# Mary Watson and the Sea Cucumber Tank

YEAR 4-8
CHEMICAL SCIENCES
PHYSICAL SCIENCES
HASS

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM NETWORK | Queensland Government

# Future Makers

Future Makers is an innovative partnership between Queensland Museum Network and Shell's QGC business aiming to increase awareness and understanding of the value of science, technology, engineering and maths (STEM) education and skills in Queensland.

This partnership aims to engage and inspire people with the wonder of science, and increase the participation and performance of students in STEM-related subjects and careers — creating a highly capable workforce for the future.

*Cover image: Framed photo of Mrs Mary Watson. © QM, Peter Waddington.*





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ENGAGE – EXPLORE – EXPLAIN – ELABORATE – EVALUATE

# Mary Watson and the Sea Cucumber Tank

## Teacher Resource

The following student activities are contextualised by the stories told about an iron tank, acquired by Queensland Museum in 1882. This tank tells the stories of the Dingaal Aboriginal people and of European settlers; it also highlights the impacts of colonisation.

The activity *Watson's Tank* provides context for future learning. We recommend implementing this activity before moving onto the remaining activities, which can be delivered in succession or as stand-alone lessons.

### Watson's Tank

In this activity, students develop an understanding about the significance of Mary Watson's tank. They sequence information about people's lives and events and examine different viewpoints to understand the motives and experiences of individuals and groups.

Students may wish to view and read the diaries kept by Mary Watson. These include her diary from Lizard Island and the diary she kept following her departure from Lizard Island. Both diaries are held at the State Library of Queensland.

Glass painted portrait of Mary Watson (artist and date unknown). QM, Peter Waddington.

Cast iron tank and paddles used by Mary Watson to leave Lizard Island. QM, Jeff Wright.

## What Floats Your Boat?

In this activity, students investigate density and buoyancy to determine how a cast iron tank was able to float with two adults, a baby and a handful of supplies, and how many additional people would have been able to sit in the tank before it began to sink.

You may like to start with some simple density problems or calculations to build students' understanding and confidence before moving on to *What Floats Your Boat?* The Physical Science: Density Laboratory (accessible via Scootle) is an online interactive simulation students could use to investigate the relationship between mass, volume, density and buoyancy and to solve simple density-related problems.

The final question asks students to consider how the buoyancy of the tank may change in liquids of different densities. While students can use mathematical problem-solving and reasoning to respond to this question, they could also design and conduct a scientific investigation to draw and present conclusions based on evidence.

## Rust Away

In this activity, students investigate the effect of salt concentration on rusting. Students are encouraged to use the provided scaffold to plan and conduct their own experiment. They then describe and explain the results, focussing on reversible/irreversible and chemical/physical change.

It is important to note the following:

- We recommend students use deionised or demineralised water. This is because there are no or very low concentrations of dissolved ions within the water, which may affect the outcome of the experiment. You can find deionised or demineralised water at many large retailers.
- While salt generally increases the rate of rusting, very high salt concentrations will actually reduce the rate of rusting; as the salt concentration increases, the amount of available oxygen within the water decreases – without oxygen, rusting cannot occur. To counter this, students could half submerge their tested objects, occasionally aerate the water, or spray their objects to ensure the presence of oxygen.
- Different objects will produce different results at different rates. We recommend using steel wool as it is cost-effective and will begin to rust within 24 – 48 hours of commencing the experiment.

Following this, students apply knowledge and findings from the experiment to real world contexts; they explain how natural processes can affect the salt concentration of the ocean, and use a sea su rface salinity map to discuss how the tank would fare in locations with high, moderate and low sali nity levels. You may also like to access the Science on a Sphere Sea Surface Salinity dataset from the National Oceanic and Atmospheric Administration (NOAA) during or after the completion of this task.

Students also learn about life as a conservator at Queensland Museum, and the treatments used to conserve rusting objects.

## Thirst Quencher Design Challenge

In this activity, students design a solution that will allow for the reliable production of drinking water in a remote location.

When completing this activity, Year 5 students should be encouraged to investigate evaporation and focus on changes of state. Year 7 students should be encouraged to focus on how they can separate substances using physical separation techniques. Regardless of year level, students should not be encouraged to drink the water that is produced by their designed solution for health and safety reasons.

Depending on your classroom context, students can produce a graphical representation of their solution and/or use materials and supplies to build and test their solution. Students should be encouraged to think about the components of listed materials and supplies, and how they could use, represent or replicate these components. For example, rather than using an entire umbrella to construct a solution, students could use lengths of bamboo to represent the frame and pieces of silk or cotton fabric covered in wax or oil to represent the waterproof material, keeping in mind that nylon was not invented until 1935. If using plant material to construct the designed solution, be mindful of the types of plants that are used, especially if students are collecting plant material themselves, as some may contain toxins that are harmful to humans if touched or ingested. As a result, you may like to familiarise yourself with the common toxic plants found in Queensland and provide students with pre-selected non-toxic plant material they can use to construct their designed solution.

