Teacher guidance

Lesson activities

Explain
teacher exposition using slides or script to support

Demonstration/watch
students watch a demonstration or video

Student activity
activity for students to complete individually such as questions on a Student Sheet

Group work
activity for students to complete in pairs or small groups

Whole class discussion
teacher conducts a whole class discussion on a topic or as a plenary review

Teacher ideas and guidance

Assesment and feedback
guidance to get the most from AfL (Assesment for Learning)

Guidance
further information on how to run an activity or learning step

Idea
optional idea to extend or differentiate an activity or learning step

Information
background or further information to guide an activity or explanation

Technical
specific ICT or practical hints and tips

Health and safety

Health and safety
health and safety information on a specific activity

Applicable standards
National Curriculum in England

Elements of the standards	Lessons 1	2	3	4	5	6	7
Biology							
• Living organisms may form populations of single species, communities of many species and ecosystems, interacting with each other, with the environment and with humans in many different ways.	✓	✓					
• Living organisms are interdependent and show adaptations to their environment.	✓	✓					
• Life on Earth is dependent on photosynthesis in which green plants and algae trap light from the Sun to fix carbon dioxide and combine it with hydrogen from water to make organic compounds and oxygen.	✓	✓					
Ecosystems							
• Some abiotic and biotic factors which affect communities; the importance of interactions between organisms in a community.		✓					
• The importance of biodiversity.	✓	✓					✓
• Positive and negative human interactions with ecosystems.		✓	✓		✓		✓
Working Scientifically							
• Using a variety of concepts and models to develop scientific explanations and understanding.				✓			
• Explaining every day and technological applications of science; evaluating associated personal, social, economic and environmental implications; and making decisions based on the evaluation of evidence and arguments.			✓				✓
Experimental skills and strategies							
• Planning experiments to make observations, test hypotheses or explore phenomena.			✓				
• Applying a knowledge of a range of techniques, apparatus, and materials to select those appropriate both for fieldwork and for experiments.			✓	✓			
• Making and recording observations and measurements using a range of apparatus and methods.			✓	✓			

GCSE Biology and Combined Science GCSE Specifications Element of AQA Combined Science: Trilogy	Lessons 1	2	3	4	5	6	7
• **4.7.1.1.** Describe different levels of organisation in an ecosystem from individual organisms to the whole ecosystem and the importance of interdependence and competition in a community.	✓	✓					

Applicable standards
National Curriculum in England

GCSE Biology and Combined Science GCSE Specifications (continued) Element of AQA Combined Science: Trilogy (continued)	Lessons 1	2	3	4	5	6	7
• **4.7.1.2.** Students should be able to explain how a change in an abiotic factor would affect a given community given appropriate data or context.			✓				
• **4.7.2.1.** Levels of organisation – A range of experimental methods using transects and quadrats are used by ecologists to determine the distribution and abundance of species in an ecosystem.				✓			
• **4.7.3.1.** Students should understand that many human activities are reducing biodiversity.	✓		✓				
• **4.7.3.5** Students should be able to describe some of the biological consequences of global warming.			✓				
• **4.7.3.6.** Students should be able to describe both positive and negative human interactions in an ecosystem and explain their impact on biodiversity.		✓	✓		✓	✓	✓
Working Scientifically							
• **WS1.4.** Evaluate given information about methods that can be used to tackle problems caused by human impacts on the environment.					✓		
• **WS 2.7.** Evaluate methods and suggest possible improvements and further investigations.							✓
• **WS 3.5.** Interpreting observations and other data (presented in verbal, diagrammatic, graphical, symbolic or numerical form), including identifying patterns and tends, making inferences and drawing conclusions.							✓
Element of AQA Combined Science: Synergy							
• **4.4.2.1.** Describe different levels of organisation in an ecosystem from individual organisms to the whole ecosystem.		✓					
• **4.4.2.2.** Describe the importance of interdependence and competition in a community.	✓	✓					

Applicable standards
National Curriculum in England

GCSE Biology and Combined Science GCSE Specifications (continued)

Element of AQA Combined Science: Synergy (continued)	Lessons 1	2	3	4	5	6	7
• **4.4.2.3.** Explain how some abiotic and biotic factors affect communities.			✓				
• **4.4.2.4.** Describe how to carry out a field investigation into the distribution and abundance of organisms in an ecosystem and explain how to determine their numbers in a given area.				✓			
• **4.4.2.6.** Describe negative human interactions within ecosystems and explain their impact on biodiversity.		✓	✓				
• **4.4.2.7.** Describe positive human interactions within ecosystems and explain their impact on biodiversity.			✓		✓	✓	✓
Working Scientifically							
• **Biology AT3.** Use transect line and quadrats to measure distribution of a species.				✓			
• **WS1.4.** Evaluate given information about methods that can be used to tackle problems caused by human impacts on the environment.					✓		
• **WS 3.5.** Interpreting observations and other data (presented in verbal, diagrammatic, graphical, symbolic or numerical form), including identifying patterns and tends, making inferences and drawing conclusions.							✓
Element of OCR Twenty-First Century Science Combined Science B							
• **3.3.4.** Describe different levels of organisation in an ecosystem from individual organisms to the whole ecosystem.	✓						
• **3.3.5.** Explain the importance of interdependence and competition in a community.	✓	✓					
• **3.4.** Explain how some abiotic and biotic factors affect communities, including environmental conditions, toxic chemicals, availability of food and other resources, and the presence of predators and pathogens.			✓	✓			✓
• **6.3.1.** Describe both positive and negative human interactions within ecosystems and explain their impact on biodiversity.		✓				✓	

Applicable standards
National Curriculum in England

GCSE Biology and Combined Science GCSE Specifications (continued) Element of OCR Twenty-First Century Science Combined Science B (continued)	Lessons 1	2	3	4	5	6	7
• **6.3.2.** Explain some of the benefits and challenges of maintaining local and global biodiversity.						✓	
Ideas about Science							
• **IaS1.** Suggest appropriate apparatus, materials and techniques, justifying the choice with reference to the precision, accuracy and validity of the data that will be collected.				✓			
• **IaS4.** Suggest reasons why different decisions on the same issue might be appropriate in view of differences in personal, social, economic or environmental context, and be able to make decisions based on the evaluation of evidence and arguments.					✓	✓	✓
OCR Gateway Science Combined Science A							
• **4.1d.** Describe different levels of organisations in an ecosystem from individual organisms to the whole classroom.		✓	✓				
• **4.1e.** Explain how abiotic and biotic factors can affect communities.			✓				
• **4.1f.** Describe the importance of interdependence and competition in a community.		✓					
• **6.1a.** Explain how to carry out a field investigation into the distribution and abundance of organisms in a habitat and how to determine their numbers in a given area.			✓	✓			
• **6.1b.** Describe both positive and negative human interactions within ecosystems and explain their impact on biodiversity.		✓			✓	✓	✓
• **6.1c.** Explain some of the benefits and challenges of maintaining local and global biodiversity.					✓	✓	✓

Applicable standards
National Curriculum in England

GCSE Biology and Combined Science GCSE Specifications (continued)

OCR Gateway Science Combined Science A (continued)	Lessons 1	2	3	4	5	6	7
Practical Skills							
• **WS2c.** Presenting observations using appropriate methods.				✓			
• **WS2d.** Communicating the scientific rationale for investigations, methods used finding and reasoned conclusions.							✓
Edexcel Combined Science							
• **9.2.** Explain how communities can be affected by abiotic and biotic factors.			✓				
• **9.3.** Describe the importance of interdependence in a community.	✓	✓					
• **9.4.** Describe how the survival of some organisms is dependent on other species, including parasitism and mutualism. Interdependence of organisms.	✓						
• **9.5.** Core Practical: Investigate the relationship between organisms and their environment using fieldwork techniques, including quadrats and belt transects.				✓			
• **9.6.** Explain how to determine the number of organisms in a given area using raw data from fieldwork techniques, including quadrats and belt transects.				✓			
• **9.9.** Explain the positive and negative interactions within ecosystems and their impacts pm biodiversity.		✓	✓				
• **9.10.** Explain the benefits of maintaining local and global biodiversity, including the conservation of animal species and the impact of reforestation.					✓		
Working Scientifically							
• **1d.** Explain every day and technological applications of science; evaluate associated personal, social, economic and environmental implications; and make decisions based on the evaluation of evidence and arguments.						✓	✓
• **1e.** Evaluate risks both in practical science and the wider societal context, including perception of risk in relation to data and consequences.							✓

Applicable standards

Next Generation Science Standards (NGSS)

High School Life Science

Element of the curriculum	Lessons 1	2	3	4	5	6	7
Ecosystems: Interactions, Energy and Dynamics							
• **HS-LS2-6.** Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem	✓	✓	✓				
• **HS-LS2-7.** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.				✓	✓	✓	✓
• **HS-LS2-8.** Evaluate evidence for the role of group behaviour on individual and species' chances to survive and reproduce.			✓				
Interdependent Relationships in Ecosystems							
• **HS-LS4-6.** Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.					✓	✓	✓
Weather and Climate							
• **HS-ESS3-5.** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.			✓	✓			
Human Sustainability							
• **HS-ESS3-1.** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.	✓	✓	✓				
• **HS-ESS3-3.** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.		✓	✓	✓			
• **HS-ESS3-4.** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.					✓	✓	✓

SCHEME OF WORK

Lesson 1: How is coral reef biodiversity useful and important?

Overview

This lesson begins by establishing the aims of the unit. The students will use the information in this unit to select and justify a site for a Marine Protected Area (MPA) off the coast of Belize. This lesson will cover the importance of coral reefs, the so called 'rain forests of the sea', to a local community in Timor-Leste. Students develop their understanding of mutualism, biodiversity and how it is useful and important to us and the Earth as a whole.

Learning outcomes

- Say what a coral reef is and identify locations
- Outline the structure and scale of a coral reef
- Define the key terms 'mutualism' and 'biodiversity'.
- Explain the importance of biodiversity to resilience

Resources

Slideshow 1:
How is coral reef biodiversity useful and important?

Student Sheet 1a:
Coral reef scales card sort

Student Sheet 1b:
Coral and biodiversity summary

Answer Sheet 1a:
Coral and biodiversity summary

Video:
Welcome to Timor-Leste

360 Gallery:
The Great Barrier Reef

Activity:
Incredible edible polyps

Subject Update:
Learn more: Coral reefs

Subject Update:
Learn more: Why use 360VR in the classroom

Subject Update:
How to: Quick Start to 360VR in the classroom

Lesson 2: How can humans directly threaten reefs?

Overview

In this lesson students will develop their understanding of how humans present direct threats to biodiversity, and how to write a logical explanation. This idea is then developed further in the next lesson. The context of the lesson is how the villagers of Com could be harming their reef by using it.

Learning outcomes

- Describe the importance of all animals within the coral reef ecosystem
- Describe threats to the reef
- Define and use the terms 'overfishing', 'destructive fishing', and 'trophic cascade' correctly

Resources

Slideshow 2:
How can humans directly threaten reefs?

Student Sheet 2a:
Species card sort

Student Sheet 2b:
Reef uses

Student Sheet 2c:
Threats to reef information sheet

Student Sheet 2d:
Threats table

Subject Update:
Learn more: Human activity on the reef

Subject Update:
Learn more: Coral futures

Lesson 3: How can humans indirectly threaten reefs?

Overview

In this lesson students will develop their understanding of indirect threats to coral reefs, such as climate change, which causes the sea temperatures to rise and coral bleaching to occur. The context of the lesson is how human activities outside of Com village could be harming the local reef.

Learning outcomes

- List human actions which can have an indirect impact on reefs
- Define and use the terms 'coral bleaching', 'sedimentation', 'turbidity' 'global warming' and 'ocean acidification' correctly
- Explain the cause and impact of a range of threats

Resources

Slideshow 3:
How can humans indirectly threaten reefs?

Student Sheet 3a:
Crown-of-thorns starfish information clues

Student Sheet 3b:
Coral threat activities

Answer Sheet 3a:
Crown-of-thorns starfish answers

Answer Sheet 3b:
Coral threat activities answers

Answer Sheet 3c:
Mark Scheme

Activity Overview 3a:
Sedimentation

Activity Overview 3b:
Ocean acidification

Activity:
Cloudy waters

Activity:
Ocean acidification in a cup

Video:
Underwater classroom: Coral bleaching

Subject Update:
Learn more: Corals in a high CO_2 world

Lesson 4: How do we decide which areas to protect?

Overview

The aim of this lesson is for students to develop their understanding of how to complete a transect and to investigate the impact of abiotic factors on distribution and abundance of biodiversity on reefs. The context of the lesson is the work of the XL Catlin Seaview Survey which aims to compile a global reef record using 360 imagery.

Learning outcomes

- Describe what a transect is
- Describe how to complete a transect
- Explain reasons for completing a transect

Resources

Slideshow 4:
How do we decide which areas to protect?

Student Sheet 4a:
Investigating information

Student Sheet 4b:
Investigation tasks

Video:
Snorkels and science

Video:
Seaview Science: Monitoring the reef

Subject Update:
About: XL Catlin Seaview Survey

Lesson 5: How can we protect the reef?

Overview

In this lesson students will start of by looking at the life cycle on coral reefs and the importance of mangrove forests and sea grass to the biodiversity of coral reefs. Following that students learn what MPAs are and decide where they would locate the four different MPAs in Com. The context of the lesson is the proposal for a new community marine protected area in Com.

Learning outcomes

- Describe the need for a variety of habitats in the lifecycle of a species
- Give some examples of how to protect reefs
- Explain why the location of an MPA has been chosen and justify with ecological reasons

Resources

Slideshow 5:
How can we protect the reef?

Student Sheet 5a:
Threats and solutions card sort

Student Sheet 5b:
Map to sketch MPA

Student Sheet 5c:
Timor-Leste MPA

Map:
Timor-Leste Google Map

Subject Update:
Learn more: Conservation on the Great Barrier Reef

Subject Update:
How to: Create a placemark on Google Earth Pro

Subject Update:
How to: Open saved placemarks in Google Earth Pro

Lesson 6: How are members of the community affected by MPAs?

Overview

Following on from last lesson, students consider the impact of biodiversity protection methods on different groups of people by watching a series of stakeholder videos. They go on to prepare arguments for a debate in the next lesson. The context of the lesson is the proposal for a new Community marine protected area in Com and what different people think about this.

Learning outcomes

- Describe how different people use the reef
- Describe how an MPA would affect different stakeholders
- Explain why a stakeholder might be for or against an MPA on the reef
- Justify the decision to place an MPA in Com, Timor-Leste

Resources

Slideshow 6:
How are members of the community affected by MPAs?

Student Sheet 6a:
Stakeholders

Student Sheet 6b:
Preparing arguments

Video:
Stakeholder on the reef: Community

Video:
Stakeholder on the reef: Fishermen

Video:
Stakeholder on the reef: Government

Video:
Stakeholder on the reef: Local Tourism

Video:
Stakeholder on the reef: Tourism Operator

Lesson 7: Which MPA proposal is the best?

Overview

Following on from last lesson, students have a debate from the perspective of the different stakeholders. After this students' will demonstrate their learning from lessons 5-7 by completing a long answer question evaluating two proposals for a new community Marine Protected Area in Com. The context of the lesson is to bring the learning from previous lessons together in order to help decide where the students might place their MPA in their final lesson.

