
Image credit: Harry Calderbank

TASMANIAN SMART SEAFOOD PARTNERSHIP

EDUCATION RESOURCE

The TSSP is hosted by NRM South and works in partnership with the Tasmanian Seafood Industry Council. It is funded by the Australian Department of Agriculture, Water and Environment through round one of the National Landcare Program's Smart Farming Partnerships.

THE TASMANIAN SMART SEAFOOD PARTNERSHIP

The Tasmanian Smart Seafood Partnership project aims to improve the sustainability of processes and practices in the seafood industry to achieve positive outcomes for marine biodiversity in Tasmanian waters. To achieve this, the project creates links between education, training, research, and restoration within the seafood industry.

ABOUT THIS RESOURCE

The Tasmanian Smart Seafood Partnership project team has consulted across the seafood industry and with educators, trainers, research scientists, policy makers and regulators to identify desired key learning outcomes. The marine environment and seafood industry depend on developing learners who understand the complexities of systems and can apply their knowledge to adapt to future challenges and opportunities. This resource has been developed to enable students and teachers to explore the connections between Tasmania's seafood industry, unique marine environment, and management. It is exclusive to Tasmania and establishes a local context for learning.

Each unit can be delivered in a stand-alone format or the whole resource can be applied to focus learning. The resource is ideal for Years 7-10 however elements can be used across year levels. The resource is integrated across the curriculum. Each unit provides information and links for teachers as well as activity ideas.

ACKNOWLEDGEMENTS

Writing: Chloe Simons and the Woodbridge Marine Discovery Centre, Dept of Education; Jennifer Hemer, NRM South; Georgie Butorac, NRM South

Consultation and Review: The project team wishes to extend thanks to numerous stakeholders from across the seafood industry as well as educators, trainers, research scientists, policy makers and regulators for sharing their knowledge and understanding of the Tasmanian marine environment and seafood industry. We also extend our thanks to all those who reviewed this document and provided feedback, of who there are many.

ACKNOWLEDGEMENT OF COUNTRY

We pay respect to the Traditional Owners of Iutruwita (Tasmania), the Tasmanian Aboriginal people, and acknowledge their continued survival and connection with their land, sea and sky Country that spans millennia.

We acknowledge the many Nations of Tasmanian Aboriginal people, past and present, as the traditional and ongoing owners of their respective countries within Iutruwita and the islands.

We pay respect to those who have passed and acknowledge today's Aboriginal communities who are the custodians of this land and sea.

We acknowledge that all land, sea, and sky Country holds cultural values that provide strong and continuing significance to the Tasmanian Aboriginal communities. We acknowledge that Tasmanian Aboriginal people are part of a continuous culture that holds traditional knowledge about the ecosystems we all depend on.

INTRODUCTION | TASMANIAN SEAFOOD INDUSTRY COUNCIL

For the seafood lover, Tasmania is as good as it gets, offering the best seafood you could hope for: southern rock lobster, abalone, scalefish, farmed salmon, oysters and so much more.

But what makes Tassie seafood so great? There is the influence of the pristine cold waters of the Southern Ocean which defines our unique marine ecosystems. There's the world's best marine resource management, driven by some of the best scientists and scientific advice in the world. There's the technology and innovation adopted and sometimes even invented by Tasmanian seafood businesses. There's the ability to catch it yourself. And if that doesn't work out, you can rely on the commercial seafood sector, purchasing sustainable fresh seafood at a retail outlet or cooked at a food service venue.

We hope that this resource can provide some insight into our Tasmanian commercial seafood industry and the unique environment we operate in.

Julian Harrington
Chief Executive
Tasmanian Seafood Industry Council

INTRODUCTION | NRM SOUTH

Tasmania's people largely live on the coast, and many of us gain nourishment from the ocean. We enjoy and value our unique marine environment, and we understand that managing the use of our marine natural resources is critical in the long term.

In addition to the intrinsic natural and cultural values of these systems, our marine environment supports a strong seafood industry of both wild caught and farmed species, a large recreational fishing community, and a rich and ongoing connection with Aboriginal fishing and sea Country.

Curated by local experts, this resource is contemporary and tailored to Tasmania – it summarises the challenges and opportunities at hand, and it provides targeted exercises that aim to engage school students in marine resource management.

Our relationship to the ocean and its resources is explored in the context of fishing practices, sustainable management, ocean systems, water quality, marine pests, biodiversity, pollution, and technology.

Increased understanding of these relationships will facilitate informed interaction with the marine environment, and awareness of the complex, science-based management in place to ensure a sustainable, healthy environment and seafood industry.

Nepelle Crane
Chief Executive Officer
NRM South

TEACHING RESOURCES

These teaching resources are also available as separate documents which can be accessed by clicking on the links below.

1. TASMANIAN SEAFOOD: CATCHING, GROWING AND HARVESTING

2. UNDERSTANDING AND MONITORING THE TASMANIAN MARINE ENVIRONMENT

3. THREATS TO SEAFOOD PRODUCTION: BIOSECURITY AND ILLEGAL HARVESTING

4. PROTECTING THE MARINE ENVIRONMENT - HABITAT RESTORATION AND MARINE DEBRIS

5. TECHNOLOGY FOR IMPROVED SEAFOOD PRODUCTION EFFICIENCY AND SUSTAINABILITY

TEACHING RESOURCE | TASMANIAN SEAFOOD: CATCHING, GROWING AND HARVESTING

Image credit: John Turnbull

RATIONALE

This resource aims to help students and teachers in secondary schools investigate and understand more about Tasmania's seafood industry, including;

- Commercial, recreational and Aboriginal fishing in Tasmania
- Species that are fished and farmed in Tasmania
- Fishing methods and aquaculture facilities
- Management of the seafood industry in Tasmania
- Buying local seafood

LEARNING OUTCOMES

- Students will learn how seafood is caught, grown and harvested in Tasmania, including wild caught fisheries, aquaculture facilities, recreational and Aboriginal fishing practices.
- Students will learn how commercial, recreational and Aboriginal fishing are managed in Tasmania.
- Students investigate the production costs of Tasmanian seafood and understand that the price of seafood reflects the quality and sustainability of the fishing resource.

LOCAL TASMANIAN SEAFOOD

Many Tasmanians are engaged in seafood collection and production for their livelihood, income and recreation. Recreational, cultural and economic factors contribute to the total amount of seafood caught and produced in Tasmania's waters. This learning resource gives an overview of seafood collection and production in Tasmania, including;

- Fishing methods in Tasmania – commercial and recreational; wild catch and aquaculture.
- Local seafood - production and costs, including eating local seafood.

Shell midden. Image provided courtesy of Aboriginal Heritage Tasmania, copyright DPIPWE. Image credit: Jillian Mundy

FISHING METHODS IN TASMANIA

Aboriginal fishing

Tasmanian Aboriginal people have a deep connection to sea country. Respecting the sea as a resource, and the understanding the cultural significance of seafood harvesting is an important part of the Tasmanian Aboriginal people's knowledge of country. Aboriginal people of Tasmania would rely on shellfish, scale fish, seals and mutton birds (shearwaters) for sources of protein. Middens found around many coastal areas of Tasmania indicate the variety and abundance of shellfish eaten by Aboriginal people.

Aboriginal people managed their resources by moving from place to place to harvest a variety of different seasonal plants and animals. Today there is a need to sustainably manage fishing resources, and fishing regulations so that Aboriginal people can continue to practice traditional harvesting. This is covered further on page 4.

Commercial and Recreational Wild Catch Fishing

Commercial fishing in Tasmania is highly regulated and licences are required for any commercial practice. Further information is available at DPIPWE Sea Fishing and Aquaculture – Commercial Fishing https://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing

An important aspect of all wild-catch fishing is reducing the catch rate of bycatch (non-target species) and juvenile animals. Most commercial fishers adopt Codes of Practice which provide advice on best practice fishing techniques to reduce the rate of non-target animals being caught. For example: https://www.tsic.org.au/uploads/9/6/8/7/96879568/scalefish_cop_august_2014_final_1.pdf

Commercial and recreational wild-catch fishing involves numerous catch methods – some of which require a licence. Responsible practices are promoted for all fishing, whether commercial, recreational or Aboriginal.

Rod and line fishing. Image credit: Chloe Simons

Wild Catch Fishing Methods

Rod and line	An attended line with a single hook where fish are caught one at a time. Some larger predatory fish are caught this way, for instance tuna species and shark.
Netting	A large range of nets are used in commercial fishing, for example gillnet and seine. Nets can be selective depending on their use, allowing non-target species to escape. They typically hang vertically in the water and stretch along a series of buoys on the surface. They are used to catch scale fish species in Tasmania (e.g. Banded Mowong, Flathead, Striped trumpeter, Bastard trumpeter, Blue grenadier, Blue eye trevalla, Snotty trevally/Blue warehou, Silver trevally).
Set lines (longlines and droplines)	An unattended line with multiple hooks either suspended from a buoy toward the seabed (dropline) or spread horizontally using weights and two buoys (long-line).
Pots	'Cray pots' are wooden circular pots with a hole in the top. Bait attracts species inside, but shape prevents southern rock lobsters from escaping. Octopus pots are ceramic or plastic pots that are an attractive place for octopus hide in, allowing them to be captured.
Jigs	Often an artificial lure - although sometime baited – with multiple sets of spikes to latch on to squid and calamari.
Diving, snorkelling and collection by hand	Target species are typically abalone, urchin, southern rock lobster, periwinkle and scallop in Tasmania; as well as foraging for shallow water gastropod and bivalve molluscs and crabs. Scallop and rock lobster are only dived for recreationally, not commercially.
Dredging	Basket shaped net dragged along the seabed on a heavy-duty frame. Bottom of the net is made from metal chain to prevent net breakage. Used to collect scallops.

Some of these fishing methods are used by recreational fishers. Information on recreational fishing methods, licence requirements, bag limits and season and size restrictions can be found in the Tasmania Recreational Sea Fishing Guide and the Tas Fish Guide app, available at:

https://dpipwe.tas.gov.au/sea-fishing-aquaculture/publications-and-products/recreational-sea-fishing-guide

For more information about wild fisheries management, go to www.fishing.tas.gov.au

Image credit: Harry Calderbank - Flickr

MARINE AQUACULTURE

Aquaculture means 'to grow in water'. Fin fish, shellfish, crustaceans and seaweeds can all be farmed in aquaculture facilities. Aquaculture is an important economic industry for Tasmania. It can also reduce pressure on wild-catch fish stocks, and there is no bycatch. Like all farming systems, growers and regulators must work together to ensure sustainability.

Types of aquaculture facilities in Tasmania

1) FIN FISH

Fin fish such as Atlantic salmon and ocean trout are farmed in fish pens in Tasmania. The aquaculture pen consists of a sea net that is held up by a floatation ring and anchored to the seafloor to stop it drifting away. There is usually bird netting to keep birds away from the fish, with an escape hatch to allow birds to escape.

Food is delivered to the fish from a 'feed hopper' boat that is usually controlled remotely from an on-shore location. Fish pens are often equipped with a range of technology such as cameras and sensors to monitor fish behaviour and detect any un-eaten food; and automatic net cleaners. Marine farm leases are marked with yellow marker buoys in Tasmania.

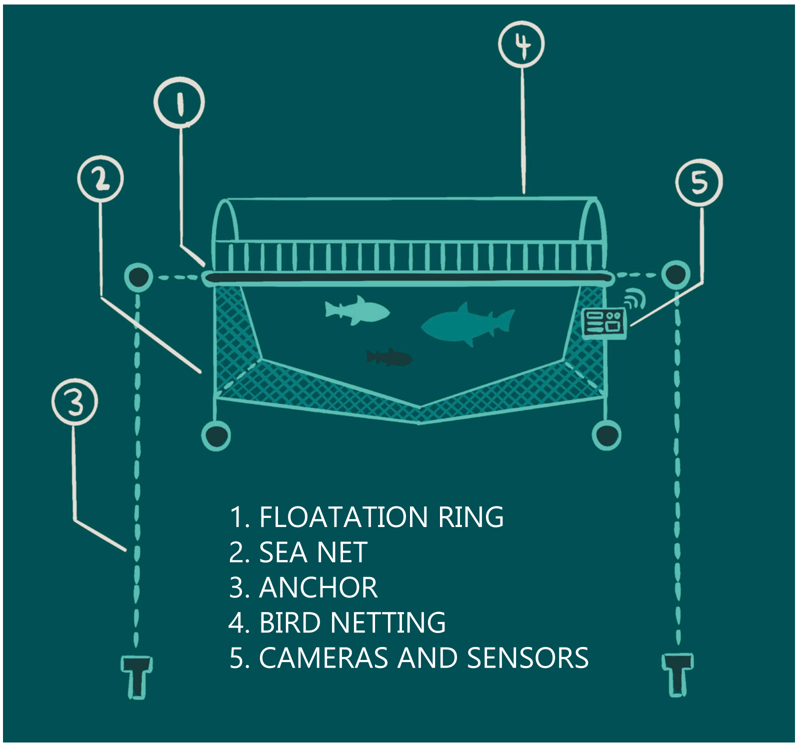


Figure 1: Aquaculture pen design

2) SEAWEED

Seaweed farming is becoming an important industry in Australia. It has uses in food products and medicine as well as carbon capture and storage. As seaweed is a photosynthesizing organism, it plays an important role in carbon dioxide and oxygen levels in the ocean.


Image credit: IMAS

3) SHELLFISH

Shellfish farmed in Tasmania include oysters, mussels and abalone. Baskets of oysters are hung from adjustable lines or ropes. The line is attached to posts by hooks. The basket height can be adjusted by transferring the line to hooks that are positioned lower or higher on the post. Mussels are often hung from ropes that are submerged in the water. The mussel spat is put into mesh bags called 'socks' that grow out over about 18 months. Abalone can be farmed in land-based tanks or sea cages.


