The ocean's twilight zone is filled with life, but there is a big risk of overfishing

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The researchers send a trawl like this 200-1.000 meters into the sea to fish for species and plankton that can make them more aware of the ecosystem in the ocean's twilight zone. Credit: Svanhildur Egilsdóttir, MFRI

Off the coast of Norway, a marine research vessel is on an important mission. A group of researchers aboard the ship are watching closely as a giant steel wire with a fine-meshed trawl net at the end is rolled out. With each rotation, the trawl net is lowered deeper and deeper into the

sea, and somewhere between 200 and 1,000 meters below the surface in what is known as the mesopelagic twilight zone, the wire fully extends and reaches its goal.

Like a large fishing net, it sifts the seawater for living organisms in search of knowledge about a place on Earth that we know less about than outer space.

This North Atlantic deep sea fishing expedition is part of a research project funded by the European Commission. The project aims to investigate whether the fishing industry can target some of the many species found in the mesopelagic zone without repeating the many disasters in fishing history: poor management resulting in overfishing, the destruction of ecosystems, and the collapse of biodiversity.

One of the researchers looking for answers in the project is Professor J. Rasmus Nielsen from the National Institute of Aquatic Resources at DTU Aqua, who processes some of the information collected by the marine research vessels along with his colleagues.

The work of the researchers from DTU Aqua concentrates on two small species of fish, i.e. the glacier lantern fish and Mueller's pearlside, which are attractive to the commercial fishing industry due to their high oil content of between 20 and 30%. These species can be used to make fish oil, fish meal, and medicine, and perhaps even as a food source.

However, according to J. Rasmus Nielsen, we know "virtually nothing" about what consequences fishing for these species may have on the food chain they form part of or what role they play in the overall ecosystem. He has done research, given advice, and taught on the subject of fisheries management and the sustainable use of marine resources his entire adult life, but the mesopelagic zone is largely unknown territory.

"It's both exciting and frightening to be doing research in an area where we know so little. This means that our research is both relevant and necessary, but it's also a huge responsibility," he says and adds:

"The first articles in a virtually unknown area can have a huge impact on later decisions. So we really need to think it through and do work that is both quick and correct."

Vast amount of biomass

The mesopelagic zone is called the twilight zone because it starts at a depth that sunlight can barely penetrate. Above it is the epipelagic zone near the surface, where sunlight supports photosynthesis and growth. However, the light levels in the twilight zone are so low that photosynthesis is virtually non-existent, and scientists have always wanted to know what is going on down there.

During World War II, when the Allied fleets used echo sounders to detect and locate enemy submarines and mines, very hard blows to the echo sounders indicated that an unknown amount of biomass was hiding in the deep sea. The size of this biomass has been widely discussed, but in 2014 a large international study gained everyone's attention with a mind-blowing estimate.

Based on global mapping, the researchers behind the study estimated that the mesopelagic zone is home to a biomass of between 10 and 20 billion tons of fish and shellfish. This is a volume 10 times greater than in previous estimates and corresponds to 90 percent of Earth's total fish biomass or, at the time of the study, about 1.3 tons of fish biomass per human on Earth.

"Obviously, those numbers attracted a lot of attention. And soon a number of interested parties were asking the next question: Can this be

exploited?" says J. Rasmus Nielsen.

Although there was, and still is, great uncertainty about the numbers in the study, they gave rise to a kind of gold rush atmosphere, particularly among the fishing, pharmaceutical, and food industries, which immediately saw an opportunity for an new business adventure.

At the same time, researchers from DTU, Norway, Spain, England, Scotland, and Portugal warned people not to exploit the resources in the mesopelagic zone without knowing the possible environmental consequences.

The animals and organisms living in the twilight zone have a huge impact on the planet's carbon balance, as every year they help move between 2 and 6 billion tons of carbon from the surface of the sea to the bottom of the ocean, where it is stored for hundreds of years.

This process is known as the biological carbon pump, and the risk of negatively affecting this natural process by ceaselessly fishing for the species that are a part of it are great.

The researchers therefore called for international research into the biology and sustainability of the twilight zone species, and this was a decisive factor to the research that J. Rasmus Nielsen and his colleagues are doing today.

Knowledge about stocks is crucial

When brand new data on the glacier lantern fish or Mueller's pearlside lands on J. Rasmus Nielsen's desk, there is one aspect in particular that he and his colleagues are interested in: the stocks of the species and the dynamics of the stocks.

