Sea lions, oceans, and climate change

A teaching and learning resource for Years 7-10

To support the film *Sea Lions: life by a Whisker* and the citizen science portal "Sea lion Spotter"

Government of South Australia
Department for Environment and Water

Acknowledgements

This online curriculum-linked resource was produced by Angela Colliver Consulting Services for the National Parks and Wildlife Service, Department for Environment and Water, South Australia.

The curriculum-linked resource is designed to introduce young people to the management and protection of the Australian sea lion and the marine environment.

The materials in this educational resource have been developed by Angela Colliver from Angela Colliver Consulting Services Pty Ltd.

Learning Experiences for Years 7, 8, 9 and 10

Activity 5: Sea lions, oceans, and climate change

Overview: Explain to the class that their task is to educate others to understand how climate change is impacting Australian sea lions and altering the nature of the ocean now and consider future impacts.

Background science for students: Pinnipeds

Australian sea lions are a type of marine mammal known as pinnipeds. Australian sea lions are endemic to Australia, meaning they aren't found anywhere else in the world. They live in the ocean in colonies, and eat things like schooling fish, octopus, penguins, sharks, fish, and squid. They are incredibly smart and have some unique feeding strategies. They feed almost exclusively on the ocean floor (benthos) in the sand, and around rocks, seagrass, and reef systems. Because of this trait, they are referred to as "benthic foragers". Sea lions have a set foraging range around their colonies which is taught socially either from mother to pup (vertical learning), or between pups (horizontal learning). Any disruptions to the marine environment locally will cause sea lions to have to spend longer at sea and return with less energy (food consumed) not only for their own health, but also, in the case of pregnant or nursing mothers, less energy for their offspring.

Background science for teachers and students: Climate science

Climate science looks at past, present, and future climate systems, and seeks to understand the impact of these on physical, biological, and human environments.

Climate science focuses on the longer term (for example, seasonal variability and climate change) whereas meteorology (the study of weather) focuses on the short-term day to day changes.

Climate scientists aim to develop a coherent and systematic understanding of linked processes using a vast range of measurements (e.g., from the deep oceans to satellites), and sophisticated computer modeling approaches to test our understanding of the factors that affect climate (such as greenhouse gas emissions), and the things climate affects (such as food security and weather). Climate scientists would usually have a strong background in mathematics, physics, biology, and environmental systems.

Source: Professor Mark Howden, Director Climate Institute, Australian National University, Canberra.

Background science for teachers and students: Weather vs Climate

Weather is the daily and hourly changes we experience in temperature, humidity, air pressure, rain, snow, etc. Fluctuations in weather in some regions can be small from day to day while other regions changes can be dramatic.

Climate is the average of all the weather over many years. Climate in a region is influenced by latitude, altitude, prevailing winds, proximity to mountains and large bodies of water, etc. While climate changes from place to place, across regions climate can be relativity stable, meaning that fluctuations in weather are predictable and occur in cycles.

Background science for teachers and students: What is climate change?

It is difficult for students as well as adults to get their heads around climate when the weather fluctuates wildly each day and between seasons. Why would a 2-degree

Celsius change in climate worry us when the temperature changes by at least 10 degrees each day?

The climate has been changing for ever. It is easily observed in the geological fossils over hundreds of millions of years and ice cores over many thousands of years. It usually changes at slower than snail pace over tens of thousands of years. We can see when there have been major sudden changes in climate because these changes are recorded as geological difference in fossils, rocks and ice. To understand climate change you need to understand two elements of climate: long term averages of normal daily, yearly and inter annual weather cycles and the impact changes in the amount of atmospheric gases has on Earth's regulatory systems - the atmosphere. Also consider the changing chemistry of the oceans, and how increased absorption of gases in the ocean are affecting marine organisms.

Whilst the changing seasons mean that daily, weekly and even yearly weather is constantly variable, these changes are generally predictable and stable and are part of the normal cycles of short-term changes in climate, *Climate change*, however, is a reflection of longer term changes in temperature and rainfall (tens to thousands of years) and refers to changes in long term *averages* of changes in temperate and rainfall. A change in the average of long-term climate change can result from either warmer (or colder) than usual days (e.g. a 40 degree day rather than a 35 degree day) or from more (or less) warm or colder days throughout the year (e.g. 10 days warmer than 35 degrees rather than 6 days warmer than 35 degrees).

