

Subject links:

Science, Geography

Age: 14-16

Curriculum links:

Human impact, Economic activity, Environmental responsibility, Natural resources, Data analysis, Ecosystems, Interdependence, Sustainability

Ocean Literacy Principles:

5. The ocean supports a great diversity of life and ecosystems
6. The ocean and humans are inextricably interconnected

Aim:

By learning about how ecosystems can be impacted by fishing, and how we can manage fishing practices to reduce these impacts, students will begin to understand what makes seafood sustainable.

Learning Objectives:

- Describe several ecosystem impacts of unsustainable fishing.
- Analyse data to determine change over time.
- Analyse infographics to determine ecosystem impacts of aquaculture.
- Generate creative solutions to reducing negative impacts of fishing practices.

Resources provided:

- Sustainable fishing Fact File
- Sustainable fishing PowerPoint
- Ecosystem impacts worksheet
- Food web game
- Aquaculture infographic
- Aquaculture worksheet
- Full curriculum links

Sustainable fishing

Sustainability Goals:



Step 1

Background

Fish are not only important for the overall health of marine ecosystems, but they also provide protein and livelihoods for billions of people.

Globally, fisheries supply over 3.3 billion people with at least 20% of their average animal protein intake. The fishing industry is also important both economically and culturally across the UK, but unsustainable fishing practices are having devastating effects on our marine environment. Approximately 90% of large predatory fish such as tuna, swordfish and sharks, have been lost due to overfishing. This loss can alter food web dynamics, and marine habitats can also be directly damaged due to destructive fishing practices like trawling. More information can be found in the [Sustainable fishing Fact File](#).

Step 2

Set the Scene

Use slides 2-4 in the [Sustainable fishing PowerPoint](#) to introduce students to the topic.

Step 3

Activities

Activity 1 – Ecosystem impacts of unsustainable fishing

Activity 1 focuses on ecosystem impacts of unsustainable fishing and is split into four mini activities looking at overfishing, habitat destruction, food web dynamics and bycatch.

Overfishing – Using the [ecosystem impacts worksheet](#), students should analyse the graph showing global trends in fish stocks and record their answers on the worksheet.

Habitat destruction – Watch the video in the [PowerPoint](#) and complete the associated questions on the ecosystem impacts [worksheet](#).

Food web dynamics – Play the [food web game](#) using the instructions and cards provided. The game explores how overfishing alters food web dynamics. After completing the game, students should answer the associated questions on the ecosystem impacts [worksheet](#).

Bycatch – Watch the video in the PowerPoint and complete the associated questions on the ecosystem impacts [worksheet](#).

Resources required: [Sustainable fishing PowerPoint](#), [Ecosystem impacts of fishing worksheet](#), [Food web game](#)

Step 3

Activities

Activity 2 – Managing fishing in a sustainable way

Split the class into small groups. Give each group one of the ecosystem impacts covered in Activity 1 (overfishing, habitat destruction, food web dynamics and bycatch).

Each group should mind map how we could improve fishing practices and the fishing industry to decrease their ecosystem impact and make fishing more sustainable. To help the students generate their ideas, write some key words on the whiteboard like fishing gear, boats, species, habitats, protection, and law.

After 5 minutes, ask students to share their ideas and create a mind map on the board for each ecosystem impact with everyone's ideas. Many ideas will have crossover between the different ecosystem impacts. Stress to students that in order for fishing to be sustainable we need to consider ways to reduce *all* the ecosystem impacts. Notes are provided in the [fact file](#) to help you with this activity.

Resources required: [Sustainable fishing Fact File](#)

Activity 3 – Aquaculture

Introduce aquaculture as a fishing practice using the [Sustainable fishing PowerPoint](#).

Using the [aquaculture worksheet](#), students should analyse the infographics and draw out key points to create a table of positives and negatives of aquaculture. Students should think about ecosystem impacts, food supply, climate impact and overall sustainability, and should not be restricted to the information on the infographics alone but also add their own knowledge and their own thoughts to their table.

To introduce positive solutions for sustainable aquaculture, show students the video in the [PowerPoint](#). After watching, use the questions in the notes section of the PowerPoint to discuss 3D farming.

Resources required: [Sustainable fishing PowerPoint](#), [Aquaculture infographics](#), [Aquaculture worksheet](#)

Extension activity ideas

Maximum Sustainable Yield

In this game students will take on the role of fish, sharks and fishers. Students will have to make choices about how many fish can viably be taken from the ocean without affecting the overall fish population, but still maintain demand for food. Worksheets are provided for students to take notes and make calculations to understand the processes that inform sustainable fishing.

