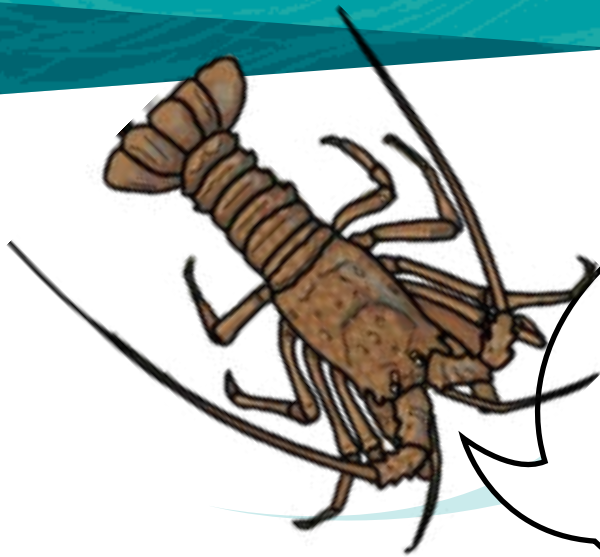


Activity 9: The health of marine environments



Let's find out how
scientists measure
the health of marine
reserves



CURRICULUM LINKS

Learning areas

Science: Levels 1–4:

- Nature of Science: Investigating in science, Participating and contributing
- Material World: Properties and changes of matter

Science capabilities: Use evidence, Interpret representations

Mathematics: Statistics

Health and Physical Education:

Healthy Communities and Environments: Community resources

English: Listening, Reading and Viewing

Learning intentions

Students are learning to:

- Understand how scientists measure the health of our marine environments
- Understand how marine reserves contribute to the health of our oceans
- Interpret graphs and information to determine the health of marine reserves.

Success criteria

Students can:

- Make observations, and carry out tests and research to determine the health of marine environments and water samples
- Describe how marine reserves help to increase the health of the ocean and people
- Read tables, graphs and information to predict the health of two marine reserves.

CONTENTS

BACKGROUND NOTES

What are healthy marine environments?	3
Are our oceans healthy?	3
How do marine reserves contribute to healthy oceans?	3
What is monitoring and why do we monitor?	3
How do scientists monitor marine reserve health?	3

LEARNING EXPERIENCE 9: THE HEALTH OF MARINE ENVIRONMENTS

Healthy seawater experiment	5
Learning about healthy marine environments	6
Monitoring the health of marine reserves and environments ...	6
The current situation for our marine environments	7
Thinking about your local marine environment	7
Extending learning	8
How real scientists monitor marine environments.....	8
Diversity and health	8
Other resources about the health of the marine environment: ..	8

STUDENT WORKSHEETS

How do marine reserves help to keep oceans healthy? (Levels 2-3)	9
How do marine reserves help to keep oceans healthy? (Levels 3-4)	11




BACKGROUND NOTES

WHAT ARE HEALTHY MARINE ENVIRONMENTS?

Healthy marine environments are places that are resilient and thriving. These environments usually host a wide variety of biodiversity, have good water quality and have little or no pollution or introduced species.

ARE OUR OCEANS HEALTHY?

The health of the oceans is varied around the planet. The unhealthiest parts of the sea are usually close to land, where over a long time, large numbers of people have lived and discharged waste, sediments and pollutants into waterways which flowed into the sea.

New Zealand has relatively healthy ocean habitats compared to most other parts of the world. However, there are also many coastal New Zealand areas that have become less healthy over time. Check with your local council for details about the health of your local coastline and whether it is safe to swim there. This information may be available on a website, e.g.  <https://safeswim.org.nz>.

HOW DO MARINE RESERVES CONTRIBUTE TO HEALTHY OCEANS?

Marine reserves help to increase the health of our oceans. No-take marine reserves create more healthy habitats for living things by reducing the number of species taken out of the ecosystem. This helps restore balance to create well-functioning ecosystems. Balanced, healthy ecosystems can more easily bounce back from changes (both natural and human-induced).



Truman Beach, Punakaiki. Photo: Baptiste Maryns

WHAT IS MONITORING AND WHY DO WE MONITOR?

Monitoring is observing, carrying out tests and recording data. We can monitor the marine environment to determine its health. When monitoring is done regularly, changes can be detected. If needed, actions can be taken to ensure the environment stays healthy.