Image credit: Spring Bay Seafoods

4) INTEGRATED MULTITROPHIC AQUACULTURE
This practice involves farming different species together in proximity, such as growing invertebrates and seaweeds near fin fish facilities. Multi-trophic farming is an emerging practice in Tasmania

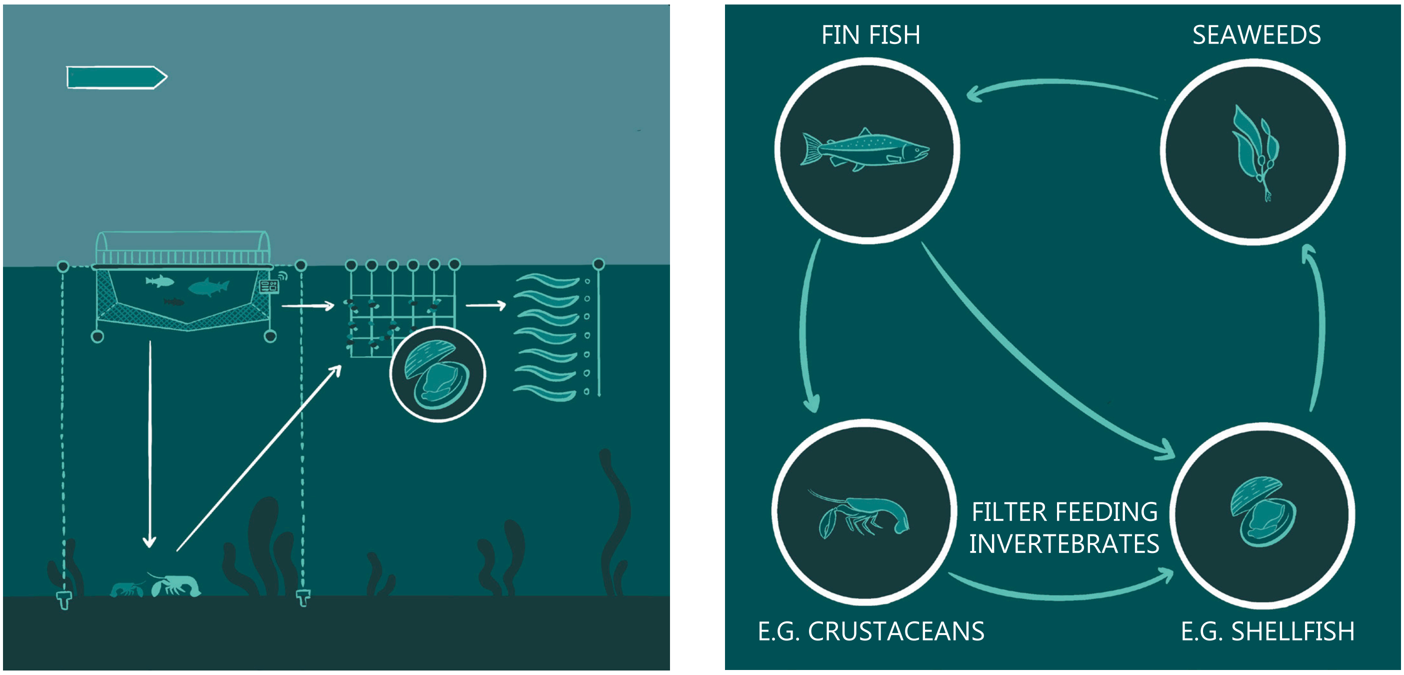


Figure 2: Filter feeding invertebrates take up excess nutrients from fin fish pens and seaweeds re-oxygenate water. Image on the right is an enlarged version of left hand side image.

MANAGEMENT OF FISHERIES IN TASMANIA

For management purposes, Tasmania's seafood industry can be divided into wild-catch fisheries management which includes commercial and recreational fishing; aquaculture farm management and Tasmanian Aboriginal fishing. To ensure sustainability of the resource, food collected from the sea is regulated with catch limits, fishing seasons and in some cases, licences.

Commercial, recreational and Aboriginal fishing activities in Tasmania are regulated under the *Living Marine Resources Management Act 1995*. Aquaculture activities are regulated under the *Marine Farming Planning Act 1995*.

Aboriginal fishing

Tasmanian Aboriginal people abide by legislation when harvesting seafood and in some instances, are exempt from the requirement to purchase a licence. There are unique regulations for Tasmanian Aboriginal fishing practices.

> **'People engaging in Aboriginal activities associated with fish and fishing must be able to prove that they are Aboriginal and that their fishing is an Aboriginal activity. The Act exempts Aboriginal non-commercial fishers from requirements to hold a sea fishing licence but requires that they must comply with all other fisheries rules, including bag and possession limits, size restrictions and seasons.'**
>
> Excerpt from Economic And Social Assessment Of Tasmanian Fisheries 2016/17.

There are parameters in the Living Marine Resources Management Act 1995 designed to support the continuation of traditional cultural practices of Tasmanian Aboriginal People. A summary of these can be found on the Tasmanian Government website.

Commercial and recreational wild catch

The commercial and recreational wild catch sector has management parameters such as:

- limiting the number of fishing licences for some species to ensure sustainability and prevent overfishing;
- setting size limits for popular seafood species; succession management, allowing young fish to reach sexual maturity and in some cases to protect active breeders;
- setting a total allowable catch (usually by weight) to aid sustainability and prevent stock depletion;
- capping the allowable catch for specific geographical zones to protect important breeding grounds or other sensitive areas;
- seasonal closures and other general closures during breeding/spawning seasons and allow successful reproduction;
- setting gear restrictions (gear type, soak time or mesh size and other controls) to minimise harm to bycatch and support animal ethics;
- limiting the time spent at sea to reduce pressure in a geographical zone and support best handling practice.

In Tasmania, stock assessments of wild fisheries are conducted by the Institute of Marine and Antarctic Studies (IMAS) at the University of Tasmania. Quotas in marine waters – including total allowable catch – are set by the Tasmanian Government using information from scientific assessments of fish stocks.

Stock assessments are conducted using the commercial catch and effort data submitted by fishers to the Department of Primary Industries, Parks, Water and Environment (DPIPWE) as a part of the compulsory Tasmanian Commercial Catch, Effort and Disposal Returns, and Commonwealth non-trawl and Southern Squid-jig Fishery logbook submissions.

Tasmanian scalefish stock assessments can be found online through the IMAS website, including scalefish fishery assessment reports that outline various sector histories; gear, catch and effort data; numbers of scalefish licences; and much more. They also categorise whether species are "sustainable", "depleting", "recovering" or "depleted".

See Table 1 in Appendix A for more information.

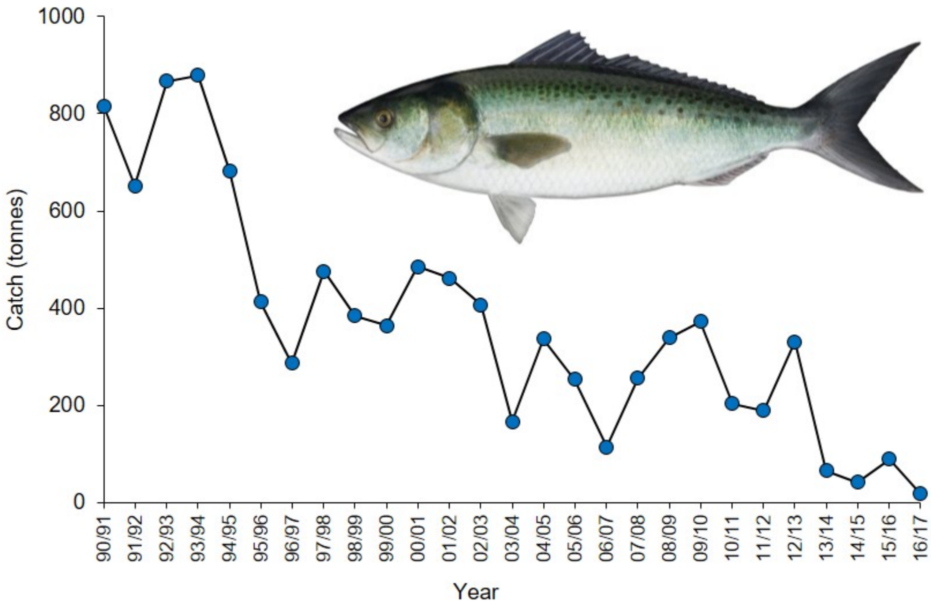


Figure 3: Australian Salmon catch through time. Source: IMAS
https://www.imas.utas.edu.au/news/news-items/the-latest-assessment-of-the-tasmanian-scalefish-fishery

Aquaculture Industry

There are different stages of aquaculture farming operations, including hatcheries, nurseries and grow-out farms. Like wild-catch fishers, all aquaculture farm businesses must be licenced to operate, and there are many management parameters affiliated with this licence. Fish farmers also require an Environmental Licence if they have the capacity to produce five tonnes of seafood or more annually, or if they hold a biomass of two tonnes or more at any one time. Aquaculture licences specify the total allowable product by tonnage.

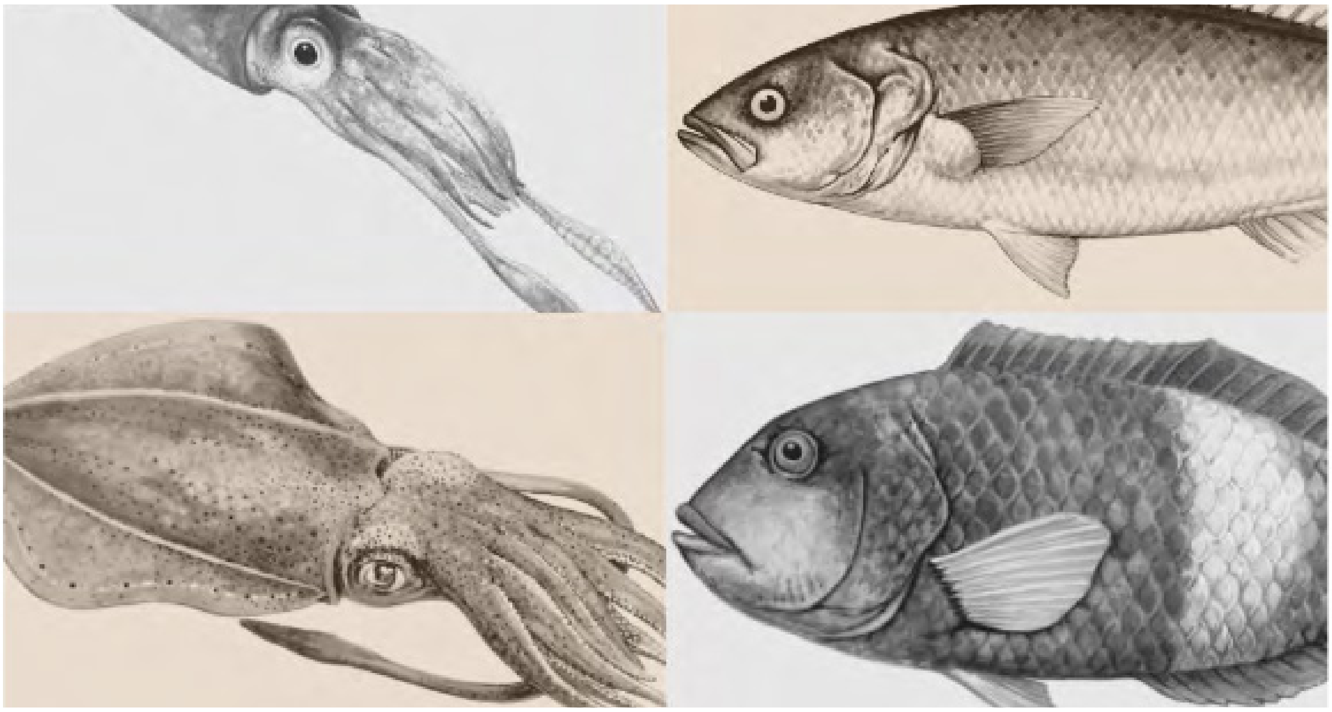
REPORTING

Wild catch
All commercial wild-catch fishers are required to submit Tasmanian Commercial Catch, Effort and Disposal Record Book, and Commonwealth non-trawl and Southern Squid-jig Fishery logbook. For scale fish, parts of the logbooks must be completed within 4 hours immediately after landing:

- before any of the landed scale fish are moved outside the landing area;
- before any of the landed scale fish are moved inside a temporary structure or a building; and
- if the fishing vessel is on a fishing trip that lasts longer than 24 hours, before the end of each day of that fishing trip.

This is to aid accuracy and assist in governance. The logbooks must be submitted by fishers to DPIPWE within 48 hours of the end of each month, accompanied by receipts for all fish commercially sold or transferred. Licence holders also document fishing trip details in a logbook.

Information about interactions with Threatened, Endangered or Protected species (e.g. seals and whales) is also captured in these logbooks. Fishers are legally obligated to report all physical interactions with a protected species. An example of a reporting page can be found in Appendix B, and more information on Tasmania's commercial scalefish fishery operations can be found here.



Aquaculture
Environmental reporting requirements vary between aquaculture sites and are specified within Environmental Licences prior to farm establishment. Environmental reports are prepared by contractors and licenced operators, and typically include results from sediment and water quality sampling. Specific salmon aquaculture licences and associated reports can be found on the Environmental Protection Authority (EPA) Tasmania website.

Tasmanian Salmon Farming Data is shared and available from the Tasmanian Government in its regulatory capacity. Some Tasmanian owned and operated aquaculture businesses also make their environmental data available on their company dashboards.

