Jane Goodall Institute

Learning Resource

Aquaculture

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Jane Goodall Institute

Aquaculture

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Farming on land (agriculture) is familiar to everyone, but not all young people will have heard of its water-based equivalent, aquaculture. Just like agriculture, the environmental impact of aquaculture varies depending on which species are being farmed and the methods used.

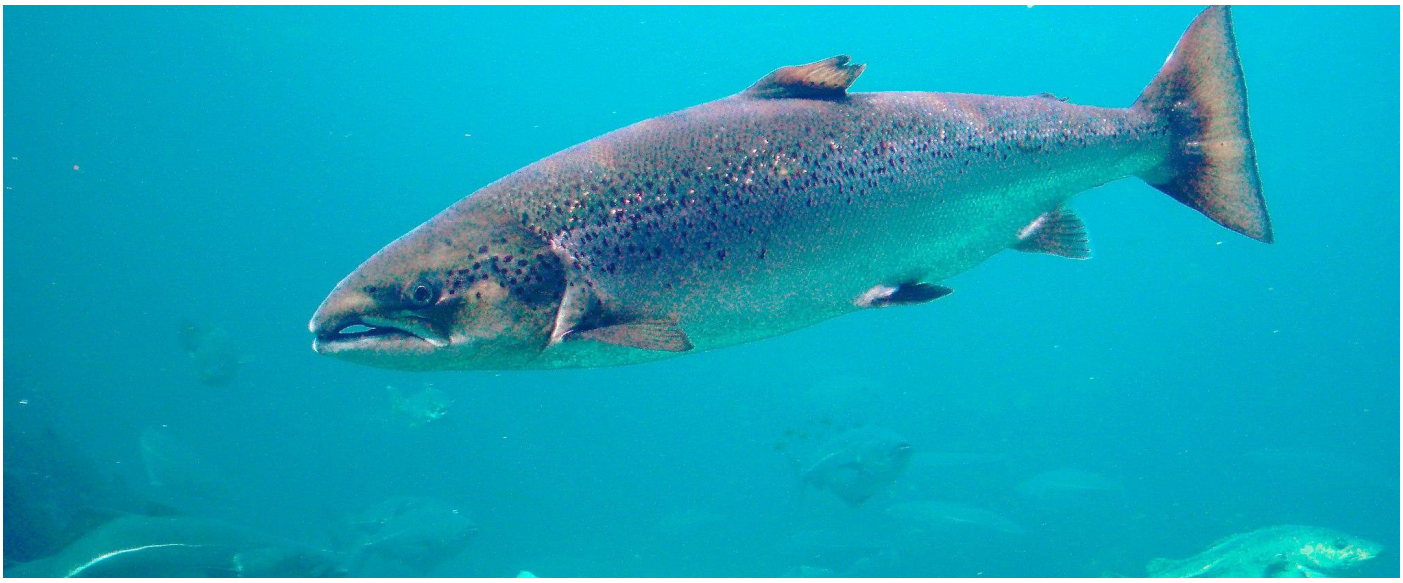
objectives

In this resource we will compare and contrast the environmental impact of salmonid (salmon and trout) farming to the farming of bivalve molluscs such as oysters and mussels and brainstorm ways that *you* can make a difference.

You do not need any specialist materials for this activity, although a whiteboard/blackboard/flipchart would be helpful.

Salmonid farming

Salmonid farming is one of the most commercially important forms of aquaculture in the world, worth over US$10 billion globally per year.



Atlantic salmon, Salmo salar, taken through glass, in Atlanterhavsparken, Ålesund, Norway Hans-Petter Fjeld, CC BY-SA 2.5, via Wikimedia Commons

What is a salmonid?

Salmonids are fish in the family ***Salmonidae*** which includes Atlantic salmon and brown trout. They are carnivorous and in the wild they feed on small crustaceans, insects and other fish. Salmonids are born and spend their early life in freshwater lakes and rivers. Many species then migrate to the ocean where they spend most of their time, coming back into freshwater to breed.

Norway and Chile are the biggest producers of farmed salmonids in the world. Some salmonids like brown trout (***Salmo trutta***) are farmed for sport fishing, but the majority are farmed for food. The most commonly farmed salmonid is the Atlantic salmon (***Salmo salar***).