Learning outcomes

- Describe positive and negative features of a proposed MPA
- Compare two proposed MPA giving positive and negative features of each
- Select the best site for the proposed MPA and justify your choice

Resources

Slideshow 7:
Which MPA proposal is the best?

Student Sheet 7a:
Long answer question

Student Sheet 7b:
GCSE style exam questions

Answer Sheet 7a:
Long answer question

Answer Sheet 7b:
GCSE style exam questions

LESSON 1

How is coral reef biodiversity useful and important?

Age 14-16

60 minutes

Curriculum links

- Understand the importance of biodiversity in ecosystems
- Explain the importance of interdependence in a community

Resources

Slideshow 1:
How is coral reef biodiversity useful and important?

Student Sheet 1a:
Coral reef scales

Student Sheet 1b:
Coral and biodiversity summary

Answer Sheet 1a:
Coral and biodiversity summary

Activity:
Incredible edible polyp

Video:
Welcome to Timor-Leste

360 Gallery:
The Great Barrier Reef

Subject Update:
Learn more: Coral reefs

Subject Update:
Learn more: Why use 360VR in the classroom

Subject Update:
How to: Quick Start to 360VR in the classroom

Lesson overview

This lesson will establish the aims of the unit and enable students to develop their understanding of biodiversity and how it is useful and important to us and the Earth as a whole. The context of the lesson is the importance of the coral reefs, the so called 'rain forests of the sea' to a local community in Timor Leste.

Lesson steps	Learning outcomes
1. Brief (10 mins) Students are introduced to the purpose of the module and gaining some background information on Timor-Leste. Students set themselves targets based on the learning criteria of the lesson. Students to look at the 360 images in The Great Barrier Reef gallery and answer questions about the coral reef.	• Understand the wider context and learning outcomes • Say what a coral reef is and identify locations
2. All about coral (15 mins) Using the slideshow, students learn background information about the scale of coral reefs and complete a card sort to rank the different scales and answer follow-up questions.	• Outline the structure and scale of a coral reef
3. Biodiversity (20 mins) Using the slideshow, students learn how biodiversity is important to ecological resilience. Students demonstrate their learning by answering questions on the student sheet.	• Define the key terms 'mutualism' and 'biodiversity' • Explain the importance of biodiversity to resilience
4. Self reflection (15 mins) Students decide if they have met their targets set at the beginning of the lesson and reflect on the lesson's importance to the context of the unit of work through answering questions.	• Reflect on learning

TEACHER GUIDANCE 1 (page 1 of 2)

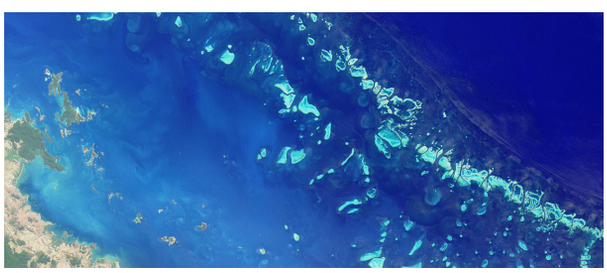
Step	Guidance	Resources
1 10 mins	Step 1 contextualises the learning: · Brief students on the unit of work overview and overall aim of the unit: to select and justify a location for a Marine Protected Area (MPA). · Show students the lesson outcomes on slide 3. Ask them to set themselves a minimum target and challenge target in their books, highlighting their expected progress if appropriate. Take feedback, ensuring targets set are suitable. · Using, where possible, individual computers, tablets or smartphones, students access the 360 gallery to explore a coral reef while answering questions on slide 4 to set the context in which this unit takes place. · Following this exploration, set the scene of the whole topic unit using slides 6-9. For most of this unit of work students will be using Timor-Leste as a case study. They need to have some contextual knowledge and understanding of Timor-Leste. 360 galleries can be viewed in several ways. At their most effective, each student will have access to a smartphone with a VR headset, but they can also be viewed on tablets or laptops or shown via a digital projector at the front of the class.	**Slideshow 1:** Slides 1-9 **360 Gallery:** The Great Barrier Reef **Video:** Welcome to Timor-Leste
2 15 mins	Step 2 develops knowledge and understanding of corals. · Use slides 10-16 to explain the location and structure of coral reefs, highlighting the scale from very large to very small. Point out the anatomy of a coral polyp, emphasising that it is not one large creature, but several smaller polyps in a mutual relationship with algae. · Students arrange the coral reef scales from biggest to smallest using the card short activity. As an extension, students can explain the term 'mutualism' related to polyps and algae, shown on slide 16. · Go through answers on slide 17, with students checking each other's answers and making corrections where needed.	**Slideshow 1:** Slides 10-17 **Student Sheet 1a:** Coral reef scales

Step	Guidance	Resources
3 20 mins	Step 3 develops knowledge and understanding of the importance of biodiversity to humans and to resilience. · Use slides 18-21 to define the term biodiversity, using the relevant exam board's definition, and explain its importance to ecosystem resilience. On slide 19 there is a useful analogy using the idea of the need for different skills within a football team. Explain that there are lots of different roles needed for the team to function properly and having reserve players lets you respond better if there is a sudden change, e.g. a player gets injured. · Define this ability to respond as resilience and highlight that a team with more reserve players will be more resilient. · Hand out the Student Sheet 1b for students to complete. · Take feedback from the class. Focus on the justification students use for their ideas. · Display or hand out the Answer Sheet, with students marking their own work.	**Slideshow 1:** Slides 18-22 **Student Sheet 1b:** Coral and biodiversity summary **Answer Sheet 1a:** Coral and biodiversity summary
4 15 mins	Step 5 reflect on learning · Students could swap books or look at their own answers and decide if they met the targets set at the beginning of the lesson. They then write a short sentence explaining their achievement. Ask, by show of hands, which students met their minimum and challenge targets from the start of the lesson. · Set homework with slide 24-25, ensuring students note down the web address or guide students to search for 'Incredible edible polyp' on encounteredu.com.	**Slideshow 1:** Slide 23-25 **Activity:** Incredible edible polyp

STUDENT SHEET 1a

Coral reef scales

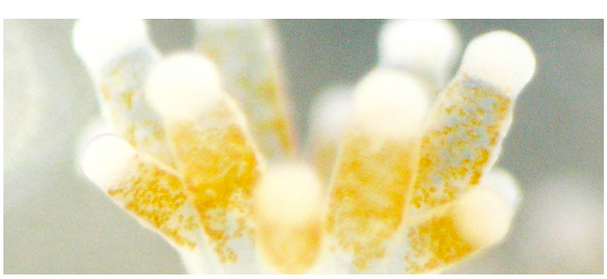
Coral reef



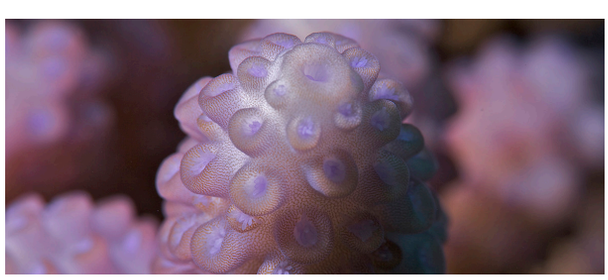
Reef mosaic

Coral colony

Habitat patch



Coral polyp



Coral branch

Algae (zooxanthallae)

Habitat zone

STUDENT SHEET 1b

Coral and biodiversity summary

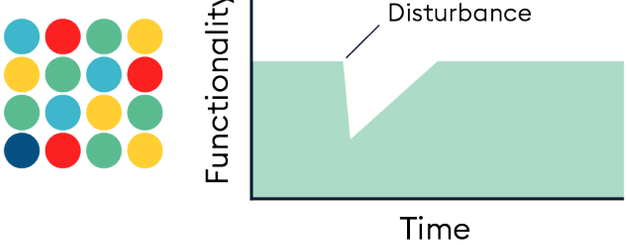
1. Where in the world do you find coral reefs? What do these regions have in common?

2. Label the diagram to outline the structure of coral.

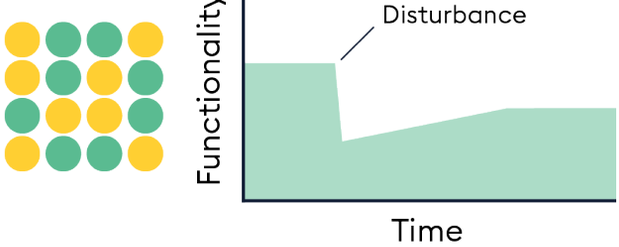
3. Define the term biodiversity.

4. Define the term “mutualism” and give examples of a mutual (symbiotic) relationship in the reef.

A



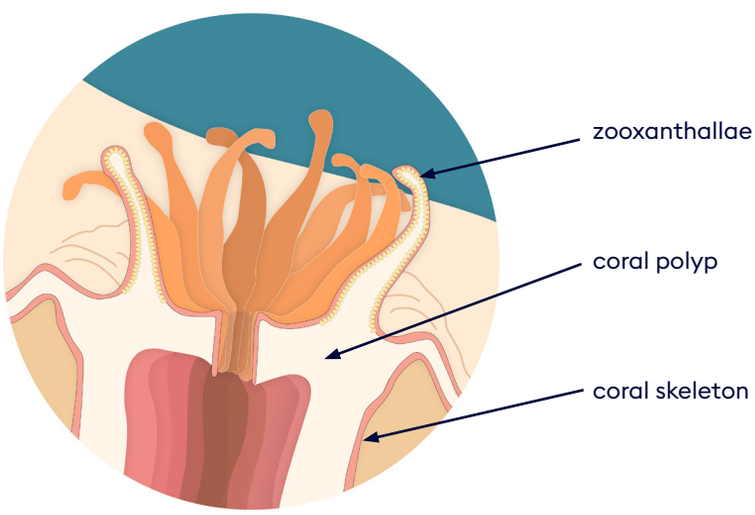
B



5. Explain the importance of biodiversity. Use the outcomes and diagrams above to help you (a link to resilience needed).

ANSWER SHEET 1b

Coral and biodiversity summary

Q	Answer	Guidance
1	In shallow tropical seas, with stable and warm temperatures.	Students should be able to tell from the map that coral reefs are in warm waters in the tropics, and shallow waters as most coral reefs grow near to land rather than in the middle of the ocean. Major regions for coral reefs are the Caribbean, the Coral Triangle and the Great Barrier Reef.
2		
3	Biodiversity refers to the variety and abundance of species in an ecosystem.	The GCSE specification incorrectly limits the definition of biodiversity to the variety of species.
4	Mutualism refers to a relationship in nature which is beneficial to both organisms involved. Examples on the coral reef include the algae and the coral polyp and the well-known relationship between the clown-fish and the sea anemone.	
5	An explanation that includes: · Resilient means the ability to return to original functionality after a disturbance whether natural or human. · The higher the biodiversity the more resilient a reef will be, because: · a biodiverse reef is more able to cope with change. · different species have different adaptations.	

LESSON 2

How can humans directly threaten reefs?

Age 14-16

60 minutes

Curriculum links

- Positive and negative human interactions within ecosystems and their impacts on biodiversity
- Impacts of ecosystem destruction on populations

Resources

Slideshow 2:
How can humans directly threaten reefs?

Student Sheet 2a:
Species card sort

Student Sheet 2b:
Reef uses

Student Sheet 2c:
Threats to reef information sheet

Student Sheet 2d:
Threats table

Subject Update:
Learn more: Human activity on the reef

Subject Update:
Learn more: Coral futures

Lesson overview

In this lesson students will develop their understanding of how humans present direct threats to biodiversity, and how to write a logical explanation. This idea is then developed further in the next lesson. The context of the lesson is how the villagers of Com could be harming their reef by using it.

Lesson steps	Learning outcomes
1. The Story so far (15 mins) Students set themselves targets based on the learning criteria of the lesson. Using the Species card sort Student Sheet, students produce a food chain, and identify producers, herbivores, carnivores, trophic levels and the direction of flow of energy.	• Describe the importance of all animals within the coral reef ecosystem
2. Uses and direct threats (20 mins) Students are to consider the different uses of the reef and how they are used by different stakeholders. Students visit the information stations placed around the room to learn about different threats to the reef, their causes and their impacts.	• Describe threats to the reef • Define and use the terms 'overfishing', 'destructive fishing', and 'trophic cascade' correctly
3. Explaining direct threats (15 mins) Students rewrite an explanation about threats to reefs, correcting scientific and literacy errors.	• Explain how a range of human activities can directly impact a reef
4. Tweeting (5 mins) Students demonstrate their understanding by composing a tweet about what they have learned.	• Demonstrate learning
5. Self-reflection (5 mins) Students decide if they have met their targets set at the beginning of the lesson, they reflect on the lesson's importance in the context of the unit of work and answer the questions.	• Reflect on learning

TEACHER GUIDANCE 2 (page 1 of 2)

Step	Guidance	Resources
1 15 mins	Step 1 contextualises the learning: · Show students the lesson outcomes on slide 3. Ask them to set themselves a minimum target and challenge target in their books, highlighting their expected progress if appropriate. Take feedback, ensuring targets are suitable. · Students are to use Student Sheet 2a Species card sort (already cut up) to create a possible food chain, and identify the producers, herbivores, carnivores, trophic levels and the direction of flow of energy. · Take feedback from the class. Reinforce the key ideas, that energy is transferred between the different animals within the food chain and changes can be catastrophic.	**Slideshow 2:** Slides 1-5 **Student Sheet 2a:** Species card sort
2 20 mins	Step 2 develops knowledge and understanding of how using reefs can reduce biodiversity. · Display slide 6, and hand out the Student Sheet 2b Reef uses. Students rank uses of the reef in order, from most to least important, then justify their thoughts. · Students then consider this exercise from a variety of stakeholders' points of view. · Ask students to present their thoughts and justifications to the class other students can share responses. · Using slide 8, make it clear to class that threats to the reef come in three parts – the threat, the cause and the impact. When considering the threats, it is important to always think about the causes and impacts of those threats. · Print three copies of Student Sheet 2c Threats to reef information sheet and place them strategically around the classroom. · Hand out the Student Sheet 2d Threats table, one to each student. · Students are to work their way round all three stations and fill in the Threats table. · Once students have filled in the table as the students some questions to assess understanding, such as: Why is dynamite fishing used? What activities do tourists do that could damage the coral reef? · Using slides 11-13 students to work through one of the examples (choose which one is most appropriate depending on the class's ability). With the class discuss what trophic cascade is and how the threats can cause it to happen. · Ask the class to define trophic cascade.	**Slideshow 2:** Slides 6-13 **Student Sheet 2b:** Reef uses **Student Sheet 2c:** Threats to reef information sheet **Student Sheet 2d:** Threats table **Subject Update:** Learn more: Coral futures **Subject Update:** Learn more: Human activity on the reef

TEACHER GUIDANCE 2 (page 2 of 2)

Step	Guidance	Resources
3 15 mins	Step 3 develops students ability to proof read and identify spelling, punctuation and grammar. · Display slide 15 and tell the students that the text contains several scientific and literacy errors. · Ask them to read the paragraph off the white board (this could be printed out and given to groups or pairs of students) and put hand up when they have identified a mistake. You are to choose a student to come up to white board, identify the mistake and make the correction. · The purpose of this task is to make it clear to the students the importance of good spelling, punctuation and grammar, especially with increasing marks in GCSE exam questions for SPaG. · Put the answer on the board and ask students to identify the other good aspects of the answer, why is it a good scientific explanation. · The students should identify things such as; use of data, named locations, clear and developed explanations and a variety of reasons given.	**Slideshow 2:** Slides 14-16
4 5 mins	Step 4 summarises the learning in the form of a Tweet. · Ask students to compose a tweet to share their learning. · Ask students to share their tweet with a partner and give each other feedback. When giving feedback encourage them to think about the following questions: Have they included all the important information from this lesson? What are threats to coral reefs? What are the consequences to the people of Timor-leste?	**Slideshow 2:** Slide 17
5 5 mins	Step 5 reflect on learning · Students could swap books or look at their own answers and decide if they met the targets set at the beginning of the lesson. They then write a short sentence explaining their achievement. Ask, by show of hands, which students think they met their minimum and challenge targets from the start of the lesson. · Set homework on slide 20, making sure that students have noted down the web address.	**Slideshow 2:** Slides 18-19

Species card sort

Maori Wrasse
Cheilinus undulatus

Kingdom	Animal (Animalia)
Phylum	Chordate (Chordata)
Class	Bony fish (Osteichthyes)

The Maori wrasse is one of the largest reef fish and the largest of the wrasse family. They are voracious predators, eating anything from molluscs to echinoderms and crustaceans, as well as small fish. They are one of the few species to eat the Crown-of-thorns starfish.