Data associated with shellfish farming, including rainfall, biotoxin levels and chemical indicators, is collected and assessed to ensure that farmers can make decisions about when to harvest healthy shellfish for human consumption. Environmental data is published weekly for farmers through the Shellfish Market Access Program (ShellMAP) and Biotoxin News. When an infringement is detected, authorised Government officers may issue an infringement notice (salmonfarming.dpipwe.tas.gov.au).

MONITORING

IMAS compiles logbook data annually and makes comparisons with previous years. They investigate trends, for example a drop in catch with the same or larger fishing effort may suggest that the species is in decline. They also consider other possible factors such as climate change and accelerated changes to ocean conditions that may impact fish stocks.

Annual fisheries stock assessment reports are produced and published online, and these are used by to inform fisheries management for the following year. This work is also undertaken for the recreational fishing sector and used to make decisions considering all users and cumulative impacts. Recreational fisheries stock assessments are conducted by phone every five years by IMAS.

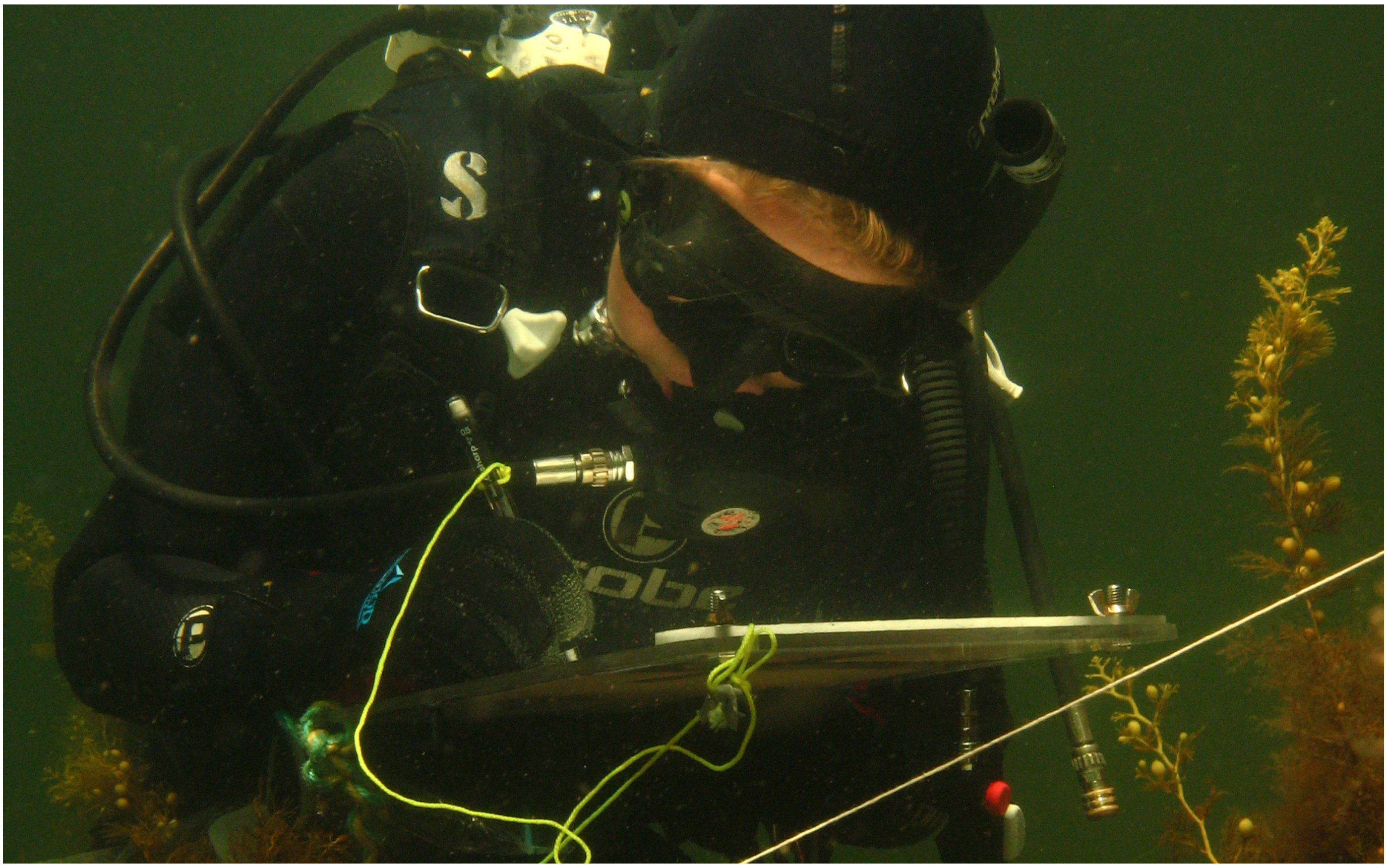
IMAS conducts studies on the effect of salmon farming on the surrounding environment, which includes the seabed, native flora, and fauna. It uses an array of sampling technologies to achieve an assessment. Examples include dissolved oxygen sensor buoys, temperature and salinity meters, Van Veen Grab sediment samplers, and GPS trackers for animals.

Salmon farms have cameras and other monitoring devices within pens that provide live dissolved oxygen and water temperature data to control centres in Hobart. Each farm has a technician in Hobart closely monitoring these readings, fish behaviour, and controlling the distribution of food pellets – ensuring that feed distribution halts when it reaches a certain depth to avoid pellet wastage and associated environmental impact.

Remotely operated vehicles are regularly used within farm monitoring operations. They perform seabed surveys, net cleaning and biosecurity inspections. According to most development plans, marine finfish farms must not have any significant visual, physio-chemical, or biological impacts at or extending 35 metres from the boundary of the lease area, unless otherwise specified by the Director, EPA.

Marine Farming Development Plans outline management controls that relate to various to parameters, for instance nitrogen outputs on the DPIPWE website.

Further information on water quality parameters can be found in the teaching resource **Understanding the Tasmanian Marine Environment.**



LOCAL SEAFOOD – PRODUCTION AND COSTS

As an island state, many individuals, families and Indigenous groups rely on harvesting seafood for cultural practices, food and/or income. Purchasing local seafood supports local communities, and consumers know they are getting a top-quality product that is sourced from clean waters with low food miles, and that they are supporting an industry that is closely monitored and managed to ensure it is as sustainable as possible. It is worth asking suppliers which of their products are from Tasmania and how it was caught and handled.

Where to buy local seafood and how to cook it

The Tasmanian Seafood Industry Council's website has a Support Local/Eat More Seafood page that uses an interactive map of Tasmania to illustrate the various local seafood suppliers. You can view the various places to purchase Tasmanian seafood, by zooming in to your local area.

There is also a free seafood cookbook available to download on this page. It describes how to prepare and cook seafood straight from the sea and includes a seasonal guide. It's important to know the market you're buying from; supporting industries that are sustainably managed ensures food security for future generations.

Cost of seafood

Choosing to purchase local seafood does more than support local producers and their families; you are contributing to an industry that operates within government regulations and is informed by scientific research. Management strategies ensure that fish stocks are closely monitored and maintained; staff receive fair wages; and that catch is regulated. Tasmanian management practices and standards are not always met by international fisheries and this is often a reflected in product price.

The price of seafood may seem straightforward, but there are background costs involved in producing seafood products. The price tag of local products can be higher than imported products, yet this does not necessarily imply a larger profit for fishers or retailers. There are several background costs to ensure Tasmania's seafood industry is well managed. Without these costs, Tasmanian seafood would be at risk of exploitation and significant stock depletion.

COSTS TO THE FISHER

Fishing license
Boating license
Leasing or purchasing quota to catch
Fishing equipment (nets, pots, rods… etc.)
Boating equipment (navigation, radio, winches…etc.)
Boat and gear maintenence (including slippage fees)
Safety equipment and maintenance for compliance
Boat engine servicing
Fuel
Mooring/marina fees
Deckhand wages (with minimum wage)
Pigovian tax
Product transportation costs

COSTS TO THE SEAFOOD RETAILER

Seafood product (i.e. payment to fisher for product)
Seafood retail license
Building maintenance
Cleaning (wages and equipment)
Staff wages (with minimum wage)
Utilities (e.g. power, water)
Sanitary products (toilet paper, paper towel, napkins)
Alcohol license
Lease
May include seafood processing licence

LEARNING ACTIVITIES

1) REVIEW AND CRITICAL THINKING QUESTIONS FOR STUDENTS

- Why do you think so many Tasmanians enjoy fishing?
- Suggest three ways that we can ensure the fishing resources are sustainable so that everyone can enjoy catching a feed of fish.
- What are some ways that the commercial fishing industry is monitored and regulated?
- Why do aquaculture operators need to apply for a permit to operate?

2) EXTENDED RESEARCH QUESTION – RESEARCH A SPECIES OF FINFISH, INVERTEBRATE OR SEAWEED THAT IS GROWN, CAUGHT OR HARVESTED IN TASMANIA.

- Provide some details about your chosen species (common name, scientific name, what is its usual habitat etc).
- How is this species grown, caught or harvested?
- What are the requirements for growth of this species (eg diet, preferred temperature, oxygen levels etc).
- What is the market for this species? (eg is it sold locally, exported, or caught and eaten by the fisher).

3) EXTENDED RESEARCH QUESTION – MULTITROPHIC AQUACULTURE

Prepare a document (report, poster, PowerPoint, brochure, movie clip, podcast etc) about Multitrophic Aquaculture. Describe:

- What is meant by 'multitrophic'?
- Why this approach may provide benefits from an environmental perspective.
- Which species can be farmed together in multitrophic aquaculture systems and how each animal/plant or algae contributes to the nutrient, oxygen and carbon dioxide levels of the water.
- Can there be any economic benefits from Multitrophic Aquaculture?
- What other efficiencies can be gained from aquaculture systems (e.g. fish attraction, marine renewable energy systems)?

4) RESEARCH QUESTIONS – COMMERCIAL FISHING

- What is quota and why do we have it?
- What are some costs involved in operating a fishing boat?
- Why is it important to reduce bycatch and how is this done for different commercial fishing areas?

5) RESEARCH AND CRITICAL THINKING QUESTION – IMPORTED SEAFOOD

Australia is an island nation with a large coastline and extensive exclusive economic zone that is reserved mainly for Australian fishing activities, however Australia imports a large amount of seafood.

Read this quote from the Australian Government's Department of Agriculture, Water and Environment web page https://www.agriculture.gov.au/fisheries/aus-seafood-trade

Australia's seafood trade: It has been estimated that around 70 per cent of the edible seafood Australians consume (by weight) is imported, predominantly from Asia. With such a long coastline and a relatively small population, people often question why Australia imports so much of its seafood.

The full article is available here https://www.agriculture.gov.au/fisheries/aus-seafood-trade/ast and contains useful information for the questions below:

CONSIDER AND RESEARCH THE FOLLOWING QUESTIONS:

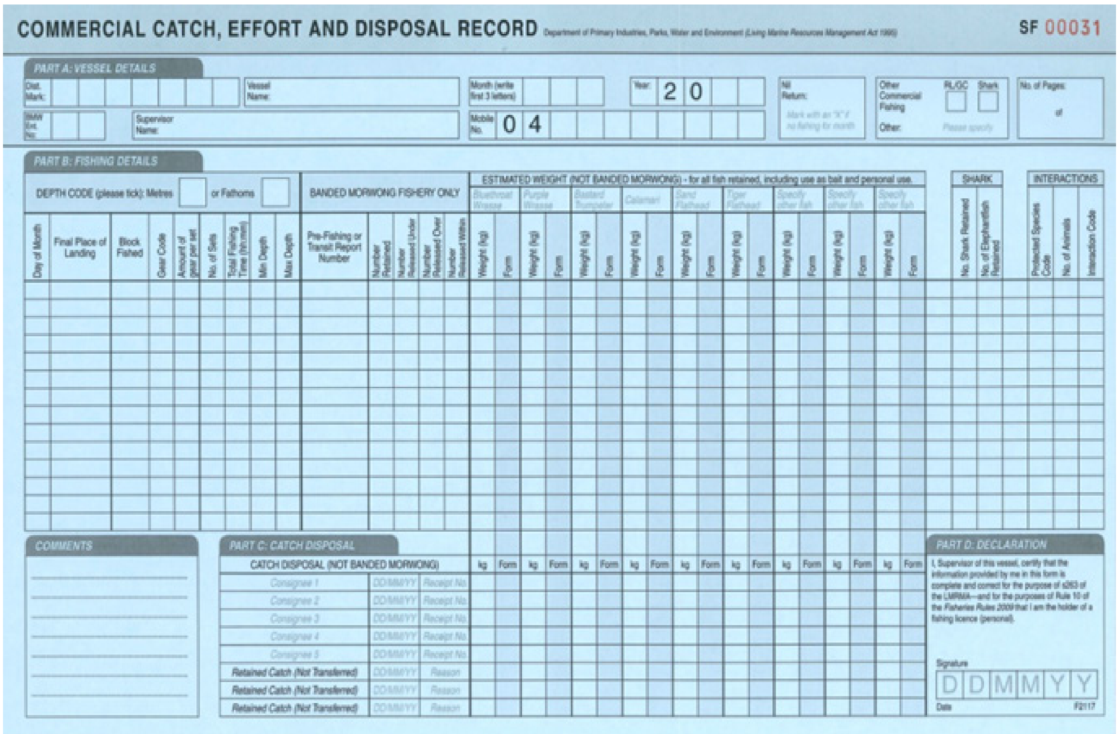
- What fish species make up the estimated 70% of seafood imported into Australia?
- Where does the majority of the imported seafood come from?
- How and where are these imported fish products sold?
- Are there any geographic, environmental, oceanographic or abiotic reasons why even though Australia has extensive coastline, we import a high percentage of seafood?
- What do you think about Australia's imports and exports of seafood, and if you were working in managing Australia's seafood industry, what would you recommend?

