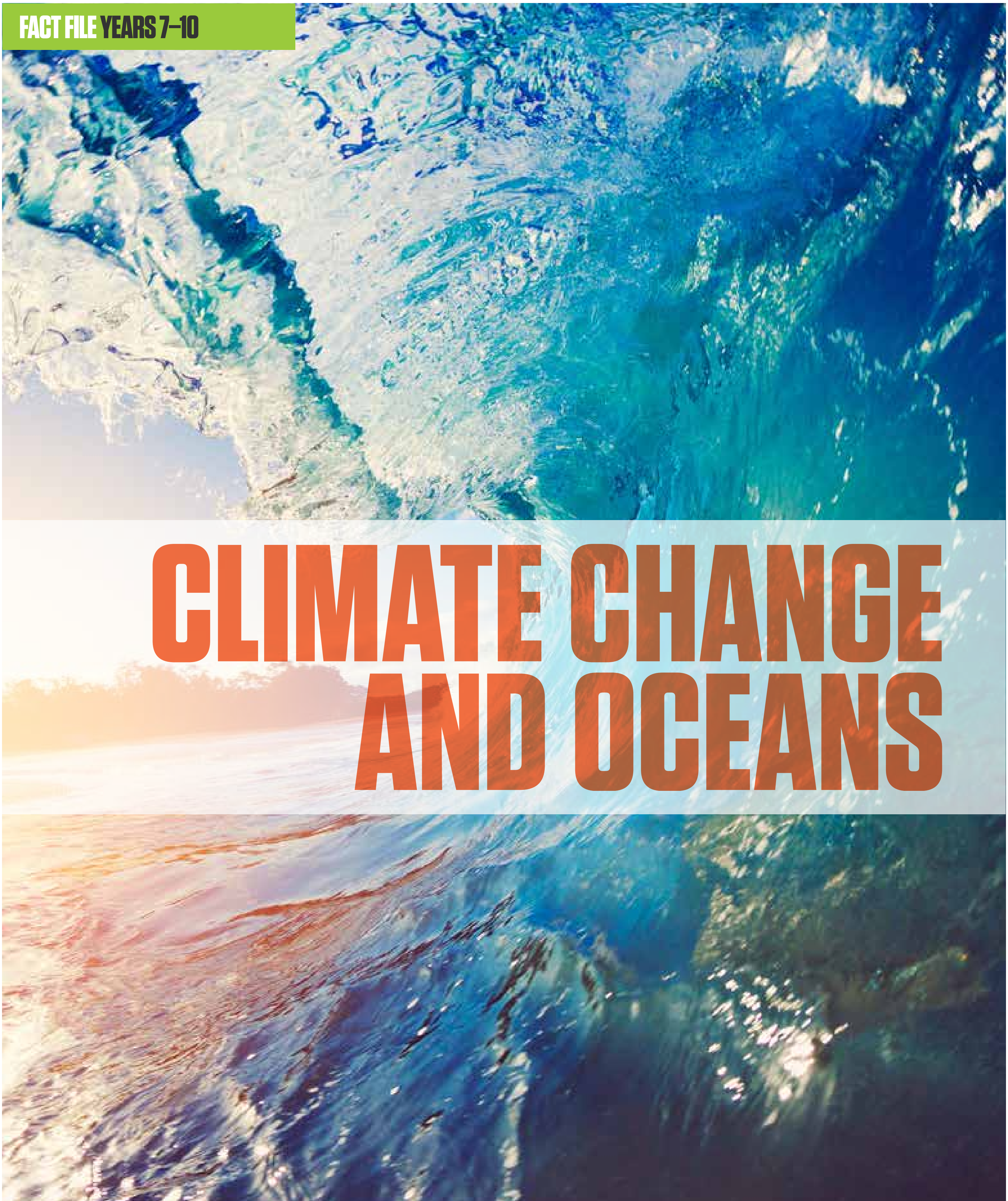
FACT FILE YEARS 7–10



CLIMATE CHANGE AND OCEANS

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TROPICAL FISH IN TEMPERATE WATERS

CLIMATE CHANGE IN THE SOUTH PACIFIC

UNIVERSITY OF WOLLONGONG AUSTRALIA
Southern Cross University
Charles Darwin University

CLIMATE CHANGE AND OUR OCEANS

HOW DOES THE EARTH KEEP WARM?

The key is in the Earth's atmosphere – the blanket of air surrounding our planet. When the sun's rays reach the Earth, gases in the atmosphere, like carbon dioxide (CO_2), stop heat from escaping, trapping some of the heat energy. This process is similar to how glass windows work in a greenhouse – letting the sunlight in to trap the warmth inside – which is why it's known as the greenhouse effect on a global scale.

