Fishing, pollution and rising temperatures: How marine science can help us save the oceans

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A healthy sea determines the planet's balance and, in turn, the health and well-being of its people. That is why ocean science has never played a

more vital role, helping us to grasp today's deterioration of the world's biggest ecosystem—and find solutions.

As scientists, public and private stakeholders and heads of state prepare to share diagnoses and cures for improving the "patient's" condition at the One Ocean Summit in Brest, France, from 9 to 11 February 2022, Ifremer, the French oceanographic institute invited to the talks, looks at some of the more promising avenues for research.

Mare incognitum

Our home is called Earth, but the name does not fully reflect the reality of a planet where liquid predominates: dry land takes up just under 30% of the globe's surface, while the sea covers the remaining 70%.

The ocean is the world's biggest ecosystem, yet it remains a huge mystery, a mare incognitum. The abyssal zone alone is thought to house up to a million species scientists have yet to document, showing how much we need science to lift the veil on a world that remains an enigma but whose crucial role in determining the health of our planet and its life forms is, in contrast, no longer a mystery.

The oceans are the biggest source of protein for three billion humans and are also responsible for about 50% of the oxygen produced on the planet—not to mention the energy resources they provide and the molecules from their biodiversity that we harvest—for example, for new medicines.

Yet the oceans' virtues are not limited to resources. They are the planet's principal climate-regulator and therefore a vital chain in its proper functioning—a precious role in an age of ever-faster global warming.

But overuse of this regulator has serious consequences on the oceans'

health, with worrying long-term symptoms, including rising water temperatures—even at the bottom of the oceans—an increasingly acidic environment, de-oxygenation and rising sea levels. The "marine carbon pump" has jammed because we have overloaded it. When these troubles combine with the effects of overfishing, pollution and the destruction of habitats, marine biodiversity is eroded and endangered before a full inventory of it has even been made.

To protect our globe's navy blue surface, research in ocean science needs to meet four main challenges: manage resources sustainably, preserve biodiversity, fight pollution, and deal with climate disruption.

Fishing made more sustainable through science

The amount of seafood consumed worldwide has already increased fivefold since the 1960s, due as much to an increase in the world's population as to people's consumption. Around half of this seafood comes from captured wild marine life, showing the share of fishing in the European and global food industry. Forecasts from the FAO and OECD predict that future pressure from demand for fish will be even stronger.

Data from scientific research is crucial to making sense of policy that governs fishing management. Although fishing goals—especially in Europe, through the Common Fisheries Policy—are still far from being met, considerable progress has been made.

In its 2020 report on fish caught in France, Ifremer stated that 60% of French catches come from sustainably exploited marine life populations, compared to only 15% twenty years earlier. But the situation in the Mediterranean, which has persistently been over-fished, remains worrying.

To reverse the trend, Europe introduced an initial multiannual management plan in January 2020. Scientists helped assess different scenarios to implement it.

Similarly, scientific work is underway to improve knowledge and form opinions about fish stocks exploited by fleets in the West Indies, French Guiana, Reunion and Mayotte, with a view to improving systems for managing these resources.

Several examples from recent history show that such emergency plans can put things right. This is well documented by the case of hake in the Bay of Biscay and the Celtic Sea, and of bluefin tuna in the Mediterranean and the Atlantic, whose populations have grown strongly in recent years.

Innovation is also one of the keys to more sustainable fishing. Though humans have come up with ingenious methods for fishing ever bigger catches over the centuries, the time has now come to put quality over quantity by fishing in a better way. That requires being more selective in our use of fishing equipment, and reducing its impact on the marine environment.

One promising path is "deep learning" technology to make fishing nets "smart." The idea is to combine use of video with artificial intelligence so that nets open and close automatically to target only the species sought .

How can we preserve and restore biodiversity?

To protect marine biodiversity, scientific innovation can also help apply policies for preserving fragile habitats and species.

Such innovation can take the form of observatories that help us better

understand ecosystems and track changes in them. For the past ten years, for example, the ocean depths observatory EMSO-Azores has been continuously monitoring a hydrothermal field. Each year, it helps us better grasp the abyssal zone and its species, which are still largely unknown.

Very recently, a new observatory was set up in a submarine canyon off the coast of Brittany. Its role is to study cold-water coral, endangered by human activity.

Researchers are also helping re-introduce certain populations in decline. A project to restore the population of flat oysters, an endangered species, has helped young larvae colonize artificial structures underwater in the Bays of Brest and Quiberon.

Scientists have shown that the ideal environmental conditions for the species are water temperature of 18°C, sufficient salinity, and structures with rough surfaces for bivalves to cling to. The results will underpin management measures needed for flat oysters to return.