# Curriculum Links

## Watson's Tank

### Humanities and Social Sciences

YEAR 4

**Inquiry and Skills**

Locate and collect information and data from different sources, including observations (ACHASSI074)

Sequence information about people's lives and events (ACHASSI076)

Examine information to identify different points of view and distinguish facts from opinions (ACHASSI077)

Present ideas, findings and conclusions in texts and modes that incorporate digital and non-digital representations and discipline-specific terms (ACHASSI082)

**History: Knowledge and Understanding**

The nature of contact between Aboriginal and Torres Strait Islander Peoples and others, for example, the Macassans and the Europeans, and the effects of these interactions on, for example, people and environments (ACHASSK086)

YEAR 5

**Inquiry and Skills**

Locate and collect relevant information and data from primary sources and secondary sources (ACHASSI095)

Sequence information about people's lives, events, developments and phenomena using a variety of methods including timelines (ACHASSI097)

Examine different viewpoints on actions, events, issues and phenomena in the past and present (ACHASSI099)

Present ideas, findings, viewpoints and conclusions in a range of texts and modes that incorporate source materials, digital and non-digital representations and discipline-specific terms and conventions (ACHASSI105)

**History: Knowledge and Understanding**

The nature of convict or colonial presence, including the factors that influenced patterns of development, aspects of the daily life of the inhabitants (including Aboriginal Peoples and Torres Strait Islander Peoples) and how the environment changed (ACHASSK107)

YEAR 6

**Inquiry and Skills**

Locate and collect relevant information and data from primary sources and secondary sources (ACHASSI123)

Sequence information about people's lives, events, developments and phenomena using a variety of methods including timelines (ACHASSI125)

Examine different viewpoints on actions, events, issues and phenomena in the past and present (ACHASSI126)

Present ideas, findings, viewpoints and conclusions in a range of texts and modes that incorporate source materials, digital and non-digital representations and discipline-specific terms and conventions (ACHASSI133)

### General Capabilities

**Literacy**

Comprehending texts through listening, reading and viewing

Composing texts through speaking, writing and creating

**Critical and Creative Thinking**

Inquiring – Identifying, exploring and organising information and ideas

**Personal and Social Capability**

Social management

**Intercultural Understanding**

Recognising culture and developing respect

Interacting and empathising with others

## What Floats Your Boat?

### Science

YEAR 7

**Science Understanding**

Change to an object's motion is caused by unbalanced forces, including Earth's gravitational attraction, acting on the object (ACSSU117)

**Science Inquiry Skills**

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

YEAR 8

**Science Understanding**

Properties of the different states of matter can be explained in terms of the motion and arrangement of particles (ACSSU151)

**Science Inquiry Skills**

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS148)

### Mathematics

YEAR 7

**Number and Algebra**

Round decimals to a specified number of decimal places (ACMNA156)

**Measurement and Geometry**

Calculate volumes of rectangular prisms (ACMMG160)

YEAR 8

**Measurement and Geometry**

Develop formulas for volumes of rectangular and triangular prisms and prisms in general. Use formulas to solve problems involving volume (ACMMG198)

## General Capabilities

### Numeracy

Estimating and calculating with whole numbers

Using spatial reasoning

Using measurement

### ICT Capability

Investigating with ICT

### Critical and Creative Thinking

Reflecting on thinking and processes

Analysing, synthesising and evaluating reasoning and procedures

# Rust Away

## Science

YEAR 6

### Science Understanding

Changes to materials can be reversible or irreversible (ACSSU095)

### Science as a Human Endeavour

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

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

### Science Inquiry Skills

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

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

Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS104)

Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS107)

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

Reflect on and suggest improvements to scientific investigations (ACSIS108)

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

YEAR 8

### Science Understanding

Differences between elements, compounds and mixtures can be described at a particle level (ACSSU152)

Chemical change involves substances reacting to form new substances (ACSSU225)

### Science as a Human Endeavour

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

### Science Inquiry Skills

Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge (ACSIS139)

Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (ACSIS140)

Measure and control variables, select equipment appropriate to the task and collect data with accuracy (ACSIS141)

Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies as appropriate (ACSIS144)

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS145)

Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements (ACSIS146)

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS148)

## General Capabilities

### Literacy

Comprehending texts through listening, reading and viewing

Composing texts through speaking, writing and creating

### Critical and Creative Thinking

Inquiring – Identifying, exploring and organising information and ideas

Reflecting on thinking and processes

Analysing, synthesising and evaluating reasoning and procedures

### Personal and Social Capability

Social management

## Thirst Quencher Design Challenge

### Science

YEAR 5

#### Science Understanding

Solids, liquids and gases have different observable properties and behave in different ways (ACSSU077)

#### Science Inquiry Skills

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

YEAR 7

#### Science Understanding

Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques (ACSSU113)

Change to an object's motion is caused by unbalanced forces, including Earth's gravitational attraction, acting on the object (ACSSU117)

#### Science Inquiry Skills

Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge (ACSIS124)

Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (ACSIS125)

Measure and control variables, select equipment appropriate to the task and collect data with accuracy (ACSIS126)

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS130)

Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements (ACSIS131)

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

### Design and Technologies

YEAR 5 & 6

#### Design and Technologies: Knowledge and Understanding

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 (ACTDEP026)

Negotiate criteria for success that include sustainability to evaluate design ideas, processes and solutions (ACTDEP027)

YEAR 7 & 8

#### Design and Technologies: Knowledge and Understanding

Analyse ways to produce designed solutions through selecting and combining characteristics and properties of materials, systems, components, tools and equipment (ACTDEK034)

#### Design and Technologies: Processes and Production Skills

Critique needs or opportunities for designing and investigate, analyse and select from a range of materials, components, tools, equipment and processes to develop design ideas (ACTDEP035)