Salmonid farming is complex because of the dual freshwater/saltwater lifecycle they lead. Eggs are hatched in freshwater tanks where the young salmon (called smolts) live for 12 to 18 months before being transferred to cages or pens in the sea near the coast. In traditional farming methods, these pens allow water from the surrounding sea to freely move in and out.

There are lots of problems associated with traditional salmonid farming methods (see a summary on Wikipedia, here: bit.ly/3frHqBu) but for this resource we are going to focus on two particular issues: environmental pollution and the impact on food chains.

Brainstorm exercise: raising an animal

- Ask the students to raise their hands if they have ever had a pet. Ask them to keep them raised if it was a pet that was kept in a contained environment such as a cage or a tank. Did anyone ever keep fish?
- Ask the students to shout out the tasks one has to carry out to care for a pet that lives in a cage or tank and make a list on the whiteboard.
- Ask a student who has/had a pet (preferably a fish) to estimate how much food it required, and how much waste it produced.

Fish farms in Scotland alone are estimated to have raised 56.6 ***million*** Atlantic salmon in 2021[1]. Can you even imagine how much food they ate and how much waste they produced!

Environmental pollution

Traditional salmonid farming in open sea pens pollutes the environment in two ways. Various chemicals used to e.g. combat fish lice can spill over into the environment. More importantly, the vast amounts of fish poo created (along with leftover food particles) is also leaked into the environment. If the local water currents are not enough to dissipate it, all this leads to local buildups of nutrient-rich organic matter which can cause **eutrophication**. For an in-depth study of this we recommend this article from the Journal of Environmental Management for older students: bit.ly/3ShuXyN

What is eutrophication?

Green algal bloom forming a thick surface layer in Lake Dora, Florida. Photo Credit: Nara Souza | Florida Fish and Wildlife Commision via Flickr https://www.flickr.com/photos/48722974@N07/5120227735

Eutrophication refers to when a body of water, such as a lake or part of an ocean, becomes overly filled with nutrients such as nitrogen and phosphorus. These high levels of nutrients can cause massive blooms of algae. When these blooms die the vast amount of rotting material they deposit depletes the oxygen in the water causing more plants and animals to die, lowering the oxygen even further. In extreme cases this can lead to the development of practically life-free areas called **dead zones**, or contribute to coral bleaching.

https://youtu.be/92TFJTtuq6k

Impact on food chains

Around 20% of the world's annual wild fish catch is used to make fishmeal and fish oil, of which about 70% then goes to fish farms to feed the carnivorous salmonids. This wild fish catch may lead to overfishing, particularly in the Global South[2]. This is harmful on the environmental scale (impacting food chains and reducing biodiversity) and on the human economic scale (affecting the livelihood of fishers in the Global South who may have no other viable source of income).

Lessening the impact of salmonid farming

Brainstorm exercise

Can your students brainstorm how (in general terms) to lessen the impact of salmonid farming? Here are some prompts to help them, and you can find some more information below.

- Many of the pollution problems are caused by the free exchange of water between the pens and the surrounding sea water.
- A large part of the salmonids' diet is made up of oils from wild fish catch. A relevant web search term to help is 'vegan cod liver oil'.

Some salmonid farms are using modern methods and feed to improve their environmental performance. For example:

- Using oils from algae as a source of Omega 3 for their farmed fish, to replace fish oil from wild fish.
- Moving away from using open pens to closed systems like raceways or re-circulation systems. Read more on SeaChoice.org here: bit.ly/3dMuq94

1 https://www.gov.scot/publications/scottish-fish-farm-production-survey-2019/pages/4/

2 The concept of Global North and Global South (or North–South divide in a global context) is used to describe a grouping of countries along socio-economic and political characteristics. The Global South is a term often used to identify regions within Latin America, Asia, Africa, and Oceania. https://en.wikipedia.org/wiki/Global_North_and_Global_South

Bivalve mollusc farming

The amount of farming of bivalve molluscs is small compared to salmonid farming and radically different in terms of environmental impact.

Picking oysters by hand at low tide, Willapa Bay, Washington, October 1969. Bob Williams, Public domain, via Wikimedia Commons

What is a bivalve mollusc?

Bivalve molluscs are a type of shellfish that have a hard shell consisting of two parts held together by a hinge. Bivalves come in all sorts of shapes and sizes and can be found attached to rocks and stones in lakes, rivers and oceans the world over. You might be most familiar with oysters and mussels.