Human activities, such as the burning of fossil fuels – like coal and gas – adds more CO_2 to the Earth's atmosphere, which in turn traps even more heat. This leads to a worldwide rise in temperature called global warming.

RISING SEA LEVELS

One of the impacts of global warming is the melting of ice and glaciers in Polar Regions. Rising sea levels due to increased water temperatures are also a concern, with coastlines and low-lying areas around the world at risk of flooding.

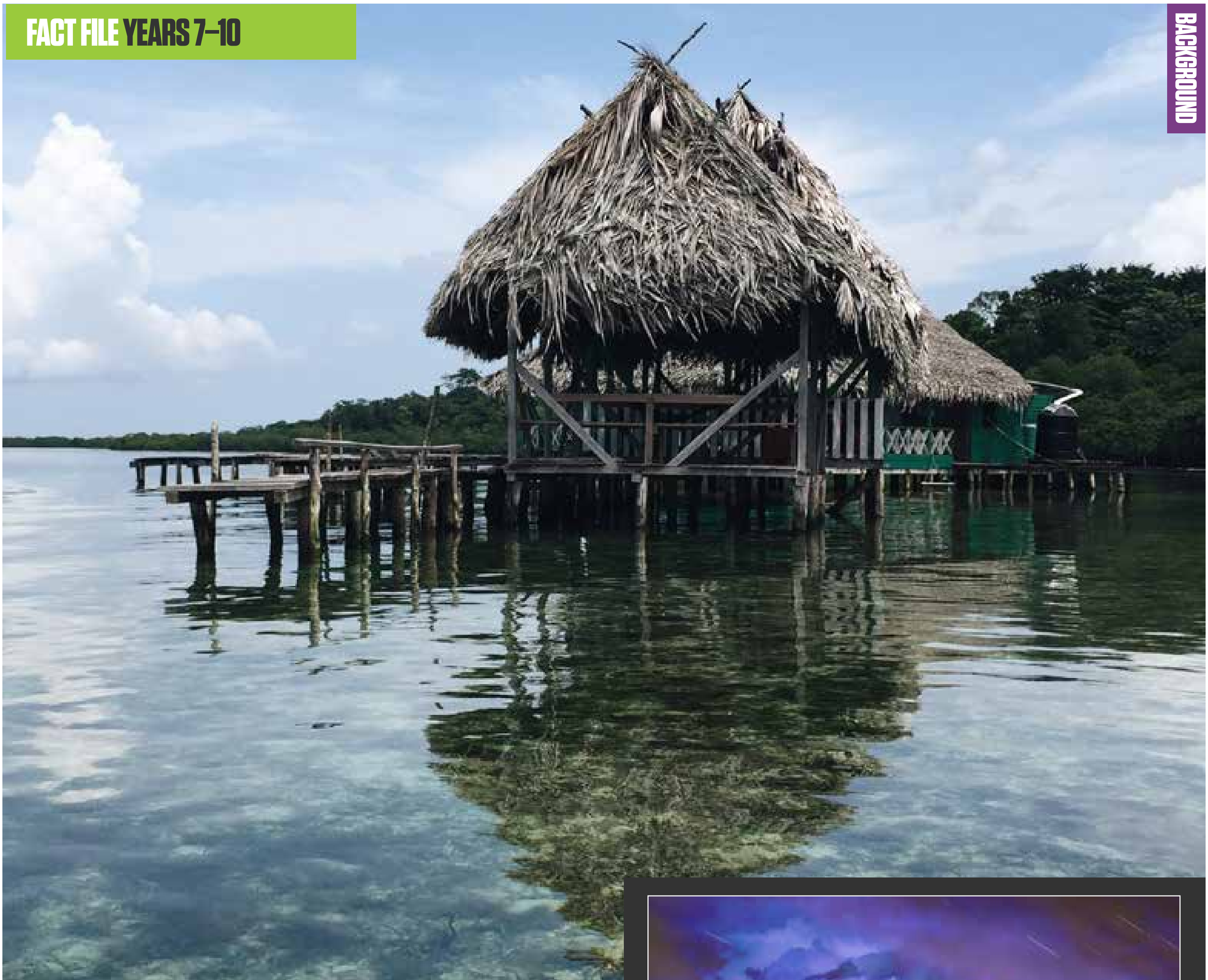
In the last two decades, some Solomon Islands in the Pacific have become submerged underwater. Communities on the Alaskan coastline have also been forced out, as the land around them is lost to the ocean. In 2016 a small rat called the Bramble Cay melomys was declared extinct because it was unable to survive the continual flooding of its island habitat on the northern Great Barrier Reef.