Size
They can grow up to 2m in length

Feeding
They feed on molluscs, crustaceans and echinoderms. They have few natural predators.

Habitat
Reefs throughout the Indian and Pacific oceans, from the shallows to a depth of 100m.

Threats
They are vulnerable to overfishing and pollution from e.g. cyanide fishing.

Did you know?
They get their name from the markings on their face which resemble traditional Maori tattoos!

Cleaner wrasse
Genus *Labroides*

Kingdom	Animal (Animalia)
Phylum	Chordate (Chordata)
Class	Bony fish (Osteichthyes)

Cleaner wrasses are fish which specialise in cleaning other, larger fish. This symbiotic relationship allows larger fish to stay clean, and provides a food source for the wrasse. The cleaner wrasses congregate in 'cleaning' areas, where bigger fish visit to be groomed by the wrasses, which swim into their mouths and gills to ensure everything is clean.

Size
Most species of cleaner wrasse are small, no bigger than 20cm long

Feeding
They feed off the dead tissue and parasites of fish they clean and have few predators, as larger fish prefer the benefits of cleaning to a quick snack!

Habitat
They live mainly around coral reefs of the Indian and Pacific oceans.

Threats
They face no specific threats except those that threaten the coral reef ecosystem as a whole.

Did you know?
Some wrasses, instead of waiting for customers in the cleaning areas, make 'house visits' for shy fish!

Nudibranch
Order *Nudibranchia*

Kingdom	Animal (Animalia)
Phylum	Mollusc (Mollusca)
Class	Gastropod (Gastropoda)

Nudibranchs are a type of mollusc and some of the most colourful animals on the Great Barrier Reef. Often referred to as 'sea slugs', these animals have a variety of different defence mechanisms to avoid being eaten, from storing poisonous cells from anemones they eat, to appearing as bright and colourful as possible to scare of would-be predators.

Size
Nudibranchs range from 2cm to 60cm long.

Feeding
Nudibranchs eat sea anemones and jellyfish. Some species are also cannibalistic. They are eaten by large fish such as wrasse.

Habitat
They live in the warm shallows of coral reefs.

Threats
They can be threatened by eutrophication caused by run-off from coastal areas, as well as fishing techniques such as dredging and bottom trawling.

Did you know?
Nudibranchs are simultaneous hermaphrodites, meaning that they have both male and female sex organs!

Brown algae
Genus *Sargassum*

Kingdom	Protist (Protista)
Phylum	Brown algae (Phaeophyta)
Class	Phaeophyceae

Sargassum includes some of almost 2,000 species of brown algae. It is a type of seaweed which grows thickly, attached to rocks in shallow waters as well as floating with the ocean currents. Its fronds have small globe-shaped compartments filled with gas. This helps it float near the sea's surface to enable photosynthesis. It plays a dual role by helping to form habitats as well as providing a food source.

Size
A few centimetres to up to 12 metres in warmer waters.

Feeding
It absorbs sunlight through photosynthesis and is eaten by smaller, herbivorous fish and sea urchins.

Habitat
Temperate and tropical waters.

Threats
Pollution can affect their ability to build proteins.

Did you know?
It is edible and tastes slightly bitter... but it must be cooked first!

Christmas tree worm
Spirobranchus corniculatus

Kingdom	Animal (Animalia)
Phylum	Annelid (Annelida)
Class	Polychaete (Polychaeta)

Christmas tree worms are a type of worm known as polychaetes. This refers to the little 'chaeta' or feet they have along their sides. The distinctive feature of the Christmas tree worm is the two crowns shaped like Christmas trees. These are used to strain the water for small particles of food, which are then transported in mucus to the mouth at the base of the crown.

Size
Christmas tree worms have a huge range of size from a few millimetres up to 3 metres.

Feeding
Christmas tree worms filter the seawater for plankton. They are eaten by fish.

Habitat
The Christmas tree worm larvae settle on damaged coral polyps and create a burrow. Preference is shown for large coral 'bommies' or mounds.

Threats
Because of their dependence on live coral, anything that threatens the coral, impacts Christmas tree worms.

Did you know?
If a fish bites off the crown, it quickly grows back!

Crown-of-thorns starfish
Acanthaster planci

Kingdom	Animal (Animalia)
Phylum	Echinoderm (Echinodermata)
Class	Sea start (Asteroidea)

The crown-of-thorns starfish is one of the most studied echinoderms on the Great Barrier Reef, because of the effects that periodic population outbreaks have on coral reefs. It is an unusual species in that it is a specialist corallivore. They have been responsible for 42% of the decline in coral cover on the Great Barrier Reef since 1985.

Size
Adults are usually 20cm to 40cm in diameter.

Feeding
Crown-of-thorns starfish feed on hard corals and occasionally soft corals and anemones. They are eaten by few species, such as the trigger fish and a marine snail, Triton's trumpet.

Habitat
On coral reefs.

Threats
There are no known threats to the crown-of-thorns starfish, but populations die out when they run out of food.

Did you know?
Divers have killed up to 120 crown-of-thorns starfish an hour to control outbreaks!

Triton's trumpet
Charonia tritonis

Kingdom	Animal (Animalia)
Phylum	Mollusc (Mollusca)
Class	Gastropod (Gastropoda)

Triton's trumpet is a large predatory sea snail. This mollusc is one of the few species that eats the crown-of-thorns starfish, as it has become immune to its toxins. One of the largest sea snails, they also feed on other starfish and sea urchins. They immobilise their prey by injecting them with a paralysing agent in their saliva.

Size
Adults grow to between 10cm and 35cm long.

Feeding
Triton's trumpet feeds on sea urchins and starfish.

Habitat
On coral reefs.

Threats
Like all organisms with a carbonate structure or shell, Triton's trumpet can be affected by ocean acidification. In some areas, the collection of shells for ornaments can be a threat.

Did you know?
The name Triton's trumpet comes from the ancient practice of cutting off the tip of the shell and using it as a trumpet!

Clown Anemonefish
Amphiprion ocellaris

Kingdom	Animal (Animalia)
Phylum	Chordate (Chordata)
Class	Bony fish (Osteichthyes)

There are 30 different species of anemonefish, so called as they have a symbiotic relationship with anemones. The anemone provides shelter from predators and provides the fish with a food source. The fish eat invertebrates which could otherwise harm the anemone and protect the anemone from other predators.

Size
Typically between 10cm-20cm long.

Feeding
They eat zooplankton such as copepods, and are hunted by larger fish.

Habitat
Shallow reefs and lagoons of the Indian and Pacific oceans, including the Great Barrier Reef and Red Sea.

Threats
Anemonefish are popular aquarium fish. The release of the Disney film 'Finding Nemo' in 2003 saw a sharp increase in demand which saw clown anemonefish populations decline.

Did you know?
Anemonefish (as well as some types of damselfish) are the only fish to be unaffected by the very strong poison of the anemone!

Pearlfish
Carapidae

Kingdom	Animal (Animalia)
Phylum	Chordate (Chordata)
Class	Bony fish (Osteichthyes)

Pearlfish are tiny fish which live inside invertebrates, including starfish, clams and sea cucumbers. They enter their host's body cavity via their anus and live there, protected from predators and with a ready source of nutrients. Most species of pearlfish live at peace with their host, but others are parasitic.

Size
From a few centimetres long to 20cm.

Feeding
Small invertebrates and crustaceans, or some feed off the organs of their host. They are eaten by larger fish.

Habitat
They live in tropical waters of the Atlantic, Indian and Pacific oceans, to a depth of 2,000m but more usually in shallow waters of less than 30m.

Threats
They face no specific threats other than those that face the coral reef ecosystem in general.

Did you know?
Their anus is close to their head, enabling quick and easy defecation by popping their heads out of their host's bottom!

Bumphead parrotfish
Bolbometopon muricatum

Kingdom	Animal (Animalia)
Phylum	Chordate (Chordata)
Class	Bony fish (Osteichthyes)

This distinctive fish has a vertical forehead and huge teeth for ramming into and then eating corals. They grow slowly and can live for up to 40 years. They are found in groups, and sleep as groups too, often in the shelter of caves or shipwrecks.

Size
They grow to over 1m in length.

Feeding
They live off algae and live corals, eating over 5 tonnes a year, and are primarily hunted by sharks, as well as humans.

Habitat
Bumphead parrotfish live around reefs and lagoons of the Indian and Pacific oceans, to a depth of around 30m.

Threats
They face no specific threats other than those that face the coral reef ecosystem in general, but can suffer from over-fishing.

Did you know?
They are hermaphrodites – they begin life as females and turn into males as they mature!

Staghorn coral
Acropora cerviciornis

Kingdom	Animal (Animalia)
Phylum	Cnidaria
Class	Anthozoa

Staghorn coral is a branching stony coral. Such hard corals are actually colonies of tiny polyps, a small animal much like the sea anemone. The polyps form a carbonate shelter and as the polyps reproduce, these carbonate structures grow as long branches. Hard corals are essential in creating the 3D reef habitat that supports so many different species.

Size
Branches range from a few centimetres to over 2m.

Feeding
Hard corals receive energy from their symbiotic relationship with zooxanthellae. The polyps also catch plankton such as copepods.

Habitat
Back and fore reef habitats at a depth of 0-30m.

Threats
Damage from changes in salinity, pH level and especially from increases in sea temperature which can cause bleaching. Locally, threats include storm damage and being eaten by the crown-of-thorns starfish.

Did you know?
Polyps reproduce both sexually and asexually and the polyps are both individual animals and linked within a colony!

Sea anemone
Order *Actiniaria*

Kingdom	Animal (Animalia)
Phylum	Cnidaria
Class	Anthozoa

Anemones are a type of polyp, the same animal that forms corals. They are usually found as single polyps, but can also form colonies. They have tentacles formed around an oval body which have stinging capsules at their ends, to immobilise their prey. They have a symbiotic relationship with some species of fish, which use the anemones as a refuge and are not stung. In return, these fish protect the anemone from predators.

Size
Anemones range from 1cm across to over 1m in diameter.

Feeding
Sea anemones eat small fish and shrimp. They are eaten by nudibranchs, some sea stars and fish.

Habitat
They usually live on the hard bottom of the sea and are found in most tropical and temperate coastal areas.

Threats
There are no known threats to sea anemones other than the general threats to the coral ecosystem. It can be affected by outbreaks of the crown-of-thorns starfish.

Did you know?
Some species of sea anemone can live for over 50 years!

Blue green algae
Phylum *Cyanbacteria*

Kingdom	Bacteria (Monera)
Phylum	Cyanobacteria
Class	-

Cyanobacteria are microorganisms, bacteria which fix nitrogen and carbon. They also produce oxygen through photosynthesis, enabling other species to live in the surrounding environment. Some live within protists (e.g. algae) or sponges, providing energy to the host, or form part of lichens in the splash zone of rocky shore environments.

Size
Microscopic, although in aquatic environments occasionally create ‘blooms’ which can be seen from space!

Feeding
They obtain energy from the sun through photosynthesis. They supply nutrients to other forms of algae and form an important part of the marine food web.

Habitat
All land and aquatic environments across the entire planet.

Threats
Pollution can affect their ability to build proteins.

Did you know?
The oldest known fossils are made from cyanobacteria and are 3.5 billion years old!

Tiger shark
Galeocerdo cuvier

Kingdom	Animal (Animalia)
Phylum	Chordate (chordata)
Class	Sharks & rays (Chondrichthyes)

One of the largest sharks in the world, the tiger shark is one of the apex predators on the Great Barrier Reef. It gets its name from the dark vertical stripes along its sides that resemble a tiger's stripes. It is a solitary creature, mainly hunting at night.

Size
Adult tiger sharks commonly grow to between 3m and 4.2m long, and can grow over 5m in length.

Feeding
They are voracious predators and not very picky, eating anything from fish to turtles, squid, marine mammals, human rubbish and car number plates.

Habitat
Mainly throughout tropical and subtropical waters worldwide, and are often found close to the coast.

Threats
They are vulnerable to fishing due to their slow growth and long lifespan.

Did you know?
About 10 people a year die from shark attacks, but humans kill 100 million sharks every year!

Manta ray
Manta alfredi

Kingdom	Animal (Animalia)
Phylum	Chordate (Chordata
Class	Sharks & rays (Chondrichthyes)

Mantas are large graceful fish, that often look like they are flying through the water with their large pectoral fins. They are filter feeders, using lobes either side of their mouth to funnel plankton towards them. Mantas are often found visiting cleaning stations, where fish such as the cleaner wrasse nibble parasites and their dead skin.

Size
Reef mantas reach 5.5 metres wide.

Feeding
Mantas are filter feeders, eating plankton and fish larvae. The mantas main predators are large sharks and orcas (killer whales).

Habitat
Typically found throughout tropical and subtropical waters.

Threats
They are slow swimmers near the surface and often become entangled in fishing gear.

Did you know?
They have the largest brain of all fish and we still have much to learn about their social behaviour!

Green turtle
Chelonis mydas

Kingdom	Animal (Animalia)
Phylum	Chordate (chordata)
Class	Reptile (Reptilia)

Green turtles are one of the six species of sea turtle that are found on the Great Barrier Reef. In the non-breeding season, turtles from the Great Barrier Reef travel as far as Fiji and Indonesia. Green turtles lay their eggs in pits they dig on beaches on islands and bays.

Size
Green turtles usually have a carapace (shell) between 80cm and 120cm long.

Feeding
Green turtles feed mainly on algae and seagrass. They are eaten by humans and larger sharks.

Habitat
Green turtles are found throughout tropical and subtropical oceans, returning to beaches to nest and they feed on coral reefs and seagrass meadows.

Threats
Destruction of seagrass meadows is the main threat. They also risk being caught in fishing nets and having their nesting sites destroyed by coastal developments.

Did you know?
Green turtles are reptiles and cold-blooded and they have been known to sunbathe to warm themselves up!

Copepod
Subclass *Copepoda*

Kingdom	Animal (Animalia)
Phylum	Arthropod (arthropoda)
Class	Crustacean (Crustacea)

A copepod is a small marine animal. It is a crustacean, and is related to lobsters, shrimps and crabs. Copepods are zooplankton, small animals that are carried by ocean currents rather than making their own way in the world. The word copepod comes from two Greek words kope- oar and pod- foot. They are the most abundant animal on this planet.

