

# IB Environmental Systems and Societies

## 4.3 Aquatic food production systems

### **Significant ideas:**

Aquatic systems provide a source of food production.

Unsustainable use of aquatic ecosystems can lead to environmental degradation and collapse of wild fisheries.

Aquaculture provides potential for increased food production



## Aquatic food webs

1. State the trophic level of phytoplankton in an aquatic food web  
Primary producer and/or first trophic level.

2. Distinguish between benthic and pelagic marine organisms.

The **benthic zone** refers to the bottom of the sea floor. Marine organisms here are often non-motile such as corals and sea weed, or live in the sandy substrate of the sea floor. The **Pelagic zone** refers to the water column and so organisms that reside here are motile, for example fish and jelly fish.

3. Explain the distribution of varying productivity in marine ecosystems

Phytoplankton (photosynthetic plankton) serve as the major primary producers in the marine ecosystem. They turn sunlight into usable chemical energy and thereby form the base of the marine food chain. As these organisms form the base of the marine food web, this variability in phytoplankton growth influences higher trophic levels.

Not all regions of the sea are equally productive. The growth of phytoplankton populations is dependent on **light levels** and **nutrient availability**. As such the oceans have varying levels of productivity based on depth. The photic zone (the top 200m of the sea) the area where light can penetrate) is more productive than the euphotic zone.

Nutrient upwellings along the coast, combined with agricultural run off can also lead to increased primary production closer to continental shelves when compared with the middle of the ocean.

The chief limiting factor varies from region to region in the world's oceans. On a broad scale, growth of phytoplankton in the tropical and subtropical gyres is generally limited by nutrient supply, while light often limits phytoplankton growth in subarctic gyres.

4. Explain why the territorial water of a country is of significant value to a nation

The territorial waters of a country provide societies with food security and economic benefits. Globally, fishing provides more than 1.5 billion people with almost 20 percent of their average per capita intake of animal protein. Most tropical coral is found within territorial waters, and these regions are incredibly biodiverse, providing natural resources as well as drawing tourists.

Additionally the legal status of territorial waters also extends to the seabed and subsoil under them and to the airspace above them. As such if there are oil deposits located within these spaces these can be of significant economic value.



## (Un) sustainable fishing

1. State and explain the trend in demand for aquatic food resources

The demand for aquatic food resource is increasing. As a greater proportion of the population becomes wealthier (particularly in China and India) they can afford to eat expensive foods such as seafood. Additionally the price of fish has dropped, and consuming fish is seen to have health benefits such as omega 3.

2. Describe what is meant by the term "aquaculture".

Aquaculture is the farming of aquatic organisms. This can involve breeding, rearing, and harvesting of fish, shellfish, plants, algae, and other organisms in all types of water environments both marine and freshwater.

3. The amount of food provided by wild-catch fish is plateauing worldwide, while the amount provided by aquaculture is increasing. Suggest reasons for this.  
The amount of food produced by aquaculture is increasing due to technological development. It is also a growing industry that is growing globally.  
In contrast wild stocks are dwindling due to wild fisheries being over-fished and mismanaged. Technological developments have allowed for large numbers of fish to be removed from the wild, but the numbers are plateauing as humans start to exceed the maximum sustainable yields.

4. Explain the need for more sustainable aquaculture

Aquaculture can be quite detrimental to the environment.

- If fish escape their pens they can compete with native/local fish for resource, and become pests/invasive.
  - Breeding fish in close proximity can lead to disease outbreaks.
  - breeding in large quantities can lead to high levels of fecal waste washing into the waterways, and can lead to eutrophication.
  - starting up an aquaculture farm off the coast can involve clearing mangrove habitats, which is detrimental to local biodiversity.
- If these issues are not managed well they can result in environmental problems.

5. Describe ways in which fish farming is becoming more sustainable:

Pens are being moved to off-shore locations, where no land clearing is required, and mangroves are left intact.

Polyculture farming is being developed where the fecal matter is then consumed by other species such as sea cucumbers or algae (which are also farmed). This reduces the nutrient levels in the water and reduces the risk of eutrophication.

Farming native fish is also more sustainable than farming introduced species. If the native fish escapes it has much less of an impact on the local ecosystem.

Feeding fish pellets made from insect rather than other fish is also a more sustainable option.



6. State two aquaculture systems that are unsustainable, and explain the ways in which they are unsustainable

Open-ocean cage aquaculture - can be unsustainable if the site selected has to be cleared (ie mangrove or reef). The influx of fish adds additional effluent to the waterway that can lead to eutrophication. If species escape the pens they can compete with local native fish.

Terrestrial tank aquaculture - this type of aquaculture requires land to be set aside for fish farming. Everything in this situation is externally controlled, from the temperature of the water to filtration of waste and added feed. Often carnivorous fish are bred, which involves feeding fish other fish (and does not solve issues of overfishing). Large volumes of waste are produced that need to be processed, and often end up in rivers or sent to landfill.



7. Explain how modern fishing practices and technology contribute to the unsustainability of the wild fishing industry. Use the table to guide your answers.