HOW DO SCIENTISTS MONITOR MARINE RESERVE HEALTH?


Scientists from the Department of Conservation (DOC) and other agencies, such as councils, regularly monitor the health of marine environments and marine reserves. They use special equipment to measure different qualities of the marine environment.



Currently, DOC scientists use the following factors to gauge the health of marine reserves:

- a. Water quality – through testing salinity, turbidity, pH, suspended sediment, nitrate and bacteria levels
- b. Habitats – which habitats are present. In marine reserves, this includes recording any changes in habitat from the time of the marine reserve opening
- c. Numbers of seafood species – monitoring species such as snapper, blue cod and crayfish
- d. Marine pests – testing for the presence of introduced species
- e. Land use – looking at the proportions of surrounding land that are vegetated, urban or rural
- f. Numbers of threatened species – monitoring the populations of threatened species.

Scientists also monitor certain animal species, habitat changes and other living things over time to gauge ecosystem health, see:  www.doc.govt.nz/little-penguin-monitoring.

National Institute of Water and Atmospheric Research (NIWA) in New Zealand monitors the wider ocean environment using devices such as argo floats. Argo floats measure temperature and salinity (saltiness) of water. Scientists can understand ocean global heat content and ocean currents from this data. See:  www.sciencelearn.org.nz/resources/710-using-argo-data.

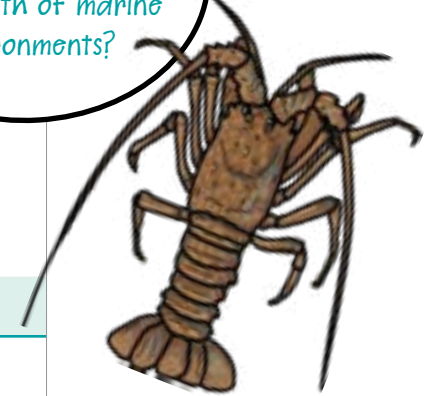


LEARNING EXPERIENCE 9: THE HEALTH OF MARINE ENVIRONMENTS

Resources for this activity

- Resources for seawater health experiment: 4 x clear glass jars, salt water, vegetable oil, vinegar, dirt, spoons.
- Healthy marine environments slideshow:
🔗 <https://goo.gl/4Zq9qc>.
- Fact sheets 'How do marine reserves help to keep oceans healthy?' (📄 pages 9–13)
- 'The gulf at crossroads' poster from the Gulf Journal poster series: 🔗 <http://gulfjournal.org.nz/poster/the-gulf-at-crossroads>.
- Current state of the oceans video clip by National Geographic (03:15 min):
▶ <https://www.youtube.com/watch?v=rE2DrmJ2I-U>.

Focus question:
How can we measure
the health of marine
environments?



Vocabulary

Health, state, marine environment, balanced, healthy, changes, monitoring.

These are suggestions only. Teachers are encouraged to adapt and change material to suit their students.

HEALTHY SEAWATER EXPERIMENT

Students can use their senses to explore local saltwater samples.

Before students arrive, set up 4 jars with salt/seawater in them. If seawater is not available, make salt water with a similar concentration to seawater by mixing a jar of tap water with 1½ teaspoons of sea salt. It would be ideal to get several real examples of local seawater for this investigation (ensure students wash their hands after handling).




Water samples. Photo: Shanthie Walker




In the first jar, add 1 teaspoon of oil. To the second jar, add one teaspoon of vinegar. To the third jar, add one teaspoon of dirt. The final jar contains only the salt water.

- **Which jar contains only pure, healthy salt/seawater?** Students can observe (using sight, touch and smell) these samples and recognise the limitations of their sensory observations.
- Ask students to use their senses to observe the jars of salt water. (They may notice the oil droplets and dirty water with their eyes, and although the jar with vinegar looks good, it may smell unpleasant or feel unusual. The plain saltwater jar is the only one that 'looks and smells' clean and healthy). Oil could represent an oil spill at sea and vinegar could represent a pollutant such as a cleaning chemical.
- Can we guarantee from our observations that jar 4 (containing only salt water) is suitable for marine animals to live in? Discuss the limitations of observations and testing only using our senses of sight, touch and smell. Explain that scientists might test the water samples using specialised equipment to get more reliable, accurate results. There is no guarantee that the fourth jar is not polluted, and we can't know that it would be safe for marine animals until it was thoroughly tested (using other scientific tests).