THERMAL EXPANSION

The major cause of sea levels rising is from expanding seawater. When water is heated, it increases in volume. As global warming increases the temperature of the Earth, it also heats up the oceans, causing the seawater to expand and occupy more volume – a phenomenon called the thermal expansion of water. Rising sea levels due to the thermal expansion of seawater is significant because oceans cover 71% of the Earth's surface and contain 97% of the Earth's water – so as sea levels rise more land will be at risk of being covered by water or washed away.

OCEAN ACIDIFICATION

Due to the burning of fossil fuels, the amount of CO_2 produced has continued to increase in the atmosphere, and the Earth's oceans absorb a lot of it. When CO_2 is mixed with seawater a chemical reaction happens that affects the pH of the water, making it more acidic. The change in the seawater's chemistry is called ocean acidification. This can negatively impact marine ecosystems because species are unable to adapt to the rapidly changing chemistry of the water surrounding them. For example, it causes oysters and shell fish such as prawns to have difficultly forming their outer layers, and corals to have trouble building their skeletons.



WILDER WEATHER

The rising temperatures caused by global warming are causing extreme weather patterns like heatwaves, heavy rain and storms to happen more frequently. As the Earth warms, there is an increase of water evaporating into the atmosphere. Due to global warming, cyclones are also becoming more severe and powerful. Cyclones are formed over oceans close to tropical regions and fuelled by warm moist air. With sea surface temperatures rising, the extra heat and energy from the warm air is the perfect environment for cyclones to gather momentum, with faster and stronger wind speeds, and cause destruction.

GLOBAL CLIMATE MODEL

Climate models are like equations created by using mathematics to map how the atmosphere, oceans and the land surfaces influence the Earth's climate. With the help of supercomputers, climate researchers can do trillions of calculations to predict how the Earth's climate will change hundreds of years into the future – using these equations to try to understand how global warming and rising levels will affect the Earth.

"Climate researchers can do trillions of calculations to predict how the Earth's climate will change hundreds of years into the future."

CASE STUDY 1

TROPICAL FISH IN TEMPERATE WATERS

Dominant kelp forests in NSW. Photo by John Turnbull, from Marine Explorer

ONE WELL-KNOWN IMPACT OF GLOBAL WARMING IN THE Earth's oceans is the widespread coral bleaching of the Great Barrier Reef. Coral bleaching is what happens when water is too warm for the corals to expel the animals living in their skeleton, causing the coral to turn white. But the warming seas are also killing kelp – a type of seaweed that grows underwater close to shore, usually in cool temperate oceans found in the far northern and southern regions of Earth.

Kelp forests are underwater habitats with high density of kelp. Thick kelp forests not only provide shelter and food for many animals, but many fish species depend on this unique and productive habitat as a breeding ground. The forests are also a crucial habitat for local fish, abalone and rock lobsters. Kelp forests require temperate and cool waters to thrive and can often be found along the coast of New South Wales, even in Sydney.

"We call it 'the Great Southern Reef'. It's much larger than the Great Barrier Reef yet many people know nothing about it," says Dr Adriana Vergés, a marine biologist at UNSW Australia, in Sydney, who is studying tropicalisation and looking at how increasing seawater temperatures are changing temperate oceans into tropical waters. "In fact 70% of Australians live next to it and don't realise."

"Warm-water species are shifting their distribution and becoming more abundant in places that before used to be dominated by cool-water species," says Adriana.

As ocean temperatures increase, species either die, adapt to the warmer temperatures or move to stay within their comfort-zone. "We are finding species along the coast of Sydney and further south that used to only be found in tropical places like the Great Barrier Reef," she says.

Many of the warm-water species that are moving are herbivores – consumers of algae and seagrasses. In tropical coral reefs, these herbivores have the vital role of trimming down large seaweeds, which make room for coral to grow. But in temperate regions, seaweeds provide the main habitat.

When voracious tropical herbivores come into temperate algal forests they can destroy native kelp forests and drive out local marine life. Tropical fish are starting to wipe out the kelp in temperate oceans faster than the kelp forests can recover, so many temperate coasts that once housed lush kelp forests are starting to look like underwater deserts.

Kelp forests support much of the biodiversity of the NSW coastline, but they are starting to disappear in the northern, warmer regions. "Seaweed forests are disappearing around the globe, not just in Australia," says Adriana.

