

Threats to the Reef

ACTIVITY BOOK

Contents

Introduction	3
How to use this activity book	3
Video 1 – Climate change.....	5
Video 2 – Poor water quality from land-based run-off.....	7
Video 3 – Impacts from coastal development.....	9
Video 4 – Illegal fishing	11
Video 5 – Marine debris.....	13
Activity 1 – Video comprehension.....	16
Activity 2 – Taking action at school or at home	18
Activity 3 – Interview with a scientist.....	21
Activity 4 – Create a local video.....	23
Activity 5 – The horrible case of Hermie the hermit crab	24
Activity 6 – Addressing key threats	27

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General comments on this document are also welcomed.



Australian Government

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Introduction

The Great Barrier Reef (the Reef) is an Australian icon and one of the most precious ecosystems on Earth. It is World Heritage listed for its outstanding universal value. It stretches more than 2300 kilometres along the Queensland coast. It's the world's largest coral reef ecosystem — about 2900 reefs are home to thousands of species — and is interconnected with other ecosystems like mangroves and seagrasses.

For 40 years the Great Barrier Reef Marine Park Authority (GBRMPA) has managed the Great Barrier Reef Marine Park so it's protected for the future. We use the best available scientific information to guide us, and engage with experts and the community.

GBRMPA's *Outlook Report 2014* found the greatest threats to the Great Barrier Reef are:

- climate change: sea temperature increase, altered weather patterns, ocean acidification and sea level rise
- coastal development and catchment modification: clearing and modifying coastal habitats, artificial barriers to flow, and disposal and resuspension of dredge material
- land-based run-off: nutrients from run-off (including its links to crown-of-thorns starfish outbreaks), sediments and pesticide run-off
- remaining impacts of fishing: illegal fishing, collecting and poaching, incidental catch of species of conservation concern, effects on discarded catch, retained take (extraction) of predators, and retained take (extraction) from unidentified or unprotected spawning aggregations
- marine debris: land and sea sources.

All actions — big or small — are vital for the Reef's future. Students can help the Reef recover from the legacy of past actions and be better able to withstand those predicted to threaten its future. This series aims to encourage students to learn about and care for their local environment, in turn contributing to the health of the Great Barrier Reef.

How to use this activity book

The activity book is broken down into two sections. The first section covers each key threat to the Reef and includes:

- background information for teachers explaining each threat to the Reef, how it affects the Reef and what students can do
- links to the Reef Beat video series, science curriculum units and other resources for further background information
- a profile of a GBRMPA expert and a transcript of an interview snippet with each expert to be used in comprehension activities.

The second section of the activity book is broken down into six activities which can be completed for each of the threats to the Reef. Activity worksheets can be photocopied for students to complete.

The activities complement GBRMPA's science curriculum units and previous Reef Beat series. The activities in this book suit science, geography and marine science classes but can be modified to suit other learning areas. There are indicative year levels for each activity which can be modified to suit any year level. These include early years (prep–year three), primary school (year four–six), middle school (year seven–nine) and senior school (year 10–12).

Reef Guardian Schools overview

GBRMPA's Reef Guardian Schools program provides students, teachers and their communities the opportunity to instigate positive change for the environment. Schools can participate in building the resilience of the Reef through education, partnership and on-the-ground stewardship projects.

The key objective of the Reef Guardian Schools program is to create awareness, understanding and appreciation for the Reef and connected ecosystems. This fosters stewardship and creates a community culture towards Reef protection. It is designed to empower students and give them a sense of participation in the bigger picture and empower them to make a positive difference to the environment.

Reef Beat education series

The Reef Beat education series encourages teachers and students to explore the Great Barrier Reef, threats to the Reef, ways to protect its health and improve its resilience, and information about the people who work to protect the Reef. This Reef Beat education series complements the other series listed over the page.

The themes of the Reef Beat education series are:

- Reef Beat 2016 — threats to the Reef
- Reef Beat 2013 — the amazing Great Barrier Reef, let's keep it great
- Reef Beat 2012 — the inshore Great Barrier Reef, bursting with biodiversity
- Reef Beat 2011 — working together today for a healthier Reef tomorrow
- Reef Beat 2010 — sea country connections
- Reef Beat 2009 — climate change and the Reef
- Reef Beat 2008 — yesterday, today and tomorrow
- Reef Beat 2007 — sustainability
- Reef Beat 2006 — wetlands
- Reef Beat 2005 — river to reef
- Reef Beat 2004 — catchments to coast
- Reef Beat 2003 — our Great Barrier Reef

The Reef Beat series is available at www.gbrmpa.gov.au/learn-about-the-reef/reef-beat-series.



Video 1 – Climate change

What is climate change?

The greenhouse effect is a natural process that warms the Earth's atmosphere by trapping some of the sun's energy that would otherwise be radiated back into space. Increased greenhouse gas emissions mean more heat is trapped in the Earth's atmosphere and temperatures increase, causing the climate to change.

Emissions from human activities are largely responsible for enhanced levels of greenhouse gases. Over the last five years, global carbon dioxide levels have increased at a rate similar to that of the last 50 years. In the last century global temperatures have increased by 0.6 degrees Celsius.

How has climate change affected the Great Barrier Reef ecosystem?

Understanding the vulnerability of such a large and complex system to climate change is challenging. A number of environmental changes predicted could potentially impact the Reef severely:

- Increased frequency of severe weather events:
 - Floodwaters can form (reduced-salinity) freshwater plumes laden with nutrients, sediments and chemicals and toxicants from urban, commercial, industrial and agricultural sources (for example fertilisers and pesticides), which can stress or kill animals and plants in coral reef ecosystems.
 - Tropical cyclones cause extensive damage to individual corals and to the structure of reefs.
- Ocean acidification:
 - The oceans absorb carbon dioxide from the atmosphere, but excessive absorption reduces the ocean's pH. By 2100 it is predicted the ocean's pH could fall from 8.2 to about 7.8.
 - Ocean acidification causes calcium carbonate minerals to become under-saturated, impacting the ability of some organisms to produce and maintain their skeletons and shells.
- Rising sea temperature:
 - Since 1910–1929 average ocean temperatures around Australia have warmed by 0.68 degrees Celsius.
 - In thermal stress corals expel tiny algae (zooxanthellae) that live within their tissues and give them colour. If conditions don't ease it can lead to mortality.
- Rising sea levels:
 - Much of the Great Barrier Reef coastline is low-lying. Increases in sea levels could cause significant changes in tidal habitats such as mangroves and cause saltwater intrusion into low-lying freshwater habitats.

What can be done?

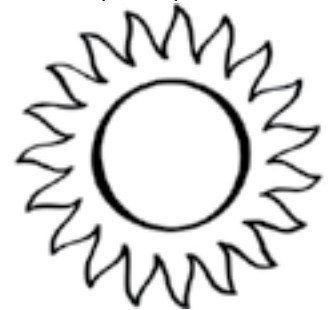
To understand the threat climate change poses to the Reef, GBRMPA developed *Climate Change and the Great Barrier Reef: A vulnerability assessment* which assesses how future climate changes are likely to affect the Great Barrier Reef.

Students can reduce their climate footprint by:

- more energy efficient and reducing energy consumption by turning off lights, air conditioners and power points they're not being used
- using renewable energy sources like solar power
- walking or riding to school, car pooling or using public transport
- planting native trees to absorb carbon dioxide from the atmosphere.

