Science
Stage 5
Sustainable fishing (G)
Set 1

NSW GOVERNMENT Education & Communities

Distance Education Science Network

Acknowledgments

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Contents

Outcomes

By completing this unit, you are working towards achieving the following outcomes:

- develop questions or hypotheses to be investigated scientifically (SC5-4WS)
- undertake first-hand investigations to collect valid and reliable data and information both individually and collaboratively (SC5-6WS)
- process, analyse and evaluate data from first-hand investigations and secondary sources to develop evidence-based arguments and conclusions (SC5-7WS)
- present science ideas and evidence for a particular purpose using appropriate scientific language, conventions and representations (SC5-9WS)
- analyse interactions between components and processes within biological systems (SC5-14LW)
- explain how scientific knowledge about global patterns of geological activity and interactions involving global systems can be used to inform decisions related to contemporary issues (SC5-15LW)
- explain how scientific knowledge about global patterns of geological activity and interactions involving global systems can be used to inform decisions related to contemporary issues (SC5-13ES)
- considering how ecological sciences are recognising the efficacy of traditional ecological practices of Aboriginal and Torres Strait Islander peoples and how restorative programs based on these practices are generating new career opportunities (Australian Curriculum - ACSHE194)

(Unless stated otherwise, Outcomes taken from the NSW Education Standard Authority's Syllabus for SCIENCE, K - 10, 2012)

Content Statements:

1VA, 2VA,3VA, WS4b, WS6b, WS6e, WS7.1a, WS7.1b, WS7.1e, WS7.2c, WS7.2d, WS7.2f, WS7.2g, WS8.d, WS8.e, LW2e, LW2f, ES3c, ES3d

Resources

Here is a list of materials you will need to gather from home to complete this unit of work

Set 1

brown beans (in mini-kit)

white beans (in mini-kit)

a straw (in mini-kit)

bowl

cup

teaspoon

clock or watch with a second hand, or timer on a smartphone

Set 2

No further equipment required for this part

Please note that the mini kit we have sent you contains the following items:

brown beans

white beans

a straw

Icons

Here is an explanation of the icons used in this unit

Write a response.

Compare your response with the one in the suggested answers section. Give yourself a tick if you were correct. Make any corrections.

Complete the Send-in exercises corresponding to the lesson.

Perform a practical task or investigation.

Glossary

The following words, listed here with their meanings may be found in the learning material in this unit.

bycatch	unwanted fish and other marine species that are caught unintentionally by commercial fishermen and are then discarded
biodiversity	is the variety of life: the different plants, animals and micro-organisms, their genes and the ecosystems of which they are a part
biologically diverse	refers to the total number of different species in an ecosystem. If an ecosystem is biologically diverse it will have a lot of different species in it
crustaceans	a very large group (or subphylum) of the arthropods. This group includes such familiar organisms as crabs, lobsters and crayfish
conservation	the protection of living things and their habitat
ecosystem	a community of living organisms (plants, animals and microbes) in conjunction with the non-living components of their environment
extinct	no longer in existence
e-waste	electronic devices that are thrown out
minerals	nonliving natural substances with a definite chemical composition
overfishing	the catching of too many fish so that the fish stock becomes depleted to an unacceptable level
pollutant	any substance, chemical or waste product that renders the air, soil, water, or other natural resource harmful or unsuitable for use
regeneration	the process of renewal, restoration, and re-growth of forested areas
renewable resource	any natural resource (such as wood or solar energy) that can be replenished naturally in a relatively short period of time
sonar	a technique that uses sound waves to perceive the environment. It is used in submarine navigation and by fishermen to find fish. Many marine mammals, for example, dolphins and whales, use sonar to perceive their environment, locate prey, etc
subsistence fishing	fishing, other than sport fishing, that is carried out primarily to feed the family of the person doing the fishing
sustainable ecosystem	an ecosystem that is biologically diverse and remains productive for future generations to use
zooplankton	tiny animals found drifting near the surface water in aquatic environments

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Lesson 1: Sustainable ecosystems

You have probably heard the word sustainable many times in the media. People talk about sustainable ecosystems and sustainable industries, but what is a sustainable ecosystem and a sustainable industry?