LEARNING ABOUT HEALTHY MARINE ENVIRONMENTS

View the *Healthy marine environments* slideshow (see  [Resources](#)) to learn more about healthy marine environments and how scientists test them. After viewing, discuss what makes a healthy marine environment.



Students could then read *Healthy marine reserves 1 and 2* ( pages 9–13) to find out more about the part marine reserves play in keeping oceans healthy. *Healthy marine reserves 1* is suitable for Years 3–5 students. *Healthy marine environments 2* is more suited to Years 6–8 students.

After reading, discuss the answers to the questions with students. Why have numbers of animals not increased dramatically inside the reserve over time? (Adult fish and animals can leave the reserve where they are not protected and can migrate or be caught by fishers).

MONITORING THE HEALTH OF MARINE RESERVES AND ENVIRONMENTS

Explain that scientists at DOC, with the help of local councils, monitor marine environments such as marine reserves over time. DOC is responsible for maintaining the health of marine reserves, in partnership with iwi, other agencies and communities.



- Students can read a real example of health report for a marine reserve: *Marine reserve report card for Cape Rodney-Okakari Point Marine Reserve*:  www.doc.govt.nz/cape-rodney-report-card (suitable for Year 5+).
- Other health reports are available at:  www.doc.govt.nz/report-card.



THE CURRENT SITUATION FOR OUR MARINE ENVIRONMENTS



Examine the current situation for marine environments using the following resources:

- *The gulf at crossroads* poster from the *Gulf Journal*:  <http://guljournal.org.nz/poster/the-gulf-at-crossroads>. Students can read the text in the poster to find out what the current situation is for snapper, crayfish, Bryde's whales, seagrass, mussels, sponges, kelp, kina, seabirds and marine pests in the Hauraki Gulf/Tikapa Moana near Auckland.
- View the National Geographic's clip *Current state of the oceans*:  <https://www.youtube.com/watch?v=rE2DrmJ2l-U>.

After viewing, discuss what students think the current situation is for Earth's oceans and the wider marine environment. Encourage thinking about the situation from a global perspective.

Inquiry stage 4: Extending thinking





THINKING ABOUT YOUR LOCAL MARINE ENVIRONMENT



- Is your local marine environment healthy or unhealthy? Record ideas about which resources, places, decisions and actions support the health of the coast and beaches and which activities or actions affect the health of the marine environment (coast and beaches)?

Decisions and actions for a healthy, and safe coast	Decisions and actions for an unhealthy or unsafe coast

Google Docs version:  <https://goo.gl/gngPCE>.

- How could you test the health of your local marine environment? Who could you ask who may already be testing it?
- The Marine Metre Squared (Mm2) project:  <https://www.mm2.net.nz> is a reliable survey to assess the health of a marine environment over time. Monitoring your shoreline regularly is a reliable way to see the changes that are occurring there. The website has tools and templates for data comparison.
- Look back at  *Activity 8: Visiting marine reserves and environments*. How can you use the information and data you gathered to assess the health of the marine environment?







- What are your conclusions about your local marine environment? Is it healthy or unhealthy? What evidence supports your ideas?
- How does this relate to the global situation for our oceans?


EXTENDING LEARNING




How real scientists monitor marine environments

Learn more about how coastal ecosystem health is monitored by DOC scientists in these articles:

- *Coastal ecosystem monitoring*:  www.doc.govt.nz/coastal-ecosystem-monitoring.
- Scientists monitor little blue penguins to gauge ecosystem health:  www.doc.govt.nz/little-penguin-monitoring.

In the wider ocean environment, explore how scientists are measuring ocean temperatures and salt content (salinity) at the Science Learning Hub:  www.sciencelearn.org.nz/resources/681-argo-project.

Diversity and health

Marine reserve ecosystems with varied biodiversity and abundant living things are not only healthy, but also more resilient and resistant to stress. Biodiversity contributes to health and healthy ecosystems can adapt to change more easily. Read more about resilience to stress in ecosystems at Science Learning Hub:  www.sciencelearn.org.nz/resources/1129-resilience-to-stress.

OTHER RESOURCES ABOUT THE HEALTH OF THE MARINE ENVIRONMENT:

- Ocean MOOC (massive open online course) *One planet-one ocean*: link www.oceanmooc.org/en/index.php. There is so much information here (e.g. video content and text) that it could extend all interests.
- Curious Minds *Sustainable seas*: link <https://www.curiousminds.nz/stories/sustainable-seas-a-national-science-challenge>.





