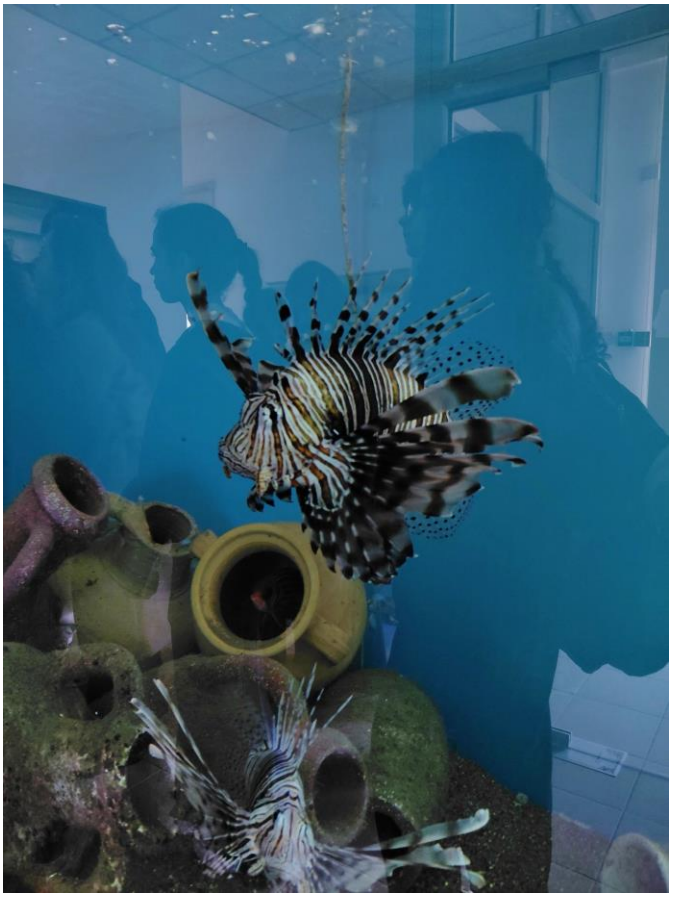
The Mediterranean Sea is heating up-what does this mean about the fish we eat?

Between 1982 and 2019, the temperature of the surface seawater of the Mediterranean Sea increased by 1.3°C, compared to a global average increase of 0.6°C, earning the label of a *'climate change hotspot'*. (1)

Fish shift their range

Cyprus' strategic location near the Suez Canal facilitates the migration of non-native species from the Red Sea into the Mediterranean (2). Many of these invasive organisms adapt quickly, reproduce rapidly, and compete with or prey upon local species, threatening biodiversity and domestic fish production. A great example of a migrated fish is the Lionfish. It's originally from Indonesia and has travelled across the Indian Ocean. Later on, it spread to diverse locations and appeared in the Mediterranean Sea via the Suez Canal in 1991. By 2010, it had established its presence in Cyprus [3]. They eat a wide range of small native fish and invertebrates, reducing biodiversity. Their lack of natural predators and fast reproduction in the warm waters constitutes a large threat to the local ecosystem. Their uncontrolled spread is **reducing local fish stocks.**



Lion fish at Fisheries Department, Larnaka

Temperature Stress and its impact on Fish Growth and Survival

Aquaculture produces over 80% (around 5,000–7,000 tonnes) of the total fishery production, making it the main source of local fish (4). Modern fish farms in Cyprus are facing unprecedented environmental pressure as climate change rapidly alters the marine ecosystem. Rising sea temperatures, shifting currents, and changing chemical conditions are reshaping the natural balance of the Mediterranean. All these directly affect aquaculture productivity and sustainability**.**

The increasing temperatures create intense physiological stress for fish, affecting their metabolism, oxygen needs, immune response, and overall health (5). That is mainly because fish are ectotherms, meaning that they can't regulate their body temperature internally. They actually rely completely on the temperature of the environment they inhabit. This can change what they eat, their developmental growth, and even have serious effects on their reproduction. Because of this, marine species become particularly sensitive to changes in water temperature.

Higher temperatures, higher production

This is actually true. Warmer waters may accelerate fish metabolism, leading to increased reproduction rates and faster growth. This can initially enhance production efficiency and shorten farming cycles. It may seem ideal, however, these benefits are often temporary and come with long-term risks linked to ecosystem instability and health complications. That is due to the fact that even though rising temperatures may accelerate fish growth, eutrophication encourages parasites and bacteria (5).

Small scale fish farm, Larnaka

Spread of Diseases

Diseases spread rapidly in overcrowded farms, damaging up to one third of Cypriot fish populations. The most significant disease has to be the Virus Nervous Necrosis (VNN). VNN is one of the most devastating infectious diseases affecting marine aquaculture. It especially affects the main fish of economic importance in Cyprus, such as European sea bass (*Dicentrarchus labrax*) (6). In addition, there is a variety of harmful bacteria and parasites as dangerous as VNN. These organisms thrive in warmer conditions, placing marine species under severe pressure and increasing the likelihood of large-scale mortality events.

Limited Treatment Effectiveness

Stressed fish often respond poorly to administered treatments and vaccines (7). To develop immunity in animals (including fish) and reduce the susceptibility of animals to communicable diseases, vaccination is vital. Fish vaccines can be made inactive by factors such as temperature, pH, and organic waste. Despite thorough investigation, only a limited number of authorized vaccines and antivirals demonstrate efficacy against viral infections, making prevention more difficult and increasing financial risks for aquaculture producers.

Extreme Weather Events

The growing frequency and intensity of extreme weather events such as storms and strong sea currents cause serious structural damage to fish farming facilities. Nets tear, cages collapse, and infrastructure losses lead to financial strain, and potential fish escapes into the wild.

Feed Composition

Feed in aquaculture mainly consists of fishmeal and fish oil, where anchovies and sardines constitute the main raw materials for production. It is dry feed that provides the necessary protein and fatty acids, which are important for the growth of farmed fish. The reduction of these elements affects the entire food chain. Thus, aquaculture is forced to find alternative ways of producing ingredients for feed preparation.

Impact on Consumers and Local Communities

Seafood is an important source of nutrients-proteins, fatty acids, calcium- supporting human health (8). Fish constitutes roughly 10% of the average Cypriot's protein intake which is above the European average. Changes in aquaculture affect consumers and the local communities that depend on it. Farms are becoming increasingly difficult to manage, and so the prices of locally harvested fish have risen sharply. As a result, essential proteins are slowly being excluded from our daily diet.

Locally farmed sea bass

Adaptation strategies

Selective breeding of fish with increased thermal resistance and disease resistance is a step that can be taken locally (8). However, climate change needs to be addressed by policy makers and there must be adherence to the Paris Agreement.

The Paris Agreement is a legally binding international treaty on climate change. It was signed at the UN Climate Change Conference in Paris 2015 by 195 parties. The world must work together to achieve the international agreement to keep global warming well below 2 degrees Celsius of pre-industrial levels. Food security is just one aspect of how climate change is affecting us all.

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