Along some regions of the southern coast of Japan and the Mediterranean Sea, more than 40% of kelp forests have been wiped out. Plus, the changing temperature from warm, compared to temperate waters, also means fewer essential nutrients are finding their way to cool-water kelp for it to thrive and grow.

> "Seaweed forests are disappearing around the world, not just in Australia."

Dominant kelp forests in NSW. Photo by John Turnbull, from Marine Explorer

Convictfish is a tropical fish that is becoming increasingly common in Sydney in late summer months. Photo credit: Adriana Vergés

Researchers fear some of the damage to kelp forests near the warm edge of their distribution is permanent, and the kelp will never grow back, which Adriana notes has a huge impacts on ecosystems. "When you remove seaweed forests all the species that depend on that habitat also disappear and you get a completely different community moving into the area."

Adriana and other marine biologists are on a mission to restore the seaweed forests. Operation Crayweed is a project that was made possible after a crowd-funding campaign.

Its goal is to replant crayweed, a type of seaweed, back on reefs where it use to thrive until the 1980s–1990s, when it disappeared, most likely because of sewage pollution. Each crayweed plant is attached to an underwater net and this is transplanted into the reefs. The adult crayweed are then able to reproduce and build new crayweed populations.

With early success and plans to restore crayweed across 16 sites along the Sydney coastline, scientists hope that one day the Sydney sea floor will be carpeted in dense seaweed forests once again.

Operation Crayweed is an extraordinary environmental success story, but only possible in areas where pollution has been cleaned up along Sydney's East Coast. For the kelp forests that have disappeared because of climate change, more firm action needs to be taken to stop CO_2 emissions and associated ocean warming.

"Restoration will only work when the reason for the disappearance of the species, like a sewage problem, has been identified and fixed," says Adriana.

> "Restoration will only work when the reason for the disappearance of the species... has been identified and fixed."

But with ocean temperatures increasing, the management of ocean ecosystems against the effects of climate change may be our best line of defence. Having more marine protected areas, for example, can create healthier ecosystems that are more resistant to the invasion of warm water species.

Another method of controlling invading fish species is to make them a target of fishing. "Rabbitfish, one of the main invading warm-water species, is nice to eat. So we could fish them for food and protect the kelp forests at the same time," Adriana points out.

CASE STUDY 2

CLIMATE CHANGE IN THE SOUTH PACIFIC

Massive *Gracilaria edulis* seaweed bloom on the foreshore of Suva, Fiji in May 2012. Photo by Dr. Antoine N'Yeurt

ALTHOUGH GLOBAL WARMING IS A WORLDWIDE ISSUE, communities living on islands in the South Pacific region are directly impacted by its consequences. Rising sea levels are washing away low-lying islands, leaving many just one metre above sea level – with parts of some islands like Tuvalu and Kiribati already underwater. Add current predictions that there could be a 1 meter rise in sea levels by the end of the century, and the problems they're facing become crystal clear.

The South Pacific Islands are also experiencing increasingly violent tropical storms known as cyclones. As global warming causes ocean temperatures to rise, the warm ocean water creates more energy for tropical storms, leading to faster wind speeds when cyclones occur. People are also becoming more vulnerable to diseases like malaria and dengue fever because higher temperatures are the perfect breeding environment for disease-carrying mosquitoes.

Dr Antoine N'Yeurt, a marine botanist at the University of the South Pacific in Fiji, has experienced first hand how climate change affects the South Pacific Islands ecosystems. "Everyone in the South Pacific region suffers from climate change, and there's an urgent need for action," he says.

Global warming is threatening the livelihood of local communities that rely on fishing for food and trade by causing the widespread death of coral reefs. Healthy coral reefs give important shelter and food for many fish species, but warmer waters cause the organisms living on the coral to die, leaving the coral bare and driving away the fish. Tuna, for example, migrate away from warm waters, while other fish that depend on corals are forced to leave.

There is also an increase in algal blooms in the South Pacific caused by both global warming and human activity like agriculture and poor waste management. Algal blooms are the rapid growth of algae in the water, caused by warming water temperatures and pollution like sewage and fertilisers being washed into the sea. The build up of nutrients combined with warming waters causes the algae to be overfed and grow rapidly to become a thick blanket on the surface of the water. These blankets of algae are so thick they block sunlight from reaching beyond the ocean's surface. They also use up excess oxygen in the water and clog the gills of marine life, causing suffocation.

Algal blooms have also had an impact on the ecosystems surrounding the South Pacific Islands. "Three to four years ago there was a sudden increase in marine algae, and now the reef ecosystems in many coastal areas of the main populated islands are dominated by algae rather than coral. So the habitat of many fish and marine creatures is lost," says Antoine.