APPENDICES

APPENDIX A: Summary of management parameters for the various wild-catch fisheries.

	Limiting entry	Size limits	Total allowable catch	Catch caps for specific zones	Seasonal closures and/or general closures	Gear restrictions	Trip limits
Scalefish	✓	✓	✓ (banded morewong)		✓	✓	✓
Abalone	✓	✓	✓	✓	✓		
Tasmanian Giant Crab	✓	✓	✓		✓	✓	
Commercial Dive (Periwinkle, sea urchin, Japanese Kelp)							✓
Scallop	✓		✓		✓		
Rock Lobster	✓	✓	✓		✓	✓	
Southern Calamari			✓		✓		

APPENDIX B



COMMERCIAL CATCH, EFFORT AND DISPOSAL RECORD Department of Primary Industries, Parks, Water and Environment (Living Marine Resources Management Act 1995) SF 00031

PART A: VESSEL DETAILS

Dist. Mark: | Vessel Name: | Month (write first 3 letters) | Year: 2 0 | Nil Return: Mark with an "X" if no fishing for month | Other Commercial Fishing RL/GC Shark Other: Please specify | No. of Pages: of

BMW Ent. No. | Supervisor Name: | Mobile No. 0 4

PART B: FISHING DETAILS

DEPTH CODE (please tick): Metres or Fathoms | BANDED MORWONG FISHERY ONLY | ESTIMATED WEIGHT (NOT BANDED MORWONG) - for all fish retained, including use as bait and personal use. | SHARK | INTERACTIONS

Day of Month | Final Place of Landing | Block Fished | Gear Code | Amount of gear per set | No. of Sets | Total Fishing Time (hh:mm) | Min Depth | Max Depth | Pre-Fishing or Transit Report Number | Number Retained | Number Released Under | Number Released Over | Number Released Within | Bluethroat Wrasse Weight (kg) Form | Purple Wrasse Weight (kg) Form | Bastard Trumpeter Weight (kg) Form | Calamari Weight (kg) Form | Sand Flathead Weight (kg) Form | Tiger Flathead Weight (kg) Form | Specify other fish Weight (kg) Form | Specify other fish Weight (kg) Form | Specify other fish Weight (kg) Form | No. Shark Retained | No. of Elephantfish Retained | Protected Species Code | No. of Animals | Interaction Code

COMMENTS

PART C: CATCH DISPOSAL

CATCH DISPOSAL (NOT BANDED MORWONG) | kg | Form | kg | Form | kg | Form | kg | Form | kg | Form | kg | Form | kg | Form | kg | Form | kg | Form

Consignee 1 | DD/MM/YY | Receipt No.
Consignee 2 | DD/MM/YY | Receipt No.
Consignee 3 | DD/MM/YY | Receipt No.
Consignee 4 | DD/MM/YY | Receipt No.
Consignee 5 | DD/MM/YY | Receipt No.
Retained Catch (Not Transferred) | DD/MM/YY | Reason
Retained Catch (Not Transferred) | DD/MM/YY | Reason
Retained Catch (Not Transferred) | DD/MM/YY | Reason

PART D: DECLARATION

I, Supervisor of this vessel, certify that the information provided by me in this form is complete and correct for the purpose of s263 of the LMRMA—and for the purposes of Rule 10 of the *Fisheries Rules 2009* that I am the holder of a fishing licence (personal).

Signature

D D M M Y Y

Date

F2117

TEACHING RESOURCE | UNDERSTANDING AND MONITORING THE TASMANIAN MARINE ENVIRONMENT

Image credit: John Turnbull

RATIONALE

This resource aims to help students and teachers in secondary schools investigate and understand more about Tasmania's unique marine environment; how it supports the seafood industry and the scientific approach used for reporting on the current state of the local marine environment to make decisions about management of marine resources. In any ecosystem, there are biotic (living) and abiotic (non-living) factors affecting the system. This resource will examine the abiotic factors of marine ecosystems, and explain why people working in the fishing and aquaculture industry need to understand and monitor these factors.

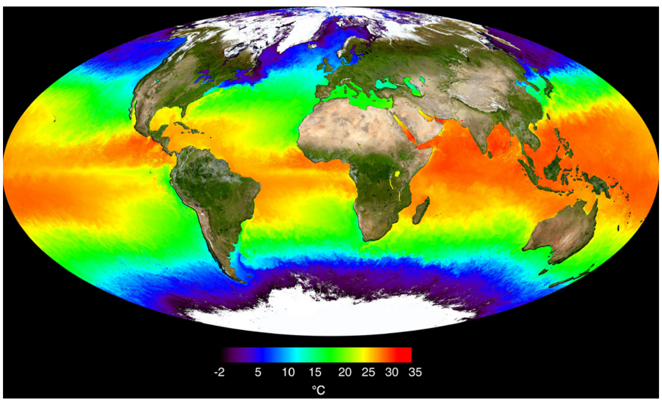
LEARNING OUTCOMES

- Understanding global and local ocean systems, and how these influence Tasmania's marine environment.
- Understanding about water quality and the different factors that are used to measure water quality in Tasmania.

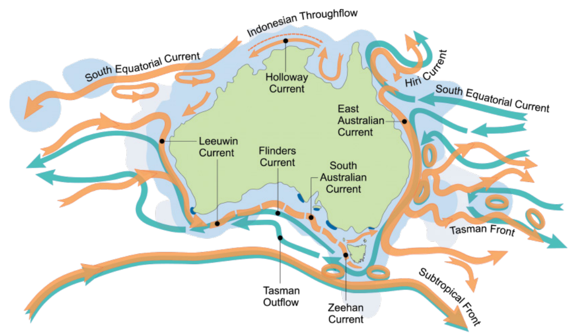
OCEAN SYSTEMS

The Southern Ocean is a dynamic and productive region. Tasmanian waters support a thriving seafood industry; from small scale shellfish farms to wild caught, high-value rock lobster and abalone, in-shore scalefish fisheries and finfish farming.

The marine environment can be influenced by multiple and cumulative factors, including local climates, currents and human activities. Scientists and marine resource managers monitor species and processes in the local marine environment to understand health and impacts, report on the current state of the local marine environment using a scientific approach and make recommendations and decisions for the management of human activities.



Tasmania's marine environment is classified as Cool Temperate (in contrast to Tropical and Polar marine environments). Source: NASA



Australian ocean currents. Source: CSIRO

Three main ocean current systems affect Tasmania. The Leeuwin and Zeehan currents come from the west and have a stronger effect during winter. The Antarctic Circumpolar Current runs around Antarctica and southerly storms bring cold upwellings to Tasmania.

The East Australian Current (EAC) runs along Australia's East Coast and brings warm (and relatively nutrient-poor) waters to Tasmania, with its strongest effect in summer. The EAC system has been strengthening in recent years and the southward extension is contributing to rising sea temperatures off Tasmania's East coast where water is warming faster than the global average.

In addition to broad scale ocean current effects, there are many localised factors that will influence Tasmania's marine and coastal waters. Local climate is impacted by topography and prevailing weather systems.

Water quality and how it relates to Tasmania's seafood industry

Healthy waterways are socially and ecologically important and have economic value. Tasmania's pristine waters support a seafood industry that produces and harvests high-quality seafood which is supplied to local and international markets. Water quality is closely monitored by seafood producers, typically at farm sites, and some aquaculture leases have real-time water quality monitoring stations that continuously transmit data to central locations in Hobart.

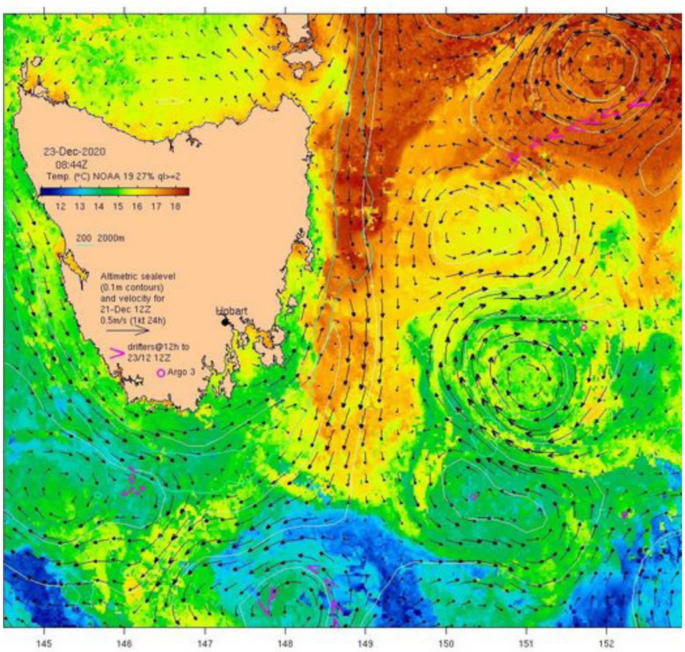
Examples of water quality variables

WATER TEMPERATURE

Water temperature naturally fluctuates on a diurnal and seasonal basis. There is an optimal temperature range for most species on earth. If aquatic species experience temperature out of their optimal range, they become stressed and more susceptible to disease; in extreme cases some may die from heat stress alone.

Changes in water temperature can also alter other abiotic factors. Two significant things to know about water temperature are:

- Cold water is more dense than warm water, so stratification layers can develop in waterways where there is little mixing from currents, wind and wave action.
- Cold water can carry higher concentrations of dissolved gasses (for example oxygen and carbon dioxide) than warm water.



Sea Surface Temperature Map, December 2020.
Source: IMOS

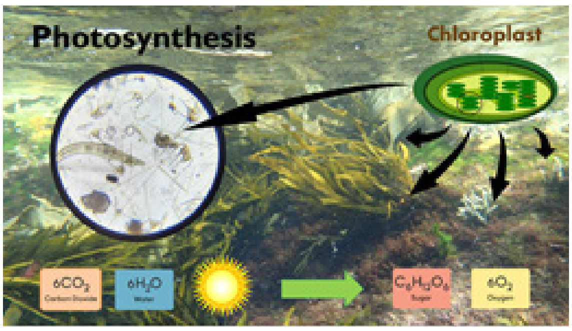
DISSOLVED OXYGEN

Dissolved oxygen (DO) is vital for most of marine plants and animals to survive, excluding marine mammals that breathe air. Ocean plants, phytoplankton and algae (seaweed) produce oxygen via photosynthesis, which increases the concentration of dissolved oxygen (DO) in our waterways.

Tasmanian aquaculture farms rely on DO to support healthy stock. DO can become limited if stocking densities are too high, if there is an abundance of organic decaying matter, if the water heats up too much, or if water movement through the farm is minimal.

- Cold water can hold more dissolved oxygen than warm water, so DO levels are usually lower over summer.
- Increased organic matter loads can reduce DO through aerobic bacterial decomposition. There can be a slight decrease in DO after rain, as runoff from land contributes organic matter (e.g. plant debris, animal bodies, and faeces).
- Oxygen can be measured in mg/L or as a percentage saturation. Water bodies are hypoxic at oxygen concentrations of less than 2 mg/L and anoxic at oxygen concentrations of near 0 mg/L.

Fish, shellfish and plants suffocate if DO concentration is too low. Aquaculture farms avoid this by maintaining clean equipment such as nets to support adequate water movement through the farm, minimising decaying organic matter, and calculating suitable stocking densities and reducing densities if DO becomes too low.



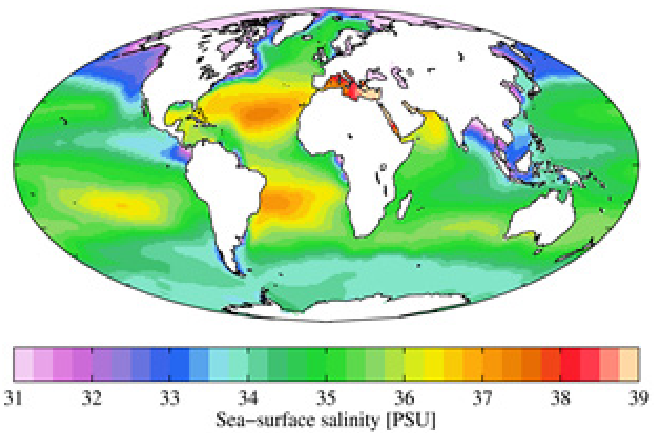
Photosynthesis by marine plants, algae and phytoplankton produce oxygen in the water. Image credit: Chloe Simons

SALINITY

Salinity is the amount of salt dissolved in water. The global average for salinity is 3.5% dissolved salts or about 35 ppt (parts per thousand). Salinity can vary significantly at a local scale depending on evaporation rates (affected by temperature and wind); precipitation (rainfall and snow) and freshwater river runoff (including snow melt).

As with other abiotic factors, each animal species has a range of salinity that can be tolerated, and outside this range, the animal will experience some degree of physiological stress or die.

- Salty water is more dense than fresh water, so fresh water will form a layer on top of salty water in areas where there is little mixing from ocean currents and wind and wave action.
- Some marine animals have a part of their life cycle that includes a fresh water stage for breeding.



Global Ocean Salinity map. Source: Wikimedia.

pH

The acidity or alkalinity of liquids/substances is referred to as pH (or potential of Hydrogen, due to the amount of free hydrogen ions in the given solution). Fresh water has a neutral pH of around 7. Sea water is more 'basic' at around 8.1. The pH of the ocean used to be around 8.2 (measured by examining ice cores). Extra carbon dioxide (CO_2) in the atmosphere dissolves into sea water forming a weak acid and therefore lowering the pH. As CO_2 emissions have increased since the industrial revolution, the pH of the ocean decreased.