How do marine reserves help to keep oceans healthy?

Marine reserves protect fish and other animals from threats like fishing, habitat loss and pollution. Inside marine reserves, everything is protected. This helps living things grow and find a natural balance again. Animals can safely breed, and ecosystems become healthier. Healthy ecosystems provide healthy food and water for animals, including humans. Outside marine reserves, fish and shellfish such as snapper and scallops are at risk from fishing, pollution and development and other threats.

Goat Island: measuring the health of a marine reserve

The table below shows measurements of the health of Cape Rodney-Okakari Point Marine Reserve, known as Goat Island. Scientists measured how clean the water was, what the habitats were like and surveyed the numbers of crayfish over time. Here are the results:

Criteria	Measurement			
Habitat	Poor	OK	Good	Excellent
Water quality	Poor	Ok	Good	Excellent
Rock lobster (crayfish)	Decreasing	Stable		Increasing

Do we need bigger or more reserves?

Looking at the data in the table above from Cape Rodney-Okakari Point Marine Reserve some species such as crayfish have declined inside the reserve, even though they are protected there. Marine reserves have no fences, and fish and crayfish can leave whenever they want to. Fishing and gathering near the outside boundaries of the reserve is reducing the overall numbers of crayfish and snapper.

Scientists think that if the protected areas were larger, or there were more reserves, this might help increase numbers of crayfish and snapper.

Questions for students:

1. Read the information in the table on the left. How healthy do you think this marine reserve is?
2. Do you think we need larger marine reserves? Explain why or why not.

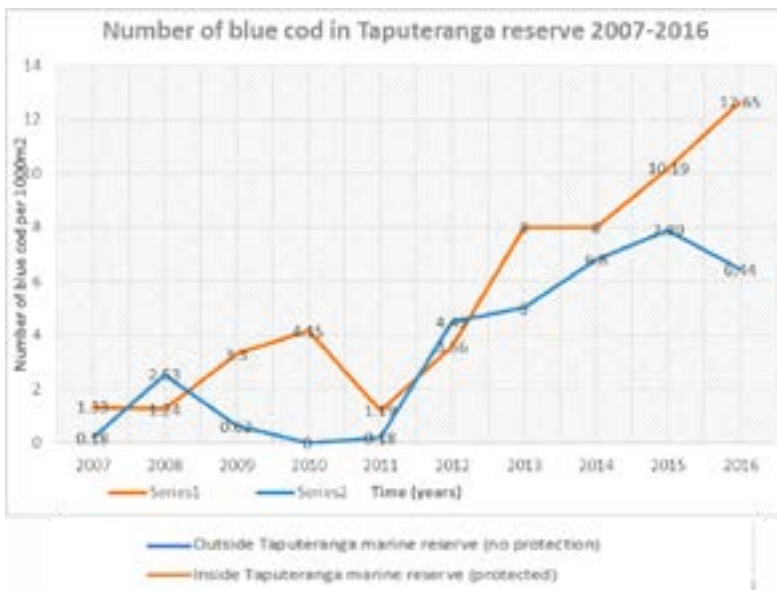




Taputeranga Marine Reserve

Measuring the numbers of blue cod

Taputeranga Marine Reserve was created in 2008. Before 2008 there was no protection of animals living there. Scientists have monitored the numbers of blue cod fish in the reserve before and after they were protected. Divers collected this data by swimming along a tape measure laid out on the seabed (called a transect) and counting the number of fish they saw within a set distance either side of that line. The numbers of fish and biodiversity in the reserve can tell us something about how healthy it is.



Questions for students:

3. What do you notice about the number of blue cod in Taputeranga Marine Reserve since 2008 when the reserve was created?
4. How healthy do you think Taputeranga Marine Reserve is? How do you know?

Blue cod.

Photo: Lorna Doogan, EMR





How do marine reserves help to keep oceans healthy?

