Want to bring your **ideas to life?**

Be part of an...

INVENTION CONVENTION

about marine parks in **South Australian waters**

An Educational Resource

for Years 5 & 6

Australian Government
Parks Australia

Australian Marine Parks

Government of South Australia
Department for Environment and Water

National Parks and Wildlife Service South Australia

Acknowledgements

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The curriculum-linked resource is designed to support teachers in schools implement teaching and learning programs about marine parks in South Australian waters.

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Contents

Introduction

The ocean is inextricably linked to our land and atmosphere through complex processes that support life. The ocean also supports rich biodiversity.

Amazingly, the ocean produces half the oxygen we breathe, so no matter where on earth you live, you are connected to the ocean and rely on it to survive. As an island nation, surrounded by the third largest marine jurisdiction in the world, this connection is very real for many Australians. This marine environment supports incredible habitats and species, drives our climate and weather, provides jobs, food, and resources, and offers us a special way of life. We have a responsibility to protect it and every Australian can play their part.

This resource book aims to support teachers in primary schools engage students in appreciating more about marine parks in South Australian waters, both Commonwealth and State. They will build an understanding of where marine parks are in South Australian waters, what benefits they provide us with, and how a variety of tools and techniques are used to survey, monitor, track and help protect the marine plants and animals they help protect.

Aim

In schools, there is scope for teachers to integrate this resource book into their existing classroom programs. The resource book provides schools with opportunities to:

- develop understandings about the role of marine parks in addressing complex real-world scenarios.
- develop understandings about the importance of attaining sustainability for marine parks.
- discover ideas and solutions to take action to tackle sustainability challenges as individuals, as a community and as the future decision-makers who need and use marine parks.
- discover and envision a range of creative solutions to real-world problems.
- design research projects with the goal of reflecting on appropriate local actions to ensure marine parks are managed appropriately to support marine conservation goals as well as the sustainable use of marine resources.
- design the steps required to create sustainable solutions for the problems.
- dream and consider the many possible solutions to deal with sustainability challenges.
- deliver and debrief solutions.
- practise and reinforce the sustainability messages delivered in the Australian Curriculum Learning Areas, General Capabilities and Cross Curriculum Priorities.

Leafy seadragon

Image: Carl Charter

How to use this resource book

This resource book provides learning experiences to support your school's involvement in marine parks in South Australian waters.

Teachers can use the following learning experiences to plan, stimulate, support, and inspire their learning about these important areas.

The resource book includes ideas to support students' involvement in investigating, exploring, experimenting, designing, creating, and communicating their understandings about marine parks in South Australian waters.

Curriculum focus

This learning resource has a variety of student activities that link to the Australian Curriculum in STEM, particularly in Technologies and Science. It also has many opportunities to integrate the Sustainability Cross Curriculum Priorities and General Capabilities.

Students develop an understanding of the roles STEM, innovation, and design play in understanding real-world scenarios in the marine parks around South Australia. They discover how STEM has, and is, enabling marine park scientists and researchers design solutions to deal with the challenges being experienced in marine parks in South Australian waters.

This unit includes ideas to support students' involvement in investigating, exploring, designing, creating, and communicating their understandings about marine park practices that make use of scientific, technological, ecological, economic knowledge. It supports students to design, plan and evaluate marine park activities, technologies, and equipment.

Students can invent or re-design a device, tool or technique that can survey, monitor, track and help protect the marine plants and animals in marine parks in South Australian waters. The chosen activity is not limited to activities already occurring in these marine parks. It can include new ideas, or ideas from elsewhere in Australia or the world.

A suggested learning methodology

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.

Curriculum Connections

Content Descriptions Source: (ACARA, 2015)

Technologies (Years 5 & 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

Science (Years 5 & 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

Science Inquiry Skills

With guidance, pose clarifying questions and make predictions about scientific investigations ACSIS231ACSIS232

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

General Capabilities

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

Cross Curriculum Priority

Sustainability

Organising Ideas

OI 2: All life forms, including human life, are connected through ecosystems on which they depend for their wellbeing and survival.

OI.3: Sustainable patterns of living rely on the interdependence of healthy social, economic and ecological systems.

OI.4: World views that recognise the dependence of living things on healthy ecosystems, and value diversity and social justice are essential for achieving sustainability.

OI.5: World views are formed by experiences at personal, local, national and global levels, and are linked to individual and community actions for sustainability.

OI.6: The sustainability of ecological, social and economic systems is achieved through informed individual and community action that values local and global equity and fairness across generations into the future.

OI.7: Actions for a more sustainable future reflect values of care, respect and responsibility, and require us to explore and understand environments.

OI.8: Designing action for sustainability requires an evaluation of past practices, the assessment of scientific and technological developments, and balanced judgments based on projected future economic, social, and environmental impacts.

Learning Goals

Learners will:

- Understand the biodiversity values of marine parks in South Australian waters.
- Understand the human and economic uses and values of marine parks in South Australian waters.
- Understand aspects of marine park management, including sustainable use practices and take actions to ensure adherence to best environmental practices.
- Investigate the purposes of tools and systems that are used to survey things in marine parks, monitor things in marine parks and track animals in the marine parks in South Australian waters.
- Invent or re-design a device, tool or technique that can survey, monitor, track and help protect the marine plants and animals in marine parks in South Australian waters.

Learning Intention

Explain to the students that their task is to invent or re-design a device, tool or technique that can survey, monitor, track and help protect the marine plants and animals in marine parks in South Australian waters. This is not limited to techniques already in use in these areas. Ideas can be taken from elsewhere in Australia or the world and applied to marine parks in South Australia where appropriate.