- Ocean pH naturally varies over 24 hours. It tends to be lower overnight, when CO_2 is released by plants and animals, and higher over the day as CO_2 is absorbed via plants during photosynthesis.
- Fish become stressed and struggle to absorb oxygen when pH is too low, and the concentration of ammonia (toxic to fish) increases if pH is too high.

NUTRIENT WASTE (NITROGEN AND PHOSPHOROUS)

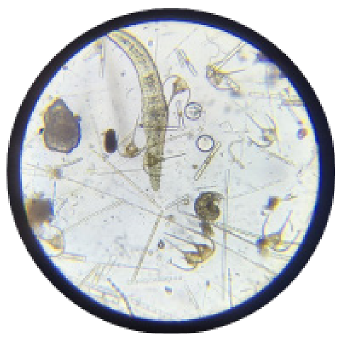
Nitrogen is cycled through the atmosphere, ocean and land through natural processes. It typically exists as ammonia (NH_3) or ammonium (NH_4^+) in the ocean. Ammonia is toxic to fish and ammonium is not.

Ammonia is a product of the breakdown of proteins. When a fish digests a protein-rich meal, ammonia is released via the gills and in urine/faeces. Ammonia can also enter the marine environment through non-consumed and high-nutrient inputs, such as fish food, and runoff from agricultural land (especially from fertiliser use).

In Tasmania, finfish farmers reduce the amount of non-consumed fish feed through remote monitoring and control of fish feeding operations. Various types of bacteria break down ammonia and ammonium in to forms of nitrogen that plants absorb to grow. Algal blooms occur when nitrogen concentrations are high. They can be problematic - blocking fish gills, in turn causing them to suffocate; and blocking light reaching other marine plants, preventing photosynthesis. Some algae contain toxins harmful to fish, which in extreme cases can cause mass death of fish species. This can lead to a lowered dissolved oxygen concentration as bacteria breakdown the flesh via aerobic decomposition (consuming oxygen).

Phosphates are another source of nutrients which promote algal blooms, and typically enter the water through excess fertiliser use.


Algal bloom. Image credit: CSIRO


Phytoplankton and zooplankton 100 x magnification.
Image credit: Chloe Simons

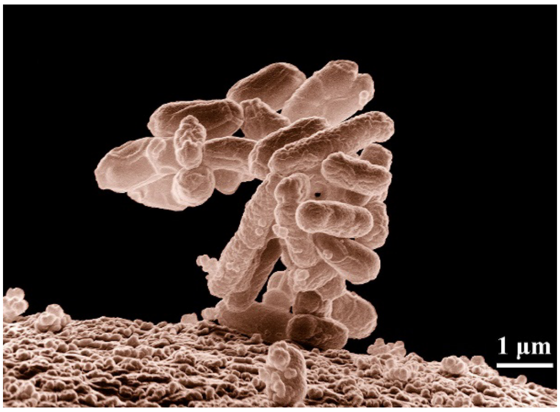
Other biological water quality indicators
Other biological indicators of water quality are the presence of different species and quantities of plankton and bacteria.

Plankton can bloom in large quantities in response to changes in water temperature and nutrient availability. Phytoplankton produces oxygen by photosynthesis, however large blooms of certain phytoplankton species can be problematic in the following ways:

- When large blooms of algae die, the decomposition releases CO_2 and uses up oxygen.
- Some species contain harmful toxins that can kill aquatic animals; or toxins can accumulate in fish (especially shellfish) and be harmful to humans.
- Large blooms can cause high turbidity of the water – lowering the transparency and therefore reducing the amount of sunlight to lower depths in the water. This can be harmful for benthic seaweed beds.

Out of the normal trends, algal blooms can indicate elevated nutrients. Chlorophyll a is the pigment that allows plants to absorb energy from the sun. A high chlorophyll a concentration in the marine environment is indicative of a recent algal bloom. Jellyfish blooms can also occasionally be problematic.

Coliform bacteria are bacteria found in faeces of warm-blooded mammals. Low levels of coliform bacteria are unlikely to cause serious illness, however large numbers can be detrimental to human health, and can sometimes signify the presence of other, more dangerous, forms of bacteria. Some bacteria strains enter freshwater and marine ecosystems via agricultural runoff and stormwater, especially if there is damage to sewage systems.



Coliform bacteria x10000 magnification. Source: Wikimedia

Introduced marine pest species are covered further in the teaching resources **Threats to Seafood Production in Tasmania, and Protecting the Marine Environment.**

More information about water quality parameters can be found on the DPIPWE website.

Reporting
Aquaculture industries operating in Tasmania have a legal requirement to test and report water quality parameters at various time intervals.

Reporting requirements can vary between aquaculture sites and are specified within Environmental Licences prior to farm establishment. Environmental reports are prepared by independent environmental contractors and licenced operators, and include water quality sampling results.

It is in industry's interest to support healthy marine ecosystems, as it sustains longevity of their operations, maximises the quality of their product and ensures stewardship of shared resources.

Specific salmon aquaculture licences and associated reports can be found on the Environmental Protection Authority (EPA) Tasmania website.

Examples of water quality results can be found online on the Tassal and Huon Aquaculture dashboards, and on the Shellfish Market Access Program (ShellMap) website.*

Various environmental data, including data on some of these indicators, can be found on:
- Land Information Systems Tasmania (LIST) website, under LISTdata; and
- CSIRO website, under Educational Datasets.

*ShellMap operates under a Partnership Agreement between the Tasmanian Government, Oysters Tasmania and the Tasmanian Seafood Industry Council, data is reported weekly and not publicly archived.

LEARNING ACTIVITIES

Water Quality Indicator Revision Questions

TEMPERATURE
- What are the main ocean currents that affect Tasmania and how do they influence the temperature of waters off Tasmania?
- What is temperature stratification in a waterbody and how does it form?

SALINITY
- Why does fresh water float on top of salt water?
- Would you expect to see higher or lower surface salinity after heavy rainfall?

DISSOLVED OXYGEN
- How do aquatic plants and algae contribute to the amount of dissolved oxygen in water?
- How does respiration by animals vary the amount of dissolved oxygen in water?
- Can cold water or warm water hold more dissolved oxygen?

pH
- Carbon Dioxide in water increases the water pH. How does the pH level vary over a 24 hour cycle?

NUTRIENTS (NITROGEN)
- Give two reasons why it is important to monitor and manage the fecal waste of farmed marine animals.

PLANKTON
- Plankton is an important part of the marine ecosystem. Give three reasons why scientists and people working in the aquaculture industry would want to monitor plankton samples regularly.

Design challenge

Make your own niskin bottle for collecting water samples:
https://www.instructables.com/id/Niskin-Bottle/

Extended Research Project

BACKGROUND:
Tasmania's location at the edge of the Southern Ocean means that it is well suited to aquaculture operations due to the cool and oxygenated water. However, the global changing climate, together with the southward extension of the East Australian Current, mean that the waters off Tasmania's east coast are warming.

SCENARIO:
Imagine you are working as a research officer specialising in water quality testing. An aquaculture company has contacted you, asking you to investigate how warming waters off Tasmania might have influence their operations in the future. The company is also especially concerned about the health and wellbeing of their fish and wants to ensure against low oxygen levels.

Prepare a report that details the following information:
- Describe to the client which ocean currents affect Tasmania and in what ways.
- Describe the relationship between water temperature and dissolved oxygen.
- Describe how photosynthesis and respiration affect oxygen levels in water.
- Investigate and suggest some possible ideas for your client, such as offshore marine farming, and integrated multitrophic aquaculture.

Suggested resources

OCEAN CURRENTS
Video resource https://www.youtube.com/watch?v=p4pWafuvdrY

THERMOHALINE CIRCULATION AND WATER DENSITY
Water density practical experiments: https://coolscienceexperimentshq.com/simple-experiments-to-learn-about-density/

WATER QUALITY INDICATORS
- Practical demonstration of photosynthesis producing oxygen https://www.youtube.com/watch?v=Uiuct-2yAxA
- Simulation of ocean acidification as carbon dioxide dissolves in sea water to increase the pH https://www.exploratorium.edu/snacks/ocean-acidification-in-cup

TEACHING RESOURCE | THREATS TO SEAFOOD PRODUCTION: BIOSECURITY AND ILLEGAL HARVESTING

RATIONALE

This resource aims to help students and teachers in secondary schools investigate and understand more about the economic and environmental impacts associated with two threats to the Tasmanian seafood industry; biosecurity and illegal fishing. It will look at how the seafood industry monitors current and emerging threats, and how industry works with the scientific community, recreational fishers and the general public to manage these threats.

LEARNING OUTCOMES

- Identify various invasive marine pests in Tasmania, and how they threaten marine biodiversity.
- Understand why and how Tasmania's seafood industry monitors current and emerging biosecurity threats.
- Understand your general biosecurity duty, and how to follow best biosecurity practices at home.
- Understand the different types of illegal harvesting in Tasmania.
- Understand the social, environmental and economic impacts of illegal harvesting.
- Problem solve and suggest solutions to introduced marine pest species and illegal harvesting of seafood in Tasmania.

PART 1: BIOSECURITY

Outline: Biosecurity in Tasmania

Tasmania's marine environment is unique and home to endemic species such as the Weedy sea dragon, Red velvet fish and Handfish. There are also many invasive marine pests that pose direct and indirect threats to endemic species, as well as to Tasmania's tourism and seafood industries.

The anthropogenic movement of water, such as boat ballast water, or on fishing or sporting/leisure equipment such as wetsuits, kayaks and dinghies can introduce biological threats to new areas.

The movement of infected plants or animals, which may be hidden in ballast water, on wetsuits, or through ship biofouling, for example, is the most significant factor in the spread of aquatic disease and pests.

All Tasmanians have a statutory duty of care to properly manage biosecurity risks under the *Biosecurity Act 2019*, referred to as a General Biosecurity Duty (GBD) https://dpipwe.tas.gov.au/biosecurity-tasmania/about-biosecurity-tasmania/biosecurity-act-2019/

The seafood industry constantly monitors fish stocks as well as for biological threats to support the health of the environment it fishes and farms.

Examples of biological threats to Tasmania's environment and seafood industry are on the next page, although there are many more.

The General Biosecurity Duty (GBD) creates an obligation on all Tasmanians and businesses to use reasonable standards of care when dealing with any biological material that may pose a biosecurity risk.

Under the GBD, any person dealing with plants or animals (or their derived products) who knows, or ought reasonably to know, that a biosecurity risk is posed or is likely to be posed has a legal duty to ensure that, so far as is reasonably practicable, the risk is prevented, eliminated or minimised. So the GBD means that we all have a role to play to manage biosecurity risks – either through the work that we do or during our recreational activity time www.dpipwe.tas.gov.au/GBD.

Viruses

Thousands of marine virus strains can survive for periods without a host, with the duration depending on the virus, environmental factors, and more. The following are examples of key seafood industry species and their respective viral pathogen.

ABALONE: Abalone Viral Ganglioneuritis (AVG) affects the nervous system of abalone and results in curling of the foot, swelling of the mouth, weakness and death. It can be transferred between abalone via water and infected abalone, including abalone mucus.

Greenlip abalone with AVG
Image credit: Victorian Dept. of Primary Industries

The virus has been shown to occur naturally in wild abalone populations in Tasmania. However, the disease only tends to emerge when abalone from separate populations (thus with separate strains) are mixed together on farms or in holding tanks. The major control for this disease is by holding regional abalone populations in separate tanks and treating water from holding facilities before it is discharged back into the natural marine environment.

Commercial abalone divers also constantly monitor the health of wild stocks, and practice preventative measures including washing boat and diving gear between locations.

ATLANTIC SALMON: Pilchard Orthomyxovirus (POMV) was first detected in Tasmania in 1999, and first detected in Atlantic salmon in Tasmania in 2006. Pilchards (a native fish species) are vectors of this virus, although there is no evidence of it causing mortality in wild populations. Pilchards are small enough to swim through salmon farm nets, where POMV can be passed to and between salmon (this has not been demonstrated but is the current accepted theory). It can be fatal to salmon but is not dangerous to humans. To avoid serious outbreaks and minimise potential spread, salmon farms keep younger and older fish in separate pens to avoid disease transfer from old to young salmon. Farms also ensure that equipment is clean and disinfected.

Image credit: Wikimedia

PACIFIC OYSTER: Pacific Oyster Mortality Syndrome (POMS) virus weakens and kills Pacific oysters. The disease also causes the adductor muscle, which is used to close their shell, to fail and expose the dead or dying oyster to scavenging and predation. POMS is spread by water movement, biofouling, and the transport of infected oysters to areas with healthy oysters. Once established, there is currently no known way to eliminate it as wild oyster populations, which cannot easily be eliminated, can reinfect farmed stock each year.

Image credit: Ian Duthie/Oysters Tasmania

Oyster farms closely monitor water quality and report to Biosecurity Tasmania and the Chief Veterinary Officer to identify POMS and Harmful Algal Blooms (HABs) which contain Paralytic Shellfish Toxins (PSTs). They also work with ShellMAP to manage sampling and testing and secure market access, and with scientists to breed pacific oysters that are more resistant to POMS.
https://dpipwe.tas.gov.au/biosecurity-tasmania/product-integrity/food-safety/seafood/shellfish-quality

Invasive species

WHITE COLONIAL SEA SQUIRT
(Didemnum spp.)
The major species of concern in Tasmania is *D. vexillum.* These grow over and smother commercial marine animals such as mussels and oysters. They travel between locations as larvae and broken fragments. There are some similar looking native species but none that are likely to hang from artificial structures in such densities. The D. vexillum colonial sea squirts have not been observed in Tasmania yet and would be catastrophic for native habitats and the oyster and mussel farms.All commercial vessels entering Australia must complete pre-arrival reporting via the Maritime Arrivals Reporting System (MARS). Biosecurity Tasmania officers routinely audit ballast water management records to ensure that appropriate treatment has been undertaken prior to discharge.


