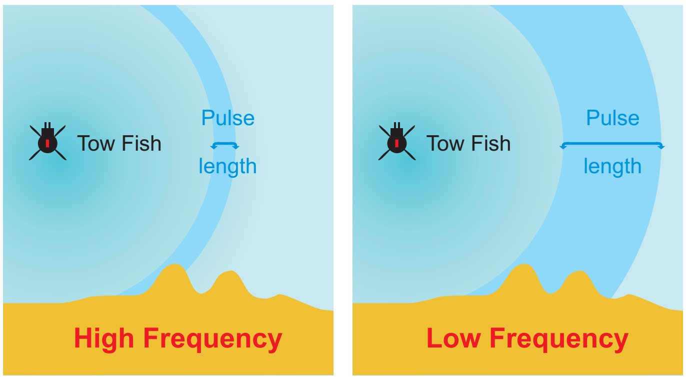
The frequency of the sound waves affects the information collected.

Frequency and resolution

High frequency signals provide higher resolution (i.e. more detailed) data or images. This is because the acoustic pulses are very short and can show small objects separately. For example, a 500kHz sidescan sonar emitting a pulse lasting 62.5 microseconds would have a pulse length of **0.1m** (using pulse time x speed of sound in water). This pulse would be able to detect two objects which were **0.2m** apart, as each object would produce its own reflection. However, if the two objects were **0.05m** apart, the pulse would cover them both at the same time and the image would appear as one object/reflection. So, as the frequency lowers, the pulse length increases, but this means that the resolution gets lower as the reflections become further apart.

Frequency and distance/penetration

Low-frequency signals do have a significant advantage over high frequency signals, as the energy can travel further or penetrate deeper into the seafloor. This way we can cover large areas to collect data or find out what is buried underneath the seafloor.



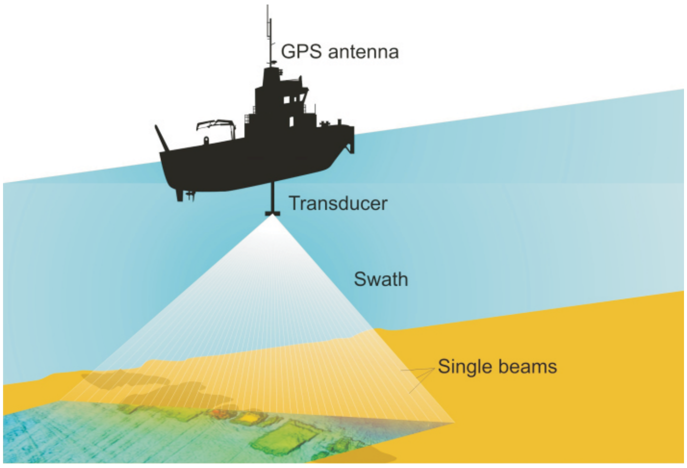
A sidescan sonar low frequency system operating at 100kHz can emit signals which can travel many hundreds of metres and still produce images, whereas a high frequency system operating at 900khz can only produce images over 50m swaths (widths of coverage). Therefore, a low frequency system allows you to get images of a large area more quickly than a high frequency system, but it produces lower-resolution images.

Multibeam Bathymetry [Slide 14]

What is it?

Sidescan sonar produces a flat image; it does not measure the depth of the seafloor. For this, scientists use different techniques.

Multibeam Bathymetry sonar collects data that allows scientists to make 3-Dimensional images of the seafloor. Multibeam sonar is called a variety of names: swathe, swath or echosounders.



This geophysical survey technique uses a transducer that is located underneath the boat. Like sidescan sonar, it emits regular sound waves from the transducer, which are reflected back when they encounter an obstruction in their path. However, instead of measuring the intensity of the returned reflection, multibeam bathymetry sonar measures the time it takes for the pulse to travel to the obstruction and return. A computer on board the boat processes the returning signal.

What does it tell us?

By doing this scientists can calculate the depths of the seafloor. This allows scientists to produce bathymetric images, which record the contours or terrain of the seafloor. It is not a flat image.

This is achieved back in the laboratory where the data is processed. It involves filtering out any interference from the images and correcting other information that could affect the results, for example the daily tides.

The results provide not only 2-Dimensional but 3-D representations of the seafloor. This information helps to map what the seafloor looks like.

