

How warming seas are forcing fish to seek new waters

Rising sea temperatures are pushing shoals hundreds of miles from native grounds



Bangladesh's national fish, Hilsa is displayed for sale in the wholesale fish markets in Dhaka. Photograph: Shafiqul Alam/Corbis via Getty Images

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Sunday 8 January 2017 00.01 GMT

Scottish fishermen have uncovered an intriguing way to supplement their income: they have added squid to the menu of marine creatures they regularly pull from the sea. A species normally associated with the warmth of the Mediterranean, rather than the freezing north, may seem an odd addition to their usual catches of cod and haddock. Nevertheless, squid has become a nice little earner for fishing boats from Aberdeen and the Moray Firth in recent years.

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Thirty years ago, squid was a rarity in the North Sea. Today, boats bring back thousands of tonnes a year – though cod and haddock still dominate catches. Nor is this

warm-water addition to northern fish menus a unique feature. Red mullet, sardines and sea bass have also appeared with increasing frequency in North Sea fishermen's nets in recent years. All of them are associated with warmer waters and their appearance is seen by many scientists as a sign that climate change is beginning to have a serious impact on our planet's oceans.

For Scottish lovers of fresh squid, this is good news. However, in many other parts of the world, rising sea temperatures – triggered by climate change – are providing fishing industries and governments with major headaches. Fish are moving hundreds of miles from their old grounds, sometimes out of zones that had been set up to protect them. In other cases, fish are simply disappearing from nets.

Part of the problem has its roots in [past overfishing](#). But now climate change is exacerbating the issue. Last week, [scientists revealed that a vast chunk of ice was set to break away from the Antarctic Larsen C ice shelf](#), while Arctic sea ice extent is now at its lowest level for this time of year since records began.

And if sea temperatures continue to rise, even greater disruption will be caused to fishing stocks. Fishermen will lose their livelihoods and communities will be deprived of their only source of food.

“There is an unambiguous trend,” said marine biologist Andrew Bakun of Miami University. “If you look at the world's fish catches as a whole, you find they are made up, more and more, of warm-water species as opposed to catches in previous years which had more species that were from cooler waters.”

Seafood is the critical source of protein for more than 2.5 billion people today. However, over-exploitation in the past has resulted in a crash in fish stocks, with the result that the world's annual catch is now decreasing by more than 1 million tonnes every year – despite the availability of the latest fishing technology: nets big enough to engulf cathedrals, echo locators, satellite navigation, and powerful engines to drive boats.

Now climate change is making the management of this threatened supply even more difficult. “All the world's oceans are facing intense problems but the problem is going to be particularly serious for tropical countries, which are often underdeveloped and are far less able to maintain sustainable management regimes for their fisheries,” said marine biologist Callum Roberts, of York University.

An example is provided by Bangladesh. Fish gives the nation 60% of its animal protein and is vital to the 16 million Bangladeshis living near the coast, a number that has doubled since the 1980s. However, a study – led by Jose Fernandes, of the Plymouth Marine Laboratory – of two key fish species, Hilsa shad (*Tenualosa ilisha*) and Bombay duck (*Harpadon nehereus*), showed that stocks of both could be devastated by climate change that would affect nutrient flows in coastal waters, ocean temperatures and sea levels.

The introduction of sustainable management measures would offset some of these impacts but stocks still face being cut significantly, the group added. “Both the sea and land environment are changing,” said Fernandes. “The problem is that we know much less about the sea than the land, so it is harder to observe and to intervene.”

Think of the problem as a double whammy, said marine ecologist Malin Pinsky, of Rutgers University, New Jersey. “Fish have already been reduced to low numbers by intense overfishing and that makes them far less able to deal with increasing temperatures or other effects of climate change.”

Pinsky points to the example of the Atlantic cod in the Gulf of Maine. “It has been badly hit by intense overfishing. Now it appears that warmer waters have been reducing survival even further. The trouble is that the fisheries management in the area did not realise this and allowed fishing to continue there at a too high level.”

Managing fish stocks in a warming world is proving to be a particularly thorny problem, he added. “Fish management maps have lines drawn on them but it turns out fish don’t see those lines.”



A school of cod in Norwegian waters. Photograph: Jukka Rapo/Folio Images/Getty Images

As waters warm, fish seek cooler waters and head to higher latitudes, a problem that has also been highlighted in the North Sea. There, closure areas have been set up to protect spawning and nursery grounds of plaice, herring and sandeel from intense fishing. “But if species shift their distribution in response to climate change it is possible

such measures will become less effective in the future,” says a study by a group of scientists led by John Pinnegar, of the government-funded Centre for Environment, Fisheries and Aquaculture Science (Cefas).

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Another example of the problem was highlighted last week by the *New York Times*, which noted that the centre of the US black sea bass population is now found in waters off New Jersey. In the 1990s, it was hundreds of miles further south. Under fishing rules that were laid down then, North Carolina fishermen are still entitled to the largest share of black sea bass catches – which requires them to steam north for 10 hours to reach the black sea bass’s current fishing grounds. By contrast, local New England fishermen are allowed to catch a small fraction of the black sea bass now found in their own neighbourhood and must throw all excess overboard.