Marine parks in South Australia

Marine parks are internationally recognised as an important way to help us conserve marine biodiversity and support the sustainable use of marine resources like fish, tourism potential and oil and gas. Marine parks often work alongside other management efforts to keep our marine environment healthy, including limiting the number of fish that can be caught and restricting the use of harmful chemicals. The United Nations encourage countries all around the world to look after their marine environment (Sustainable Development Goal 14). One of the key indicators (Sustainable Development Goal Target 14.5) is the establishment of marine parks. In Australia, 37% of our marine environment is currently protected within a marine park: we are doing a good job meeting this global target.

In South Australia, there are 26 marine parks. Nineteen of these occur in coastal waters and are managed by the National Parks and Wildlife Service South Australia and the remaining seven occur in offshore waters and are managed by Parks Australia, a Commonwealth government agency.

This means that marine parks can be established by either the Commonwealth, the Northern Territory, or the states. In South Australian waters, there is a mix of State and Commonwealth marine parks. An important design principle for marine parks is that, where possible, they should complement existing management measures. In South Australia, the newer Commonwealth marine parks were positioned so that boundaries and zones align across State and Commonwealth waters, extending protection for habitats, species and the processes that connect them.

What is in a name?

There are lots of different names for marine parks – which means it can get confusing quickly! Often, people refer to marine parks in slightly different ways to distinguish their purpose, their rules or who manages them. It isn't necessary to be across all the terms but is useful to be aware that even in South Australia, some marine parks are called different things but have the same purpose (Sanctuary Zones (core conservation zones) in State marine parks are the same as National Park Zones in Commonwealth marine parks)). This article provides an interesting overview.

Marine Parks 101

How do marine parks work?

A marine park is an area of our marine environment where rules apply to limit human activities. Marine parks can be established to protect fragile habitats like corals or seagrass or sensitive life events like birth or migration – they are often parts of our marine environment we know more about – but not always. Marine parks also protect representative examples of "ordinary" habitats found in an area, as in the design process, habitats are usually a surrogate for biodiversity. Marine parks also protect areas of seafloor that are unmapped, or areas we do not know very much about yet (the precautionary principle). These kinds of marine parks play an important role in supporting overall marine health and resilience.

Are marine parks just for nature?

No! Marine parks are for humans and nature. Most marine parks are zoned – different rules apply in the different zones – and this is how managers make sure marine parks balance different needs and provide benefits for all. Please refer to zoning infographic in the Appendix.

Why are there different marine parks?

The responsibility for looking after Australia's marine environment is shared between the Commonwealth and the individual states and the Northern Territory. The latter are responsible for coastal waters, defined as generally 0 – 3 nautical miles from shore. The Commonwealth look after waters from 3 nautical miles out to the edge of our Exclusive Economic Zone (200 nautical miles*). There are a few places around Australia where these figures differ slightly. The Commonwealth is also responsible for the waters surrounding our seven offshore territories.

* A nautical mile (M) is a unit of distance equal to 1852 metres.

South Australia's State marine parks

State and Territory governments in Australia have established many marine parks. Some are natural extensions of their National Parks or nature reserves, whilst others are discrete sites. These marine parks protect a range of habitats including wetlands, inshore reefs, seagrass beds and all of the marine species that depend on them.

The South Australian Government manages a network 19 marine parks in its State managed waters. These marine parks cover 44% of these waters, with 6% protected within Sanctuary Zones. They span from the Victorian border to the Western Australian border and include coastal and offshore waters, gulfs and offshore islands. They are designed to represent the vast range of habitats and ecosystems within South Australia's eight marine bioregions (as scale models of these bioregions).

South Australia's waters are rich and unique and are part of the Great Southern Reef. They are in a temperate marine zone and support a range of habitats and species of biological importance, whilst also allowing for sustainable uses such as fisheries, tourism, shipping and other marine industries.

South Australia's fisheries range from large-scale industrial-sized fisheries such as prawn, shark and lobster fisheries, to small-scale community-based fisheries such as those which operate within the Marine Scalefish and Lakes and Coorong fisheries. These fisheries support commercial, recreational and Indigenous traditional fishing activities which contribute to the social and economic well-being of the State and many regional coastal communities.

Did you know that marine parks in the Great Australian Bight were established to protect breeding populations of southern right whales? It has both State and Commonwealth managed marine parks. The Far West Coast Marine Park is managed by the State Government and the adjacent Great Australian Bight Marine Park is managed by the Commonwealth Government.

You can find your local State marine parks by using this interactive mapping tool.

Discover the remarkable range of species the State marine parks protect on the Plants and animals page or by visiting the life in our bioregions page.

You can find out more about the science behind State marine parks on the Understanding the effectiveness of marine parks page or the scientific reports page.

You can find out about what's protected in individual State marine parks in the Marine Parks Report and Management Plan sections on Enviro Data SA.

You can find out more about South Australia's marine environment by visiting The Rockpool, the Great Southern Reef, the Good Living Blog, and virtual tours of EP Marine Parks and NRM Education and Experiencing Marine Sanctuaries.

South Australia's Commonwealth marine parks

The seven Commonwealth marine parks – also called Australian Marine Parks – off South Australia protect a total of 139,595 km². That is a lot of ocean! Together these marine parks protect an incredible range of habitats, plants, and animals.