These changes in the long-term averages of climate are influenced by the mix of gases in the atmosphere. Some gases which include carbon dioxide and methane can hang on to heat better than oxygen and nitrogen which makes up most of the atmosphere.

The sun warms the Earth and a lot of that heat is reflected back into space which cools the Earth at night. The balance between the Sun's direct heat and the cooling of the Earth is the major influence determining our climate. When less heat is reflected into space the Earth warms up. The extra gasses in the atmosphere work just like putting on an extra blanket at night.

One or two degrees hotter may not sound like a big deal. However, what it means is that the entire atmosphere, the top layer of the ocean and the Earth's surface have all on average increased the amount of heat being stored. This is a mind-boggling amount of energy.

Background science for teachers and students: Effects of climate change

The long-term climate record has been increasingly changing for the past few decades with record high temperatures occurring around the world. Some aspects of these changes have been more obvious. The ice caps on the North Pole are shrinking and glaciers are retreating. In Australia, the sea life of warmer waters along the east coast are moving south as the sea temperature in that region increases.

It is likely the biggest impact of climate change for all Australian people is changes to our normal weather cycles, with hotter drier temperatures in southern Australia and more intense rainstorms and cyclone events in the northern Australia. This will result in more frequent and intense fires in the southern and more frequent and intense flooding in the north. Other issues include rising sea levels, droughts, strong winds, and more heatwaves, less rain in some regions and drier conditions over winter

Whilst scientists and farmers have done many studies on the impact of climate change on water resources and agriculture, we know less about the effects of changes in climate on Australia's plants and animals. Some of these effects may be obvious and dramatic, such as the loss of alpine swamps (through drying) on the

endangered Corroboree frog. Others may be more subtle, but equally devastating such as the mismatch in timing of when an insect emerges and a flower needs pollinating, or the inability of hard-shelled marine organisms (crustaceans, molluscs, gastropods) to build and maintain their exoskeleton through ocean acidification.

Background science for teachers and students: How citizen science can help?

We have no idea what most of the impacts of climate change will be. Which animals and plants can migrate to more suitable homes? Which can adapt? How will it play out? What are the knock on effects? How can we help?

More scientists are needed to gather important data on how our plants and animals are coping with changes in climate. Yet scientists can't be everywhere and sending out teams of researchers can be costly. Luckily, in many cases, untrained volunteers can make the same accurate observations as trained scientists when they are provided with proper tuition and the right tools. Using volunteers to assist scientists allows for many more sets of eyes, ears and minds to help understand and solve many of today's environmental issues. When volunteers partner with professional scientists to conduct meaningful research, we call this 'citizen science'. A 'citizen scientist' can work alone, in groups or as part of an international network, but what separates them apart from other types of volunteers is that they are following the principles and rules of authentic scientific research and are working to solve a real-world problem.

The field of citizen science has been around for centuries and citizen scientists have made many important contributions to the field of science (some have discovered new stars and galaxies, found new species, or made medical breakthroughs). Some of our most famous scientists started off as citizen scientists (Charles Darwin, for instance, was acting as a citizen scientist when on the *Beagle*). More recently the explosion of different mobile technologies has made it easier for people to collect, identify, analyse, and report information to scientists and so there are now thousands of different citizen science research projects across the world.

Citizen scientists can help researchers in all stages of the scientific process: from question selection (e.g., which creeks are most polluted in my area?), to data collection (recording monthly water quality), data analysis (crowd sourcing of photo analysis – see 'Sealspotter' & 'Sea lion spotter'), communication and interpretation (reporting in local newsletters or through Facebook) and even in restoration or mitigation. Without the help of many thousands of citizen scientists, professional scientists would not be able to solve many of world's problems.