Resources

- Climate Change and the Great Barrier Reef: A vulnerability assessment
www.gbrmpa.gov.au/managing-the-reef/threats-to-the-reef/climate-change/how-climate-change-can-affect-the-reef/great-barrier-reef-vulnerability-assessment
- Climate change: year 10 Australian science curriculum focus: <http://hdl.handle.net/11017/2995>
- Reef Beat 2016 — threats to the Reef, climate change: <http://bit.ly/2asXyBr>
- Reef Beat 2007 — climate change and the Reef: <http://hdl.handle.net/11017/656>



Meet our expert

GBRMPA director — tourism and stewardship **Dr Roger Beeden** (2016) and has been at GBRMPA for eight years and is responsible for GBRMPA's tourism, engagement and stewardship programs.

Roger has always been interested in discovering why things work. In 2004 he moved to Townsville from England to complete a Master of Science (Marine Biology) at James Cook University. He has combined this knowledge with 12 years of commercial marketing experience from the pharmaceutical industry to identify strategies to support the future of the Great Barrier Reef ecosystem under a changing climate.

Roger has focused on improving Reef stewardship and building knowledge about the resilience of coral reef ecosystems to climate change. He has a PhD in environmental science that explored how understanding coral reef health and impacts of climate change informs resilience-based management of the Great Barrier Reef.

Extract of video transcript

Narrator

Climate change is the long-term significant change in weather patterns, including air and sea temperatures, humidity, wind, storms and rainfall.

Over the coming decades, climate change may have critical effects on the Reef. Increased concentrations of greenhouse gases, particularly carbon dioxide in the atmosphere, result in more heat being trapped, increasing the Earth's temperature. This can increase the frequency of severe weather events like flooding and cyclones which often cause severe and widespread damage to coral reefs.

Increasing absorption of carbon dioxide by oceans also results in ocean acidification which is a gradual reduction in the pH of seawater. Even a relatively small increase in ocean acidity decreases the capacity of marine animals to build calcium carbonate skeletons and shells.

Rising sea surface temperatures put corals under thermal stress causing them to expel the tiny algae that live within their tissues. It's this algae that gives corals their colour and most of their food and energy. This results in coral bleaching.

Rising sea levels will be significant because much of the Great Barrier Reef coastline is low-lying. Small changes in sea levels will mean land inundation which will cause significant changes in tidal habitats such as mangroves and salt-water entering into freshwater habitats.

Dr Roger Beeden, Director — Tourism and Stewardship

Climate change is the greatest threat to the Great Barrier Reef in the long term for one specific reason — it actually threatens the foundations of the Great Barrier Reef which are the coral systems that form this amazing three-dimensional structure that the actual creatures that we see on the Great Barrier Reef use as their home.

The reason why that's threatened by climate change is because corals rely upon on a relationship with little algae that sit inside of their tissues. They photosynthesise, just like plants do, and produce lots of extra energy and the corals use that for food and they use it to build their calcium carbonate structure.

It also causes a process called ocean-acidification — the chemistry of the ocean is being changed as carbon dioxide is dissolved into the water and that threatens the foundations of the Reef and many other creatures. Anything that uses calcium carbonate to build their skeleton or shell — ocean acidification process can mean they're not able to produce the things they depend upon to live.

Clayton Carnes, Principal — Hermit Park State School

Hermit Park is teaching students the affect they can have around climate change. So everything from turning air conditioners off, to having lights turned off and really reducing their footprint on the planet.

Reef Guardian School student

We've got laminated posters around the classrooms telling us to switch lights off before the lessons end.

Narrator

You can help protect the Great Barrier Reef from climate change. Reduce your climate footprint by being more energy efficient and reducing your energy consumption. Turn off lights, air conditioners and power points when you aren't using them. Use renewable energy sources like solar power. Walk or ride your bike, car pool or use public transport. Plant native trees to absorb carbon dioxide from the atmosphere. Share your knowledge by raising awareness of climate change and its impact on the Reef. Encourage your family, friends and community to take ownership of the Reef, motivating them to take action to protect it.



Video 2 – Poor water quality from land-based run-off

What is poor water quality from land-based run-off?

The Great Barrier Reef receives run-off from 35 major catchments that drain water from 424,000 square kilometres of coastal Queensland. Reefs grow best in waters with naturally low nutrient (nitrogen and phosphorus) and sediment concentrations.

Small coastal catchments which support intensive farming provide a continuous flow of freshwater to the Reef. Grazing areas tend to be seasonal and influenced by flooding.

Increased use of nutrients, pesticides and other pollutants on land has resulted in higher nutrient and sediment loads in waterways and the Great Barrier Reef. Over the past 150 years, sediment inflow into the Great Barrier Reef catchment has increased on average four to five times, even up to 10 times in some catchments.

How does water quality affected the Great Barrier Reef ecosystem?

Declining water quality can impact corals, seagrass and other habitats and the marine animals they support. In turn, this can impact tourism and fishing industries.

The impacts of poor water quality on the Great Barrier Reef include:

- reduced hard coral cover caused by reduced light and smothering
- increased algal growth because increased nutrients in the water reduces space for coral polyps to settle and grow
- high levels of dissolved inorganic nutrients can cause ecological and metabolic changes in most marine plants and animals
- coral disease and crown-of-thorns starfish outbreaks can be attributed to nutrients in the water and reduce resilience of reefs
- pollutants can build up in animals which are higher on the food web or are long-lived (e.g. whales and dolphins), impacting on reproduction, the immune system and health problems
- declines in fish populations following a loss of inshore habitats.

What can be done?

GBRMPA is a partner in the Australian and Queensland governments' *Reef Water Quality Protection Plan* (Reef Plan) which aims to halt and reverse water quality decline of water reaching the Great Barrier Reef by:

- restoring wetlands to ensure they filter nutrients, sediments and chemical contaminants from run-off that would otherwise go into creeks and rivers leading to the Reef
- reduce the amount of household nutrients and contaminants (like detergents and litter) that enter local waterways and drains.

Resources

- Reef Beat 2016 — threats to the Reef, land-based runoff: <http://bit.ly/2aR5uJl>
- Reef Water Quality Protection Plan: www.reefplan.qld.gov.au
- Wetlands: year 7 Australian science curriculum focus: <http://hdl.handle.net/11017/2992>
- Reef Beat 2006 — wetlands: <http://hdl.handle.net/11017/2783>
- Reef Beat 2005 — rivers to Reef: <http://hdl.handle.net/11017/2784>



Meet our expert

Paul Groves is project manager — coastal ecosystems (2016) and worked at GBRMPA for 11 years.

Paul is part of the reef recovery team, where he works to better understand the functions the natural ecosystems in the catchment provide for the Reef, how these have been impacted by development and how we can improve the health of the catchment and the Reef.

When Paul was seven, he accidentally overfed goldfish he was looking after. His mum went to the local aquarium shop to replace the fish and was offered a job. Paul hung out at the aquarium store for many years and developed an enthusiasm for the aquarium fish sold there. He worked in retail aquarium stores before completing a Bachelor of Science (in Marine Science with a minor in Marine Biology) and moving to public aquaria.

Paul previously worked in the curatorial sections of Reef HQ Great Barrier Reef Aquarium and the Aquarium of Western Australia where he worked with a wide range of species such as leafy seadragons and Antarctic fishes. Paul has researched ways to create more habitats for fish (such as barramundi and mangrove jack) that use the catchment for part of their life cycle.



Extract of video transcript

Narrator

Run-off is water that flows from the land into waterways. When run-off flows into the waterways, it can pick up contaminants including sediments, nutrients and pesticides. Coral reefs grow best in waters that have naturally low concentrations of nutrients and sediments. This is why run-off is one of the most significant threats to the long-term health and resilience of the Great Barrier Reef.