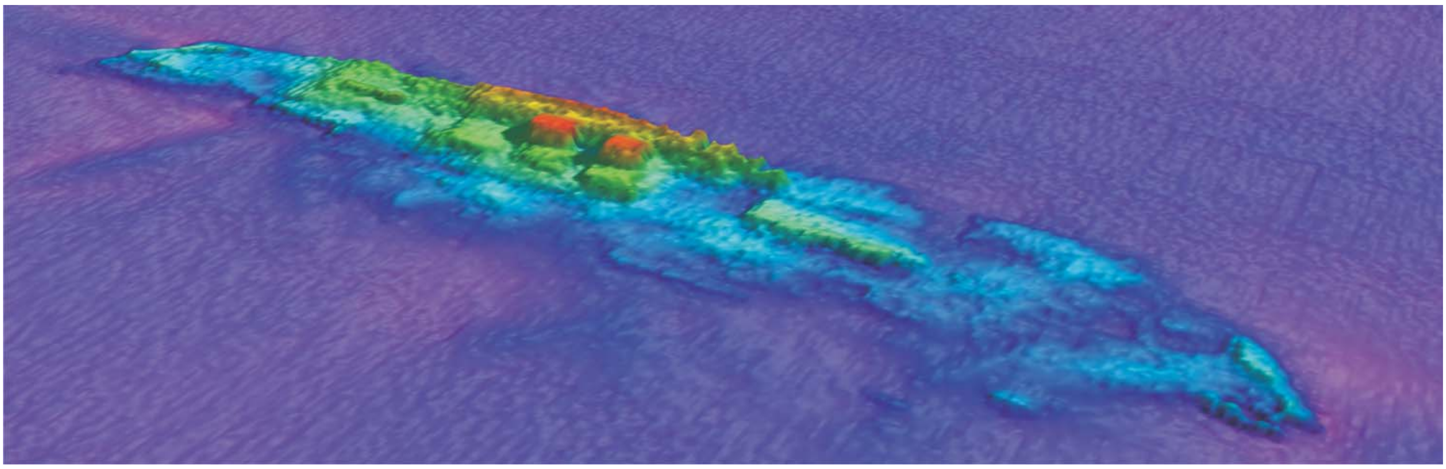
Motion correction

Multibeam bathymetry measures the depth of the seafloor with an accuracy of centimetres or tens of centimetres. To do this, one of the most important adjustments to be made is to correct for the motion of the vessel, as the survey ship moves up and down or rolls from side to side on the sea. These corrections are made by a Motion Reference Unit, which measures this movement and makes corrections to the data that is collected.

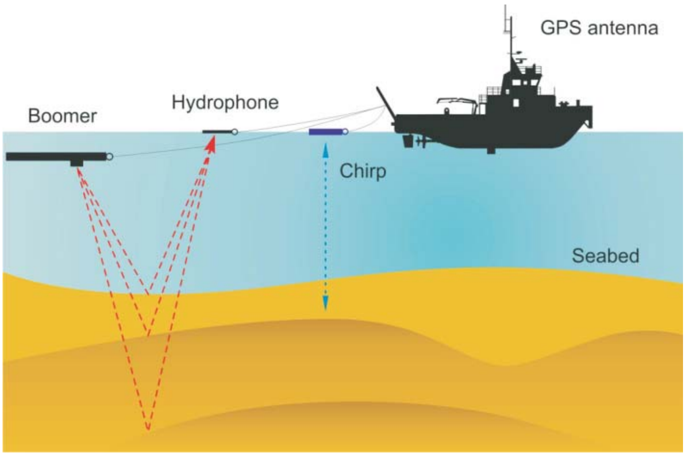
Multibeam Bathmetry sonar examples [Slide 14]

- **SS *Mendi*** – this is a World War One shipwreck located in the South Coast REC.

- **Silver Pit** – this is a tunnel created during the Ice Age, by glaciers; it is located in the Humber REC and is now an important habitat for a variety of sea animals.



Sub-Bottom Profiler [Slides 15 and 16] What is it?
Sub-bottom profiling does not map the seafloor but instead it records a section of the layers below the seafloor surface.



There are three main types of sub-bottom profiler, which draw their names from the frequency of the signals they emit.

- **Boomer** emits signals at 1kHz
- **Pingers** emit signals at 8kHz
- **Chirps** emit signals at a range from 3 to 15 kHz

In each case, the transmission device is either mounted on the boat or towed behind. It sends out sound pulses that penetrate into the seafloor and make an image of the geological layers beneath it. As the sound waves travel through the ground, they are reflected back when a change in the geology occurs. These reflections are called '**horizons**', which can be mapped across the study area.