In some areas of the parks, water depths are quite shallow (~15 metres). Here, where conditions are warmer, lighter, and more protected, coral, and rocky reefs and seagrass beds thrive. The residents of these habitats are quite familiar – you will find Australian sea lions, octopus, flathead, rock lobster and weedy sea dragons. These areas are used by a wide range of people including recreational fishers and tourism operators.

As you move further offshore, the seafloor slopes away and conditions become more hostile for humans – but biodiversity still flourishes. The seafloor can be broadly characterised in three zones: the continental shelf, continental slope and the abyssal plain. Examples of all three zones are found in Australian Marine Parks, with some areas 6000 metres below the ocean surface. Depth strongly influences the types of animals you find living on the seafloor, as does substrate and gradient. Substrates can be categorised into many different types but they're broadly hard or soft – the soft areas are made up of sands and muds and can look quite sparse at first glance but provide a great home for many burrowing animals like worms, molluscs and brittle stars. The hard areas provide a great surface for a range of habitat-building species like corals and sponges which in turn provide food and shelter for other plants and animals. Seafloor gradient is influenced by features like hills, valleys, canyons, or the continental slope. Some of these features are immense, like the Murray Canyon in Murray Marine Park which is bigger than the Grand Canyon. These features influence the movement of surrounding water, creating localised currents that benefit filter feeders; they are often associated with higher benthic (animals that live in association with the seafloor) diversity. Did you know? These offshore marine parks are an important feeding ground for Australian sea lions who dive to depths of 80 metres to eat benthic species like perch, rays, and cuttlefish.

If a seafloor feature is large enough, they also influence water movements further away, creating eddies and upwellings. These oceanographic habitats aggregate nutrients in the water column, fuel hotspots of phytoplankton and zooplankton, the bottom of the ocean food web. Free-swimming animals of all shapes and sizes flock to these hotspots to feed, from schools of anchovies and mackerel, to tunas and white sharks. Seabirds like albatross and petrels will travel hundreds of kilometres to feed in these locations and scientists also believe that they influence the migration routes of species like whales.

Fewer humans venture to the farthest reaches of these marine parks but they do support economically important commercial fisheries and the oil and gas sector. Did you know? The Great Australian Bight supports Australia's most valuable fishery, the Southern Bluefin Tuna Fishery.

- Australian Marine Parks website
- Australian Marine Parks are managed in networks – take a look at the South-west Marine Parks Network and South-east Marine Parks Network . Encourage students to identify the seven Australian Marine Parks that occur along the South Australian coastline and research each one.
- Australian Marine Parks protect natural values – use the Australian Marine Parks Science Atlas to explore these in more detail. Using the interactive map, select the park of your choice and select the 'natural values' tab at the top. Encourage students to identify at least one biologically important area, bioregion and key ecological feature that occurs in an Australian Marine Park off South Australia.
- Look at the species that live within the marine parks using Atlas of Living Australia – the interactive map. Turn on the marine parks layer, using the menu to the left. Double click on the park of your choice to see a list of species that have been recorded to occur there. Encourage students to search for records of species like Australian sea lion, flesh-footed shearwater, shy albatross, laternfish and sperm whale.
- Look at habitats or habitat characteristics within Australian Marine Parks using the interactive mapping site Seamap. The menu to your left contains different layers of information under 5 key groups – go to Management Region Layers and select ***Aus Marine Parks (2018)*** – click on the eye icon to see the information.

TOP TIP!

Use the zoom function to highlight waters off South Australia. Encourage students to toggle through the layers, turning data on and off to explore what we know about the marine environment.

Alternatively, explore the following features and discussion points to help students understand important aspects of the offshore marine environment:

- **Sea surface temperature** (SST) is a habitat characteristic of the pelagic environment. Sustained areas of low SST can indicate upwellings or meso-scale eddies which drive enhanced productivity. Show the Third-party layer tab – SST seasonal variation layer (see image below). Red/orange areas indicate higher SST (warmer waters) and blue areas indicate lower SST (colder waters). Can you spot South Australia's most famous seasonal pelagic feature, the Bonny Upwelling on the map? What do you notice about the waters in the gulfs or areas like Streaky Bay or Smoky Bay?

- **Bioregions** are areas of the seafloor with broadly similar characteristics and communities. They were defined to help Australia select marine park areas that included all our marine habitats and species. Show the Management Regions Layer Tab – IMCRA. How many bioregions are present in South Australia's offshore waters and how many are represented within an Australian Marine Park?
- **Bathymetry** or depth is significant habitat characteristic that influences what species are found in an area. Show the Bathymetry Layers Tab – 50m Resolution Bathymetry Grid. Ask the students to think about species that like to live at 15 m depth vs 150 m depth – what differences are there be that might affect the ability to live there... light, pressure, temperature.
- Seafloor features influence benthic and pelagic marine communities. Review Australian Marine Park's Key Ecological Features here and see if you can see where these features occur using the Third-party Layers Tab – Regional – Aus Hillshaded Bathymetry layer. Encourage students to name three key ecological features that occur in Australian Marine Parks around South Australia?
- Consider economic activities within Australian Marine Parks including shipping, oil and gas, and commercial fishing (you can view these in Seamap). You can also read:

  – 2017 government report 'The Economic contribution of South Australia's marine industries'

  – Generic infographics – tourism and ocean wealth

Managing marine parks

Managing marine parks is challenging. It depends of lots of different people working together to contribute their knowledge and skills.

Science plays an important role in both creating marine parks and looking after them. Scientists have spent years studying South Australia's unique marine environment which means we know a lot about the animals, plants, and habitats here, especially if they occur close to shore or have an important commercial or community value. Less is known about the habitats and species that live in deeper water: exploring the midnight zone pushes the very limits of our technical ability and is expensive.