The issue has already reached the status of causing international discord, as is revealed through the example of the humble mackerel. “Until recently, mackerel in the Atlantic were fished mainly by Britain, Ireland and Norway and stocks were protected by an EU quota system,” said Roberts. “Then stocks began to head north, most probably because sea temperatures were rising. Eventually, mackerel reached Iceland – at which point Iceland asked to be included in fishing quotas. This request was rejected – so Iceland went ahead and started catching mackerel in any case.”

The result was a drop in mackerel stocks and an international dispute that lasted several years and which has only recently been resolved – though this respite may only be temporary. “Unless we find ways to adapt quota agreements speedily and efficiently, we are going to see a lot more disputes like this one in future,” Roberts said.

This point is highlighted in the study led by Pinnegar, which revealed that anchovy stocks are now spreading along the south coast of England. Talks are taking place to determine whether French or Spanish boats can fish for these – on the grounds that these stocks are extensions of existing populations from the south. Others argue that the new anchovy stocks are a separate population that is only now rebounding in numbers thanks to greatly improved climatic conditions, and that French and Spanish boats should be allowed only restricted access to them. The “anchovy wars” are looming, it would seem.

In addition to overfishing and warming sea temperatures, marine creatures face a further danger: ocean acidification. Increased amounts of carbon dioxide, pumped into the atmosphere from cars and factories, are being absorbed by the oceans, making their waters more acidic. The impact on coral reefs, which provide homes to thousands of different species of fish, is already being felt. Last year, it was reported that a rare underwater heatwave, combined with an increase in ocean acidity, had destroyed swathes of Australia’s Great Barrier Reef.

This has led marine biologists to warn that all coral reefs risk being destroyed by the end of the century even if carbon dioxide emissions are kept to relatively low levels in future decades. Apart from the impact on one of the world's greatest natural wonders, the effect on fish stocks, and in particular shellfish, could be grim. Shells of marine creatures are made from calcium carbonate and their formation is disrupted by acidic water.

An example is provided by oyster farms on the Oregon coast. These farms regularly suffer from upwellings of acidic water from deep regions of the Pacific. When this happens, larval oysters die at the point when they have to form their first shells. "From the time eggs are fertilised, Pacific oyster larvae precipitate roughly 90% of their bodyweight as calcium carbonate shell within 48 hours," George Waldbusser at Oregon State University told the Climate News Network. "They must build their first shell quickly on a limited amount of energy – and, along with the shell, comes the organ to capture external food. It becomes a death race of sorts. Can the oyster build its shell quickly enough to allow its feeding mechanism to develop before it runs out of energy from the egg?"

Increasingly, the answer to this question appears to be no.

This point is summed up by Roberts. "Prawns, lobsters, clams and scallops – which now dominate our intensively fished seas – all lay down carbonate shells. The fishing industry is therefore badly exposed to risk from more acidic seas. Not only that, acidification threatens the important role that filter-feeding shellfish play in cleansing ocean water. Quite frankly, increased acidity is the last thing marine life needs given all of the other ways in which we are making oceans a tougher place to live."



A lobster is processed at the Sea Hag Seafood plant in Maine, US. Photograph: Robert F Bukaty/AP

And then there is question of just how much seafood is actually eaten today. This turns out to be an issue of considerable controversy, one that was stoked last year in a study – by Daniel Pauly and Dirk Zeller of the University of British Columbia – that was published in the Nature Communications online journal. It indicates that the UN's [Food](#) and Agriculture Organisation (FAO) has seriously underestimated the world's appetite for fish and miscalculated global annual catches. The FAO – using figures provided by individual governments – had suggested that annual catches began rising significantly over the 20th century, peaked at 96m tonnes in 1996 and have been declining slowly since then – largely due to the fact that fish stocks had been so seriously overfished.

Pauly and Zeller put the annual “peak fish” figure for 1996 at 130m tonnes while adding that levels have fallen off far more dramatically and worryingly as stocks have become depleted at a rate that is far sharper than realised previously. In other words, far more fish – millions of tonnes – is being taken from the seas than has been recorded by official statistics. This extra annual catch is made up by small-scale and subsistence fisheries and fish thrown back in the sea as discards, according to Pauly and Zeller.

What is particularly worrying about this discovery is the sharp rate of decline of fish catches in recent years. Despite sending out more boats, fitted with advanced fish detection technologies, fishermen are unable to catch as much as they used to.

Nor do Pauly and Zeller anticipate that it will stop. “I expect a continued decline because I don't expect countries to realise the need to rebuild stocks,” Pauly told the *Guardian*. “I don't see African countries, for example, rebuilding their stocks, or being allowed to by the foreign fleets that are working there, because the pressure to continue to fish is very strong. We know how to fix this problem but whether we do it or not depends on conditions that are difficult.”

It is against this grim background that the world's oceans are warming significantly, with temperature rises of several degrees being forecast by the end of the century. Inexorably, fish stocks will be pushed further towards high latitudes, confusing attempts to manage and to protect them, while the make-up of local fisheries will undergo drastic changes. The stress on one of the world's most important resources is going to be intense. The great fish migration has begun.

LINK: <https://www.theguardian.com/environment/2017/jan/08/fish-ocean-warming-migration-sea>