national science week 2020

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Deep Blue:

innovation for the future of our oceans

Resource Book of Ideas

FOR NATIONAL SCIENCE WEEK 2020

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Deep Blue:
innovation for the future of our oceans

Acknowledgements

This online curriculum-linked resource was produced by the Australian Science Teachers Association (ASTA).

It is designed to introduce students to the importance of science and technology in preserving the health of ocean ecosystems, solving problems, designing new solutions, and driving an evolution in marine-based industries.

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The materials in this educational resource have been developed by Angela Colliver from Angela Colliver Consulting Services Pty Ltd and designed by Carl Davies, CMD photographics.

We wish to acknowledge Professor Graham Durant, Geoff Crane, Patrick Helean, Andrew Walsh, Jonathon Boland, Bob Winters, Fiona Cole, Doug Tyres and Rosemary Anderson for their assistance and feedback.

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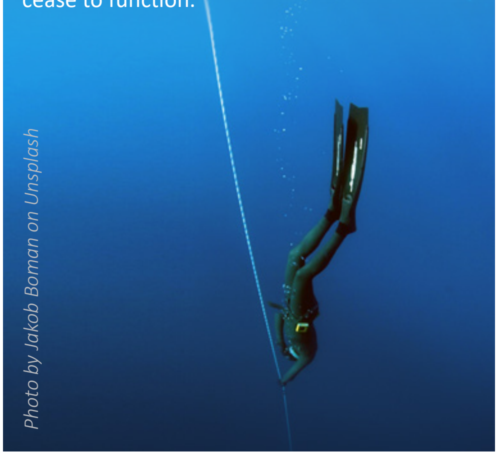
All links to websites were valid between October 2019 and January 2020. As content on the websites used in this resource book might be updated or moved, hyperlinks may cease to function.



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Resource Book of Ideas
FOR NATIONAL SCIENCE WEEK 2020

Minister's Foreword

The Honourable Karen Andrews MP

Minister for Industry, Science and Technology

The Australian Government is a proud supporter of National Science Week. It provides high profile science engagement activities across the nation. It is also an important opportunity for the science community to celebrate and showcase science to a broader group of Australians and the world.

This year the school theme is 'Deep Blue: innovation for the future of our oceans'. Australia's vast oceans are at the heart of the energy, food and economic future of our country. Their value to all Australians is matched only by the enormous economic and environmental wealth afforded us by this national asset.

Earlier this year, the Blue Economy Cooperative Research Centre (CRC) was launched in Launceston. It aims to drive an evolution in marine-based industries, unlocking enormous economic, environmental, and technological benefits for Australia.

It will oversee a $329 million research project and is a10-year collaboration between 45 national and international partners from industry, research and government, of which the Australian Government is providing a $70 million cash investment.

Australia punches above its weight in terms of scientific excellence. Our scientific community, including CRCs, CSIRO and their RV Investigator, Australian Institute of Marine Science (AIMS) and other research organisations continue to deliver outstanding achievements in science and research-based innovation for our oceans. Many of these innovations lead to new industries, ventures, products and policies enabled by science.

National Science Week gives us the opportunity to increase our communities' understanding and engagement with ocean science and to support young people being active in science-driven research and innovation which can prepare them for the jobs of the future.

I commend the Australian Science Teachers Association for another excellent publication that will encourage and inspire innovation for the future of our oceans.

I look forward to being updated on the inspirational stories and initiatives from within your school communities throughout National Science Week.

national science week 2020

An Australian Government Initiative

Inspiring Australia

Australian Science Teachers Association

Introduction

National Science Week is Australia's annual celebration of science and technology.

It aims to provide an opportunity to acknowledge the contributions of scientists, use science, technology, engineering and mathematics (STEM) professionals, innovators, designers, and entrepreneurs to the world of science.

It also aims to encourage an interest in science and STEM among the general public, and this year, it aims to encourage younger people to become fascinated by our planet's oceans, which cover two-thirds of its surface and help control its weather systems and the make-up of the atmosphere.

'Deep Blue: innovation for the future of our oceans' is the school theme for National Science Week in 2020.

This is an important theme for teachers and their students to focus on the oceans. They are always out there, creating climates, absorbing carbon dioxide, lapping away at the shoreline, and it is impossible to ignore, as the Earth's oceans cover more than two-thirds of the Earth's total surface area. The ocean theme also enables teachers and students to discover and investigate Australia's world-renowned contributions to marine science, marine based industries, marine technologies, and marine innovations.

In April 2019, the Australian Government established the Blue Economy Cooperative Research Centre (CRC) in Launceston, Tasmania. The CRC will use 'big picture thinking' to solve problems and use science, technology, engineering and mathematics (STEM) to design new solutions to forge future paths in the areas of offshore engineering and technology, aquaculture and marine ecology, and marine renewable energy.

According to the CSIRO, "The concept of a 'blue economy' is one that balances sustainable economic benefit from the world's oceans and coastlines with the need to protect their long-term health. Given Australia's geopolitical position, the blue economy is fundamental to our and our neighbours', ongoing economic, environmental and social prosperity. The blue economy is generally taken to consider all aspects of the marine, maritime, and coastal regions that have a direct or indirect impact on the economy.

This could include:

- The ocean and coastal environment.
- Oceanography, climatology and meteorology.
- Maritime safety and security.
- Shipping traffic (particularly international) and ports.
- Offshore oil and gas.
- Fisheries.
- Aquaculture (ocean/coastal).
- Ocean renewable energy.
- Oil spills and other human-induced marine incidents.
- Coastal surges, sea level rise and other climate-related incidents including climate change.
- Tourism (ocean/coastal).
- Seabed mineral exploration.
- Marine biotechnology."

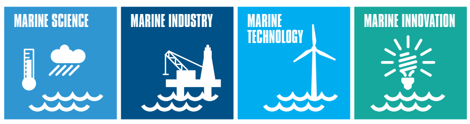
Source: **CSIRO, Innovation for the Blue Economy**, *page 1.*

This year's *Resource Book of Ideas for National Science Week* offers teachers and students the opportunity to explore these concepts in addition to the cultural, commercial, environmental and recreational aspects of our oceans.

In compiling this resource book and its ideas, we have tried to sample the full breadth of topics and issues that might interest students in early childhood, primary and secondary school settings. We have also attempted to highlight marine science, marine research, marine based industries, marine technologies and marine innovations at work in Australia and overseas in the case studies and impact stories scattered throughout the resource.

The case studies have also been linked to the **Sustainable Development Goals** (SDGs) in acknowledgement of the United Nations proclamation of a **Decade of Ocean Science for Sustainable Development (2021-2030)**. The Oceans Decade has been declared in order to 'support efforts to reverse the cycle of decline in ocean health and gather ocean stakeholders worldwide behind a common framework that will ensure ocean science can fully support countries in improved conditions for the sustainable development of the ocean.' The preparatory phase for the Oceans Decade is occurring over the period 2018-2020 and during this time many Australian agencies and institutes are engaged in helping to shape the science objectives of the Oceans Decade. Australian ocean science and technology will be part of Australia's contribution to the Oceans Decade and this resource book provides excellent learning and insight as to what our contribution to this global effort could be.

The following icons can assist teachers in locating activities and case studies that support inquiries in those areas.



How to use this resource book

This resource book provides learning experiences to support your school's involvement in National Science Week 2020.

A suggested learning sequence

The Project Based Learning (PBL) learning sequences used in some of the learning activities in this book are underpinned by the work of Lee Watanabe-Crockett.

It uses the Solution Fluency methodology through six phases: Define, Discover, Dream, Design, Deliver and Debrief. The phases of the model are based on the **21st Century Fluencies** created by Crockett et al (2011).

The Essential Fluencies are outlined extensively in the book Mindful Assessment (Crockett, L. & Churches, A. (2016) Mindful Assessment (Solution Tree)). See also '**Solution Fluency**' on the Global Digital Citizen Foundation website, and the Solution Fluency video **Solution Fluency** on YouTube (3:13 min).

For reference, the fluencies are:

- **Define:** The 'Define' phase begins with lessons that intellectually engage students with a challenge, problem, question, and task. This phase captures their interest, provides an opportunity for them to express what they know about the topic, share understandings being developed, and helps them to make connections between what they know and the new ideas.
- **Discover:** The 'Discover' phase includes activities in which students can explore, investigate, research, read, discuss, gather, organise and compare knowledge and data. They grapple with the challenge, problem, question, or phenomenon and describe it in their own words. This phase provides a context and enables students to acquire a common set of experiences they can use to help each other make sense of the new knowledge or understandings.
- **Dream:** The 'Dream' phase enables students to imagine and develop possible solutions and explanations for the challenge, problem, question, and task they have experienced. The significant aspect of this phase is that the students' explanations follow substantive conversations and higher-order thinking experiences.
- **Design:** The 'Design' phase provides opportunities for students to apply what they have learned to new situations, to map production processes and so develop a deeper understanding of the challenge, problem, question or phenomenon. It is important for students to extend explanations and understandings, using and integrating different modes, such as diagrammatic images, written language, and media.
- **Deliver:** The 'Deliver' phase has two stages—production and publication or presentation. In the production phase, the task comes to life—this is the doing aspect. At the end of this phase, the student task should be completed. Next, they present or publish their work sample to an audience.
- **Debrief:** The 'Debrief' phase provides an opportunity for students to revisit, review, and reflect on their own learning and new understanding and skills. This is also when students provide evidence for changes to their understanding, beliefs and skills.

*Source: '**Solution Fluency'**, Global Digital Citizen Foundation website.*

Aims

The National Science Week Resource Book, ***Deep Blue: innovation for the future of our oceans*** provides schools with opportunities as follows:

- explore the creative processes at the heart of STEM and their far-reaching influence in marine science, marine based industries, marine technologies and marine innovations;
- develop an understanding of the roles STEM, design and innovation play in understanding and addressing complex real-world ocean-related scenarios;
- discover how STEM has, and is, enabling scientists, researchers, inventors, entrepreneurs, engineers, and creative thinkers in growing marine industries to influence marine research and developments;
- discover and envision a range of creative solutions to real-world ocean scenarios;
- dream and consider the many possible solutions to deal with the challenges posed by mankind's advances in offshore marine-based industries and ventures;
- design research projects with the ultimate goal of sharing exhibitions, events, performances, and educational activities, as part of National Science Week;
- design the steps required to create exhibitions, events, performances and educational activities, as part of National Science Week;
- deliver and debrief solutions for real-world ocean scenarios; and
- practise and reinforce the STEM messages delivered in the Australian Curriculum Learning Areas, General Capabilities and Cross-Curriculum Priorities.

For schools, there is also the scope for teachers to integrate this resource book into their existing classroom programs.

Teachers can use the learning experiences to plan, publicise, provoke, stimulate, support, and inspire their National Science Week festivities. It is recommended that the activities are read and considered before National Science Week, as many involve preparation and timing considerations.

The 'Solution Fluency' project-based learning (PBL) activities require many weeks of work. The standalone activities and fun ideas for science stations referenced to on page x can be undertaken during National Science Week.

The resource book includes ideas to support students' involvement in investigating, exploring, experimenting, designing, creating, and communicating their understandings about past and present marine and ocean practices that make use of scientific, technological, ecological, social, and economic knowledge. It also supports students to design, plan, and evaluate marine enterprises, activities, technologies, and equipment.

The resource book is complemented by a National Science Week **journal** that can be downloaded and printed. It is intended for older students to record their ideas: from defining the problems posed in the suggested activities to debriefing the solutions they devise.

The stand alone activities and ideas for classroom work and science fairs found in the 'Have a go at this' sections of this resource book involve the purposeful application of knowledge, experience, and resources to invent, design, create, and make ocean-related objects, products, services, and environments or experiment with scientific concepts of buoyancy, gravity, density, corrosion, and navigation.

Our goal in providing this range of activity types is to provide students with exciting and creative educational experiences, so they can contemplate career paths in Ocean Sciences.

The 'At a glance' section (**page 6**) gives an overview of activities and a list of the videos linked to this resource book.

The 'Looking for PBL Tasks for National Science Week' section (**page 7**) provides an overview of what is involved in each PBL task that uses the Solution Fluency methodology in the resource book.

Curriculum focus

This learning resource has a variety of student activities that link to the Australian Curriculum for science, technologies, mathematics, and the arts. It also has many opportunities to integrate the Australian Curriculum's General Capabilities and Cross Curriculum Priorities into schools' learning programs.

STEM, STEAM, Project Based Learning (PBL), and the use of makerspaces are supported in the ideas in this resource book.

Teaching and learning featured in this resource book can therefore be integrated into a range of learning areas and learning contexts in the lead up to and during National Science Week.

At a glance…

The following overview chart provides page references and links to stand alone activities, videos and ideas for science fairs. The number in brackets after each activity denotes a page number.

Activity Type – Standalone activities for Science Fairs

Foundation–Year 2	Year 3–Year 6	Year 7–Year 10
Learn about density and make saltwater jars (page 16)	Design and make a model sailing boat (page 29)	Renewable energy systems (page 58)
Design and create an ocean habitat (page 17)	Ocean energy (page 30)	Aquaculture systems (page 59)
Create a 3D ocean creature using Quiver (page 18)	Responsible fishing (page 31)	Design a satellite that can track the ocean (page 60)
Let's create and make (page 19)	Design a fish farm (page 32)	Bycatch in our oceans (page 61)
Write it up (page 20)	Sustainable tourism (page 33)	A change starts with ideas (page 66)
	Ocean acidification and shells (page 42)	
	Design a compass (page 43)	
	Ocean probes (page 45)	
	Design a floating rig (page 46)	
	What can you do to help make people aware of the range of marine and coastal survey techniques used to understand our oceans? (page 47)	

Looking for PBL Tasks for National Science Week

The following information provides an overview of what is involved in each PBL task that uses the Solution Fluency approach in this resource book.

Foundation–Year 2

Activity 1: Our oceans (page 10)

In this learning sequence, students are challenged to explore the Earth's oceans. They will design and produce a diorama that illustrates some of the fascinating discoveries they have made about oceans and present these as part of National Science Week.

Students will:

- investigate the oceans using videos, stories, images, and other information;
- locate information about features of the oceans;
- learn about the oceans' waves and tides;
- use makerspaces and experiment with different substances to simulate and make waves, tides, tsunamis;
- learn about ocean animals and plants
- use their findings and the words needed to design a diorama;
- share the observations and facts learned about the Earth's oceans; and
- present their dioramas as part of National Science Week.

Activity 2: Oh buoy. Innovations floating out and about on the oceans (page 13)

In this learning sequence, students are challenged to investigate what objects can be found floating on the oceans, and they design, engineer, and build a model that floats.

Students will:

- use makerspaces and explore how rafts, fish farms, boats, gardens, and hotels can float; and
- design and make a book about what floats on the ocean.

Year 3–Year 4

Activity 1: Cleaning up the oceans (page 23)

In this learning sequence, students explore pollution in the Earth's oceans. Their task is to help others understand the effects of pollution and waste in our oceans and empower them to know what can be done to counter those effects.

Students will:

- explore sources of pollution in the ocean;
- experiment with sources of pollution and water;
- investigate innovative projects helping to clean up oceans; and
- design an experiment, animation or digital presentation to empower others to know what they can do to counter those effects.

Activity 2: Design an underwater exhibit (page 26)

In this learning sequence, students investigate the living and non-living things in our oceans and use science, technology, and art to design an underwater exhibit of things they have identified as either living or non-living.

Students will:

- investigate living and non-living things found in oceans;
- read and view fiction and non-fiction books about animals and plants in oceans;
- locate information and images of non-living things found in oceans;
- view underwater art installations;
- design their underwater exhibit; and
- present their underwater exhibit as part of National Science Week.

Year 5–Year 6

Activity 1: Ocean innovation: marine debris (page 36)

In this learning sequence, students explore innovative ways to tackle marine pollution and then design and produce a solution for managing plastics and marine debris.

Students will:

- view videos in which Sir David Attenborough shares his understanding about marine debris in oceans;
- investigate the life of plastics in the ocean;
- learn about marine debris and innovations that are reducing or removing plastics and other debris from oceans;
- design a technology, product, or system to remove debris from oceans; and
- present their designed solution to inspire others about ocean debris and what they can do to counter those effects.

Activity 2: Ocean innovation and exploration (page 39)

In this learning sequence, students learn about how boats and submersibles are engineered and designed with systems to explore, collect, and retrieve items from oceans.

Students will:

- investigate the purposes of tools and systems that grip, retrieve, and collect objects;
- explore how robots and draglines are used to collect and retrieve objects and samples from oceans;
- design and build a boat and submersible that can collect and retrieve things from a simulated ocean; and
- trial and test their designed solutions as part of National Science Week.

Year 7–Year 10

Activity 1: Smart solutions (page 50)

In this learning sequence, students investigate a range of smart solutions for the oceans and then design a product, system, or environment and produce a folio of ideas to explain their entrepreneurial thinking.

Students will:

- discover how marine scientists, marine-based industries, marine technology companies, and entrepreneurs are designing smart solutions to solve problems confronting the oceans;
- analyse theories and business ideas;
- consider sustainable products and systems integrated into ocean activities;
- explore innovative ideas;
- investigate how drone technologies, remote sensors, satellites, robotics, and the Internet of Things Underwater (IoT Underwater) are now part of the innovation occurring in ocean activities;
- re-imagine and design a service, product or system that could be used in the ocean; and
- share it as part of National Science Week.

Activity 2: Oceans and climate change (page 55)

In this learning sequence, students research how climate change is altering the nature of the ocean, its circulation, temperature, and chemistry. They 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 oceans.

Students will:

- research ideas about how climate change is altering the ocean's circulation, temperature and chemistry;
- investigate some of the programs that are active around Australia and internationally, attempting to understand the effects of a changing climate on the ocean;
- use a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis to analyse seaweed farming and marine permaculture as possible solutions; and
- create a photo-essay to share as part of National Science Week.

For the

Early Years of Schooling

Years Foundation–2

Activity 1: Our oceans

Overview: *Explain to the class that they will be exploring the Earth's oceans. They will design and produce a diorama that illustrates some of the fascinating discoveries they have made about oceans and present these as part of National Science Week.*

Background science for teachers and students: Earth's oceans

Nearly three-quarters of the Earth's surface is covered by water. Most of the water on Earth is saltwater found in oceans and seas. The rest is fresh water, found in rivers and lakes.

An ocean is a large area of salty water. All of the salty water on the Earth is connected, however, it has been divided into five different oceans. The five oceans on Earth are the Arctic Ocean, the Atlantic Ocean, the Pacific Ocean, Southern Ocean and the Indian Ocean.

Australia's oceans and seas include those off the mainland and its offshore territories in the Pacific, Southern and Indian Oceans as well as the Timor, Tasman and Coral Seas.