In the marine environment, scientists use a range of methodologies to learn about an area (this cool infographic provides a good overview). Typically, researchers will start by looking at the habitat. This is because the presence or absence of certain habitat characteristics give us lots of clues about the kinds of animals and plants that are likely to live there or where to focus your research efforts. In shallow water, you can create habitat maps using high-resolution photography and satellite imagery or in deeper water, we use remote cameras to capture images and equipment that send out sound waves to "see" seafloor features.

TOP TIP!

Interactive mapping tools are a great way to explore marine parks and interrogate available scientific data. Explore State marine parks using Naturemaps (switch layers on and off to see different features) and Commonwealth marine parks using the Science Atlas or these maps. You can also view outer marine park boundaries and management zones using these tools.

You can find out about South Australia's coastal marine habitats here.

In addition to helping us discover new things about the marine environment, scientists also monitor the things we already know. Regular surveys can include counting the number and type of species observed in specific areas (called reference sites). This type of data helps us understand how our marine environment is changing over time and if we're making the right management decisions. You can find out the latest Status Report for South Australia's State marine parks here.

Not all knowledge is new! Aboriginal people, South Australia's traditional owners, have collected knowledge about coastal lands and the marine environment for thousands of years and passed it from generation to generation through stories. Over the last 20,000 years, sea levels have risen inundating land they once used. The ancient coastline (visualise it here), which now lies between 90 and 120 meters below the ocean's surface, indicates where the land once met the sea. This means that traditional owners have strong cultural connections to many areas within marine parks and have a central role to play in their management. Each group also have their own traditional language and connection to their own Country. You can find out the traditional owners of your local land and sea by using this map. Use this book about the language of the Barngarla people to learn some traditional Barngarla language and then search for the language of your local First Nations people.

Sharing what we know about marine parks is another important part of management. It is important that marine park users understand the rules or know where to access them. Information about the marine parks in South Australia are broadcast in a range of ways including through websites, apps, social media, handouts, and signs. For others, education and engagement helps build an appreciation for our marine environment, the role of marine parks and an understanding of the direct and indirect benefits they provide us all. Tour operators that operate in marine parks such as Experiencing Marine Sanctuaries play a pivotal role in this education. Sharing fantastic photographs and interesting facts and figures is a great way to achieve this. With technological advances, you do not have to visit a marine park to enjoy it or take care of it.

Education makes a big difference to the way people use marine parks – most of us want to do the right thing – but there are still people that do not know the rules or choose not to obey them. In these instances, it is important that marine park staff are on (or above) the water to make sure everyone is following the rules. In South Australia, State and Commonwealth agencies work together to deliver this compliance program. This compliance work is a key part of ensuring threats are removed, which will give the protection the best chance of positively influencing the animals and plants in these zones. If we do not remove the threats from a zone (by not ensuring people are doing the right thing), then when we carry out the monitoring, we may not get the results we expect. An effective compliance program complements the monitoring program and ensures the marine parks are managed effectively.

The essential question:

What can you do to monitor, survey, track and protect the marine plants and animals in marine parks in South Australian waters?

Scenario:

South Australia's marine environment is fortunate to have a network of 26 marine parks. Nineteen of these occur in coastal waters and are managed by the National Parks and Wildlife Service South Australia and the remaining seven occur in offshore waters and are managed by Parks Australia, a Commonwealth government agency.

South Australia is home to some of the world's most amazing marine plants and animals. It boasts colourful marine sponge gardens, the iconic leafy sea dragon, the giant Australian cuttlefish, and marine mammals such as the Australian sea lion, southern right whales and common bottlenose dolphin. In fact, Australia's southern waters are home to 7,500 marine species, 85 per cent of which are endemic which means they are not found anywhere else in the world. The Great Southern Reef is thought to be more biodiverse than the Great Barrier Reef.

Did you know that the South Australian Government is undertaking the largest ongoing marine biodiversity monitoring programme in South Australia's history? You can find the latest results here.

An example of this is the collaborative monitoring and research expedition to Western Eyre (Commonwealth) and Investigator (State) Marine Parks around Pearson Island. Find out more about what the team did here or view the short film of their adventures here. As part of a Design Team, your challenge is to think like a scientist, engineer, traditional owner or designer and re-engineer a device, tool or technique that can be used to survey, monitor, or track the marine plants and animals that live in the marine parks around South Australia.

For example, can you re-engineer a baited remote underwater video system (BRUVs) to work at 200 metres depth? Or could you design one for your local school?

Can you think of a way to track the vulnerable listed (EPBC Act 1999) Australian sea lion as it rests, plays and forages to determine how it is using marine park waters? You can watch this video to find out how this is being done already. This video also shows how drones are being used to monitor populations.

Can you think of a way to monitor and manage the potential impacts of ecotourism on the surrounding environment. The shark cage diving industry is an example of best practice in nature based tourism, monitored and managed by the South Australian Government. You can find out more by watching this short film.

Can you research a local Aboriginal Sea-Country story and explore how that story tells us what animals and plants lived in that location and at what point in time. How has this changed?

Could you re-design some other type of tracking, monitoring or surveying device? Which one? How? Why?

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

Set up an activity day where teachers, students, and parents can learn all about the surveying, monitoring, or tracking techniques used by scientists to learn or monitor biodiversity in marine parks.

A suggested learning sequence

Step 1: Define

Objective: Have students illustrate their understanding of the challenges set out in the scenario by providing an oral definition of the task.