Paul Groves, Project Manager — Coastal Ecosystems

Land-based run-off is basically any rainfall that falls on the Great Barrier Reef catchment that makes its way out to the Reef either overland across the top of the landscape, through rivers and wetlands or into the ground through groundwater.

The way we've changed the landscape has resulted in water flowing off a catchment at a much faster rate. Not only is it going off faster and in bigger quantities, but it's also taking things like topsoil, nutrients, pesticides and other chemicals with it.

Sediments and nutrients are a natural part of the system but in excess they can become a problem. Nutrients promote the productivity of the inshore reef but if we get too much of it, it can become toxic and it can actually kill parts of the Reef. In the same way, sediments can smother seagrass and corals, blocking out light and killing those animals.

Even in your own backyard you can make a difference. Looking at the way water flows on your property, for example if run-off from your roof is better off going into the ground than into the stormwater system.

Narrator

You can help improve the quality of water that flows from the land to the ocean. Look after your local wetlands and ecosystems. Improve the quality of water from your school by building wetlands and picking up litter. Join an environmental group and revegetate your local environment to slow the flow. Get your school involved in drain stencilling to raise awareness that your drains lead to the Great Barrier Reef.

Video 3 – Impacts from coastal development

What is coastal development and catchment modification?

The Great Barrier Reef inshore ecosystems are made up of complex estuarine and marine ecosystems including mangroves, seagrasses and inshore coral reefs, coastal freshwater wetlands, coastlines and forested floodplains. These ecosystems are interconnected and rely on one another for their health and resilience.

Coastal ecosystems deliver physical processes such as sediment and water distribution and cycling, nutrient and chemical cycling processes and biological processes such as habitat and food provisioning.

Substantial areas within the Great Barrier Reef catchment have been extensively developed over the past 160 years. Development activities in the Great Barrier Reef catchment from largest to smallest area are: grazing, intensive agriculture, urban area, water supply, road and rail infrastructure, mining, ports and industry. There are around 100 urban settlements on the coast and islands with a total population of more than 1,165,000.

Coastal development and catchment modification threatens Reef health. The main impacts are from vegetation clearing or modification, agriculture expansion and intensification, urban expansion, infrastructure development, construction of barrages and levees and agricultural management practices (which includes fertilizer and pesticides application).

How has coastal development and catchment modification affected the Great Barrier Reef ecosystem?

The proximity of development activities to the coast increases the threat to the Reef ecosystem by losing or modifying coastal habitats. Coastal habitats are important as feeding and breeding grounds for marine species. They also filter sediment and nutrients out of the water before it enters the Reef.

Some of the impacts of coastal development are habitat loss, loss of physical and ecological connectivity between habitats, altered hydrology and salinity, altered sediment and nutrient loads and disturbance of potential acid sulphate soils.

What can be done?

GBRMPA works with stakeholders to understand and manage coastal ecosystems and the role they play in the health of the Reef. GBRMPA is working to protect, restore, enhance and manage the environmental values and functions of coastal ecosystems in the catchment.

Students can understand how their local catchments function and work to protect and restore their catchment. They can also join on-the-ground projects contributing to restoring local ecosystems.

Resources

- Reef Beat 2016 — threats to the reef, coastal development: <http://bit.ly/2aO3B2U>
- Habitat: year 1 Australian science curriculum focus: <http://hdl.handle.net/11017/2987>
- Ecosystem: year 9 Australian science curriculum focus: <http://hdl.handle.net/11017/2994>
- Reef Beat 2012 — the inshore Great Barrier Reef, bursting with biodiversity: <http://hdl.handle.net/11017/2777>

Meet our expert

Donna Audas is manager — coastal ecosystems (2016) and has been at GBRMPA for 17 years. She is responsible for assessing the effects of the changes in ecosystems on the health and resilience of the Great Barrier Reef.

Donna has worked in coastal management for more than 25 years. She has specialist knowledge of the land-based impacts on the marine environment and a passion to see better land practices implemented to protect the Reef. Donna has a Masters Degree in Tropical Environmental Management and Geographic Information Science and Cartography, Honours in Marine Ecology, and a Bachelor of Science in Coastal Management.

Donna loves science and the coast — oceans and the coastal zone are her passion! This passion is what drove Donna to pursue a career into coastal management at 19 years of age. Donna says “the shift our society has had to realise that the environment is critical to our future and the actions of the past and the decisions we make now are pivotal in our future.” This drives her desire to understand the catchment and its role in the health of the Great Barrier Reef.

Extract of video transcript

Narrator

Coastal development is any development activity within the Great Barrier Reef catchment — this includes farming, mining, urban and industrial development, port and marina development, aquaculture, and developments on islands. In the Great Barrier Reef catchment, coastal development is driven by mining, industry and population growth which modifies coastal ecosystems, such as wetlands, and their functions.

Donna Audas, Manager — Coastal Ecosystems

Coastal development is one of the biggest threats to the Great Barrier Reef because those changes that have happened in the catchment change the function and services that support the health of the Great Barrier Reef.

We've got nice big deep waterholes for fish to go up and down, we've got lovely flows of water, big flushes of freshwater during flood events — all of these things are important to the health of the Great Barrier Reef. And as we change the landscape we change the way water flows so those aquatic changes are modified and we end up with changes to the receiving waters of the Great Barrier Reef.

The changes in water flows are bad for the Reef because it needs a certain amount of freshwater, and it needs a certain amount of nutrient as well but we've changed those so we've got artificial flows, faster flows that come with huge velocity, they don't have time to slow down and get filtered and get cleaned before it gets to the Great Barrier Reef. So every urban area that goes in, cement goes in and changes the ability for the ground to absorb water and process it before it actually reaches the Great Barrier Reef. So the water comes in bigger flows with lots more things in it like litter, pollution, they don't have time to be cleaned before they get to the Reef and then our Marine Park flora and fauna get impacted by that.

The impacts from that are actually losing those deep waterholes. You've got lots of water coming and it has lots of sediment which fills up the holes in the rivers and creeks so fish don't have anywhere to go when there's a dry season. They end up in those areas where we've got nurseries for small fish, they can't actually survive anymore. So we've got lots and lots of changes that come from that water that's being delivered there because it's not in its natural state anymore.

Narrator

You can help protect the Great Barrier Reef's coastal areas by looking after beaches, wetlands and habitats. Get involved with your local Landcare or catchment care group and replant vegetation and riparian zones. Keep ecosystems intact and connected — always use designated walking or riding tracks. Consider your 'footprint' on coastal environments. Adopt your local beach, creek or wetland.



Video 4 – Illegal fishing

What is illegal fishing?

The Great Barrier Reef supports commercial, recreational, Indigenous and charter fishing. It targets fish, sharks, crabs, prawns, lobsters, and invertebrates such as sea cucumbers.

Illegal fishing in the Great Barrier Reef Marine Park breaches Marine Park zoning and regulations (Commonwealth and State) including Queensland fisheries regulations.

The Great Barrier Reef Marine Park Zoning Plan 2003 (Commonwealth) and Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004 (State) form a comprehensive zoning system designed to protect the biodiversity and improve the health and resilience of Great Barrier Reef. Additionally, all fishing in the Marine Park must be conducted in accordance with the provisions of the *Fisheries Act 1994* and all subordinate supporting legislation.

Each zone has different rules for the activities that are allowed, the prohibited activities and activities that require a permit. Key zones include Marine National Park (Green) Zones which is a 'no-take' area, Preservation (Pink) Zones which is a 'no go' area and Scientific Research (Orange) Zones which allows for research undisturbed by extractive activities. Fishing is not allowed in these zones.