Antoine and his team are researching ways to protect ocean ecosystems surrounding the South Pacific Islands and fight against the impacts of climate change, for example by patrolling coral reefs for populations of Crown of Thorns Starfish, which devour and kill coral. In one study they are harvesting algal blooms and making them into seaweed fertiliser – an environmentally friendly alternative to chemical fertilisers for local islanders. Algae can also be a source of renewable clean energy to create power.

"To combat global warming there needs to be an international effort to monitor and reduce human impact in coastal areas," Antoine says. "Education is key, and younger generations have the power to make a change. It's important to be aware of the issues and risks of climate change – so we can act responsibly and make a difference."

"To combat global warming there needs to be an international effort to monitor and reduce human impact in coastal areas."

PROFILE 1

INVESTIGATING MARINE MOLLUSCS

Australian dogwhelk (Dicathais orbita) – a marine predatory snail that produces anticancer agents

KIRSTEN BENKENDORFF, A MARINE RESEARCHER AT Southern Cross University (SCU) in NSW is keeping an eye on how global warming is affecting the oceans, and she has a special soft spot for marine molluscs – an animal group that includes snails, slugs, octopus, mussels and oysters.

"Few other careers would allow me to spend a lifetime working on slugs and snails – and yet there is so much we can learn from these amazing chemists!" says Kirsten.

Marine molluscs are able to create chemicals that researchers have discovered could be powerful anti-cancer drugs. There is a lot more we could learn about these sea creatures, but global warming is threatening mollusc health and survival through ocean acidification. In an ocean that is too acidic, many animals like lobsters, coral and mussels are unable to form strong shells, and are therefore becoming more vulnerable to harmful diseases.

Kirsten's job is to see how marine molluscs are reacting to this stressful change in their environment, and find out what can be done to help them.

"My work involves investigating the value of marine molluscs in nutrition and medicine, so I've been actively investigating the impacts of ocean climate change on molluscs," she says.

Back in the laboratory Kirsten can recreate climate change oceanic conditions by using a wide range of digital technologies, such as gas mixers to control the amount of dissolved gas in water, and devices to control water temperature. During Kirsten's experiments digital monitors make sure that the water temperature, level of salt in the water and acidity is the same as ocean conditions created by climate change. Kirsten's research also takes her to rocky coastlines to study molluscs up close in their natural habitat. Here she uses a thermal-imaging camera with infrared sensors to detect heat radiating off objects and view the core temperature of the molluscs.

Kirsten says the skills she developed while studying for her Higher School Certificate – subjects like art, maths, biology and chemistry – are all really important skills that she still uses. "Some may be surprised by the mix of art, but good science is actually a creative endeavour," she says.

Kirsten surveying for molluscs on an intertidal boulder field in Lennox Head, NSW

"My work involves investigating the value of marine molluscs in nutrition and medicine."

She says she uses maths in many parts of her research, too. "I use maths to calculate how strong the chemicals and compounds are. I use fairly basic maths like algebra to calculate the diversity of marine species, and I use sophisticated statistics to analyse the effects of climate change on marine molluscs."

After studying Biological Sciences at Macquarie University in Sydney, Kirsten completed a PhD in Marine Biology and Chemistry at the University of Wollongong in NSW. What attracted Kirsten to research was not only making new discoveries, but the chance to inspire the next generation of scientists.

"I love discovering through research, and sharing scientific knowledge and research skills with others," she says.

Kirsten believes that passion, self-motivation and good time management are crucial in research – but the rewards are enormous.

"The competition can be fierce, but with perseverance and commitment it's possible to achieve great things and contribute significantly to current knowledge," she adds.

Catherine in a greenhouse monitoring session checking capsicums for pests and disease

PROFILE 2

STUDYING ALGAE FOR GOOD

ON THE SHORES OF FIJI, A SMALL ISLAND NATION IN THE South Pacific Ocean, algal blooms are invading – the sudden uncontrollable growth of algae on the water surface that can be toxic to both humans and marine creatures. Whenever algal blooms appear, Fiji's tourism and fishing industry are forced to stop due to the large shoals of fish dying from either the toxic chemicals or lack of oxygen caused by the algae.

But where most locals in Fiji see algal blooms as a troubling sign of global warming, climate change researchers like Catherine Taunani Soreh are looking to transform algal blooms into a tool to combat ocean pollution. Catherine is a research student completing her Masters degree in the Pacific Centre for Environment and Sustainable Development at the University of the South Pacific. In Fiji, Catherine aims to stop the pollution of the ocean ecosystem with the power of fertilisers made from seaweed. After harvesting the seaweed and turning them into fertiliser, Catherine tests the experimental fertiliser on crops.