Share the essential question with the class and talk about the tasks that need to be addressed. See **Resource 1.1** in the Students Project Files.

Present the scenario, assign teams if appropriate, and ask learners to define the tasks they have been set. See **Resource 1.2** in the Students Project Files.

Marine parks

Explain to the class that marine parks are an important tool for protecting marine biodiversity and ensuring we can use marine resources sustainably.

Talk about how they also play an important role in supporting our economy and providing social benefits – for example, marine tourism (like Cuttlefest in Whyalla), shark cage diving or enjoying a day at the beach. Discuss how marine parks complement fishing management measures.

Explain how there are two types of marine parks in South Australian waters: those managed by South Australia which occur in near-shore waters (out to 3 nautical miles - which is approximately 5.5 kilometres from the coast) and Australian Marine Parks which are managed by the Commonwealth government and occur between 3 and 200 nautical miles from shore. Note: A nautical mile (M) is a unit of distance equal to 1852 metres.

Challenge students to locate the marine parks and record their names and locations in their Student Project Files. Remind students that they should be able to locate 26 marine parks. Ask learners to see if they can identify who manages each park (State or Commonwealth). See **Resource 1.2.1** in the Students Project Files.

Ask learners to look deeper into these marine parks and the types of management zones each marine park contains. Ask students to think about the different activities that are allowed in each zone – and to think about how a mix of zones ensure all uses and the needs of all users can be met. Think about how animals and plants utilise these marine parks. Are they resident or migratory, do they spend their whole life in one area, or do they travel for part of their lifecycle? How are these marine parks connected via physical processes like currents or upwellings? See **Resource 1.2.2** in the Students Project Files.

Scientists, engineers, traditional owners and designers

Talk about the role western science, Aboriginal knowledge, engineering and design play in identifying, establishing and managing marine parks. This work usually starts with a question or 'brief'. Explain how the brief they have been given is to think like a scientist, engineer, traditional owner or a designer and invent or re-engineer a device that can survey, monitor, or track marine plants and animals in marine parks in South Australian waters.

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

Prerequisite for progression:

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

Note: The Prerequisite for Progression are the checkpoints that occur at the end of each stage of the learning sequence. This is the time when formative feedback is given to the students about what they have accomplished in that stage. It describes what the students must complete before they move onto the next phase of the unit. (Crockett, et, al, 2011)

Step 2: Discover

Objective: Have students research, read, view, listen to, discuss, gather, organise ideas and information about devices, tools and techniques that can survey, monitor, or track marine plants and animals in marine parks in South Australian waters.

Surveying, monitoring, tracking, and protecting plants and animals in marine parks

Invite students to list the names of species they think might be monitored, tracked, or surveyed in marine parks. They can start with a State or Commonwealth marine park.

Talk with students about the conservation objective of marine parks – think about the various habitats, plants and animals we know occur in State and Commonwealth marine parks in South Australian waters. Discuss the common marine threats (climate change, marine pollution, ship strikes, fishing, human disturbance, resource use, coastal development, invasive species) and how they might impact the marine environment. Brainstorm how marine parks might help protect the marine environment by helping to reduce the impacts of those threats.

Think about what kinds of information you might need about these habitats, plants and animals to understand them (i.e., you need to identify them and count them) – and what kinds of steps would scientists need to take to track them over time (i.e., regular visits, same sites, compare diversity and abundance). What questions can we answer with this kind of data? Can we determine if a marine park is working using this kind of data? How would these results differ across a marine park zone that offered high protection (i.e., Sanctuary or National Park Zones) versus one that offers partial protection (Habitat Protection or Multiple Use Zones)?

Brainstorm and record ideas about the different ways the students think researchers might survey, monitor, or track the different animals, plants and habitats that live in marine parks around South Australia.

Introduce baited remote underwater video system or BRUVs and explain how this method is used to collect some of the necessary data – including identifying and counting marine animals and plants. Watch this video about how BRUVs are being used to monitor or read this paper. Review the video on the Western Eyre expedition and see how BRUVs was used to collect data in deeper waters. Talk about where the use of BRUVs is appropriate and its limitations with depth.

Read this blog about BRUVs use in South Australia

Discover how students at Cocos Island District High School built a baited remote underwater video system (BRUVs) platform to conduct fish surveys in their lagoon for Science Week in 2016.

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

Ask students to identify the challenges of surveying deep-sea marine environments – the recent Deep-sea Coral and Canyon Adventure undertaken by the R/V Falkor highlights the challenges of surveying nearby Bremer Canyon (This canyon is part of the Bremer Marine Park in the South-west Marine Parks Network off Western Australia).

Surveying techniques

Ask students to 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. Ask students to use the information and record four interesting points about the surveying techniques used by Geoscience Australia.

Research the RV Investigator which undertakes research and monitoring in Commonwealth waters, including Australian Marine Parks. The videos below provide an overview of the techniques they use and show how their different equipment works:

- Surveying the ocean with the RV Investigator
- Measuring our oceans on the RV Investigator
- Mapping the seafloor on the RV Investigator
- Trawling to sample biodiversity on the RV Investigator

Encourage the class to reflect on how it often takes a lot of different skills to collect the necessary data – research teams often bring together oceanographers, modellers, species specialists, statisticians and equipment technicians.

As a class, learn about CSIRO's underwater robot Starbug X that monitors and surveys ocean ecosystems. Invite students to sketch the robot and label its different parts identifying what they do.