A sustainable ecosystem is one that will be healthy far into the future, so that generations from now will still be able to use the resources from the ecosystem. This will only happen if we use our resources wisely.

A sustainable industry is one that will exist into the future.

We should be aiming for industries such as fishing and logging to be sustainable. We need to harvest the fish and trees wisely now, so that there will still be fish and trees into the future.

For these industries to be sustainable, the oceans and forest ecosystems need to remain healthy. There will need to be a wide variety of living things so that food webs can continue to support all forms of life. In this way, fish and trees will keep growing and reproducing for future generations.

Why worry now?

For ecosystems to be sustained for future generations to use, we all need to protect and manage them now.

The way in which we live affects how everything will survive in the future. People, animals and plants in 100 or 1000 years need to have the same healthy planet to live on and we need to make sure this happens.

If everyone does their part in the place where they live, changes will be made that affect the whole world! We need to all be responsible and use only what we really need and dispose of wastes carefully.

Activity 1: Sustainable ecosystems

Complete the following sentences by choosing the matching phrase from the box below.

1. A sustainable ecosystem is _____

_____

2. Sustainable ecosystems are important _____

_____

_____

3. We need to work together now to have sustainable ecosystems

_____

_____

- for future generations so that they can have the resources they need to survive.
- because how we live affects the health of ecosystems both now and in the future.
- one that will still be healthy far into the future.

Check your responses by going to the suggested answers section.

Why are people worried about ecosystems?

To survive, humans need food, shelter, clothing, air and water.

Food, shelter and clothing and all of our other possessions are obtained from resources taken from the Earth's ecosystems.

In Australia, we have a large supply of natural resources such as coal, gas minerals and seafood, but we are using up these resources at a fast rate.

We produce and harvest a lot of food in Australia – chicken, beef, lamb, fish, wheat, rice and many types of fruit and vegetables.

To continue to be productive, the farmer needs to make sure pollutants don't damage the soil or water that is used for irrigation.

However, all of us create a large amount of waste that can pollute our land, air and water. We consume things and we throw things away.

The photo below is a dump in Sydney just for electronic devices. This type of waste is a big problem in the 21st century. It is called **e-waste**.

What should we do with such waste?

Did you think about recycling it?

Recycling of e-waste

Recycling televisions recovers valuable metals, plastics and glass and prevents dangerous materials entering the ecosystem.

The Australian Government now has recycling regulations for televisions and computers and has set up the **National Television and Recycling Scheme**.

The regulations are that every company that makes or imports televisions and computers pays for their recycling.

How are the old televisions and computers collected to be recycled?

This is where we play our part.

It is up to each of us to deliver our old stuff to the correct place. Many councils have special drop-off places for televisions and computers, but it is up to each one of us to find out where these places are and deliver our old stuff for recycling. This helps to divert hazardous materials away from landfill and enables the re-use of the valuable resources in e-waste.

We are one of the richest countries in the world and have an important role in helping the Earth's ecosystems to become sustainable. This can only be achieved if schools, communities, farmers, businesses and governments all work towards sustainability.

Population growth means growth in waste and the reduction of resources

The population in Australia has more than doubled in the last fifty years, going from 8 million to more than 23 million. This also means that we are using more resources and creating more waste. The same problems are occurring in the rest of the world.

Every second, the world is increasing by approximately 2.4 people or 146 people each minute. That means there are an additional 76 million people in the world every year.

Using resources wisely – reduce, re-use, recycle

To help keep ecosystems healthy and productive, all of us can try to reduce the amount of garbage and waste that we make. We all have recycling bins to collect paper, glass, metal and some plastics. All of these materials can be recycled. We can choose to take our shopping home in re-usable shopping bags rather than use the plastic ones supplied by the shop. We can choose to re-use plastic containers and bags rather than throw them out after one use. Every action we take can reduce the amount of waste that is produced.