Size
Copepods are typically 1mm to 2mm long.

Feeding
Copepods are secondary producers, eating algae and turning this into the more complex building blocks needed for larger marine life, such as filter feeders.

Habitat
Throughout the oceans from pole to pole.

Threats
Copepods are susceptible to a decrease in the pH of the ocean from the process of ocean acidification.

Did you know?
There are an estimated 1,347,000,000,000,000,000,000 copepods in the world's oceans!

Boulder coral
Family *Portidae*

Kingdom	Animal (Animalia)
Phylum	Cnidaria
Class	Anthozoa

Poritidae is a family of hard corals that can form large coral mounds, known as 'bommies'. Such hard corals are actually colonies of tiny polyps, a small animal much like the sea anemone. Hard corals are essential in creating the 3D reef habitat that supports so many different species. They grow very slowly at a rate of 1-2cm a year.

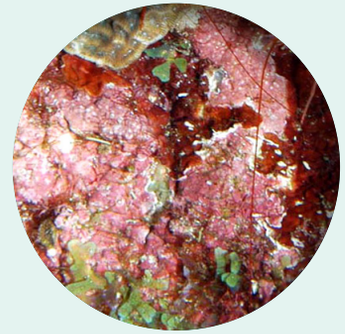
Size
These mounds can range up to 8m high and 5m across.

Feeding
Hard corals receive energy from their symbiotic relationship with zooxanthellae. The polyps also catch plankton such as copepods with their stinging tentacles.

Habitat
The 'bommies' favour lagoons and proximity to the reef slope.

Threats
Hard corals are susceptible to damage from changes in pH level and especially from increases in sea temperature which can cause bleaching. Locally threats include pollution from runoff and being eaten by the crown-of-thorns starfish.

Did you know?
Some of these coral colonies are over 700 year olds and they can be dated by counting their annual growth bands!



Red coralline algae
Genus *Porolithon*

Kingdom	Protist (Protista)
Phylum	Red algae (Rhodophyta)
Class	Rhodophyceae

Porolithon are pinkish algae which build and strengthen coral reefs. They live on rock, binding materials together and forming a calcified layer beneath them to protect the reef crest from the impact of waves and storms, and are known as ‘reef cement.’ They also convert nutrients into food for other species and generate oxygen.

Size
From microscopic up to 25cm.

Feeding
They absorb sunlight through photosynthesis and provide a food source for smaller, herbivorous fish.

Habitat
Primarily reef crests, as well as the inner and outer reef, in warm and tropical waters.

Threats
They are under threat from ocean acidification which makes it harder for the formation of their carbonate structures. Pollution and higher water temperatures also have an impact.

Did you know?
Although they appear red or pink in colour they also contain green chlorophyll!

Mantis shrimp
Order *Stomatopoda*

Kingdom	Animal (Animalia)
Phylum	Arthropod (Arthropoda)
Class	Crustacean (Crustacea)

Mantis shrimps are aggressive and typically solitary creatures. They kill their prey in two different ways, by spearing or smashing with their large front claws. Some species are 'spearers' impaling their prey and other are 'smashers', striking their victims and stunning or killing them.

Size
Mantis shrimps grow to between 1cm and 40cm long.

Feeding
'Spearers' prefer animals without a hard shell such as small fish. 'Smashers' prey on crabs, snails and other molluscs. They are preyed upon by larger fish.

Habitat
Mantis shrimps live in crevices in the coral or rock in lagoons and also burrow in the sand.

Threats
They face no known threats, except those that threaten the coral reef ecosystem as a whole.

Did you know?
Their smash is so powerful and fast it can create a sonic boom and there are reports of mantis shrimps kept in aquaria breaking the glass.

Sea cucumber
Class *Holothuroidea*

Kingdom	Animal (Animalia)
Phylum	Echinoderm (Echinodermata)
Class	Sea cucumber (Holothuroidea)

Sea cucumbers are a diverse and common type of echinoderm, found all along the Great Barrier Reef. Within sea cucumbers, a number of species have some quite surprising habits. Some sea cucumbers reproduce asexually, splitting in half to form two complete individuals. A favourite defence mechanism to avoid being eaten by fish, is to shoot their guts and internal organs out of their anus.

Size
Adults typically range from 10cm to 30cm in length.

Feeding
Most sea cucumbers sift through the sediment for plankton and decaying organic matter. They are eaten by a range of fish.

Habitat
Found on coral reefs, the intertidal zone and in deep water.

Threats
Edible species of sea cucumber (yes - they are widely considered delicious!), known as bêche-de-mer are under threat from overfishing.

Did you know?
Some species have also developed a symbiotic relationship with species such as the pearl fish, which shelters in the sea cucumber's anus to avoid predation!

STUDENT SHEET 2a

Sea Urchin
Class *Echinoidea*

Kingdom	Animal (Animalia)
Phylum	Echinoderm (Echinodermata)
Class	Sea Urchin (Echinoidea)

Sea urchins are related to starfish and sea cucumbers. Most sea urchins hide during the day to avoid predators. They also have poisonous spines to protect them. Sea urchins are mainly herbivorous eating the algae that grows on the coral reef. They play an important role in making sure that the coral reef is not overrun by seaweed.

Size
Adults typically range from 6cm to 12cm in diameter, not including the spines.

Feeding
Most sea urchins eat algae. They are preyed upon by snails such as Triton's trumpet and also by some crabs, rays and sharks.

Habitat
Found on coral reefs, sand flats and seagrass beds.

Threats
Sea urchin larvae are extremely sensitive to ocean acidification as well as threats to the coral ecosystem.

Did you know?
Most sea urchins only have mild venom, and although not fatal to humans, can be very painful if stepped on!

STUDENT SHEET 2b

Reef uses

Mining

Coral skeleton is made from calcium carbonate like limestone. The blocks are used to make buildings and roads.

Resilience

The more diverse a habitat, the more resilient it is. This means it can cope better with changes in the environment.

Spawning

Lots of fish that live in other habitats reproduce around reefs.

Tourism

Lots of tourists visit the reef to see its spectacular beauty.

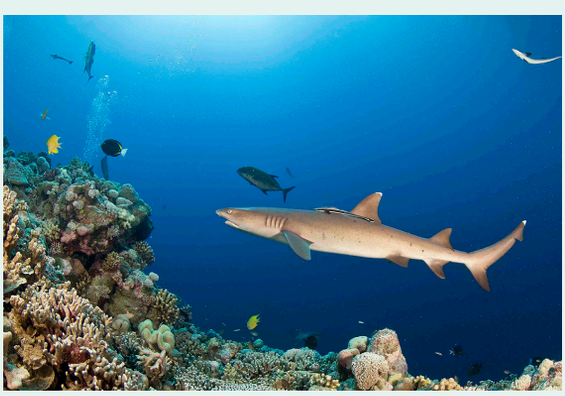
Coastal protection

Reefs protect coasts from waves, storms and floods.

Fishing

Coral reefs provide sources of food: approximately 59% of people in coastal communities on Timor-Leste rely on seafood as their main source of protein.

Habitat



Coral reefs support 25% of all marine life.

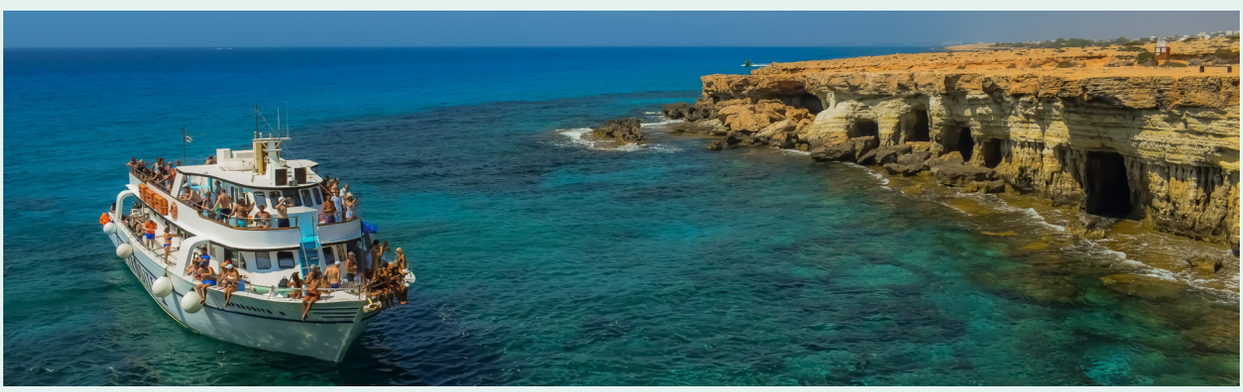
Medicine

Reefs could help develop many drugs.

STUDENT SHEET 2c

Threats to reef information sheets

Tourism



Humans can be curious creatures who want to explore their surroundings and have new experiences. The coral reef is no exception. The chance to explore the reef can bring in much needed money to the local economy. However, activities such as scuba diving, snorkelling and boating can cause direct physical damage to reefs. Despite strict instructions, divers will sometimes collect keepsakes and souvenirs from the seabed. This might involve direct destruction and removal of parts of the reef. In addition, careless accidental damage from divers, boats and equipment can lead to direct destruction of the reef.

Overfishing

Com relies heavily on the reef as a source of food. The villagers tend to eat the larger fish in the reef. They make regular catches using various methods. However, if too many of these larger fish are caught (overfishing), the populations of the smaller fish will rise, because there will be fewer predators to eat them. Whilst this might seem like a benefit, too many small fish could have unpredictable consequences for the reef's ecosystem. Recently there has been a lower fish diversity than previously observed, for example there are fewer snapper and parrotfish on reefs at sites near Dili.

Dynamite fishing

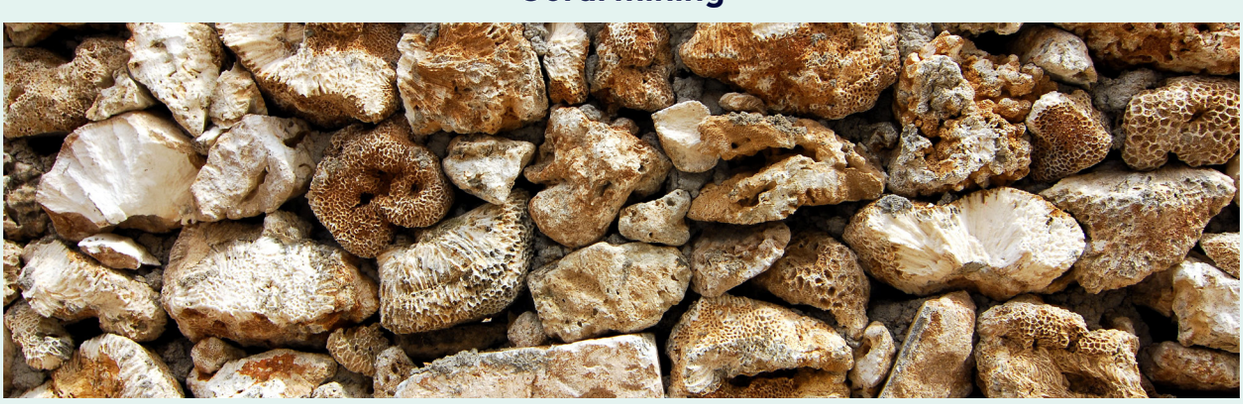
Drajay1976, CC BY-SA 3.0, from Wikimedia Commons

Dynamite fishing is the use of explosives stun or kill fish in large numbers for easy collection. It is a form of destructive fishing. This is generally an illegal practice, and it can be extremely destructive to the ecosystem. The explosion often damages or destroys the coral reef that supports the fish. This damage can disrupt the ecosystem and the food chain. This is a dangerous practice that can lead to many injuries and accidents amongst the fishermen.

Cyanide fishing

Cyanide fishing is the use of a chemical called Sodium Cyanide to stun fish without killing them, so they can be collected and sold, usually as ornamental pets. It is a form of destructive fishing. This is an illegal practice, and it can be extremely destructive to the ecosystem. Cyanide can cause coral to die, even in low doses. The cyanide can also kill the essential algae that lives in the coral polyp's tissues. This leads to coral bleaching and makes the coral more susceptible to disease. The combined effect of these could result in a drastic loss of coral.

Coral mining



Humans are always in need of construction materials. The skeleton of coral is made from calcium carbonate, the same chemical composition as limestone. Sand and limestone from coral reefs can be made into cement for new buildings, bricks and to fill holes in roads. The direct destruction of the coral reef can have devastating effects higher up the food chain.

STUDENT SHEET 2d

Threats table

Threats	Cause	Impacts

LESSON 3

How can humans indirectly threaten reefs?

Age 14-16

60 minutes

Curriculum links

- Link global warming to coral reef destruction
- Understand the negative human impacts on ecosystems

Resources

Slideshow 3:
How can humans indirectly threaten reefs?

Activity Overview 3a:
Sedimentation

Activity Overview 3b:
Ocean acidification

Student Sheet 3a:
Crown-of-thorns starfish information clues

Student Sheet 3b:
Coral threats activities

Answer Sheet 3a:
Crown-of-thorns starfish answers

Answer Sheet 3b:
Coral threats activities answers

Answer Sheet 3c:
Mark scheme

Activity:
Cloudy waters

Activity:
Ocean acidification in a cup

Video:
Underwater classroom: Coral bleaching

Subject Update:
Learn more: Corals in a high CO_2 world

Lesson overview

In this lesson students will develop their understanding of indirect threats to coral reefs, such as climate change, which causes the sea temperatures to rise and coral bleaching to occur. The context of the lesson is how human activities outside of Com village could be harming the local reef.