The Arctic Ocean surrounds the North Pole and is largely frozen. The Pacific Ocean is the largest of all the oceans. At 166 million square kilometres, it is twice the size of the Atlantic Ocean. The Pacific Ocean's depth is more than 4000 metres, making it the world's deepest ocean. The Atlantic Ocean is the second largest ocean, at 82 million square kilometres. The Indian Ocean has a total area of 73 million square kilometres, and at 14 square kilometres, the Arctic Ocean is the smallest amongst the world's oceans. It is also the shallowest.

Oceans are never completely at rest. They move with several kinds of movements, including waves, currents and tides. Waves begin when the wind stirs up the ocean. When the wind blows, it creates pressure on the ocean's surface, causing vibrations and ripples. As the wind increases, bigger and bigger waves are formed. Then they break, tumbling down near the shoreline. The pull of gravity between the Earth, Moon and Sun makes tides and contributes to ocean currents.

At certain places in the Earth's oceans, land rises above the water to form continents and islands, and the surface under the ocean is called the ocean floor.

There is life everywhere in the ocean. From the surface to the seabed, the Earth's oceans are home to many species of mammals, reptiles, fish, birds, and plants, and they all depend on it for their survival.

The essential question:

How can we investigate and understand more about the Earth's oceans?

The scenario:

Be inquisitive and understand more about the Earth's oceans. Observing and recording information is an important part of science.

National Science Week is looking for classes to observe things about the Earth's oceans and then design and make a diorama to share observations and facts about them.

What science investigations might help you?

Your challenge is to use science and observe, discuss, and record your observations and the facts you learn about the Earth's oceans and share these with an audience as part of National Science Week.

A suggested learning process:

Define:

Share the essential question with the class and talk about the Earth's oceans.

Use students' prior learning and record students' ideas on a classroom's 'Word Wall'.

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

Discover:

Capture student interest by viewing **images** of the Earth from space. Ask the students what they observe. Talk about how the blue areas are the oceans, the brownish-green areas the continents, and the white areas are clouds. Share observations and record known ideas.

View the video **Oceans of the World for Kids** on YouTube (8:43 mins) about the world's oceans. As a class, talk about and describe what the ocean looks like.

View online galleries of images of the ocean and make lists of students' comments and questions. These could be presented as a table under the headings "What we know", "What we are not sure about", and "What we want to know".

Introduce 'STEM Story time' and share non-fiction stories about the Earth's oceans. The following are examples that can be used.

- **Seas and Oceans by Issi Howell. This book** features real photographs and photo illustrations accompanied by a paragraph per page. The book describes what an ocean is, what its waves are, what lives on the ocean floor, in tropical oceans, polar oceans, and temperate oceans, and how we use the ocean.
- **What Lives in the Sea? by Australian Geographic. This book helps students** understand the many creatures that live in the sea, the way they catch prey and protect themselves from enemies.
- **Ocean by Emmanuelle Grundmann. This book is** filled with clever cut-outs exploring the ocean, from the shoreline to the murkiest depths.

After sharing and reading stories, talk about what students now know about the Earth's oceans.

As a class, brainstorm what facts students know and discuss the questions for which they might still like to find answers.

Group words used and create a 'word wall' of the students' understandings.

Talk about the oceans and ask students what they might taste like. Ask students to design and record a way to make fresh water taste like the ocean.

Ask students if they can recall seeing the ocean in different shapes. Talk with students about how the ocean comes in and goes out and discuss the different shapes of the ocean like flat seas, waves, tidal swells, currents and king tides.

Focus on waves. Explain that waves begin when the wind stirs up the ocean. Discuss how the wind creates pressure and pushes down on the ocean's surface, causing little vibrations that become bigger and bigger.

Model some waves on an ocean. View a **video** on YouTube (2:16 mins) and create an ocean in a bottle, complete with waves.

Go further and explain how the highest points of a wave are called 'crests' and the lowest points are called 'troughs'.

Dive deeper into the topic of waves and explore what a tsunami is. View a **video** on YouTube (3:00 mins) that explains how a tsunami is a huge wave that is sometimes caused by an earthquake or an underwater volcanic eruption, where the ocean is pushed up and outwards rising up in the form of an extremely powerful wall of water.

Talk about how, twice a day, the ocean comes high up onto beaches and then goes back out again and that these events are tides.

Set up a few makerspaces and experiment with waves, tides, and tsunamis. (Note that these may be best set up on a grassed area outside). For example:

Makerspace 1 - 'Make waves'.

The Makerspace can be set up with tubs of water, several straws, plastic syringes, tubing, cardboard cylinders found in the centre of toilet rolls, gladwrap or alfoil. Invite students to experiment with the materials and make and create waves.

Ask students to describe how waves are formed on the ocean and demonstrate their understanding to others in the class.

Ask students to think about how they might represent waves in their ocean diorama.

Makerspace 2 - 'Make some tides'.

The Makerspace can be set up with tubs of water, plastic balls, or balloons.

Ask students to design a way to show the high and low tides experienced on oceans and change the water levels.

Ask students to describe how the changes in water levels were formed on the ocean and demonstrate their understandings to others in the class.

Ask students to think about how they might represent tides in their ocean diorama.

Makerspace 3 - 'Make a wall of water like a tsunami'.

The Makerspace can be set up with tubs of water, bricks, and blocks of wood.

Ask students to design a way to make a wall of water that splashes over the sides of the tubs.

Ask students to describe how the wall of water or 'tsunami' was formed on the ocean and demonstrate their understanding to others in the class.

Ask students to think whether they would represent a tsunami in their ocean diorama and explain why or why not.

As a class, record the different ocean shapes that students can recall. For example, flat, curved, like a prism, like a triangle, etc.

In groups, look at **images** of different shapes of ocean plants and animals. Ask students to make and record observations about three animals and plants.

Introduce plants like seagrass, seaweed, and kelp. View **images** of these ocean living plants, undertake some picture research, and ask students to make observations and describe their features. Ask students to draw the ocean plants that might feature in their diorama. Discuss these plants features.

Talk about the animals that might live in seagrass meadows or kelp forests. Explain that seagrasses can be home to many types of fish, sharks, turtles, marine mammals (dugongs and manatees), molluscs (octopus, squid, cuttlefish, snails, bivalves), sponges, crustaceans (shrimp, crabs, copepods, isopods and amphipods) worms, sea urchins and sea anemones—and the list goes on.

Go further and discover the range of places that ocean creatures can live by visiting the Australian Marine Environment Protection Association (AUSMEPA) **website** and downloading the Power Point titled 'Where sea creatures live'.

Visit the library or use the class iPads and ask students to research ocean creatures and list their features.

Read fiction and non-fiction books and learn more about animals that live in the seagrass meadows and kelp forests in oceans. Some titles include:

- Brown, A. "Turtle's Song", University of Queensland Press, 2001.
- Carle, E. "A House for a Hermit Crab", Hodder & Stoughton, 1996.
- Freymann, S. "One Lonely Seahorse", Scholastic, 2000.

View a **video** of the story 'Commotion in the Ocean' by Giles Andreae and ask students to identify other animals that live in the ocean that might feature in their diorama.

Assign an animal seen in the book to pairs of students and ask them to focus on their parts and features. Ask them to count the eyes, nostrils, flippers, tails, legs, tentacles, gills (if they have them).

View a **video story** (3:16 mins) about a seagull that gets tangled in fishing line that was found in and on the ocean. As a class, talk about the problem and solution featured in the story. Talk about litter and debris that can be found on our shores and beaches and in the ocean. Discuss what everyone can do about the problem of litter and debris found on beaches and in the ocean.

In small groups, ask students to choose three things they have learned about the Earth's oceans and formulate a draft text.

Invite students to read aloud and share the observations and facts learned about the Earth's oceans.

Ask students to identify words they may not be familiar with. Display these where all students can see them. Use a dictionary and look up the words and model this process for the students.

As a class, make a glossary of words and phrases about the Earth's oceans.

Dream:

Ask students to visualise their diorama of the ocean. Using a shoe box, model a guessing game text to assist students visualise a diorama and presentation. For example: In this box, I've got some creatures. Guess what they are by checking their features.

Ask students to decide on the ocean's features that they are going to incorporate into their ocean diorama.

Ask students to imagine the steps involved in creating their ocean dioramas to represent, share, and reflect on observations or facts learned about the Eath's oceans.

Challenge students to think about the materials, tools, and equipment they will need to make or draw parts of their ocean dioramas.

Design:

Ask students to design their diorama's layout and decide on its title.

Ask students to plan what illustrations will be included.

Invite a peer class group to the class and ask students to explain their diorama's concepts to this audience and seek feedback on their ideas.

Ask students to gather the materials, tools, and equipment needed and then make their ocean dioramas. Photograph students at work.

Deliver:

Ask students to create their ocean diorama that features information about the Earth's oceans that they investigated.

Visit a local pre-school, kindergarten, Foundation class or day-care centre and share the dioramas and discuss the ideas learned about the Earth's ocean with younger children.

Share photos and students' work samples via National Science Week's online community. The ASTA loves to see pictures of children in the classroom learning and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek! Please ensure you have parental permission prior to posting any images of students.

Debrief:

Ask students to:

- reflect on their learning about the Earth's oceans and draw and write about something new they discovered;
- describe their favourite memory of creating their diorama;
- describe how they might improve on what they have done; and
- name one thing they still want to learn about the Earth's oceans.

Curriculum connections

Australian Curriculum: Science (ACARA)

Foundation

Science Inquiry Skills

Pose and respond to questions about familiar objects and events ACSIS014

Participate in guided investigations and make observations using the senses ACSIS011

Engage in discussions about observations and represent ideas ACSIS233

Share observations and ideas ACSIS012

Year 1

Pose and respond to questions and make predictions about familiar objects and events ACSIS024

Participate in guided investigations to explore and answer questions ACSIS025

Use a range of methods to sort information, including drawings and provided tables, and through discussion, compare observations with predictions ACSIS027

Compare observations with those of others ACSIS023

Represent and communicate observations and ideas in a variety of ways ACSIS029

Year 2

Pose and respond to questions and make predictions about familiar objects and events ACSIS037

Participate in guided investigations to explore and answer questions ACSIS038

Use a range of methods to sort information, including drawings and provided tables, and through discussion, compare observations with predictions ACSIS040

Compare observations with those of others ACSIS041

Represent and communicate observations and ideas in a variety of ways, such as oral and written language, drawing and role play ACSIS042

Foundation, Year 1 and Year 2

Science as a Human Endeavour—Nature and development of science

Science involves observing, asking questions about, and describing changes in objects and events ACSHE013 ACSHE021 ACSHE034

Foundation

Physical sciences

The way objects move depends on a variety of factors, including their size and shape ACSSU005

Technologies (ACARA, 2015b)

Foundation, Year 1 and Year 2

Design and Technologies Processes and Production Skills

Explore needs or opportunities for designing and the technologies needed to realise designed solutions ACTDEP005

Generate, develop, and record design ideas through describing, drawing, and modelling ACTDEP006

Use materials, components, tools, equipment, and techniques safely to make designed solutions ACTDEP007

Use personal preferences to evaluate the success of design ideas, processes, and solutions, including their care for environment ACTDEP008

Sequence steps for making designed solutions and working collaboratively ACTDEP009

General Capabilities:

Literacy, Critical and creative thinking, Personal and social capability

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

Marine Discovery Centres

Discover the fourteen **Marine Discovery Centres** that are located across Australia and in the Torres Strait and learn about the school and holiday programs about Australia's oceans they offer.

National Marine Science Centre

Find out more about the **National Marine Science Centre** located in Coffs Harbour in NSW and the programs and field studies it offers schools.

St Columba's Primary School

St Columba's Primary School transformed their curriculum with the Operation STEAM Clean the Bay program. In 2018, the shore became the classroom to pursue citizen science and share indigenous historical and scientific knowledge, while improving the environmental health of Port Phillip Bay and encouraging sustainability. This renewed curriculum, with the help of the Eco Warrior Team – staff and parents included – plus the school's partnership with the Port Phillip EcoCentre and CERES, brought a much deserved Resource Smart Schools 5 Star certification and a Baykeeper Award.

SEA Museum

Find out about the school programs offered by the **Australian National Maritime Museum** in Sydney and the exhibits and events visitors can use to learn about the ocean.

Activity 2: Oh buoy. Innovations floating out and about on the oceans

Overview: *Explain to the class that they will be investigating what objects can be found floating on the oceans and that they will design, engineer, and build a model that floats as well as a class book reflecting their learning.*

Background science for teachers and students: Floating and sinking

Objects that float are said to have positive buoyancy while those that sink – negative buoyancy. When objects float, it means they weigh less than an equal volume of water and when they sink – this means they weigh more. An object is neutrally buoyant when it neither sinks, nor floats. Source: **Wikipedia**

When an object is placed in liquid, its weight displaces (pushes away) a volume of the liquid. This liquid pushes back on the object with a force called 'upthrust'. If the upthrust is equal to or greater than the object's weight, the object will float. The object will sink if its weight is not equal to the thrust of the water.

The essential question:

What happens when we understand how scientists, engineers, and technicians design and engineer solutions that put humans and lots of equipment on the oceans?

The scenario:

Brilliant ideas have driven science throughout time.

Thanks to scientists, physicists, engineers, technicians, mathematicians, software experts, and designers, we have put lots of equipment and people on the oceans.

Your challenge is to think like a scientist, engineer, or a designer and try a number of science activities and then design, engineer, and build a model of something that floats and test it on water at school.

You are also required to describe what you have learned about things that float and contribute it to a book about what floats on the ocean. Are you up for the challenge?

A suggested learning process:

Define:

Capture students' interest by showing them some images of boats, sailing ships, commercial ships, cargo ships, tankers, ferries, fishing vessels, surfboards, canoes, buoys, aquaculture farms, and floating hotels.

Ask students to articulate their understanding of the task/challenge through oral conversation and, if appropriate, a written (scribed) statement.

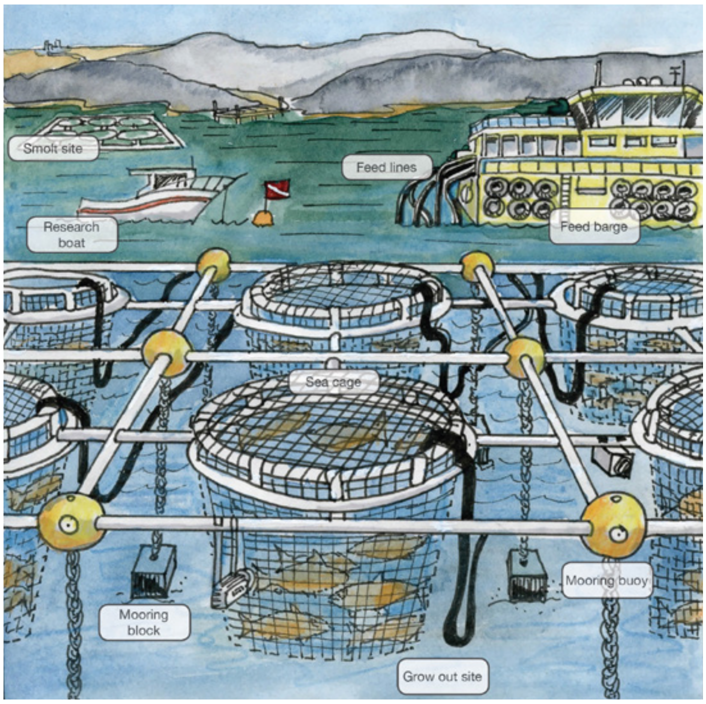
Discover:

Discover ideas about floating and sinking by sharing a story titled 'Who Sank the Boat', by Pamela Allen or watching a video reading on YouTube (2:15 mins) **here**.

As a class, discuss why the boat in the story stayed afloat and then sank.

Brainstorm and record ideas about materials the class thinks will float and sink.

Try some experiments and investigate which materials float and which ones sink. Using a sink, plastic bath, glass aquarium, or large tub filled



with water and random objects, for example, a piece of wood, a carrot, orange, plastic bag, a rock or an inflated balloon, invite students to predict whether each object might float or sink.

Ask students to predict what might happen if they were to push items like the inflated balloon and piece of wood under the water and release them. Invite students to push both items under the water, check their predictions, and see what happens.

Explain to the students that, in the case of the balloon, when you push the balloon underwater and let go, the water pushes the balloon back up. Explain that this is called a 'buoyant force' and that water always pushes up on anything placed in it. Go further and explain that the size of the force on the object depends on how much water the object pushes out of the way.

Ask students to place the piece of wood on the water and push it underwater and explain why it floats on the water. (When it is underwater, the buoyant force on the wood is larger than its weight, so it floats to the surface).

Using some blu-tac or plasticine, go further and invite students to roll a ball and drop this in the water. Make predictions about why it sinks. (This happens because the buoyant force on the ball of plasticine is less than its weight).

Invite students to mould their ball of plasticine into a shape that they predict might float on the water. Create shapes and test them. Determine how buoyant the plasticine shapes are by adding coins, metal washers, or marbles into the shapes.

Talk with the students about the Greek mathematician Archimedes, who was the first person to work out the answer to why things float or sink. Go further and read or view a reading of 'Mr Archimedes Bath' by Pamela Allen on You Tube (3:09 mins) **here**.

Invite students to explore makerspaces with lots of materials, equipment, and tools, where they can explore and design, engineer and build a model of something that floats out on the ocean. Provide students with waterproof materials for testing and elastic bands, tape and string for tying.

Suggestions for makerspaces include:

Makerspace 1- Make a floating raft

Ask students to design a floating raft, combining materials that will float, and to test their designs on watery surfaces.

Ask the students, working in pairs or small groups, to talk about the design features of the different rafts they have made and tested. Ask students to share and compare their findings.

Invite students to justify their findings and discuss ways in which the different materials and their properties used in the design of their rafts enabled them to float.

Makerspace 2- Design a buoy that will remain upright

Makerspace 2 can be set up with upcycled PET bottles, a large tub of water, and a variety of weights including sinkers, blocks of wood, marbles, tape, string and glue. Challenge students to use a PET bottle as a buoy. Then, using weights, design a system that allows the PET bottle to always stay upright in water, even when there are waves or the buoy is pushed over.

Makerspace 3 Design a floating fish farm

Makerspace 3 can be set up with a template (see below) to make a floating fish farm with pipe cleaners, plastic mesh, hessian, balloons, polystyrene, weights, bubble wrap, paper straws, sticky tape, textas, glue and thick card.

Ask students to design and make their fish farm. Image: Courtesy of the Primary Industries Education Foundation Australia (PIEFA).

Makerspace 4- Design a boat using "Minecraft"

Makerspace 4 can be set up with digital devices and the game Minecraft.

Ask students to use their knowledge about boats to create a new world and then design and build a boat in Minecraft.

Challenge students to describe the design features included in their boat.