Background science for teachers and students: Sea lion Spotter and ClimateWatch

National Parks and Wildlife Services (NPWS) in conjunction with Parks Australia have developed a citizen science program in which budding scientists can research a seal ion colony and then count and classify Australian Sea Lions.

The *Sea lion Spotter* portal is an online depository of drone images used to count sea lion populations living on the remote South Australian west coast.

Anyone with internet access can help NPWS staff and research scientists to remotely count populations of adult and pup Australian sea lions.

The *Sea lion Spotter* was developed to provide an easy way for anyone with an interest in sea lions and marine life to contribute to the recovery of the endangered species.

For more information and to sign up a spotter, visit www.sealionspotter.com

ClimateWatch has also produced an app for collecting data on animals and plants. The app automatically records location and time and after the user has recorded information; the app sends the data to a central database. ClimateWatch provides a range of indicator species for land and marine ecosystems. To input data, it is essential that the user can accurately identify species to avoid mistakes being placed into the database.

Essential question:

What happens when we understand that climate change is affecting Australian sea lions and is altering the nature of the ocean, its circulation, temperature, and chemistry?

Scenario:

Arguably, there has never been a time in history when knowledge of global environmental change has been greater than it is today. Climate scientists, atmospheric scientists, oceanographers, geochemists, agronomists, and biologists have all researched and published their specialist knowledge and findings about the planet, its atmosphere, oceans, plants, and animals, as they are today and were in the recent past.

Climate change education is covered under Article 12 of the Paris Agreement, to which Australia is a signatory. Under the Paris Agreement Work Programme, countries have agreed to develop extensive education programs about the changing climate. A number have national education programs addressing climate change. Currently, Australia is not one of them.

Your task is to research how climate change is impacting Australian sea lions and altering the nature of the ocean, its circulation, temperature, and chemistry. Then learn about some of the programs that are active around Australia and internationally, attempting to understand the effects of a changing climate on the ocean.

Finally, design and produce a photo-essay to tell the story of Australian sea lions, and the ocean living with climate change.

A suggested learning process:

Define:

Capture students' interest and share the video on YouTube (2:03 mins) 'Nature is Speaking' (Harrison Ford speaks as the ocean). Talk about the messages conveyed in the video.

View the 'Sea lion Spotter' video on You Tube (7.31 min) that describes an opportunity for students to register as citizen scientists, learn more about sea lions and better understand how sea lions can be used to identify changes, including climate variability, in the marine environment.

Process images in Sea lion Spotter, count and classify sea lions, and contribute to the conservation of Australian sea lions.

View a video (4:05 mins) that explains climate change and its effects on one part of the ocean.

Present the scenario, assign pairs or small groups if appropriate, and ask students to define the task they have been set.

Discover:

Read about climate change.

Ask students to investigate how climate change is altering the nature of the ocean.

View a TED talk, 'The astonishing hidden world of the deep ocean' by Robert Ballard at https://www.ted.com/talks/robert_ballard_on_exploring_the_oceans

Support students with a range of credible scientific sources. Some examples can include:

- CSIRO Oceans and Coasts
- CSIRO and frequently asked questions about climate change
- National Climate Change Adaptation Research Facility (NCCARF)
- Bureau of Meteorology (BoM)
- Australian Institute of Marine Science – Climate Change (AIMS)
- Great Barrier Reef Marine Park Authority – Climate Change (GBRMPA)
- Australian National University – Climate Change (ANU)

Gather data about sea surface temperatures in Australia using the BoM website and plot a graph of a locality near you. Compare the data with the sea surface temperatures experienced on the waters of the Great Barrier Reef and Ningaloo Reef.

Delve deeper into ocean acidification, read about what it is, its effects on crustaceans, how it affects food webs, and some strategies to reduce its effects on oceans.

Learn about the Antarctic Division and their research into ocean acidification.

Ask students to read a Marine Report Card and learn about Australian research teams involved in investigating climate change and the ocean, including ocean acidification, ocean temperatures, ocean oxidization, sea level, and ocean currents. Look at some of the island sea lion colonies and consider how they will be affected by sea level rise.