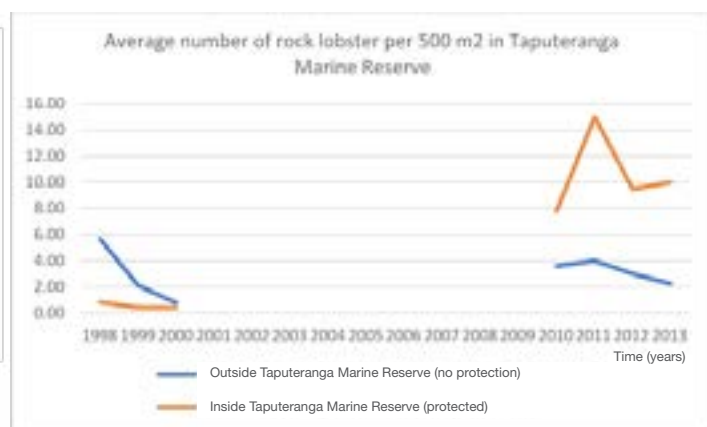
Marine reserves protect fish and other animals from threats like fishing, habitat loss and pollution. Inside marine reserves, everything is protected. This helps living things grow and find a natural balance again. Animals can safely breed and ecosystems become healthier. Healthy ecosystems provide healthy food and water for animals, including humans. Outside marine reserves, fish and shellfish such as snapper and scallops are at risk from fishing, pollution, development and other threats.

Measuring the numbers of blue cod and rock lobster (crayfish) in Taputeranga Marine Reserve

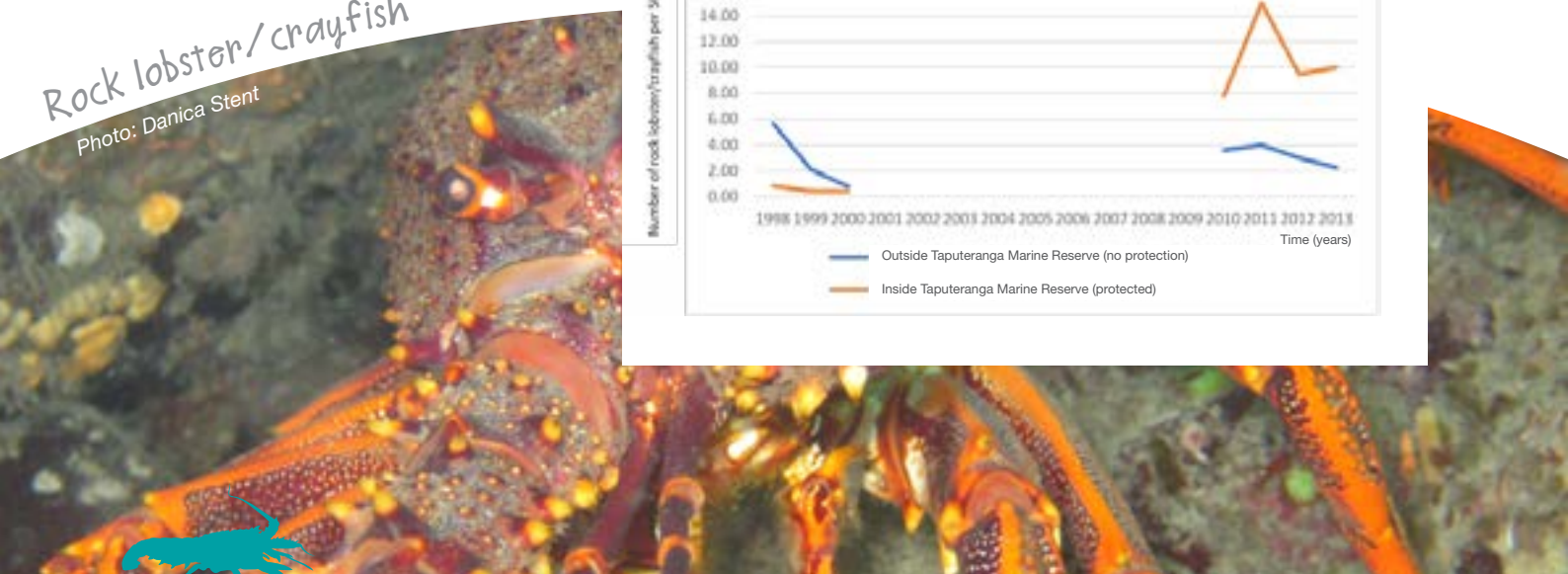
Taputeranga Marine Reserve was created in 2008. Before 2008 there was no protection of animals living there. Scientists have monitored a type of fish called blue cod and crayfish inside the reserve over time (from before they were protected to now). Divers collected this data as they swam along tape measures laid out on the seabed (called transects) and counted the number of fish and crayfish they saw.