Marine mammal (whale, dolphin and seal) research

Ask the students who has seen a marine mammal and if they know what species it was – ask about what features they can remember about their animal and see if you can decide together what it might have been. Talk about the types of marine mammals found in South Australian waters – the most commonly sighted are southern right whale, humpback whale, Indo-Pacific bottlenose dolphin, long-nosed fur seal and Australian sea lions. Discuss how all marine mammals are protected by law in Australia. Ask students to think about what threats might impact these animals - entanglements in fishing gear or other debris, ship strikes, eating plastics – and the different ways we can help protect them from these threats (Hint – including marine parks).

Use the resources from the South Australian Whale Centre and the Head of Bight Whale Centre for more information.

Ask the class to see if they can find out what the conservation status of South Australia's common whale, dolphin and seal species are. You can use the Species Profile and Threats (SPRAT) database to determine this. What is the difference between a species being listed as endangered versus vulnerable?

Discuss how these marine animals use different marine parks – e.g. southern right whale nursery in Far West Coast, Thorny Passage or Encounter Marine Parks or migrate through the offshore waters in the Great Australian Bight, Western Eyre or Nelson Marine Parks. Consider the Indo-Pacific dolphins in the Adelaide Dolphin Sanctuary. Encourage students to think about why it might be important to have a network of marine parks? (Hint: marine species depend on different areas of the ocean to support different behaviours)

Think about how Australian sea lions use rocky coasts and beaches in State marine parks like Southern Kangaroo Island Marine Park to rest and nurse their young and head further offshore to waters within Western Eyre or Murray Marine Parks to forage. Watch a video about Australian sea lions to learn how scientists are tracking this species. Look at this land-based tour you can do at Seal Bay and consider some of the information marine park rangers share with visitors. Ask students how they think this type of education contributes to the protection of this species. This additional video also details how drone technology is being used to monitor Australian sea lion populations.

Talk about how many people enjoy seeing whales, dolphins and seals in marine parks and how tour operators can make a business by taking them there – this creates economic benefits (business) and social benefits (it is fun and interesting to go and see marine animals up close). Talk about how this is one way marine parks benefit humans – ask students to think about what kind of rules tour operators might need to follow to make sure marine life stays safe.

The shark cage diving industry is an example of ecotourism managed and scientifically monitored by the South Australian Government. You can find out more by watching this short film.

You can use these resources to find out about rules around respecting marine mammals.

- Respect marine mammal's personal space
- Whale watching tips
- Adelaide Dolphin Sanctuary users' guide

Ask students to find the traditional words for whales, dolphins and seals in their local First Nations language. Can they find a dreamtime story about these animals and what does that tell us?

As a class, discover more about some of the research being done to monitor the southern right whale population in South Australia (the Great Australian Bight Right Whale Study and the Encounter Bay Right Whale Study). Learn how researchers identify individual whales from lumps of hardened skin on their heads called callosities. Ask the class why it might be important to identify individual whales when monitoring the population? Discuss how

everyone can contribute to this monitoring effort through the Whale Watch citizen science project (see log sightings data base to understand more.)

Look further afield and discuss 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.

Invite students to think about a way they might be able to survey, monitor or track migratory species like the Australian sea lion or southern right whale in a marine park. Brainstorm and record the student's ideas on an 'Ideas Wall'.

Understanding the physical characteristics of the ocean

As a class, view the ABC Education video (5:04 mins) and learn about a nautical robot that the CSIRO named Argo.

Discover what an argo float is. How does their design help them sink, come back to the surface, and float? What kinds of technology do they rely on to make them work?

Learn about the data it collects and how this helps us understand ocean habitats and threats like climate change.

Talk about how the floats are designed to travel through the oceans to collect scientific information. Explain that they measure temperature and salinity, two very important physical characteristics of the ocean that determine where marine plants and animals like to live. Discuss how they transmit their data to land-based centres via satellites. Think about how the probes are deployed.

Ask the class to think about what this data can be used for (i.e. create maps and climatologies) that help us understand the ocean's different zones.

Stimulate thinking by asking the following questions:

- 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 back to scientists?
- What design features will it need to be able to resurface?

Invite students to draw their own ocean robot design. Ask students to think about what kinds of data their robot will collect and what ocean zone it will be suitable for (and hence what marine park it could be used in). Include labels of its equipment and its instruments.

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 survey, monitor and track marine life and bring their findings back to class.

Prerequisite for progression:

Students have worked as a class, individually and in teams and collected research on devices and techniques that can survey, monitor, track and help protect the marine plants and animals

in marine parks in South Australian waters. Websites, videos, images, and stories are used to contextualise understanding. Students will share their ideas with peers, the teacher and family.

Step 3: Dream

Objective: Ask students to imagine how they are going to invent or re-design a device, tool or technique that can survey, monitor, track and help protect the marine plants and animals in marine parks in South Australian waters.

Ask design teams to create a vision for their device or technique that they are re-imagining. See **Resource 1.4** in the Students Project Files.

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 it help us understand the marine habitats, plants, or animals in marine parks in South Australian waters?

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

Progressions for Learning:

The class have brainstormed ideas to begin re-designing their device, tool or techniques that can survey, monitor, track and help protect the marine plants and animals in marine parks in South Australian waters. They have answered the questions posed in the dream phase.

Step 4: Design

Objective: Ask students to explain, prepare and action how they are going to invent or re-design a device or techniques that can survey, monitor, track and help protect the marine plants and animals in marine parks in South Australian waters.

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 survey, monitor or track marine plants and animals in marine parks. 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. See **Resource 1.5** in the Student Project Files.