"I do research on seaweed bio fertilisers and agricultural crops. My work involves making bio fertilisers from brown and red algae and using them on agriculture crops like capsicum, tomatoes and Pak Choy Chinese cabbage," she says.

Catherine says that there was no shortage of seaweed for her to make into fertiliser. Ocean pollution has caused seaweed to become a pest because of the thick blankets of algae on the water surface fouling the water and clogging up waterways.

"Seaweeds are abundant, accessible and easily obtained in most South Pacific Island communities, especially those on the coasts."

For Fiji and many other island states, agriculture and farming forms the backbone of their economy. Farmers rely heavily on expensive chemical fertilisers that they ship in from other countries, and these chemical fertilisers, along with rising temperatures caused by climate change, are the cause of increasing algal blooms on the coral reefs.

Maths is an important skill for Catherine, which she uses constantly to analyse her results. By using statistics she is able to find how effective the different types of fertilisers used in her experiment are compared to one another.

Samples of seaweed liquid bio fertilizers of Gracilaria edulis and Sargassum polycystum

Catherine says one of her greatest personal achievements was the determination, motivation and endurance to complete the fieldwork despite all the difficulties she encountered along the way.

After completing her studies, Catherine is planning to continue her research. She is also dedicating herself to providing community support on how to make seaweed bio fertilisers. Only by educating the local community to accept seaweed bio fertilisers is it possible to stop the pollution of ocean ecosystems. But Catherine is also hoping to contribute to social change as well. By empowering rural women in the Solomon Islands with essential skills, they would be able to take the lead in organic farming to sustain their own livelihoods.

Catherine says that determination is important. "Stay focused on your interests. Be aware that whatever career path you take you will face challenges. Be strong and determined to succeed."

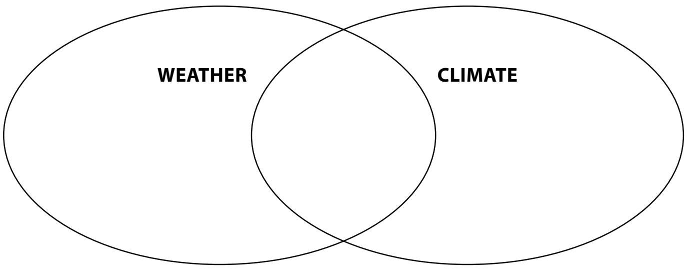
> "My work involves taking bio fertilisers from brown and red algae and using them on agriulture crops."

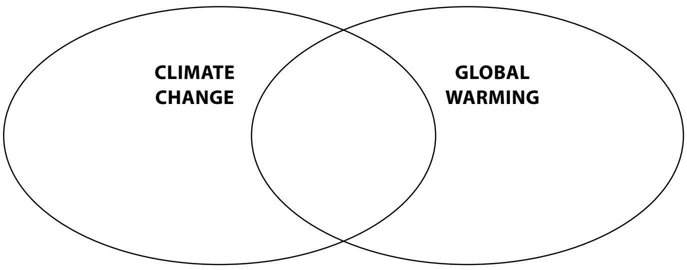
TEACHER TOOLKIT

GENERAL CAPABILITIES

Literacy

Before getting started, it is important to understand what climate change really is and how it differs from other phenomenon such as climate, weather and global warming. Complete the Venn diagrams using definitions, examples and drawings to compare and distinguish these concepts.





Numeracy

Graphing the effect of excess CO_2 on the pH of water.

INTRODUCTION

In Profile 2 you learnt about Kirsten Benkendorff and her research to help better look after molluscs. When greenhouse gas carbon dioxide is dissolved in ocean water there is a consequential effect on the shell-building capabilities of molluscs. The ocean's waters are becoming more acidic because they are absorbing some of the excess carbon dioxide in the atmosphere. This in turn is affecting the organisms that live in the oceans, such as coral, that cannot tolerate the increased acidity. Carry out this investigation to find out how the molluscs shells can be affected by increasing amounts of carbon dioxide.