Fisheries Queensland manages Queensland's fisheries and enforce fishing rules including but not limited to size, take and possession limits, fishing gear restrictions, seasonal closures and protected and no take species.

How has illegal fishing affected the Great Barrier Reef ecosystem?

Illegal fishing is a serious threat to the Great Barrier Reef. Impacts include:

- compromised ecological benefits of zoning by reducing biodiversity and ecological resilience of the Great Barrier Reef
- depleted fish stocks and reduced reproduction and recruitment
- disruption to the livelihood of lawful fishers.

Specific examples of impacts of illegal fishing include:

- illegal trawl fishing can cause direct physical impacts to sensitive habitats, including altering the vertical relief of seabed features, redistribution of sediments and removal or damage of seabed plants and animals
- illegal line and spearfishing can remove fish and sharks from no-take areas disrupting the ecological balance
- illegal large mesh net fishing can kill protected species, such as dugong, marine turtle and inshore dolphin.

What can be done?

GBRMPA contributes to fisheries management through zoning, restricting fishing activities. Enforcement of zoning rules is also conducted directly by Commonwealth agencies, including GBRMPA.

When students are out on the Reef, they should make sure they fish responsibly:

- take only what is needed
- if unsure of the fish species or size, release the fish immediately
- remove fish from the hook or net immediately and kill it humanely if keeping it
- clean up all fishing gear (eg. discarded tackle and line, and bait bags) and take it back to shore to dispose of it properly
- know where you are and have a zoning map
- abide by Fisheries Queensland regulations
- report any suspected illegal activity by calling **1800 380 048** to report Marine Park offences
- Report fishing breaches to the Fishwatch hotline on **1800 017 116**.

Resources

- Reef Beat 2016 — threats to the Reef, impacts of fishing: <http://bit.ly/2azHb1d>
- Reef Beat 2013 — the amazing Great Barrier Reef let's keep it great: <http://hdl.handle.net/11017/2786>
- Let's go fishing: year 6 Australian science curriculum focus: <http://hdl.handle.net/11017/2991>

Meet our expert

GBRMPA manager — operations support **Dr Mark Read** (2016) is works for GBRMPA and Queensland Parks and Wildlife Service (QPWS) joint Field Management Program, which conducts day-to-day on-ground actions to protect and maintain the Marine Park. Mark was a crocodile biologist and wildlife manager for nearly 12 years at QPWS before joining GBRMPA in December 2007 as manager — species conservation. He stayed in this role until joining the Field Management Program in February 2015.

Mark has spent his entire working life looking at how human activities impact species and habitats and then trying to work out mutually-beneficial solutions to minimise the impact. He is a very keen recreational fisher who spends as much time as possible exploring the creeks, rivers and reefs trying to catch a fish. His role in the Field Management Program allows him to provide a balanced and informed view on the impacts of illegal fishing and how this impacts the biodiversity of the Great Barrier Reef.

Mark has a PhD in Zoology (nutritional physiology of estuarine crocodiles), a Bachelor of Science (Hons) in Zoology (feeding ecology of juvenile green turtles), and a Bachelor of Science in Zoology and Animal Biology. Mark became a scientist because of his life-long passion for wildlife and wild places. For him, science is the language that allows him to better understand and appreciate the beauty of the natural world and then use this to try and make a difference in his everyday job.

Extract of video transcript

Narrator

Fishing is important to coastal communities — for recreation and their livelihoods. The Reef supports a range of recreational, commercial and charter fishing activities targeting fish, sharks, crabs and prawns. It's important that fishing is sustainable. Marine Park zoning — like a town planning scheme — outlines what activities can occur in each location. There are also fisheries rules about fish sizes and when certain species can be taken.

Mark Read, Manager — Operations Support

When we're talking about the remaining impacts of fishing we're talking about those things in the Marine Park that we still need to focus on when it comes to marine fishing activities. That could be things like recreational fishers who aren't abiding by the Zoning Plan, and they're being non-compliant going and fishing in green zones. What we need to do when we think about fishing is just make sure that it doesn't have long-term impacts on the fish stocks and the biodiversity of the Marine Park. So it's about making sure that we've got fish for the future, that we've got rules in place that allow fishing to be conducted sustainably, we've got good education messages out there and it also means we should be working in collaboration with commercial fishers to make sure they understand our needs and we understand theirs.

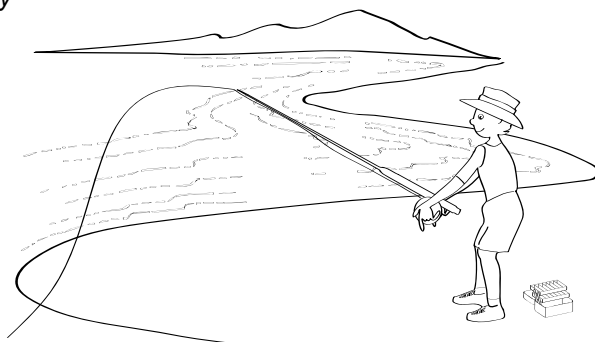
So one of the zones we have in the Marine Park are what we call green zones. They're a zone where you're allowed to enter to engage in activities like swimming and boating and snorkelling and diving but you're not allowed to engage in fishing or any form of extractive activity. Science has told us that they [green zones] have bigger fish and that those fish in those areas are now producing young that go into other nearby zones that are open for fishing. They're an insurance policy to ensure the longevity of the Marine Park.

Reef Guardian School student

Green zones are important to help restock areas that have been heavily affected by fishing so that fish stocks can replenish and prevent overfishing so there is a sustainable fish stock for future generations.

Narrator

Help the Reef to be as healthy as possible so it's more resilient to threats. Follow our love the Reef principles. Pick up a zoning map before you go fishing, keep an eye on your GPS and know where you can go and what you can do. Practice safe catch and release methods. If you're unsure of the fish identity or size, release the fish immediately. If you're keeping the fish, remove it from the hook or net immediately and kill it humanely. Return all undersized and unwanted fish quickly and carefully to minimise injury. Only take what you need, there's a future to feed. Clean up all fishing gear (such as discarded tackle and line, and bait bags) and take it back to shore to dispose of it properly. Use our Eye on the Reef sightings app and report any illegal activity.



Video 5 – Marine debris

What is marine debris?

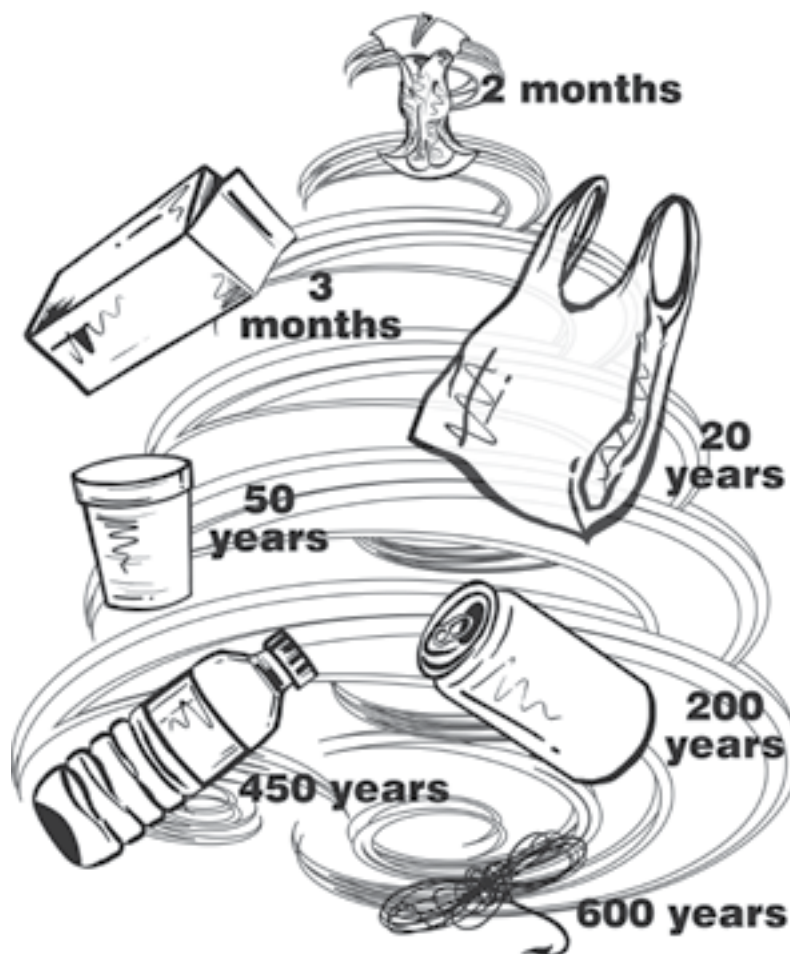
Marine debris is litter or any manufactured solid material that finds its way into the coastal and marine environment.