Makerspace 5 - Design a floating garden

This makerspace can be set up with plastic bottles, plastic containers, pebbles, soil, small plants and tape to make a garden that floats on the ocean.

Makerspace 6 - Design a floating hotel

This makerspace can be set up with waterproof materials, plasticine, elastic bands, tape, string, textas, boxes, cardboard and sponges.

Makerspace 7- Design something that floats with Lego

This makerspace can be set up with Lego bricks and a digital device with the Lego WeDo program.

Challenge students to design and then build something that floats on the ocean with Lego bricks.

Dream:

Ask students to imagine the steps involved in designing their model and a page about what they have learned about things that float in the ocean that will be part of the class book.

Challenge students to think about the materials, tools, and equipment they will need to design their individual work samples.

Design:

Ask students to design their model and the layout for the accompanying page and decide on its title and text.

Ask students to draft their text and plan what illustrations will complement the text.

Invite a peer class group to the class and ask the students to explain their model's concepts and features to this audience and seek feedback on their ideas.

Deliver:

Ask students to make their model and test it and then create their page and what they have learned about things that can float in the ocean.

Prepare a class book of students' work samples.

Visit a local pre-school, kindergarten or day care centre to test the models and share the class book then discuss the facts your students have learned with younger children.

Debrief:

Ask students to recall what fascinating facts about things that float in the ocean they discovered.

Talk about what they might still like to discover and whether there is anything they would like to research or delve into more deeply.

Ask students to imagine ways to improve the design of their models and reflect on possible additional improvements.

Ask students to describe their favourite part of designing, engineering and building a model that floats in the ocean, and sharing it with others as part of National Science Week.

Share photos and students' work samples via National Science Week's online community. The ASTA loves to see pictures of children in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek! Please ensure that you have parental permission prior to posting any images of students.

Curriculum connections

Australian Curriculum: Science (ACARA, 2015a)

Foundation, Year 1 and Year 2

Science as a Human Endeavour—Nature and development of science

Science involves observing, asking questions about, and describing changes in objects and events ACSHE013 ACSHE021 ACSHE034

Foundation

Science Inquiry Skills

Respond to questions about familiar objects and events ACSIS014

Participate in guided investigations and make observations using the senses ACSIS011

Engage in discussions about observations and represent ideas ACSIS233

Share observations and ideas ACSIS012

Physical Sciences

The way objects move depends on a variety of factors, including their size and shape ACSSU005

Year 1

Science Inquiry Skills

Respond to and pose questions and make predictions about familiar objects and events ACSIS024

Participate in guided investigations to explore and answer questions ACSIS025

Use informal measurements to collect and record observations, using digital technologies as appropriate ACSIS026

Use a range of methods to sort information, including drawings and provided tables, and through discussion, compare observations with predictions ACSIS027

Compare observations with those of others ACS213

Represent and communicate observations and ideas in a variety of ways ACSIS029

Year 2

Science Inquiry Skills

Pose and respond to questions and make predictions about familiar objects and events ACSIS037

Participate in different types of guided investigations to explore and answer questions, such as manipulating materials, testing ideas, and accessing information sources ACSIS038

Use informal measurements in the collection and recording of observations, with the assistance of digital technologies as appropriate ACSIS039

Use a range of methods to sort information, including drawings and provided tables ACSIS040

Compare observations with those of others ACSIS041

Represent and communicate observations and ideas in a variety of ways, such as oral and written language, drawing and role play ACSIS042

Physical Sciences

A push or a pull affects how an object moves or changes shape ACSSU033

Technologies (ACARA, 2015b)

Foundation, Year 1 and Year 2

Design and Technologies Knowledge and Understanding

Explore how technologies use force to create movement in products ACTDEK002

Design and Technologies Processes and Production Skills

Explore needs or opportunities for designing and the technologies needed to realise designed solutions ACTDEP005

Generate, develop, and record design ideas through describing, drawing and modelling ACTDEP006

Use materials, components, tools, equipment, and techniques safely to make designed solutions ACTDEP007

Use personal preferences to evaluate the success of design ideas, processes and solutions, including their care for environment ACTDEP008

Sequence steps for making designed solutions and working collaboratively ACTDEP009

General Capabilities:

Literacy, Numeracy, ICT capabilities, Critical and creative thinking, Personal and social capability, and Ethical understanding.

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

The Seabin Project

In 2005, two Australians, Andrew Turton and Pete Ceglinski, designed a prototype of a floating ocean garbage collecting 'Seabin'.

View a **video** on YouTube (4:06 mins) and learn more about the Seabin Project, the design used, and how it works.

World Fisheries Film Festival 2020

The World Fisheries Congress held every four years brings together some of the best fisheries scientists from across the globe. Its goal is to share a diversity of knowledge, interests and culture.

The Fisheries Research Development Corporation (FRDC) is coordinating a short film festival, using the conference as a way to focus a global conversation on fisheries and the role they play in the lives of millions of people.

The focus for the content generated out of the World Fisheries Film Festival revolves around the four-core conference themes:

- Sustainable fisheries (assessment, regulation, enforcement)
- Fish and aquatic ecosystems (biodiversity, conservation, ecosystem function)
- Fisheries and society (contributions to sustainable development)
- Future of fish and fisheries (innovations in fisheries)

The festival invites schools from around the globe to undertake research on fisheries, then develop and submit a short film (1-2 minutes). A key component is that each film should relate to fisheries in their community or how fisheries influence or are part of relate to their community.

Activity 3: Learn about density and make saltwater jars

Your challenge is to demonstrate that salty water is denser than freshwater.

Be creative and design and make saltwater jars.

You will need:

- two cups of water;
- two same sized (identical) glass jars;
- water;
- half a cup of salt;
- red and blue food colouring; and
- a spoon.

What to do

Make predictions about which would be heavier (more dense), freshwater or saltwater.

Test ideas by adding some blue food colouring to one of the cups of water. Stir it with the spoon until the water is completely blue.

Repeat this by adding the red food colouring to the other cup of water and use the spoon to stir it.

Add the salt to the red water and stir it to help the salt dissolve.

Pour half of the blue coloured water into one of the glass jars and half of the red salty water into the other jar.

Slowly top up the jar containing the blue water with the remaining red coloured water.

Then, carefully and slowly pour the rest of the blue water into the jar containing the red salty water.

Without disturbing either jar, place lids on the jars and let them stand for a while.

Observe what happens.

Document your project from start to finish using a video camera and share your video as part of National Science Week.

How it works

Adding salt to the water makes it denser. In this activity, the 'red' water contains the salt, and when it is poured on top of the 'blue' water, it sinks through and the colours mix.

When the solutions are poured the other way around (the 'red' before the 'blue'), the non-salty water floats on top because it has been placed on a liquid with a higher density.

HAVE A GO AT THIS!

Activity 4: Design and create an ocean habitat

What might fish, octopus, turtles, clams, crabs, jellyfish, seals, dolphins, sharks and other ocean creatures need to be safe and healthy?

Ocean creatures need to have shelter, food to eat, and clean seawater in which to live.

Your task is to imagine what their sustainable habitat might look like.

Your group can write and draw, record and video, or design and make a model of the sustainable ocean habitat, accompanied by a text about what your chosen ocean creature might need, now and in the future, to grow and survive in the ocean.

Remember, some ocean creatures like to swim in the ocean, others live in rock pools, and some live in seagrass meadows, while others live in reefs in the ocean.

Your group might like to read a **story** about ocean creatures, read a Torres Strait Islander story about '**Dhyum the Dugong**', view **images** or download and view an AUSMEPA **PowerPoint presentation** that features a range of ocean creatures before deciding which ocean creatures to include in your ocean habitat.

Your task is to imagine what their sustainable habitat might look like.

Your group can write and draw, record and video, or design and make a model of the sustainable ocean habitat, accompanied by a text about what your chosen ocean creature might need, now and in the future, to grow and survive in the ocean.

Think about whether a sustainable habitat would be polluted or pollution free.

Did you know that the largest threat to the two species of manta ray, the giant manta (*Manta birostris*) and reef manta (*Manta alfredi)* is the destruction of their habitat due to pollution and fishing?

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

Dugongs and Seagrass Watch

The dugong (*Dugong dugon*) is an herbivorous marine mammal dependant on seagrass for food. It lives in shallow waters along some coastlines that have seagrass meadows. Habitat degradation, vessel strikes, water pollution, fishing-related fatalities and hunting are the main cause of the dugong's decline. Seagrass meadows are diminishing around the world, principally as a result of nutrient runoff from the land which stimulates algal growth and in turn reduces the ability of seagrass to photosynthesise. Learn more about **Seagrass Watch** the largest scientific, non-destructive, seagrass assessment and monitoring program in the world. Read about the monitoring that is currently occurring at over 205 sites, and numerous sites exist along Queensland's coastline.

Learn about how Seagrass-Watch raises awareness about the condition and trends in near shore seagrass ecosystems and provides an early warning of major coastal environment changes.

Activity 5: Create a 3D ocean creature using Quiver

Have you ever used an augmented reality, colouring program to make things come alive with 3-dimensional features, movement and colour?

Download the **Quiver Education app**, use cutting-edge colour technology and experience an augmented reality colouring experience.

Locate the sea turtle and sea-related pages and colouring packs, colour them in, print them and use the Quiver Education app to bring them to life.

Try to act out how your creature moves. Ask other students to work out what kind of animal is being acted out.

Create a National Science Week Quiver Festival for others to attend, see and enjoy.

(Note the app is free and some colour-in packs require a one-time purchase but there are some free marine-themed images available to download.)

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

Thumbs up for Turtles

Did you know that of the seven sea turtle species that six are listed as either critically endangered, endangered or as vulnerable? In Australia it is the Flatback Sea Turtle that is considered vulnerable. Sea turtles face many threats, including the degradation of their nesting beach habitats, pollution, entanglements in nets, bycatch in commercial fisheries and global warming.

Discover more about Jane Goodall's, "Roots and Shoots" youth-led program **Thumbs up for Turtles** campaign that aims to raise awareness about the impact of our waste footprint and promote solutions to minimise our impact on the oceans.

Activity 6: Let's create and make

Use the National Science Week **Science Activity Characters** (you will need to scroll to the bottom of this web page) and create a range of art samples to celebrate the ocean as part of National Science Week.

Create a visual for the ocean that connects people to the ocean's incredible beauty that is visible in the worlds beneath its surface.

How might you use this character?

HAVE A GO AT THIS!

Activity 7: Write it up

View the Oscar Winning short movie **Piper** on YouTube (3:20 mins) about a baby sandpiper shorebird that has a fear of the ocean. Ask students to think about whether they think the baby sandpiper took more than it needed for a feed?

Drag and drop the National Science Week **Science Activity Characters** into a storyboard. Choose a character and write a story about how they might find a solution for an ocean animal or plant.

You can also download and print **outlines of the National Science Week characters** to colour.

For the

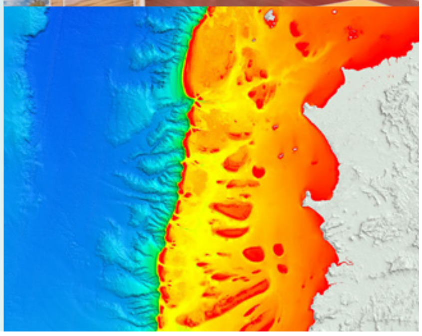
Primary Years of Schooling

Years 3–4

Australian Government
Geoscience Australia

EDUCATION PROGRAM

GA PP-3352



At Geoscience Australia we use a range of technologies to map and understand the ocean floor. We also educate and engage the next generation of marine geoscientists through an exciting range of activities and classroom resources.

In the month of August 2020 our marine scientists will be at sea on a voyage of discovery to the Coral Sea aboard RV *Falkor*.

We will be mapping submarine canyons and undersea landslides; deploying underwater video and robots to collect samples and images of the seafloor; and discovering deep sea habitats and lifeforms.

Follow us on Facebook to stay updated on how you can join us exploring the depths of the Great Barrier Reef and remote reefs and canyons of the Coral Sea Marine Park.

You'll also find great earth and marine science resources, along with our student and teacher programs online.

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Learning Experiences for **Year 3 and Year 4**

Activity 1: Cleaning up the oceans

Overview: *Explain to the class that their task is to help others understand the effects of pollution and waste in our oceans and empower them to know what they can do to help the oceans.*

Background Science for Students: Water pollution

Pollution is the introduction of harmful materials into the environment. Water pollution is when waste, chemicals, or other particles cause a body of water (ie. oceans, rivers, lakes, wetlands, etc) to become harmful to the fish, animals, reefs, and plants that need the water to survive. Water pollution can also have damaging and disruptive impacts on the natural water cycle.

Most people are affected in some way by water pollution in oceans and beaches. However, fewer people are aware of the many sources of water pollution.

Human causes of water pollution

A lot of water pollution comes from human activity. Some human causes include that which is washed into stormwater drains that lead to rivers and the sea. Other causes include pesticides, insecticides, herbicides and fertilisers from farms, wastewater and poisonous chemicals from factories, schools and offices, silt from construction sites, and rubbish from people littering which gets washed into dams, rivers and the sea after rain.

In the oceans, a lot of pollution comes from things that are thrown overboard from boats and by rubbish that washes into the ocean from the land and from rivers. Plastics, fishing line, fishing nets, and other wastes can affect the creatures living in our oceans.

Plastic pollution is considered in the top three dangers to a continuing healthy ocean.

The thoughtless disposal of manures, fertilisers, and toxic or hazardous waste is a serious problem because these chemicals can cause pollution, even if they are in small quantities in waterways or stormwater drains that feed into our oceans.

Industry is not permitted by law to discharge materials or chemicals directly into waterways, the stormwater system, or the oceans. However, many industries are allowed to dispose of materials or chemicals into the wastewater system. They must do so under strict guidelines.

Natural causes of water pollution

Sometimes water pollution can occur through natural causes, like volcanoes, algal blooms, animal waste, and silt from storms and floods.

The essential question:

What happens when we understand that are our oceans are under stress from pollution?

The scenario:

The National Science Week is looking for innovative ideas to help others understand the effects of pollution and waste in our oceans and empower them to know what they can do to counter those effects.

What science investigations can assist you in your mission to leave our ocean waters in a better condition than we find them today?

Your challenge is to help others understand the effects of pollution and waste in our oceans and empower them to know what they can do to help. Will you design an experiment, animation, or digital science presentation? Are you up for the challenge?

If so, then National Science Week would like you to celebrate clean water and host a 'Clean and Sustainable Oceans Day' as part of National Science Week.

A suggested learning process:

Define:

Share the essential question with the class and talk about the need to have clean, healthy water in our oceans.

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

Discover:

Capture student's interest and read **Alba the One Hundred Year Old Fish** by Libby Hawthorne. It tells the story of a beautiful coral reef that becomes a littered graveyard. Alba the fish becomes stuck in a plastic bottle and is saved by a little girl who recruits her community to clean up the ocean and release Alba.

Locate where water can be found in the classroom area. Talk about what it is used for, e.g. washing hands, cleaning paint brushes and paint containers, making glue, cooking, watering plants, watering classroom animals, etc. Talk about how water is used outdoors eg. washing cars, watering lawns and gardens, washing windows, etc.

Go on a drain hunt. Find drains that take water into the stormwater system and out to the ocean. Talk about the water that goes down the drain in and around the school grounds and local area. Discuss how water pollution here affects others downstream, and how pollution upstream affects you.

In pairs or small groups, talk about the ways the class can be more careful of what is allowed to be washed down outside drains and care for their oceans. Encourage pairs or small groups to report back their ideas.

Collate ideas. For example:

- Ways we can care for the ocean by:
- Scrape left-over paint back into paint pots and not wash paint brushes near drains.
- Wash cars on lawns.
- Sweep leaves away from gutters and use them as mulch.
- Put litter in a bin.
- Pick up after our dogs and compost doggy poo.
- Reuse plastics.
- Stop releasing balloons.
- Never dispose of oil or chemicals down the gutter or into a drain.
- Identify areas in and around the school and children's homes where water is found.
- Discuss any environmental issues connected with those areas.

Draw cause and effect charts to show the issue and the problem. For example: drains (insert arrow) blocked with leaves and litter (insert arrow) polluted water that can flow to the ocean.

Download the **AUSMEPA PowerPoint presentation** about pollution in the ocean and discover more about stormwater discharges with litter, plastics, oil, chemicals, fertilisers and dog poo and their effects on marine animals and birds.

Talk with students about what happens to leaves, plastics, and other types of litter that are washed into drains. Follow their path to the ocean. Simulate what happens and immerse leaves, plastics, paper, aluminium, bread, fruit peel and litter in buckets of water. Leave them outside in the sun and overnight for a week or so and observe what happens. Download the **AUSMEPA 'My Stinking Experiment' file** and record observations and findings.

Brainstorm ways the class could get involved in activities for the protection of the ocean environment, e.g. sweep gutters and asphalt, collect leaf litter, compost leaf litter, collect litter and recycle.

Set up teams of Gutter-Guardians and Litter-Busters to ensure all street gutters near the school and drains in the school grounds are cleared and litter is collected, sorted and disposed of wisely during and after play periods.

Think of ways to refuse using plastics at school, for example, plastic free lunches.

Discuss the environmental issues affecting the ocean and possible ways to solve the problems.

Talk more about how plastics are affecting the oceans.

Introduce students to **Molly Steer**, a Year 4 student from Cairns in North Queensland who has started a campaign called 'Molly's Straws No More'. It all began when Molly and her mother saw a film **Plastic Ocean** (1.05 mins).

View a **video** on YouTube (1.26 mins) and discover nine ways we can all help reduce plastic pollution.

Introduce a range of innovations that are currently helping to clean up our oceans and make them more sustainable. Introduce the **Seabin Project**, where two Australian surfers have designed and engineered a floating bin that can capture thousands of pieces of floating debris and plastics.

Introduce **Boyan Slat**, a young innovator, and discover his Ocean Cleanup prototype that promises to clean up the ocean.

Learn about what we can all do to reduce micro-plastics from the ocean. Watch a **video** (3:10 mins) and hear from high school students who won the 2019 Eureka prize.

Introduce Jane Goodall's "Roots and Shoots" youth-led campaign called **Thumbs up for Turtles** that aims to raise awareness about the impact of our waste footprint and promote solutions to minimise our impact on the oceans. Read about the things we can do to reduce plastic and protect our oceans **here**.

Dream:

In pairs or small groups, envision or dream about the many possible solutions to pollution problems in our oceans.

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.

Remind students that their solution needs to explain the effects of pollution and waste in our oceans, as well as empower others to know what they can do to help.

Record a video, sing a song, or read an announcement to explain this.

Design:

Invite students, in pairs or small groups, to begin drafting their designs for their solutions.

Ask students to draft the steps involved in making their 'Clean and Sustainable Oceans Day' item.