Generate, develop, test and communicate design ideas, plans and processes for various audiences using appropriate technical terms and technologies including graphical representation techniques (ACTDEP036)

Select and justify choices of materials, components, tools, equipment and techniques to effectively and safely make designed solutions (ACTDEP037)

Independently develop criteria for success to evaluate design ideas, processes and solutions and their sustainability (ACTDEP038)

### General Capabilities

#### Literacy

Composing texts through speaking, writing and creating

#### Numeracy

Using measurement

#### ICT Capability

Investigating with ICT

Creating with ICT

#### Critical and Creative Thinking

Inquiring – Identifying, exploring and organising information and ideas

Generating ideas, possibilities and actions

Reflecting on thinking and processes

Analysing, synthesising and evaluating reasoning and procedures

#### Personal and Social Capability

Social management

# Watson's Tank

## Student Activity

### Lizard Island

Lizard Island is known as Dyiigurra (Jiigurru) to the Dingaal Aboriginal people, the Traditional Owners of the land. The Dingaal people have lived in this area for tens of thousands of years, and for them, the island is a sacred place with a rich cultural history.


Lizard Island is located 250 km north of Cairns.

Aerial view of Lizard Island (background), Palfrey Island (left) and South Island (right). QM, Gary Cranitch.

The Dingaal people believe that the Lizard group of islands were created in the Dreamtime; the islands form a stingray, with Lizard Island forming the body and the surrounding islands forming the tail.

The Dreamtime is a term coined by English anthropologists. The term refers to the complex network of Aboriginal spiritual beliefs that "permeates all aspects of Aboriginal cultures and societies".[1] This worldview encompasses the past, present and future, and establishes societal structures, rules for social behaviour and rules for interacting with the natural world.[2 3]

Lizard Island is also home to the *manuya*, or sand goanna, whose presence is linked with traditional stories and culture. The presence of the *manuya* on the island makes it a sacred place. Lizard Island was given its Western name when Captain James Cook passed through it on 12 August 1770: "*The only land animals we saw here were lizards, and these seem'd to be pretty plenty, which occasioned my naming the island Lizard Island*".

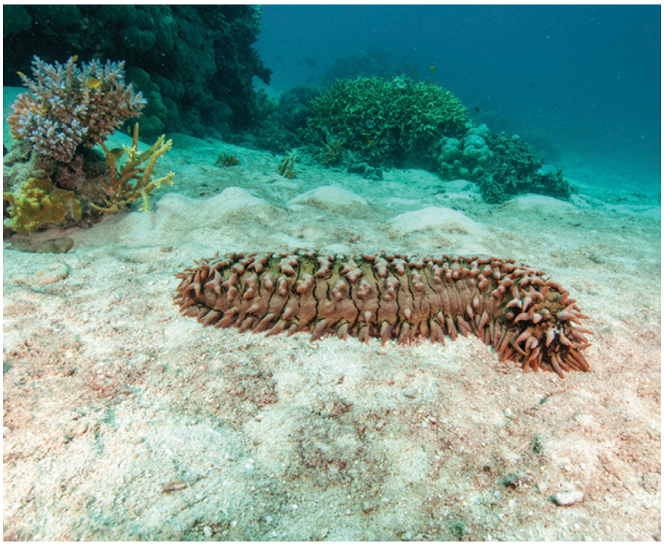
A century later, sea cucumber fishermen began using Lizard Island. Soon after, tragedy struck.

1 Tripcony, P. (2007). Too obvious to see: Explaining the basis of Aboriginal spirituality. Retrieved from https://www.qcaa.qld.edu.au/downloads/approach2/indigenous_read001_0708.pdf
2 University of South Australia. (2013). Respect, relationships, reconciliation. Dreaming. Retrieved from https://rrr.edu.au/glossary/dreaming/
3 Nicholls, C.J. (2014). 'Dreamtime' and 'The Dreaming' – An introduction. Retrieved from https://theconversation.com/dreamtime-and-the-dreaming-an-introduction-20833

## Mary Watson

Mary Watson was born in England in 1860. She emigrated with her family to Maryborough, Queensland in 1877. Some time later, Mary moved to Cooktown and subsequently married Captain Robert E. Watson in May 1880. Captain Watson was a sea cucumber fisherman. In June 1880, the couple moved to Lizard Island to set up a fishing station with Captain Watson's business partner, Percy Fuller.

Glass painted portrait of Mary Watson (artist and date unknown). QM, Peter Waddington



The Prickly Redfish (*Thelenota ananas*) is one species of sea cucumber that was harvested during the nineteenth century. QM, Gary Cranitch.

Europeans began to harvest sea cucumbers (otherwise known as trepang or *bêche-de-mer*) in the nineteenth century. Cooktown was the centre of this industry, and was the point from which sea cucumbers were exported to south-east Asia and China. The continuous overfishing of sea cucumbers during this period resulted in the severe depletion of these once plentiful animals, which affected both the ecosystem and the food supply of the Aboriginal and Torres Strait Islander peoples who had been harvesting this resource well before the arrival of European settlers. A further impact of this industry was the abuse of and lack of pay for Aboriginal and Torres Strait Islander workers.[4 5]

On 1 September 1881, Watson and Fuller departed on a fishing trip, leaving Mary, their four month old son, Thomas, and two Chinese workers, Ah Sam and Ah Leung, on the island.