GPS navigation	GPS Fish finders enable fishermen to locate fish in the water. This means that they will find fish rapidly, and know how many are nearby. With satellite tracking shoals of fish can be tracked from space and caught in record time.
At-sea refrigeration techniques	At sea refrigeration enables fishermen to snap freeze fish as they are caught. Since the fish will not rot, the ship can stay at sea until the ship is full of fish, rather than having to return to shore and get the fish to market. This allows thousands of fish to be caught and stored.
Factory vessels	A factory vessel is a ship with with extensive on-board facilities for processing and freezing caught fish. Capable of storing tonnes of fish and keep trawling for weeks at a time, these boats are enormous up to 144 meters. They can deplete stocks rapidly.
Indiscriminate fishing equipment	Indiscriminate fishing equipment is problematic as there is a large amount of by-catch (any organisms captured including dolphins, turtles that are not intended to be caught.) by-catch do not have high survival rates.
Use of trawlers	Trawlers are boats that throw large nets into the ocean and indiscriminately haul up fish. They can be incredibly destructive if using bottom trawlers that also destroy the sea floor ecosystems (reefs) as they drag across them.



8. Summarise ways in which unsustainable exploitation of aquatic systems can be mitigated

Moratoriums on fishing

Marine reserves set up seasonally or permanently

Net hole sizing that is more specific for the species of fish targeted and reduce by-catch

Long lining rather than trawling

Consumers reduce our consumption of endangered species, or species whose harvesting is particularly damaging such as wild caught prawns.

Seeding reefs and releasing stock to boost wild fish stock

9. Evaluate the above strategies

Marine reserves are one of the better methods to mitigate aquatic exploitation. When regions of the ocean are set aside, fish populations rebound. By conserving habitat an increasing abundance of fish inside the marine reserve often follows. Interestingly this also increases the production and spillover of fish outside the marine reserve. In the long term, fishermen also harvest more fish.

However, setting up a marine reserve requires policing of the waterways to ensure that people do not fish in the reserve. Fish can still be fished outside the reserve, so ensuring that nursery sections of the environmental are under protection is very important.



## Controversial fishing

1. Describe what is meant by the term "biorights"

Biorights are the equivalent of human rights, but exist for plants and animals. An organism has the biological right to exist, live and breed, independent of human value systems.

2. What type of environmental value system is expressed by a person who puts a strong emphasis on bio-rights?

Ecocentric or deep ecologists

3. Summarise the arguments against harvesting of seals and whales

Seal and whale hunting can be considered quite brutal and cruel.  
The populations of seals and whales are vulnerable, and so need protecting.  
Seal and whales have a role to play in the ecosystem.

4. List some of the products made from whales

Whale meat is consumed directly. Their blubber used to be used as oil for lamps. Their bones used to be used in umbrellas and corsets. Ambergris is also used in perfumes.

5. State on justify your opinion on the harvesting of whales

Whale harvesting is a cruel practice that IS necessary and

Whales have a significant role to play



## Controversial fishing – CASE STUDY

To answer the following questions you will need to conduct your own research into whaling in Iceland, and amongst Inuit people. You can use the following resources as a starting point:

[iwc.int/](http://iwc.int/)

[iwc.int/aboriginal](http://iwc.int/aboriginal)

[uk.whales.org/issues/whaling-in-iceland](http://uk.whales.org/issues/whaling-in-iceland)

1. What is the International Whaling Commission and what is their role?

The IWC is the global body charged with the conservation of whales and the management of whaling.

2. There is currently a moratorium on whaling. Explain what this means

A moratorium is a temporary ban on an activity. A whaling moratorium means that the act of hunting and killing whales is prohibited, they can not be killed.

3. Summarise Iceland's historical relationship with the IWC

The IWC agreed to stop all commercial whaling by 1986, Iceland however continued its "scientific whaling" programme. Since then Iceland has continued whaling, approximately 200 whales per year. In 2019 they have not hunted any whales to date.

4. Despite being a member of the IWC and there subject to the moratorium, Iceland continued to hunt fin whales (amongst other whale species). What loophole did they use?

Iceland and Japan have taken out 'reservations' against the listing of fin whales under Appendix 1 of the Convention on International Trade in Endangered Species (CITES) and can legally trade this endangered species with each other. Iceland is the largest exporter of whale meat: Japan the largest importer.

4. State and explain the current ruling on whaling for aboriginal groups such as Inuits.

From the outset, the IWC recognised that indigenous or aboriginal subsistence whaling is not the same as commercial whaling. Aboriginal whaling does not seek to maximise catches or profit. It is categorised differently by the IWC and is not subject to the moratorium. Aboriginal whaling is part of cultural practice, and only kills one or two whales a season. as such it will not have a large impact on whale populations.



5. Compare whaling practices and justification by Iceland with those of the Inuit people.

Whaling is part of the culture for Inuit people. Subsistence whaling is important as whales constitute more than half of the Inuit diet, the rest being made up of caribou, walrus and other animals whose populations predicts would be rapidly depleted if whaling came to a halt. The Inuit people hunt less than 5 whales per annum.

In comparison whale meat is not culturally significant in Iceland. It is not a traditional dish. A 2016 survey revealed that only 1.5% of the population regularly purchases whale meat. Most of the whale hunted in Iceland is exported to Japan for commercial gains, and most of the minke whale meat is served to tourists. With growing awareness and demand for whale meat declining globally, whalers are concocting desperate uses for whale products, including dog treats, iron supplements and even a so-called flavouring for beer! Each year between 50-200 whales are landed.

