Ecosystem and Edible Urchins

Teacher Guide

Coastcare Victoria School Kit

Coastcare Victoria

VICTORIA State Government | Energy, Environment and Climate Action

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Ocean Imaging.

Acknowledgment

We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it. We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

We are committed to genuinely partner, and meaningfully engage, with Victoria's Traditional Owners and Aboriginal communities to support the protection of Country, the maintenance of spiritual and cultural practices and their broader aspirations in the 21st century and beyond.

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Accessibility

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Contents

Curriculum links

Year 5 and 6 Curriculum Area	C/ Code	Content Description	Elaboration / Link to this lesson/ Learning intentions.
Science/ Science understanding > science as a human endeavour	VCSSU073	Scientific understandings, discoveries and inventions are used to inform personal and community decisions and to **solve problems** that directly affect people's lives	Learning about how the removal of sea urchins may help control the balance of a kelp forest ecosystem.
Science/ Science Understanding /Biological Sciences	VCSSU075	The growth and survival of living things are affected by the **physical conditions** of their environment.	Sea urchin populations may be affected by biotic and abiotic factors in the environment.
Science/ Science Inquiry Skills > Recording and processing	VCSIS085	Construct and use a range of representations, including tables and graphs, to record, represent and describe observations, patterns or relationships in data.	Plan scientific sampling and record data on urchin densities on example reefs. Represent data in tables and make conclusions from describing patterns and relationships.
Science/ Science Inquiry Skills > Analysing and evaluating	VCSIS086	Compare data with predictions and use as evidence in developing explanations	Make predictions about a population size from sample data. Make predictions on sustainable seafood choices based on background information
Science/ Science Inquiry Skills > Analysing and evaluating	VCSIS087	Suggest improvements to the methods used to investigate a question or solve a problem	Outline problems with a basic scientific investigation and provide suggestions for improvement.
Geography /Geographical Knowledge	VCGGK096	Environmental and human influences on the location and characteristics of places and the management of spaces within them	Identifying local vs remote sources of plastic.

Year 7 and 8 Curriculum Area	C/ Code	Content Description	Elaboration / Link to this lesson/ Learning intentions.
Science/ Science understanding > science as a human endeavour	VCSSU089	Scientific knowledge and understanding of the world changes as new evidence becomes available; science knowledge can develop through collaboration and connecting ideas across the disciplines and practice of science	Learning about how the removal of sea urchins may help control the balance of a kelp forest ecosystem. Comparing how sea urchin populations may be controlled in other places in Australia and overseas.
Science/ Science understanding > science as a human endeavour	VCSSU090	Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations	Learning about how an increased understanding and closer relationship with seafood may impact the health of marine ecosystems.
Science/ Science Inquiry Skills > Recording and processing	VCSIS110	Construct and use a range of representations including graphs, keys and models to record and summarise data from students' own investigations and secondary sources, and to represent and analyse patterns and relationships.	Plan scientific sampling and record data on urchin densities on example reefs. Represent data in tables, graphs and make conclusions from describing patterns and relationships.
Science/ Science Inquiry Skills > Analysing and evaluating	VCSIS111	Use scientific knowledge and findings from investigations to identify relationships, evaluate claims and draw conclusions	Make predictions about a population size from sample data. Make predictions on sustainable seafood choices based on background information
Science/ Science Inquiry Skills > Analysing and evaluating	VCSIS112	Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of the data collected, and identify improvements to the method	Outline problems with a basic scientific investigation and provide suggestions for improvement.

Science/ Science understanding > biological sciences	VCSSU093	Interactions between organisms can be described in terms of food chains and food webs and can be affected by human activity	Use simple food chain diagrams to compare how marine ecosystems may be controlled by top down and bottom up processes.
Geography / Geographical Knowledge / Landforms and landscapes	VCGGK119	Human causes of landscape degradation, the effects on landscape quality and the implications for places	Learning about how the Millenium Drought and nutrients have impacted the water quality and marine life within Port Phillip Bay

Australian Curriculum Cross Curriculum Priority	C/ Code	Content Description	Elaboration / Link to this lesson/ Learning intentions.
Sustainability > Systems		All life forms, including human life, are connected through ecosystems on which they depend for their wellbeing and survival.	Introduced to the population dynamics and interconnectedness of a marine ecosystem.
Sustainability > Systems		Sustainable patterns of living rely on the interdependence of healthy social, economic and ecological systems.	Learning about how the removal of sea urchins may help control the balance of a kelp forest ecosystem. Learning about how sustainable seafood choices impact marine ecosystems.