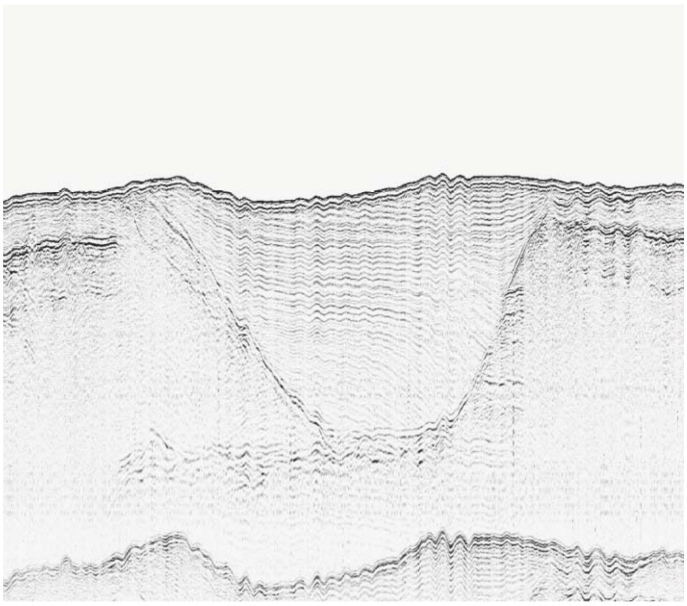
What does it tell us?
The horizon can indicate a change in the seafloor sediment type, for example between a layer of rock and a layer of sand. It can also show where there is a major change in the angle and character of deposits.

The results produce profiles of the seafloor that can help geologists and archaeologists understand how the seafloor formed over time and reconstruct ancient landscapes. For example, they can map buried river channels that formed a long time ago and then filled up with seafloor sediment, as this can be seen in profile on the geophysical survey images.

As sub-bottom profiling acquires vertical images, rather than images of the surface, marine geophysicists must carefully select where to use this technique to get the best information they can.

Sub-Bottom Profiler example

- **Palaeo-Arun** – this shows the profile of an ancient river, which ran across a section of the South Coast REC study area when it was dry land, before sea levels rose and covered it. Seafloor sediments have filled in the river channels, so you cannot see it on the seafloor surface. We will learn more about this river in the Results section.



Discussion - Can you see the profile of an ancient river? why is it buried?

Frequency: noisy neighbours [Slide 16]
As explained above, the higher the resolution the less penetration into the seafloor, however recording below the surface of the seafloor is a sub-bottom profiler's main purpose.

Q: Have you ever had a problem with a noisy neighbour's loud music? You can hear the bass thumping through the wall, but not the rest of the music – why is that?

A: The high frequency signals of the melody reflect back off their wall, so you cannot hear them, but the low frequency noise of the bass penetrates through the wall.

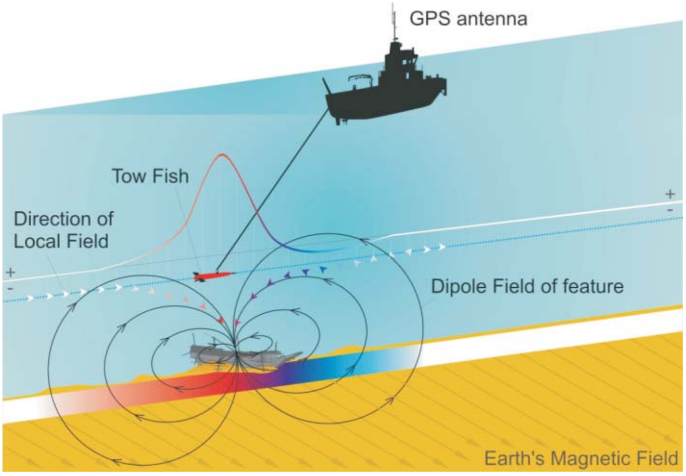
In the same way, sub-bottom profilers can use a low frequency Boomer system to record reflections from up to 60m below the seafloor, while a high frequency Pingers system can only record reflections from up to 5 or 6 metres below the seafloor, but in more detail.

Activity - Interactive Whiteboard Lesson
Using sound waves

Magnetometry [Slide 17]

What is it?

Marine magnetometry is different from the previous techniques, which all used acoustic energy. Magnetometry does not use sound waves; instead it detects variations in the Earth's total magnetic field. The variations in the magnetic field are caused by the presence of ferrous (iron) material on or under the seafloor.



What does it tell us?

Marine magnetic surveying has become a standard technique for mapping the location of ferrous material on the seabed. The equipment needs to be towed behind the boat at a sufficient distance to avoid any magnetic disturbance caused by the boat itself. The data collected is combined and displayed in different ways.