Lesson steps	Learning outcomes
1. Crown-of-thorns starfish (10 mins) Students set themselves targets based on the learning criteria of the lesson. Using the clues work out what has caused the crown-of-thorns starfish explosion.	• List human actions which can have an indirect impact on reefs
2. Indirect threats (25 mins) Using the information available at the different stations and watching the videos students are to complete the different activities and questions on the activities Sheet. Using the red, yellow and green cards students participate in the traffic lights game to assess their learning and understanding.	• Define and use the terms 'coral bleaching', 'sedimentation', 'turbid' 'global warming' and 'ocean acidification' correctly
3. GCSE Style Exam Question (15 mins) Students demonstrate their learning by answering the exam question. Using the mark scheme students peer assess each other's answer.	• Explain the cause and impact of a range of threats
4. Self-reflection (10 mins) Students decide if they have met their targets set at the beginning of the lesson and reflect on the lesson's importance to the context of the unit of work and answer the questions.	• Reflect on learning

TEACHER GUIDANCE 3 (page 1 of 2)

Step	Guidance	Resources
1 10 mins	Step 1 contextualises the learning: · Show students lesson outcomes on slide 3. Ask them to set themselves a minimum target and challenge target in their books, highlighting their expected progress if appropriate. Take feedback, ensuring targets are suitable. · Hand students the Crown-of-thorns starfish information clues (cut up in an envelope). Displaying slide 4, tell students they need to use the clues to figure out what happened to the crown-of-thorns starfish (COTS) and why it is a threat to coral reefs. Students to sketch a flow chart or diagram to show their thoughts. · Display the answer on Slide 5 or hand out the Answer sheet and discuss the answer.	**Slideshow 3:** Slides 1-5 **Student sheet 3a:** Crown-of-thorns starfish information clues **Answer sheet 3a:** Crown-of-thorns starfish answers
2 25 mins	Step 2 develops the knowledge and understanding of different indirect threats. · Displaying slide 6, tell students that they are to visit three mini 'practical' stations to define and give the causes of the coral bleaching, ocean acidification and sedimentation on the coral reef. · The stations will need to be set up around the room in advance of the lesson. See technician notes supplied in the Activity Overview sheets for more information. In addition, print slides 7, 9 and 11 to act as instructions for each of the stations. · Hand out the activities Student Sheet. · Students need to be evenly spread out between the three stations. · When looking at **Sedimentation**, students will make the water turbid, then place the sensor in the water. The current should decrease when the sensor is in the dark. This represents the light being unable to get to the algae, so they can't photosynthesise which is detrimental to corals. Ask students to work in pairs to cut out the cards and sort them into the correct order to describe how deforestation causes sedimentation which reduces biodiversity. · When completing the analysis of **CO_2 and ocean acidification**, students add acid drops to limestone 'coral' to see the effect of acid on coral reefs. They should infer that as levels of CO_2 in the atmosphere increase as will acidity of the ocean causing damage to the reef. · When examining **Coral Bleaching**, ask students to work in pairs to complete the tasks, answering the questions and fill in the missing words to understand the threats caused by rising CO_2 levels. · Show the videos from the activities to further develop knowledge and understanding of the threats; bleaching, acidification and sedimentation.	**Slideshow 3:** Slides 6-23 **Student Sheet 3b:** Coral threats activities **Answer Sheet 3b:** Coral threats activities answers **Activity Overview 3a:** Sedimentation **Activity Overview 3b:** Ocean acidification **Video:** Underwater classroom: Coral Bleaching **Activity:** Cloudy waters **Activity:** Ocean acidification in a cup **Subject Update:** Learn more: Corals in a high CO_2 world

Step	Guidance	Resources
	· Check the answers as a class using Answer Sheet 3b. · Traffic lights game - Assess students by asking them to show which colour arrow has the correct answer for the questions on Slides 13 to 23.	
3 15 mins	Step 3 develops knowledge and understanding as students answer a GCSE style exam question. · Ask students to complete the GCSE Style exam question. · Go through the exam question with the class, what is the command word – explain, what are the key words of the question – increasing demand, threaten reef biodiversity. · Following this student's to peer asses each other's responses using the mark scheme. Students give each other feedback on how to improve their answer.	**Slideshow 3:** Slide 24 **Answer Sheet 3c:** Mark scheme
4 10 mins	Step 5 reflect on learning. · Students could swap books or look at their own answers and decide if they met the targets set at the beginning of the lesson. They then write a short sentence explaining their achievement. Ask, by show of hands, which students think they met their minimum and challenge targets from the start of the lesson. · Challenge students to think about the global consequences of their actions by asking them the questions on slide 26. · Set homework shown on slide 27, making sure you guide students to the discovery zone on encounteredu.com.	**Slideshow 3:** Slide 25-27

Sedimentation

Age 14-16
(adult supervison)

5 minutes

Details

What you need (per station)

- **Student Sheet 3b:** Coral threats activities
- A series circuit containing an ammeter and a Light-Dependent Resistor capable of being submerged in water. The reading on the ammeter should significantly reduce if the LDR is covered
- A bottle or beaker of water containing mud. The water should become cloudy when stirred, and clearer when the water is left to rest
- A glass rod

Safety and Guidance

Precautions

Do not drink the water

Overview

Students put a light dependent resistor into turbid water to see how the amount of light able to get through turbid water is affected

Running the Activity

1. Stir the muddy water to make it cloudy ("turbid")
2. Place the LDR in the water and watch the ammeter reading

Expected results

The ammeter reading should reduce in the cloudy water, representing the lack of light getting to the algae in the reef when the water is turbid.

Ocean acidification

Age 14-16
(adult supervison)

5 minutes

Details

What you need

- **Student Sheet 3b:** Coral threats activities
- Limestone chips ("coral sample")
- 1M Hydrochloric Acid
- Droppers / Pipettes
- Plastic dish to conduct experiment

Safety and Guidance

Precautions

Wear goggles when handling Hydrochloric Acid

Overview

Students drop a weak acid solution to limestone "coral" samples to see the effect of acidic oceans on coral reef

Running the Activity

1. Place a sample of coral in the plastic dish
2. Take a small sample of HCl with the pipette
3. Drop the acid on to the coral sample and note the effects

Expected results

Limestone "coral" should react with the acid, causing fizzing and noticeable erosion of the sample.

STUDENT SHEET 3a

Crown-of-thorns starfish information clues

Use the information on the cards to explain in detail why there was a sudden rise in the number of crown-of-thorns starfish

If many species are affected, then the amount of biodiversity will be reduced

If more nutrients are available, more offspring can survive to adulthood

The coral reef is a delicate system. If one part of it is disrupted, it can influence the wider reef

Eutrophication happens when increased levels of nutrients in the oceans cause excessive growth of algae

Crowns-of-thorns starfish have venomous spines

Coral have a hard 'skeleton' made from calcium carbonate

Many species choose to spawn in the reef

Algae are able to photosynthesise

Fertilisers contain nitrogenous compounds

Mutualism: Coral polyps and algae have a symbiotic relationship

More land nearby is being used for farming

More sewage from farms and homes is being pumped into the sea

The larvae (young) of the crown-of-thorns starfish eat algae

Fertilisers and manure contain the types of nutrients that algae need

Adult crowns-of-thorns starfish prey on coral

If there is less coral, then the other species in the reef will suffer

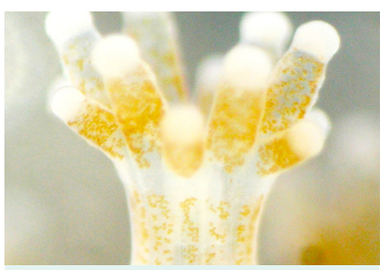
Farmers use fertilisers and manure to help grow their crops

Algae are tiny organisms (living things) that live in the sea

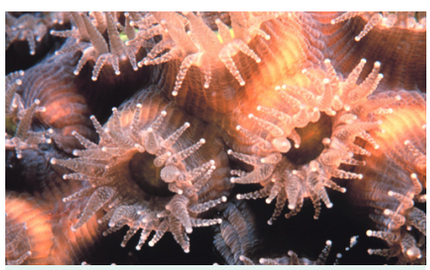
STUDENT SHEET 3b

Coral threats activities

Activities
Sedimentation



Algae photosynthesise less



Corals grow more slowly

Biodiversity of reef reduces

Less light reaching the algae

Deforestation and / or soil erosion causes soil to enter water

Water becomes more turbid

Ocean acidification

1. How does the sample of coral react to the drops of acid?

2. What could happen to a coral reef if the pH of the ocean decreases?

3. How can changes to atmospheric carbon dioxide lead to the pH of the ocean decreasing?

4. How are humans contributing to the rise in atmospheric carbon dioxide?

Coral bleaching

1. Explain how and why the relationship between algae and polyp changes causing coral bleaching.

2. Why might the sea temperature be increasing?

3. Why is bleached coral less likely to survive?

Coral bleaching and ocean acidification

As we burn _ _ _ _ _ _ _ _ _ _ _, we increase the concentration of _ _ _ _ _ _ _ _ _ _ _ _ _ _ in the atmosphere, which can affect the coral in the sea in two ways. Firstly, the carbon dioxide adds to the _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ in the atmosphere, which traps _ _ _ _ heat raising global _ _ _ _ _ _ _ _ _ _ _ _ _. The _ _ _ _ _ _ _ _ in sea temperature stresses the coral _ _ _ _ _ _ and causes them to expel the _ _ _ _ _ from their _ _ _ _ _ _ _ _. As the algae inside the coral polyp provides 70% to 90% of its _ _ _ _ _ _, bleached coral starts to starve. If temperatures do not return to normal levels, the coral polyps will die. The coral now looks white, so we say it has been _ _ _ _ _ _ _ _.
Secondly, lots of the extra carbon dioxide is _ _ _ _ _ _ _ _ by the sea: making it more_ _ _ _ _ _, this is known as ocean acidification. This makes it _ _ _ _ _ _ for the coral to build their protective coral _ _ _ _ _ _ _ _.

Add words for differentiation

absorbed	carbon dioxide	skeleton	algae
harder	greenhouse gases	thicker	polyps
bleached	fossil fuels	more	increase
energy	temperature	tissues	acidic

ANSWER SHEET 3a

Crown-of-thorns starfish answers

More land nearby is being used for farming

↓

Farmers use fertilisers and manure to help grow their crops

↓

Fertilisers contain nitrogenous compounds

↓

Fertilisers and manure contain the types of nutrients that algae need

↓

More sewage from farms and homes is being pumped into the sea

↓

Algae are tiny organisms (living things) that live in the sea

↓

Algae are able to photosynthesise

↓

Eutrophication happens when increased levels of nutrients in the oceans cause excessive growth of algae

↓

Mutualism: Coral polyps and algae have a symbiotic relationship

↓

Many species choose to spawn in the reef

↓

Coral have a hard 'skeleton' made from calcium carbonate

↓

The coral reef is a delicate system. If one part of it is disrupted, it can influence the wider reef

↓

Crowns-of-thorns starfish have venomous spines

↓

The larvae (young) of the crown-of-thorns starfish eat algae

↓

If more nutrients are available, more offspring can survive to adulthood

↓

Adult crown-of-thorns starfish prey on coral

↓

If there is less coral, than the other species in the reef will suffer

↓

If many species are affected, then the amount of biodiversity will be reduced

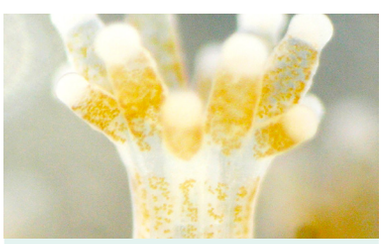
ANSWER SHEET 3b

Coral threats activities

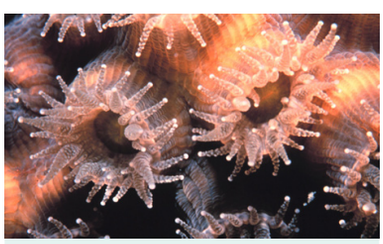
Deforestation and / or soil erosion causes soil to enter water

Water becomes more turbid

Less light reaching the algae



Algae photosynthesise less



Corals grow more slowly

Biodiversity of reef reduces

Ocean acidification

1. How does the sample of coral react to the drops of acid?
   It fizzes / the coral is eroding, causing damage.

2. What could happen to a coral reef if the pH of the ocean decreases?
   The amount of coral will reduce due to the increasingly acidic ocean.

3. How can changes to atmospheric carbon dioxide lead to the pH of the ocean decreasing?
   It dissolves in the ocean, creating an acid (carbonic acid).

4. How are humans contributing to the rise in atmospheric carbon dioxide?
   By burning more fossil fuels.

ANSWER SHEET 3b

Coral bleaching

1. Explain how and why the relationship between algae and polyp changes causing coral bleaching.
   The temperature of the water increases, stressing the coral polyp and making it expel the algae. This causes the coral to lose colour, which is why we say it has been bleached.

2. Why might the sea temperature be increasing?
   Global warming is having an effect on ocean temperature.

3. Why is bleached coral less likely to survive?
   It is more susceptible to disease and will not benefit from the nutrients it gets from the mutual relationship with algae.

Coral bleaching

As we burn **fossil fuels**, we increase the concentration of **carbon dioxide** in the atmosphere, which can affect the coral in the sea in two ways. Firstly, the carbon dioxide adds to the **greenhouse gases** in the atmosphere, which traps **more** heat raising global **temperatures**. The **increase** in sea temperature stresses the coral **polyps** and causes them to expel the **algae** from their **tissue**. As the algae inside the coral polyp provides 70% to 90% of its **energy**, bleached coral starts to starve. If temperatures do not return to normal levels, the coral polyps will die. The coral now looks white, so we say it has been bleached. Secondly, lots of the extra carbon dioxide is **absorbed** by the sea: which makes it more **acidic**, which we call ocean acidification. This makes it **harder** for the coral to build their protective coral **skeleton**.

ANSWER SHEET 3c

Mark scheme

Marks	Literacy Guidance	Content guidance
1-2	**Step 1** · Many spelling errors. · Full stops and capitals rarely used correctly. · Answer is not well organised. · Some science vocabulary is used.	Named at least TWO threats. Said that there will be a loss of or decrease in biodiversity.
3-4	**Step 2** · Some spelling errors. · Full stops and capitals used correctly. · Answer covers most of the major points and shows some logic in organisation. · Good use of science vocabulary.	Outlined a direct threat AND an indirect threat: At least TWO linked points from a direct threat AND at least THREE linked points from an indirect threat. **OR** Explain a direct threat OR an indirect threat: At least THREE linked points from a direct threat OR at least FOUR linked points from an indirect threat.
5-6	**Step 3** · Few spelling errors. · Good use of punctuation. · If a diagram is used, presented clearly. · Answer divided into sensible paragraphs · Answer flows in a logical order · Large variety of science vocabulary is used.	Explain a direct threat AND an indirect threat: At least THREE linked points from a direct threat AND at least FOUR linked points from an indirect threat.

Points to include

Direct threats: Overfishing

- Level of fishing will increase / overfishing.
- Fish at the top of the food chain more likely to be targeted.
- Possibility of a trophic cascade.
- Loss of fish species / reduction in biodiversity.

Direct threats: destructive fishing practices

- Level of destructive fishing practices could increase.
- E.g. dynamite fishing which physically destroys the reef.
- E.g. cyanide fishing, which kills more than just the target species.
- Loss of fish species / reef structure / biodiversity.

Indirect threats: deforestation

- Land cleared for farming / deforestation.
- Increases soil erosion / more sediment is washed into the sea.
- Turbidity is increased.
- Less light reaches coral.
- Less photosynthesis.
- Loss of coral species / biodiversity.

Indirect threats: fertiliser and the crown-of-thorns starfish

- Increased use of fertiliser.
- Fertiliser washed into the sea.
- Algae population increases.
- Crown-of-thorns starfish population increases as juveniles have more food.
- More adult Crown-of-thorns starfish which feed on coral.
- Loss of coral species / biodiversity.

LESSON 4

How do we decide which areas to protect?

Age 14-16

60 minutes

Curriculum links

- Understand how to complete an investigation
- Use transect line and quadrats to measure distribution of species

Resources

Slideshow 4:
How do we decide which areas to protect?

Student Sheet 4a:
Investigation information

Student Sheet 4b:
Investigation tasks

Video:
Snorkels and science

Video:
Seaview Science: Monitoring the reef

Subject Update:
About: XL Catlin Seaview Survey

Lesson overview

The aim of this lesson is for students to develop their understanding of how to complete a transect and to investigate the impact of abiotic factors on distribution and abundance of biodiversity on reefs. The context of the lesson is the work of the XL Catlin Seaview Survey which aims to compile a global reef record using 360 imagery.