Activity 2: Reducing waste and recycling

Use these words to complete the sentences below:

reduce future recycle grow resources

As the world's population continues to _____ rapidly, we need to look after Earth's _____ wisely to ensure that they are available for _____ generations. This means that we should be trying to _____ the amount of waste we produce, and to re-use and _____ resources as much as possible to help keep Earth's ecosystems healthy and productive.

Check your responses by going to the suggested answers section.

Now think back over the main points in the lesson and read the following summary.

Summary of Lesson 1

- A sustainable ecosystem is one that will be healthy far into the future so that in many generations from now, people will still be able to use the resources from the ecosystem.
- A sustainable industry is one that will exist into the future.
- We need to work together now to have sustainable ecosystems because how we live affects the health of ecosystems both now and in the future.
- To help keep ecosystems healthy and productive, we can try to reduce the amount of garbage and waste that we make.
- Recyclable materials should be recycled where possible.

Lesson 2: Managing sustainable ecosystems

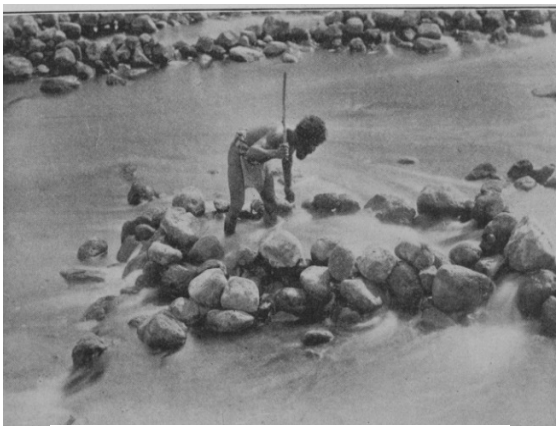
Traditional practices of Aboriginal and Torres Strait Islanders

Aboriginal people successfully managed their ecosystems for at least 40,000 years. Ecosystems provided their resources for clothes, food, building materials and all other items needed for life. These resources were not used up.

By eating a large variety of foods in a systematic way, no one food source was ever totally used up.

For example:

- enough seeds were left, so there would always be new plants growing
- the young of any animal species was rarely killed and eaten, so that they would grow to maturity and reproduce
- female animals still caring for their young were rarely killed, so that the young could grow and reproduce
- some eggs from a bird's nest were always left to hatch, so that they could grow and reproduce



Stone walls in the river at Brewarrina (NSW) form fish traps.

- fish traps built were small, so that only the fish needed to eat were caught. The other fish were left to grow and reproduce.

These traditional practices, as well as many others, meant that Aboriginal people and Torres Strait islanders managed sustainable ecosystems. Each generation used the resources wisely, so that the resources were available for future generations.

Activity 3: Traditional practices

Traditional food gathering by Aboriginal and Torres Strait islanders meant they had sustainable ecosystems.

Name two of their traditional food-gathering practices that kept their ecosystems sustainable. Give a reason why.

(1) _____

_____

(2) _____

_____

Check your responses by going to the suggested answers section.

Managing sustainable ecosystems: non-traditional practices

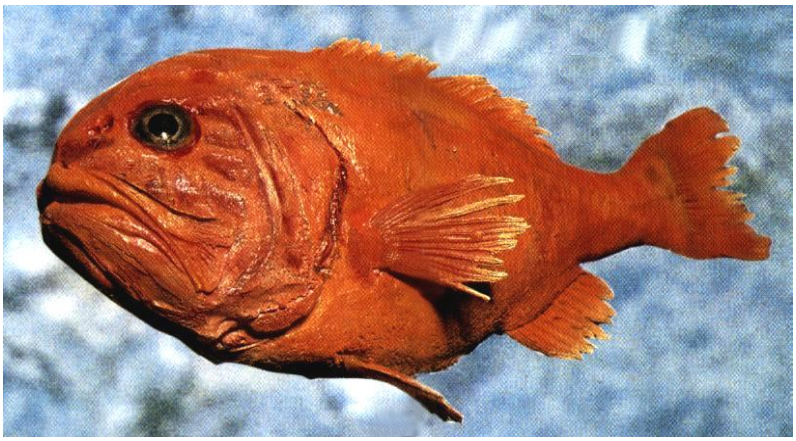
In Australia we have a large supply of natural resources such as coal, gas, iron ore, bauxite (aluminium ore) and titanium oxide (rutile). However, we are using up these resources at a fast rate.