Magnetometry sample

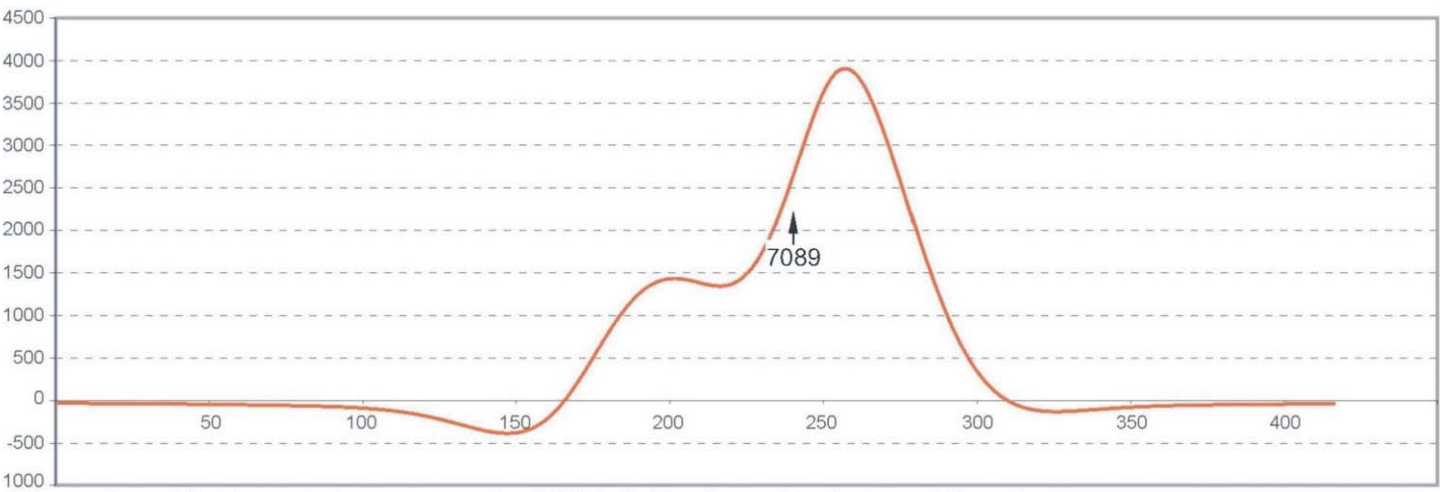
- **SS *Mendi*** – One way to display the information is a line graph. The rise in readings indicates the location of a metal wreck. Magnetometry is primarily used for finding metal wrecks, in particular shipwrecks made of iron, like the World War One shipwreck, SS Mendi.

Results vary [Slide 18]

When processing the data that has been collected, to create images of the seafloor, many different factors are taken into consideration which can affect the results, for example, the strength of the sea currents. The results also vary depending on the purpose of your survey. For example, surveying a known wreck for more information can produce a very detailed image, but will take a long time and be very expensive. In most cases the geophysical images just show a lump or a bump, known as an **anomaly**. It is rare to get a detailed image like the plane in this slide. It takes expertise to be able to tell if an anomaly is a wreck or just a geological feature, such as an outcrop of rocks.

Activity - Interactive Whiteboard Lesson: Interpreting geophysics (2) And/Or Activity Sheet 2: Interpreting geophysics

Film - Exploring an aircraft wreck



Magnetic profile shows a large anomaly of 5872.6nT adjacent to the wreck location.

Covering the study area, and spotting the gaps [Slide 19 and 20]

Geophysical survey is undertaken on a boat. The boat travels in transects (lines), up and down, collecting corridors of information usually over several kilometres. Slide 19 shows geophysical transects undertaken for the South Coast REC.

The REC area covers 5600 km²; therefore they could not survey the entire study area, so instead they survey a representative portion. This is still a large area and so a less detailed survey was undertaken.