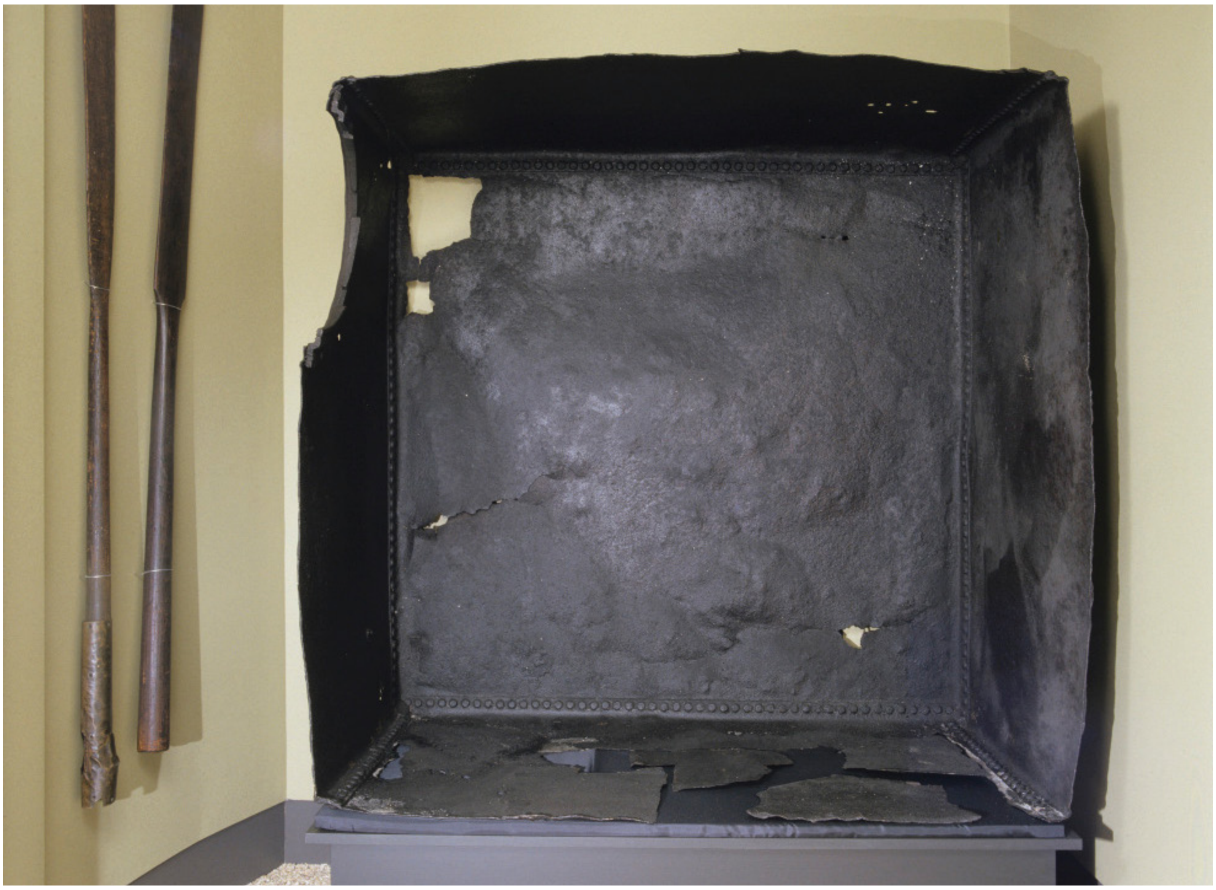
Several weeks later, on 29 September 1881, a group of mainland Aboriginal people of the Guungu Yimmidir group arrived on the island to collect their valued fish oils.

There are different perspectives about what happened next, and why. Conflict broke out between the Guungu Yimmidir people and the settlers. Ah Sam was attacked, and suffered several spear wounds; Ah Leung was killed. Mary shot at the Guungu Yimmidir people.

Most written accounts suggest that Mary Watson accidentally trespassed on ceremonial ground. According to traditional stories, the whole island is a sacred site, which the Watsons, Fuller and their workers should never have been living on.

4 Daley, B. (2014). The Great Barrier Reef: An environmental history. Routledge.
5 Ryle, P. A. (2000). Decline and recovery of a rural coastal town: Cooktown 1873 – 1999 [PhD thesis]. James Cook University.

Following the conflict, Watson, her son and Ah Sam left the island in a cut-down iron tank used to boil sea cucumbers. They took only a few supplies, including some food and water. The date was 2 October 1881.



Cast iron tank and paddles used by Mary Watson to leave Lizard Island. QM, Jeff Wright.

After departing Lizard Island, the group drifted and paddled in and out of reefs and small islands. Watson kept a makeshift diary during this time. She wrote about their journey, their dwindling supplies and their need to find fresh water.

### Mary Watson's Diary Entries

4 October 1881: "*Made for the sand bank off the Lizards, but could not reach it. Got on a reef.*"

6 October 1881: "*Able to pull the tank up to an island with three small mountains on it. Ah Sam went ashore to try to get water as ours was done.*"

7 October 1881: "*Made for another island four or five miles from the one spoken of yesterday. Ashore, but could not find any water. Cooked some rice and clam-fish.*"

The group stayed on this island, No 5 Howick Island, awaiting rescue or rain. Unfortunately neither came in time; all three died of thirst between 11 and 12 October.