Key Themes:

Food webs, marine ecology, bottom up vs top down controls of ecosystems, scientific research and sampling techniques.

Learning intentions

Students will understand:

- Sea urchins are natural herbivores in kelp forest ecosystems but population explosions can have negative consequences.
- Living things have structural features and adaptations that help them to survive in their environment.
- Sea urchin populations may be affected by biotic and abiotic factors in the environment.
- Removal of sea urchins may help control the balance of a kelp forest ecosystem.
- The basic principles of a simple scientific investigation to estimate population size using a quadrat.

Success Criteria

Students are able to:

- Distinguish between a local and international kelp forest ecosystem.
- Using sampling techniques to make population estimates.
- Illustrate and/or describe how factors in the environment led to high urchin numbers in Port Phillip Bay.
- Use simple food chain diagrams to compare how marine ecosystems may be controlled by top down and bottom up processes.
- Outline problems with a basic scientific investigation and provide suggestions for improvement.
- Make predictions about the sustainability of local seafood species.
- Use the GoodFish website or app to determine the sustainability of local seafood species.

Background

Sea urchins are spiny echinoderms (a phylum including starfish, brittle stars and sea cucumbers) that live in all oceans of the planet. Sea urchins are herbivores. In regular numbers they play an important role in the ecosystem, maintaining algae growth. However, when numbers are too high they can damage kelp habitats through overgrazing and preventing recruitment of seaweeds. Urchins are capable of devastating their environments, creating what biologists call an “urchin barren”. Loss of the habitat and nutrients provided by kelp forests leads to a wide range of negative consequences on the resulting low productivity and low biodiversity marine ecosystem created by the barrens.

There are two problematic sea urchin species in Australian temperate waters. The short spined sea urchin *Heliocidaris erythrogramma* and the long spined sea urchin *Centrostephanus Rodgersii.* Populations of the long spined sea urchin have been expanding southward down the east coast as far as Tasmania as the water has been warming but are only an issue in the eastern part of Victoria.

Short spined sea urchins are normally found in the waters of Port Phillip Bay and other sheltered waters along Victoria’s coast. Research scientist Dr. Paul Carnell from Deakin University first realised there was a sea urchin problem in Port Phillip Bay during his PhD. After 12 years of research, Paul and his team have started to understand the historic cause of the issue and are also responsible for the ongoing monitoring of reefs.

This video investigates the cause of the urchin problem in Port Phillip Bay and follows Paul on a dive to survey a reef at Williamstown and investigate some of the solutions to the problem. Licensed recreational fishers are allowed to catch up to 40 sea urchins per person per day (note: urchins must be caught below 2m depth). However, for most Australians, sea urchin is not a commonly eaten seafood. The video also

introduces Chef Johnson from Melbourne urchin restaurant Uni Boom Boom, who is out to change people's perceptions of the seafood, a delicacy in many Asian countries. Johnson shares the preparation methods for the urchin and an insight into what could be a highly lucrative sustainable industry in the country.

However the solution isn't as straightforward as it may sound. Urchins collected from barrens are usually low quality and contain small roe (the edible part of the sea urchin) because they are living in a low food environment. Research from the University of Melbourne and Deakin University has shown after 12 weeks of feeding sea urchins, they are actually good enough to be able to eat or sell back into the market.

There are other introduced species in Port Phillip Bay which are also causing a problem for ecosystems. One of these is the Northern Pacific Kelp - Undaria. Another is the North Pacific Sea Star which loves eating shellfish. When they get in really large numbers they can go through and clear a lot of shellfish in an area.