Monitoring data from Taputeranga for rock lobster (crayfish)

	Outside Taputeranga Marine Reserve (no protection)	Inside Taputeranga Marine Reserve (protected)
1998	5.67	0.83
1999	2.13	0.44
2000	0.77	0.42
2000–2010	No data	No data
2010	3.61	7.78
2011	4	15
2012	3	9.49
2013	2.25	10



Rock lobster/crayfish
Photo: Danica Stent

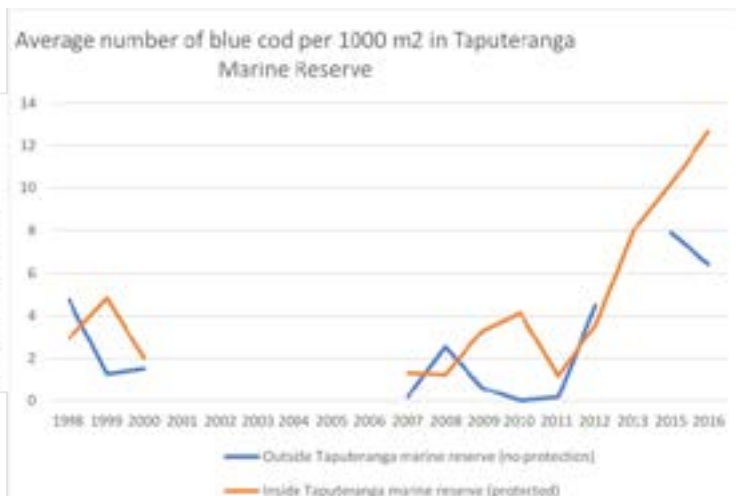




Monitoring data from Taputeranga for blue cod

	Outside Taputeranga Marine Reserve (no protection)	Inside Taputeranga Marine Reserve (protected)
1998	4.74	2.96
1999	1.28	4.83
2000	1.52	2
2000–2007	No data	No data
2007	0.18	1.33
2008	2.53	1.24
2009	0.62	3.3
2010	0	4.15
2011	0.18	1.19
2012	4.49	3.56
2013–2014	No data	8
2015	7.89	10.19
2016	6.44	12.65

Note: There is a gap in the monitoring data between 2000 and 2007 (not consecutive monitoring years). Also, there was not enough data in 2013 outside the marine reserve to give us a good average for that year.



Questions for students:

1. What do you notice about the number of crayfish and blue cod since the creation of the marine reserve in 2008?
2. How healthy do you think Taputeranga marine reserve is? What evidence do you have to support your ideas?





Possible answers: Worksheet 1

1. Read the information in the table on the left. How healthy do you think this marine reserve is?

From these results you could assume that the reserve is in good to excellent health. The evidence of the numbers of blue cod and crayfish support this idea, but there would need to be other evidence to reach reliable conclusions.

2. Do you think we need larger marine reserves? Explain why or why not.

Scientists think that if the protected areas were larger, or there were more reserves, this might help to significantly increase numbers of crayfish, blue cod and snapper.

3. What do you notice about the number of blue cod in Taputeranga Marine Reserve since 2008 when the reserve was created?

The graph shows that over the years since the reserve has been established there has been an increase in the number of blue cod. The trend inside the reserve in the past 5 years of monitoring is that the abundance of blue cod is increasing. Since the creation of the marine reserve there have been more blue cod inside the marine reserve than outside its boundaries.

4. How healthy do you think Taputeranga Marine Reserve is? How do you know?

From these results you could assume that the reserve is in good to excellent health. The evidence of the numbers of blue cod supports this idea, but there would need to be other evidence to reach reliable conclusions.

Possible answers: Worksheet 2

1. What do you notice about the number of blue cod in Taputeranga Marine Reserve since 2008 when the reserve was created?

The tables and graphs show that over the years since the reserve has been established there has been an increase in the number of both blue cod and crayfish. The trend inside the reserve in the past 5 years of monitoring is that the abundance of both species is increasing. Since the creation of the marine reserve there have been more rock lobster inside the marine reserve than outside its boundaries.

2. How healthy do you think Taputeranga marine reserve is? What evidence do you have to support your ideas?

From these results you could assume that the reserve is in good to excellent health. The evidence of the numbers of blue cod and crayfish support this idea, but there would need to be other evidence to reach reliable conclusions.