Image credit: Wikimedia

NORTHERN PACIFIC SEA STAR
(Asterias amurensis)
Indiscriminate, aggressive predators which consume anything organic, primarily molluscs and invertebrates. They are reported to displace many other species and in some regions have become the predominate benthic predator. A single female sea star can carry up to 20 million eggs which spread as eggs or larvae in water for 120 days.

They are a marine farm pest as the larvae can settle and grow on farming equipment and prevent adequate water flow and add additional weight to floating farming equipment. Although seastars can be present in biofouling and may settle in oyster baskets as larvae, they primarily are a benthic species and do not contribute to net farm biofouling or prevent water flow. Frequent cleaning of farming equipment helps to prevent this species establishing.


The Northern Pacific sea star (left), and the New Zealand cushion star (right) are both introduced species present in Tasmania.

LONG SPINED SEA URCHIN
(Centrostephanus rodgersii)
These non-specific feasters consume organic material (seaweeds and animals). They create underwater barrens where nothing else can survive and spread to new areas in their larval form. The only known natural predators are large southern rock lobsters. The abalone and southern rock lobster sectors of Tasmania's wild catch fisheries are working in conjunction with scientists to control this pest species, including reporting sightings and harvesting the urchin for commercial trade. More information can be found here.

An animated story about Long-spined sea urchins and the barrens they've created since they were first found in Tasmanian waters in the 1970s. Click here to watch video.

LEARNING ACTIVITIES

1. Select a marine pest species to research. Describe its biology and why it is or could be a pest species in Tasmania. How did it or could it arrive here and what is currently being done to control it?

2. Students read the biosecurity scenarios and design a way to solve the problem presented.

Scenarios

1) WETSUITS AND BEACH GEAR

Jemma and her two brothers love to snorkel at the beach in front of their house. They have lived there for over ten years and have discovered secret spots with lots of seaweeds and creatures. The beach gets a lot busier in summer when families from the city come to visit for a beach escape. Jemma has heard about the negative impact Northern Pacific sea stars have on marine ecosystems, and fears that someone may unknowingly carry its eggs or larvae to their beach on their wetsuits and leisure equipment (such as boogie boards, kayaks or absorbent beach balls).

Can you design a way to educate beach visitors of the impact of this marine pest, and teach them how to prevent introducing it to new areas?

2) FISHING EQUIPMENT

Rick and his mother are from a small seaside town. They go fishing together at least three times a week and have done so for a very long time. To avoid interacting with other fishers, they decide to travel to a new fishing spot about 40 minutes south of their usual spot. They don't know about marine pests or that they could be carrying larvae, spores or eggs of pest species on their fishing equipment.

Your challenge is to design a way to teach Rick and his mum about marine pests and the way you can prevent introducing them to new areas.

3) KAYAK

Max is two weeks away from a kayaking trip with his ocean-adventure club. There are 20 other people going, ranging between 12 and 17 years old. The camping equipment and kayaks were last used on a trip in waters close to an oyster farm that was suffering from Pacific Oyster Mortality Syndrome (POMS). Max is worried that the gear has not been cleaned properly after their last use and would like to teach the other club members and leaders about how important this is. Max has decided to design a sticker, like a car bumper sticker, that can be placed on kayaks and boats to remind people to wash down their equipment.

Your challenge is to design an eye-catching sticker that will remind people of the need to wash down their beach equipment and boats to avoid spreading marine pests.

4) DIRTY BOAT

Wendy works as a marine engineer at the local shipyard. Boat hulls begin to foul with marine organisms after several months of being submerged. After 1 -2 years, all sorts of life such as mussels, sponges, slimes, seaweeds and even crabs begin to live on the hull. Boat owners must put their boats on 'the slip' (lifting them out of the water with a large sling) and clean them.

Wendy has seen boats from all over the state arrive to the shipyard to clean and repair their hulls. She is concerned that boat owners may unknowingly be introducing pests to new areas as they travel with extremely fouled hulls. Wendy would like to put systems in place for owners of marinas and shipyards to make sure contaminated biofouling is disposed of correctly when cleaning boats.

Your challenge is to produce a document with a list of ways people can avoid contaminated biofouling (marine organisms stuck to the bottom of boats) being washed into the water when boats are cleaned and repaired.

5) SPECIES RELOCATION

Julia is extremely excited to show the rest of the family the fantastic creatures she found whilst visiting the east coast. To ensure they didn't miss out, she has collected a handful of them in a large container filled with seawater (to keep them alive) and seaweeds that she also picked up from the same spot. She has various crabs, shellfish, and even a small sea star from a rock pool and is planning to release them at their local beach once her family has seen them.

Can you think of any biosecurity issues that Julia has overlooked? Your challenge is to design a way to communicate and teach people like Julia why they should not relocate organisms and seawater.

PART 2: ILLEGAL HARVESTING

Outline

Illegal harvesting can deplete fish stocks, damage fish ecosystems and damage the livelihood of lawful fishers. It is also very difficult to account for marine resource managers to make decisions for lawful fishers when they cannot account for illegally harvested stock. There are many different forms of illegal seafood harvesting in Tasmania and governing them can be difficult due to need to monitor a vast area – police cannot be constantly watching all fishing efforts. Community plays a key role in reporting, which contributes to accounting for illegal harvesting in stock management.

Types of illegal harvesting

- **Fishing in no-catch zones** (i.e. marine reserves and restricted harvest areas). Fishing in no-catch zones is prohibited unless otherwise specified. They are intended to provide sanctuary for all marine life.

- **Catching fish when season is closed.** Seasonal closures can be introduced during spawning times to protect breeding stock or to limit the catch for a fishery. Closures may also be in place for public health reasons (such as biotoxins).

- **Collecting threatened or protected species.** The population of threatened and protected species is usually under threat from habitat loss or historic overfishing. Tasmanian Aboriginal People may harvest limpets and elephant snails when engaged in cultural activities.

- **Keeping undersized fish.** Size limits exist for most fishable species to help maintain a healthy fish stock. It is important that a large enough proportion of a population reaches sexual maturity for succession.

- **Exceeding bag, boat and possession limits.** Limits are in place to help maintain a healthy fish stock. The Institute for Marine and Antarctic Studies prepares fishery assessments based on catch data from the previous year. These assessments inform the State Government who set quota.

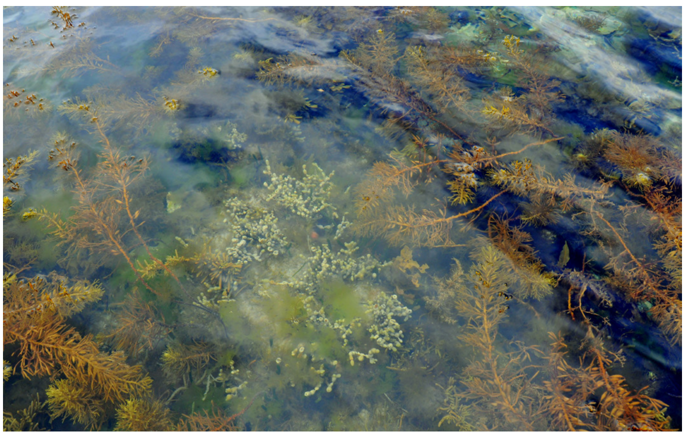
- **Harvesting without a license.** Some fisheries have limited licences available to ensure the sector is sustainable.

- **Using prohibited fishing equipment** (e.g. explosives, driftnet or spearfishing). The use of various forms of fishing equipment are prohibited in Tasmania. Some reasons for prohibition include animal ethics, negative impacts of non-target species and by-catch.

- **Exceeding the length of time for active pots/ nets.** This is otherwise known as soak time and it differs between gear type. Soak times are implemented to minimise by-catch and other negative impact on non-target species.

- **Harvesting native seaweeds from their substrate.** People may collect up to 100 kg of wrack – seaweed that washes ashore – per year. To protect marine ecosystems, it is illegal to harvest native seaweed from its substrate in Tasmania.

Image credit: Fisheries Tasmania



Tasmanian species commonly targeted

- **Abalone:** Greenlip and Blacklip – harvested without a licence, undersized, and exceeding bag limits.
- **Southern Rock Lobster:** Harvested without a licence, undersized, and exceeding bag limits.
- **Scallops:** Exceeding bag limits and out of season.
- **Scalefish:** Stripy trumpeter, Banded morwong – out of season and undersized.
- **Native Seaweeds:** Harvested from substrate.
- **Plants and animals along shorelines:** Exceeding bag limits and collecting threatened or protected species.

An example of legal seaweed harvesting. Many individuals collect seaweed from beaches to eat or use in the garden as a fertiliser.
Image credit: Milkwood Permaculture.

Reporting

- Squads associated with the Tasmania Police Marine and Rescue Division are responsible for most monitoring efforts.
- Difficult due to vast area – authorities cannot be everywhere at once.
- Community can support reduction in illegal harvesting through education and advocacy (hospitality, tourism, public areas), and by reporting illegal fishing to Fishwatch (with as much information as safely possible).

FISHWATCH
REPORT ILLEGAL FISHING
0427 655 557

LEARNING ACTIVITIES

1. Students choose one area of illegal fishing to investigate and research:

- The implications this has on the marine environment.
- The current legalities; ways it's communicated to the public; and who monitors and governs this?

2. Students read the five scenarios below and determine whether this is accidental, ignorance, or blatant defiance. Design a way to educate and inform the general public on the problems of illegal harvesting.

Scenarios

1) HARVESTING FROM THE FORESHORE

You notice a white minibus pulled over in a carpark by the foreshore. People often stop here for a scenic lookout, however this time a large group of people disembark a minibus, each person holding a bucket. You then see them disperse along the coastline collecting handfuls of molluscs, crabs, and seaweeds. They return to the minibus and you can see that they have many buckets full of shellfish and have taken native seaweed directly off the rocks. A few weeks later, you notice the same thing happen! Your friends say that they have also seen this in other areas.

Your challenge is to decide whether this form of illegal harvesting is accidental, ignorance, or blatant defiance, and to design a way to combat it.

2) COLLECTING FOR A FISH TANK AT HOME

The local beach is a well-known spot to see Weedy seadragons. There is a carpark at the far end of the beach, and a few small cafes along the esplanade. Emma walks her dog along the esplanade every afternoon. Last Friday, she noticed someone hopping out of the water carrying a bucket. It caught her attention as it was a crisp winter day, and it would have been freezing in the water. As she walked past and exchanged pleasantries, the person showed her what was in their bucket. It was a Weedy seadragon, and they said that is was for their home aquarium. Horrified, Emma's voice froze. Eventually she was polite, excused herself and headed home.

Your challenge is to decide whether the person that Emma bumped in to was illegally harvesting accidentally, ignorantly, or blatantly defying the law, and to design a way to combat it.

3) UNDERSIZED ABALONE

Pete is walking along the waterfront in front of his house when he bumps into two young people heading in the opposite direction to him. They are wearing wetsuits and carrying snorkelling gear and a white plastic bag. He asks how their swim was, and they say, 'refreshing'. He then asks if they got anything, and they reply, 'some abalone'. They seem to be in a hurry and not wanting to chat, so he leaves the conversation there. He thinks that they may have collected undersized abalone, as he knows the area well and has never seen a sized abalone here.

Your challenge is to decide whether the people that Pete bumped in to were illegally harvesting accidentally, ignorantly, or blatantly defying the law, and to design a way to combat it.

4) EXPIRED LICENCE

Laura and her family head to their shack on the coast every Christmas. Last Christmas they she went snorkelling for abalone with her older brother and before they left, they had to jump online to purchase a Recreational Abalone Fishing Licence. This year they take their boat to a small reef further up the coast and decide to have a snorkel. They see plenty of abalone of good size and decide to grab a few. They harvest 2 abalone sized each (one each for them and one each for their mum and dad), but as they head back to the boat ramp they see a local Fishcare group talking to people about responsible fishing, and Laura and her brother realise they have not renewed their fishing licences for this year.

Your challenge is to decide whether Laura and her brother illegally harvested accidentally, ignorantly, or blatantly defying the law, and to design a way to combat it.

5) SELLING TO A LOCAL RESTAURANT

Joe has loved fishing his entire life. He is friends with the owner of a local restaurant who has been looking to source local seafood for their menu. Joe does not have his commercial fishing licence, but decides to sell his catch to the restaurant, after all, they are friends.

Your challenge is to identify whether Joanna and her friend are breaking the law. If so, decide whether Joanna and her friend have done this accidentally, ignorantly, or blatantly defying the law, and design a way to combat it.