This was not the only incident of its kind to occur at this time. Reports around the time of Watson and Ah Sam's deaths indicate that the conflicts between the fishermen and Aboriginal land owners were part of a larger conflict also happening on other islands in the reef.

1. Use this information to develop a timeline of events.

| Date | Event |
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2. Express how the Guungu Yimmidir people may have felt in their situation, after discovering European people on their land. Consider knowledge, beliefs and practices, and how these may impact perspectives and points of view.

3. Express how Mary Watson may have felt in her situation, after moving to Lizard Island and experiencing conflict with the Guungu Yimmidir people. Consider knowledge, beliefs and practices, and how these may impact perspectives and points of view.

# What Floats Your Boat?

## Student Activity

Cast iron is used to make a wide variety of objects. You may like to conduct an internet image search for 'cast iron uses' to take a look at the types of objects that are made with this material.

Based on your observations:

- What physical properties would you associate with cast iron?
- Do you have anything made of cast iron in your home or school?
- Would you expect this material to float on water?

Following conflict with Aboriginal land owners, Mary Watson used a cast iron ship tank to leave Lizard Island with her infant son and a Chinese worker. They travelled over 64 km in the tank, between the reefs and islands of the Great Barrier Reef.

Glass painted portrait of Mary Watson (artist and date unknown). QM, Peter Waddington.

Cast iron tank and paddles used by Mary Watson to leave Lizard Island. QM, Jeff Wright.

How was a cast iron tank able to float with two adults, a baby and a handful of supplies? How many additional people would have been able to sit in the tank before it began to sink? You will investigate the answers to these questions below.

## Density

What determines whether an object will float or sink in a liquid? Density!

Density is a physical property of matter, and is a measure of the amount of matter in a given space. The density of an object depends on:

- The number and mass of atoms or molecules that make up the object; and,
- How closely the atoms or molecules are 'packed' within the object.

Density is calculated using the equation:

$$\textbf{Density (g/cm}^3\textbf{)} = \frac{\textbf{Mass (g)}}{\textbf{Volume (cm}^3\textbf{)}}$$

If an object is less dense than the liquid it is placed in, then it will float, e.g. a volleyball on the water. If an object is denser than the liquid it is placed in, then it will sink, e.g. a sandstone rock in the water.

1. Determine the density of salt water. Explain how you came to this result and record any working out below. (Hint: You can use the density equation above.)

2. Calculate the density of the following. Determine whether each will float or sink in salt water, and explain why this is the case (recall how the size, mass and arrangement of atoms or molecules within an object affects its density).

    a. Mary Watson's Tank
    Use the dimensions provided by Queensland Museum and assume a thickness of 5 mm.
    Use a metal calculator, such as https://www.onealsteel.com/resources/metal-calculator/, to determine the approximate mass of the tank.

b. Mary Watson's tank with two adults, a baby and a handful of supplies.

*You may assume the following:*

| | |
|---|---|
| *In 1880, the average mass of a woman:* | *55 kg*[6] |
| *In 1880, the average mass of a man:* | *75 kg*[6] |
| *Average mass of a four-month-old baby:* | *6.7 kg*[7] |
| *Mass of supplies:* | *5 kg* |

c. Mary Watson's tank with the entire sea cucumber camp population, if all were on the island and had survived the conflict. This includes: Mary Watson, Robert Watson, Thomas Watson, Percy Fuller, Ah Leong and Ah Sam.

d. Determine how many additional people would have been able to sit in Mary Watson's tank before it started to sink.

6 Hathaway, M. (1959). Trends in heights and weights. Retrieved from https://naldc.nal.usda.gov/download/IND43861419/PDF
7 Whelan, C. (2019). What's the average baby weight by month? Retrieved from https://www.healthline.com/health/parenting/average-baby-weight

## Buoyancy

When an object is placed in a liquid, it displaces (pushes away) some of the liquid. The displaced liquid pushes up on the object. This upward force is called buoyancy.

If the object is equal to or lighter than the amount of liquid it has displaced, it will float. However, if the object is heavier than the amount of liquid it has displaced, it will sink. This is because the liquid is not capable of exerting enough force to keep the object afloat. The buoyancy of an object will also change in liquids of different densities.

3. Draw force diagrams to represent the buoyancy of the tank in each of the previous situations. Use your understanding of forces to explain what is happening in each situation.

   a. Mary Watson's Tank

| Force Diagram | Explanation |
| --- | --- |
| | |

   b. Mary Watson's tank with two adults, a baby and a handful of supplies.

| Force Diagram | Explanation |
| --- | --- |
| | |

c. Mary Watson's tank with the entire sea cucumber camp population.

| Force Diagram | Explanation |
|---|---|
| | |

d. Mary Watson's tank sinking.

| Force Diagram | Explanation |
|---|---|
| | |

4. Imagine an ocean of vegetable oil, honey, detergent or milk! How would you expect the buoyancy of the tank to change in liquids of different densities?

# Rust Away

## Student Activity

Take a look at Mary Watson's tank.

QM, Jeff Wright.

What do you notice about the condition of the tank?

Do you think the tank was in this condition when Mary Watson set off f om Lizard Island? Why?

What could have caused these changes?

