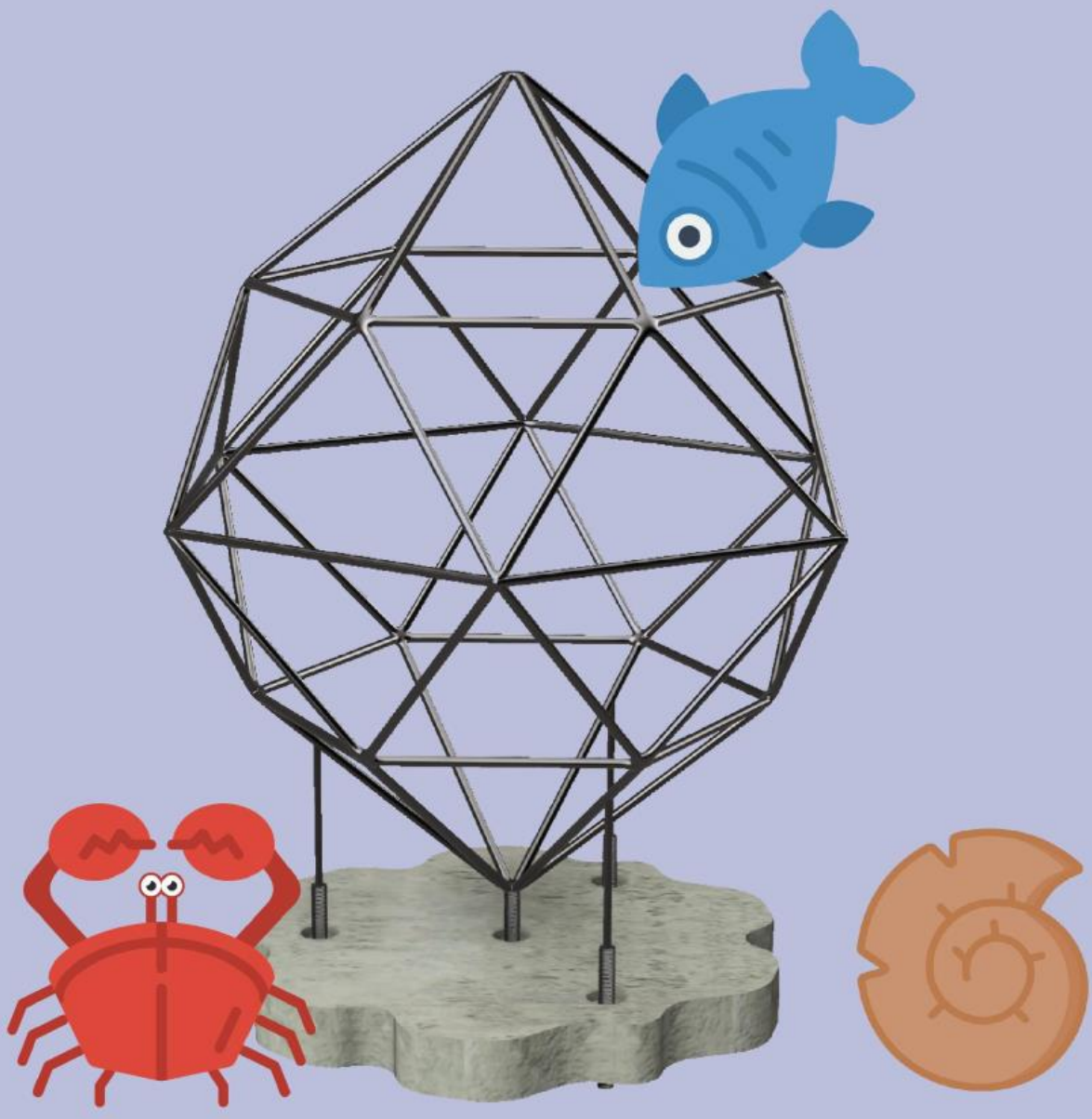
Sydney Opera House
Teacher Resources

Artificial Reef Project

Stages 2, 3 & 4



Welcome

Sydney Opera House is one of the indisputable masterpieces of human creativity and has long been a place for learning and sharing knowledge.