The most commonly farmed bivalve molluscs are oysters and mussels. Oysters are farmed all over the globe. China is the biggest producer, followed by Korea, Japan, USA and France (see bit.ly/3r7nqql). Mussels are also farmed worldwide, although in lesser quantities. Again, China is the biggest producer with Chile and Spain also being important. As well as being a source of food, oysters are also farmed for their pearls (used in jewellery) and for their shells which are coated in nacre (also known as 'mother of pearl') and often used as buttons.

Bivalves tend to be farmed in shallow, tidal water near to the coast or in tidal estuaries (meaning harvesting can be carried out relatively easily at low tides). Often, farms are sited on existing mollusc beds. The farming environment usually closely mimics natural conditions and does not require additional food to be added to the water.

Bivalves: nature's water filters

Oysters and mussels are both active ***filter feeders***, meaning that they feed themselves by sucking in water from their surroundings, straining out microscopic algae and nutrients and then releasing the water. The oyster's faeces and anything it accidentally filters that it can't digest (like sand) are packed up together along with sticky mucus inside its shell and then occasionally expelled.

This process makes bivalves natural water filters – not only are algae and nutrients directly removed from the water for food, the undigested matter (and faeces) is packed into heavier pellets which fall out of suspension when expelled from the shell. In optimal conditions a single oyster can clean as much as 5 litres of water per hour, actively helping to fight against eutrophication!

Using bivalves to measure water quality

Bivalves are great at filtering excess algae and nutrients out of water, but only up to a point. If the water quality drops too far then the bivalves start to get stressed, which they show by closing their shells. This means that you can use the length of time that a bivalve shuts its shells while underwater to get a rough estimate of water quality.

The company Spyvalve is trying to use this method to measure changes in water quality in real time – check out what they are doing at spyvalve.com

What can we do?

Brainstorm exercise

Can your students brainstorm how individuals can help lessen the environmental impact of aquaculture? Here are some prompts to help them, and you can find some more of our ideas below.

- Think about what ***actions can you take personally***?
- Recognise that what works for them may not work for everyone else as they have different constraints on their lives. Putting yourself in someone else's shoes, ***what actions could they take***?
- People will not change if they don't know there is a problem. ***How can you inform people?***
- Industries will not change without pressure. ***How can you legally create that pressure?***

Some ideas we came up with are:

- **Personal change of eating habits from any piscivores!** For example:
  - Reduce amount of farmed salmon eaten. Switch to eating more vegan alternatives, committed piscivores can consider switching to farmed bivalves!
  - **Research farmed salmon providers that use cleaner farming techniques** and switch to those (note that this is likely to be more expensive, so need to stress ***where possible and affordable***). ASC labels are a starting point (bit.ly/3Cg5ujD) although they come with their own problems, see for example this article on SeaChoice.org: bit.ly/3LNVQYu
- **Create a set of resources to inform other people** (e.g. other students at school) about what you have learnt and present practical ways that they can make a difference. E.g.
  - Posters for your school wall
  - Gather and share recipes that people could use as an alternative to existing fish dishes – here are some suggestions to get you started: bit.ly/3BTwqUR
- **Write to an aquaculture company** in your country to ask them about the methods they use and how they are minimising their environmental impact.

Want to help improve this activity?

This activity is a living document! Help us by editing this activity to make it as good as possible, just use this short link (just type it into your web browser's address bar): bit.ly/3emZkoH – full instructions are provided. Any edits that can make this resource easier to use in the classroom are very welcome, so please follow the link and make your contribution!

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The Jane Goodall Institute has partnered with DP World to support the growth of the Roots & Shoots programme. DP World are a leading provider of worldwide smart end-to-end supply chain logistics with a presence in 55 countries, enabling the flow of trade across the globe. This exciting partnership supports the creation of resources on the wider marine ecosystem as well as supporting the expansion of Roots & Shoots groups around the world. **Find out more: bit.ly/jgi-dpw**

Tell us how you got on

When your project is finished we'd love to see what you did! If you already have an account you can upload a story with images to the Jane Goodall's Roots & Shoots UAE website (find us at uae.rootsandshoots.community) to show off pictures and videos of your ships to a wider audience. If your school or youth group does not already have an account then just fill in the form on the website and we can set you up.

Keep up to date with Jane Goodall's Roots & Shoots UAE

As well as the website you can also find us on Facebook at **facebook.com/RootsnShoots.ae** or on Twitter as **@JaneGoodallUAE**

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