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 CO2 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

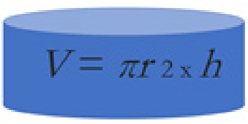
Fish farming in areas with high water flow (currents and wave action) helps to bring oxygenated water to the fish and help disperse any nutrient waste. Offshore fish farming poses challenges due to rough sea and weather conditions. Australia is involved in the Blue Economy CRC - investing significantly 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.



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

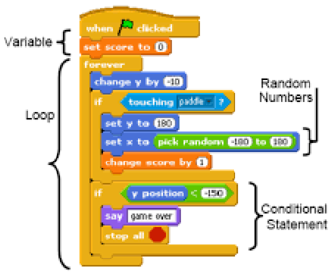
Can you design a way of generating renewable energy on an offshore aquaculture facility (for powering a water desalination unit or charging an ROV).

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.

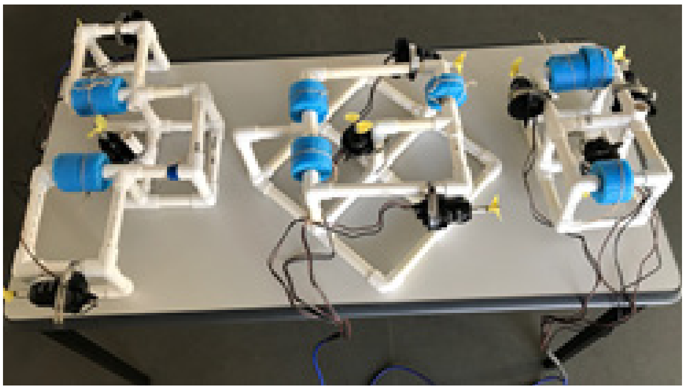
DESIGN CHALLENGE: BUILD YOUR OWN ROV AT SCHOOL.

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/

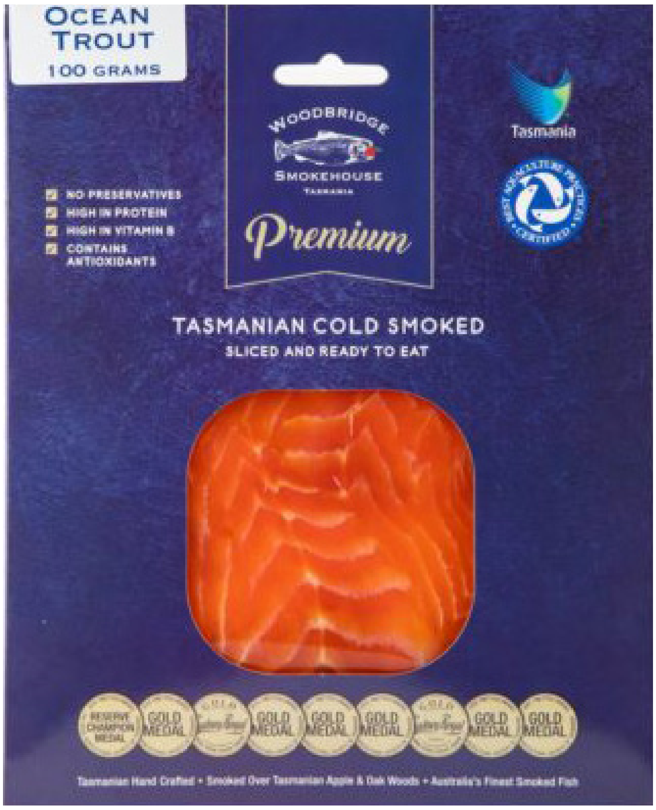


Student built ROVs at the Marine Discovery Centre
Image: Chloe Simons

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.