Sydney Opera House stands on Gadigal country and was known to its traditional custodians, the Gadigal people of the Eora Nation, as **Tubowgule**.

A stream carried fresh water down from what is now Pitt Street to the cove near Tubowgule, a rock promontory that at high tide became an island. The mixing of fresh and salt waters formed a perfect fishing ground. Middens of shells were a testament to Tubowgule's long history as a place where the Gadigal gathered, feasted, sung, danced and told stories.

We acknowledge the Gadigal, the traditional custodians of this place, also known as Bennelong Point.

First Nations readers are advised that this document may contain the names and images of Aboriginal and Torres Strait Islander people who are now deceased.

In this program

3	Introduction	**11**	Geography & Geography Elective Activities
4	The Creative Learning Journey	**14**	Design & Technology Activities
5	About the Artificial Reef Project	**16**	Additional Resource Materials
6	What is an Artificial Reef?	**18**	Curriculum Links
7	Science Activities		
8	History Activities		

Did You Know…?

Sydney Opera House is home to eight flagship Australian performing arts companies which bring art to life every day beneath the famous shells. We are proud to partner with the Australian Chamber Orchestra, Bangarra Dance Theatre, Bell Shakespeare, Opera Australia, Sydney Theatre Company, The Australian Ballet, the Sydney Symphony Orchestra and Sydney Philharmonia Choir.

130,000 people attend performances at the Sydney Opera House, for young audiences annually.

Since 2014, one furry guest has caught the attention of locals and international visitors alike. The northern VIP steps of the Opera House, otherwise unoccupied for the majority of the year, is the favourite sunbathing spot of a wild long-nosed fur seal, affectionately called 'Benny' (named after Bennelong Point).

You can now experience the Opera House, as never before, on *Google*'s digital museum platform with 1270 digital artefacts and 50 interactive online exhibits; the Sydney Opera House's presence on the *Google Cultural Institute* allows people everywhere to experience the symbol of modern Australia.

Description and Synopsis

How do you care for your own backyard? The Sydney Opera House is surrounded by water and to ensure that this backyard is cared for, The Sydney Opera House have adopted many sustainable practices.

One of the recent initiatives was the Artificial Reef Project - In May 2019, a modular artificial reef was installed alongside the Opera House sea wall as part of a three-year research project to restore marine habitats and rebalance biodiversity around Bennelong Point.

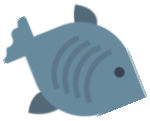
The reef is made up of hexagonal pods constructed from marine-grade steel and concrete. Over time, the reefs have become encrusted with seaweed and sea life, providing a home and food source for smaller fish species.

This project highlights the importance of sustainable practices and conservation as students unpack the scientific research and the impact of the installation on the biodiversity in Sydney Harbour. This project develops student's critical and creative thinking and their personal and social capabilities they see the positive impact of the Artificial Reef Project and consider how they can help to care for their own environment/backyard.

Sydney Opera House Creativity Framework

These Creative Learning Resources have been written using the Sydney Opera House *Creativity Framework* as the pedagogy. The Framework aims to define the creative process in a way that educators can use to teach and be inspired by.

At a glance this Creativity Framework is:



Prepare

Tools and Pathways

Preparing mind, body, space, materials and time

Buy in

Presence and Enthusiasm

Convincing students that they want to be there

Imagine

The Fertile Unknown

Exploring a subject through arts practice. Using form to uncover content. Allowing uncensored expression to reveal new ways of seeing a subject

Question

Analysis, investigation and revelation

Creating new understanding by analysing what just happened when honing the imagination

Make

Forging form from content

Putting shape to content and moving towards a project; scripts, composition, choreography, project design

Show

Commit, frame, judgement

Performing and presenting the work

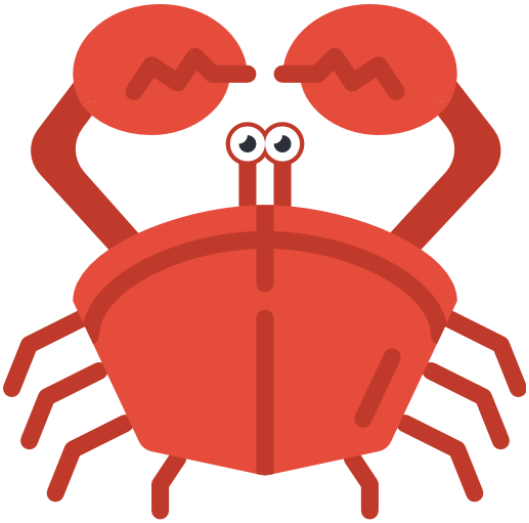
Reflect

Remembering, Processing, exiting

Creating understanding and healthy memories from the creative process and product.