Resources required: [Marine Stewardship Council Go Fish activity pack](#)

Trawling and Ocean Biodiversity

Our recent report, [Marine unProtected Areas](#), highlights how bottom trawling is damaging ocean biodiversity. Students could draw out key findings of the report to write a summary blog post or newspaper article.

Resources required: [Marine unProtected Areas Summary Report](#)

Summary Videos

[This is a sustainable fish](#) – This video sums up the ecosystem impacts of fishing and what sustainable means (stop video at 2:11 as last section is USA focused). It could be shown before Activity 3 to sum up what has been learnt and to introduce aquaculture.

[Will the ocean ever run out of fish?](#) – This video brings together everything learnt in this lesson from overfishing, habitat destruction and management challenges. You could watch this at the end of your lesson and ask students to write a paragraph to summarise all they have learnt.

Step 4

Reflect

How does unsustainable fishing lead to overfishing? How does it lead to habitat destruction? How does it change food web dynamics? What is bycatch and how could it lead to unsustainable fishing? How could we manage fishing practices more efficiently to reduce unsustainable fishing? What is aquaculture? How can the environmental impacts of aquaculture be reduced?

Step 5

Follow up

To continue looking into key threats affecting the ocean take a look at our [Climate change](#) lesson, which explores how our ocean is impacted by and can help reduce climate change.

Our [Marine pollution](#) lesson explores how pollution enters the ocean, how it damages the marine environment and what we can do to help reduce it.

Sustainable fishing Fact File



Fishing and the planet

Fish are not only important for the overall health of marine ecosystems, but also provide protein and livelihoods for billions of people. Globally, fisheries supply over 3.3 billion people with at least 20% of their average animal protein intake. (1) The fishing industry is also important both economically and culturally across the UK.



Ecosystem impacts of fishing

© Anney Lier



Overfishing

Overfishing means catching fish faster than they can reproduce. Many fish stocks are in a state of serious decline due to overfishing, as it pushes the fish population into smaller and smaller numbers, until there are so few fish that fishers can't make a living, and fish populations find it harder to grow again. Approximately 90% of large predatory fish like tuna, swordfish & sharks have been lost. (2)

© NarriscFotoSS



Habitat destruction

A wide range of fishing methods are used throughout the world, with different methods used to catch different types of fish. Some of these methods – like bottom trawling and dredging – involve scraping heavy machinery along the seafloor, which can be very destructive to marine habitats. Less than 2.5% of UK waters are closed to bottom trawling. (3)

© IrenePic84



Food web dynamics

Overfishing a species can alter food web dynamics, for example if a cod population is overfished their predators such as seals will have less to feed on. Also, smaller fish that cod would normally feed on could increase in number, due to having less predatory pressure.

Sustainable fishing Fact File

© Ivan Sarenas



Bycatch

During fishing, animals accidentally caught along with 'target species' are known as bycatch. These animals can include dolphins, turtles, sharks and whales, as well as young fish deemed too small. In many parts of the world, bycatch are usually thrown back into the sea either dead or dying. In order to reduce the number of fish harmed in this process, in the UK it is illegal to throw some species of fish back into the sea. Approximately 10% of fish caught worldwide are bycatch. (4)



Sustainable fishing

We need to end overfishing in order to maintain healthy marine ecosystems, and to sustain livelihoods and food security into the future.

There are several ways of managing fishing practices:

- Quotas based on scientific evidence on how many and what type of fish can be caught can help limit **overfishing**.
- The improvement of fishing gear can help **reduce bycatch** by increasing the selectivity of the fishing activity.
- Limiting damaging fishing practices in sensitive and diverse areas can help **reduce damage** to the overall environment.
- No Take Zones or Highly Protected Marine Areas, where no fishing activity is allowed, will allow fish populations to recover and will help **protect and restore** the marine environment.
- Managing fishing activities to ensure everyone adheres to the rules is tricky in a large ocean environment, which means **technology** plays a big part in fisheries management.
- **Consumer choice** can influence overfishing. We tend to eat the same key species, which puts a lot of pressure on their stocks. **Increasing awareness** amongst consumers is important in achieving sustainable fishing. Consumers can use the [Good Fish Guide](#) to help them choose sustainable seafood.

Sustainable fishing Fact File



Sustainable aquaculture

Aquaculture is a catch-all term for seafood farming, including fish, shellfish and seaweeds.

Approximately half of the fish we eat are farmed. Fish are usually raised from eggs in hatcheries and moved to bigger pens or tanks until they reach the size for harvest. Different fish are grown in different ways depending on their needs and the country they are grown in.

Why do we farm fish?