Delve deeper and read about CSIRO scientists who have contributed their scientific understandings to the October 2019 Intergovernmental Panel on Climate Change (IPCC) report that flags risks and response options for polar and ocean environments.

Delve into the Integrated Marine Observing System (IMOS) website and learn about the innovative probes, systems, and technologies used to monitor and observe changes in the ocean.

Discover how Argo floats and takes readings of the ocean's temperature and salinity.

Learn about Deep Water Arrays that observe deep ocean currents and the contribution they make to understanding the role of the ocean on climate and its variability.

Learn about the Jason-2 satellite designed to make observations of ocean topography for investigations into sea-level rise, and the relationship between ocean circulation and climate change. The satellite also provides data on the forces behind such large-scale climate phenomena as El Niño and La Niña.

Learn about the Grace and Grace Follow-On satellites that can track the ocean's water movement across the planet.

Collate ideas about the innovative ways that scientists are monitoring changes in the ocean using a mind mapping app or mapping ideas using a concept mapping technique.

Go further and investigate how climate change impacts Australian sea lions and affects coastal habitats that may include corals, mangroves, seagrass, and seaweeds.

Read a CSIRO blog for information.

Talk about blue carbon that is defined by Wikipedia as 'carbon that is captured and stored by the world's coastal ocean ecosystems. Discuss how at the UN's Climate Change Conference in Paris (2015), Australia committed to accelerating action in the use of coastal blue carbon for climate change action. Find out about the steps that have been taken to set up a blue carbon market and allow Australians to capitalise from this nature-based approach to offset carbon emissions.

Delve deeper into information about the effects of a changing climate in sea lions. Talk about how sea lions have a set foraging range around their colonies which is taught socially either from mother to pup (vertical learning), or between pups (horizontal learning). Explain that any disruptions, including climate change, to the marine environment locally will cause sea lions to have to spend longer at sea and return with less energy (food consumed) not only for their own health, but also, in the case of pregnant or nursing mothers, less energy for their offspring.

Research the effects of a changing climate on sea lions and record information for use later in the essay.

Be inspired by citizens who are taking action and harvesting coral spawn, restoring mangroves, and re-planting seaweed forests.

Introduce a SWOT analysis. Talk about 'SWOT' being an acronym for **S**trengths, **W**eaknesses, **O**pportunities and **T**hreats.

Model the use of a SWOT analysis using the example of seaweed farming for capturing CO_2 as a climate change solution for the ocean, and identify:

- strengths of the concepts
- weaknesses of the concepts
- real opportunities that the concepts offer the ocean; and
- threats that might adversely impact on the ocean environment.

Ask students to clarify ideas and explanations and summarise these in written form.

Many entrepreneurs, companies, individuals, and communities have also devised climate solutions. Investigate the Spanish company that has developed a concrete that can breathe in carbon dioxide from the air and recycle it.

Read about thirteen ocean-based solutions for climate change here.

Scientists tell us that if we are to avoid the worst effects of climate change and safeguard wildlife, we need to protect at least 30% of our oceans by 2030. In 2020, at the UN negotiations, world leaders are coming together to discuss a Global Ocean Treaty, an agreement that would make it possible to protect oceans outside national borders from human exploitation by making them ocean sanctuaries. Research and find information about the Global Ocean Treaty.

Ask students how they might communicate the ways their ideas or photo-essay might present their findings about the effects of climate change on Australian sea lions and the ocean.

Dream:

In pairs or small groups, students envision or dream about the many possible ways they might design their photo-essay.

Further develop ideas for possible solutions using sketches and labels.

Ask students to visualise their most creative solution.

Invite students to think about what materials, tools, equipment, and ingredients they will need to make their solution a reality.

Design:

Invite students, in their pairs or small groups, to begin drafting their designs for their photo-essay to share with others.

Ask students to draft the steps involved in making their photo-essay.

Ask students to gather the materials, tools and equipment needed and then design and create the photo-essay.

Deliver:

Pairs or small groups showcase their ideas about how climate change is impacting Australian sea lions and altering the nature of the ocean, its circulation, temperature, and chemistry, and some of the programs that are active around Australia and internationally, attempting to understand the effects of a changing climate on the ocean.