Resources

- Video
- Video transcript
- Presentation slides
- Quiz
- Sustainable Seafood Investigation worksheet
- Urchin investigation reef grids
- Urchin investigation reef grids digital powerpoint version
- What's the problem text
- Urchin comic strip activity pictures and text
- Urchin comic strip activity pictures blank
- Urchin comic strip activity words blank PDF
- Urchin sampling activity interactive worksheet
- Urchin adaptation types worksheet (year 5-6)
- Urchin adaptations investigation worksheet (year 7-8)
- Top down systems worksheet (year 5-6)
- Top down systems worksheet (year 7-8)
- Urchins Glossary

Other useful links:

- Uni Boom Boom Menu
- Article: Otters and Californian kelp forests
- Animated video: Who's eating all the kelp?
- Transect Analysis - Advantages and Limitations
- Goodfish website

Lesson Plan

Activity 1: Quiz

Activity 2: What's the problem?

Hand out the What's the Problem Text or use the Urchin comic strip activity pictures and text worksheet or the Urchin comic strip activity pictures blank worksheet.

This is a transcript of the section of the video which explains what scientists think has caused the sea urchin problem in Port Phillip Bay. Play the video again from 1:50. Because this section is quite dense, this gives the students another opportunity to understand what has been going on. Before the video plays, run through the slides on abiotic vs biotic factors impacting the ecosystem.

1. As the video plays students can underline biotic (living) factors and **circle abiotic (non-living factors).**
2. Next the student will link up the sentences with the images.

Use What's the problem text answers

Activity 3: Comic Strip

From the previous activity, students will have been introduced to the concept that the change in the ecosystem was driven from the bottom-up. The bottom-up control is driven by the presence or absence of the producers in the ecosystem. Bottom-up processes are generally driven by the abiotic conditions required for primary producers to grow, such as availability of light and nutrients

In this activity students will build on their understanding of the problem through a comic strip. The activity may be run in a variety of different ways depending on your students' learning styles and ability levels. You may like to have your students illustrate the comic strip using the Urchin comic strip activity pictures blank worksheet or write the text in their own words Urchin comic strip activity words blank worksheet. You can view suggested answers with the Urchin comic strip activity answers document.

To assist with this activity, run through the presentation slides explaining that a producer makes its own energy from the sun and consumers eat other organisms in order to survive. Use the glossary sheet for this lesson to help students with any of the complex terms. Explain that trophic levels are an organism's position in the food web. The ground floor of this pyramid lays the foundation for the entire food web providing the first sources of energy (or food) for all other organisms. In the top-down control, the populations of the organisms with lower trophic levels (bottom of the pyramid) are controlled by the organisms at the top. This approach is also called the predator-controlled food web of an ecosystem.

Use the Top down systems worksheet as a teaching tool to build student knowledge or as an assessment tool.

Extension 1: Use the link to Animated video: Who's eating all the kelp?. Have students watch and compare the similarities and differences between the urchin problem in Tasmania versus Port Phillip Bay.

Extension 2: Use the link to Article: Otters and Californian kelp forests. Have students read and compare the similarities and differences between a Californian and Australian kelp forest.

Adaptations Investigation

Urchins are highly successful animals that can be found in all of the world's oceans, to depths as deep at 5000m! There are 950+ species worldwide. Only an animal highly suited (adapted) to their environment could be so successful. In this investigation students can investigate the various adaptations of sea urchins using the Urchin adaptations investigation worksheet. For younger students this investigation may be run as a simple activity using the Urchin adaptation types worksheet (answers below).

Scientists classify adaptations in three main categories. But some adaptations may fit multiple categories.

- Behavioural: things organisms **do** to survive / reproduce.
- Physiological: a **body process** that helps an organism survive / reproduce.
- Structural: a **physical feature** that helps an organism survive / reproduce.