Seawater contains many dissolved solutes; the main (and most noticeable!) one is sodium chloride, or salt. On average, most seawater has about 35 g of salt in every 1000 g of water. However, the salt content (salinity) of the ocean can vary between places around the globe - especially at the surface of the ocean.

Seawater affects materials in different ways. You will now design an experiment to investigate how the amount of salt in water can affect the rate of rusting (corrosion).

**Aim**

To investigate the effect of salt concentration on rusting.

**Hypothesis**

How will salt concentration affect rusting? Write a prediction, giving reasons for your answer.

**Variables**

Record the variables in the table below.

| Independent variable | Dependent variable | Control variable |
|---|---|---|
| | | |

**Materials**

List all of the equipment you will use in the experiment. Remember to include numbers and amounts.

**Method**

List the steps you will take to conduct your experiment.

| |
|---|
| |

**Risk Assessment**

What safety considerations must be made before, during and after this experiment? Identify at least five hazards and how to minimise them.

| Hazard | How to minimise hazard |
|---|---|
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**Results**

1. Record your observations in a table (you may wish to use Excel for the table and graph).
2. Present your results in a graph.
3. Describe the results in words.

**Discussion**

1. Explain the results and observations. Do the results support your hypothesis?

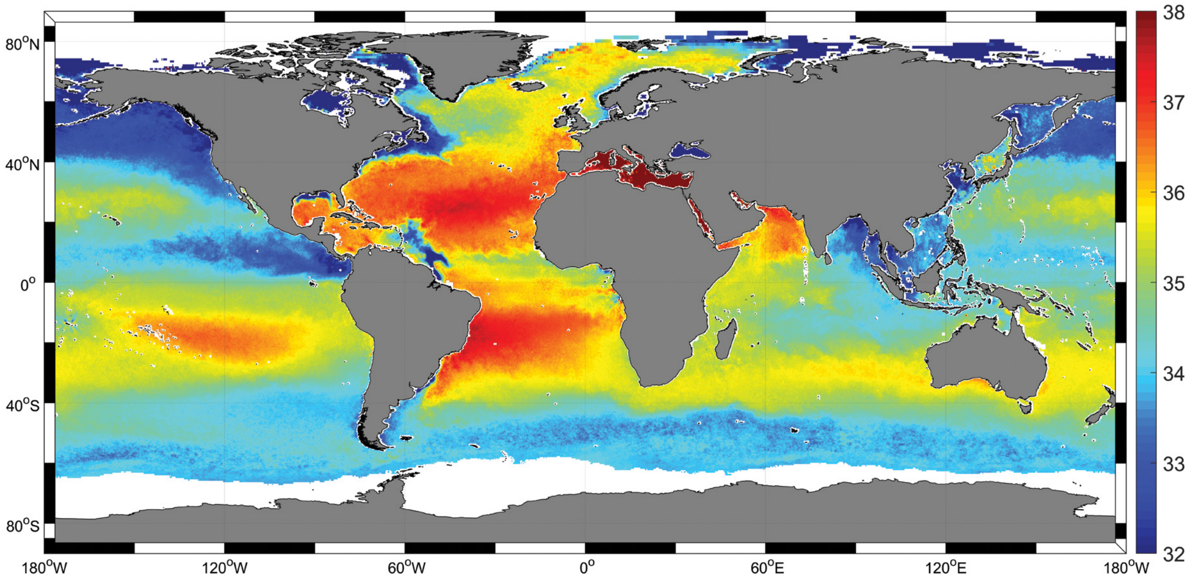
2. Describe which materials in the experiment are elements, compounds and mixtures (include chemical formulas where possible). In the mixture, what is the solution, solute and solvent? **(Year 8)**

3. Draw a labelled diagram of the experiment, showing the materials before and after.

4. Justify the type of change (physical or chemical) that has occurred within this experiment, and whether it is reversible or irreversible.

5. The salt content (salinity) of the ocean can vary between places around the globe. Salinity levels are affected by evaporation, rainfall, thawing ice and the flow of rivers. Explain how these processes affect the salt concentration of the ocean.

6. Observations collected from three satellites (SMOS, SMAP and Aquarius) were used to develop a map of sea surface salinity.




Global sea surface salinity, measured in grams of salt per 1000 mL of water. European Space Agency Climate Change Initiative.

Compare the salinity levels of the following locations: the Mediterranean Sea, the coastline of Alaska and the coastline of eastern Australia. Discuss how these conditions would be likely to affect the state of Mary Watson's tank.

7. Describe any challenges you experienced during the investigation.

8. Explain how you could improve the investigation.

## Conclusion

Summarise the experiment and results.

## Queensland Museum: The Conservation of Rusting Objects

Queensland Museum has a responsibility to collect, research and promote Queensland's natural, cultural and technological heritage. Our collections provide evidence of changes occurring in our natural and cultural environments.

Cultural and historical collections are comprised of objects that are significant to the people of Queensland. These objects are cared for on behalf of all Queenslanders so that they can be enjoyed by future generations. The people who care for these objects are called conservators. They use chemical and physical tests to determine the age and composition of different objects, and use their understanding of materials science and their problem-solving skills to determine how best to stabilise, restore and preserve the objects.

### A Chat with Sue Valis, Conservator, Museum of Tropical Queensland

Sue Valis is a Conservator at the Museum of Tropical Queensland. Learn more about conservation, particularly about the preservation of rusting objects below.

Sue Valis working on one of the diving helmets from the Queensland Museum collection.