Whilst written as a sequence, the Sydney Opera House *Creativity Framework* is not a method or system but a way of articulating the creative process. As the Framework is applied it becomes apparent the sequence dissolves and many of the specific sections live in one exercise. These resources have been written with this in mind.

This Framework underpins the Sydney Opera House *Creative Leadership in Learning* program that sees schools partner with the House for three years of teacher professional learning, student projects and performances. For more information please see the Sydney Opera House website.



About the Project – Artificial Reef Project

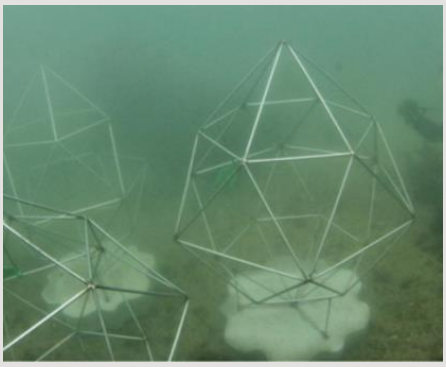
In 2015, the United Nations defined 17 goals, known as the Global Goals, to address the world's most pressing challenges by 2030, including poverty, inequality, climate, education, and justice. The Global Goals provide a to-do list for the world and a roadmap to achieve a more sustainable and prosperous future for all. They have been widely adopted by leading global and Australian companies and government organisations. The Opera House's Environment Action Plan supports global efforts to safeguard our natural environment. The Opera House will hold itself to the highest standard in conserving resources, minimising waste, enhancing the natural environment, and inspiring change in the community.

The Artificial Reef Project contributes to Goal 14 "Life Below Water" of the UN Global Goals. The project was announced in 2017 and funded through a NSW Government Environment Trust Restoration and Rehabilitation grant to find different ways to increase local marine biodiversity in Sydney Harbour. The Sydney Opera House worked with the University of Technology Sydney (UTS) and Reef Design Lab on the project which saw the installation of the modular reef along the Sydney Opera House sea wall. The installation of the pods took place in May 2019 and in short time has seen results with Professor David Booth of School of Life Sciences, University of Technology Sydney stating "It's amazing, after only a few weeks the pods are already attracting the interest of the types of species we hope will be drawn to this new habitat such as leatherjackets, bream and octopus."

What is an Artificial Reef?

Reefs are natural structures that are comprised of coral, sand or rocks that are just above or below the surface of the sea.

On the other hand, artificial reefs are man made structures that are made to model the characteristics of reefs. Artificial reefs are often created to encourage biodiversity in the water. Artificial reefs can be purpose built structures that are deliberately installed to encourage and support biodiversity in areas or at times they can be accidental e.g. a sunken ship.



Installing one of the artificial reef pods on the harbour floor beside the Opera House. Photo: Alex Goad https://www.uts.edu.au/news/health-science/artificial-reef-makes-its-debut-sydney-opera-house

The Living Seawalls Project: https://www.reefdesignlab.com/living-seawalls

Port Macquarie OAR deployment in February 2016: https://www.dpi.nsw.gov.au/fishing/recreational/resources/artificial-reef

Port Macquarie OAR deployment in February 2016: https://www.dpi.nsw.gov.au/fishing/recreational/resources/artificial-reef

Newcastle offshore artificial reef https://www.dpi.nsw.gov.au/fishing/recreational/resources/artificial-reef/newcastle-offshore-artificial-reef

Post-Video Science Activities
Stages 2, 3 & 4

Stage 2

1. Watch the below News Report by 9 News - https://www.youtube.com/watch?v=xIH_ZQbZpQ0 Discuss what happened when the artificial reef was installed and get students to write a description of what happened after the “hidey holes” were installed along the Opera House sea wall.