- Global aquaculture is growing to match a growing world population and our increasing demand for seafood. Wild capture fisheries are not able to catch any more fish than they do at the moment, therefore farming fish helps to fill the gap between demand and supply.
- Fish such as salmon, which used to be caught, are now in very low numbers, so now nearly all of the salmon we eat are farmed.
- Aquaculture helps to reduce stress on the ocean and wild fish populations.
- Farming fish has the ability to provide fish all year round.



Fish farm in Scotland
© Richard Johnson



Mussel farming
© Sergii Rudiuk

Did you know? There are more than 600 sustainability ratings on the [Good Fish Guide](#), covering around 130 species. Every one is carefully researched and rigorously reviewed, ensuring the guide is accurate, transparent and credible.

Sustainable fishing Fact File



Sustainable aquaculture

Negative environmental impacts of aquaculture

- Fish like salmon and prawns need to be fed. The food they eat is made of lots of ingredients, including other fish, and some of these are from unsustainable sources. Plants like soya are also included in the feed, and it's really important that this comes from a sustainable supply, but this is not always the case.
- The pens that some fish, like salmon, are grown in are open to the surrounding sea. Therefore, any uneaten fish food, waste chemicals and fish waste sinks to the seafloor causing pollution.
- In some areas, diseases and parasites can be a real problem, especially if they spread outside the farming area and infect wild fish.
- Sometimes farmed fish escape due to large storms or holes in the nets, which has the potential to have negative effects on wild fish in the area due to the spreading of disease or interbreeding.

Sustainable Aquaculture

- Good management and regulation is important to reduce negative environmental impacts and work towards sustainable aquaculture.
- The [Good Fish Guide](#) provides sustainability ratings for wild and farmed fish so consumers can make informed choices on the food they eat.



Fishmonger
© PickOne



Aerial view of fish farm
© Richard Johnson



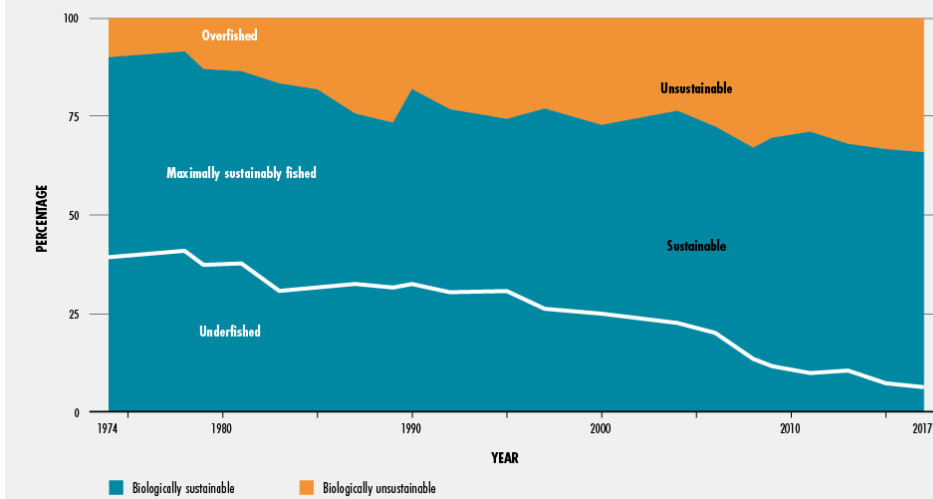
Oyster farming
© Divedog

Ecosystem Impacts

Name: _____

Overfishing

FIGURE 19
GLOBAL TRENDS IN THE STATE OF THE WORLD'S MARINE FISH STOCKS, 1974–2017



What was the percentage of unsustainable fishing in 1974?

What was the percentage of unsustainable fishing in 2017?

Describe how the global trend of fish stocks changes between 1974 and 2017

Habitat destruction

How big can super bottom trawlers be?

How does bottom trawling affect marine life and plants living on the seabed?

Bycatch

What is a target species?

What is bycatch?

Why is bycatch bad for wildlife, and why is it unsustainable?

Food web dynamics

What species were affected by the loss of mussels from the food chain?

How does overfishing change food web dynamics? Discuss changes to the direct food chain and wider food web. Consider changes to predator and prey dynamics.

Food web game instructions

1. Move to an open space, like a school hall or outside. Explain that together you're going to make a marine food web. Ask if students know what a food web is (a connection of food chains).
2. Stand in a large circle and hand out the food web elements cards to some students (there are 14 cards so won't be enough for one each).
3. Draw attention to the smaller text showing where the organism gets its energy. Remind children this is really important for the game.
4. Start with the sun, and ask who gets their energy from the sun (plankton and seaweed). Explain that these are producers. Connect these to the sun using separate pieces of string.
5. Now ask who gets their energy from seaweed, and link with string.
6. Work through one food chain at a time, using a different length of string for each food chain.
7. Explain that the creature at the end of the food chain is a predator.
8. Continue until all food chains are complete. This will form a visual food web.