RESOURCES AND FURTHER READING

BIOSECURITY

1. https://www.youtube.com/watch?v=YUkcwCmhqfI (Oysters in Hot Water - IMAS video about POMS)
2. https://dpipwe.tas.gov.au/biosecurity-tasmania/aquatic-pests-and-diseases/aquatic-biosecurity-threats
3. https://www.imas.utas.edu.au/research/fisheries-and-aquaculture/fisheries/Long-spined-sea-urchin-Centrostephanus-Rodgersii
4. https://dpipwe.tas.gov.au/biosecurity-tasmania/product-integrity/food-safety/seafood/shellfish-quality
5. https://dpipwe.tas.gov.au/biosecurity-tasmania/aquatic-pests-and-diseases/protecting-against-aquatic-threats
6. https://dpipwe.tas.gov.au/biosecurity-tasmania/about-biosecurity-tasmania/biosecurity-act-2019
7. https://www.marinepests.gov.au/what-we-do/publications/marine-pest-plan
8. https://nimpis.marinepests.gov.au/

ILLEGAL HARVESTING

1. https://dpipwe.tas.gov.au/sea-fishing-aquaculture/recreational-fishing/recreational-fishing-seasons
2. https://dpipwe.tas.gov.au/sea-fishing-aquaculture/recreational-fishing/other-fisheries/protected-species
3. https://dpipwe.tas.gov.au/Documents/SeaFishingGuide2020-21FULL.pdf

TEACHING RESOURCE | PROTECTING THE MARINE ENVIRONMENT - HABITAT RESTORATION AND MARINE DEBRIS

RATIONALE

This resource aims to help students and teachers in secondary schools investigate and understand more about some of the ways we can protect and restore the marine environment and reduce the impact of human activities in Tasmania. Climate change also has a significant impact on marine environments, and the effects of warmer waters around Tasmania could impact Tasmania’s seafood production and alter the marine species found in Tasmania. See Teaching Resource - Understanding and Monitoring the Tasmanian Marine Environment for more information on water temperature in Tasmania.

LEARNING OUTCOMES

- Understand how humans are impacting marine environments, focusing on changes to marine habitats and marine plastic pollution.
- Understand the importance of restoring and conserving marine habitats to support marine biodiversity in Tasmania.
- Research a marine habitat restoration project; understand why it was needed; and how it supports the environment, society, and the economy.
- Understand the origin of marine debris.
- Understand the impacts (human health, environmental and economic) of marine debris.
- Research a marine debris mitigation method and evaluate the effectiveness.
- Consider some alternatives to plastics and how people could be motivated to use less plastic.

PART 1: HABITAT RESTORATION

Outline: Habitat restoration in Tasmanian marine environments

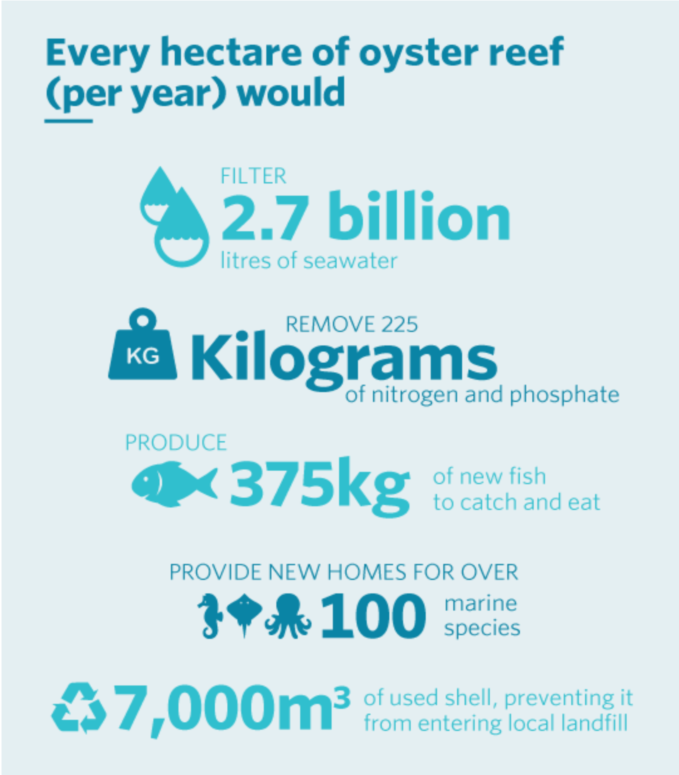
There are many diverse marine habitats in Tasmania, from coastal shallow waters, to rocky reefs and deep open ocean. Many Tasmanians enjoy beach and ocean based recreational activities. We also have thriving seafood and tourism industries that rely on healthy marine habitats. Unfortunately, some marine habitats have been negatively impacted over the last 100 years in Tasmania due to a range of different factors.

Image credit: John Turnbull

CASE STUDIES

Oyster reef/bed restoration

Over 90% of Australia's native oyster reefs were destroyed during the late 1800's and early 1900's through a combination of destructive dredging methods, changes to estuarine conditions, and overfishing. The native Angasi oyster (Ostrea angasi), also known as the Flat oyster, forms the foundation of these reefs, providing habitat for other species (shellfish, fish, crustaceans, invertebrates, and algae). Efforts are underway to restore 60 native oyster reefs by 2025, by placing suitable substrate (for example cured shellfish shells) seeded with Angasi oysters into suitable areas around southern Australia (including Tasmania). More information can be found on The Nature Conservancy website.



Source: Nature Conservancy Australia

Giant Kelp restoration

Giant Kelp *(Macrosystis pyrferia)* is a fast-growing brown alga that grows in cool and nutrient rich waters. Strands of Giant Kelp can form tall underwater kelp forests, providing habitat for many other species.

Tasmania has lost 95% of its surface canopy-forming Giant Kelp population over the past few decades due to warming waters. Climate change is increasing water temperatures globally, however the warm East Australian Current has been extending further south from northern Australia, meaning that the Tasmanian east coast is warming at a rate faster than the global average. Increasing water temperatures and low nutrient levels of the East Australian Current are contributing to a dramatic loss of Giant Kelp.

Kelp Forest. Image credit: Dr. Cayne Layton

The underwater Giant Kelp forests contribute to carbon sequestration and are a unique and integral part of Tasmania's marine ecosystems. Trials are underway to repopulate areas of Giant Kelp with kelp individuals that can withstand warmer waters, to a stage where they will self-recruit. Gametophytes from the remaining thermally tolerant kelp are being collected and grown in the IMAS lab, and the young kelp is transplanted to trial sites around southern Tasmania.

More information can be found on the IMAS website or in a case study on the TSSP page. See also Teaching Resource - Understanding and Monitoring the Tasmanian Marine Environment for more on the East Australian Current and water monitoring.

Removing the long-spined sea urchin *(Centrostephanus rodgersii)*

This urchin was first reported in Tasmanian waters in 1978, although it is likely that it arrived in the 1960s. Larvae of the species are thought to have been carried to Tasmania by the East Australian Current. This opportunistic eater consumes a wide range of organic material including seaweeds and animals. Its eating habits create underwater 'barrens' (vast areas of bare rocks which were previously covered in kelp), destroying natural habitat and significantly reducing biodiversity. Once an urchin barren is established, it is very difficult for kelp to recover as urchins can survive on a range of food sources, so the population of urchins doesn't decline once the kelp has disappeared.

Urchins threaten marine biodiversity as well as commercially and recreationally valuable species that rely on rocky reef habitats (i.e. abalone and rock lobster). One of the main predators of the long-spined sea urchin in Tasmania is Southern Rock Lobster. Historically rock lobsters have been heavily targeted by Tasmanian commercial and recreational fishers, to a point where their population on the east coast has reduced to 10% of natural levels. Management strategies were introduced in 2010 to assist with population recovery. They were complemented by relocation of rock lobsters from the south-west coast, where they are abundant, to areas impacted by the urchin.

Seafood industry workers are collaborating with scientists to remove urchins by hand and investigate habitat recovery. Efforts to create a market for these problematic intruders aids harvesting efforts. Urchin roe can be a cuisine delicacy with its rich seafood flavour, or compounded urchins can be deposited on garden beds as fertilizer. More information on the long-spined sea urchin story can be found in this UTAS news article.

Image credit: John Turnbull

PART 2: MARINE DEBRIS

Outline: Marine Debris – Sources, Impacts and Seafood Industry Mitigation

Marine debris is any abandoned item found in the marine environment that would not naturally occur there. About three quarters of the debris found is plastic, however there are many other materials that classify as marine debris.

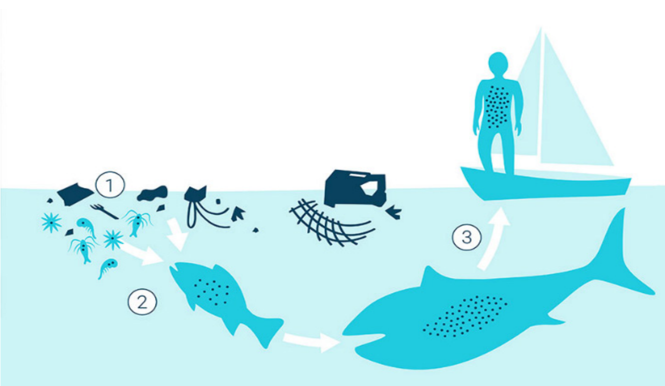
However, most marine debris comes from rubbish that has not been managed on land, including rubbish that has blown or been washed into the ocean. Research from CSIRO tracked the source of marine debris found in Australia and found that most debris was of Australian origin and debris increases around highly populated areas.

Sources

Humans create huge amounts of waste each year, and not all waste is managed correctly.
Some debris entering the ocean and foreshore areas has been accidently or deliberately discarded from human activities on the water, for example recreational activities, commercial fishing, aquaculture, oil rigs, shipping cargo, and the tourism industry.

Marine debris includes items such as nylon rope, shellfish baskets, buoys, PVC piping, cigarettes, bottles, soft plastics, hard plastic fragments, aluminium cans, textiles, rubber, wood or fishing gear.

BIOACCUMULATION



Plastics in the ocean can enter the marine food web. As one animal eats another, plastic can be passed up the food chain, and eventually accumulate in larger animals and fish, some of which might be eaten by humans.

Impacts

WILDLIFE ENTANGLEMENT
Animals may be strangled, drown or starve when trapped in floating debris. Animals can accidently swim into lost or discarded fishing nets, which can wrap around their fins, flippers and tails making it difficult for the animals to swim, catch food and escape predation.

INGESTION BY WILDLIFE
Animals can choke or suffocate from eating soft plastics and balloons. Hard plastics with sharp edges can damage an animal's internal organs. Animals can also have so much plastic in their stomach that there is no room for food, and they starve.

BOATING HAZARDS
Recreational and commercial boats can hit floating marine debris causing propeller entanglement or damage to the boat.

HAZARD TO BEACH VISITORS
Broken glass, sharp plastics and metal can be dangerous to humans and other animals.

NEGATIVELY IMPACTS TOURISM
People don't want to visit highly polluted areas.

TOXIC EFFECTS OF MARINE PLASTICS
Chemical contaminants can be toxic to humans and animals. Toxins can enter the food chain through being ingested as plastics or microplastics, and reach humans via bioaccumulation.

Seafood Industry Mitigation Methods

- Aquaculture companies regularly replace moorings, ropes and nets to avoid losing them in the event of breakage.
- Aquaculture companies use specific rope colours to aid accountability and data collection at clean ups.
- Aquaculture companies report to MAST when a large piece of gear is lost. MAST alerts waterway users of hazard.
- Aquaculture companies conduct clean-up days, where different companies target sections of the coast around southern Tasmania and remove rubbish.
- The Department of Primary Industries Parks Water and the Environment (DPIPWE) introduced a zero-tolerance policy to marine debris in July 2018.
- Tasmanian Salmon Growers Association released a debris tracking application for smart phones, which allows people to report sightings (type and location). Reports are sent to Marine and Safety Tasmania and the Marine Farming Branch of DPIPWE, for collation and any necessary action.
- The wild catch fishing sector supports coastal clean up activities by supplying use of boats and volunteer time.

LEARNING ACTIVITIES

1) RESEARCH A MARINE HABITAT RESTORATION PROJECT

Students should summarise the cause of damage to the natural resources; what are the consequential impacts (i.e. social, economic, environmental); what are the restoration activities and who is conducting them; and have they been successful? Share with class.

2) DESIGN A CLEAN-UP DAY FOR A SECTION OF BEACH OR FORESHORE

Choose a section of coast and describe why you think this area needs cleaning up. Think about who you will get to help clean up (e.g. members of the public, industry workers). Design promotional material to help people engage with your clean up (e.g. flyer, news article, social media event). Consider other impacts of your clean-up, for example nesting shorebirds, and factor this into the timing of your event.

3) ARTIFICIAL REEFS

Can artificial reefs be a solution to habitat damage and an opportunity to increase biodiversity, or is introducing artificial structures into the marine environment adding further human intervention to the ocean habitat? Share with class.

4) RESEARCH ABOUT 'GHOST GEAR'

What it is, how it occurs, why it harms marine life and what can be done about reducing it? Recreational fishes can also contribute to marine plastic pollution. Design a sign for popular fishing spots and boat ramps to inform people about the problems of lost fishing gear.

5) DESIGN CHALLENGE

Marine farmed oysters are grown in plastic baskets. Design an oyster basket that is robust and easily cleaned but is made from a biodegradable material.

6)REUSE CHALLENGE

Re-using and Recycling. Investigate a possible use for old marine farm rope; or research an alternative to plastic rope.

7) PACKAGING OF SEAFOOD

Seafood must be kept cool and free from bacteria to ensure it is safe for the consumer. Investigate the research into making plastic-like material from biological products, such as corn or rice starch, arthropod chiton, and algae; or look at re-usable options for seafood product transportation.

RESOURCES AND FURTHER READING

HABITAT RESTORATION

1. https://www.shellfishrestoration.org.au/
2. https://seagrassrestorationnetwork.com/
3. https://www.imas.utas.edu.au/research/ecology-and-biodiversity/projects/projects/assessing-the-potential-for-restoration-and-permaculture-of-tasmanias-giant-kelp-forests
4. https://ozfish.org.au/projects/

MARINE DEBRIS

1. https://www.huonaqua.com.au/identifying-our-equipment/
2. http://www.ourwaterway.com.au/wp-content/uploads/2014/09/101160+Coastline+Responsibility+Map.compressed.pdf
3. https://dpipwe.tas.gov.au/wildlife-management/marine-conservation-program/marine-mammal-incident-response
4. https://www.nationalgeographic.com/magazine/2018/06/plastic-planet-health-pollution-waste-microplastics/
5. https://www.aquaculturealliance.org/advocate/plastic-2-ocean-seafood-packaging-made-from-shellfish/

TEACHING RESOURCE | TECHNOLOGY FOR IMPROVED SEAFOOD PRODUCTION EFFICIENCY AND SUSTAINABILITY

RATIONALE

This resource aims to help students and teachers in secondary schools investigate and understand more about current and emerging technologies (digital, mechanical and biological) in Tasmania's seafood industry, and how they can be used to improve production efficiencies and environmental sustainability.