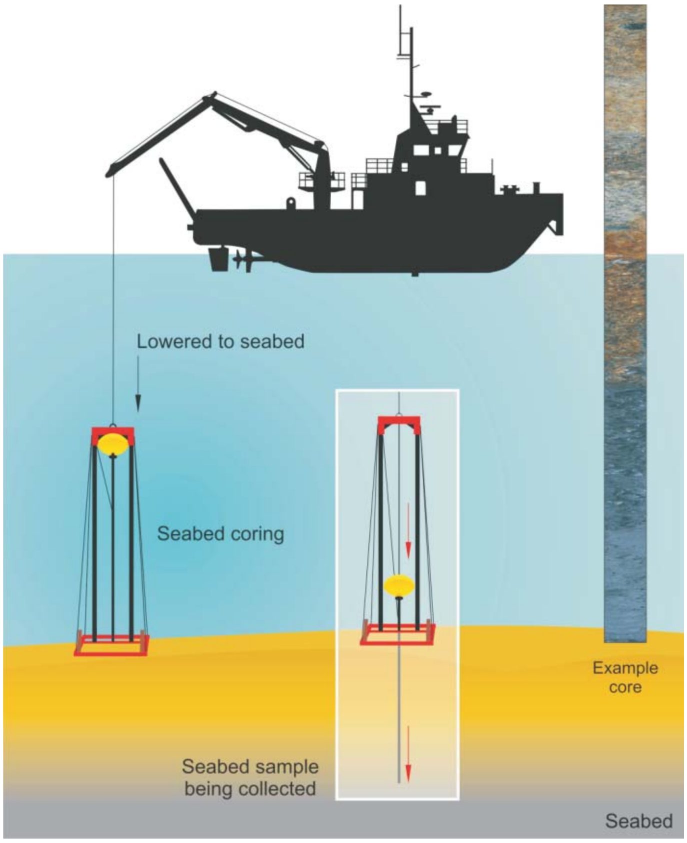
However, bad weather during the summer allocated for fieldwork meant only a small amount of the proposed survey was actually completed, as shown on Slide 19. The solution was to look at information from previous surveys, undertaken for a variety of reasons, to fill in the gaps in the data, as shown on Slide 20.

Discussion - [Slide 19] What do the lines on the map represent? Do they provide a representative coverage of the study area?
What are some of the considerations
and issues when undertaking geophysical fieldwork?

Sampling: Vibrocorer [Slide 21]

Samples of seafloor sediments are taken from underneath the seabed. Both geologists and archaeologists study these samples. Vibrocore samples were not taken during the South Coast REC study (although they were taken for the other three RECs). For the South Coast study, the scientists used information collected from Vibrocores taken for past research projects in that area.

- The **REC geologists** focused on analysing the different deposits, their character and thickness, to help understand how the seafloor was formed over time.
- The **REC archaeologists** studied this too but they also examined the environmental remains found in the different deposits, to understand what plants and wildlife lived on the land over time.



How does a Vibrocorer work?

The Vibrocorer works by vibration and consists of a long tube, up to 6 metres in length, known as a core. First, it is lowered from the boat to the seafloor. Once stable, the motor is turned on, which vibrates the core into the seafloor. It is allowed to run until it either reaches the end of the core or it hits a hard layer that it cannot be pushed through. It can penetrate quite hard layers, like clay.

Processing cores

Samples were taken across the REC study area. At each sample site, two cores were collected. One core was sealed in a black core liner so that it could be dated using a technique called Optically Stimulated Luminescence (OSL). In the laboratory, the other core was split in half lengthways for scientists to record sediment grain size, type of sediment, colour of sediment and any other material found inside. Types of material included shells and bits of wood.

Environmental remains
For archaeologists, it is most useful when peat is found in a core sample. Peat is created when plant material rots in conditions where there is no oxygen (anaerobic conditions). The lack of oxygen means the plant material does not completely break down. Peat is exciting because it is organic material which used to grow on dry (or marshy) land. By studying pollen and seeds found in peat, we can work out what types of trees and plants were growing in the area, at the time when it was dry land.

Discussion - What kind of information do you think the scientists collected about this core?

Activity - Interactive Whiteboard Lesson: Studying Environmental Remains

Clamshell Grab
The Clamshell Grab collects large volumes of sediment from the seafloor. It is operated by hydraulics and has a capacity of up to 300 litres. It is lowered slowly to the seafloor from the side of a boat, to collect a sample of seafloor sediment. When it reaches the seafloor, a mechanical arm drives a large bucket through the sediments. This means it is only used where the seafloor is made up of sands and gravels, rather than rock, where it cannot scoop up the seafloor.

Once the sample is lifted up to the boat it is emptied into a stainless steel tray. The sample in the tray is then mixed, photographed and divided into sub-samples for different scientific analyses. These are:

- A sample for archaeological study
- A sample for geological study
- A sample for Particle Size Analysis
- A sample to be kept as an archive record

The rest of the sample is sieved using a 5mm mesh, to see if it contains are any small archaeological artefacts.

Hamon Grab
A similar grab called a Hamon Grab, used by the REC ecologists to collect small sea animals living in the seafloor, can be used to collect seafloor sediments for geologists to study too.

Find Out More - Download our Ecology Lesson: What animals live on the seafloor?