This activity should take no more than 10 minutes. If you have time then complete extension activity.



Food web game instructions

EXTENSION

1. Ask students what they think might happen to the food web if one of the animals disappeared, for example, if mussels were overfished. Then remove mussels (person holding shellfish lets go of string).
2. Children should identify the impact of this loss, i.e. animals feeding on mussels would have less food, possibly impacting their numbers. Those students holding cards that eat mussels should then be removed by letting go of the string.
3. Observe how this has impacted the web. Discuss how creatures that mussels feed on may increase in number because of lack of prey.
4. Explain that each element within a food web can affect the others.



Human

Eats whelk, edible crab, mussels, flatfish and seaweed



Orca

Eats otter



Seal

Eats flatfish



Flatfish

Eats mussels



Mussels

Eats plankton



Whelk

Eats hermit crab and mussels



Hermit crab

Eats seaweed



Otter

Eats urchin



Urchin

Eats seaweed



Edible crab

Eats worm, mussels and seaweed



Worm

Eats whelk, edible crab, flatfish and seaweed



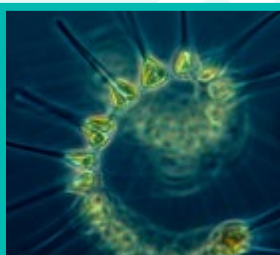
Basking shark

Eats plankton



Plankton

Gets energy from the sun



Seaweed

Gets energy from the sun



Food web worksheet

Apex
Predators

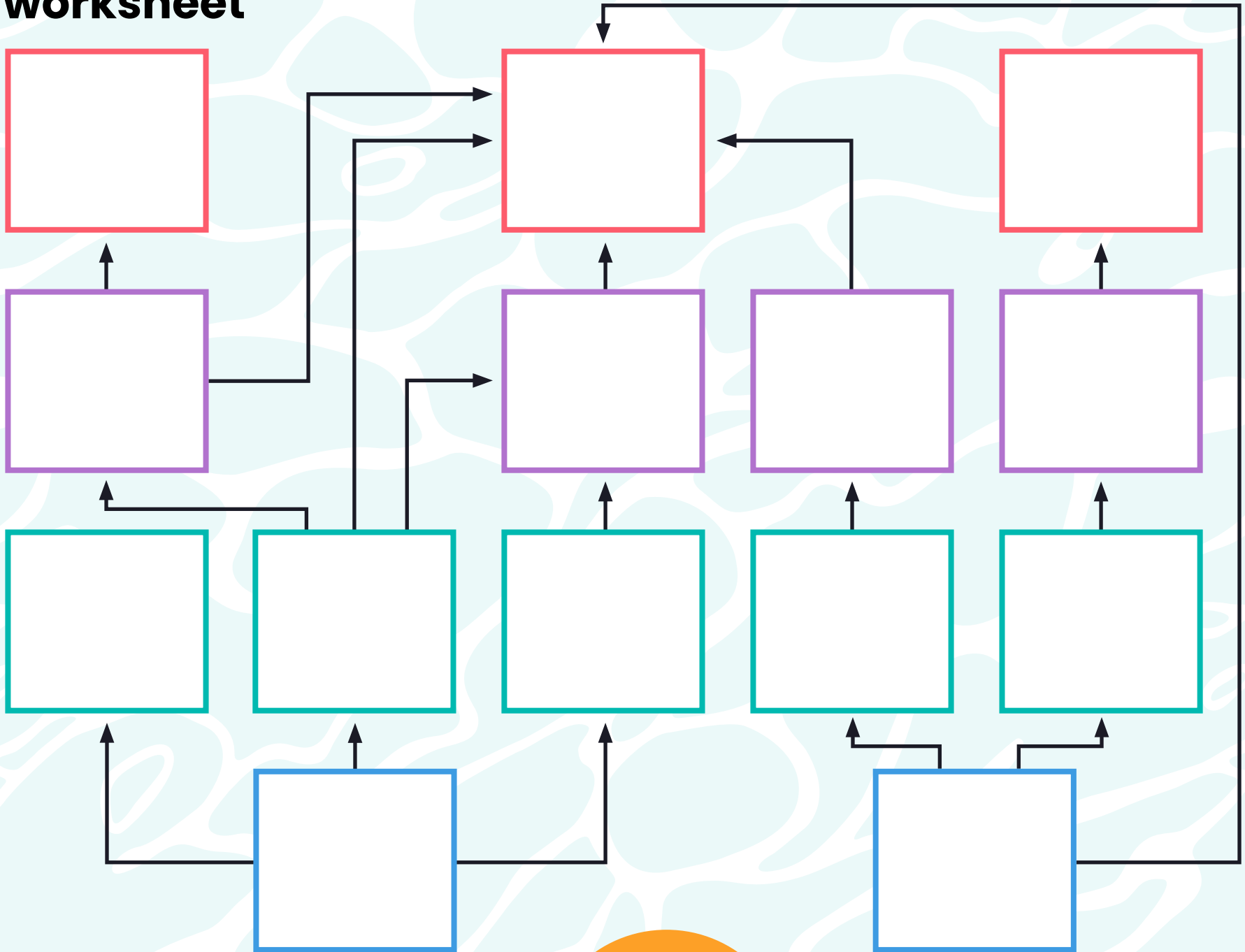
Secondary
Consumers

Primary
Consumers

Producers

Energy

Sun



Food web worksheet

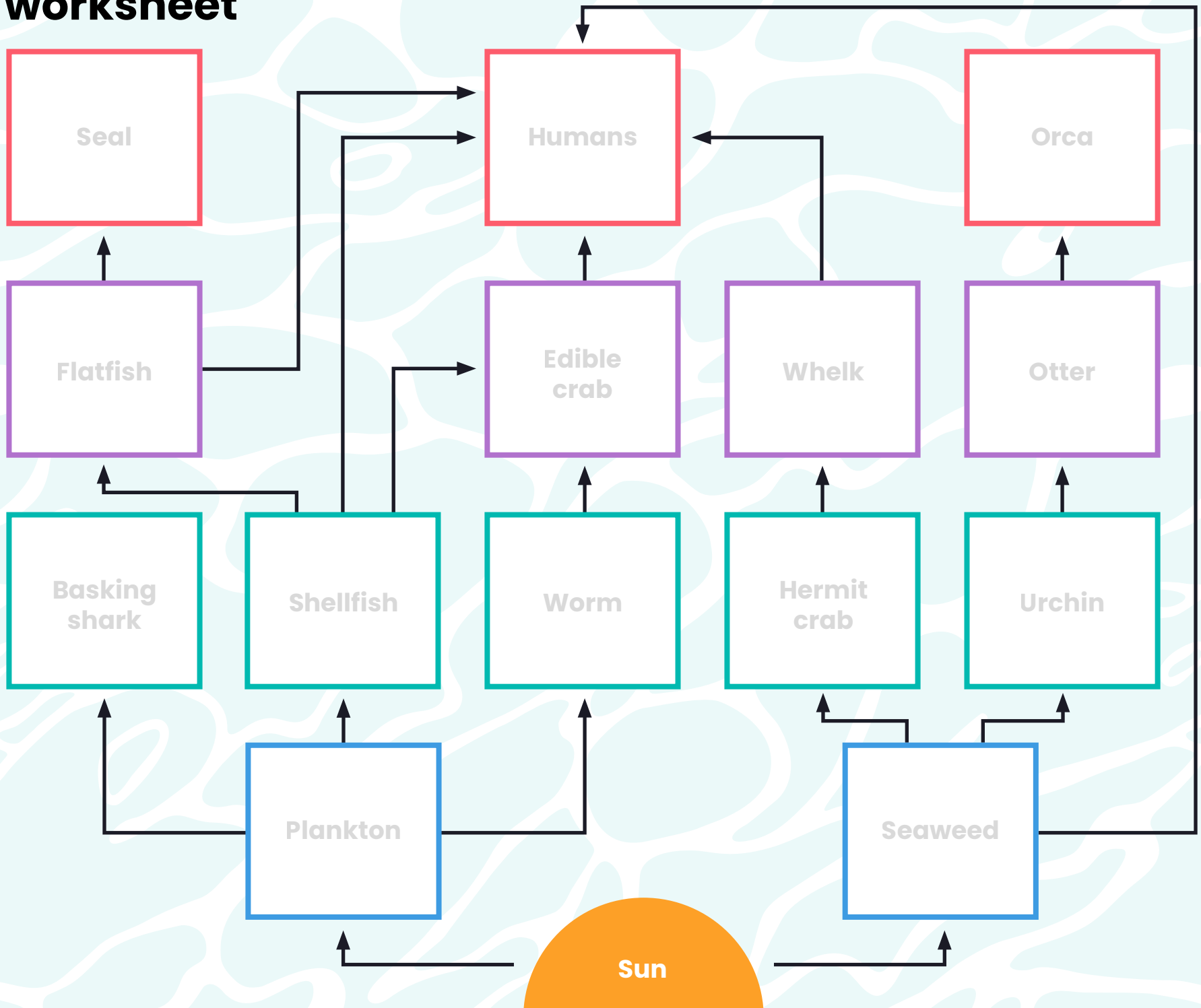
Apex predators

Secondary consumers

Primary consumers

Producers

Energy



Aquaculture

Name:

Analyse the infographics and complete the table below to show the positives and negatives of aquaculture.