MATERIALS

- straw
- small beaker
- universal indicator paper and colour chart

PROCEDURE

1. Make sure the beaker is clean before you start by rinsing it with tap water.
2. Fill the beaker half full with tap water.
3. Use the universal indicator to measure the pH of the tap water. Record pH in the 'Results' table below.
4. Using a clean straw, blow bubbles into the water for 30 seconds.
5. Use the universal indicator to measure the pH of the tap water. Record pH in the 'Result' table below.
6. Empty the water from your beaker and rinse it.
7. Repeat the experiment 2 more times and record all results in the 'Results' table below.
8. Calculate the average pH of the water before and after blowing bubbles.
9. Calculate the change in pH for each of the three trials.

RISK ANALYSIS

Consult your teacher to complete a risk analysis for this investigation.

HAZARD	PRECAUTION	CONSEQUENCE

RESULTS

This table shows the change in pH of water using exhaled breath.

	pH OF WATER	
	A. before bubbling CO_2 into water	B. after bubbling CO_2 into water
Trial		

Use the space below to create a graph to show the average change in pH of normal tap water before and after CO_2 has been bubbled through it.

DISCUSSION QUESTIONS

1. What is pH?
2. Did the water become more acidic or basic when CO_2 was bubbled through it for either the exhaled breath or the acid carbonate reaction?
3. What might happen to seashells (calcium carbonate) or coral if they are exposed to an increase in acidity over a long period of time?

Digital Technologies

In Case Study 1 you read about the warming of oceans and coral bleaching. Scientists use statistics to monitor a variety of ocean conditions. Imagine you are a climate and oceans scientist who uses the Australian Governments Bureau of Meteorology website to collect the following data on daily ocean temperatures this week.
www.bom.gov.au/oceanography/forecasts

1. Click on forecast loop tab at the top of the page.
2. Choose the link to the map for Queensland.
3. Hold the cursor over the capital city Brisbane and record the latitude and longitude in the data table below.
4. Click on the link for temperature where it says 'Forecasts' and use the scaled key to read and record the ocean temperature range.
5. Clink on the link for salinity where it says 'Forecasts' and use the scaled key to read and record the ocean salinity.

MAP LINK	LATITUDE OF CAPITAL CITY (YELLOW DOT) IN DEGREES AND MINUTES	OCEAN TEMPERATURE RANGE (°C)	SEA SURFACE SALINITY RANGE (PSU)
Queensland			
New South Wales			
South Australia			
South Western Australia			

DISCUSSION QUESTIONS

1. On what day was your information collected?
2. Which map showed the greatest range in temperature?
3. Which map showed the greatest range in salinity?
4. Is there a relationship between water temperature and salinity? If so describe it?

5. Which of the scientists mentioned in the texts would find the information in this website useful in their studies?
6. Was there any data readings that surprised you? Share your thoughts with the class.

Critical and Creative Thinking

THINKING ABOUT BIOFILMS

Case study 2 and Profile 2 both discuss algal blooms. Algal blooms are biofilms, which have an important role in biology. But what exactly are biofilms and where do they come from?

INTRODUCTION

When algae cover the surface of water they form a biofilm. Biofilms are groups of microorganisms that stick together on different surfaces. They are composed of different types of microorganisms, such as bacteria, fungi and protozoans. The microorganisms secrete a substance that causes the cells to stick together on living or non-living surfaces. Biofilms can be found all around the home where there are small amounts of moisture. For example the slime on bath toys, sink pipes, slime in shower recesses, contact lenses and the plaque on your teeth.

This activity will help you understand what biofilms are and how algal blooms might form.

MATERIALS

- pipette
- glass microscope slide
- 5 agar Plates per group
- 5 test tubes
- 5 rubber stoppers to fit the test tubes
- test tube holders
- marking pens
- spatula
- measuring cylinder

METHOD

1. Fill up 5 test tubes with 5ml of water each.
2. Walk around the laboratory and school looking for biofilm growth; for example slime, mouldy areas on bricks, or algal growth on footpaths.
3. Use the spatula to scrap a section of the biofilm off the surface.
4. Place the biofilm sample into one of the test tubes.
5. Put the rubber stopper on top of the test tube to seal.
6. Repeat for 4 other biofilm samples across the school.
7. Take the test tubes back to the laboratory.
8. Shake up each of the test tubes with the biofilm to dissolve the sample through the water.
9. Use a pipette to collect a sample of water from each of the test tubes.
10. Open up an agar plate and empty the pipette out onto the agar.
11. Seal the plate with masking tape.
12. Label the plate with the sample site, date and your name.
13. Place in a warm place in the lab and check each day (up to 7 days) for the growth of microorganisms.
14. Record the numbers of colonies of microorganisms that form on each of the plates.
15. Keep the agar plates sealed at all times.

RISK ANALYSIS

Complete the following table to note any risks that you will be undertaking while carrying out this investigation.