Lesson steps	Learning outcomes
1. The story so far (10 mins) Students set themselves targets based on the learning criteria of the lesson. Students estimate the percentage of a square filled with a blue shape, to introduce the idea of quadrats.	• Describe what a transect is
2. Conduct a transect (30 mins) Using Investigation Information, students learn how to conduct a transect. Students are to follow the instructions to conduct their own 'transect', analyse the findings and concluding whether they prove the hypothesis.	• Describe how to complete a transect • Explain reasons for completing a transect
3. GCSE Style Exam Question (15 mins) Students demonstrate their learning, by answering an GCSE style exam question. Following this student's will use the mark scheme to peer assess each other's answers.	• Describe how to complete a transect. • Reflect on learning
4. Self-reflection (5 mins) Students decide if they have met their targets set at the beginning of the lesson and reflect on the lesson's importance to the context of the unit of work by answering the questions.	

TEACHER GUIDANCE 4 (page 1 of 2)

Step	Guidance	Resources
1 10 mins	Step 1 contextualises the learning. · Remind students of the overall context and aims of unit. · Share the learning outcomes with the class and set the context to engage students with the learning. · Students set themselves a minimum and challenge target using the lesson criteria. · Displaying slide 4, ask students to decide how much of the area shown is covered by the shape. Ask students to calculate the percentage of area is covered by the blue shape. Each box equals 4% of the shape. · This task demonstrates the use of quadrats. It helps to contextualise the lesson, as well as allowing you to explain how quadrats work.	**Slideshow 4:** Slides 1-4
2 30 mins	Step 2 develops knowledge and understanding of how to conduct a transect. · Use slides 5-7 to explain to students what transects are and why they are needed to survey the reef and how they are used to find out which areas should be protected. Go through the step-by-step method to conduct a transect. · Play the videos, this will give the students two examples of people completing transects. Whilst watching the video students are to answer the questions on slide 8. · Hand out Student Sheet 4a Investigation information. · Go through the expectations of the investigation with the students. · Students are to use Student Sheet 4a and complete all the activities on Student Sheet 4b. · Once students have completed the investigation go through their findings. Students should ultimately conclude that the hypothesis is correct.	**Slideshow 4:** Slides 5-17 **Student Sheet 4a:** Investigation information **Student Sheet 4b:** Investigation tasks **Video:** Snorkels and Science **Video:** Seaview Science: Monitoring the reef
3 15 mins	Step 3 develops knowledge and understanding as students answer a GCSE style exam question. · Go through the exam question with the class. Ask students to identify and define the command word and key terms. This ensures the students understand exactly what the question is asking them to do. · Ask students to complete the GCSE style exam question in their books. · Ask students to peer assess each other's responses using mark scheme on slide 19.	**Slideshow 4:** Slides 18-19

TEACHER GUIDANCE 4 (page 2 of 2)

Step	Guidance	Resources
4 5 mins	Step 4 reflect on learning · Students could swap books or look at their own answers and decide if they met the targets set at the beginning of the lesson. They then write a short sentence explaining their achievement. Ask by show of hands, which students think they met their minimum and challenge targets from the start of the lesson. · Set homework on slide 21, making sure students have noted down the task and you have guided them to the resources available on encounteredu.com.	**Slideshow 4:** Slides 20-21

STUDENT SHEET 4a

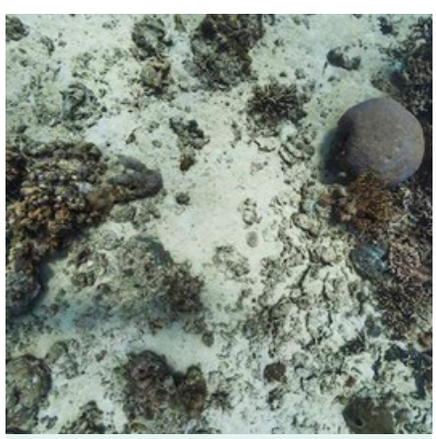
Investigation information

1. 5km from Com

2. 5.1km from Com

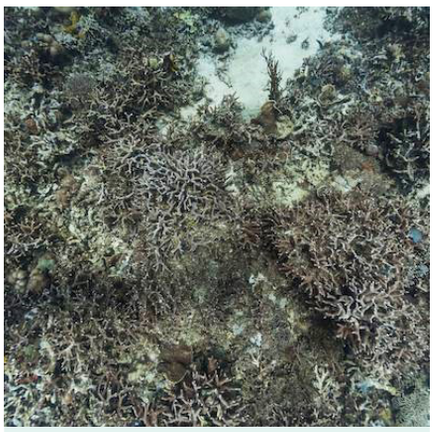
3. 5.2km from Com

4. 5.3km from Com



5. 5.4km from Com

6. 5.5km from Com



7. 5.6km from Com

8. 5.7km from Com

9. 5.8km from Com

10. 5.9km from Com

Hypothesis

The abundance of coral species will increase with the distance from Com village, because there is less disturbance.

Variables

We are changing the distance from the Com village and measuring the species abundance.

To check the influence of abiotic factors we will also measure the temperature, the pH, the light intensity and the concentrations of CO_2 and Ca^{2+}.

To ensure a fair test, keep the following variables the same:

- The time of year.
- The time of day.
- The size of the quadrat used ($1m^2$).
- Minimum area covered by a coral to be included within the count ($25cm^2$).

Equipment

What you need

- String
- Quadrat ($1m^2$)
- Coral ID book
- pH meter
- Thermometer
- Underwater slate and pencil
- CO2 meter
- Ca2+ meter
- Light meter
- Diving equipment

Method

1. Fix a line across your site.
2. Place your quadrat carefully over the reef.
3. Record the number of coral types within the quadrat.
4. Record the values of the abiotic factors.
5. Repeat every 10 meters along the line. Make sure you have at least 5 samples.

Safety and Guidance

To be safe

- Dive in pairs.
- Avoid touching any coral as some species are poisonous.
- Check your gear.
- Practice safe ascents.
- Rule of thirds - According to this rule, a diver should designate a third of his or her air supply for the outward journey, a third for the return journey, and the final third as a safety reserve.
- Practice vital skills – such as the signals used to communicate.

To be ethical

- Do not remove any of the coral.
- Avoid contact with the coral.
- Use a quadrat with legs to suspend it above the reef surface.

STUDENT SHEET 4b

Investigation tasks

Hypothesis

"The abundance of coral in the reef increases with distance from the village of Com"

Aim

To gather evidence from the coral reef, transect to prove or disprove the hypothesis.

Method

1. You will be presented with a series of images taken on one of the XL Catlin surveys of the reef near Com. The first image is closest to Com, the last image is furthest.
2. Working together, decide on how much of the seabed is covered by coral reef. Consider how you will ensure your estimate is accurate.
3. Repeat the steps for the 10 images in the survey.

Controls / Validity

1. How have the scientists ensured the survey is representative of the entire reef?
2. The XL Catlin surveys have been made open-source, meaning they are freely available for all scientists to use. What advantages / disadvantages can you see to this, and how does it impact on the validity of the research?

Results

Image number	Distance from the reef (km)	% of seabed covered by coral

Analysis:

3. Select a suitable method to graphically represent your results. Attach your graph(s).

4. To what extent do your results support the given hypothesis? Refer to your graph and results.

5. A previous analysis of Com reef conducted by another group of scientists supported the given hypothesis. Explain why the abundance of coral might increase further from the village of Com.

6. Are there any other indications about the biodiversity of the reef across the transect? If so, what did you see and what does it suggest?

7. What implications might your research have for the people of Com and the site of your MPA?

Virtual Transect - Survey Sheet

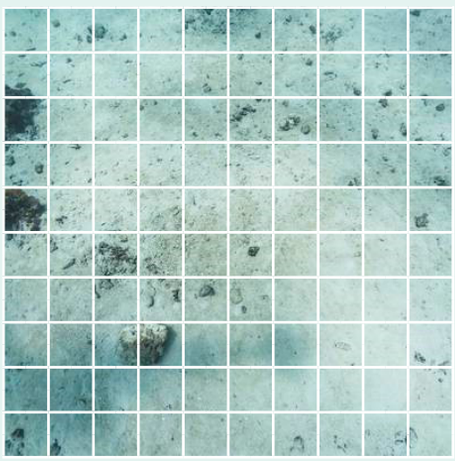


Image 1

Distance from reef: .....

% of seabed covered by coral: .....

Any other features of note?

.....

.....

.....

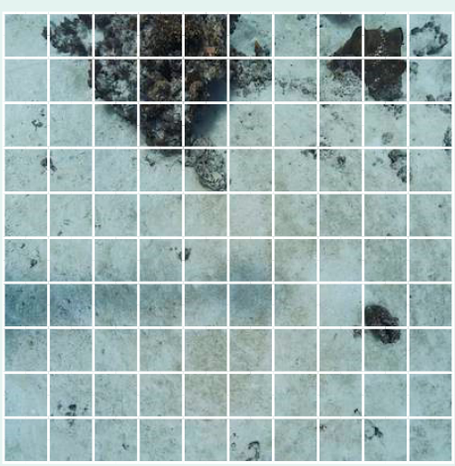


Image 2

Distance from reef: .....

% of seabed covered by coral: .....

Any other features of note?

.....

.....

.....

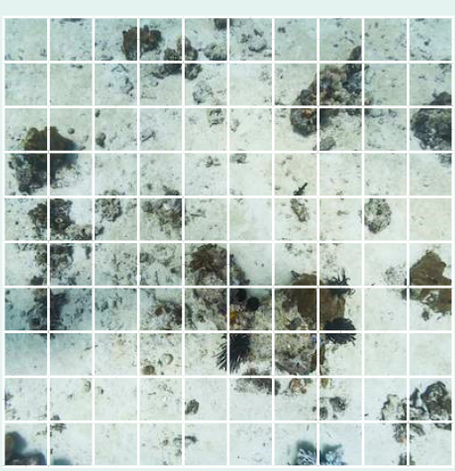


Image 3

Distance from reef: .....

% of seabed covered by coral: .....

Any other features of note?

.....

.....

.....

Image 4

Distance from reef: .....

% of seabed covered by coral: .....

Any other features of note?

.....

.....

.....

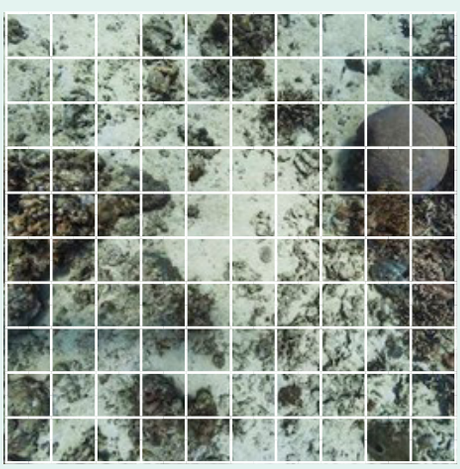


Image 5

Distance from reef: .....

% of seabed covered by coral: .....

Any other features of note?

.....

.....

.....

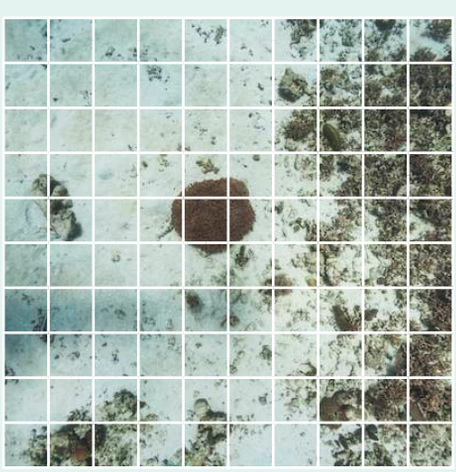


Image 6

Distance from reef: .....

% of seabed covered by coral: .....

Any other features of note?

.....

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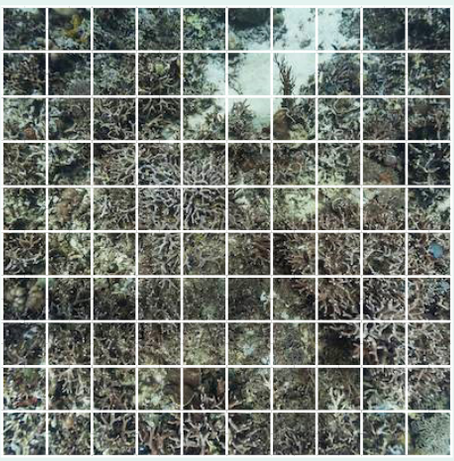

Image 7

Distance from reef: .....

% of seabed covered by coral: .....

Any other features of note?

.....

.....

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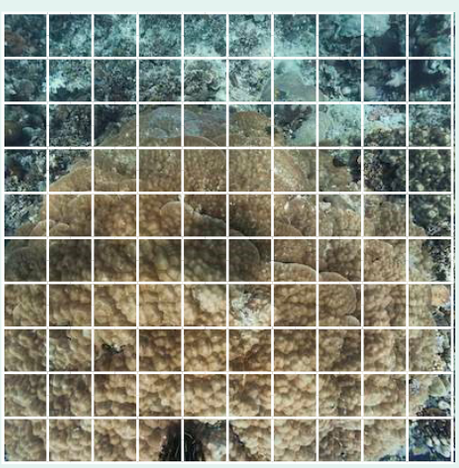

Image 8

Distance from reef: .....

% of seabed covered by coral: .....

Any other features of note?

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Image 9

Distance from reef: .....

% of seabed covered by coral: .....

Any other features of note?

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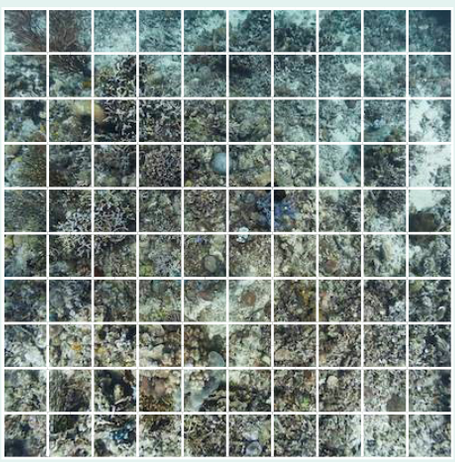


Image 10

Distance from reef: .....

% of seabed covered by coral: .....

Any other features of note?

.....

.....

.....

LESSON 5

How can we protect the reef?

Age 14-16

60 minutes

Curriculum links

- Maintaining biodiversity
- Describe both positive and negative human interactions within ecosystems and explain their impact on biodiversity.

Resources

Slideshow 5:
How can we protect the reef?

Student Sheet 5a:
Threats and solutions card sort

Student Sheet 5b:
Map to sketch MPA

Student Sheet 5c:
Timor-Leste MPA

Map:
Timor-Leste MPA
Google Map

Subject Update:
Learn more: Conservation on the Great Barrier Reef

Subject Update:
How to: Create a placemark on Google Earth Pro

Subject Update:
How to: Open saved placemarks in Google Earth Pro

Lesson overview

In this lesson students will start of by looking at the life cycle on coral reefs and the importance of mangrove forests and sea grass to the biodiversity of coral reefs. Following that students learn what MPAs are and decide where they would locate the four different MPAs in Com. The context of the lesson is the proposal for a new community marine protected area in Com.