Consider the ecosystem impacts, food supply, climate impact and overall sustainability.

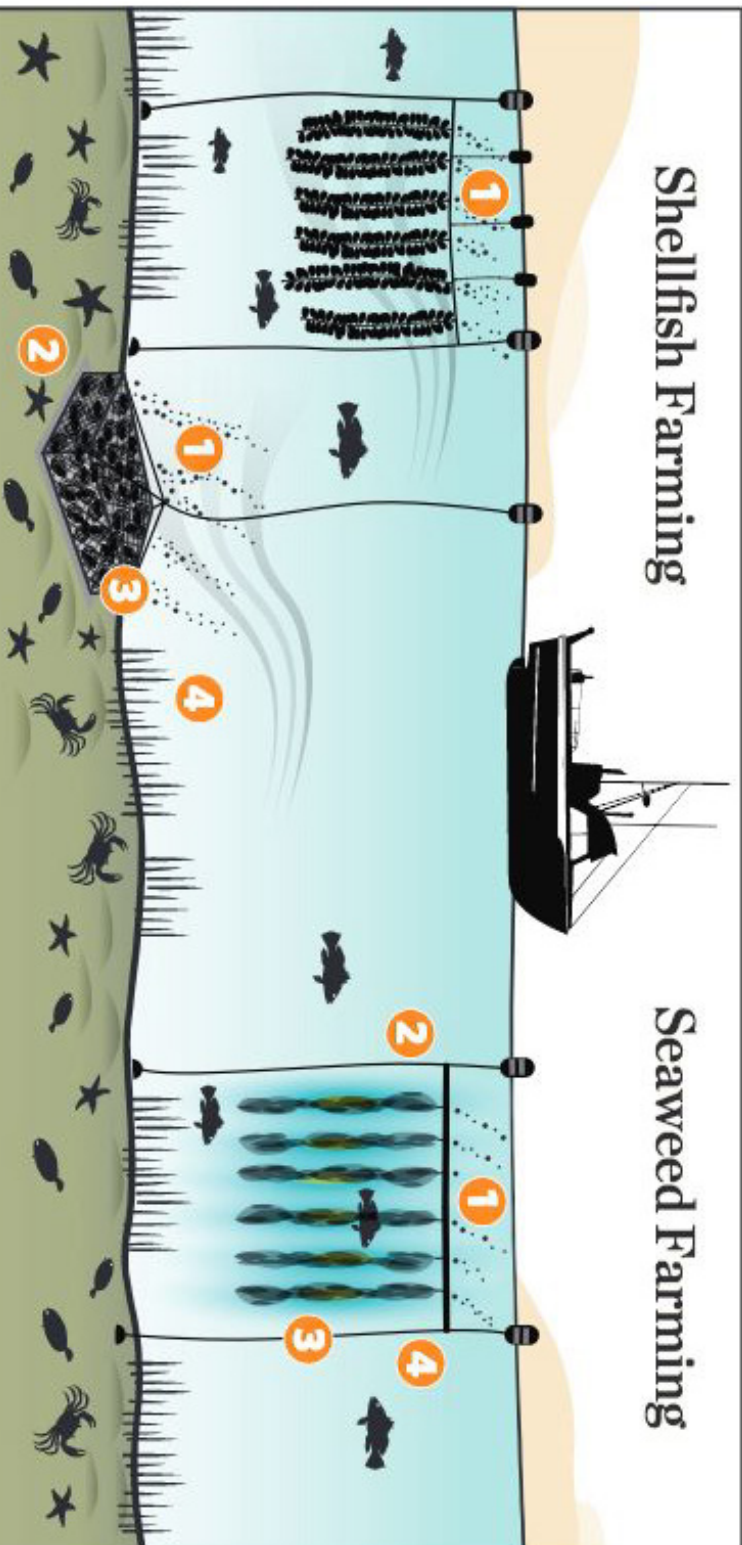
Once you have finished analysing the infographics add to the table with your own knowledge and thoughts on aquaculture.

Positives of aquaculture:

Negatives of aquaculture:

Shellfish Farming

Seaweed Farming



1

Mitigate Pollution

Shellfish and seaweed aquaculture can improve water quality by extracting nitrogen and phosphorous from coastal waterways. As filter feeders, bi-valve shellfish can improve water clarity. These factors can lessen the symptoms of eutrophication, which effects 415 estuaries worldwide.

2

Habitat Provision

85 percent of native oyster populations have been lost worldwide and many seaweed communities are similarly in decline. Shellfish and seaweed aquaculture can provide some of the benefits of these lost habitats.