2. Several sea creatures have been sighted in these “hidey holes”.
Using found materials get students to create a diorama of the artificial reef and the species that have been spotted.

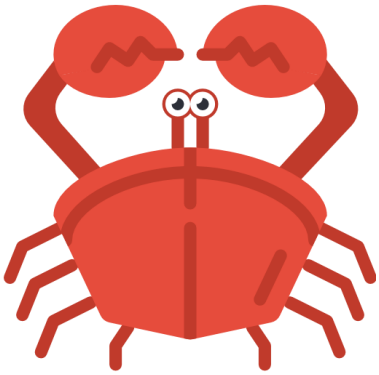
3. Create a fact sheet about one of the species that have been spotted. In the fact sheet include: the scientific name, description/identification, habitat, distribution, feeding and diet and breeding. Use the Australian Museum Factsheets as a guide – here is one of the Australian bass: https://australianmuseum.net.au/learn/animals/fishes/australian-bass-macquaria-novemaculeata-steindachner-1866/

Stage 3

1. Testing of Biodegradability: A lot of products today that we consume state that they are biodegradable, degradable, or compostable? Conduct a test of biodegradability with the class by burying different objects (fruit cores, plastic cup, compostable coffee cup degradable plastic bag, paper). Ensure that the items are of a similar size and bury them in the same depth of moist soil. Mark the spot the items were buried and come back in a month and discuss the findings. Students to write up a report on which items were biodegradable, compostable, or degradable and which were not.

2. From the experiment discuss with students what could be done to help their environment and steps they could take individually and as a class to reduce the amount of waste on earth. Students to share their ideas and ideas can be adopted if they are appropriate for the classroom e.g. Using paper for composting, reducing plastic lunches, repurposing items etc.

3. Build your own eco-system. Using **NOAA Ships Okeanos Explorer Educational Materials Collection** https://oceanexplorer.noaa.gov/okeanos/edu/collection/media/wdwe_ecosystem.pdf follow the instructions to create and then observe the healthy ocean ecosystems.



Stage 4

1. Scientific Research was at the heart of the Artificial Reef Project. A hypothesis was developed, a method was written as was a discussion of results and a conclusion. Develop your own experiment as a class about how you could assist with an environmental concern in your environment or “backyard”. Some suggestions include: How to improve soil (https://education.abc.net.au/home#!/media/104056/soil-healthy-dirt-makes-healthy-plants), Energy-Efficient houses (https://education.abc.net.au/home#!/media/1497537/energy-efficient-house)

2. Present the results of your Scientific Research by creating an engaging video that explains the importance of your experiment and your findings. Use an online video tool like Adobe Spark Video to put your presentation together. Try to incorporate music and voice overs where possible.

Post-Video History Activities
Stages 2, 3 & 4

Stage 2

This view of Circular Quay from Milsons Point shows the great changes in the Sydney skyline over 100 years: The Opera House replaced a tram depot at Bennelong point; the Harbour Bridge connected the north shore to the city; and the skyline has seen six storey 'towers' dwarfed by skyscrapers. Despite all this change, ferry activity continues unabated. (1914 - State Library of NSW Collection: Unknown photographer. 2014 - 702 ABC Sydney: John Donegan)

(https://www.abc.net.au/news/2014-07-25/sydney-transitions-1914-2014-digital-montages-of-changing-city/5630156)

1. Look at the image and list the ways that Sydney Harbour has changed over 100 years.

2. Empathy Task: Imagine that you were a school child watching as the buildings developed in Sydney Harbour. Write a diary entry about visiting the city and seeing the changes to the harbour. In your entry write about what changes occurred in the harbour and how it has affected the sea life.

3. The Artificial Reef Project is a part of the Sydney Opera House's sustainability plan. Sustainability is not a new concept and has been practiced for hundreds of years. Using the interview with a local indigenous person in the video, list the sustainability practices of the First Nation's people in Australia. Create an infographic (https://piktochart.com/formats/infographics/, https://venngage.com/templates , https://venngage.com/) showing one of the sustainability practices.

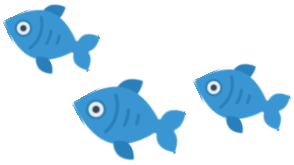
Stage 3

1. Sydney Harbour has changed dramatically in 100 years. Look at the NSW Records https://www.records.nsw.gov.au/archives/magazine/galleries/darling-harbour and list ways that living in Australia has changed.