Ask students to gather the materials, tools, and equipment needed and then design and create the solution.

Invite a peer class group to the class to find out more about the effects of pollution and waste in our oceans and know what they can do.

Deliver:

In pairs or small groups, showcase the creations and associated messages explaining the effects of pollution and waste in our oceans and what others can do to ensure clean and sustainable oceans.

Share photos and students' work samples via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of children in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek! Please ensure that you have parental permission prior to posting any images of students.

Debrief:

Ask students to reflect on their learning and something they learnt that was new.

Ask students to describe what worked well and not so well in their efforts to create a solution to pollution problems in our oceans.

Photo: Bob Winters

Curriculum connections

Australian Curriculum: Science (ACARA, 2015a)

Year 3 and Year 4

Science Understanding—Biological sciences

Living things depend on each other and the environment to survive ACSSU073

Science as a Human Endeavour—Nature and development of science

Science involves making predictions and describing patterns and relationships ACSHE050 ACSHE061

Science as a Human Endeavour—Use and influence of science

Science knowledge helps people to understand the effect of their actions ACSHE051 ACSHE062

Science Inquiry Skills

With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge ACSIS053 ACSIS064

Represent and communicate observations, ideas, and findings using formal and informal representations ACSIS060 ACSIS071

Technologies (ACARA, 2015b)

Year 3 and Year 4

Design and Technologies Knowledge and Understanding

Investigate the suitability of materials, systems, components, tools, and equipment for a range of purposes ACTDEK013

Design and Technologies Processes and Production Skills

Generate, develop, and communicate design ideas and decisions using appropriate technical terms and graphical representation techniques ACTDEP015

Select and use materials, components, tools, and equipment using safe work practices to make designed solutions ACTDEP016

Evaluate design ideas, processes, and solutions based on criteria for success developed with guidance and including care for the environment ACTDEP017

Plan a sequence of production steps when making designed solutions, individually and collaboratively ACTDEP018

General Capabilities:

Literacy; Numeracy, ICT capabilities, Critical and creative thinking, Personal and social capability.

Cross Curriculum Priority:

Sustainability.

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

Kreative Koalas

Learn about a new school program that inspires schools to reflect on global sustainability issues and view a video that showcases how fibreglass koalas can spread the word about what we all can do to protect our planet, including the oceans.

View the **video** (from the start to 2:17 mins) and discover what they did.

School leaders

Watch the video '**Tangalooma EcoMarines, Bulimba State School**' on YouTube (2:00 mins) to find out what this Queensland primary school does to enhance the ocean environment of Moreton Bay.

Watch the video '**Student Dedication**' on YouTube (1:52 mins). Bulimba State School students demonstrate and discuss the ways they reduce, recycle, recover, rethink and remanufacture waste at their school.

Warrnambool East Primary School

Using the natural surroundings and involving the wider community in learning about the environment is a key part of sustainability at **Warrnambool East Primary School**. The school teaches sustainability from Prep to Year 6 and works with experts in the community to provide fun environmental education. The Inspiring Young Scientists program, recognised with the Victorian Education Excellence Award, offers real-life learning experiences with Deakin University students. The Marine Entanglement Community Action Day gathers the broader community around workshops, such as constructing reef ecosystems, beach clean-ups and sorting marine debris.

Activity 2: Design an underwater exhibit

Overview: *Explain to the class that their task will be to investigate the living and non-living things in our oceans and use science, technology, and art to design an underwater exhibit of things they have identified as either living or non-living.*

Background science for teachers and students: Life in the oceans

From the seashore to the deepest depths, oceans are home to the most diverse life on Earth.

Mammals: There are many mammals that live in the ocean, and these include dolphins, seals, walruses, whales, porpoises, manatees and dugongs. They all come up to the surface to breathe air and, like mammals on land, they give birth to their young.

Reptiles: Reptiles can be found in the sea although only in warm waters. These include turtles, sea snakes, crocodiles and iguanas. Like mammals they need to come to the surface to breathe.

Fish: Animals with fins, and one or more gill openings are called fish. Fish with bony skeletons are called ray-finned fishes because of the thin bones in their fins. Seahorses are tiny ray-finned fishes, but have horse-shaped heads and a curly body. Fish that have skeletons, made of cartilage, with thick fins, and more than one gill opening, include sharks, skates and sting rays.

Echinoderms: Echinoderms are spiny-skinned animals (*echino*=spikes, *derm*=skin); they have no brain, however they have complex sensing organs. Sea stars, sea urchins, and sea cucumbers are all echinoderms.

Arthropods: The group with most numbers of species on Earth is the arthropods. On land this includes spiders, insects, and scorpions, but in the sea there is a smaller sub-group called crustaceans which includes crabs, lobsters, prawns, shrimp, krill, and barnacles. They have hard skeletons on the outside of their bodies. Prawns, krill, and shrimp can swim, while most lobsters and crabs walk, scuttling along the ocean floor.

Molluscs: The group with most numbers of species in the sea, and thus greatest diversity, is the molluscs. These soft-bodied animals include sea snails, sea slugs, squid, octopuses, cuttlefish, and clams. Many live inside shells such as whelks, limpets, top shells, winkles, cowries, and cone shells. Some can be found in rock pools, and shallow water or hold fast to rocks. They can survive when exposed as the tide goes out, while others live on the ocean floor. Mussels, oysters, clams, scallops, and cockles have two shells enclosing their bodies, and breathe with the help of gills hidden inside the shell. In contrast, the highly colourful nudibranch sea slugs have feather-like gills (or “branchi”) that are exposed on their body (or nude), hence the name nudibranch. Squid, cuttlefish, and octopuses are also molluscs, and have long tentacles with suckers to grab their prey.

Cnidaria: Jellyfish, sea anemones, and coral belong to the group Cnidaria which means “nettle” because they have stinging tentacles to catch their prey. Jellies are often shaped like a bell which, when flexed, propels them through the water. Sea anemones mostly stay stuck to a hard surface. Corals build their own hard surface which becomes an important reef habitat for other animals. Some animals look like plants. Sponges, for example, are marine animals, but do not have eyes, ears, a head, arms or legs. Their bodies have thousands of pores that help them to filter food from the ocean water.

Non-animals in the ocean include algae (or seaweed) which can range from small clumps on rocks to tall forests of kelp. Seagrasses are flowering plants. Algae and seagrass need sunlight to survive, and they provide food and homes for many animals.

Plankton: Many people are confused about plankton. It is not a single group of animals, but rather a mixture of microscopic and macroscopic algae, bacteria, plants, and animals that are unable to swim against the current. They are most abundant near the surface but can be found throughout the ocean depths. Animal plankton are called zooplankton, and many are simply babies (or *larvae*) of much larger animals. The plant-like plankton, that need sunlight to survive, are called phytoplankton, and are the start of the marine food chain. Plant-like bacteria in the phytoplankton called *Prochlorococcus* is thought to be the most abundant single species of life in the ocean, and thus on Earth, and there are probably upwards of three octillion individuals. That’s three followed by twenty-seven zeroes!

There are also many **non-living things** in the ocean including sunlight, oxygen, carbon dioxide, water, salt, rocks, sand, volcanoes, and black smokers.

The essential question:

How can we investigate and understand more about oceans and the many living and non-living things in and on them?

The scenario:

Oceans play an important part in controlling the climate and weather, as well as providing us with food, energy, fuels, minerals, routes for communication and transport and, of course, a large area for recreation. The oceans and their wildlife have provided us with myths and legends and subjects for stories, painting, music and poetry.

Your challenge is to design an exhibition piece for an underwater museum display that explores the living or non-living things that can be found in the ocean.

How might you design an underwater exhibit of things you have identified as either living or non-living? How might you decide what to include? What could you put in your own exhibition piece so that other people could understand more about the ocean?

How might you anchor your design pieces? What materials will they be made of so they don’t corrode or dissolve in sea water?

A suggested learning process:

Define:

Capture students’ interest by recalling exhibits they all really liked.

Talk about what made the exhibits interesting and so memorable.

Use **Pinterest** to find exhibits and displays made by students and discuss their features.

Make a list of the features of exhibits the students like.

Invite students to recall the focus of the exhibit they have been invited to design and create.

Find out what students already know about the ocean. Ask students to draw or write (or both) a picture about what they know about the ocean. This may simply be about an animal they know that lives on or in the ocean or an object that is used on or in the ocean.

Use these drawings/writings to start a class ocean display. Encourage students to add to this display throughout the unit and ensure students understand the ocean is a multiple use area.

Talk with students about the words ‘living’ and ‘non-living’. What do the words mean?

Ask students to share what they know about any of living and non-livings things that we might find in the ocean.

Assign groups and provide each group with a large sheet of paper with one of the questions below. You may change these questions, add more, or take some away according to number of groups and to suit the needs of the class. Read the questions and explain any difficult words but do not discuss the questions.

- What different animals live on or in the ocean?
- What different plants live on or in the ocean?
- Give examples of non-living things on or in the ocean.
- Give examples of how sea animals use living and non-living things to help them survive on or in the ocean.

Ask students what they might need to know more about in order to undertake the challenge that has been set. Might they need to know something about animal and plant species that live in and on the ocean? Might they need to know something about how the ocean is used for food, energy, fuels, minerals, transport, communication and recreation? Might they need to think about objects for their exhibition piece that can survive the effects of saltwater? Could they actually create their exhibition piece using their digital devices? Could they create their exhibition piece using other materials and tools?

Discover:

View the video **Oceans of the World for Kids** on YouTube (8:43 mins) about the world’s oceans. As a class, talk about and describe what the ocean contains.

View online galleries of images of the ocean with examples of living and non-livings things in it and on it and make lists of students’ comments and questions. These could be presented as a table under the headings “What we know”, “What we are not sure about”, and “What we want to know”.

Introduce ‘STEM Story time’ and share nonfiction stories about the Earth’s oceans. The following are examples that can be used.

- **Seas and Oceans** *by Issi Howell.* This book features real photographs and photo illustrations accompanied by a paragraph per page. The book describes what an ocean is, what its waves are, what lives on the ocean floor, in tropical oceans, polar oceans, and temperate oceans, and how we use the ocean.
- **What Lives in the Sea?** *by Australian Geographic.* This book helps students understand the many creatures that live in the sea, the way they catch prey and protect themselves from enemies.
- **Ocean** *by Emmanuelle Grundmann.* This book is filled with clever cut-outs exploring the ocean, from the shoreline to the murkiest depths.
- **Oceans and Seas** *by Margaret Hynes.* This book includes images and information about both living and non-living things found in and on our oceans.

After sharing and reading stories, talk about what students now know about the Earth’s oceans and the living and non-living things found in or on it

Ask students to identify similarities and differences between living and non-living things. Discuss things the students were not sure of. Discussion questions can include:

- What similarities are seen among living things?
- What do all living things seem to do? (discuss growing, moving, reproducing and response to stimuli, eg. light or touch)
- Is there anything that was once living? What does once living mean?
- Is there anything that was never living?

As a class, decide on a definition for the terms living and non-living and display these in the classroom.

In groups, look at **images** of different shapes of ocean plants and animals. Ask students to make and record observations about three animals and plants.

Introduce plants like seagrass, seaweed and kelp. View **images** of these ocean living plants, undertake some picture research, and ask students to make observations and describe their features. Ask students to draw the ocean plants that might feature in their underwater exhibit. Discuss these plants’ features and whether they are living or non-living.

Brainstorm the range of non-living things that could be found on the ocean, eg. fishing nets, fishing line, plastics, boats, buoys, oil rigs, wind turbines, jetties, ferries, or fish farms. Locate images of non-living things found in oceans **here**.

Visit the library or use the class iPads and ask students to research living and non-living things found in or on the ocean.

Introduce the **Museum of Underwater Art** (MOUA) and the Great Barrier Reef’s first **underwater sculpture and marine education trail**. Invite students to view the different exhibition pieces, identify whether they are living or non-living, and explore the materials used to create them.

Invite students to start brainstorming the types of materials they might use in their underwater exhibits.

Remind students that seawater is salty and may therefore have an effect on some types of materials.

Undertake a range of **coin corrosion activities** in the class using Coca Cola, lemon juice, salty water, and vinegar solutions and ask students to place coins and nails in each solution and observe any changes in the metals. This activity can also use lemon juice and seashells.

Using iPads, students can also walk around the school taking photographs of corroded things, compare them, and discuss why they have corroded.

Ask students to think about the natural and processed materials they might use to design and create their underwater exhibit.

Invite students to sketch a plan of what their exhibit might contain and look like. Ask students to consider the placement of their living or non-living objects within their exhibits.

Share the students’ understandings with others. For example, ask students to share what they have been learning about with family members at home.

Dream:

Revisit sketches and ask students to think about the story their exhibit might tell others about living or non-living things on or in the ocean.

Look at ways that museums display exhibition pieces. Using digital devices, revisit underwater museums and think about how to display the exhibit.

View a **video** on YouTube (2:16 mins) that shows one way of representing the ocean in a bottle, complete with waves.

Talk about colour and how students can use it to bring their exhibit to life. Introduce glow in the dark paint for exhibits that might be kilometres down on the ocean floor.

Talk about how digital tools and devices can also be used to design and create the exhibits.

Ask students to visualise their exhibit. What features might they include?

Challenge students to think about the materials, tools, and equipment they will need to create their exhibit and how they might present it.

Design:

Ask students to describe the features and purpose of their exhibit of things they have identified as either living or non-living in or on the ocean.

Review rules on personal safety, group safety, and classroom and furniture safety with the students.

Ask students to establish a workstation and to gather the materials and tools they require.

Talk about safely storing their exhibit and keeping a record of the processes they undertake.

Ask students to apply what they have learned about living and non-living things in the ocean and to create their exhibit.

Invite families and friends to the class and share the process used to create the exhibition pieces they have identified as either living or non-living in or on the ocean.

Deliver:

Ask students to share ideas about how they are going to deliver their exhibit that features either living or non-living things in the ocean and ways to protect the ocean.

Ask students to share and explain their exhibit during National Science Week.

Share photos and students' work samples via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of children in the classroom learning and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek! Please ensure you have parental permission prior to posting any images of students.

Debrief:

Ask students to talk about the processes they used to create their underwater exhibit.

Invite students to evaluate their exhibit and write three sentences about the tasks that were involved. Ask them to include details of the quality of their research and planning, their finished exhibition piece, and whether they enjoyed the task.

Invite others to critique the exhibits. Did they communicate living or non-living things that can be found on or in the ocean?

Curriculum connections

Technologies (ACARA, 2015b)

Year 3 and Year 4

Design and Technologies Knowledge and Understanding

Recognise the role of people in design and technologies occupations and explore factors, including sustainability, that impact the design of products, services, and environments to meet community needs ACTDEK010

Design and Technologies Processes and Production Skills

Generate, develop, and communicate design ideas and decisions using appropriate technical terms and graphical representation techniques ACTDEP015

Select and use materials, components, tools and equipment using safe work practices to make designed solutions ACTDEP016

Evaluate design ideas, processes, and solutions based on criteria for success developed with guidance and including care for the environment ACTDEP017

Plan a sequence of production steps when making designed solutions, individually and collaboratively ACTDEP018

Science (ACARA, 2015a)

Year 3

Biological sciences

Living things can be grouped on the basis of observable features and can be distinguished from non-living things ACSSU044

Year 4

Chemical sciences

Natural and processed materials have a range of physical properties that can influence their use ACSSU074

Year 3 and Year 4

Science as a Human Endeavour—Nature and development of science

Science involves making predictions and describing patterns and relationships ACSHE050 ACSHE061

Science as a Human Endeavour—Use and influence of science

Science knowledge helps people to understand the effect of their actions ACSHE051

General Capabilities:

Literacy; Numeracy, ICT capabilities, Critical and creative thinking and personal and social capability.

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

Oysters making reefs

Discover how the environmental group, the Nature Conservancy, has partnered with Melbourne restaurants, wholesalers and markets to use **recycled shells to restore reefs**, aiding water quality and potentially reviving angasi stocks. Over the past two years, an Melbourne Cricket Ground sized area of oyster reef has been created in the bay through a program called "Shuck Don't Chuck". The restored sites are in Hobson's Bay off St Kilda, and Wilson's Spit off Geelong. The project uses discarded oyster and mussel shells from restaurants to regenerate the bay's reef ecosystem, half of which was once covered by shellfish reefs.

REDMAP

Learn about a citizen science program called **REDMAP** that invites Australians to share sightings of marine species that are 'uncommon' to their local seas.

Operation Posidonia

Discover more about restoring underwater seagrass meadows **here**.

AUSMAP

View a **video** (1:41 mins) and find out about the citizen science program that is mapping micro-plastics around Australia.

Saving Turtles

Read about the **Indigenous Rangers in Cape York** who are working with a CSIRO scientist to protect baby turtles from feral animals and ensuring they hatch safely and reach the ocean.

Activity 3: Design and make a model sailing boat

Sailing boats use the energy of the wind to move. Can you design a boat with a sail that is moved by the wind?

Your challenge is to design the boat with a mast and a sail.

Try making boats from a range of different materials and experiment with a variety of sail shapes.

- What materials could you use for the boat?
- What is the best shape for a boat that will stay afloat?
- What is the best shape for a boat to help it travel efficiently on water? Does altering the boat's shape improve its performance?
- How do we keep the boat upright?
- How can the mast and boom be secured?

Research sailing boats and sail shapes. Which is the best shape and size for a sail?

Learn about a program in the USA called **Educational Passages** where autonomous student-built sailing boats are released into the sea and tracked via satellite. Their positions can be viewed on the website.

Watch videos about the science of sailing such as: **The trigonometry of sailing** on YouTube (4:34 mins) and **Wind Velocity and Sailing** (4:02 mins).

Build your boat and experiment with a variety of sail shapes.

Then, test the sails by placing the boat in a container of water and simulate the wind by blowing on the sail, using a paper drinking straw. Undertake a second test using a handheld battery powered fan and compare your results.

Can you make the boat sail in different directions? Can you make it sail in a circle?

Can you make the boat travel from one place to another and return to its starting point?

Can you design and make a catamaran, a trimaran, or an outrigger canoe...or a balloon or elastic band powered boat?

Hold a Boat Show during National Science Week and demonstrate what your boat can do.

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

Boats

Learn about some of the most **innovative sailboats** and discover their design features.

Discover more about **electric boats** and explore their innovative features.

Activity 4: Ocean energy

Did you know that about one-third of the world's total reserves of oil and gas lie offshore below the ocean's surface?

The oceans are also a source of energy because the ocean's wind, waves, heat, and tides can all be harnessed to drive electricity generators.

These types of renewable energy sources are very important for our sustainable future.

Your challenge is to think like an engineer and design and make a model of an offshore wind turbine.

Have you ever seen an offshore wind farm in the ocean?