LEARNING OUTCOMES

- Students understand that there are a range of mechanical, digital and biological technologies involved in sustainable seafood production in Tasmania.
- Students will understand that technologies are informed by science and are used to solve a problem or improve a practice.
- Students will use the design cycle (design, test, refine and evaluate) to construct a prototype of a form of technology.

TECHNOLOGY IN TASMANIA'S SEAFOOD INDUSTRY

The seafood industry is always looking for ways to improve production and mitigate some of the challenges of wild catch fishing and aquaculture. Technology in the seafood industry is used to increase productivity (such as increased production or catch rate of fish) and to improve environmental sustainability of the fishing resource and minimise damage to the marine ecosystem.

In many cases, a particular technology might improve both environmental sustainability and production efficiency. Some examples are given in the tables below.

AQUACULTURE

TECHNOLOGY AND HOW IT IS USED	Improved Sustainability	Improved Efficiency
Remotely operated vehicles (ROVs): conduct seabed surveys to monitor biodiversity and inspect pens for fouling to support adequate flow through and monitor biofouling.	✓	✓
Sensor technology: monitor temperature, dissolved oxygen, and nitrogen to assist with water quality maintenance or advise on public health measures.	✓	✓
Biological pathogen testing: for example, to detect toxins in shellfish that cause paralytic shellfish poisoning, or POMS virus.		✓
Remote surveillance: inspect pens and monitor wildlife interactions.	✓	✓
Remote feeding centres: monitor and control pellet distribution, minimises fuel consumption and feed wastage, improves health and safety of employees.	✓	✓
Aquaculture feeds and ingredients maximises growth rate and minimises excretion of nutrients.	✓	✓
Genetics: selecting fish that are efficient energy converters, which grow fast and excrete minimal waste.	✓	✓
Renewable energies: reduces fuel consumption and CO_2 emissions.	✓	

SEAFOOD PROCESSING AND WHOLESALING

TECHNOLOGY AND HOW IT IS USED	Improved Sustainability	Improved Efficiency
Robotics used for automated processing of fish products: Increased speed of processing.		✓
Packaging: vacuum sealing and canning extends shelf-life and reduces food wastage.	✓	✓
Product tracking: Systems to trace the origin of seafood such as Radio-frequency identification (RFID) and Barcode ID help ensure fish catch is correctly identified and sustainably caught.	✓	

FISHING (COMMERCIAL)

TECHNOLOGY AND HOW IT IS USED	Improved Sustainability	Improved Efficiency
Electronics for fish finding allows fishers to target their catch, minimising time spent at sea and reducing fuel consumption.	✓	✓
Satellite communications and navigation: accurately targeting catch and reducing time at sea – reduces fuel consumption.	✓	✓
Submerging buoys: GPS trackingto locate buoys which descend when set and ascend upon retrieval, reducing risk of marine mammal entanglement.	✓	✓

TASMANIAN RESEARCH ORGANISATIONS

Tasmania has world-class research institutions relating to marine science. Here are some examples of technology in marine science from CSIRO and UTas/IMAS. Students might like to use these examples for ideas when creating their own design challenge.

MARINE ROBOTICS

- https://www.amc.edu.au/facilities/auv-facility
- https://research.csiro.au/robotics/starbug-underwater-vehicle-collecting-data-sea/
- Abiotic oceanographic monitoring https://www.csiro.au/en/Research/OandA/Areas/Marine-technologies/Argo-robotic-floats

GENETIC TECHNOLOGY: Improving year-round production of salmon by genetic selection.

https://data61.csiro.au/en/Our-Research/Our-Work/Monitoring-the-Environment/Tracking-environmental-health/Developing-a-Genomic-Selection-Platform-for-the-Tasmanian-salmon-industry

MONITORING BIODIVERSITY: Using a range of technology in deep sea reefs to help better understand impacts on fisheries and biodiversity.

https://www.imas.utas.edu.au/research/ecology-and-biodiversity/projects/projects/tasmanias-coastal-reefs-deep-reef-habitats-and-significance-for-finfish-production-and-biodiversity

UNDERWATER ELECTRONICS: Underwater data logging technology for measuring catch distribution of Abalone (now also being used for the invasive Centrostephanus urchin)

https://www.imas.utas.edu.au/research/fisheries-and-aquaculture/projects/projects/abalone-spatial-mapping-research

BIOTOXIN TESTING: Development of fast and cheap biological testing kits to monitor for toxin in shellfish.

https://www.imas.utas.edu.au/research/fisheries-and-aquaculture/projects/projects/improved-understanding-of-tasmanian-harmful-algal-blooms-and-biotoxin-events-to-support-seafood-risk-management

DESIGN CHALLENGES

Tasmania generally has a clean environment and a well-managed fishing sector. Human activities impact on the marine environment and using science and technology as a human endeavour we research issues and create solutions to improve practice.

This learning resource encourages students to have a positive attitude to designing solutions and take a creative and science focused approach to finding ways to improve practice.

Students can use the design cycle to create solutions to some challenges in seafood production and environmental sustainability. Students can work through the suggested design challenges below, and/or complete a negotiated design challenge (possibly drawing inspiration from one of the real-world projects listed previously).

Offshore Aquaculture

Fish farming in areas with high water flow (currents and wave action) helps to bring oxygenated water to the fish and help disperse any nutrient waste. Offshore fish farming poses challenges due to rough sea and weather conditions. Australia is involved in the Blue Economy CRC - investing significantly in developing resources from the sea and specifically sustainable seafood production and renewable energy. https://blueeconomycrc.com.au/

DESIGN CHALLENGE: DESIGN AN OFFSHORE AQUACULTURE FACILITY

1. Students choose a suitable 'offshore' location around Tasmania. Use data from the Bureau of Meteorology and IMOS find the average sea temperature and wave heights for the chosen area. http://www.bom.gov.au/australia/charts/viewer/index.shtml?domain=combinedW&type=sigWaveHgt and http://oceancurrent.imos.org.au/sst.php

2. Students design an aquaculture pen that minimises animal interactions by;
- Being resistant to seals
- Allowing birds to escape if they get trapped in the protective netting.

3. Using the below equation, calculate the volume of your sea pen and work out how many fish you can ethically keep in your pen.

$$V = \pi r^{2} \times h$$

4. Optional extensions – conduct an experiment to test rope strength for your pen; build a desalination unit for the pen; create a renewable energy source for the facility; design a feeding sensor to reduce uneaten food or build an ROV for your aquaculture facility to monitor the nets for damage or describe other opportunities for an offshore facility such as what other parameters you could monitor and why. See below for details.

Extensions

1) DESIGN A STRONG BUT BIODEGRADABLE OR RECYCLABLE ROPE FOR THE AQUACULTURE PEN

Aquaculture pens need to be anchored down to the sea floor to prevent them drifting away. Areas of high wave energy and large swells require strong ropes to hold the pens in place. Conduct an experiment to test the strength of different rope materials that could be used to hold a sea pen in place.

http://www.hopspress.com/Books/Curriculum_Guide/Lesson_Plans/Grass_Ropes.htm

https://www.education.com/science-fair/article/tensile-stregth-fishing-line/

2) CREATE A DESALINATION DEVICE TO PROVIDE FRESHWATER FOR BATHING FISH IN THE SEA PENS

Fish in aquaculture facilities can sometimes have a parasite called 'gill amoeba' that can be potentially fatal. Gill amoeba is reduced by bathing fish in freshwater. Can you design a way to create freshwater from seawater using a renewable energy source?

https://study.com/academy/lesson/desalination-lesson-for-kids.html

3) GENERATING WAVE ENERGY FOR THE AQUACULTURE PEN

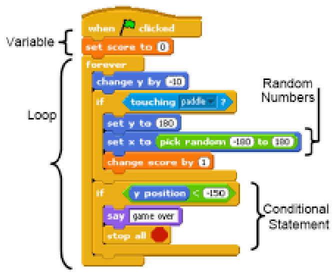
Can you design a way of generating renewable energy on an offshore aquaculture facility (for powering a water desalination unit or charging an ROV).

https://static1.squarespace.com/static/5aa9f94e5ffd209c73921fa3/t/5bbd39dce4966b89e26bfa60/1539127773145/Wave+Energy+curriculum.pdf

4) SENSOR TECHNOLOGY TO DETECT UNEATEN FOOD PARTICLES FALLING TO THE BOTTOM OF THE NET

Use Scratch block coding program to create a simulation of a motion sensor.

https://scratch.mit.edu/studios/201435/



Marine robotics

Remotely operated and autonomous vehicles are used extensively in aquaculture and ocean research. They provide information on biodiversity, abiotic conditions of the ocean, and can be used to check for damage to aquaculture pens.

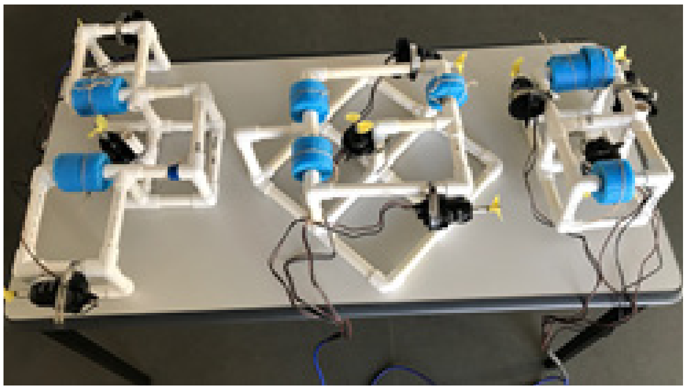
DESIGN CHALLENGE: BUILD YOUR OWN ROV AT SCHOOL.

There are many websites providing materials lists and instructions for designing and building your own ROVs.

- https://www.instructables.com/Build-Your-Own-Underwater-ROV-From-Scratch/
- http://www.homebuiltrovs.com/
- https://rea.org.au/subs-in-schools/

Alternatively, the Woodbridge Marine Discovery Centre in Southern Tasmania runs a one-day ROV program where students build and test an ROV, and use commercial ROVs.

https://www.woodbridge.education.tas.edu.au/marine-discovery-centre/mdc-secondary/cross-curricular-stem-programs/

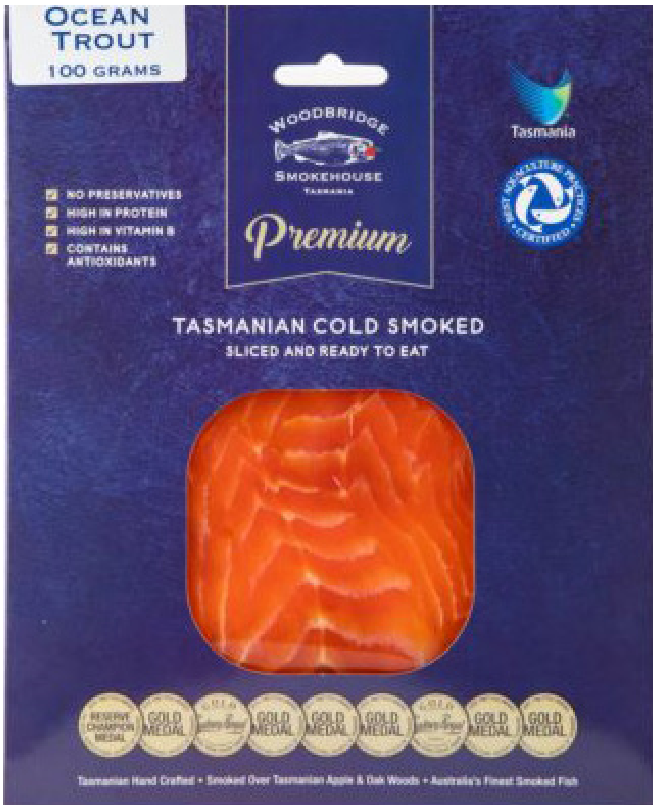


Student built ROVs at the Marine Discovery Centre
Image: Chloe Simons

Processing and Packaging Seafood

BIODEGRADABLE PACKAGING

Research an alternative to plastic for packaging seafood. The packaging must seal the product to keep it air tight. Consumers also generally like to see the product they are purchasing.



TRANSPORTING SEAFOOD

Design a refrigerated vehicle for transporting seafood that runs on renewable energy.

Recreational fishing app

The Tasmanian Sea Fishing App is a resource for Tasmanian fishers. Advances in image recognition in apps such as iNaturalist and LeafSnap allow real time identification of animal and plant species. Image recognition technology could also help prevent misidentification of wild catch fish.

Flathead is a popular seafood and there are two types (species) fished in Tasmania; sand flathead and tiger flathead. These two species have different fishery statuses according to an assessment conducted by the Institute for Marine and Antarctic Studies. The sand flathead fishery is depleting, whereas the tiger flathead is sustainable. It can be hard to tell the difference between the two species at seafood retailers, and sometimes they are mislabelled.

Design a set of instructions to produce a smartphone app to help recreational fishers tell the difference between different fish species such as Tiger and Sand Flathead. Consider image recognition technology so the fisher can take a photo of the fish and the app will ID the fish.

NEGOTIATED DESIGN CHALLENGE

Students choose an area of seafood production, marine biodiversity or environmental sustainability to focus on. Choose a sustainability or efficiency issue that could be improved and research a solution.