Lesson steps	Learning outcomes
1. The Story so far (10 mins) Students set themselves targets based on the lesson criteria. Students discuss why a local fisherman might be pleased to have an MPA placed in the Com region. After this students will look at the life cycle on the reef.	• Describe the need for a variety of habitats in the lifecycle of a species
2. Solutions (30 mins) Using the information about the threats and solutions to coral reef, students to categorise the threats to the coral reef and some strategies used to protect the coral reefs. Students will then consider the solutions and differences between top-down and bottom-up conservation methods. Students choose where they would put the MPA and justify their choices.	• Give some examples of how to protect reefs • Explain why the location of an MPA has been chosen and justify with ecological reasons
3. Google Earth Pro (15 mins) Students draw their own proposed MPA on the map using Google Earth Pro in the location they choose and write a justification for this choice of location. They must not exceed an area of 25 hectares due to funding restrictions.	• Explain why the location of an MPA has been chosen and justify with ecological reasons
4. Self-reflection (5 mins) Students decide if they have met their targets set at the beginning of the lesson and reflect on the lesson's importance to the context of the Scheme of Work by answering the questions.	• Reflect on learning

TEACHER GUIDANCE 5 (page 1 of 2)

Step	Guidance	Resources
1 10 mins	Step 1 contextualises the learning: · Show students the lesson outcomes on slide 3. Ask students to set themselves a minimum target and challenge target based on the lesson criteria. · Working in pairs students bullet point reasons why a fisherman such as Alfredo might be happy to have restrictions on his fishing activities. · Discuss with students their responses and go through the importance of No Take Zones to protect the spawning grounds of different species. Establishing an NTZ can allow the numbers of fish to increase in the wider reef, ultimately helping the fishermen. · Go through the life cycle with the class, highlighting the importance of having a variety of habitats to ensure the health of lifecycle of species and environments, and ask them to consider how this will affect the placement of their MPA. Make it clear to class that for a coral reef to be healthy it needs mangrove forests and sea grass nearby as many of the animals that live on or use the coral also rely on the mangrove forest or sea grass for services such as spawning and as a source of food.	**Slideshow 5:** Slides 1-6
2 30 mins	Step 2 develops knowledge and understanding of the different threats to coral reefs and solutions such as using MPAs. · Hand out Student Sheet 5a: Threats and solutions card sort (they should be already cut out). · Ask students to work in pairs to match the reef threats to their solutions. There are more solutions to the threats. · Once complete, they can identify which of the solutions they think are imposed on the people of Com (top-down), and which solutions they have decided for themselves (bottom-up) and decide if top-down or bottom-up solutions are better and why. · Check answers with class and discuss thoughts about the top-down and bottom-up solutions. Is it better for the reef's residents to decide for themselves what to do or for a large multination organisation to decide? · Show students slides 11-12, explain that there are different types of MPA, and the need for each of them. · Hand out Student Sheet 5b Map to Sketch an MPA. · Using the information, they have learnt students choose where they would locate each MPA, they draw it on the map and justify why they have chosen this location. This is just the initial thought, to get students thinking about planning where to locate an MPA in future when they have more information and restrictions.	**Slideshow 5:** Slides 7-13 **Student Sheet 5a:** Threats and solutions card sort **Student Sheet 5b:** Map to sketch MPA **Subject Update:** Learn more: Conservation on the Great Barrier Reef

Step	Guidance	Resources
	· When ready, show students slide 13, which has a professionally placed MPA shown. · Discuss with students why the scientists have chosen this location for the MPA – include in your description that by having the MPA covering a variety of ecosystems it will allow the reef to be resilient as it contains a variety of habitats that are needed for all stages of life cycles, so biodiversity will be protected. It will also allow locals to continue their business in the reef to a certain extent, allowing them to make a profit to survive / feed themselves etc. The MPA is also placed away from the village to prevent disturbances.	
3 15 mins	Step 3 gives students the chance to improve their ability to use Google Earth Pro. · Using laptops students are to log in to Google Earth Pro so they can draw their proposed MPA on the map in the location they choose. They also need to write a justification for this choice of location considering everything they have planned so far. You can download and edit the KML file from Timor-Leste MPA Google Map. · If students do not have access to laptops, then the Timor-Leste MPA Google Map can be downloaded from encounteredu.com · You can also use Student Sheet 5c which has a map showing the Timor-Leste MPA and a 1-hectare grid, which students can use to locate their proposed MPA on the map, colouring 25 squares to indicate the 25 hectares. · A restriction they need to comply with is that the MPA's they want to use most not exceed an area of 25 hectares due to funding restrictions. · Students using Google Earth Pro should take a screenshot of the map and add their justification underneath using word processor. · For support using Google Earth Pro see the Subject Updates.	**Slideshow 5:** Slide 14 **Student Sheet 5c:** Timor-Leste MPA **Map:** Timor-Leste MPA Google Map **Subject Update:** How to: Create a placemark on Google Earth Pro **Subject Update:** How to: Open saved placemarks in Google Earth Pro
4 5 mins	Step 5 reflect on learning · Students could swap books or look at their own answers and decide if they met the targets set at the beginning of the lesson. They then write a short sentence explaining their achievement. Ask, by show of hands, which students think they met their minimum and challenge targets from the start of the lesson. · Set homework on slide 17, ensure students make note of the task.	**Slideshow 5:** Slides 15-17

STUDENT SHEET 5a

Threats and solutions card sort

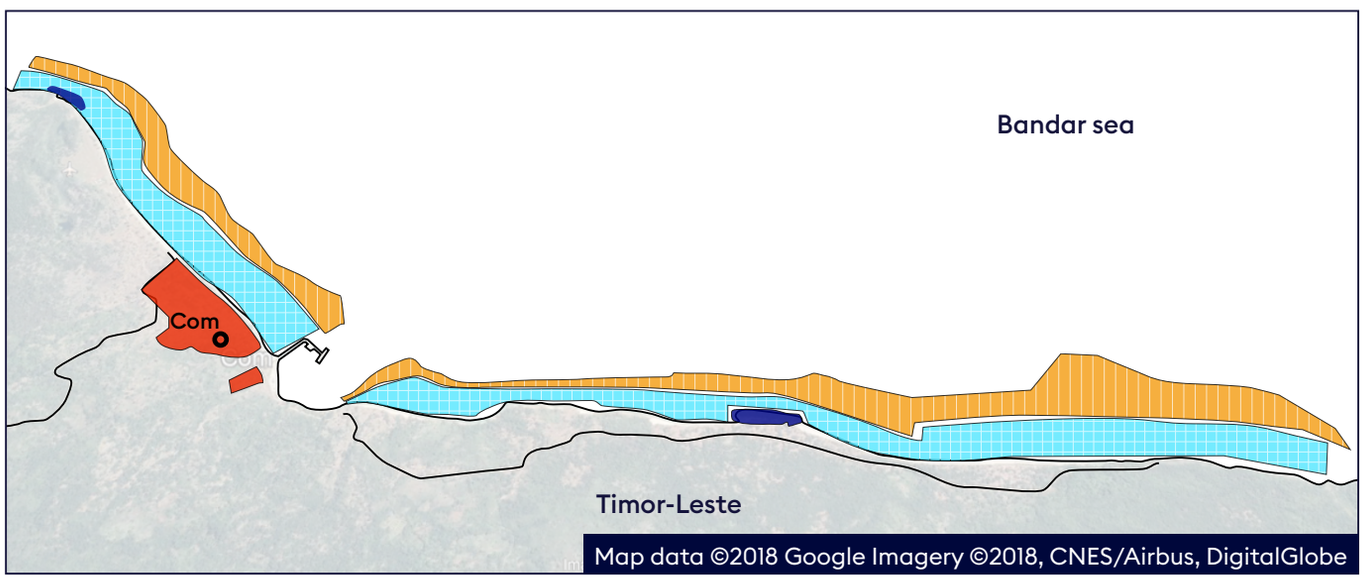
Government signs international treaties to reduce carbon emissions, e.g. the Paris agreement.	Coral bleaching caused by CO_2 driven climate change.	Fishermen are educated about natural resource management. This is often done by scientists and other non-governmental organisations.
Deforestation leading to sedimentation. Land is often cleared for farming.	Sewage systems are built to stop the untreated waste reaching the sea.	Harmful fishing practices e.g. overfishing, dynamite and cyanide fishing.

STUDENT SHEET 5a

Community creates and enforces its own marine protected area (MPA), to control activities like tourism and fishing and include a no take zone (NTZ).	Crown-of-thorns starfish decimating coral reefs. This is due to higher nutrient levels in the sea from fertiliser and sewage, which help algae to grow rapidly.	The government creates a sustainable development plan so that the county's growth doesn't increase fishing, intensive farming and unsustainable coastal developments.
Government creates and enforces a marine protected area (MPA) to control activities like tourism and fishing and include a no take zone (NTZ).	Coral mining for buildings and roads.	Government creates and enforces policies about using fertilisers and deforestation.
Increased levels of tourism leading to more untrained divers and tour operators damaging the reef.	Tour operators have to be licenced. They gain this licence after completing an education programme about sustainable reef use.	Scientists and non-government organisations work with farmers to reduce the impact of fertiliser and deforestation.

STUDENT SHEET 5b

Map to sketch MPA



Sea grass and sandy | Coral reef | Mangrove | Com village

Using the information provided, add to your map:

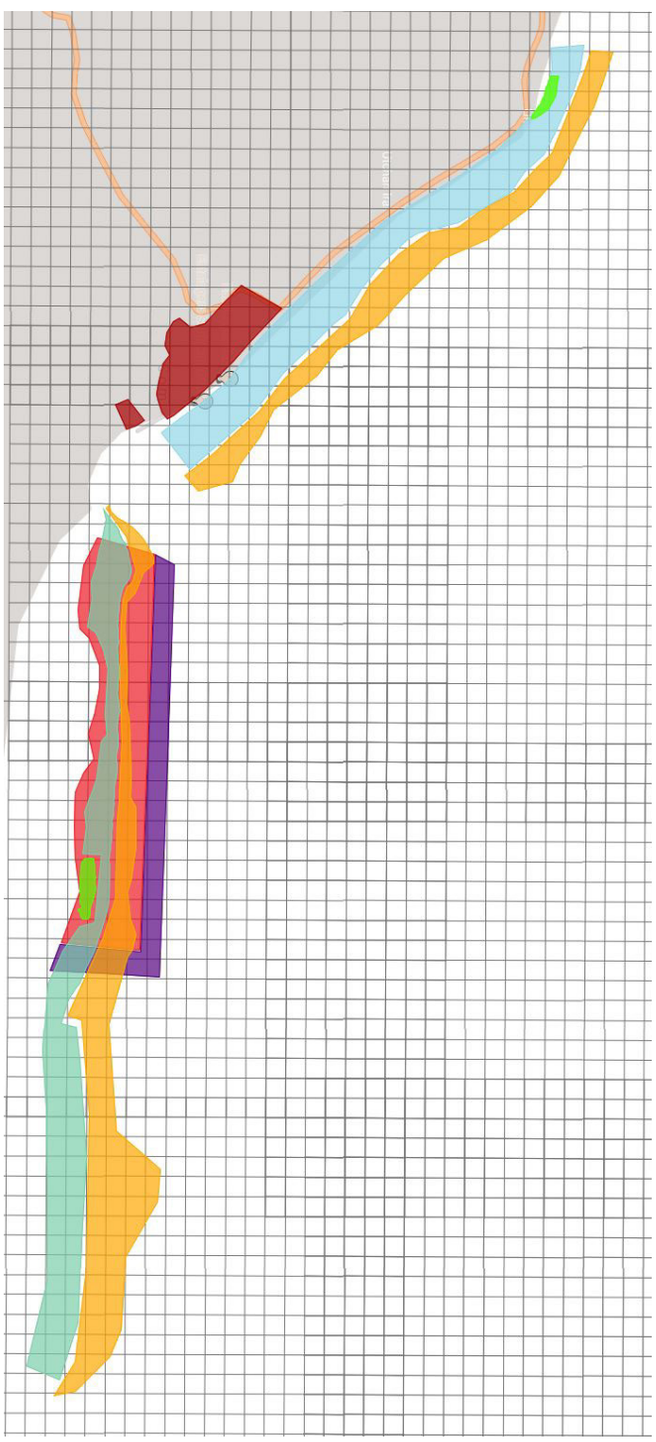
- A core MPA
- A scientific research zone
- An NTZ
- A buffer zone

Justify why you have placed each zone in the locations you have.
What are you trying to achieve with each?

STUDENT SHEET 5c

Timor-Leste MPA

One small square on the grid represents one hectare.



LESSON 6

How are members of the community affected by MPAs?

Age 14-16

60 minutes

Curriculum links

- Positive human impacts on biodiversity
- Implications of science on people and the environment

Resources

Slideshow 6:
How are different members of the community affected by MPAs?

Student Sheet 6a:
Stakeholders

Student Sheet 6b:
Preparing arguments

Video:
Stakeholder on the reef: Community

Video:
Stakeholder on the reef: Fisherman

Video:
Stakeholder on the reef: Government

Video:
Stakeholder on the reef: Local Tourism

Video:
Stakeholder on the reef: Tourism Operator

Lesson overview

Following on from last lesson, students consider the impact of biodiversity protection methods on different groups of people by watching a series of stakeholder videos. They go on to prepare arguments for a debate in the next lesson. The context of the lesson is the proposal for a new community Marine Protected Area in Com and what different people think about this.

Lesson steps	Learning outcomes
1. Brief (5 mins) Students set themselves a minimum target and challenge target in their books, highlighting their expected progress. Students bullet point ideas as to what they think different members of the community want from the coral reef.	• Describe how different people use the reef
2. Stakeholder's views (20 mins) While watching the videos from the different reef stakeholders, students complete the table thinking about how the MPAs affect the different stakeholders.	• Describe how an MPA would affect different stakeholders • Explain why a stakeholder might be for or against an MPA on the reef
3. Preparing arguments (20 mins) Using information from the videos, students prepare an argument from a stakeholders' point of view.	• Explain why a stakeholder might be for or against aN MPA on the reef
4. Tweeting (10 mins) Students demonstrate their learning by composing a tweet about what they have learned.	• Demonstrate learning
5. Self-reflection (5 mins) Students decide if they have met their targets set at the beginning of the lesson and reflect on the lesson's importance in the context of the unit of work by answering the questions.	• Reflecting on learning

TEACHER GUIDANCE 6 (page 1 of 2)

Step	Guidance	Resources
1 5 mins	Step 1 contextualises the learning. · Read through the lesson outcomes with the students, reminding them of the overall context and aims of unit. · Show students the lesson outcomes on slide 3 and ask them to set themselves a minimum and challenge target. · Choose a few students to read out their target to check they are setting suitable targets.	**Slideshow 6:** Slides 1-3
2 20 mins	Step 2 develops knowledge and understanding of the different stakeholder views about the implementation of an MPA in Com. · Display slide 4, students to come up with bullet points to suggest what different stakeholder would want from the coral reef. · Select students randomly to give their answers. · Ask students to think about how potential mitigation strategies such as the MPA would affect the interests of the different stakeholders. · Hand out Student Sheet 6a. · Show students each of the videos which focus on stakeholders in Timor-Leste. While the videos are playing students are to make notes on Student Sheet 6a. · Once all the videos have been played, have a discussion with the class, ask them questions such as: · How do the different stakeholders use the reef? · Will they be for or against an MPA?	**Slideshow 6:** Slides 4-10 **Student Sheet 6a:** Stakeholders **Video:** Stakeholder on the reef: Community **Video:** Stakeholder on the reef: Fisherman **Video:** Stakeholder on the reef: Government **Video:** Stakeholder on the reef: Local Tourism **Video:** Stakeholder on the reef: Tour operator
3 20 mins	Step 3 develops the students ability to prepare an argument. · Show students the task on slide 11. Explain that they will be debating from the point of view of a stakeholder next lesson. Allocate students the stakeholder whose perspective they will be debating from. Questions the students should consider are: · Are you in favour of an MPA? Why / why not? · Which other stakeholders will agree with you? · How might you use this to help your debate? · Put students into groups of four. With each group having a mixture of stakeholders. · Hand out the Student Sheet 6b Preparing your arguments. Ensure students have one each.	**Slideshow 6:** Slides 11-12 **Student Sheet 6b:** Preparing arguments

Step	Guidance	Resources

	· Ask students to work in their groups to discuss and prepare the initial thoughts of their stakeholder, filling out the thought bubbles on the Student Sheet 6b.
	· Following this, display slide 12. Students write a one-minute speech in preparation for next lesson. They should use the information from the Stakeholder student sheet for ideas.
	· To challenge higher ability students, give them a stakeholder perspective to consider the views of a stakeholder that wasn't mentioned on the videos e.g. local government or a child.
	· Ask several students targeted questions, for example:
	  · Who are you?
	  · Do you want an MPA or not?
	  · Who should control the MPA?	