These resources cannot be replaced as they are not renewable resources. Once our coal and metals are all dug up, the mining industry will not exist. Mining, therefore, is not a sustainable industry.

We also have fantastic fish resources because we are surrounded by oceans. Fish are a very important resource. Billions of people around the world eat fish.

However, because billions of people eat fish, there is a problem with maintaining fish populations. There are a growing number of fish species that are in danger of becoming extinct, i.e. totally wiped out.

An Australian example – Orange roughy



Orange roughy are quite unattractive fish. They have also been called *slime head*, but this name was changed when they began to be sold in fish shops. People did not want to buy and eat a fish called *slime head*.

The orange roughy is an interesting fish:

- it grows and matures very slowly.
- it lives up to 150 years old.
- it starts to reproduce when it is about 25 years old.
- it lives in the very deep waters of Southern Australia, up to 1.8 km deep.

Orange roughy were not harvested by commercial fishermen until about 1990, because they live so deep in the water. But then they became a valuable resource, and the fishing industry made a lot of money selling them.

By using technology such as huge nets and sonar, the orange roughy were fished almost to extinction. Harvesting fish to the point of extinction is called **overfishing**.

Even though the orange roughy are in danger of becoming extinct, they are still fished today and sold in shops. In fish shops, orange roughy are sold as *deep sea perch*.

Using a model to show overfishing

Models are often used in Science to help us understand the world around us and the way it works. In this investigation you will use a model of commercial fishing to see if advances in technology affect the number of fish in the oceans.

In the model you are a commercial fisherman and you and your family depend on the money you make from catching and selling fish. You want to make as much money as you can - you want the best for you and your family and it is a hard job. The fish you catch are orange roughy, which breeds very slowly, and salmon which breed once a year. You will be fishing over a number of seasons.

Activity 4: Modelling commercial fishing

Here is a list of the materials you will need to collect.

- brown beans (in mini-kit)
- white beans (in mini-kit)
- straw (in mini-kit)
- a bowl
- a cup
- a teaspoon
- a second hand on a clock/watch or timer on a smartphone

In this model each of the materials listed above represents some part of your commercial fishing job.

Material	Represents
brown beans	orange roughy
white beans	salmon
straw	fishing rod
bowl	the ocean
cup	the boat
teaspoon	huge advance in fishing technology

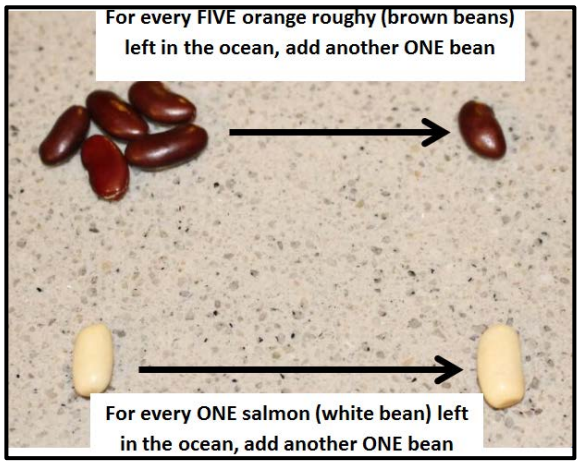
How it works

- You will fish in 3 or 4 separate seasons. Each season will last 20 seconds.
- To catch your fish you need to get the beans from the bowl to the cup (get the fish from the ocean to the boat)
- Each season will have an advance in technology that lets you catch more fish (see pictures with each season showing you how to fish)
- After each season is finished, the fish left in the bowl (ocean) will breed. There will be some fish born. This means you can add some beans to your bowl after each season. But there are strict breeding rules (see below).
- The fish breed at different rates. Salmon breed (reproduce) more quickly than orange roughy.