In developed areas most debris comes from the land — rain and wind washes litter left by people into stormwater drains or waterways. In less populated areas debris is transported on ocean currents from domestic and international sources, either accidentally washed or blown overboard of a vessel or intentionally dumped.

Plastic is the most common type of marine debris found on beaches in the Great Barrier Reef and worldwide — it makes up between 50 to 90 per cent of all debris items recorded.

Plastic does not decompose or break down, it only breaks up into smaller pieces. In fact, a single plastic bottle can break up into more than 10,000 pieces of microplastic.

Microplastics — small plastic particles smaller than five millimetres — can come from a range of sources. Many are used for their texture and colour as an ingredient in consumer products ranging from cleaners to facial scrubs and toothpaste and wash down the drain, while some clothing release microplastic fibres when washed.



How does marine debris impact the Great Barrier Reef?

Marine debris impacts the Great Barrier Reef in many ways:

- marine debris can trap wildlife — when entangled, animals can be injured, suffer physical deformities, suffocate, drown or starve to death
- animals can mistake debris as food. For example, turtles can confuse plastic bags as jellyfish or tiny fragments as plankton. This can cause a false sense of fullness, internal injuries or blockages and even death. Additionally, microplastics accumulate within the food chain as animals consume one-another. This is called bioaccumulation
- marine debris can pose a navigation hazard to boats. A collision with a large piece of submersed debris could sink small vessel, and fishing nets and lines can entangle engines and propellers
- transports invasive species — although invasive species can be transported across the ocean naturally on driftwood, marine debris is more durable and increases the likelihood of these pests reaching the Reef and posing a potentially devastating threat to local ecosystems
- damage habitats by breaking, smothering or suffocating corals, plants and benthic organisms
- economic loss to coastal communities — marine debris on popular tourist destinations is an eyesore and clean-ups are very costly for coastal communities.

What can be done?

GBRMPA supports on-ground projects aimed at reducing marine debris, including beach clean-ups and working with communities to reduce their land-based litter sources.

- Don't be part of the problem — be part of the solution. Students are encouraged to adopt a sustainable lifestyle and reduce your waste.
- Be a litter role model and pick up litter yourself. You can also participate in or organise local clean-ups.

Resources

- Reef Beat 2016 — threats to the reef, marine debris: <http://bit.ly/2aR5Xez>
- Reef Beat 2011 — working together today for a healthier Reef tomorrow: <http://hdl.handle.net/11017/2778>
- GBRMPA's Don't let your litter bug our Reef video www.youtube.be/UyaGjSMEjsA

Partners

- EcoBarge www.ecobargecleanseas.org.au
- Tangaroa Blue Foundation www.tangaroablue.org

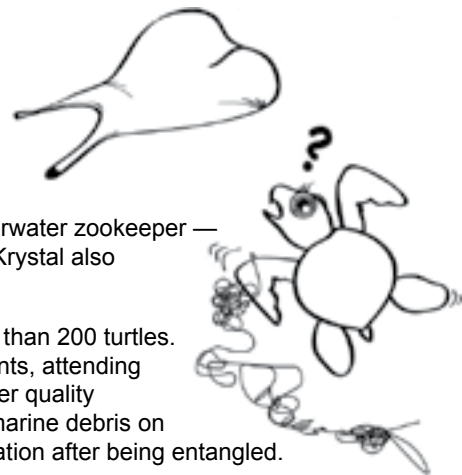
Meet our expert

Krystal Huff is an aquarist at Reef HQ Great Barrier Reef Aquarium. She is an underwater zookeeper — maintaining displays, water quality, animal health and conducting educational talks. Krystal also helps develop new exhibits.

Krystal joined the Reef HQ Aquarium Turtle Hospital in 2010 and has cared for more than 200 turtles. This includes seeking veterinary advice and consultation, delivering medical treatments, attending sea turtle health conferences and day-to-day care of turtles such as feeding and water quality maintenance. Unfortunately, Krystal has seen first-hand the devastating impacts of marine debris on turtles which have ingested fishing tackle and through seeing their injuries and starvation after being entangled.

Previously, Krystal worked at aquaculture facilities throughout Queensland growing black tiger prawns, barramundi, blue swimmer crabs, mangrove jacks, black kingfish/cobia, coral trout, giant grouper, barramundi cod, ornamental fish (such as seahorses) and invertebrates. Krystal has a Bachelor of Science (marine biology and zoology) and a Certificate II in Animal Studies (veterinary assistant).

Krystal always had a keen interest in nature and how the world around her worked. She wanted to know more about the ocean and the animals that inhabit the underwater world. Krystal's passion for nature inspired her to go to university and launch her career towards the world she has always loved.



Extract of transcript

Narrator

Have you ever been down to the beach or river and seen plastic bottles, balloons or even a tyre sitting on the bank or floating in the water? That's marine debris. It's any solid, manufactured material that makes its way into the ocean. Anything can become marine debris if we don't dispose of it in the right way — from a small cigarette butt to a big piece of rope. Rubbish being dropped in the street can make its way down a drain and into the ocean. In fact, plastic is one of the most common forms of marine debris. Once plastic is in the ocean, it never disappears it just breaks up into smaller and smaller pieces. These tiny pieces of plastic are called microplastics.

Krystal Huff, Aquarist — Reef HQ Great Barrier Reef Aquarium

All of our species of turtles found in Australian waters have been impacted by marine debris. They might have eaten it or become entangled in it. So sometimes turtles have come in because they have been starving and later they have pooped out things like fishing line. So we don't always know they have been impacted but a lot of the times they have. They can eat things like plastic bags because they mistake them for their natural food of jellyfish. Once the plastic gets inside a turtles stomach it can block it up and cause it to not work anymore. This can cause what we call floating syndrome; they get stuck at the surface, they might be more vulnerable to things like boats but also predators. With me here I have some plastic bags that have actually passed through a turtle's stomach and come out the far side. In some cases there is so much plastic inside a turtle's stomach that it can't work properly any longer.

Microplastics are tiny little plastics that get into the ocean from all different ways. Sometimes they're made that way, so things like beads in conditioning products are microplastics. Other times they are bigger plastics that have broken down. Microplastics are impacting a lot of our marine life including our turtles. So little bits of plastic are inside their food and can build up inside their body.