3

Support Fish Populations

Shellfish and Seaweed aquaculture gear provides refuge for macro-fauna including fish, crustaceans, and other invertebrates.

4

Reduce Local Climate Change Impacts

Seaweed aquaculture can reduce carbon dioxide and oxygenate waterways, and thereby locally mitigate the effects of ocean acidification. Through increased water clarity, shellfish aquaculture may promote the growth of eelgrass beds, a carbon sink.



European Commission

AQUACULTURE PRODUCTION

EU is the **8th** biggest producer in terms of volume



Did you know?

Aquaculture will soon surpass wild fisheries as the main source of seafood. This reflects the transition which happened on land in the past with the evolution from hunting to farming.

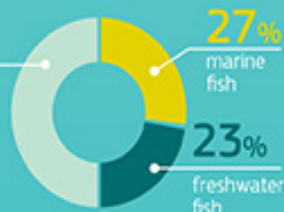
In AD 79, Pliny the Elder described fish and oyster farming techniques in his book *Natural History*



AQUACULTURE IN THE EU

1.25m tonnes produced in the EU each year

50% molluscs & crustaceans



5 main EU aquaculture producers



Top 7 aquaculture species produced in the EU

- 1 Mussel
- 2 Trout
- 3 Salmon
- 4 Oyster
- 5 Carp
- 6 Sea Bream
- 7 Sea Bass

EU aquaculture provides a fresh, local supply of healthy seafood and follows strict rules to protect the consumer, the fish and the environment.

FARMED IN THE EU

AQUACULTURE CONSUMPTION



The **2** most consumed aquaculture species in the EU are salmon and mussel



Did you know?

Nine out of ten mussels eaten in the EU are actually farmed



AQUACULTURE BENEFITS

85 000 directly employed in European aquaculture

+14 000 enterprises in the **LOCAL EU**
90% of which are micro-enterprises (with under 10 employees)



Fish and shellfish provide oils, healthy proteins and minerals.

omega 3



At every step from egg to plate, farmed seafood is traceable



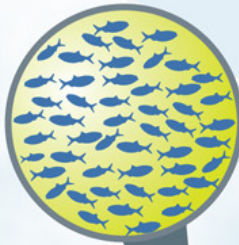
Sustainable aquaculture is needed because fisheries alone will not meet the growing global demand for seafood. Aquaculture can also help reduce pressure on wild fish stocks.



Environmental Impacts of Open-Ocean Aquaculture

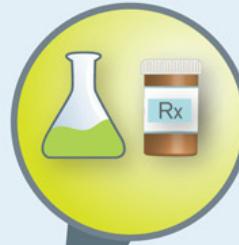
Fish Meal & Fish Oil

Using wild-caught fish to feed farmed fish puts additional pressure on these populations and can impact other wildlife that depends on them for food.



Drugs & Chemicals

When used, antibiotics, parasiticides, and other chemicals flow out of pens and can affect wild fish as well as the broader marine ecosystem.



Escaped Fish

Escaped fish compete for food and habitat, transmit diseases, and prey on and breed with local fish, reducing the health of wild populations.

Diseases & Parasites

Disease, pathogens, and parasites can multiply in crowded pens and rapidly spread to wild fish.

Fish Waste

Fish waste flows out into the ocean, adding potentially harmful extra nutrients to the ecosystem. Uneaten food can also build up on the ocean floor underneath pens, altering the abundance and biodiversity of these communities.

Predators

Seals, sea lions, sharks, birds, and other marine wildlife can become entangled in fish pens. The use of deterrents like underwater loudspeakers can alter the natural behavior of predators.

Curriculum Links – England

Key Stage 3

Science

- Interactions and interdependencies
- Relationships in an ecosystem
 - The interdependence of organisms in an ecosystem, including food webs and insect pollinated crops
 - How organisms affect, and are affected by, their environment, including the accumulation of toxic materials.

Geography

- Collect, analyse and communicate with a range of data gathered through experiences of fieldwork that deepen their understanding of geographical processes
- Human and physical geography
 - Understand, through the use of detailed place-based exemplars at a variety of scales, the key processes in: Human geography relating to: economic activity in the primary, secondary, tertiary and quaternary sectors; and the use of natural resources
 - Understand how human and physical processes interact to influence, and change landscapes, environments and the climate; and how human activity relies on effective functioning of natural systems.

Key Stage 4

Science

- Ecosystems
 - Levels of organisation within an ecosystem
 - Some abiotic and biotic factors which affect communities; the importance of interactions between organisms in a community
 - Positive and negative human interactions with ecosystems.