2. Living in Australia has changed over time and this is shown in the timeline on the Records https://www.records.nsw.gov.au/archives/magazine/galleries/darling-harbour. How has your environment changed? Research your local community to create a timeline of the experiences of people living in your community. You may want to include when the community was established, major events etc.

3. Sustainable practices were practiced by the First Nations People. Conduct research into their sustainability practices. Choose one sustainability practice and develop an interactive presentation (PowerPoint, Prezi, PowToon, Adobe Spark etc.) on the practice to show to your class.

Post-Video Geography/Geography Elective Activities
Stages 2, 3 & 4

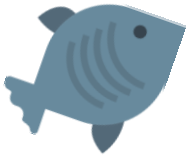


Stage 2

1. The Artificial Reef project was launched to coincide with the United Nation's World Environment Day. Using their website: https://www.un.org/en/events/environmentday/ create a poster that creates awareness of the day.

2. Watch Mission Blue's Video: **Sydney Coast Hope Spot** – Dr. Sylvia Earle (https://youtu.be/i8zTIiy7w2A) and as a class discuss what makes Sydney's water so special and what they can do to bring hope to the future. Students to conduct research into one of the species in Sydney's Harbour and present a speech about the species and how they can be protected.

3. How have environmental changes impacted the animals that live in the harbour? Watch this clip by the Sydney Opera House https://www.youtube.com/watch?v=pj6oo8_VR-A and identify how marine life were affected by artificial structures and how the artificial reefs have aim to change this. Draw a visual to represent this change in a Before and After.



4. What impact have humans had on the environment? Dr David Booth says that rebuilding the habitats around Sydney Harbour is very important due to years of human impact in this area. However, he believes in most instances it is better for humans to avoid interfering with nature at all. Write a speech that talks about humans and the way they impact the environment.

5. What lives in our backyard? Walk around the school and local area and note the different types of animals that live in the area. Using a device (phone, tablet, camera etc) students take pictures of these animals. Students will conduct research on the types of animals that live in the school's backyard and devise a plan on how to keep these animals safe. E.g. Making sure to pick up litter, putting rubbish in the bin so it does not end up in the local creek.

Stage 3

1. As a class read through this interview with Professor Booth https://www.sydneyoperahouse.com/backstage/backstage-articles/a-healthier-harbour.html and answer the following questions:

a) What type of coral does Sydney have?
b) How many species of fish live in Sydney?
c) What are some of the threats to marine life in Sydney Harbour?
d) Why was this project important for the biodiversity of Sydney Harbour?
e) How can humans interact positively to ensure that the environment is protected?

2. Professor David Booth has explained that rebuilding the habitats around Sydney Harbour is very important due to the human impact on the environment. However, he believes in most instances it is better for humans to avoid interfering with nature at all. Fill in the following table explaining the benefits of artificial reefs and the instances that building an artificial reef would not be beneficial:

Positives of building an artificial reef	Negatives of building an artificial reef

3. Watch the video and read the article https://www.abc.net.au/news/2019-09-13/sydney-growing-own-coral-reef-with-help-from-tropical-fish/11466192

a) In the article, it states that there is spread of more sub-tropical coral in Sydney. Why is this the case?
b) What is this type of coral called?
c) Describe what this coral looks like.
d) How many species of fish are coming into Sydney?

4. The Artificial reef installed in 2019 by the Sydney Opera House was not the first of its kind. Research other artificial reefs that have been installed around the world and compare how places and environments are managed in a report.

5. Sustainable practices are not new in Australia. Conduct research into the sustainability practices of the First Nations people and write a report about how they interacted with the environment.

6. What lives in my backyard? Students are to survey their own backyards and identify native plants and animals. If students do not have a backyard, they can survey the local community. Students are to choose one plant or animal to research the species and present a three-minute speech about the plant or animal and ways to ensure that they can continue to thrive in the environment.