Narrator

Marine debris is a big problem for the Great Barrier Reef's animals, plants and habitats. We all have an important role to play in protecting the Great Barrier Reef. Marine debris starts with us and can end with us. Queensland students of the Great Barrier Reef Marine Park Authority's Reef Guardian program are getting involved in the fight against marine debris.

Reef Guardian Schools students

We make sure that we protect our beautiful riverway just next to us and we make sure that no litter goes into it.

We're putting stencilling down across all the drains.

Stencilling the concrete will obviously show boys that our rubbish does affect the Reef.

We also have something called Nude Food Days where it's plastic-free lunchboxes.

In a litter free lunchbox you might find that there's no plastic or anything that can pollute the ocean.

Our school does paper recycling in classrooms, we do can recycling and we do yellow bin recycling.

Narrator

You have the power to stop marine debris before it starts. Ask yourself where your rubbish will go and make sure you:

- **refuse:** make a choice and say no to throw away plastic containers and drink bottles,
- **reduce:** reduce the amount of plastic you use, take snacks to school that don't come in plastic bags or containers,
- **reuse:** use a reusable or refillable container or water bottle instead of disposable containers and bottles,
- **recycle:** put your rubbish in the right bin and help others use the right bin too so your rubbish can have a second life, and
- **take action:** join a clean-up of your local beach or creek.
- don't let your litter bug our Reef.

The marine debris Reef Beat episode was created as part of the Great Barrier Reef Clean-up, a project delivered by the Great Barrier Reef Marine Park Authority through the Australian Government's Reef Trust.



Australian Government



Reef Beat - Threats to the Reef

GREAT BARRIER REEF MARINE PARK AUTHORITY AND THE REEF GUARDIAN SCHOOLS PRESENT "THREATS TO THE REEF"
 WITH DR ROGER BEEDEN PAUL GROVES DONNA AUDAS MARK READ AND KRYSTAL HUFF
 STUDENTS FROM IGNATIUS PARK COLLEGE HERMIT PARK STATE SCHOOL BELGIAN GARDENS STATE SCHOOL
 ST ANTHONY'S CATHOLIC COLLEGE CALVARY CHRISTIAN COLLEGE AND KIRWAN STATE HIGH SCHOOL

Feature Running Time: Approx. 5 Minutes

* Visit www.youtube.com and search GBRMPA Threats to the Reef to view videos.

This product is authorised to be used for education purposes

G GENERAL AUDIENCE

All Ages Permitted



A Great Barrier Reef Marine Park Authority Initiative

Activity 2 – Taking action at school or at home

Overview

On-the-ground projects provide opportunities for conservation, building resilience and managing the environment. They inspire others and raise awareness of environmental issues.

Outcome

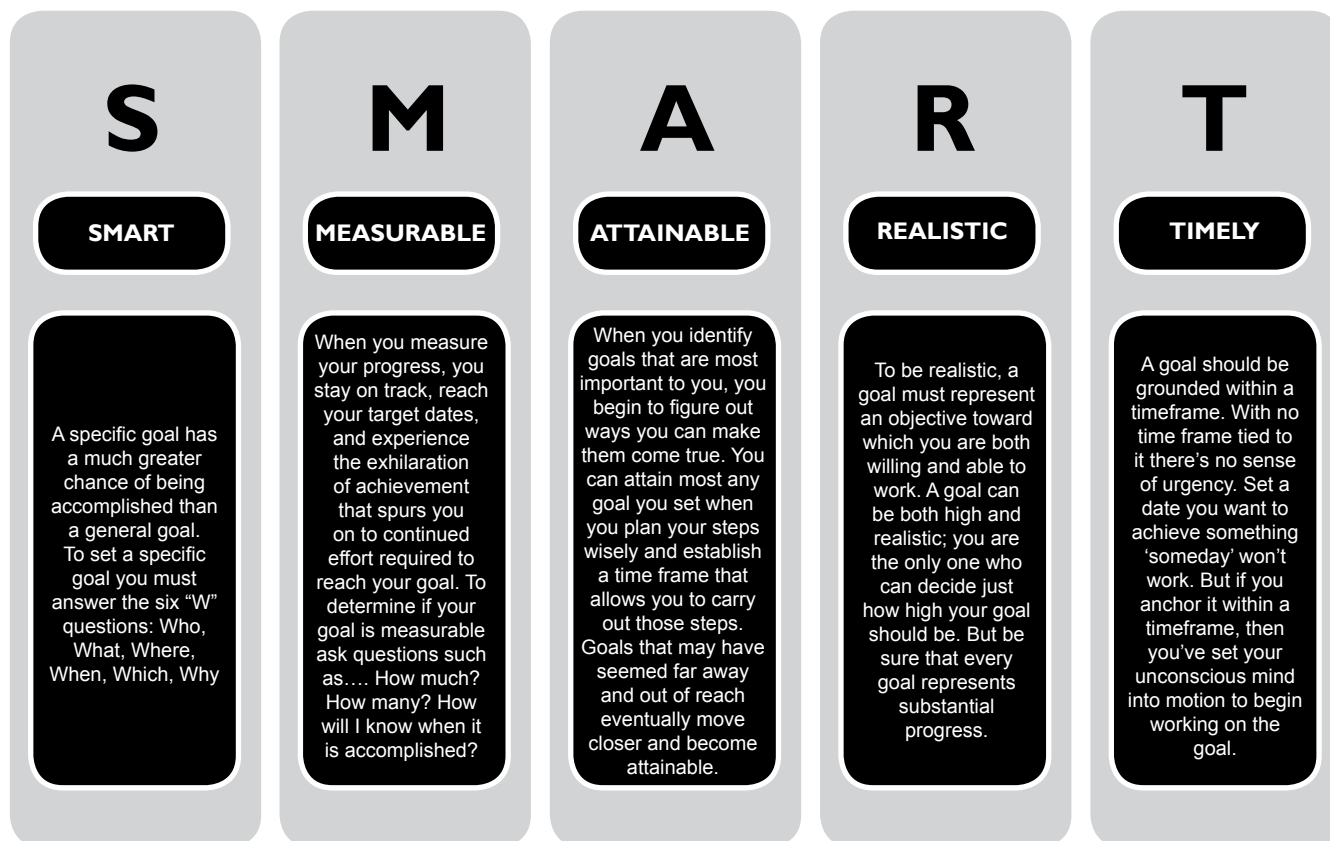
Students will select a project idea, develop a project plan, take action and evaluate the process.

Year level

Early years, primary school, middle school and senior school

What to do

1. Students pick an action(s) they will complete at home, school or in the community to improve the health and resilience of the Reef. Use the ideas for taking action described in the videos.
2. Use the model Idea > Plan > Act > Evaluate to guide you to complete your action.
3. Students should use a SMART goal for their action project planning.



Ideas for what you can do:

- Drain stencilling
- Create a timeline of litter breakdown
- Beach clean-up with data collection
- Reduce waste at school or home
- Beach access planning activity (where to put paths/vegetation areas)
- Energy audit (carbon footprint)

Ideas for who can help?

- Eye of the Reef
- Tangaroa Blue
- Local natural resource management groups
- Local council
- Outdoor education centres

Planning sheet

Idea	<p>Brainstorm action project ideas:</p> <ul style="list-style-type: none">• Which key threat are you passionate about?• What can you do to take action? Have other people done projects before that have been successful?• What do you want to achieve and who can help you achieve this (partners)?
Plan	<ul style="list-style-type: none">• Use the planning tool sheet to determine your SMART goals and organise your action project.• Brainstorm possible issues and solutions.• Decide who is going to do what tasks and due dates to complete these tasks by.• Compile a list of resources, materials, equipment and information you will need.
Act	<ul style="list-style-type: none">• Get ready to do what you have planned.• Keep good and open communication; make sure everyone is organised and knows what to do to their part of the project, and know what work needs to be completed.• Record what you do (take photos) and keep track of what tasks have been completed.
Evaluate	<ul style="list-style-type: none">• Celebrate your successes by sharing them with your class, family or the community (you could even share it with the local media).• Hold a debrief meeting and review how successful your project was, have everyone share what they have learnt and would do differently next time.