Students will then use their labelled drawing, model, and procedure in a 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 survey, monitoring tool, or tracking device for marine plants and animals in marine parks in South Australian waters.

Progressions for Learning:

Students can document in oral or written/ digital forms how this project is to occur. The understanding is demonstrated by the students explaining their thinking to a peer in the class.

Step 5: Deliver

Objective: Have students deliver their re-designed survey, monitoring tool or tracking device to help protect the marine plants and animals in marine parks in South Australian waters.

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 re-designed survey, tool, or device that the design teams are re-imagining should be completed.

Ask students to design and create their individual design samples required in this unit. See **Resource 1.6** in the Students Project Files.

In the Publish phase, students get to 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.

Progression for learning:

Each Design Team has solutions for a re-designed survey, monitoring tool, or tracking device to help protect the marine plants and animals in marine parks in South Australian waters.

Step 6: Debrief

Objective: Assess the results of the re-designed survey, monitoring tool or tracking device to help protect the marine plants and animals in marine parks in South Australian waters.

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 re-designed solution.

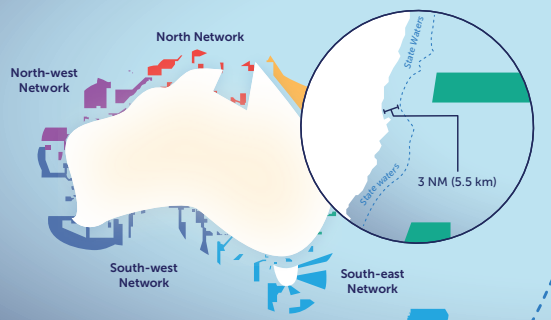
Invite students to reflect on the learning by completing a self-assessment activity. Ask questions like:

- How has my/our attitude and behaviour changed because 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? See **Resource 1.7** in the Students Project Files.

Australian Marine Parks

Australian Marine Parks protect our offshore marine environment

The Australian Government manages waters between 3 and 200 nautical miles offshore.



Managing our marine parks is a balancing act.

Australian Marine Parks cover 2.8 million km². That's an area the size of Queensland, NSW and Victoria combined!

Zoning shows where different activities are permitted.

Green zones

Green zones protect important locations like breeding and feeding areas. Here you can watch wildlife, snorkel, dive and do research.

Yellow zones

Yellow zones protect sea floor habitats like reefs and seamounts. Watch wildlife, snorkel, dive, do research and fish, but don't disturb the seafloor.

Blue zones

Blue zones allow other sustainable activities like fishing. Here, and in yellow zones, Australian fishers can provide us with the seafood we love.

Australian Marine Parks

protect habitats and species

support sustainable marine industries

are amazing places to enjoy

Marine parks achieve the best conservation and sustainable use outcomes when park users, Traditional Owners and local communities are engaged and supportive. We work alongside our stakeholders to deliver all aspects of management so that they're places we can all enjoy and benefit from.

Australian Marine Parks

Visit parksaustralia.gov.au/marine to learn more

Australian Government
Parks Australia

Australian Marine Parks

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Student Project Files

Image: Carl Charter

Giant Australian cuttlefish

In memory of Ethan London

The Project File

> Your Project File is a vital communication tool for your project. It should document your project's development.

> Start by recording your understanding of the design brief through to the final evaluation of your designed solution.

> Use concept maps, word clouds, annotated concept sketches, photographs, flow charts, labelled drawings, and information to communicate your ideas.

Resource 1.1

Your Design Brief

The essential question:

What can you do to monitor, survey, track and protect the marine plants and animals in marine parks in South Australian waters?

Scenario:

South Australia's marine environment is fortunate to have network of 26 marine parks. Nineteen of these occur in coastal waters and are managed by the National Parks and Wildlife Service South Australia and the remaining seven occur in offshore waters and are managed by Parks Australia, a Commonwealth government agency.

South Australia is home to some of the world's most amazing marine plants and animals. The waters of the marine parks boast colourful marine sponge gardens, the iconic leafy sea dragon, the giant Australian cuttlefish, and marine mammals such as Australian sea lions, whales, and dolphins. Of the 7,500 species that call southern Australia's waters (Great Southern Reef) home, about 85 per cent is endemic or not found anywhere else in the world. Scientists believe the Great Southern Reef has more diversity than the Great Barrier Reef.

Did you know that the South Australian Government is undertaking the largest ongoing marine biodiversity monitoring programme in South Australia's history?

An example of this is the 2018 Expedition of Discovery to Western Eyre (Commonwealth) and Investigator (State) Marine Parks. Where scientists on board a research vessel carried out a range of monitoring and research to understand more about these offshore marine parks.

You can find out more here and view a short film here.

As part of a Design Team, your challenge is to think like a scientist, engineer, traditional owner or a designer and re-engineer a device, tool or technique that can survey, monitor, track and help protect the marine plants and animals in marine parks in South Australian waters.

For example, can you re-engineer a Baited Remote Underwater Video System (BRUVS) to work at 200 metres depth? Or could you design one for your local school?

Can you think of a way to track Australian Sea lions across multiple marine parks? How would you know where they are, how can you find out what they are eating, how are they using that marine park? You can watch this video for ways this is being done already.

Can you think of a way to monitor and manage the potential impacts of ecotourism on the surrounding environment? The shark cage diving industry is an example of best practice in nature based tourism, monitored and managed by the South Australian Government. You can find out more by watching this short film.

Can you research a local Aboriginal Sea-Country story and explore how that story tells us what animals and plants lived in that location and at what point in time. How has this changed?