Fish Breeding Rules – adding extra beans

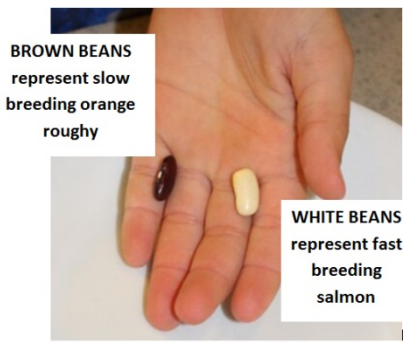
Breeding occurs at the end of each fishing season:

- count the number of white beans (salmon) left in the bowl. Add one white bean for every white bean left in the ocean.
- count the number of brown (orange roughy) beans left in the bowl. Add one brown bean for every five that are left in the bowl.



Set up your ocean

Set up your population of fish to catch. Count 15 brown beans and 15 white beans into the bowl.



How to model each fishing season

Season 1 – modelling a fishing rod

Fish by using a straw with your hands behind your back.

Time allowed – 20 seconds

Suck beans from the bowl to the cup.

Count your catch and enter the numbers in the table on the next page.

Fish breeding time – add beans following the **Fish Breeding Rules.** Enter the number of new fish added to your bowl in the table on the next page.

Season 2 – modelling drift nets, an advance in technology

Fish by holding the straw with your hands.

Time allowed – 20 seconds

Suck beans from the bowl to the cup.

Count your catch and enter the numbers in the table on the next page.

Fish breeding time – add beans following the **Fish Breeding Rules.** Enter the number of new fish added in the table on the next page.

Season 3 – modelling drag nets, a big advance in technology

Fish by using a teaspoon.

Time allowed – 20 seconds

Spoon out beans from the bowl to the cup.

Count your catch and enter the numbers in the table on the next page.

Fish breeding time – add beans following the **Fish Breeding Rules.** Enter the number of new fish added in the table on the next page.

Season 4 – use Season 3 rules if you continue to fish.

Let's start fishing!

1. Starting with Season 1, select the correct fishing technology and fish for 20 seconds.
2. **Count** the number of each type of bean (fish) caught in 20 seconds and record it in the results table (fishing log) for that Season .
3. **Record** the number of each type of bean (fish) left over in the bowl (ocean).
4. Allow your fish to **breed** and **add beans** (fish) to your ocean by following the breeding instructions in the **Fish Breeding Rules** (on page 19).
5. Then **record** the number of each type of bean (fish) that are in the bowl (ocean) after the breeding activity is complete.
6. This will be the starting number of fish in your ocean for your next fishing season.
7. Now repeat the steps 1-6 above, changing the fishing technology for season 2, 3 and 4.

Results Table – Fishing Log

Season	Number of fish 'caught'		Number of fish left in the ocean		Number of fish after 'breeding'	
	orange roughy (brown beans)	salmon (white beans)	orange roughy (brown beans)	salmon (white beans)	orange roughy (brown beans)	salmon (white beans)
1						
2						
3						
If you have beans left over, continue fishing with the 'teaspoon' technology						
4						

EXERCISE

Complete the Send-in exercises for Lesson 2

Impacts on sustainable fishing

Orange roughy are not the only fish in danger of extinction. Other Australian fish that are overfished are:

- blue warhou, which are also sold as Sea Bream
- gemfish, which are also sold as Hake
- mulloway, which are also sold as Jewfish.

The new technologies that are used by fishermen to greatly increase the number of fish caught include:

- sonar to find schools of fish
- huge drift nets to drag all fish in an area. This form of fishing drags up not only the wanted fish but also unintentionally caught fish and other marine species – these are called the 'bycatch'. The bycatch are usually thrown back overboard. This can be tonnes of unwanted fish and other species.