Processing Grab Samples [Slide 23]
Particle Size Analysis (PSA)
Particle Size Analysis enables geologists to classify all the sediment samples and map their distribution (where they are located) over the REC study areas. You can see the results in each of the RECs' Geology sections on the website.

To analyse the grain size of the sediment, geologists pass samples through a series of sieves with different mesh sizes, the largest first and then smaller and smaller. This subdivides the sediment into its different particle sizes; for example, very fine particles that make up mud, then through coarser sand and up to very coarse gravel.

Geologists can then see the different percentages of sediment types that make up the seafloor, for example a sample may be formed of 80% sand and 20% gravel. It would be described as sandy gravel.

Find Out More - South Coast's Geology web page: http://ets.wessexarch.co.uk/recs/southcoast/geology/

Folk Classification

There is a standardised classification system, which allows geologists to compare their results and decide what overall type of seafloor they are looking at, for example, sandy gravel. This is called the 'Folk Classification' system, because Robert Folk, a professor of sedimentology in America in the 1950s, invented it.

Underwater Photography [Slide 24]

Images of the seafloor are important to help put the information into context. The scientists used a range of cameras for a variety of different reasons, and this was added to the geological and ecological research. You can find out what the different types of cameras are by checking out our Explore the Seafloor website.

Find out more - Explore the Seafloor website: How do we study the seafloor? http://ets.wessexarch.co.uk/recs/how-we-study-the-seafloor/

Desk Based Assessments (DBA) [Slide 25]

DBAs are often the first step for each of the different scientists, when asked to assess an area. This assessment is required as part of the planning process for certain activities that could affect the seafloor.

A DBA collects and **summarises in a report** information about a defined area, in this case the REC study area. This will include any relevant research already undertaken and other sources of information about the geology, ecology and archaeology for the study area. Often an area, particularly a large one, has been subject to lots of past scientific investigations. A DBA is useful as it can bring together many individual pieces of work into one place, so that people can find references to it easily. This information is usually created by a variety of different organisations for a variety of different reasons. Again, like the survey, the detail the DBA goes into will be affected by time, money and the aims of the project. Often DBAs will tell you 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.

DBAs can provide more detailed information from smaller research projects or fill in missing gaps in your data. In the case of the South Coast REC, they provided extra geophysical survey data and vibrocore sample data.

Stage 2: Results: Using GIS [Slides 26 - 32]

GIS stands for Geographic Information System. GIS takes data with a known geographic position and places it on a map. It allows you to view, analyse and interpret data to reveal relationships and patterns. Geographically-referenced information can be added to one GIS to gain a greater understanding about an area. The RECs produced four WebGIS's, to make their data available to the public.

This section will look at some of the results.

Find out more - South Coast REC GIS: http://southcoastrecgis.org.uk/sc/
You can explore all the mapped data

Modelling Data

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 what unsampled areas will be like passed on the sampled areas. It fills in the gaps.

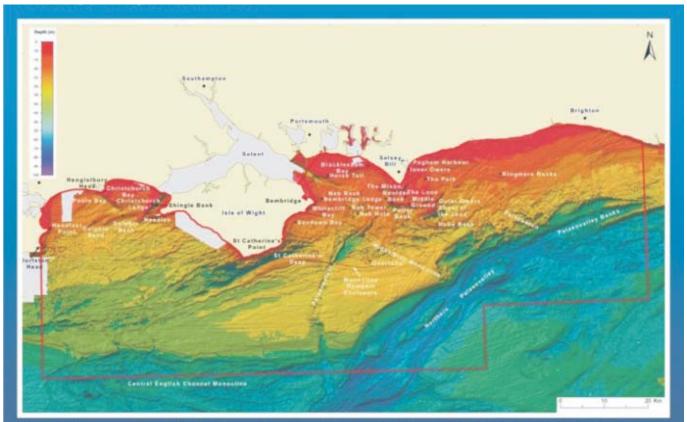
Scientists use a wide range of data to calculate this information. They take into consideration variables in the conditions, when collecting information about the physical properties.

Based on these informed estimates, the REC produced detailed maps for the whole of each study area. Many people, not just the scientists that created them, can understand these maps. They can be used to help make planning decisions, so that we use the sea sustainably, without damaging archaeology or important sea animal habitats.

Geology results [Slides 27 and 28]

What does the seafloor look like? [Slide 27]

As well as new survey data, the geologists used previously collected data. SeaZone, a marine data company, supplied the majority of this information, amalgamated from different types of geophysical data undertaken over several years, for a variety of reasons, by a variety of organisations and companies. From all this information the geologists created an overall bathymetric map of the South Coast REC study area, which showed what the seafloor looked like. They also created a computer-generated 3-dimensional model.