- **How did you become interested in your field of study?**

  While studying Art and Archaeology for my first degree, I worked with a paintings conservator. This exposed me to the principles of conserving cultural materials and its practice. I loved the combination of working with my hands and at the same time having to think about the science and technology behind the making of the object, as well as the ethical issues guiding the treatment. Conservation is about stabilising objects and acknowledging their history and use, rather than 'restoring' them to look new again. This mental and physical combination of skills made me realise that I wanted to make conservation my career. As I had not studied Chemistry in high school, a prerequisite for a conservation degree, I enrolled in evening classes at the local technical college and then went on to complete the three year Bachelor of Applied Science in Conservation at the University of Canberra.

- **What is your favourite part of your work?**

  Probably my second favourite part is to receive an object requiring treatment and having to look at its background: where it comes from, the way it was made, and assess what kind of life it has had in order to explore which conservation treatment would be most suitable. This always varies, because no two objects are the same or are in the same condition. My favourite part is, of course, completing a successful treatment and knowing that the object is stable and preserved for many years to come.

- **Describe some of the objects you have worked on, and the treatments you used to conserve these objects.**

  During my career, I have conserved a variety of objects ranging from meteorites, a famous dress belonging to a wife of one of the Prime Ministers of Australia, to an 1855 Locomotive. Since working at Queensland Museum, my work has been mainly on artefacts recovered from shipwrecks along the Queensland coastline.

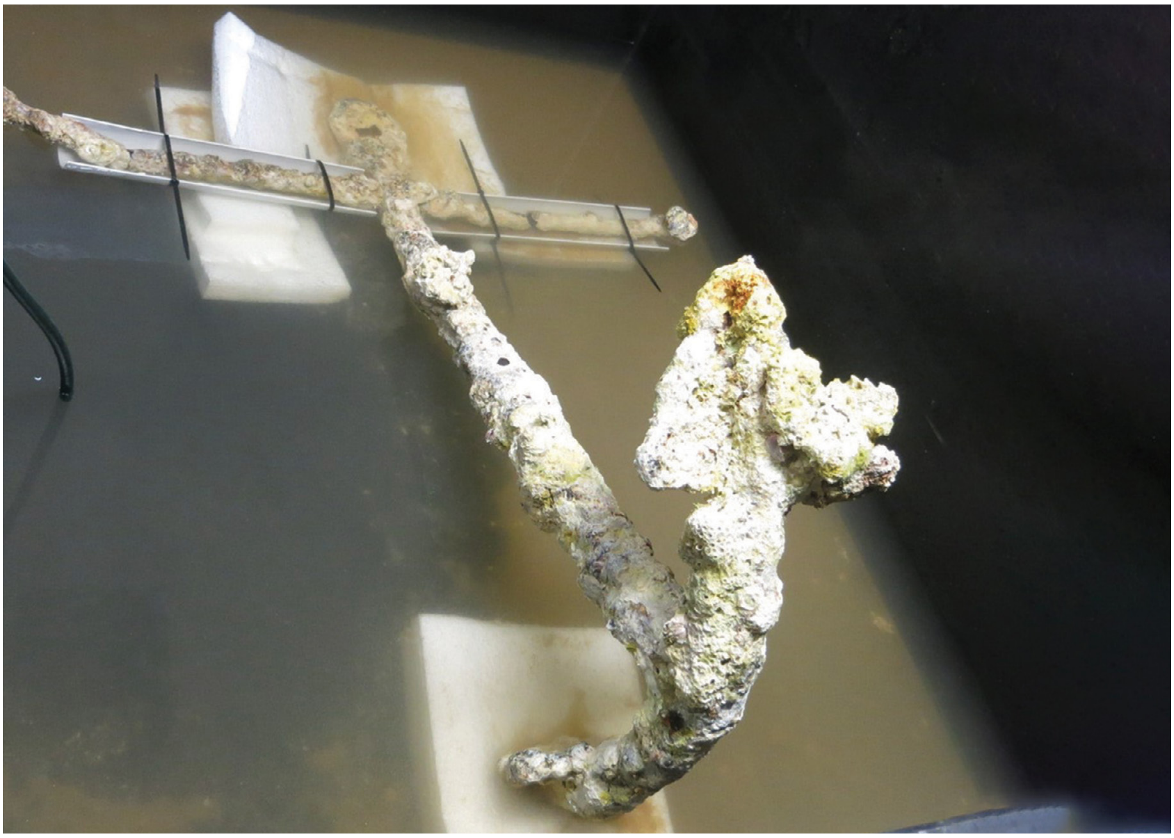
  An example of a treatment on an 'unknown' object was the mass of concretion (a hard, compact mass of mineral matter) from the SS Brinawarr (1918), which was recovered in Mackay's Pioneer River. The mass was deconcreted and the individual items were desalinated and coated with a protective layer of microcrystalline wax to reduce the chance of corrosion. Concretions, such as this one, are usually x-rayed to determine what is hidden inside them.

**Before treatment**

**After treatment**

A mass of concretion (left) from the SS Brinawarr and the separate components (right).

Currently I am working on the conservation of a 120 kg iron anchor from the HMCS Mermaid (1829) which was recently recovered from the shipwreck site off the coa t of Cairns. The anchor is immersed in a large tub, containing a 2% sodium hydroxide solution, which will draw out the salts from the metal over a long period of time. The solution is tested on a regular basis, and once the salt levels plateau out, it is changed, a new solution is added and the process starts again. All material from the ocean needs to be desalinated prior to being dried; otherwise the dried salt crystals can damage the material and exacerbate corrosion reactions. This process can take years, depending on the size and density of the object.