Stage 4

1. What does your backyard look like? Do you live around freshwater, seas, forests? Look at how different educational packs for the different environments developed by **WWF**: https://www.wwf.org.au/our-planet/education#gs.100tmuf Choose one of the packs: Our forests and jungles, our freshwater, our grasslands, our seas or our frozen worlds and read through the information pack carefully. Using this information create a presentation that educates students and encourages them to consider the solutions.

2. The Opera House has an **Environmental Action Plan** (https://www.sydneyoperahouse.com/content/dam/soh/brand/un-sustainability-goals/soh-global-goals.pdf). Identify what the Opera House has implemented and the results of this. As a class discuss what could be included in an Environmental Action Plan for your classroom/school. Discuss how this could be implemented and what the results would be. For a source of inspiration watch the ABC series War on Waste and consider what Kiama High School implemented in their war on Waste - https://www.kiamaindependent.com.au/story/5729082/how-kiama-high-school-saves-800-a-month-fighting-a-war-on-waste/

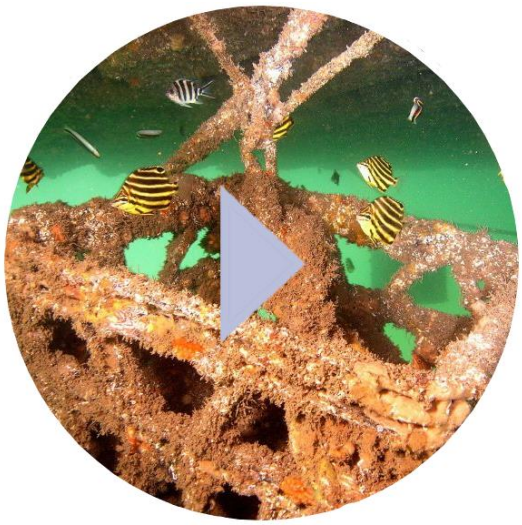
3. Look at the website Take3 https://www.take3.org/
Working in groups use the information on the website specifically looking at “The plastic facts” tab: https://www.take3.org/the-plastic-facts/ come up with ideas that you could take to reduce rubbish at school and take care of the environment. These ideas could include: a plastic free day at school, decorate school bins with slogans to reduce rubbish and care for the environment, posters advocating for change, videos to go on the school website to inform individuals of the need to care for the environment etc.

4. Watch Salt Life’s What are Artificial Reefs? (https://www.youtube.com/watch?v=3SW_poyvAyk) After watching this clip explain how artificial reefs work.

5. Professor David Booth believes that artificial reefs are not always the solution. His stance is that nature should be left alone wherever possible, however, he believes that rebuilding the habitats around Sydney Harbour is very important due to the hundreds of years of human disturbance. Write an essay that discusses the impact that humans have made on our environment. In your response refer to local case studies.