Classes host an 'Investigating Sea Lions, Oceans and Climate Change Day' and invite students, teachers, and parents to discover more about the issues.

Debrief:

Ask students to reflect on their learning and something new they learned.

Ask students to describe what worked well, and not so well, in their efforts to engage others in thinking about what is socially and ethically responsible about mining asteroids.

Curriculum connections

Technologies (ACARA, 2022)

Year 7, Year 8, Year 9 and Year 10

Design and Technologies: Knowledge and Understanding

Analyse how people in design and technologies occupations consider ethical and sustainability factors to design and produce products, services and environments AC9TDE8K01 AC9TDE10K01

Analyse the impact of innovation and the development of technologies on designed solutions for global preferred futures AC9TDE8K02 AC9TDE10K02

Year 7 and Year 8

Design and Technologies: Processes and Production Skills

Analyse needs or opportunities for designing, and investigate and select materials, components, tools, equipment and processes to create designed solutions AC9TDE8P01

Generate, test, iterate and communicate design ideas, processes and solutions using technical terms and graphical representation techniques, including using digital tools AC9TDE8P02

Select, justify and use suitable materials, components, tools, equipment, skills and processes to safely make designed solutions AC9TDE8P03

Develop design criteria collaboratively including sustainability to evaluate design ideas, processes and solutions AC9TDE8P04

Year 9 and Year 10

Design and Technologies: Processes and Production Skills

Analyse needs or opportunities for designing; develop design briefs; and investigate, analyse and select materials, components, tools and equipment to create designed solutions AC9TDE10P01

Apply skills to generate, test, iterate and communicate design ideas, processes and solutions, including digital tools AC9TDE10P02

Select, justify, test and use suitable technologies, skills, processes, and apply safety procedures to safely make designed solutions AC9TDE10P03

Develop design criteria independently including sustainability to evaluate design ideas, processes and solutions AC9TDE10P04

Science (ACARA, 2022)

Year 7, Year 8, Year 9, and Year 10

Science as a Human Endeavour—Use and influence of science

Examine how proposed scientific responses to contemporary issues may impact on society and explore ethical, environmental, social and economic considerations AC9S7H03 AC9S8H03

Investigate how advances in technologies enable advances in science, and how science has contributed to developments in technologies and engineering AC9S9H03 AC9S10H03

Explore the role of science communication in informing individual viewpoints and community policies and regulations AC9S7H04 AC9S8H04

Examine how the values and needs of society influence the focus of scientific research AC9S9H04 AC9S10H04

Year 7 and Year 8

Science as a Human Endeavour—Nature and development of science

Explain how new evidence or different perspectives can lead to changes in science knowledge AC9S7H01 AC9S8H01

General Capabilities: Literacy, Digital Literacy, Critical and Creative Thinking, Ethical Understanding and Personal and Social Capability.

Cross Curriculum Priority: Sustainability

Organising Ideas

SS1: All life forms, including human life, are connected through ecosystems on which they depend for their wellbeing and survival.

SS2: Sustainable patterns of living require the responsible use of resources, maintenance of clean air, water, and soils, and preservation or restoration of healthy environments.

SD1: Sustainably designed products, environments and services aim to minimise the impact on or restore the quality and diversity of environmental, social and economic systems.

SD2: Creative and innovative design is integral to the identification of new ways of sustainable living.

SD3: Sustainable design requires an awareness of place, past practices, research and technological developments, and balanced judgements based on projected environmental, social and economic impacts.

SF1: Sustainable futures are achieved through informed individual, community, business and political action that values local, national and global equity and fairness across generations into the future.

SF2: Sustainable futures require individuals to seek information, identify solutions, reflect on and evaluate past actions, and collaborate with and influence others as they work towards a desired change.

Department for Environment and Water.
Government of South Australia
February 2023

Report prepared by:
Angela Colliver Consulting Services for the National Parks and Wildlife Service,
Department for Environment and Water

www.environment.sa.gov.au

Government of South Australia

Department for Environment and Water