Stretching our **mussels**?

Shellfish could provide the UK with much more healthy, cheap food than they do at present, but concerns about pollution and its possible impact on people's health stand in the way, and environmental change could make the problem worse. Shelagh Malham and James McDonald explain how their research will help.

Mussels and other bivalve shellfish are a nutritious food source. They are high in protein, low in cholesterol and fat, contain numerous vitamins and minerals and are a rich source of Omega-3 fatty acids – an important part of a healthy diet that is linked to better cardiovascular health. Shellfish have been hailed as a sustainable and valuable food source for the future, as the land's capacity to feed our population falls and the world's population increases.

Shellfish farming is also an important commercial activity in estuaries and coastal waters. The UK is a major producer of shellfish, harvesting more than 39,000 tonnes of mussels in 2011. Most of these are exported, with only about 20 per cent eaten in the UK. With better water quality, better site provisioning and more financial support for the industry, the UK could double aquaculture production, boosting this affordable and sustainable supply of nutritious food as well as local industry and livelihoods.

On top of the health benefits of eating mussels, growing and eating more mussels would create jobs harvesting and preparing seafood, as well as distributing and selling it. This would also help make the UK's food supply more secure and less dependent on other countries. Mussels are also important and beneficial members of the marine ecosystem, recycling nutrients, regulating phytoplankton blooms and improving water quality.

But one problem is that shellfish absorb pollutants from the water around them, and if they've grown in the wrong conditions they can cause food poisoning. Environmental change could make this problem worse. Coastal environments will face increased temperatures, heavy rainfall and storms, compounded by coastal development and increased population size, as well as emerging infectious diseases of both shellfish and humans. There are significant challenges in understanding and managing microbial contamination, shellfish safety and future food security.

Bivalves are collected from the wild or from cultivated stocks; they can be grown either on the seabed or on ropes in the water. But there are restrictions on shellfish farming and harvesting due to public health concerns around eating them. Bivalves get food by filtering particles from the water, and some of the coasts and estuaries where they live have poor water quality, containing contaminants that can infect humans such as bacteria and viruses.

People can catch these harmful microbes from eating raw or undercooked shellfish, ending up with food poisoning. Pathogenic bacteria and viruses get into freshwater, estuaries and coastal waters via surface run-off, wildlife excrement, septic tank outputs and storm and sanitary sewer overflows. Once on the loose, they can attach to sediment particles, known as 'flocs' – these are aggregates of organic and inorganic material – which are either deposited in the estuary or are washed down to the coast.

Flocs aren't just isolated reservoirs containing higher concentrations of harmful microbes than the surrounding waters – around seven times more, in some cases. They are also reserves of macro-nutrients – compounds containing carbon, nitrogen and

An estuary full of mussel beds.

Checking water quality on a mussel farm.

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phosphorus that humans need in large quantities. We know very little of what ultimately happens to these nutrients, flocs and associated microbial pathogens in the environment, or how they affect water quality and interact with sediments. Nor do we know how the nutrients affect the viability of microbes as they move through the estuary before reaching the shellfish.

Bivalves' filter-feeding nature means that contaminants, including pathogens, can build up in their tissues, potentially endangering public health. The survival and persistence of microbial pathogens from catchment to coast could be a threat to shellfish food safety.

Many food poisoning cases are caused by water-borne pathogens, including *E. coli* 0157. This can damage both food security and the local economy, whether by harming the fish and shellfish industry's sales, affecting workers' health, causing beaches to lose their blue flag status, or simply generating negative publicity that makes tourists stay away.

Securing safer shellfish

Food safety is strictly regulated, and mussels must be harvested from areas classified under the Food Hygiene Regulations, which use the number of faecal indicator bacteria such as *E. coli* to assess whether an area of shellfish can be harvested. But *E. coli* numbers are only an indicator of microbial pollution; many *E. coli* are harmless to humans, so we need to know more about how many of the bacteria detected in shellfish waters are actually dangerous to us. It's possible we could be safely eating shellfish from areas that are currently considered too polluted.

A new NERC-funded project on macronutrients will let us investigate the impact of pathogens that come from river catchments on human health, tourism and food security, and how these are affected by changes in available nutrients and the weather. Recently Bangor University, working with organisations like the NERC Centre for Ecology & Hydrology and stakeholders such as Conwy County Borough Council, the Environment Agency and Welsh Water, have shown that *E. coli* are found in muddy sediments in rivers and estuaries, and survive up to 6cm deep in the mud. There are also fewer potentially pathogenic bacteria in faster-flowing water.

The research also shows that flocs have higher general bacterial and potential pathogen numbers than either the water or the mud, perhaps because their macronutrient levels increase the chance that bacteria survive the journey from the land to the mussel beds.

Our work will focus on pathogenic microbes. This will involve taking samples of water, flocs and sediment from several places in the river and where the river meets the sea, both from boats and from river banks and other access points. We will then analyse these samples for macronutrients, bacteria and viruses as well as floc size, salinity and the speed of the water.

These field measurements will also be reproduced in the laboratory under controlled conditions to provide more insight into how macronutrients, floc size and salinity affect pathogenic bacteria. Our research will let us estimate how many potential pathogens are going from the land to the river to the mussel beds at the coast. We will investigate these interactions in relation to changing tidal states, nutrient availability and environmental conditions such as rainfall, so that we can produce new policy guidelines on public health risk.

Understanding the effect of macronutrients and flocs on the survival and transport of potentially pathogenic bacteria, both in current conditions and after future environmental change, will lead to more effective regulation, protect commercial food production and contribute to food security. Our project is a major first step in uncovering the interaction between macronutrients and pathogens as they move from fresh river water to estuarine salt water, and will help us sustain this important food resource for the future.

MORE INFORMATION

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