4 10 mins	Step 4 asks students to summarise their learning by composing a tweet. · Ask students to compose a tweet to share the thoughts of their stakeholder. · Students peer assess each other's tweets.	**Slideshow 6:** Slide 13
5 5 mins	Step 5 reflect on learning. · Students could swap books or look at their own answers and decide if they met the targets set at the beginning of the lesson. They then write a short sentence explaining their achievement. Ask, by show of hands, which students think they met their minimum and challenge targets from the start of the lesson. · Set homework on slide 15, making sure that students have noted down where they can access 'Adaptations on the reef' from encounteredu.com.	**Slideshow 6:** Slide 14-15

STUDENT SHEET 6a

Stakeholders

Stakeholder	Why is the reef important to them?	Are they for or against an MPA?	Why?
Fisherman			
Guest house owner			
Warden			
Tour guide			
Scientist			

STUDENT SHEET 6b

Preparing arguments

Why is the reef important to me?

Why would an MPA benefit me?

Overall, do I support forming an MPA? Why?

How could an MPA have a negative effect on me?

Which stakeholders will disagree with me? Why?

Which other stakeholders might agree with me? Why?

LESSON 7

Which MPA proposal is the best?

Age 14-16

60 minutes

Curriculum links

- Positive human impacts on biodiversity
- Implications of science on people and the environment

Resources

Slideshow 7:
Which MPA proposal is the best?

Student Sheet 7a:
Long answer question

Student Sheet 7b:
GCSE style exam questions

Answer Sheet 7a:
Long answer question

Answer Sheet 7b:
GCSE style exam questions

Lesson overview

Following on from last lesson, students have a debate from the perspective of the different stakeholders. After this students' will demonstrate their learning from lessons 5-7 by completing a long answer question evaluating two proposals for a new community Marine Protected Area in Com. The context of the lesson is to bring the learning from previous lessons together in order to help decide where the students might place their MPA in their final lesson.

Lesson steps	Learning outcomes
1. Brief (5 mins) Students set themselves a minimum target and challenge target in their books.	• Describe positive and negative features of a proposed MPA
2. Debate (20 mins) Students have a debate. One student representative of each of the different stakeholders comes to front of class and reads their one-minute presentations produced last lesson. Following this, the class and other stakeholders have a chance to ask questions and put their views across.	• Describe positive and negative features of a proposed MPA
3. Long answer question (25 mins) Using the information on the Student Sheets students complete the long answer question. The question offers two possible options of an MPA, and the students must compare and contrast them.	• Compare two proposed MPA giving positive and negative features of each • Select the best site for the proposed MPA and justify your choice
4. Self-reflection (10 mins) Students to consider how the whole unit has impacted their thoughts on protecting coral reefs, and how even places far from home can have a wider impact on their lives.	• Reflect on learning

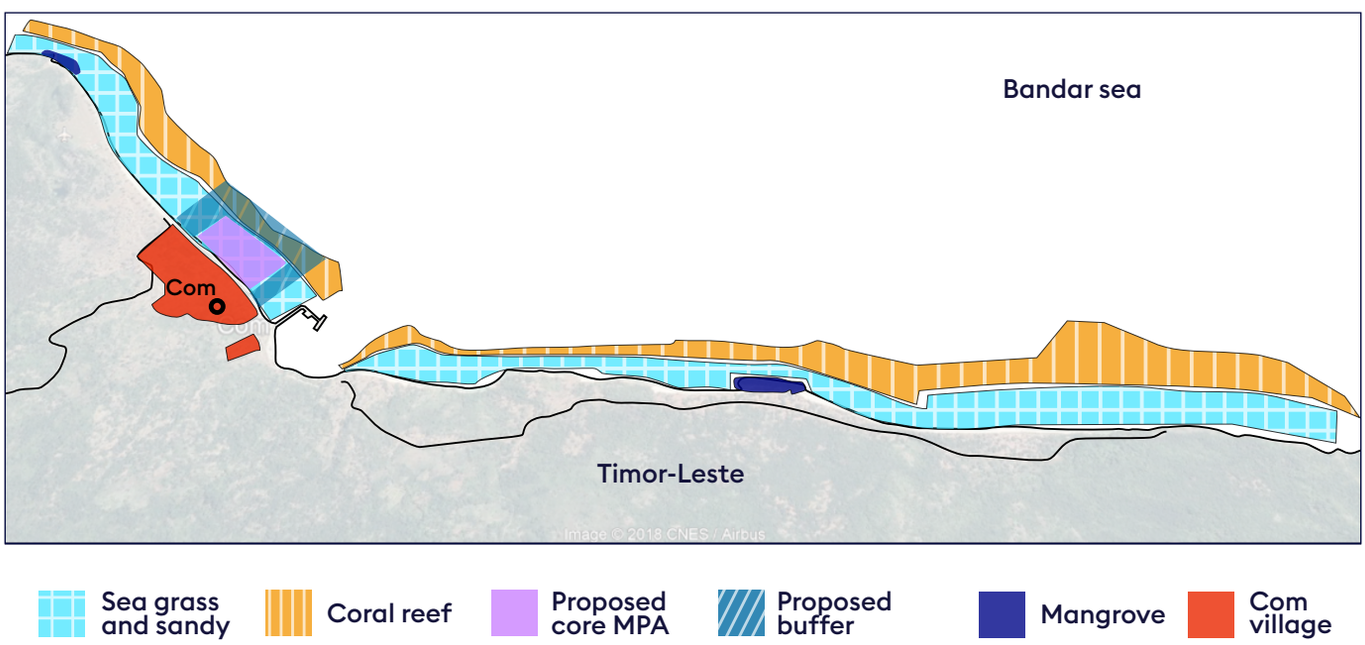
TEACHER GUIDANCE 7 (page 1 of 1)

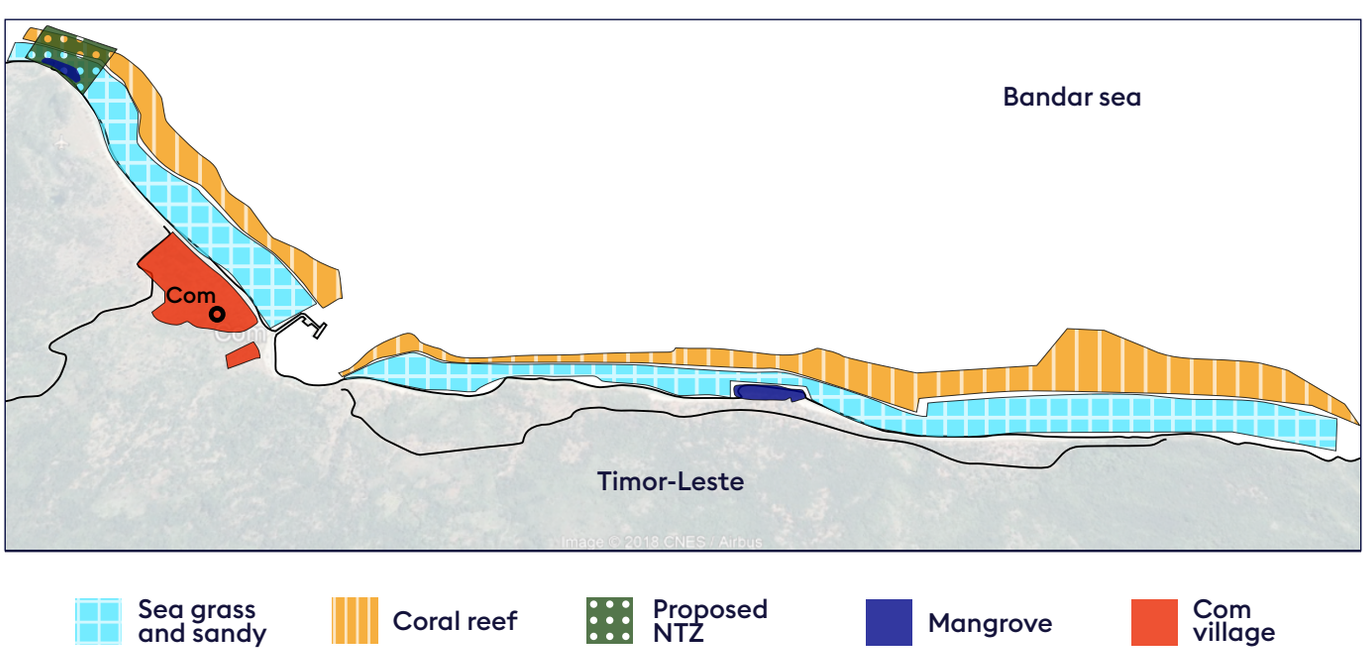
Step	Guidance	Resources
1 5 mins	Step 1 contextualises the learning · Read through the lesson outcomes with the students, reminding them of the overall context and aims of unit. · Show the lesson outcomes on slide 3. Ask students to set themselves a minimum and challenge target.	**Slideshow 7:** Slides 1-3
2 20 mins	Step 2 develops the student's ability to debate and speak to an audience. · Select a student to represent each of the different stakeholders and ask them to stand at the front of the classroom. · These students will read their one-minute presentations produced in the last lesson. Following this, the class and other stakeholders have a chance to debate by asking questions and putting their views across. · You as the teacher are the moderator and must enforce the debate rules outlined on slide 5. · As the moderator it is important you ask students targeted questions to gauge their understanding of their stakeholder's views, · For example: 'Who stands to gain most?' and 'Who will this have a negative impact on? Does this matter?'	**Slideshow 7:** Slide 4
3 25 mins	Step 3 develops knowledge and understanding of the MPAs by comparing two MPAs. · Hand out the Student Sheet 7a. · The long answer question offers two possible choices of MPA, students must compare and contrast them. Students are to answer the question. A good answer will consider the benefits and drawbacks of both and make a justified conclusion as to which they think is best. · Students to peer assess each other's responses using Answer Sheet 7a giving each other a mark out of 6.	**Slideshow 7:** Slides 5-6 **Student Sheet 7a:** Long answer question **Answer Sheet 7a:** Long answer question
4 10 mins	Step 4 reflect on learning · Lead students in a discussion about the whole unit, reflecting on what they have learnt. · Ask students to share their understanding about their impact on coral reefs as well as the impact coral reefs have on their lives (e.g. source of food). · Set homework on slide 8, these exam questions can be peer assessed next lesson using the mark scheme, or you can mark them as an assessment.	**Slideshow 7:** Slide 7-8 **Student Sheet 7b:** GCSE style exam questions **Answer Sheet 7b:** GCSE style exam questions

STUDENT SHEET 7a

Long answer question

Two different MPAs are being proposed for Com village: the details are shown below.





Zone	Net / spear fishing	Dynamite / cyanide fishing	Tourism / diving	Dredging	Gleaning	Scientific research
Core	X	X	X	X	X	With a permit
Buffer	With a permit	X	With a permit	X	With a permit	With a permit
NTZ	X	X	X	X	X	With a permit

Write a paragraph that compares and contrasts these proposals and concludes which proposal you think is best.

(Consider the following: Are there benefits and drawbacks of both proposals? These should be discussed. Overall, which do you think is better and why?

STUDENT SHEET 7b

GCSE style exam questions

1. Describe the importance of coral reef ecosystems being diverse.

(4 marks)

2. Explain the threats to the health of coral reefs, including the consequences.

(4 marks)

3. Explain how reef species are interdependent.

(4 marks)

4. What is trophic cascade?

(2 marks)

5. Define what an MPA is?

(2 marks)

6. Suggest how the threats to coral reefs could affect the life cycle between the different ecosystems.

(6 marks)

ANSWER SHEET 7a

Long answer question

Marks	Literacy Guidance	Content guidance
1-2	**Step 1** · Many spelling errors. · Full stops and capitals rarely used correctly. · Answer is not well organised. · Some science vocabulary is used.	Given any TWO features.
3-4	**Step 2** · Some spelling errors. · Full stops and capitals used correctly. · Answer covers most of the major points and shows some logic in organisation. · Good use of science vocabulary.	Made at least THREE points covering TWO areas.
5-6	**Step 3** · Few spelling errors. · Good use of punctuation. · If a diagram is used, presented clearly. · Answer divided into sensible paragraphs · Answer flows in a logical order · Large variety of science vocabulary is used.	Made at least FIVE points covering THREE areas.

Points to include

Comparing: positive features of both

- No take zones increase biodiversity / protect habits.
- No take zone increases fish stocks in other areas.
- Destructive fishing practices are banned.

Contrasting: Positive features of option A over option B

- Greater variety of habitats protected
- Further from the village so less disturbance threats
- Better for protecting biodiversity

Accept points reversed.

Contrasting: positive features of option B over option A

- Larger area protected
- Other activities are allowed with permits
- Some stakeholders such as tour operators can still earn an income from the reef.
- People can still find food on the reef.

Accept points reversed.

ANSWER SHEET 7b

GCSE style exam questions

Q1 4 marks

Describe the importance of coral reef ecosystems being diverse.

Level 1 – (1-2 marks)
Limited relevant points made.
The answer lacks detail.

Level 2 – (3-4 marks)
A detailed and coherent description is given.
Clear links identified between different plants and animals within the coral reef ecosystem.

Q2 4 marks

Explain the threats to the health of coral reefs, including the consequences.

Level 1 – (1-2 marks)
Discrete relevant points are made.

Level 2 – (3-4 marks)
A detailed and coherent description is given.
Clear links identified between the threats and impacts on coral reefs.

Q3 4 marks

Explain how reef species are interdependent.

Level 1 – (1-2 marks)
Discrete relevant points are made. The logic may be unclear.

Level 2 – (3-4 marks)
A detailed and coherent explanation is given.
Clear links between different species.

Q4 2 marks

What is trophic cascade?

1 x 2 marks
One mark for definition.
One mark for example.
A trophic cascade is an ecological event that is caused by the removal of predators and will cause changes in the populations of the other animals within the food chain.

Q5 2 marks

Define what an MPA is?

1 x 2 marks
One mark for definition.
One mark for development of idea.
An MPA is a clearly define geographical space that is managed to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

Q6 6 marks

Suggest how the threats to coral reefs could affect the life cycle.

Level 1 – (1-2 marks)
Discrete relevant points made.
Limited use of examples.

Level 2 – (3-4 marks)
Description of a variety of different threats with some detail.

Level 3 – (5-6 marks)
A detailed description of the different threats with examples.