Sea urchin adaptations:

- They can survive in a low food environment by shrinking their shell size (if you are smaller you need less food). **Physiological/Structural**
- They put less investment in reproduction in low food environments. Less energy in the roe (eggs and gonads). **Behavioural**
- Spines - protects them from predators and they can also use them to catch bits of seaweed as they float past. They also use the spines to pass food to the underneath side where their mouth is. **Structural/Behavioural**
- Mouth on bottom - this means they can graze along the rock and eat anything that's attached there. Mouth is called an Aristotle's lantern and looks a bit like a beak. **Structural**
- Sea urchins move by walking, using their many flexible tube feet. **Structural**

Activity: Urchin sampling

Often when sampling underwater scientists use a square called a quadrat to count organisms of interest in an area. They can then extrapolate to make predictions about the broader densities of that organism over the area of the reef. In the video the scientists threw a quadrat at various points along a transect line.

In this activity students will learn about scientific data collection methods. First use the website Transect Analysis - Advantages and Limitations to have students investigate the advantages and disadvantages of various sampling methods.

Then, using the Urchin investigation reef grids or Urchin investigation reef grids digital powerpoint version students can collect data on the urchin densities in five different reefs. You may like to turn this activity into a competition between individuals or as groups to see who can get the closest estimates to the actual reef numbers which are as follows.

	Reef A	Reef B	Reef C	Reef D	Reef E
Total Urchin Count	306	552	289	299	297

Final steps:

Compare results with others in the class. Students will work out that the results vary substantially. They may also notice that on some reefs the urchins 'cluster' in particular patches. If more quadrats land in these areas, the estimates will be higher.

Encourage the students to reflect on the experimental design, how could the experiment be improved? The best way to improve the reliability of the estimates is to take more samples. In a real world example it may also be important to re-sample the reef in a different season.

Investigation: Sustainable Seafood

In this task students will use the sustainable seafoods worksheet to research some marine species to determine their trophic level and make predictions on their sustainability. There are three versions of the worksheet depending on ability level and how long you want the lesson to take. In version one, students will use the internet to research the diet of the marine species, whereas in version two this is already filled out and students just need to fill in the prey size, trophic level and make a prediction on the sustainability.

Emphasise to students that a general rule is the smaller the prey of the organism, the lower they are in the food chain and the more sustainable they are likely to be. They can use a traffic light system (green = sustainable, orange = eat less, red = say no) and use the Goodfish website to check their predictions. Students will notice that the sustainability classification may depend on the location. Click here for the Sustainable Seafood Investigation answers.

At the conclusion of the lesson, or for an extension, have students write a paragraph about what they have learned in this investigation.

Review Questions

Top down systems worksheet year 5-6
Top down systems worksheet year 7- 8

Glossary

Adaptation: a special way that an organism is suited to survive and reproduce in an environment.
Barren: a low productivity and low biodiversity area where urchins have eaten down the vegetation.
Density: a measure of how many (organisms) are in a particular space.
Echinoderm: a marine animal with radiating arrangement of parts and a body that may protrude as spines and including the sea stars, sea urchins, brittle stars, sea cucumbers, etc.
Ecosystem: a community of interacting organisms and their environment.
Foraging: searching for food.
Intertidal: coastal spaces between high and low tides.
Millennium drought: an extended period of low rainfall affecting most of southern Australia from 2001 to 2009.
Nutrient: a substance that an organism must obtain from its surroundings for life and growth.
Organism: any living thing.
Overabundant: being beyond what is needed.
Population: the number of organisms of the same species that live in an area at the same time.
Predator: an animal that lives mostly by killing and eating other animals.
Prey: an animal that is hunted or killed by another animal for food.
Proliferate: increase rapidly in number, reproduce and multiply at a rapid rate.
Producer: an organism that is able to use light energy from the sun to create their own food.
Recreational fishing licence: a licence required to take seafood from Victoria's marine, estuarine or inland waters.
Roe: edible part of the sea urchin, specifically the animal's gonads which produce its eggs.
Sea urchin: a marine echinoderm having a spherical or flattened shell covered in mobile spines, with a mouth on the underside.
Survey: examine and record an area and features.
Sustainable seafood: seafood that has been caught in a way that means there's plenty more fish in the sea now and in the future.
Trophic level: the position an organism is in a food chain.
Uni: Japanese name for the edible part of the sea urchins.