There are many in the oceans around northern Europe, and the first offshore wind farm in the southern hemisphere is being built off the Victorian coast.

Wind turbines use large blades which catch the wind. When the wind blows, the blades rotate, driving a generator that makes electricity. The stronger the wind, the more electricity is produced. Offshore wind turbines tend to generate more electricity than onshore turbines because winds on the ocean are usually stronger than those on land.

Check out some images of offshore wind farms **here**.

What materials might you use? Can you make a model using paper straws, icy pole sticks, long bamboo skewers, recycled milk cartons, aluminium cans, plastic bottles, plastic spoons, paper cups, corks, modelling clay, glue, or sticky tape?

Photo by Nicholas Doherty on Unsplash

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

Offshore renewable energy systems

The Blue Economy CRC located in Launceston aims to identify, and develop offshore renewable energy systems and devise new solutions that can meet our energy demands. Learn more about what it aims to do **here**. Listen to an ABC Future Tense podcast about offshore architecture and a range of perspectives about a blue economy **here**.

HAVE A GO AT THIS!

Activity 5: Responsible fishing

People go fishing for many different reasons eg. food, enjoyment, work, and income.

Your challenge is to design a game to educate others about responsible fishing.

Did you know that people can make sure they fish responsibly by:

- taking only what is needed;
- catching and releasing their fish if they have enough for a meal;
- making sure they don't keep undersized fish;
- if unsure of the fish species or size, releasing the fish immediately, removing fish from the hook or net immediately and killing it humanely if keeping it;
- cleaning up all fishing gear (eg. discarded tackle and line, and bait bags), and taking these items back to shore to dispose of properly;
- placing other people's discarded fishing gear and litter in bins;
- abiding by the fisheries regulations in the state they live in;
- reporting any suspected illegal fishing activity; and
- reporting fishing breaches to the Fishwatch hotline on 1800 017 116.

Check out one type of **fishing game** and then experiment with your game design ideas, troubleshoot the design challenge, flow chart your ideas, document your process, and design a solution.

Share photos and students' work samples via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of children in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek! Please ensure that you have parental permission prior to posting any images of students.

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

Fair Fish

Discover an innovative way of delivering fresh fish that is available to customers in South Australia. Learn about how **Fair Fish** enables customers to buy a share of a fisherman's catch and how they are introduced to some of the more underutilised fish found in the ocean.

Fish surveying

Discover how students at Cocos Island District High School built a **Baited Remote Underwater Video (BRUV)** platform to conduct fish surveys in their lagoon for Science Week in 2016.

Go further and view some **BRUV footage** from the Woodbridge School Marine Discovery Centre in Tasmania.

HAVE A GO AT THIS!

Activity 6: Design a fish farm

In Australia, there are commercial fishers who supply wild-caught fish for domestic consumption and export, and recreational fishers who catch fish for personal eating and recreation.

There are also many aquaculture and fish farmers who farm fish for our consumption. There are a range of aquaculture production systems where some kinds of shellfish and fish are farmed in ponds, pens, tanks, cages, baskets and racks.

Your challenge is to research what fish farms look like and the technologies they use to raise, feed and grow shellfish or fish like salmon, trout and tuna.

Then design a floating fish farm and make a model with pipe cleaners, plastic mesh, hessian, balloons, polystyrene, weights, bubble wrap, paper straws, sticky tape, textas, glue and thick card.

Decide which criteria will be used in your fish farm. Will your fish farm:

- Make it easy to catch the fish?
- Be seal proof?
- Have plenty of water circulation?
- Prevent fish waste entering the sea? and
- Be able to cope with big waves and storms?

Design, make and share your design as part of National Science Week.

Share photos and students' work samples via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of children in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek! Please ensure that you have parental permission prior to posting any images of students.

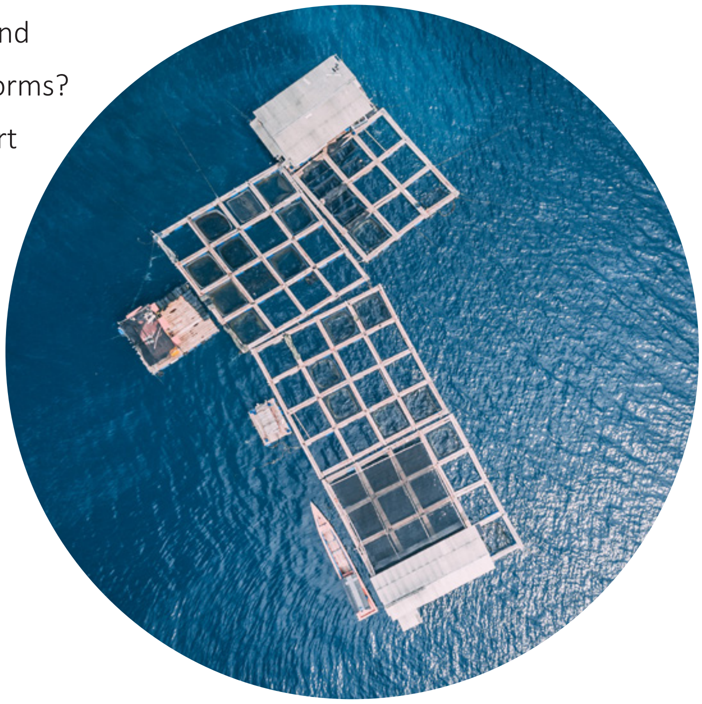


Photo by Hanson Lu on Unsplash

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

Offshore aquaculture systems

The Blue Economy CRC located in Launceston aims to design and develop offshore aquaculture systems for a range of fish and other seafood species. Learn more about what it aims to do **here**. Listen to an ABC Future Tense podcast about offshore architecture and a range of perspectives about a blue economy **here**.

HAVE A GO AT THIS!

Activity 7: Sustainable tourism

Show your support for National Science Week and entertain at the same time, by creating a cartoon that influences tourist behaviours while in or on our oceans.

Tourism is booming on our oceans. Can you think ways to make tourist activities and operations more sustainable?

Check **20 ways to reduce the impact of tourism** and use these ideas to inform your cartoon.

Using the National Science Week Science Activity Characters and a range of **cartoon templates,** bring your ideas alive with a unique story and a visual voice about how to leave a lighter tourist footprint on, in or near our oceans during National Science Week.

Photo by Ina Carolino on Unsplash

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

Bluefin Tuna

High demand for atlantic, pacific and southern bluefin tuna in sushi and sashimi markets has led to overfishing and sometimes illegal fishing of this species, causing their populations to decline severely over the past decades.

Bluefin tuna (*Thunnus thynnus*) are a top predator in the marine food chain and they help maintain a balance in the ocean environment.

Learn about the **tagging programs** that are helping scientists understand their migratory behaviours and advising fisheries managers about how best to protect them.

Questacon

The National Science and Technology Centre

SPARK YOUR STUDENTS' CURIOSITY!

IN CANBERRA

Questacon offers over 200 hands-on experiences in eight themed galleries. Perfect for self-guided exploration, the galleries encourage interaction and invite questions as students explore the science behind our world. Students can free fall down a six metre slide, star in a *Spectacular Science Show* and take a piece of Questacon home with them from the Questacon Shop. Guided *Q by Night* experiences are also available after hours.

NATIONAL PROGRAMS

Questacon is on tour in regional Australia in 2020. With exciting and educational in-school science shows for primary students, workshops for high school students, teacher workshops and pop-up science centres, there is something for the whole community.

Term 1 – Canberra region and South Coast, New South Wales

Term 2 – Central Queensland

Term 3 – New South Wales/Victoria border region

Term 4 – Tasmania

Engineering is Elementary is a free workshop series for primary school teachers providing experience and resources to deliver hands-on inquiry activities in science and mathematics. The program requires participants to develop technologies using engineering principles to solve a real world problem. *Engineering is Elementary* workshops will be delivered in the Northern Territory, New South Wales, Queensland and South Australia in 2020.

CAN'T COME TO QUESTACON? WE'LL BRING A VIRTUAL EXCURSION TO YOU!

Questacon delivers engaging workshops via videoconference to schools across Australia, from one hour workshops to ongoing cross-curricular projects. Whether interacting with the innovation process or connecting with scientists across Australia, students and teachers can explore STEM through interactive, real time experiences.

Bookings are essential for all Questacon programs. Contact us at bookings@questacon.edu.au or visit our website for more information.

www.questacon.edu.au

Australian Government

Questacon

The National Science and Technology Centre

For the

Primary Years of Schooling

Years 5–6

Learning Experiences for **Year 5 and Year 6**

Activity 1: Ocean innovation: marine debris

Overview: Explain to the class that their task will be to explore innovative ways to tackle marine pollution and then design and make a product, technology or system for managing plastics and marine debris.

Background science for teachers and students: Marine debris

Marine debris can consist of plastic litter washed or blown from land into the sea, fishing gear abandoned or lost by recreational and commercial fishers, and solid non-biodegradable floating materials (such as plastics, glass bottles, aluminium cans) disposed of or lost by ships at sea. Other debris includes metal, paper, leaves and wood.

Plastic materials are defined as bags, bottles, strapping bands, sheeting, synthetic ropes, synthetic fishing nets, floats, fibreglass, piping, insulation, paints and adhesives.

Seven billion tonnes of various types of litter enter the world's oceans every year. Plastics generally make up about 60 percent of rubbish, the vast majority of which breaks apart due to sunlight and wave action. These particles eventually become encrusted with microscopic marine life and then they sink to become sediment. On the way to becoming sediment, plastic either as large or small pieces of microscopic particles can affect ocean life.

Harmful effects of marine debris

Marine debris can have a range of environmental impacts on marine wildlife and their environment.

Smaller pieces of rubbish, like cigarette butts and fishing hooks, can be confused with prey and swallowed by marine wildlife, causing internal blockages, often resulting in starvation and other complications. Sharp objects are also a major concern, as they may be swallowed, causing damage to an animal's mouth, digestive tract, and stomach.

It is estimated that one million seabirds and 100 000 other marine animals, including birds, turtles, seals, whales, dugongs and countless fish, are killed as a result of plastic litter every year.

It is estimated that between 50 and 80 million plastic shopping bags enter the Australian environment as litter every year. If 80 million plastic bags were made into a single plastic sheet, it would cover 16 square kilometres. Each side of the plastic sheet would be four kilometres long which would be big enough to cover the Melbourne central business district.

Although much marine debris ends up on beaches, many items will never float ashore. Many, particularly nets, become entangled underwater on rocky outcrops and reefs. Some may be washed back out to sea during high winds and tides.

Marine debris can also become a navigational hazard. Debris, especially torn fishing nets, have resulted in the entanglement of rudders and propellers of marine vessels, and there have been reports of smaller items clogging cooling water intakes and causing engine failure. Debris is also a hazard to beachgoers, especially children playing on beaches who may cut themselves on broken glass.

The essential question:

How can we clean up the oceans? What is the best way to get people thinking about finding solutions to the debris issues in the ocean?

The scenario:

A study recently published in the *Proceedings of the National Academy of Sciences* (PNAS) found that at least 88 percent of the Earth's ocean surface is polluted with plastic debris. The study was conducted by researchers from the University of Cadiz, Spain, as well as the University of Western Australia. Source: **Quora**.

Right now, there are entrepreneurs, companies, scientists, and individuals designing innovative ways to tackle marine pollution. In fact, there are government agencies, non-profit organisations, environmental groups, social purpose organisations, universities and innovative thinkers all over the world devising new policies, campaigns and solutions.

What do you feel might be some innovative ways we can stop plastics from choking our oceans and the life within and on them?

Your task is to support them by creating a pollution free ocean and designing a technology, product or system to remove debris from the ocean. You need to communicate your design ideas in labelled drawings and then make a model. Finally, write a procedure of how to use the designed solution. You are also challenged to inspire other people about ocean debris issues and what they can do about them as part of National Science Week.

A suggested learning process:

Define:

Share the essential question with the class and talk about the problem of marine debris in the ocean.

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

Discover:

Listen to these two short podcast episodes of "Skeptoid": **Ocean Plastics: Facts and Falsehoods** and **China, Imported Recyclables, and Ocean Plastic**. What do you think?

Find out if any students have watched Sir David Attenborough's documentary the 'Blue Planet'. Ask students to share their recollections of the message he shared about our oceans.

View this **survey map** of a study that sampled the ocean for plastic debris in various locations around Australia. Do the results surprise you?

Share a short **video** that captures the essence of the documentary (2:56 mins).

View a **video** on YouTube (2:47 mins) about the actions that were inspired by the documentary and witness how many schools, families, and governments in the United Kingdom responded to the issue about plastics in the ocean.

Discover more information and view a video about **the life cycle of a plastic bottle**. YouTube (4:06 mins)

Read an **article** about the CSIRO scientists who are analysing 40 years of data about the amount of discarded fishing nets in the ocean and their effects on wildlife.

Discover more about **Tim Silverwood**, who studies plastics in the ocean and is the founder of the Take 3 initiative that asks everyone to take three pieces of rubbish when they leave a beach or waterway.

Watch the video **How we can keep plastics out of the ocean** YouTube (3:10 mins) and conduct some research on the new plastics economy where change makers are designing economies where plastic never becomes waste.

Learn about how Hawaiian students are **taking action against ocean plastic**. YouTube (4:26 mins)

Find out about an Australian designed technology called the **Sea Bin** that has been installed all over the world and even at the Australian National Maritime Museum. Think about whether you might be able to re-engineer the catch bag so that it can collect micro-plastics.

Learn about a start-up company in India that is making **edible spoons** to help remove plastic from our lives. YouTube (0:51mins)

Read about scientists who have discovered that **wax worms can eat through plastic**.

Learn about the idea of a new plastics economy, where plastic never becomes waste and **how we can keep plastics out of the ocean**. YouTube (3:10 mins)

Find out about a company that makes **sunglasses out of recycled plastics** from the ocean.

Discover more about **Boyan Slat**, who used a high school science project to drive his ideas about how to rid the oceans of plastic pollution.

Brainstorm the many ways people can reduce the amount of plastic litter that enters our oceans.

As a class, build understanding by sharing ideas and recording issues that the class would like to know more about.

Encourage students to find more examples of what people are doing are to address sustainable practices and promote ways people can reduce the amount of plastic litter that enters our oceans and bring their findings back to class.

Go further and discuss the bigger picture. Talk about how all people can manage the use of natural resources like the land, freshwater, and the ocean more sustainably to ensure other species' needs can be supported as well.

Dream:

In pairs or small groups, envision making a product, technology, or system to remove debris from the ocean. Further develop ideas for possible solutions using sketches and labels.

Ask students to visualise their most creative solution. Ask students to think about the following questions:

- Will the design be stationary, or will it move?
- Will it need any kind of technology?
- How will waste be removed and how will it be disposed of?

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

Design:

Invite students, in pairs or small groups, to begin drafting their designs for their solutions.

Ask students to draft the steps involved in making their solutions.

Ask students to gather the materials, tools, and equipment needed and then design and create their solution.

Ask students to illustrate the steps involved in their product, system or technology to remove debris from the ocean. Remind them that they need to communicate their design ideas, and instructions in labelled drawings and then build a model of it.

The students then need to write a procedure of how to use the designed solution. They then evaluate their design, and suggest improvements, where necessary, giving reasons.

Students will then use their labelled drawing, model and procedure in a National Science Week presentation to spread the word about what might be possible.

Invite a peer class group to the class to hear from the students, and find out more about creating a pollution free ocean.

Deliver:

In pairs or small groups, showcase the creations and associated messages.

Classes host an 'Ocean Innovation Day' and invite students, teachers and parents to discover what innovations the class thinks might be possible.

Share photos and students' work samples via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of children in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek! Please ensure that you have parental permission prior to posting any images of students.

Debrief:

Ask students to reflect on their learning and draw something they learnt that was new.

Ask students to describe what worked well and not so well in their efforts to design their ocean innovation.

Curriculum connections

Science (ACARA, 2015a)

Year 5 and 6

Science as a Human Endeavour—Nature and development of science

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions ACSHE081 ACSHE098

Science as a Human Endeavour—Use and influence of science

Scientific knowledge is used to solve problems and inform personal and community decisions ACSHE083 ACSHE100

Technologies (ACARA, 2015b)

Year 5 and Year 6

Design and Technologies—Processes and Production Skills

Critique needs or opportunities for designing, and investigate materials, components, tools, equipment and processes to achieve intended designed solutions ACTDEP024

Generate, develop, and communicate design ideas and processes for audiences using appropriate technical terms and graphical representation techniques ACTDEP025

Select appropriate materials, components, tools, equipment and techniques and apply safe procedures to make designed solutions ACTDEP026

Develop project plans that include consideration of resources when making designed solutions, individually and collaboratively ACTDEP028

General Capabilities:

Literacy, ICT capability, Critical and creative thinking, Ethical understanding and Personal and social capability.

Cross Curriculum Priority:

Sustainability.

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

CSIRO National Marine Debris Research

Find out about the **CSIRO research** which shows that approximately three-quarters of the rubbish along the Australian coast is plastic. Read about how most is from Australian sources, not from overseas, with debris concentrated mainly near urban centres, and how in coastal and offshore waters, most floating debris is plastic.

The Plastic Bank

Learn more about the **Plastic Bank** that lifts people out of poverty, reduces plastics in the ocean, inspires supermarkets in Indonesia to take plastics as payment for grocery items from those that collect them, and helps families in Haiti pay for their children's school tuition via the amount of plastic they remove from the ocean, collect and recycle.

Country Road

Learn about how the fashion shop **Country Road** is using discarded fishing nets, plastic yoghurt containers, and recycled ocean plastic. The store, the first standalone fashion shop in Australia to achieve a five-star green rating from the Green Building Council of Australia, includes tables made from discarded yoghurt containers, fitting room hooks made from recycled ocean plastic, and carpets constructed from old fishing nets.

Activity 2: Ocean innovation and exploration

Overview: *Explain to the class that their task is to learn from engineers and design and build a boat with an attached submersible that can be used to help explore, collect, and retrieve samples from the ocean.*

Background science for teachers and students: Engineers

Engineers do an amazing job designing and building different types of boats that can take us across the ocean and submarines or submersibles that take us below the ocean's surface.

Did you know that there are many types of engineers?

1. Marine engineers design, build, and maintain ships, from aircraft carriers to submarines and from sailboats to tankers. They are responsible for the internal systems of a ship, such as the propulsion, electrical, refrigeration, and steering systems.
2. Aerospace engineers design and build satellites that are used to monitor the oceans.
3. Chemical engineers discover and manufacture plastics, paints, fuels, fibres, medicines, fertilisers and paper.
4. Structural engineers oversee the construction of boats, submersibles, buildings and structures.
5. Civil engineers design roads, bridges and unique structures.
6. Electrical engineers develop the electrical parts of most things we use.
7. Mechanical engineers design and make all sorts of equipment.
8. Industrial engineers design efficient systems that integrate workers, machines, materials, information, and energy to make a product or provide a service.