Choosing an action project idea

Which key threat to the Reef is your action focused on? _____

List all the ideas you have for your potential action project:

- _____
- _____
- _____
- _____
- _____
- _____

Use the ideas for taking action in the videos as a starting point or create your own ideas. Think about what you can achieve in your home or school.

With your group or class discuss everyone's ideas and select your best idea. Write down in more detail what your action project proposal is:

Planning your action project			
Goal:			
Objectives:	Who?		
	What?		
	Where?		
	When?		
	Why?		
	How?		
Group:			
Tasks:		Who:	Due Date:
Tools:			
Equipment:			
Materials:			
Information:			
Resources:			

Activity 3 – Interview a scientist

Overview

Scientists have special expert knowledge related to their professions and interviews are an excellent way to access this knowledge and learn from their experience. Scientists use experiments and research to solve problems and learn more about the natural world.

Outcome

Students will develop interview questions suitable to ask a scientist and conduct a role-play interview. They will create a scientific method to investigate a problem relating to one of the key threats.

Year level

Primary school and middle school

What to do

Marine scientist interview

1. Students write questions they would ask four different marine scientists.
2. Discuss with the class the components of a successful interview, ensure questions are directed at the scientist, relevant to their work, are thought provoking and will generate interesting responses.
3. Students to conduct research and write answers to the questions they have written.
4. Working with a partner, students prepare an interview to present to the class.

Extension: select four scientists who work in your local area and conduct this activity again. For example, students could select a geologist, chemist, environmental scientist and medical scientist.

Science experiment

1. Marine scientists use research and experiments to learn more about the natural world.
2. In small groups, students should select one of the key threats to the Reef and write an experiment proposal (or a scientific method) about a problem they wish to investigate about that key threat.

Extension: approved students could conduct the experiment and write a scientific report.

Interview with a marine scientist

Marine science is the scientific study of our oceans and coastal habitats. It includes a wide range of disciplines in the biological, chemical, physical and earth sciences.

1. Below are four marine scientists who study in different fields. Write down a series of interview questions you would ask each scientist.



Marine biologist



Aquarist



Oceanographer



Coastal geologist

2. Select at least one scientist and conduct your own research to answer the questions you have written.
3. Working with a partner, one student act as the interviewer and the other as a scientist, conduct the interview.
4. Swap roles and conduct the interview again.
5. Present your interview to the class. You might like to dress up and use props in your interview.

Activity 4 — Create a local video

Overview

Short informative videos provide an excellent visual resource with specialised scientific knowledge to engage, inform and promote stewardship the wider community.

Outcome

Students will create their own video about how a key threat to the Reef impacts their local environment.

Year level

Primary school, middle school and senior school

What to do

1. Students select a key threat to the Reef and produce a short informative video.
2. They should research how the local area contributes to the threat, how the local area is impacted by the threat, any relevant local relevant scientists or organisations (you could interview a local scientist for your video), and how you or other locals have taken action.
3. Use a storyboard tool to plan the components and structure the video.
4. Write a script for the narrator of your video, interview questions to ask a scientist and/or script for any people who feature in your video.
5. Shoot video footage and gather images of local people and environmental activities.
6. Edit and construct your final video.
7. Hold an event and share your video with your class, school, family or wider community. Upload you video and share it with the online community. You could enter your video into a video competition. Remember education is a key component in making change.

Threat to the Reef video storyboard planning

Movie title: _____ Page: _____ of _____

By: _____ Date: _____

Activity 5 – The horrible case of Hermie the hermit crab

Overview

This is a fun activity where students apply their knowledge of the causes and effects of the threats to the Reef to evaluate and organise crime scene evidence to theorise and justify how Hermie the hermit crab's shell disappeared.

Outcome

Students will apply their knowledge to evaluate evidence and propose a suspect justifying their reasoning.

Year level

Primary school and middle school

What to do

1. Go through the introduction and instructions as a class.
2. Read through the list of evidence. This could be done individually or as a class.
3. Students are to group different pieces of evidence together and draw a conclusion, explaining what that evidence proves.
4. There are many possible correct answers students could come up with as to which threat to the Reef caused Hermie's shell to disappear.

Introduction and class instructions

The Great Barrier Reef has been rocked with the news of the disappearance of Hermie's shell. From the moment the underwater police discovered the gruesome scene they suspected foul play. They highly suspect members of the Reef Threats gang as ultimately responsible for this horrible crime. As the investigation progressed, more and more of the evidence pointed to one of the Reef Threats gang.

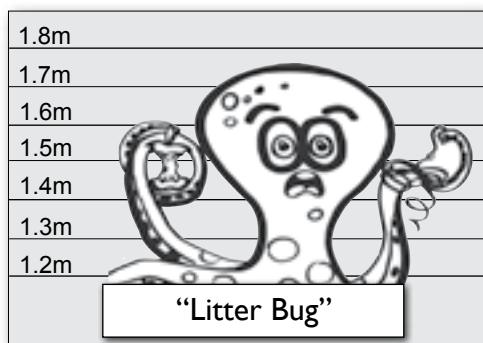
Whatever really happened, this is shaping up to be the trial of the underwater century!

Below is a list of evidence tied to the investigation. Evidence points to each of the key threats to the Reef as being responsible. Your job is to come up with three to four evidence-based arguments that will help you prove your case. Most pieces of evidence don't prove much when considered individually, but several pieces considered together can help argue your case.

Use the evidence worksheet to group several pieces of evidence together. Each argument could be based on two to six pieces of evidence. Your explanation should be a couple of full sentences long.