What is the seafloor made of? [Slide 28]

The mapping of the seafloor properties shows that different areas of the South Coast REC study area are characterised by different types of seafloor sediment. The maps showed that 75% of the South Coast REC study area consists of only a thin layer of mainly sandy gravels or gravelly sands, covering the older bedrock layers. You can find out more about the older deposits below. These seafloor deposits are Holocene sediments, laid down during the last 11,700 years.

Film - [Slide 27] Fly through: 3-D of the South Coast REC morphology

Discussion - [Slide 28] Can you use the legend to work out what the majority of the South Coast seafloor is made of?

Archaeology results [Slide 29 - 30]

Archaeologists study the material remains of the past. During the REC they aimed to map the physical evidence of our past on the seafloor.

Mapping submerged prehistoric landscapes [Slide 29]

For prehistoric archaeological evidence, archaeologists aimed to map areas where there is a potential for finding evidence. The evidence is buried under the seafloor so we cannot see it.

Geologists and archaeologists used the information collected to understand how the seafloor formed and to reconstruct what it looked like in the past, when it was dry land. They mapped ancient river courses. These are ideal places for people to live as they provided water and food. Information from artefacts, for example a mammoth's tooth and stone tools found at sea by marine industries working there, also helped build up a picture of what the past was like and what we could potentially find. Lastly the environmental evidence from Vibrocore samples helped to understand what the environment was like, by analysing what plants and animals lived there.

Bringing all this information together, the archaeologists can reconstruct a landscape. Slide 29 shows an image from a 3-D film that archaeologists made to show the environment of the palaeo-Arun, an ancient river, during the Mesolithic period (Middle Stone Age).

Find Out More - Download our Geography Lesson: How did climate change affect prehistoric people?

Film - Fly-through: palaeo-Arun prehistoric reconstruction

Finding Archaeology – ship and aircraft wrecks [Slide 30]
Archaeologists identified many geophysical anomalies that could possibly be ship or aircraft wrecks. As the geophysical survey only covered part of the whole study area, there are probably many more undiscovered wrecks on the seafloor. They compared the approximate location information of known historical records with the anomalies and by doing so were able to identify some wrecks, for example a German U-boat. The archaeologists could not find historic records for most of these anomalies, so many are completely new discoveries.

For some anomalies, it is not clear if they are archaeology. These will be flagged as potential sites, but will require further research in the future to confirm the interpretation.

Geophysics has been excellent for identifying shipwrecks that date from the 19th century onwards, but not so good for detecting earlier ships. This is because later ships are substantial and made from metal, which shows up well on geophysical survey, unlike older ships. Historical records did show that there are shipwrecks in the area dating to before the 19th century.

Find Out More - Download our History Lesson - What can the seafloor tell us about WWII?

Ecology Results [Slides 31 – 32]
Habitats
The sediment distribution map created by the geologists (Slide 28) is very important for ecologists. It tells them the location of different types of sea animal habitats, as different fish like to live in different types of seafloor environments.

The ecologists map these habitats and the animals that live there. This is important as different types of habitats are suitable for different animals. 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 they require protection.

Film [Slides 31 to 33] - Talk to the scientist: why do we map the seafloor?

Find Out More - Download our Biology Lesson: What animals live on the seafloor?

Biotope maps [Slide 32]
Ecologists used the seafloor sediments distribution map, created by the geologists to help map seafloor communities. This is very complex and you can find out more in our Explore the Seafloor Biology Lesson.

Stage 3: Recommendations [Slide 33]
Using all this information, the scientists made recommendations that aim to help use the sea sustainably. They highlighted features of special interest in the South Coast REC, which are important and need to be looked after. For example, archaeologists highlighted the ancient river course of the palaeo-Arun as there is a high potential of finding prehistoric evidence there.

An interesting example that ecologists highlighted is the **Black Bream breeding grounds**.

The South Coast is one of the few places in the UK where you can find the fragile nests of the black bream. Each spring, black bream migrate from the deeper waters of the English Channel to the shallow coastal waters of the South Coast study area, in order to reproduce.