Engineers use a design process. It helps them stay on track when developing a technology used on or under the ocean or a solution to a problem.

The essential question:

What happens when we understand how boats and submersibles are engineered and designed with systems to explore, collect, and retrieve items from the ocean?

The scenario:

Given that the ocean is the largest living space on our planet and covers 71 percent of Earth's surface, it seems that perhaps we ought to know a bit more about the planet we call home.

However, we have only explored five percent of the world's oceans. That means that 95 percent of our ocean is unknown. Source: **NOAA**

Your design team's challenge is to design and build a boat with an attached, remotely operated submersible vehicle (ROV) that can be used to help explore, collect, and retrieve samples found at a depth of 30cm in the ocean.

Imagine you are a team of expert engineers and design and build your design solution that can explore the ocean and make scientific contributions to our understandings of how it is changing and its resources.

What investigations can assist you to develop your engineering skills? How might you design and build a boat with an attached unmanned submersible that can be used to help explore and collect samples in the ocean? How might you test it and demonstrate that it can safely grip, retrieve, and collect samples?

A suggested learning process:

Define:

Share the essential question and scenario with the class and talk about different tools that are used to grip, collect, and retrieve items.

Imagine a crane that grips and collects building materials, a robot that can grip and retrieve objects, or a prosthetic hand that can grip and pick up items.

View a **video** on YouTube (2:47 mins) that features Ocean One, a robot that goes underwater and retrieves objects. Talk about its functions.

Imagine a dragline with a bucket that can scoop, retrieve, and collect ocean samples.

View **images** of draglines and talk about how they work.

Discuss other ways scientists explore the ocean. Explain to the students that many scientific discoveries are being made with the assistance of buoys, satellites, and underwater probes.

Talk about how the work of an engineer always begins with a 'brief'. Explain how the brief they will be given as engineers is a set of requirements written by the people with whom they will be building the boat with, an attached unmanned submersible that can be used to help explore and collect samples in the ocean.

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

Discover:

Locate where different kinds of grippers or draglines can be found. Talk about what they are used for and the types of people who design and build them.

Ask students to bring to class, barbecue tongs, pegs, and grippers (that might used by elderly people who can reach distances to pick things up) and investigate their shapes and properties. Talk about their ability to grip and retrieve objects.

As a class, talk about the Ocean One robot. Use Google Images to source photos of the robot designed by Stanford University. Discuss how it collects samples.

Ask students to look at its shape and design features and describe what they see.

Ask students to view the robot, other mini-submarines, and submersibles used to explore and collect samples in the ocean and, in design teams, brainstorm ways to use similar ideas in their designs and determine the materials they might use.

In design teams, discuss whether the proposed submersible might retrieve objects magnetically/mechanically.

Talk about the weight and size of the team's proposed boat and submersible. What might the optimum weight and size be?

Invite design teams to use these ideas as a springboard to help them consider ways they can design and produce their own boat with an attached unmanned submersible that can be used to help explore and collect samples found at a depth of 30 cms in the ocean.

Ask students to consider manipulating materials, developing prototypes, testing ideas, and accessing information sources to use in subsequent phases of their designs.

Talk about using either high-tech solutions, like Minecraft, to scope their design. Low-tech solutions, like LEGO®, or no-tech solutions, like recycled materials for the boat that will float and similar recycled materials that can sink the submersible. Challenge students to design their tool that can retrieve and collect samples and attach it to the submersible.

View student-built ROV models and competitions at **Woodbridge School Marine Discovery Centre**, **Re-Engineering Australia Foundation Subs in Schools program**, **Hallett Cover Robotics Club** and **SeaPerch**.

Dream:

In pairs or small groups, envision or dream about the many possible design solutions to build a boat with an attached unmanned submersible that can be used to help explore and collect samples in the ocean.

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.

Remind students that their solution needs to float on water as well as be able to sink a submersible. Its attachment needs to retrieve and collect samples found in the ocean.

Design:

Invite students, in pairs or small groups, to begin drafting their designs for their solutions.

Ask students to draft the steps involved in designing and building their boat, submersible, and attachment.

Ask students to gather the materials, tools and equipment needed and then design and build the solution.

Invite students to prototype and test their model, evaluate its ability to float on a test surface, sink its submersible, collect an ocean sample, and where necessary redesign their solution.

Encourage students in their design teams to demonstrate their models operating on a test surface.

Ask groups to talk about how they solved any problems that emerged as they designed, built, tested, and adjusted their models.

Talk about the forces that may have affected the models as they floated, sank, and were dragged and moved.

Invite a peer group to the class to hear the engineers in the class describe the type of boat, submersible and sample collector they designed and built and see them demonstrate how they work.

Deliver:

In pairs or small groups, showcase the models they designed and built as well as demonstrate how the prototypes of their boat and submersible that can collect ocean samples to a depth of 30 cms.

Host an 'Ocean Exploration Day' as part of National Science Week and invite students, teachers and parents to discover what students can do.

Share photos and students' work samples via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of children in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek! Please ensure that you have parental permission prior to posting any images of students.

Debrief:

Ask students to reflect on their learning and answer the following questions.

- What worked and what didn't?
- How could you improve on what you have done?
- What are three things you learned that you didn't know before?
- What are three things that surprised you?
- What was your most inspiring moment in the challenge?
- How can you apply what you have learned to other challenges, now and in the future?

Curriculum connections

Science (ACARA, 2015a)

Year 5 and Year 6

Science as a Human Endeavour—Nature and development of science

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions ACSHE08 ACSHE098

Science as a Human Endeavour—Use and influence of science

Scientific knowledge is used to solve problems and inform personal and community decisions ACSHE083 ACSHE100

Science Inquiry Skills

With guidance, pose clarifying questions and make predictions about scientific investigations ACSIS231 ACSIS232

Identify, plan, and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks ACSIS086 ACSIS103

Compare data with predictions and use as evidence in developing explanations ACSIS218 ACSIS221

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts ACSIS093 ACSIS110

Technologies (ACARA, 2015b)

Year 5 and Year 6

Design and Technologies—Knowledge and Understandings

Examine how people in design and technologies occupations address competing considerations, including sustainability in the design of products, services, and environments for current and future use ACTDEK019

Investigate characteristics and properties of a range of materials, systems, components, tools and equipment and evaluate the impact of their use ACTDEK023

Design and Technologies—Processes and Production Skills

Critique needs or opportunities for designing, and investigate materials, components, tools, equipment and processes to achieve intended designed solutions ACTDEP024

Generate, develop, and communicate design ideas and processes for audiences using appropriate technical terms and graphical representation techniques ACTDEP025

Select appropriate materials, components, tools, equipment and techniques and apply safe procedures to make designed solutions ACTDEP024-6

Develop project plans that include consideration of resources when making designed solutions, individually and collaboratively ACTDEP028

General Capabilities:

Literacy, ICT capability, Critical and creative thinking, Ethical Understanding and Personal and social capability.

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

Tracking the ocean

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.

Ocean probes below the ocean

Discover how ocean probes make up the **Argo** array, which takes readings of the ocean's temperature and salinity readings.

Satellites that measure icesheets and glaciers

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

Student-built unmanned ocean sailing probes

Learn about the **Educational Passages** program where schools can launch an unmanned mini-sailing boat that is tracked by satellite. When the vessel eventually makes landfall in another country, the nearest school can refurbish it, contact the original school, and send it back out to sea.

Photo: Bob Winters

HAVE A GO AT THIS!

Activity 3: Ocean acidification and shells

Ocean acidification has been called the evil twin of climate change. It is the other carbon dioxide problem. Around a quarter of the carbon dioxide produced by burning fossil fuels dissolves into the ocean where it combines with water to form carbonic acid. While this acid is extremely weak it is nevertheless strong enough to dissolve the calcium carbonate shells of corals, microscopic molluscs or effect other animals. As the acid dissolves calcium carbonate, it releases more carbon dioxide that, in turn, makes more carbonic acid.

Scientists are starting to see evidence and the consequences of ocean acidification and what it means for marine life.

Did you know that egg shells are made of the same compound from which coral and mollusc shells are made ie. calcium carbonate? Try the following activity and see if you can make a shell disappear.

You will need

- 2 eggs
- 1litre vinegar
- 2 small bowls
- large bowl
- jug
- measuring cup
- spoon
- salt
- water
- ruler

What to do

Day one:

- Put the eggs in the large bowl.
- Pour vinegar into the bowl until the eggs are completely covered. The eggs will start to bubble.
- Leave the eggs to stand overnight.
- Create a salt solution in a jug by dissolving as much salt as possible into 500 mls water. Keep adding salt until a few salt crystals are left on the bottom that will not dissolve, no matter how long you stir.

Day two:

- The eggs should be soft. Remove from the vinegar and gently brush any remaining shell off the egg until you can see the yolk through the membrane (clear covering).
- Measure each egg with a ruler.
- Carefully put one egg into each of the small bowls.
- Gently cover one of the eggs with water.
- Cover the other egg with the salt solution from the jug.
- Leave both eggs overnight. Measure the eggs. Have they changed in size?

What's happening?

Eggshells contain calcium carbonate ($CaCO_3$), and vinegar's active ingredient is acetic acid (CH_3COOH). When these chemicals react together, the result is a salt called calcium ethanoate, some water, and bubbly carbon dioxide gas. The reaction for this equation looks like this:

$$CaCO_3 + 2CH_3COOH \rightarrow Ca(CH_3COO)_2 + CO_2 + H_2O$$

Once an egg's shell is dissolved by this reaction, its membrane is revealed. This membrane is 'selectively permeable', which means it will allow some things through but not others. An egg's membrane will allow small molecules like water to pass through but not large ones like salt.

The egg left in water will look very different to the one in saltwater due to a process called osmosis. Osmosis occurs when two solutions are separated by a selectively permeable membrane. Water moves by osmosis from a weak (dilute) solution to a strong (concentrated) solution, such as the solution inside the egg. So, when the egg is left in water only, water flows in through the membrane, making the egg expand.

The egg in the saltwater shrinks. This is because the solution outside the egg is more concentrated, so the water flowed out from the dilute solution to the concentrated solution.

Source: Adapted from "The Vanishing Shell", Carbon Chemistry, CSIRO, 2009.

Activity 4: Design a compass

Long before satellite navigation was invented, people relied on compasses to navigate the ocean.

A compass has a needle that always points north or south to match the Earth's magnetic field.

An important part of this activity is magnetising the compass needle. This activity suggests using a dress pin or needles, however, any thin steel object can be used.

You will need

- Two felt tipped pens
- A plastic cup
- A plastic lid that is wider than the base of the plastic cup
- A small bowl of water
- A magnet
- A dress pin or steel needle
- Some adhesive putty
- A pair of scissors
- A ruler
- A smartphone

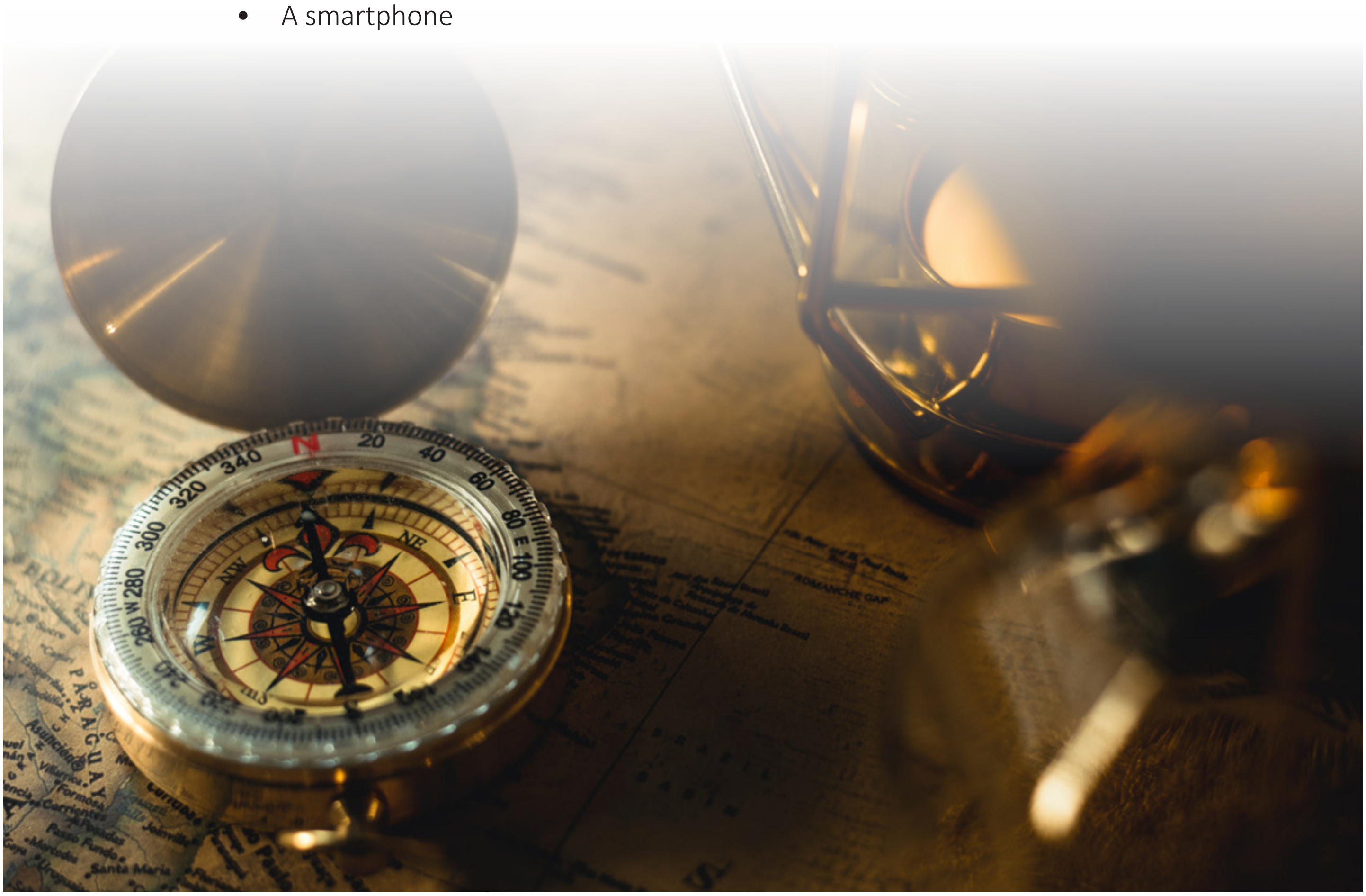
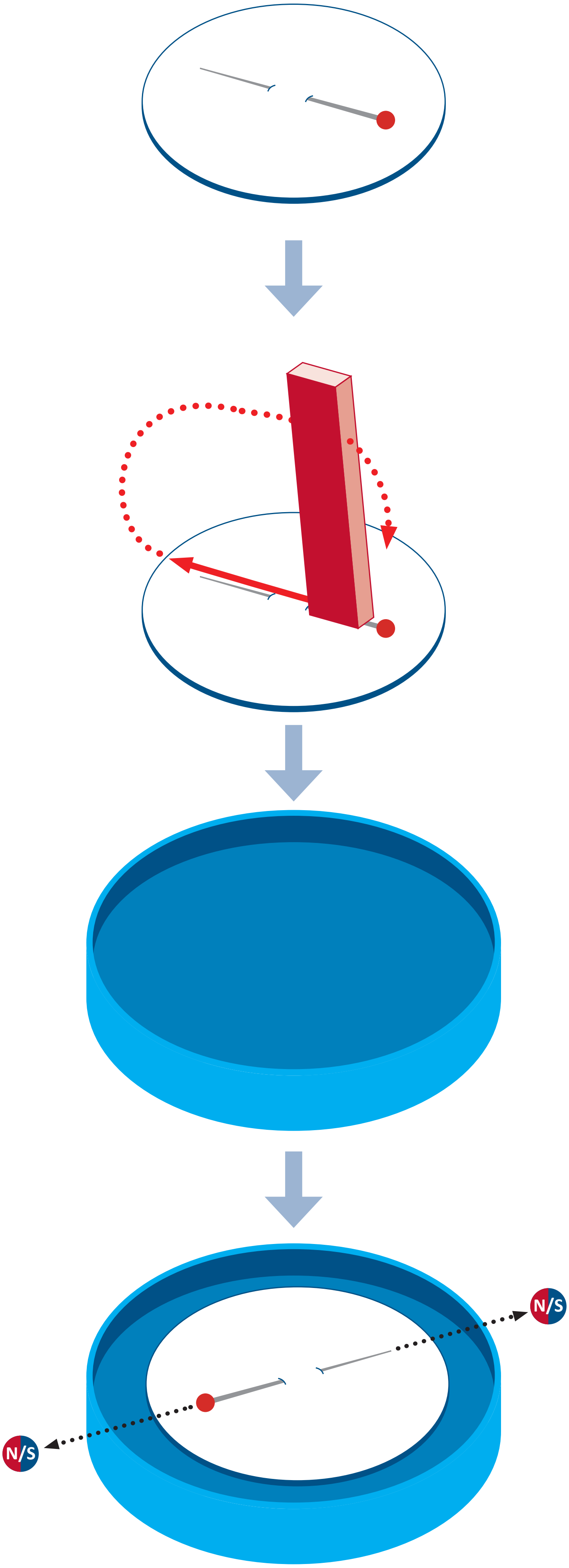


Photo by Cherise Evertz on Unsplash



What to do

1. Using the scissors, cut off the base of the plastic cup. This will float on the water, so the compass needle can turn freely.
2. Hold the base of the plastic cup and then find the centre of the plastic base. Use the ruler and measure one centimetre inward from the edge of the cup's base.
3. Using a felt tipped pen, mark this measurement using a coloured dot and repeat this on the other edge of the centre of the cup.
4. Place a small rolled ball of adhesive putty beneath the cup's base and carefully slide the pin down through one dot and up through the other dot.
5. Magnetise the pin by stroking the magnet all along the length of the pin (in one direction only) and lifting the magnet away from the end of the pin each time. Do this approximately 50 times. Always use the same end of the magnet.
6. Pour water into the plastic lid, ensuring there is enough water for the plastic base of the compass to float freely.
7. Float the compass on the surface of the water (make sure the compass is not placed in strong winds, next to large metal objects, or electrical appliances).
8. Observe and take note of how the compass needle turns and moves to line up with the Earth's magnetic field.
9. Use a smartphone to find 'north'. Note which end of the pin points north and mark N, S, E and W on the compass.
10. Document your project from start to finish using a video camera and share your video as part of National Science Week.

How it works

All magnets have a magnetic field around them and two ends, or 'poles', where the magnetic field is strongest.