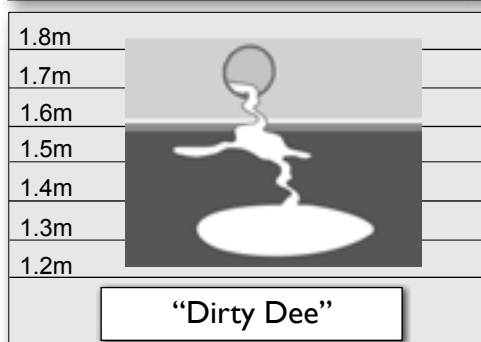
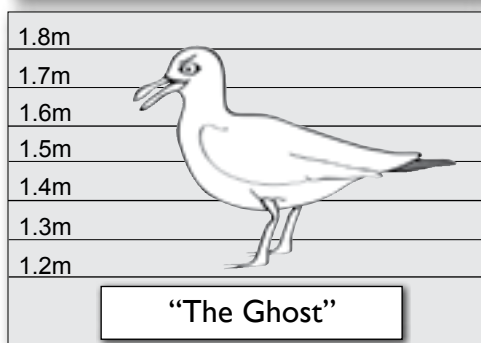
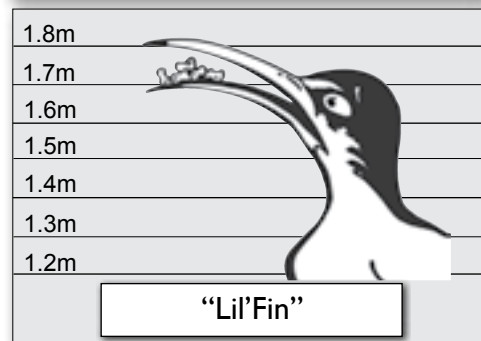
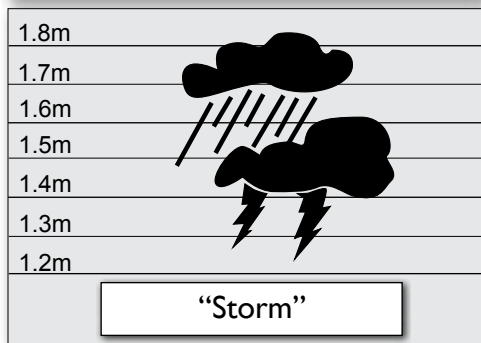
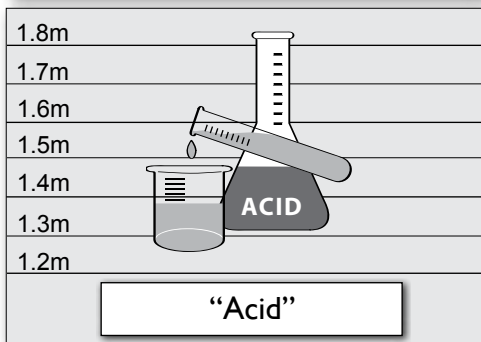
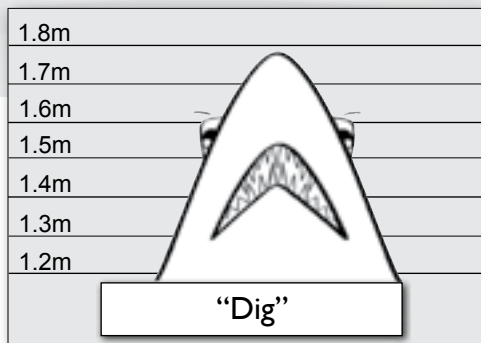
The horrible case of Hermie the hermit crab

The suspects of the Reef Threats gang



Crime scene evidence

1. Hermie the hermit crab discovered his shell was missing when he awoke on Sunday morning.
2. A number of items were found near where Hermie lives: a bottle, a toothbrush, a fishing hook and some tangled net. One of the crime scene investigators got his foot caught in the net at the scene.
3. The seagrass near where Hermie lives had been disturbed. There was sediment on top of patches and some grass had been ripped out at the roots.
4. Investigators noticed the water nearby was not quite as clear as it usually was and had a 'tangy' taste to it.
5. A marine veterinarian inspected Hermie and could not



definitively conclude how his shell had been removed, stating there were no signs of forced removal.

6. Crime scene investigators conducted water quality testing near where Hermie reported his shell had gone missing from. The pH was 7.5, which is low for seawater, but the area is near the mouth of a river. The seawater temperature was 24 degrees Celsius which is warm for this time of year.
7. Hermie's shell has not been recovered since the night of the crime.

Suspect evidence

8. In the weeks prior to Herbie losing his shell, he had been seen arguing with Dirty Dee and Dig at a nearby beach, where a new resort is being built near the sand dunes. Builders at the resort suspect Dirty Dee and Dig have caused sediment run-off into the ocean from where they had been clearing vegetation to make room for the resort.
9. Storm and Litter Bug were seen in the area that night creating big wind and waves and leaving lots of rubbish lying around.
10. Marine Park officers say they've been trying to catch Lil' Fin and his crew for illegally fishing in the area.
11. The Ghost, Dirty Dee and Acid have been previously charged for water contamination crimes.

Witness testimony

12. Teresa the crown-of-thorns starfish, who recently moved in next door to Hermie, said she'd noticed Hermie looking ill in the last few weeks.
“He just didn't quite seem as red as he usually is, but that could be because of the stress of losing his shell,” she said.
13. Builders at the resort construction site saw Hermie argue with Dig at the site, protesting about the resort being built on the sand dunes. Hermie was saying to Dig and Dirty Dee that he could hardly see where he was going once they'd started building.
14. Lil' Fin and his fishermen friends were interviewed and asked if they had been fishing near the area and seen anything at the time of the crime. They said they never fish near there because it is a green zone and that would be illegal.
15. Carl the coral trout, who lives near Hermie, was interviewed and said he did not believe Lil' Fin's story.
“I've confused his lures for little fish quite a few times – luckily I'm not that easy to catch. Lil' Fin probably hooked Hermie's shell while they were fishing in the cover of the night,” he said.
16. Hermie's sister Henrietta had been the victim of one of Acid's pranks one month before Hermie's incident.
“Acid attacked me one night and damaged my shell, I had to find a new one after that because it cracked and had started to fall apart,” she said.
17. A local group of plankton were interviewed and were concerned that Dirty Dee and The Ghost had been upsetting a lot of algae that lived in coral over the last few weeks. They had enough and moved to a reef further away leaving the coral that they had called home for a long time.

Processing the evidence

Put together the pieces of evidence to prove what happened to Hermie's shell.

Evidence items: # _____ # _____ # _____ # _____ # _____ # _____

When you put the pieces of evidence above together, what do they prove?

Evidence items: # _____ # _____ # _____ # _____ # _____ # _____

When you put the pieces of evidence above together, what do they prove?

Evidence items: # _____ # _____ # _____ # _____ # _____ # _____

When you put the pieces of evidence above together, what do they prove?

Evidence items: # _____ # _____ # _____ # _____ # _____ # _____

When you put the pieces of evidence above together, what do they prove?

Which 'Reef Threat' gang member do you suspect committed the crime? Justify your reasoning.

Activity 6 – Addressing key threats

Overview

Adaptive management is when a program is continually improved based on its results — it's learning by doing.

GBRMPA's adaptive management plans consider the entire Reef, including regional and local solutions. Clear goals for Reef resilience are monitored through measurable targets.

Outcome

Students will investigate Reef impacts in their local area. Evaluate current management strategies and make recommendations to improve these.

Year level

Middle school and senior school

Resources

- Great Barrier Reef Outlook Report 2014: www.gbrmpa.gov.au/managing-the-reef/great-barrier-reef-outlook-report
- Reef 2050 Long-term Sustainability Plan: www.gbrmpa.gov.au/managing-the-reef/reef-2050
- Great Barrier Reef Strategic Assessment Program Report: www.gbrmpa.gov.au/managing-the-reef

What to do

You have been asked by GBRMPA to review their strategies addressing threats to the Reef. Evaluate how these strategies apply in your local area and make recommendations to improve these strategies. Justify each recommendation with a reasoned argument.

Research the topic:

- Go to www.gbrmpa.gov.au/managing-the-reef/threats-to-the-reef and list the causes and effects of each threat to the Reef.
- Review the *Reef 2050 Long-term Sustainability Plan* and the *Great Barrier Reef Strategic Assessment Program Report*. Identify which of these strategies directly relate to your local area. Identify any organisations with management strategies that complement GBRMPA's strategies.
- Select activities in your local area which contribute to the threats to the Reef. Consider recreational, commercial, industrial and natural pressures (for example agriculture, illegal-dumping or mining).
- Investigate what local management strategies apply to these activities (for example local council laws).
- Make recommendations to improve the local management strategies and suggest why these improvements would have a positive impact on the health and resilience of the Reef.
- Prepare a report or presentation explaining how the threats to the Reef impact your local area, what local management strategies exist and recommendations to improve them. Use maps and other visual aids where appropriate.



Australian Government

Great Barrier Reef
Marine Park Authority

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#lovethereef