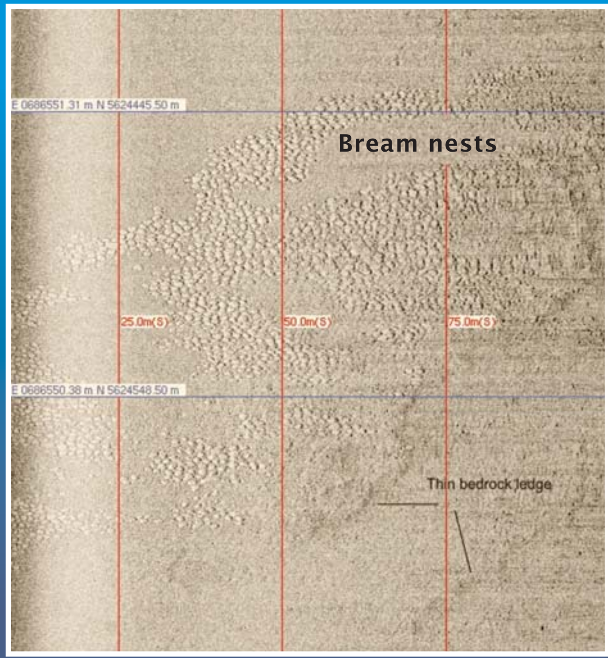
The male fish searches for certain types of seabed sediments that are suitable for building their nests. Black bream like to build nests on hard bedrock covered with thin sands and gravel, a habitat that is found in the South Coast REC.

The male fish excavates the thin sands and gravels to create a depression or 'nest' about 1 - 2 metres wide and 5 - 30 centimetres deep. The female lays her eggs in the nest and the male fertilises them. He will then stay and guard the nest until the eggs hatch.

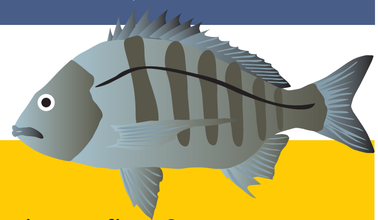
These black bream nests and breeding grounds were first identified in the South Coast REC through the geophysical survey images and ecological samples. However, the nests are very fragile and can be easily damaged both by natural events and by our use of the sea, for example fishing. The information collected by the REC will help us understand how to protect these important areas.

Find Out More - You can find out about more Features of Special Interest by visiting the Explore the seafloor website.
http://ets.wessexarch.co.uk/recs/southcoast/sustainability/

Sidescan geophysical data image

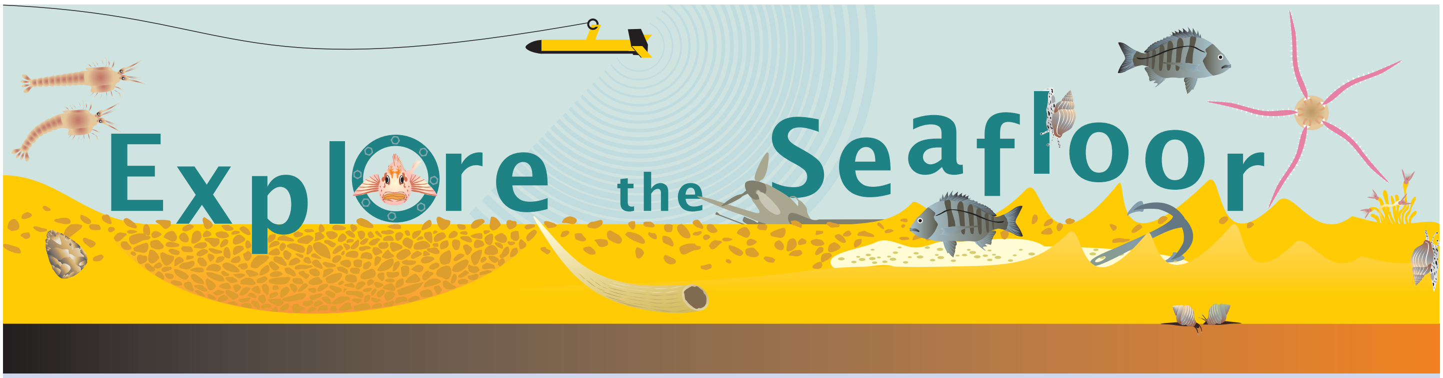


Can you see the Black Bream nests? (*Spondyliosoma cantharus*)



Discussion [Slide 34]

- So how do we map the seafloor?
- Discuss what these methods are and what some of the advantages and disadvantages might be
  - Geophysical survey
  - Desk based assessment
  - Taking samples
- How can frequency affect the following acoustic survey techniques
  - Sidescan sonar
  - Multibeam bathymetry
  - Sub-bottom profiler
- Discuss why scientists mapped the seafloor?
- Do you think it is important that we protect our seafloor? Why?



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