Geography

- Use of data
 - Data should include both qualitative and quantitative data, interpretation and analysis.
- People and environment: processes and interactions
 - Global ecosystems and biodiversity – An overview of the distribution and characteristics of large scale natural global ecosystems. For two selected ecosystems, draw out the interdependence of climate, soil, water, plants, animals and humans; the processes and interactions that operate within them at different scales; and issues related to biodiversity and to their sustainable use and management.
 - Resources and their management – An overview of how humans use, modify and change ecosystems and environments in order to obtain food, energy and water resources. Detailed study of one of either food, energy or water, recognising the changing characteristics and distribution of demand and supply, past and present impacts of human intervention, and issues related to their sustainable use and management at a variety of scales.

Curriculum Links – Wales

Progression Step 4

Science

- Being curious and searching for answers is essential to understanding and predicting phenomena.
 - I can explain how the impact of our actions contribute to the changes in the environment and biodiversity.
- The world around us is full of living things which depend on each other for survival.
 - I can describe the interdependence of organisms in ecosystems and explain how this affects their chances of survival.

Humanities

- Enquiry, exploration and investigation inspire curiosity about the world, its past, present and future.
 - I can analyse, present and reflect on my findings, describing patterns and explaining relationships across data and sources.
- Our natural world is diverse and dynamic, influenced by processes and human actions.
 - I can understand and explain how human actions affect the physical processes that shape places, spaces, environments and landforms over time.
 - I can understand and explain the range of factors that affect the interrelationships between humans and physical processes.
- Informed, self-aware citizens engage with the challenges and opportunities that face humanity, and are able to take considered and ethical action.
 - I have an understanding of my own and others' environmental, economic and social responsibilities in creating a sustainable future.

Progression Step 5

Science

- Being curious and searching for answers is essential to understanding and predicting phenomena.
 - I can evaluate contemporary issues that affect the planet and biodiversity.

Humanities

- Our natural world is diverse and dynamic, influenced by processes and human actions.
 - I can explain and analyse the wide range of interrelationships and interdependencies between the human actions and physical processes that shape places, spaces, environments and landforms over time.
 - I can evaluate the extent to which economic, social, political, cultural, religious and non-religious beliefs, practices and actions have led to changes to the natural world.
- Informed, self-aware citizens engage with the challenges and opportunities that face humanity, and are able to take considered and ethical action.
 - I can explain the importance of the role played by groups, governments, businesses and non-governmental organisations in the creation of a sustainable future, and how they impact on people and their rights and on the environment.

Curriculum Links – Scotland

Third-Fourth Level

Science – Third Level

- Biodiversity and interdependence
 - I can sample and identify living things from different habitats to compare their biodiversity and can suggest reasons for their distribution.

Science – Fourth Level

- Biodiversity and interdependence
 - I understand how animal and plant species depend on each other and how living things are adapted for survival. I can predict the impact of population growth and natural hazards on biodiversity.

Social Sciences – Third Level

- People, place and environment
 - I can identify the possible consequences of an environmental issue and make informed suggestions about ways to manage the impact.

Social Sciences – Fourth Level

- People, place and environment
 - I can discuss the sustainability of key natural resources and analyse the possible implications for human activity.
 - I can develop my understanding of the interaction between humans and the environment by describing and assessing the impact of human activity on an area.

Senior Level

Environmental science

National 4

- Skills, knowledge and understanding
 - Demonstrating knowledge and understanding of environmental science by making statements, describing information and providing explanation
 - Applying knowledge of environmental science to new situations, interpreting information and solving problems.
- Living Environment
 - Interdependence, adaptation for survival; the impact of population growth and natural hazards on biodiversity; and the nitrogen cycle and the environmental impact of fertilisers.
- Sustainability
 - The sustainability of key natural resources and possible implications for human activity; the interaction between humans and the environment and the impact of human activity on an area; the role of agriculture in the production of food and raw material and its environmental impacts and sustainability; society's energy needs and the impact of developments in transport infrastructure in a selected area; and development of sustainable systems.

National 5

- Skills, knowledge and understanding for the course
 - Demonstrating knowledge and understanding of environmental science by making statements, describing information, providing explanations and integrating knowledge.
 - Applying knowledge of environmental science to new situations, interpreting information and solving problems.
- Living Environment
 - Investigating ecosystems and biodiversity
 - Interdependence
 - Human influences on biodiversity
- Earth's Resources
 - Biosphere
- Sustainability
 - Introduction to sustainability
 - Food

Geography

National 4

- Skills, knowledge and understanding
 - Demonstrating knowledge and understanding of selected global issues by giving factual descriptions and straightforward explanations.
- Global Issues
 - The impact of human activity on the natural environment.

National 5

- Skills, knowledge and understanding
 - Demonstrating knowledge and understanding of selected global issues by giving detailed descriptions which are mainly factual with some theoretical content, and giving detailed explanations.