Post-Video Design and Technology Activities
Stages 2, 3 & 4

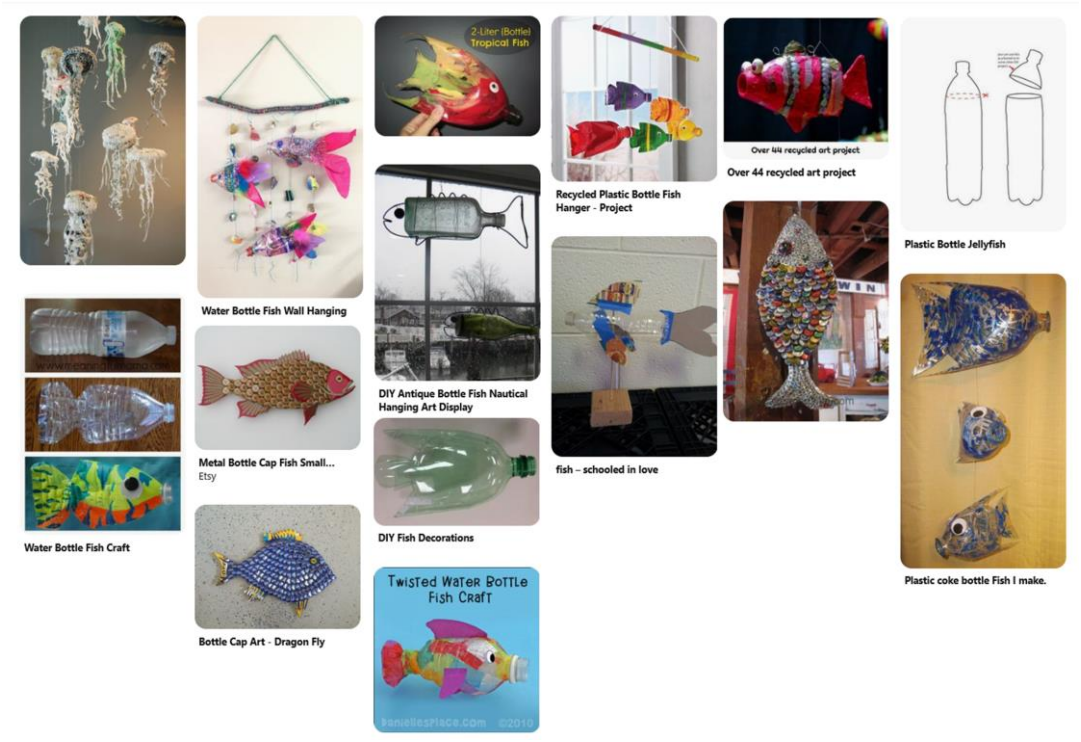
Stage 2



1. Watch the short clip on **ABC News**: https://www.abc.net.au/news/2017-08-22/sydney-opera-house-to-trial-artificial-reef/8830756 In the clip David Lennon describes what materials need to be used for artificial reefs. There are three things he lists. Write down these three things in your book. Using this information about the materials of artificial reefs, draw a design for your own artificial reef design. When you finish drawing your design explain why you have designed your reef this way.

2. Thinking of the same three materials design a structure that could help the wildlife in your "backyard" or local area. When you finish drawing your design explain what you have designed and why it would help the animals in your area.

3. There are many individuals around the world who have use recycled materials to create artworks. Here is a sample of how plastic bottles have been used to create marine art. The mediums vary from using recycled plastic, clothes hangers, and bottle tops. Drawing inspiration from these images taken from Pintrest create your own piece of art using recycled/repurposed or found materials:



Stage 3

1. Reef Design Lab created the fish habitat structures that have been installed on the Opera House sea wall. Look at the description of the structures https://www.reefdesignlab.com/sydney-opera-house-research-project Sketch these structures in your process book and identify the different materials used. Conduct research into the properties of the materials.

2. Using the information from your research and conducting further research, create a design for an artificial reef. In your design process you need to include your design sketched to scale, and a description of all the materials used and justifications for all your choices.

3. Watch this clip about Los Angeles artist Clare Graham https://www.youtube.com/watch?v=ap9NFCiz4HI Using this clip as inspiration get students to think about how they can reuse and repurpose materials. As a class discuss what the class could make together. Using materials that would usually be discarded (perhaps ask students to bring in articles from home they were going to dispose of (e.g. egg cartons, milk bottles etc.) and brainstorm what could be constructed. Have students sketch designs together and spend time in class to construct this artwork together.

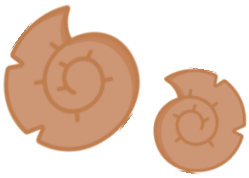
Stage 4

1. The Sydney Opera House installed the artificial reef in 2019. Many other artificial reefs have been installed all over the world to encourage biodiversity. As a class conduct research on these artificial reefs (https://www.livescience.com/54487-outstanding-artificial-reefs-to-visit.html). Students then are divided into small groups to extend on the development on one of the specific reefs, the material and technology used to present this to the class.

2. Several pieces of Reef Design Lab's fish habitat structures were 3D printed. Working in groups conduct research and brainstorm ideas of how you could encourage the biodiversity of your area (this is dependant of the environment that students live in and could vary from encouraging birdlife, bees or local fish). Using this research, create a portfolio that includes your research of your environment, research of materials, the materials and process you would undertake. Present your design to the class and vote on the most functional design.

3. Different artists from around the world have reused and repurposed materials that they have found. As a class look through the article 13 Artists Who Turned Ocean Trash Into Amazing Art by Marisa Gertz: https://time.com/4358434/world-oceans-day-art-marine-plastic/ Go through and discuss these pieces of art:

a) What materials have been used?
b) How have they been used?
c) What meaning does each artwork have?