Your compass needle is made of steel, which is made up of lots of tiny crystals called 'domains'.

Each domain is a tiny magnet, and when the needle was stroked with the magnet, all the domains lined up. Therefore, the magnetic fields point in the same direction.

The Earth's magnetic field *almost* lines up with its axis of rotation, so we can use a compass to navigate.

HAVE A GO AT THIS!

Activity 5: Ocean probes

*View the ABC Education **video** (5:04 mins) and learn about a nautical robot that the CSIRO named Argo.*

Discover what it is made of, how it floats, sinks and comes back to the surface.

Learn about the data it collects that helps scientists know more about ocean warming.

Did you know that probes do not have Global Positioning Systems (GPS)? They are designed to travel through the oceans to collect scientific information. They can have instruments that take pictures, measure ocean conditions, and then report the data back to Earth. These probes send back data for scientists to study.

Your challenge is to design a probe that can be launched into the ocean to create maps and take close-up photographs of the ocean's different zones—all while the probe is floating and communicating what it finds back to scientists.

What might an ocean probe need so that it can be propelled into the ocean?

What might it carry and contain so that it can communicate with scientists?

What might it need so that it can stay deep within the ocean?

What equipment will it have so that it can send its data, including the maps and photographs, back to scientists?

What design features will it need to be able to resurface?

Define your challenge then discover and record information about ocean probes.

Imagine your ocean probe and draw your designed solution. Include labels of its equipment and its instruments.

Finally, make and test your ocean probe and deliver it as part of National Science Week in 2020.

Share photos and students' work samples via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of children in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek! Please ensure that you have parental permission prior to posting any images of students.

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

Pisces

Learn about a new technology designed by **SafetyNet Technologies** that emits light and helps fishers target the fish they want to catch and reduces bycatch.

HAVE A GO AT THIS!

Activity 6: Design a floating rig

About one-third of the world's total reserves of oil and gas lie offshore below the ocean.

Your task is to design a model of a structure that can support an offshore exploration rig that will remain upright and can float on water.

The rig is used to determine what petroleum products, such as crude oil or gas, may be below the surface of the sea floor.

View images of some offshore exploration rigs **here** and below.

Your model floating rig needs to have a maximum weight of 500 gms, and its maximum length in any direction should not exceed 40 cms.

Your rig needs pontoons and anchors to ensure its position on the ocean surface.

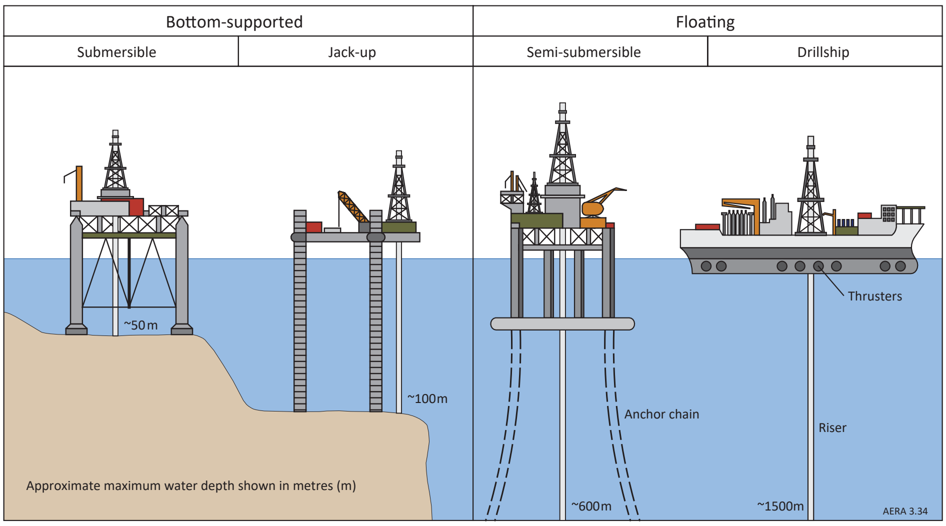
It also needs to pass a number of tests before it can put to sea.

The design tests for the floating rig include:

- Float test- When placed in water, does it float?
- Wave test – Does it survive when you simulate small waves by agitating the water?
- Large wave test – Does it survive in rough water?
- Rain test – Does it survive when rained on (use a watering can)?
- Heavy storm test – Does it survive in heavy storms (use a bucket of water)?
- Buoyancy test – Can you add water to the pontoons to simulate appropriate buoyancy?
- Wind test – Can the anchors, pontoons, and rig survive strong winds (use a battery powered fan, hairdryer, or leaf blower)?

Imagine your floating rig and draw your designed solution. List the materials you need for your design.

Build, test, and modify the floating rig. Take photos of all the processes used and record each step along the design journey.



Type of offshore drilling vessels. Source Geoscience Australia (Adapted from Wilkinson 2006) Page 68 AERA 3.34 **https://d28rz98at9flks.cloudfront.net/70142/70142_complete.pdf**

Finally, deliver it as part of National Science Week in 2020.

Share photos and students' work samples via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of children in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek! Please ensure that you have parental permission prior to posting any images of students.

HAVE A GO AT THIS!

Activity 7: What can you do to help make people aware of the range of marine and coastal survey techniques used to understand our oceans?

*Begin finding out about the **surveying techniques** used by Geoscience Australia to help understand more about the animals found within the different ocean zones and the seafloor.*

Learn about CSIRO's underwater robot **Starbug** that monitors and surveys ocean ecosystems.

Record information about what you discover and then think about how you might share your ideas with others.

Might you design a question and answer game using standard art materials, or might you incorporate the use of digital technologies using apps like **Poll Everywhere** or **Mentimeter**?

Might you design a talking avatar using **Voki**?

Might you design an info graphic?

Set up an activity day where teachers, students, and parents can learn all about the survey techniques used by scientists in their everyday research.

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

Whale research

Seeing whales can be a humbling experience. Their immense size and stature can be overwhelming. Many whales are listed as threatened in Australia. The pervasiveness of ghost net entanglements, ship propeller strikes and plastics in the ocean means that their future hangs in the balance.

Discover more about the **Australian Institute of Marine Science** (AIMS) and its research programs that focus on the vulnerable humpback whale and the endangered pygmy blue whale populations in Australia's north-west.

Future Gen Education

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- real life learning experiences
- project based learning (PBL)
- ideas for making learning inspirational
- virtual learning
- a playlist curriculum

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FUTUREGEN EDUCATION

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For the

Secondary Years of Schooling

Years 7–10

Learning Experiences for **Year 7, Year 8, Year 9 and Year 10**

Activity 1: Smart solutions

Overview: *Explain to the students that their task is to investigate a range of smart solutions for the challenges to achieving a functioning and sustainable ocean that is vital for the health of the planet.*

Background notes for teachers and students: Blue Economy CRC

The Blue Economy CRC was announced in Launceston in April 2019 by the Minister for Industry, Science and Technology, Ms Karen Andrews. It aims to drive an evolution in marine-based industries, unlocking enormous economic, environmental, and technological benefits.

The $329 million research project is a10-year collaboration between 45 national and international partners from industry, research and government, underpinned by a $70 million cash investment from the Federal Government.

The essential question:

What happens when we understand that, unless we define the ocean innovations we would prefer, it may be left to others to create?

The scenario:

Discover how marine scientists, marine-based industries, marine technology companies, and entrepreneurs are designing smart solutions for the ocean.

Investigate how the use of drone technologies, remote sensors, satellites, robotics and the Internet of Things Underwater (IoT Underwater) are now part of the innovations occurring in ocean activities.

Then, as part of a design team, re-imagine how you would like the ocean to be and design a product, system, or environment and produce a folio of ideas to explain your entrepreneurial thinking.

Each design team is also tasked with then sharing their solution for the ocean as part of National Science Week.

A suggested learning sequence:

Define:

Share the essential question with the class and talk about the tasks that need to be addressed.

Present the scenario, assign teams if appropriate, and ask students to define the task they have been set.

Introduce students to the **Blue Economy CRC** in Launceston. Talk about the charter under which it must deliver innovation in sustainable seafood and renewable energy.

Ask students to brainstorm and describe the types of innovation in the ocean that might be part of a suite of activities in sustainable seafood and renewable energy production. For example, aquaculture systems, platform-based hatcheries, offshore seafood processing and packaging facilities, hybrid renewable energy systems, offshore energy storage solutions, etc.

View **images** on the Blue Economy CRC website to imagine what solutions are envisaged.

Explain that the Blue Economy CRC will also be designing offshore engineering infrastructure that supports the development of offshore systems for aquaculture and renewable energy. For example, anchoring devices, sea cage infrastructure and innovative maintenance technologies. View an image of what this might look like **here**.

Highlight that the Blue Economy CRC will also be designing systems to monitor the impacts of these innovations on the ocean environment and its ecosystems.

Discuss how investors and successful businesspeople are currently investing in designed solutions for the ocean, including the World Bank, Departments in government, etc.

Talk with the students about how exciting ocean innovations and activities are areas of study. Describe how they provide opportunities to solve all sorts of problems in a practical way by designing and making things and changing and adapting things that already exist.

Discover:

Talk about the word 'sustainability'. As a class, consider the differences between 'environmental sustainability', 'economic sustainability' and 'social sustainability'. For example, when an ocean-based industry thinks of being economically sustainable, it might ask itself a question such as 'Are we sustainably profitable?' or 'What do we need to do to make sure that a new design provides a living for our family into the future?'

When a manufacturer of ocean technologies thinks about being socially sustainable, they might ask themselves a question like 'Are we behaving in a way such that the community will support us into the future?' or 'How should we be involved in our community, to support the community and benefit us into the future?'

When researchers from the Blue Economy CRC think about being environmentally sustainable, they might ask themselves a question like 'Are we maintaining our offshore aquaculture systems and their assets for future generations?' or 'How can we utilise the ocean so that future seafood producers can operate successfully in that environment?'

Delve deeper and think about how waste management, waste re-use, water management, water re-use, wastewater treatment, resource recovery, and innovative power generation features when designing a service, product or system that could be utilised as a solution for the ocean. Ask students to visualise how these ideas might be integrated into new designs.

Ask students to develop criteria describing the standards they feel best describe 'sustainable solutions' for the ocean. Share these as a class and display ideas for future reference.

As a class, build understanding by sharing ideas and recording issues that the class would like to know more about regarding how a scientist, entrepreneur, designer, engineer, or innovator might address sustainable processes and systems in such business areas as those being embraced by the Blue Economy CRC.

Talk about what a 'functioning' ocean might mean. Ask students to brainstorm and record their thoughts and ideas. Share a **video** on YouTube (2:02 mins) that can support students to understand more about what functions the ocean provides, what it gives us, what it regulates, what it supports and what it provides the Earth.

Talk about the ocean being the other lungs of the planet. Discuss how it provides at least half the oxygen we breathe, removes toxins from the air and controls our climate. Talk about how, working with the Sun, the ocean is a huge rain making factory. Talk about the food that the ocean provides for millions of people on Earth. Discuss ocean currents and how they act much like a conveyor belt, transporting warm water and precipitation from the Equator toward the poles and cold water from the poles back to the tropics helping regulate *global climate*. Go further and discuss the diversity and productivity of the world's oceans.

Focus on ocean innovation. Introduce students to CSIRO's Autonomous Underwater Vehicle (AUV) called **Starbug** a high-tech marine observing technology used in marine research.

Discover how students at Cocos Island District High School built a **Baited Remote Underwater Video (BRUV)** platform to conduct fish surveys in their lagoon.

Capture students' interest and introduce the **Plastic Bank** that lifts people out of poverty, reduces plastics in the ocean, inspires supermarkets in Indonesia to take plastics as payment for grocery items from those that collect them, and helps families in Haiti pay for their children's school tuition via the amount of plastic they remove from the ocean, by collecting and recycling.

View a **video** on YouTube (1:13 mins) and introduce students to a robot that collects coral spawn on the Great Barrier Reef. Talk about the innovation designed by Queensland scientists, and read **information** about the benefits the innovation has produced.

Introduce students to a **startup company** that uses shellfish shells innovatively to develop a compostable plastic type wrap.

Read about **AlgaeVeg**, an innovative 2D system for the cultivation of red seaweeds instead of the traditional one-dimensional long line system, which will allow a production yield eight times higher than the traditional system.

Learn about **Farm MoJo**, a machine learning based mobile application that helps shrimp farmers using aquaculture systems achieve more sustainable farming practices through data collection and analysis. Find out how FarmMoJo helps farmers to achieve maximum efficiency by regulating the feed inputs, early diseases prediction, timely actions, and reducing the operational costs.

Photo: Bob Winters

View a **TEDX Talk** (15:18 mins) about Bren Smith's vertical ocean farm in Long Island Sound that grows seaweed and shellfish and is designed to restore ecosystems, mitigate climate change, and create blue-green jobs for fishermen.

Read how vertical gardens for aquaculture are being incorporated into design concepts for **floating cities** which, like ideas visualised by the Blue Economy CRC, envisage being built on floating platforms that are moored to the ocean floor. Read about how these cities will be built using sustainably sourced timber, will incorporate renewable power sources, innovative sewage and water recycling systems and have desalination plants that produce potable water for the community's use.

Introduce **Sea Smart** and their sea drone technologies, which have the capability to monitor aquaculture pens for damage and record conditions such as temperature, oxygen and nutrient levels.

Challenge students to research the Internet of Underwater Things (IoUT) and discover the world-wide network of smart interconnected underwater objects that enable scientists and researchers to monitor the oceans.

Ask students to research the range of satellites NASA and its' partners operate to monitor and track changes in the ocean.

In design teams, students use a SWOT analysis and analyse whether the technologies, products and systems the class has been introduced to add value to sustainable ocean activities.

Talk about Artificial Intelligence (AI) and Machine Learning. Explain to the students that, hypothetically, it is possible for machines to learn to solve any problem relating to the physical interaction of things within a defined or contained environment through the use of artificial intelligence and machine learning.

Explain that the principle of artificial intelligence is one where a machine can become aware of its environment, and through a certain capacity of flexible rationality, take action to address a specified goal related to that environment. Machine learning is when a machine receives sets of data that can be categorised using specified protocols. When this is done, the machine's ability to rationalise in areas relevant to the supplied data increases, allowing it to 'predict' a range of outcomes for similar data.

In design teams, ask students to investigate the application of Machine Learning and AI being used by scientists at the **Australian Institute of Marine Sciences** (AIMS) in activities that process photographs taken of the sea floor and catalogue the marine images.

Ask each design team to share what their research has told them and what they still have to accomplish within the task.

Dream:

Ask design teams to create a vision for a service, product or system that could be used in the ocean that they are re-imagining.

Ask the teams to use all the knowledge they have gathered to re-imagine how they would like the ocean to be and to design a product, system or environment and produce a folio of ideas to explain their entrepreneurial thinking.

Ask students to visualise what the solution will appear like in the future.

Ask students to consider the many possible ways they can design their idea. Talk about the use of research, working sketches, models, drawings, 3D modelling, experimentation, or photographic samples.

Ask students to develop possible solutions by brainstorming ideas.

Introduce students to the S.M.A.R.T. goals.

SPECIFIC	Ensure that your idea is clear and has a narrow focus.
MEASURABLE	Can you measure your idea? Stay on track by asking: How will I know when it's done?
ACHIEVABLE	Aim high, but make sure your project idea is something that you can actually do.
RELEVANT	Is your idea linked to what you are trying to achieve? Will your idea help you to achieve your desired result?
TIME-BOUND	A deadline will help establish a sense of urgency and help keep your project focused and on-track.

Ask students to use the S.M.A.R.T. goals and their criteria when visualising their designed solutions.

Ask students to imagine the steps involved in designing the service, product or system used in space exploration that they are re-imagining.

Challenge students to think about the materials, tools, and equipment they will need to design their individual work samples. Will they use digital or non-digital equipment and tools?

Design:

Ask students to explain how they are going to re-imagine and document design ideas for a service, product or system that could be used in the ocean.

Talk about how the students might use a model, prototype, blog, display folder, digital presentation, or a combination of these to show evidence of their design and production process.

Ask students to draft the steps involved in making their chosen design.

Talk about the importance of a clear layout of information and a clear design that makes it easy for an audience to understand and interpret the information given.

Discuss the importance of including information in the design about how the service, product or system used in the ocean might:

- manage water, energy and waste productively and sustainably;
- treat the ocean and its plants and animals ethically;
- reduce, minimise or eliminate marine pollution;
- maintain equipment sustainably;
- collect and/or transmit data; and
- make money or save money.

Talk about the importance of sourcing graphics, photos and information correctly.

Review rules on personal safety, group safety, and classroom and furniture safety with the students. Ask students to establish a workstation and to gather the materials and tools they require. Talk about storing their design safely and keeping a record of the processes they use to create it.

Remind students to record the steps involved in making their chosen digital or non-digital design.

Talk with students about how they might share and present their designs to an audience.

Ask students to explain how they plan to finalise and create their designs with a peer in their class to seek feedback on their ideas.

Deliver:

The delivery phase has two stages—production and publication. In the production stage, the project comes to life. This is the 'doing' phase. At the end of this phase, the publication/presentation of the design for the service, product or system used in the ocean that the design teams are re-imagining should be completed.

Ask students to design and create their individual design samples required for this unit.

In the publication phase, students showcase all their thinking and planning. This is the time when students present their designs to each other or an audience and is a good time for peer or self-assessment.

Ask students to share their designs with others.

Video student presentations, and if possible, enjoy a whole day of learning about how sustainability ideas might pioneer a better future for the ocean.

Share photos and students' work samples via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of children in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek! Please ensure that you have parental permission prior to posting any images of students.

Debrief:

Ask students to evaluate their designs and write about whether their design:

- matched the definition of the task;
- used a clear layout and design;
- was feasible; and
- included the sources of the ideas and information each design piece used.

Ask students to write about the quality of their planning, their finished design, and whether they enjoyed the task.

Invite students to reflect on the learning by completing a self-assessment activity. Some example questions to stimulate reflection follow.

- How has my/our attitude and behaviour changed as a result of my learning?
- How well did I/we contribute to any team learning activities?
- How can I/we apply what I/we have learned to another topic?