Could you re-design some other type of tracking, monitoring or surveying device? Which one? How? Why?

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

Set up an activity day where teachers, students, and parents can learn all about the surveying, monitoring, or tracking techniques used by scientists in their everyday research in places like marine parks.

Resource 1.2

Define

> What is your challenge?

> Read your design brief carefully.

> Write a definition of the tasks and challenges you need to undertake.

Resource 1.2.1

Getting to know South Australia's marine parks

South Australia has 26 marine parks in its waters. Nineteen of these are managed by the South Australian Government and seven are managed by the Commonwealth Government.

> Your task is to research and record the names and locations of the marine parks managed by the South Australian and Commonwealth governments in the space below. Remember 26 different ones can be found.

> Can you identify who manages each park (State or Commonwealth)?

> Remember to locate the marine parks off South Australia only.

Marine park name	Location – Coastal (C) or Offshore (O)	South Australian	Commonwealth

Resource 1.2.2

South Australia's marine parks – zones and connections

Marine parks are often made up of different zones. This approach helps marine parks benefit nature and humans at the same time. Each zone has different rules - which affects the level of protection they provide.

TOP TIP!

Commonwealth and State marine parks share similar zone types but some have slightly different names.

> Sanctuary Zones (State marine park) and National Park Zones (Commonwealth marine park) provide the same level of protection. Find and record what activities are allowed in these zones. What activities are not allowed?

Clue - these zones are often referred to as 'no-take zones'

Activities	Marine park zone					
	Sanctuary zone	National Parks Zone	Habitat Protection Zone (State)	Habitat Protection Zone (Commonwealth)	General Manged Use Zone	Multiple Use Zone
recreational fishing	✓ ✗	✓ ✗	✓ ✗	✓ ✗	✓ ✗	✓ ✗
commercial fishing	✓ ✗	✓ ✗	✓ ✗	✓ ✗	✓ ✗	✓ ✗
mining	✓ ✗	✓ ✗	✓ ✗	✓ ✗	✓ ✗	✓ ✗
tourism	✓ ✗	✓ ✗	✓ ✗	✓ ✗	✓ ✗	✓ ✗
aquaculture	✓ ✗	✓ ✗	✓ ✗	✓ ✗	✓ ✗	✓ ✗
scientific research	✓ ✗	✓ ✗	✓ ✗	✓ ✗	✓ ✗	✓ ✗
surfing	✓ ✗	✓ ✗	✓ ✗	✓ ✗	✓ ✗	✓ ✗
diving/snorkelling	✓ ✗	✓ ✗	✓ ✗	✓ ✗	✓ ✗	✓ ✗

Think about how animals or plants may be protected by a Sanctuary or National Park Zone.

> How do animals use marine parks and their zones. Are they resident or migratory, do they spend their whole life in one area, or do they travel for part of their lifecycle?

> Use the Australian sea lion as an example and describe how they use different parts of the ocean and how they use different marine parks and their zones. Why is it important to the Australian sea lion to have many marine parks and many sanctuary or conservation zones?

Clue - they don't stay in the one place (video).

Resource 1.3

Discover

Surveying, monitoring, tracking, and protecting plants, animals and habitats in marine parks. Let the research begin.

Identify what you need to know and what you need to be able to do.

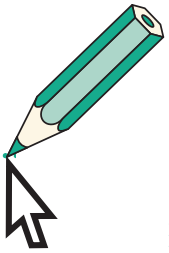
Record notes about BRUVS in the space provided below.

Take notes about the surveying techniques used by scientists to help understand more about the animals, habitats and plants found within marine parks.

Then, record four interesting points about the surveying techniques used.

Tell me what you know about robots that monitor and survey marine parks.

Sketch a robot and label its different parts and identify what they do.



My favourite way I think that I might be able to survey, monitor or track a whale, dolphin or seal in a marine park is...

Reflect on what you know about ocean probes and answer the questions below.

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?

Resource 1.4

Dream

What does the blog post look like in your mind?

Visualise a creative and appropriate design solution.

Resource 1.5

Design

Prepare a project plan and outline what needs to be done, who is responsible, when things will be done and write it down as a suggested order of the work.

> What do I need to do?

> How will I gather the information?

> How will I create my designs?

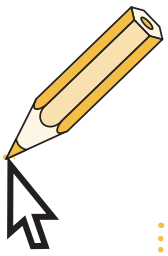
> When will I do this?

> How can my products and processes be improved?

> Other notes and ideas

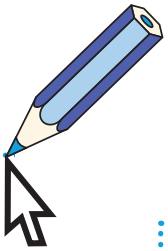
Draw your solutions.

Illustrate the steps involved in your product, system, or technology to survey, monitor, track and help protect the marine plants and animals in South Australia's marine parks.



Remember that you also need to communicate your design ideas, and instructions in labelled drawings and then build a model of it.

Illustrate your design ideas here.



Design your procedure.

You need to write a procedure of how to use the designed solution.

Write the introduction:

Write the body:

Write the conclusion:

Remember to evaluate your design, and suggest improvements, where necessary, giving reasons.

Finally, use your labelled drawing, model, and procedure in a presentation to spread the word about what might be possible.

Resource 1.6

Deliver

Make your solution(s) and place one or more photos of them here.

Resource 1.7

Debrief

Were you successful? Why or why not?

Resource 1.8

Re-Design

How would you improve your designs?

Australian Government
Parks Australia

Australian Marine Parks

Government of South Australia
Department for Environment and Water