4. Drawing inspiration from the article 13 Artists Who Turned Ocean Trash Into Amazing Art by Marisa Gertz: https://time.com/4358434/world-oceans-day-art-marine-plastic/ students are to work on their own piece of artwork using recycled or repurposed materials. In their piece of art, they should consider what materials they are going to use and the meaning of their artwork.

Additional Resource Materials

- **A Healthier Harbour** - *https://www.sydneyoperahouse.com/backstage/backstage-articles/a-healthier-harbour.html*
- **Sydney Opera House Research Project** - *https://www.reefdesignlab.com/sydney-opera-house-research-project*
- **Ocean Conservation Front and Centre in Australia with Sydney Coast Hope Spot** - *https://mission-blue.org/2019/04/ocean-conservation-front-and-center-in-australia-with-sydney-coast-hope-spot/*
- **How and what does Nature Recycle Naturally** - *https://www.kidsecologycorps.org/kid-power/activities/how-and-what-does-nature-recycle-naturally*
- **Inspiring Positive Change (Sydney Opera House and the Global Goals)** - *https://www.sydneyoperahouse.com/content/dam/soh/brand/un-sustainability-goals/soh-global-goals.pdf*
- **How Kiama High School saves $800 a month fighting a war on waste** - *https://www.kiamaindependent.com.au/story/5729082/how-kiama-high-school-saves-800-a-month-fighting-a-war-on-waste/*
- **Sydney Coast Hope Spot – Dr. Sylvia Earle** - *https://youtu.be/i8zTIiy7w2A*
- **War on Waste** - *https://www.abc.net.au/ourfocus/waronwaste/*
- **Artificial Reef makes its debut at Sydney Opera House -** *https://www.uts.edu.au/news/health-science/artificial-reef-makes-its-debut-sydney-opera-house*
- **New artificial reef installed along Sydney Opera House sea wall | Nine News Australia** - *https://www.youtube.com/watch?v=xIH_ZQbZpQ0*
- **12 Outstanding Artificial Reefs to Visit** - *https://www.livescience.com/54487-outstanding-artificial-reefs-to-visit.html*

- **The Life in Dirt** - *https://education.abc.net.au/home#!/media/104056/soil-healthy-dirt-makes-healthy-plants*
- **Energy-efficient house** - *https://education.abc.net.au/home#!/media/1497537/energy-efficient-house*
- **The Opera House has Installed an Artificial Reef** - *https://www.youtube.com/watch?v=pj6oo8_VR-A*
- **Sydney transitions 1914-2014: Digital montages from a pre-war city to a 21st century metropolis** - *https://www.abc.net.au/news/2014-07-25/sydney-transitions-1914-2014-digital-montages-of-changing-city/5630156*
- **Build your own Ocean Ecosystem** - *https://oceanexplorer.noaa.gov/okeanos/edu/collection/media/wdwe_ecosystem.pdf*
- **12 ways to live more sustainably** - *https://www.biologicaldiversity.org/programs/population_and_sustainability/sustainability/live_more_sustainably.html*
- **Top 10 tips for living sustainably** - *https://www.sustainability.vic.gov.au/You-and-your-home/Live-sustainably/Top-10-tips-for-living-sustainably*
- **What is Sustainable Living?** - *https://www.conserve-energy-future.com/15-ideas-for-sustainable-living.php*
- **Take 3 for the Sea**- *https://www.take3.org/*
- **Australian Bass, *Macquaria novemaculeata*** - *https://australianmuseum.net.au/learn/animals/fishes/australian-bass-macquaria-novemaculeata-steindachner-1866*
- **What are Artificial Reefs? | Salt Life** - *https://youtu.be/3SW_poyvAyk*
- **Pintrest Board** - *https://pin.it/TV2JVFV*
- **Global Goals – Life Below the Water Webpage -** *https://www.globalgoals.org/14-life-below-water*

Let's keep in touch

Sydney Opera House
Creative Learning
Bennelong Point
Sydney NSW 2000

Call us on 02 9250 7770
or email creativelearning
@sydneyoperahouse.com

Join our *Sydney Opera House for Teachers and Educators* Facebook Group

Animation: Flaticon/Freepik

This project has been assisted by the New South Wales Government through its Environmental Trust