Curriculum connections

Technologies (ACARA, 2015b)

Year 7, Year 8

Design and Technologies Knowledge and Understanding

Investigate the ways in which products, services and environments evolve locally, regionally, and globally and how competing factors including social, ethical, and sustainability considerations are prioritised in the development of technologies and designed solutions for preferred futures ACTDEK029

Year 9 and 10

Critically analyse factors, including social, ethical, and sustainability considerations, that impact designed solutions for global preferred futures and the complex design and production processes involved ACTDEK040

Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions ACTDEK041

Science (ACARA, 2015a)

Year 7, 8, 9 and 10

Science as a Human Endeavour—Use and influence of science

Solutions to contemporary issues that are found using science and technology may impact other areas of society and may involve ethical considerations ACSHE120 ACSHE135

People use science understanding and skills in their occupations, and these have influenced the development of practices in areas of human activity ACSHE121 ACSHE136

People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science to affect people's lives, including generating new career opportunities ACSHE160 ACSHE194

Values and needs of contemporary society can influence the focus of scientific research ACSHE228 ACSHE230

Science as a Human Endeavour—Nature and use of science

Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures ACSHE223

General Capabilities:

Literacy, ICT capability, Critical and creative thinking, Ethical understanding and Personal and social capability.

Cross Curriculum Priority:

Sustainability.

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

Multibeam sonar

Learn more about an **offshore surveying tool** that uses multiple sound signals to detect the seafloor when satellites cannot see through the ocean's water and depths.

Drones and whale and dolphin snot

Learn about **Dr Vanessa Pirotta** who collects information about the health of our oceans using drones that collect whale snot. View the TEDx talk (11:23 mins), and discover how it's done and the range of data sets that are collected that help us understand more about the ocean and its health.

In addition, read about how drones are used to also collect dolphin snot **here**.

Startup that uses shellfish shells and developed a compostable plastic type wrap

Read about a Scottish startup company called **Cuan Tech** that has devised a way to upcycle seafood shells and has developed a type of food wrap that can be composted.

Activity 2: Oceans and climate change

Overview: *Explain to the class that their task is to educate others to understand how climate change is altering the nature of the ocean.*

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 (eg. 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.

The essential question:

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

The 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 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 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 a **video** (4:05 mins) that explains climate change and its effects on one part of the ocean, the Great Barrier Reef.

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.

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.

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 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.

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

Explore what the future could look like by the year 2040 and investigate the **seaweedaquaculture plan** that is a climate solution in the film 2040 made by Damon Gameau.

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 offers 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 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 as part of National Science Week.

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 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 Oceans and Climate Change Day' as part of National Science Week and invite students, teachers and parents to discover more about the issues.

Share photos and students' work samples via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of children in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek! Please ensure that you have parental permission prior to posting any images of students.

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

Science (ACARA, 2015a)

Year 7, Year 8, Year 9 and Year 10

Science as a Human Endeavour—Use and influence of science

Solutions to contemporary issues that are found using science and technology may impact other areas of society and may involve ethical considerations ACSHE120 ACSHE135

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity ACSHE121 ACSHE136

People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science to affect people's lives, including generating new career opportunities ACSHE160 ACSHE194

Values and needs of contemporary society can influence the focus of scientific research ACSHE228 ACSHE230

Science as a Human Endeavour—Nature and use of science

Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures ACSHE223

Year 10

Earth and space sciences

Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere ACSSU189

Technologies (ACARA, 2015b)

Year 9 and 10

Design and Technologies Knowledge and Understanding

Critically analyse factors, including social, ethical and sustainability considerations, that impact designed solutions for global preferred futures and the complex design and production processes involved ACTDEK040

Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions ACTDEK041

Investigate and make judgments, within a range of technologies specialisations, on how technologies can be combined to create designed solutions ACTDEK047

Design and Technologies Processes and Production Skills

Apply design thinking, creativity, innovation and enterprise skills to develop, modify, and communicate design ideas of increasing sophistication ACTDEP049

Cross Curriculum Priority:

Sustainability.

General Capabilities:

Literacy, ICT capability, Critical and creative thinking, Ethical understanding and Personal and social capability.

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

Sydney's Living Seawall Project

Learn about the Sydney Institute of Marine Science and its **Living Seawall Projects** where seawalls are being enhanced with habitats.

Plastic Bank

Learn about the **Plastic Bank** that empowers disenfranchised communities to remove plastic from the ocean and then to exchange it for currency.

Blue Carbon

Discover more about blue carbon and the **Blue Carbon Laboratory** at Deakin University.

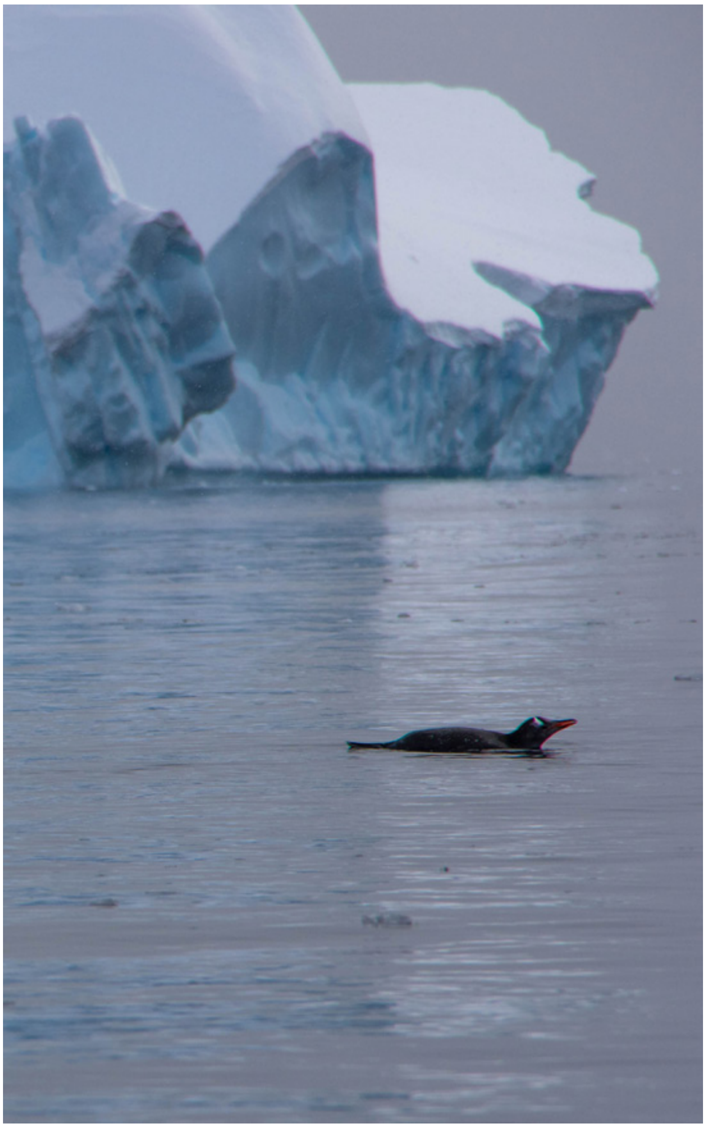

Photo: Bob Winters

HAVE A GO AT THIS!

Activity 3: Renewable energy systems

Scientists and researchers at the Blue Economy CRC in Launceston, Tasmania, are aiming to identify and develop offshore renewable energy systems that potentially can generate, capture and store energy that might support offshore aquaculture operations.

Renewable energy *is energy* that comes from natural resources such as sunlight, wind, waves, tides, geothermal heat, and agricultural wastes, which are renewable (naturally or sustainably replenished).

Your task is to design an offshore ocean-based research centre that is powered by renewable energy. Might you consider hybrid systems that use two renewable sources?

View pages of **The Usborne Book of the Future** published in 1979 for inspiration. How much of this has come true?

Hybrid Renewable Energy Generation

Discover how engineers at **Hydro Tasmania** are changing the existing power system, integrating it with renewable power sources like wind and solar, to create a more sustainable energy future. Read about Hydro Tasmania's **success stories** about the design used which combines and produces electricity from at least two technologies. Investigate an **app** with real time energy dashboards and interpret the data they provide.

HAVE A GO AT THIS!

Activity 4: Aquaculture systems

Scientists and researchers at the Blue Economy CRC in Launceston, Tasmania are also involved in designing infrastructure that can support the development of offshore systems for aquaculture that are aiming to produce their own energy from wind, wave and tidal energy systems.

Learn about what's involved in aquaculture. Did you know that aquaculture production systems vary, and many are being informed by scientific research and the implementation of scientific findings?

Aquaculture can involve 'water-based' and 'land-based' techniques and aquaculture can be undertaken in ponds, pens, tanks, cages, baskets and racks.

There can be various stages of aquaculture operations including:

- a hatchery operation, which produces fertilised eggs, larvae or fingerlings;
- a nursery operation, which produces small larvae to fingerlings or juveniles; and
- a grow-out operation, which farms fingerlings or juveniles to marketable sizes.

View a **video** (3:41 mins) or view **images** to learn more about aquaculture designs and construction.

Then, view a **TEDX Talk** (15:18 mins) about vertical ocean farming that grows seaweed and shellfish and is designed to restore ecosystems, mitigate climate change, and create blue-green jobs for fishermen.

Record key ideas shared about the designs used, the methods and technologies used in farming various species. Then, design an offshore sea-cage structure that can farm and produce a type of seafood in the ocean.

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INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

Aquaculture

Discover how farming on the sea was envisaged in 1979 in **The Usbourne Book of the Future**.

Fish X

Discover more about the FRDC **Fish X** program that looks for people in the fisheries and aquaculture industries who have big ideas.

It's all about the data

Learn about **Farm Mojo** which is a machine learning based mobile application that helps shrimp farmers achieve more sustainable farming practices through data. Read about how it helps aquaculture farmers achieve maximum efficiency by regulating the feed inputs in their systems, how it assists with early diseases prediction, timely actions, and can reduce the operational costs of the aquaculture farm.

HAVE A GO AT THIS!

Activity 5: Design a satellite that can track the ocean

Since 1992, NASA, the National Oceanic and Atmospheric Administration (NOAA), and European partners have been tracking the ocean surface from satellites that are more than 1,336 kilometres above the Earth.

Your challenge is to investigate satellite designs. Then sketch, ideate, and design a satellite that might measure sea level rise or how much the icesheets and glaciers are shrinking.

Read about the many satellites and associated technologies being used by NASA to track changes in our oceans **here**.

Learn more about satellites and how NASA suggests you might design a satellite **here**.

Design your satellites with its technologies that can capture data about our oceans and present it as part of National Science Week.

Share photos and students' work samples via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of children in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek! Please ensure that you have parental permission prior to posting any images of students.

Innovation for the future of our oceans: case study

Classroom on the Reef

Learn about **Classroom on the Reef**, and discover how a set of camera systems coupled with a series of sensors on James Cook University's Orpheus Island Research allows secondary school students in Queensland schools monitor the underwater environment in, and around the island.

INNOVATION FOR THE FUTURE OF OUR OCEANS:

case studies

Pisces

Learn about a new technology designed by **SafetyNet Technologies** that emits light and helps fishers target the fish they want to catch and reduces bycatch.

Activity 6: Bycatch in our oceans

When fishers target species they want to catch, they also sometimes catch other species by accident. These non-target species are called bycatch and can include fish, sharks, marine mammals, marine reptiles, and seabirds or invertebrates, such as crabs and shells.

The type of bycatch depends on the type of fishing gear and fishing method used and where and when the fishing takes place.

Bycatch can be caught in commercial, recreational and indigenous fisheries, because most conventional fishing methods can lead to bycatch being caught.

Australian fisheries are trying to reduce bycatch. The management of commercial fisheries focuses on the impact of fishing on, not just the target species, but also bycatch species, the marine habitats and ecosystems in which fishing occurs. This is called an ‘ecosystem approach’. The management of bycatch is necessary for several reasons:

- to prevent waste: if the bycatch is not going to be used, catching it should be avoided as much as possible;
- to reduce the work for fishers in sorting their catch and prevent damage to the catch from bycatch species;
- to ensure the catch of a particular species as bycatch does not threaten the long-term survival of a population. This is particularly important for species that are considered vulnerable to local and even global extinction due to declining numbers;
- to minimise impacts on bycatch species that are protected under Australian legislation; and
- to ensure the catch of a particular species as bycatch does not adversely affect the marine ecosystem, e.g., through removal of predators or key prey species from a food web.

Photo Mark Caldicott from Pixabay

Fish and Invertebrates

Bycatch includes unwanted fish species and small individuals (usually juveniles) of the species being targeted. Many commercial fisheries try to reduce and avoid the catch of small individuals through modifications to their fishing gear.

In fisheries that use trawl gear to target fish, there is usually a minimum mesh size that enables small individuals to pass through the mesh and not be retained in the trawl.

In hook and line fisheries, the size of the hook and bait used will determine the size of the fish caught. To avoid catching juveniles, a larger hook can be used.

In most tropical prawn trawl fisheries, there tends to be a lot of bycatch caught, mainly fish and invertebrates (crabs, shells, sponges, etc). This is because the trawl nets are unselective, and these species live in the same area as the prawns and so are caught by the nets.

In recent years, there has been a lot of effort in the development of Bycatch Reduction Devices (BRDs), which allow the fish to escape from the net, while still retaining the prawns. These include devices such as "square mesh windows", "fish-eye" and the "fish box". These all work on the fact that fish have better swimming abilities than prawns and can actively escape if there is a device to let them out.

In lobster pot fisheries, there are escape gaps in the pots through which undersized lobsters to can crawl out.

Turtles

In Australia, all boats that use trawl nets to target prawns in tropical waters must have Turtle Excluder Devices (TEDs) fitted to their nets. Turtles are occasionally caught as bycatch by prawn trawlers as they occur in the same areas where the fishing occurs. The TEDs are a grid within the net. If a turtle enters the net, this grid guides it to an opening at the top of the net so that it can escape. The prawns pass through the grid to the end of the net and are caught. The use of TEDs has dramatically reduced the bycatch of turtles in Australian tropical prawn trawl fisheries. At the same time, safe handling procedures for turtles have been developed for fishers, in case a turtle is still caught. The TEDs have also benefited larger sharks and stingrays, as they are also able to escape through this device and so fewer are caught as bycatch.

Sharks

Some sharks are protected species in Australia, such as the grey nurse shark and great white shark. Some other sharks, mainly deep-water species are of concern, as they tend to be long-lived, slow growing and can be susceptible to overfishing.

Fisheries around Australia have taken steps to reduce shark bycatch.

In Australia's tuna longline fisheries, the Eastern Tuna and Billfish Fishery and the Western Tuna and Billfish Fishery, sharks are a bycatch that are sometimes retained and sold (a by-product). However, this does not include any protected shark species that cannot be kept. To manage and reduce shark bycatch, these fisheries have a limit of 20 sharks that can be retained in a fishing trip. These fisheries have also banned the use of wire trace. Wire trace is a length of wire used to attach the hook to the fishing line. Without wire trace the sharks have a greater chance of biting through the fishing line and not being caught.

In the South East Scalefish and Shark Fishery, areas have been closed to reduce the bycatch of school shark and deepwater shark species.

In the Northern Prawn Fishery, the introduction of TEDs has also reduced the bycatch of large sharks and rays.

Seals and Sea Lions

Seals, mainly the Australian Fur Seal and occasionally the NZ Fur Seal and Australian Sea lion, interact with boats using trawls to catch fish in southern Australian waters and may be accidentally caught. The interactions occur because the seals occur in the same areas as the fisheries, they are inquisitive, and their diet includes the fish targeted by the trawlers. Seals can also learn to associate trawlers with food and may be attracted to fishing boats.

These fisheries have been looking at whether Seal Excluder Devices (SEDs), which are very similar to TEDs, are effective at reducing seal bycatch. The Commonwealth-managed South East Scalefish and Shark Trawl Fishery also has a Code of Practice, which describes fishing practices aimed at reducing interactions and bycatch of seals. These include:

- Not deploying trawl gear when seals are near the stern of the vessel.
- Rapidly deploying gear to reduce the time the gear is in shallow water where the seals are most likely to be.
- Not turning during trawling if the net mouth is near the surface, to avoid potential trapping of seals in the net.

Seabirds

The accidental bycatch of seabirds, particularly albatross and petrels, in pelagic longline fisheries is of global and national concern. In Australia, it is addressed through Australia's Threat Abatement Plan – Bycatch of Seabirds. Seabirds dive on the baited hooks when the hooks are near the surface during setting or hauling of the longline and can get hooked or entangled.

A range of measures have been introduced in fisheries to reduce bycatch of seabirds; these include:

Setting the longlines at night, as most seabirds are less active at night.

Using tori-lines or bird-scaring lines. These are lines attached to a pole at the back of the boat that extend out above where the hooks are being set or hauled. The tori-lines have streamers on them, which stop the birds from trying to get the baits.

Using weighted swivels on the hooks. These are weights that make the hooks sink faster, so that the birds cannot get them.

Other things that are being researched include: dyeing the baits so it is harder for the birds to see them and underwater setting chutes so the birds can't get the baits.

Seals and Sea Lions

Fishers, researchers, and managers are also working together to collect more information on seal interactions in this fishery to understand the bycatch issue.

A small population of Australian sea lions lives along the mid-west coast of Western Australia. This population overlaps with the western rock lobster fishing grounds, which is both a commercial and recreational fishery. While a rare occurrence, small sea lion pups can become trapped in the rock lobster pots and drown. The industry, researchers, and government have worked together to develop Sea Lion Excluder Devices (SLEDs), which are simple, relatively cheap devices, basically an upright bolt fitted to the base of the pot that rises towards the pot opening. It stops the sea lion pups entering the pots but does not affect the catch of lobsters. All rock lobster pots, both commercial and recreational, used in the waters near the sea lion population must have SLEDs.

Source: **Australian Government Department of Agriculture**.

Your design brief:

There is a public perception that some fish are being discarded when caught as they may be undersized or not targeted by people who fish and provide us with a food source.

Your task is to re-engineer a range of bycatch reduction devices.

Can you re-engineer and design a bycatch reduction device for lobsters to ensure baby or undersized lobsters are not caught by standard lobster pots?

How might you re-design fishing nets that are meant to target prawns but also catch other small fish?

Could you re-design some other type of bycatch reduction device? Which one? How? Why?

Research and find information about bycatch reduction devices that use fisheyes, different types of mesh, radial escape sections, square mesh panels, grids, or turtle exclusion devices which are all about trying to sort the catch as it starts to collect towards the back of a net.

Did you know that recent research has focussed on making modifications to the front of nets? How might these modifications be designed? How might they work?

Read an article on pages 4-6 about bycatch reduction devices in the Fisheries Research and Development Corporation's **FISH magazine**, Volume 25 Number 2, June 2017.

MARINE SCIENCE

HAVE A GO AT THIS!

Activity 7: A change starts with ideas

Scientists have recorded many threats to the ocean, however there are solutions to threats as well.

View an **infographic gallery** that cites a number of threats to the ocean and use a SWOT analysis to identify not only the threats but also the opportunities they might present.

Use a SWOT analysis and find a solution for the ocean.

Choose a concept that is a threat to the ocean and identify the following:

- strengths of the concept;
- weaknesses of the concept;
- real opportunities that the concept offers the ocean; and
- threats that might adversely impact the ocean environment.

Share these during National Science Week in 2020.

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