Farm aquatic food, not wild stocks

Aquaculture is the cultivation of aquatic organisms, including fish, shellfish and seaweeds. It takes place in freshwater or marine environments, using ponds, tanks, cages and other systems.

1. TWO DIFFERENT WAYS TO PRODUCE SEAFOOD

Capture fishery

Harvest organisms from wild populations. The catch depends on wild stocks and fishing effort.

Aquaculture

Raise organisms through managed production. Farmers influence stocking, growth conditions and harvest.

2. WHY AQUACULTURE HAS EXPANDED

The syllabus highlights efficient production, relatively small water areas and low fuel requirements. Concentrating production can yield substantial food from a limited farming area, while farmers do not need to search widely for a catch. Aquaculture can supplement seafood supply and support livelihoods. These are potential advantages, not a guarantee that every farm uses little energy: pumping, aeration, temperature control and feed production also consume resources.

3. EXTENSION: SPECIES AND FEEDS CHANGE THE PICTURE

Fed finfish systems require a supply of suitable food. Some feeds contain fishmeal and fish oil from wild-caught fish or seafood-processing trimmings, so a farm can remain linked to wild fisheries. Alternative ingredients can reduce this dependence. Bivalves such as oysters and mussels filter naturally available particles; seaweeds absorb dissolved nutrients and use sunlight. Marine bivalve and seaweed grow-out generally needs no added feed. More farmed seafood therefore does not automatically mean less fishing pressure: consider what is farmed, what it eats and whether it replaces wild-caught seafood.

Production and farming systems: NOAA Fisheries, Understanding Marine Aquaculture.
Feed ingredients and wild-fish links: NOAA Fisheries, Aquaculture and Recreational Fishing.
Low-input grow-out: NOAA Fisheries, Benefits of Shellfish and Seaweed Aquaculture.

Scope: College Board AP Environmental Science CED, Topic 5.16, p. 112.

Follow the environmental pathways

The core risks are polluted water, disease transmission and escaped fish interacting with wild populations. Their severity depends on the species, stocking density, location and management.

1. WASTE CAN LOWER WATER QUALITY

Uneaten feed and feces add organic matter; excretion and decomposition add dissolved nutrients. Organic wastes increase microbial oxygen demand. Nutrient enrichment can also stimulate algal growth; later decomposition consumes dissolved oxygen and can stress aquatic animals.

Feed and animal waste
Organic matter + nutrients

→

Microbial decomposition
Oxygen is consumed

→

Low dissolved oxygen
Stress or death if severe

Ammonia, suspended solids and residues from some drugs or chemicals are additional concerns.

2. HIGH DENSITY CAN FAVOR DISEASE

Keeping many susceptible fish close together can increase opportunities for pathogens and parasites to spread. Connected water allows infections to move between farmed and wild populations; fish need not escape for disease transmission to occur. Poor water quality can add stress. This is a risk pathway, not proof that every farm has an outbreak or that every disease in a wild population originated on a farm.

3. ESCAPES CAN AFFECT WILD POPULATIONS

Fish can escape through damaged nets or during farm operations. Survivors may compete with wild fish for food or habitat. Where reproduction is possible, farmed fish may interbreed with wild populations and alter their genetic composition. An escaped organism does not automatically become invasive: survival, establishment and harmful effects depend on the species and receiving ecosystem. Preventing escapes reduces these opportunities.

Core risks: College Board, STB-1.F.2.
Waste, oxygen demand and other pollutants: US EPA, Managing Aquaculture to Protect Water Quality.
Competition, genetic effects and escape prevention: NOAA Fisheries, Aquaculture Interactions.

Scope: College Board AP Environmental Science CED, Topic 5.16, p. 112.

Compare systems and manage trade-offs

Extension: aquaculture is not one uniform technology. Keeping fish inside a farm and keeping dissolved wastes inside it are different challenges; evaluate both production and environmental outcomes.

1. OPEN WATER VERSUS RECIRCULATING TANKS

Open-net pens	Water passes freely through the enclosure. Fish are contained, but waste and pathogens can exchange with surrounding water. Siting and stocking levels strongly affect local impacts.
Recirculating systems	Land-based tanks reuse water after treatment. Solids removal and water-quality management offer more control over discharges and separation from wild fish.
The trade-off	Recirculating systems need equipment, skilled operation and energy for pumping and treatment. Reusing water does not mean zero wastewater, zero disease or zero environmental impact.

2. MATCH A CONTROL TO ITS RISK

Waste loading	Avoid overfeeding, collect solids where feasible, and treat discharges. Match fish biomass to site conditions; currents disperse waste but do not destroy it.
Disease spread	Monitor fish health and water quality, manage stocking density and use biosecurity measures. Treatment does not replace prevention.
Escapes	Use suitable containment, inspect nets and maintain equipment. Plan for damage and handling events, not just normal operation.

3. JUDGE A FARM USING EVIDENCE

Compare feed inputs, energy use, water quality, disease records and escape events, as well as food output. A high yield alone does not establish sustainability. Likewise, one poorly managed farm does not show that every aquaculture system has the same impacts.

Waste loading and site selection: NOAA Fisheries, Nutrient Impacts of Finfish Aquaculture.
System types: NOAA Fisheries, Understanding Marine Aquaculture.
Energy trade-offs: Badiola et al., Energy Use in Recirculating Aquaculture Systems: A Review.

Scope: College Board AP Environmental Science CED, Topic 5.16, p. 112.