"When we know the dynamics of a natural stock, we also know the surplus amount produced and thus how much we can sustainably take from the stock," says J. Rasmus Nielsen.

Here is an example of what the trawl brings back to the surface. Credit: Webjørn Melle, Institute of Marine Research, Norway.

Specifically, he and his colleagues assess the distribution of length, weight, and the different life stages of the fish coming in from the various research locations in Spain, Norway, and Iceland. They use the data from each location to determine the growth and the different life stages of the fish.

This provides an overall picture of when the fish mature and spawn, and with the help of statistical stock models, the researchers can use this

information to assess the size of the stock and its capacity for reproduction. In addition, differences in growth and mortality rates can help clarify whether or not the fish from the different locations are from the same stock.

"The same stock usually has roughly the same rates, so if there's a big difference in the rates between, for example, the fish from Norway and the fish from Spain, it's a good indication that they're from different stocks," says J. Rasmus Nielsen.

The preliminary results from the ongoing research show that the rates do vary between the different research fishing locations and thus that the fish are most likely from different stocks. The next step is identifying the stocks that can stand sustainable fishing and those that cannot.

J. Rasmus Nielsen expects in-depth knowledge about the stock dynamics to be ready some time in the next 10 years. At the same time, he knows that it is very unlikely that the industry will wait that long.

"We need to act quickly, because if it suddenly turns out that there is a high-value product down there, they're just going to go for it," he says.

Sustainable food for the future

So far, it looks like he is right in his prediction. The commercial fishing industry is already showing a great interest in the research.

SINTEF, an independent research institute in Norway, has already made headway in developing efficient commercial fishing gear for catching glacier lantern fish and Mueller's pearlside. And Norwegian Food Institute, Nofima, is experimenting on how to make Mueller's pearlside an attractive food item for the future.

"We inject the fish with different enzymes to find out what happens to the taste, and then we look at whether we can come up with something that's commercially interesting," says Runar G. Solstad, who conducts research in the field of marine biotechnology and is affiliated with the EU project.

The injection is called enzymatic hydrolysis and is a chemical process where equal parts fish and water are mixed together and then enzymes are added. Once the enzymes have reacted with the mixture for about an hour, they are deactivated using heat and the water is filtered out so that only the protein remains. After that, they are dried and eaten as a protein-rich snack.

The ongoing experiments with Mueller's pearlside have shown that it is possible to infuse the fish with different flavors, and the next step is therefore an external assessment of whether the twilight zone snack has commercial potential.

"That's the whole point of this research. If it turns out that we can harvest these mesopelagic resources sustainably, and if it turns out that they're nutritious and can be used for food, then we may have a sustainable food source for the future, and then it makes a lot of sense to move forward with it," says Runar G. Solstad about the future perspective of the ongoing research.

J. Rasmus Nielsen is less optimistic, but that does not mean that he is against utilizing these resources.

"I'm certainly not saying you shouldn't look into it. We live in a world where the global population is growing. We will have food shortages. We need to look into our options for food production. But you can't look at the sea as a piece of agricultural land where you can just increase production. And you can't remove parts of the food chain and hope that

the system will compensate for the loss. Because that's not how it works," he says.

Overfishing affects marine ecosystems

According to J. Rasmus Nielsen, the UN currently does not have sufficient regional management bodies covering mesopelagic fishing, and there are no quotas limiting fishing from individual stocks.

Therefore, J. Rasmus Nielsen and other researchers are working to inform managers and authorities about the need for this, e.g. through their participation in the EU project. Most recently, J. Rasmus Nielsen co-authored an article on the subject.

"We shouldn't touch this until we've established whether the fishing is sustainable and until we have the right institutional setup and the right management agencies that are able to act if people overexploit the resources," he says.

Through his many years of research and advice on fisheries management, he has witnessed the risks and examples of overexploitation in the fishing industry. The result is usually that we lose large fishing and income opportunities due to poor management, and at the same time it negatively affects marine ecosystems.

Therefore, J. Rasmus Nielsen's work with the mesopelagic zone is more than just a job. It is a chance to pave the way for the sustainable fishing industry of tomorrow.

"I hope that this time we can prevent people from repeating the fishing mistakes of the past. That's my biggest hope. But it will take knowledge," he says.

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