Another example would be the Bay of Toulon, where a team of researchers has designed and installed artificial concrete reefs topped with artificial sea grass beds. The aim is to provide small fish with refuges. The fish will be able to grow sheltered from predators, therefore boosting natural populations.

Work is also underway in partnership with the French Development Agency (Agence française de développement) to develop tools that effectively restore coral reefs endangered by periods of bleaching in the Pacific.

Stepping up the fight against pollution

Because there are no closed borders between the sea and dry land, 80% of sea pollution comes from dry land and flows via rivers and coastlines. But thanks to effective public initiatives, especially in wastewater treatment, such pollution can decrease, as we have seen in France, where the quality of the marine environment has clearly been improving for the past thirty years.

The latest results from coastline monitoring reveal improvements on several fronts: chemical pollution, microbiological pollution, microalgae spread, and eutrophication. Yet the need for vigilance remains in some coastal areas and in overseas French territories, which face specific issues (chlordecone, sargassum, ciguatera).

Particular attention has been given to plastic pollution. A recent study showed that eight to 18 million tons of plastic waste end up in the sea each year. This waste is not biodegradable, so it breaks up into microplastics that are five millimeter long or less. Scientists estimate there are 24,400 billion of these fragments in the sea—five times more than we previously thought.

The effects on fauna and flora are far-reaching. Microplastics are a Trojan horse for a microscopic ecosystem of bacteria, viruses, microalgae, and micro-predators, which "board" these plastics like life-rafts. Some invasive species also use this new means of transport to conquer new lands.

This "invasion" has brought about another peril: filtering organisms confuse plastic microparticles and nanoparticles with plankton and ingest them. An experiment on the Crassostrea Gigas Pacific oyster revealed that exposure of these molluscs to polystyrene microparticles and nanoparticles in laboratories affected their reproduction.

Sea pollution is not due to microplastics alone, and the phenomenon is

still largely a mystery. An attempt to better understand the nature of sea pollution and its effects on biodiversity is one of the seven pillars of the "Ocean and Climate" research program, jointly coordinated by Ifremer and France's scientific research institute CNRS.

Avoiding overheating

The ocean has long been ignored as a key factor in the climate equation because of a lack of knowledge about how the marine environment works. Ever since the the international program Argo was founded in the 2000s, it has made the ocean's secrets more fathomable via a network of over 4,000 floats that monitor the sea, virtually in real time. The data they provide has helped marine science take a leap forward.

As researchers put together pieces in the puzzle, we are discovering that the sea softens the blow of climate change. Since the start of the Industrial era, it has absorbed 93% of excess heat from human activities and 30% to 40% of CO_2 in the atmosphere.

This "generosity," however, has a price. Sea temperature reached a record high in 2021, underlining a series of alarming signs about the ocean's health and that of its "inhabitants": sea levels that continue to rise, less oxygen dissolved in seawater, a more acidic sea, and thermal stress for some sealife species. Another sign has been an increase in extreme weather phenomena, which overseas French territories are especially vulnerable to.

Like coral, oysters and mussels, for instance, can suffer from less concentration of calcium carbonate, a chemical compound they need for their shells to form. Researchers have shown that when these molluscs are placed in more acidic conditions, they develop thinner, lighter shells, which suggests less resistance to predators and impacts such as waves or the effects of shellfish farming.

For the first time ever, a scientific project is now studying the combined effects of global warming and acidification on several generations of bivalves in northern Brittany and the Mediterranean.

Developing global governance

Although the international community has only recently become aware of the ocean's vital role in climate issues and biodiversity, this realization is now evident. Ocean science has grown in weight, standing as a requirement in preserving a deteriorating ecosystem.

Signs of this new trend include the development of protected marine zones, the creation of governance structures such as IPBES or the UN Intergovernmental Conference on Marine Biodiversity of Areas Beyond National Jurisdiction, the publication of a special IPCC report on the sea and the cryosphere, and the continuous increase in scientific publications on this subject.

The United Nations Decade of Ocean Science for Sustainable Development announced in 2021 is another major milestone in uniting the world's scientific community, governments, and civil society around a search for transformative changes that can help us preserve the sea and exploit it sustainably.

In October 2021, the One Ocean Science global campaign pursued work toward this same goal by bringing together scientists from 37 research bodies and 33 countries to underline the vital role ocean science must play for us to better understand and protect the sea.

The One Ocean Summit plows this same furrow. It takes place in Brest this week, hosting heads of state and scientists who are experts in these issues, with a shared aim: a sea that is no longer just a source of global concern, but also a gate to fresh solutions.

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