The tub with the iron anchor from the HMCS Mermaid being refilled with solution during treatment.

- **If we wanted to stop something rusting at home, what is the most important thing to do?**

  Rusting or corrosion occurs in the presence of high humidity and therefore it is important to avoid exposing your objects to moisture. This can be achieved by raising them off the g ound to avoid transfer of moisture through the floor or keeping them away from external walls of rooms. Dust can also trap moisture, so maintaining your objects dust-free will also reduce the chance of corrosion.

  Pollution is also attributed to corrosion, although this is not going to be an issue for objects at home. However, some materials emit vapours that have a corrosive effect on certain metals. Avoid placing objects on chipboard, wool or felt fabrics. Lastly, since oils and sweat can enhance corrosion, wash your hands prior to handling your objects or use gloves.

- **What would you recommend for students who would like to work in a similar field?**

  Because conservation is an unusual profession with limited job opportunities, it is extremely important to receive some work experience, before embarking on a degree in conservation. The combination of knowledge and skills required to undertake the work, including the patience needed to carefully approach any treatment does not suit everyone. However, if you are a person with the right qualities, it is an extremely rewarding career.

If you want to learn more about life as a conservator, you can watch Sue Valis talk about her career and how she conserves other objects in Queensland Museum's collection.

You can also learn about how the team at Cobb+Co Museum in Toowoomba conserved a GS (General Service) Wagon used by the British and Australian armies during the First World War. Part of this work involved removing rusted rivets, manufacturing new rivets by hand, and removing and replacing damaged wood.

# Thirst Quencher Design Challenge

## Student Activity

Mary Watson made landfall on one island after another, but failed to find any fresh drinking water. However, what if it was possible to produce drinking water rather than relying on the possibility of a chance find?

### Task:

You are to design a solution that will allow for the reliable production of drinking water on a remote island, using only the surrounding natural materials and supplies brought by Mary Watson.

### You must:

- **Investigate** the types and properties of available construction materials and the range of physical separation techniques. Evaluate the viability of using different materials and separation techniques on a remote island. Develop criteria that solutions would need to meet to successfully resolve the problem (success criteria).
- **Design** a solution that will allow for the reliable production of drinking water on a remote island using listed materials and supplies.
- **Create** a prototype of your solution.
- **Test** your solution. How well does your solution produce drinking water? Evaluate your results against the success criteria.
- **Refine** your solution to improve the production of drinking water. Repeat your scientific investigation to determine the impacts of any changes made to your design.
- **Evaluate** your solution continuously against the success criteria, and make changes to improve the design.
- **Collaborate** in teams of two or three. You may also be required to evaluate social interactions to effectively work in a team.

## Investigate

You have access to the following materials and supplies:

- Sand
- Rocks
- Vegetation, including the leaves and branches of plants and washed up plant material
- Cotton clothing
- Cotton blanket
- Bonnet
- Umbrella
- Three cans of tinned food
- Saw
- Hammer
- Matches
- Watch
- Book
- Pencil

View from Lizard Island, over the Great Barrier Reef.

1. Investigate the types and properties of materials available for construction. Evaluate the viability of using these materials on a remote island.

| Material | Properties | Plus | Minus | Interesting |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

2. Investigate the physical separation techniques that will allow you to produce drinking water. Evaluate the viability of using these separation techniques on a remote island using only the available materials and supplies. **(Year 7)**

| Separation Technique | Plus | Minus | Interesting |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

3. Develop criteria your designed solution would need to meet to successfully solve the problem (success criteria).

## Design

Draw a labelled diagram of your solution. Make sure you identify and justify the materials you will use to create the solution, and justify reasons for design.

## Create

Create a prototype of your solution.

### Test

Test the effectiveness of your solution. How well does your solution produce drinking water? Record and discuss your results below.

### Recording Results

1. Before you start, what safety considerations must be made before, during and after this test? Identify at least five hazards and how you will minimise them.

| Hazard | How to minimise hazard |
|---|---|
| | |
| | |
| | |
| | |
| | |

2. Describe the results of this test.

| |
|---|
| |

### Discussing Results

1. Explain the results of this test.

| |
|---|
| |

2. Explain how you obtained the drinking water. What changes occurred, and how did you make these changes occur? You may like to draw a diagram to help communicate your response.

3. Discuss the effectiveness of your solution. Consider any success criteria in your response.

4. Explain how you could refine your solution to increase its effectiveness.

## Refine

Modify your solution based on the ideas discussed in the previous question. Retest your solution to determine how these changes affected your solution's ability to reliably produce drinking water. Evaluate the impact of these modifications.

## Evaluate

Reflect on your actions with your team or class after you have completed the design challenge. You might like to think about the following questions to assist with your reflection:

- What scientific knowledge helped you make decisions about your solution?
- What aspects of your solution are you very satisfied with and why?
- Describe any further changes you could make to improve the solution.
- What were the main challenges you experienced during the design process? How did you overcome these challenges?
- What have you learnt about separation techniques and the design process from this activity?
- How could you apply this knowledge and understanding to your learning in other contexts?
- What more would we like to know about how to produce drinking water?