HAZARD(S)	PRECAUTION(S)	CONSEQUENCE(S)

RESULTS

1. Design a table in the space below to record the results of your observations.

2. Take photographs or make some diagrams that show the different types of colonies of microorganisms found on the plates and label them.

DISCUSSION QUESTIONS

1. Where did you look for biofilms growing and why did you look in these spots?
2. What environmental conditions do you think were the best for biofilm growth around the school?
3. Which biofilm sample produced the most different types of microorganisms?
4. Suggest why biofilms can be harmful.
5. Identify one difficulty you had while carrying out this investigation and describe how you overcame it.
6. Suggest a question you have about biofilms.

Personal and Social Thinking

After reading and thinking about all the articles on Oceans and Climate change, bring it all together by summarising current issues and possible strategies to combat them by thinking about the questions below.

1. List the current global problems related to global warming.
2. List some causes of the greenhouse gases responsible for global warming.
3. Set five personal goals that you can achieve to alleviate the amount of greenhouse gases you produce.
4. Design a strategy to upscale your own personal greenhouse alleviating strategies into the community. For example if one of your personal goals was to grow some vegetables to reduce the amount of carbon it takes to get food to your table, a social version of this would be to start a community garden.

Ethical Thinking

After reading all the articles, have a class discussion or carry out a jigsaw learning activity to examine the following ethical question: Whose responsibility is climate change mitigation? Discuss the roles of; the everyday individual, factory management, environmentalists, the famous, local government, state government, federal government, school curriculum and scientists in relation to taking responsibility for leading society through climate change issues.

Subsidiary questions might include:
Who should be leading the debate? Should responsibility be shared or weighted across groups? Who should monitor or research climate change mitigation strategies?

Intercultural Understanding

Case study 2 discusses the plight of the South Pacific Islanders who are prone to suffering the consequences of rising sea levels. Write a case study of your own about of how global warming and climate change has affected the life of an Islander and present this information in any format you wish, such as a newspaper or magazine article, a storyboard (www.storyboardthat.com), or an awareness pamphlet or poster. You can research information of day-to-day impacts of climate change on the South Pacific Islanders in order to include real people and real events in your presentation.

CURRICULUM LINKS

SCIENCE UNDERSTANDING

YEAR 7
Earth and Space Science
Some of the Earth's resources are renewable but others are non-renewable **(ACSU116) All capabilities**

YEAR 8
Physical Sciences
Energy appears in different forms, including movement, heat and potential energy, and energy transformations and transfers cause change within systems **(ACSSU155) Lit, DT, CCT, PSC, ET, ICU**

YEAR 9
Biological Sciences
Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems **(ACSSU176)**
All capabilities

YEAR 10
Physical Sciences
Energy conservation in a system can be explained by describing energy transfers and transformations **(ACSSU190)**
DT, CCT, PSC, ET, ICU

Earth and Space Science
Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere **(ACSSU189)**
Lit, Num, DT, PSC, ET, ICU

SCIENCE AS A HUMAN ENDEAVOUR

YEAR 7 AND 8
Nature and development of science
Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures **(ACSHE223)**
ET, ICU

Use and influence of science
Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations **(ACSHE120)**
All capabilities

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity **(ACSHE121)**
ET, ICU

YEAR 9 AND 10
Use and influence of science
People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities **(ACSHE160) ET, ICU**

Values and needs of contemporary society can influence the focus of scientific research **(ACSHE228) ET, ICU**

SCIENCE INQUIRY SKILLS

YEAR 7 AND 8
Planning and conducting
Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed **(ACSIS125) Num**

Measure and control variables, select equipment appropriate to the task and collect data with accuracy **(ACSIS126)**
Num

Processing and analysing data and information
Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies as appropriate **(ACSIS129) Lit, Num**

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence **(ACSIS130) Lit, Num, ET**

Evaluating
Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements **(ACSIS131) Num**

Communication
Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate **(ACSIS133)**
Num, PSC

Year 9 and 10
Planning and conducting
Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods **(ACSIS165) Num**

Select and use appropriate equipment, including digital technologies, to collect and record data systematically and accurately **(ACSIS166) Num**

Processing and analysing data and information
Use knowledge of scientific concepts to draw conclusions that are consistent with evidence **(ACSIS170) Lit, Num**

Evaluating
Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data **(ACSIS171) Num**

Critically analyse the validity of information in primary and secondary sources and evaluate the approaches used to solve problems **(ACSIS172) Num**

Communicating
Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations **(ACSIS174) Lit**

THANK YOU FROM OUR SPONSORS

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