Sustainable fishing – what can we do as consumers and citizens?

There are actions we can take to ensure that fisheries are managed in a sustainable way such as:

- *choosing not to buy fish that are overfished*. This means knowing which fish to buy. If we do not buy the fish, then fishermen will not make any money catching the fish.
- *supporting the fishing quotas that governments have introduced*. Quotas limit the amount of fish that fishermen can catch in an area. Quotas allow fish time to breed.
- *learning about what is being done by commercial fishermen and large commercial fishing vessels*. If we consider that their activities lead to unsustainable ecosystems we can write to the government.

If enough people voice their concerns, governments will take action.

An example of this is the problem of over-fishing by super-trawlers.

Super-trawlers such as the Margiris super-trawler have been banned from Australian waters by the Federal Government after many people objected to the possible damage they would have on maintaining sustainable fishing.

Why did people think super-trawlers were bad for sustainable fishing?

Super-trawlers are a very large fishing trawler. This is a picture of a super-trawler compared to a regular fishing trawler.

It has a very large drift net that collects an abundance of bycatch. The net can be up to 2.5 km long. 30% of the fish caught are thrown back dead. Super-trawlers have had a devastating effect on fish and other marine life in many parts of the world.

At present, the ban on super-trawlers in Australian waters has been put into place for an indefinite period of time. If this position ever changes, people will need to voice their concerns again.

A quote to think about…

In the end, our society will not only be defined by what we create, but by what we refuse to destroy.

John Sawhill (Former President, The Nature Conservancy)

Activity 5: Managing sustainable ecosystems

1. Name and describe two commercial fishing methods which are commonly used and contribute to overfishing.

_____

_____

_____

_____

2. What is 'bycatch'?

_____

_____

3. Describe two actions that you can take to ensure that fisheries are managed in a sustainable way

(1) _____

_____

(2) _____

_____

Check your responses by going to the suggested answers section.

Send-in Exercises: Sustainable fishing Set 1

Lesson 2: Managing sustainable ecosystems

The following questions refer to *Activity 4: Modelling commercial fishing.*

1. In your ocean, what colour beans represented:

   (a) slow-breeding orange roughy? _____

   (b) fast-breeding salmon? _____

2. (a) Assess the effect of the new technology on the total number of fish caught in Season 3.

   _____

   _____

   (b) Assuming each fish is worth $10, in which season would you make the most money? _____

   (c) (i) Would it be possible to make a worthwhile income after Season 3? YES / NO (circle the correct answer)

   (ii) Explain your answer. _____

   _____

   _____

3. (a) What is harvesting fish to the point of extinction called?

_____

(b) (i) Which fish in your model is most in danger of extinction.

_____

(ii) Explain why this fish is most in danger of extinction.

_____

_____

4. Assess how you could you have made your fishing sustainable.

_____

_____

_____

_____

5. Evaluate the effectiveness of your model in predicting whether overfishing in this area is a risk.

_____

_____

_____

_____

_____

_____

EXTENSION ACTIVITY (Optional)

For this activity, you will need the following digital resource: https://aiatsis.gov.au/exhibitions/brief-history-indigenous-fishing. It can be found by searching **"AIATSIS - history of indigenous fishing"** with your chosen search engine.

Once you have found the article, read through it and answer the following questions:

1. How important fishing is to Aboriginal and Torres Strait Islander people?

   _____
   _____
   _____
   _____
   _____

2. What types of fishing methods do Aboriginal and Torres Strait Islander people use?

   _____
   _____
   _____
   _____
   _____

3. Describe how one of these techniques works.

   _____
   _____
   _____
   _____
   _____

4. Discuss why the technique is sustainable.

_____

_____

_____

_____

_____

5. What unwritten law ensures that all indigenous fishing practices are sustainable?

_____

_____

_____

_____

_____