INSTITUTE OF MARINE RESEARCH

2020/2021

Norway is leading the way on marine resource management, and our waters are home to some of the world's biggest fish stocks. The Institute of Marine Research (IMR) is the leading centre of marine expertise in Norway, and we are constantly expanding our monitoring and advisory activities. Our annual surveys are at the very heart of what we do. Amongst other things, they allow us to expand our unique time series.

The oldest series are over 100 years old, and they provide input to ongoing climate research and resource management – both in Norway and internationally. The IMR does research on the deepest oceans, shallow coastal waters, what's on people's dinner plates and even what happens in their hearts! The big picture is key in reaching the Sustainable Development Goals. We believe that our knowledge and expertise should benefit the rest of the world – we are glad that more and more people want to learn from us.

If the world's growing population is to have enough, nutritious food without depleting the oceans – we must work together to find permanent solutions. The IMR can make a real difference in this area.

Professor Sissel Rogne,
Director of the Institute of Marine Research

Studying the environmental impacts of delousing agents

The chemicals used to deal with salmon lice at fish farms may have undesirable impacts on wild animals and plants. Researchers are working hard to discover how delousing agents affect other species.

New laboratory experiments show that small concentrations of hydrogen peroxide may harm sugar kelp. Five percent of the treatment dose for salmon proved to be deadly for a lot of the kelp. The study does not say whether these concentrations can reach kelp around a sea cage in nature, but the findings will be added to our bank of knowledge on the environmental impacts of delousing agents. The IMR is also developing models for how these chemicals disperse in the sea.

SALMON LICE LIMIT THE AQUACULTURE INDUSTRY – WE MONITOR THEM

Our model for the spread of salmon lice is a key piece in the traffic light system that determines the growth of the Norwegian aquaculture industry. The model incorporates the number of salmon lice on fish reported by fish farms, and what we know about salmon lice biology and sea currents. It then estimates how many infectious lice there are along the coast at any given time. To check how well the model corresponds to reality, marine scientists count the number of lice on wild fish during the summer.

REINVENTING THE SEA CAGE

In a snorkel cage, a net roof at a depth of 20 metres stops salmon from swimming in the same water layer as the salmon lice. The salmon can top up the air in their swim bladders by swimming up a tube, or snorkel, that goes up to the surface. In tests, the number of lice on salmon was reduced by 75 percent, with 43 percent fewer delousing operations on cages.

The search for sustainable food

There is huge potential to produce more food in the ocean, and the further down the food chain we go, the bigger the potential. Low trophic level species such as kelp and mussels are some of the most sustainable food sources. Mussels contain nutrients like protein and iodine, and they feed themselves from sea water. In recent decades, we have made great strides in our understanding of how to farm them. New models of currents and nutrients put marine scientists in a better position to advise on suitable coastal areas for mussel farming.

Meanwhile, the coast of southern Norway is being invaded by the Pacific oyster. This oyster is an unwanted species, but it can become a resource. Researchers have found several potential uses: as a delicacy harvested by fishers or gastro-tourists; or as a raw ingredient in animal feed, soil improver, quicklime and foundation in road building.

WHOLE SMALL FISH ARE SURPRISINGLY NUTRITIOUS

Finding new types of food is not the only way to feed a growing population. We must also become better at using all of the raw ingredients we already have. As well as being more sustainable, it may be good for us.

Researchers at the IMR have analysed smoked anchovies and sardines from fish markets in Ghana. These small fish, which are eaten whole, contain surprising amounts of vitamins, omega-3 fatty acids and minerals. The sources of these nutrients include the head and bones.

MONITORING SEAFOOD

Each year, the IMR tests samples from almost 14,000 farmed fish for toxins. We check that the feed given to fish doesn't contain anything dangerous, and make sure that the fish are getting the nutrients they need. We monitor toxins in bivalves and wild fish to make sure that the food we eat is safe. New species being used for food, such as kelp, are also examined.

SAFE AND HEALTHY SEAFOOD

A look back on 2019

In January, the IMR led a major international expedition to Antarctica on the new vessel Kronprins Haakon. *The main aim was to ascertain the quantity of krill in the fishing zone in the Southern Ocean, where Norway is the leading krill harvesting nation. The researchers also recorded the number of predators such as penguins, seals and whales, and estimated how much krill they need.*

The conference Science for Ocean Actions gathered 150 marine experts from over 50 countries in Bergen. They were asked to come up with specific measures to deal with the biggest challenges facing the ocean. The final report was presented to Prime Minister Erna Solberg in March 2019.

New experiments show that farmed salmon display signs of pain when deloused in warmed water. This method has become a common alternative to using delousing agents. The Norwegian Food Safety Authority has signalled that the method should be phased out.

The IMR led an expedition to the sunken Russian nuclear submarine Komsomolets *in the Norwegian Sea. Using the ROV* Ægir, *researchers were able to confirm that there is a radioactive leak from a ventilation pipe in the wreck. The leak is small and doesn't pose a risk to people or the environment.*

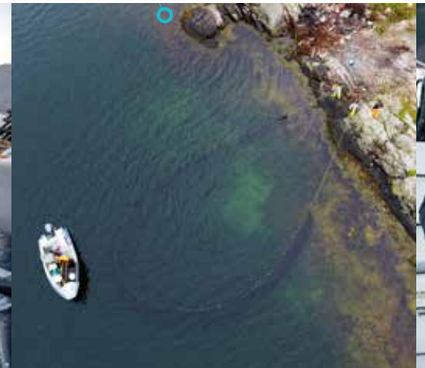
The large pelagic fish stocks in the Norwegian Sea are economically important. For 2020, our marine scientists advised a mackerel fishery of up to 922,000 tonnes. For Norwegian spring spawning herring, the recommended quota was up to 525,000 tonnes.

Two of our summer interns were bright orange saildrones from Silicon Valley, weighing 750 kg each. We sent them on a mission to the North Sea to examine their potential as affordable and eco-friendly data collectors. The saildrones are equipped with scientific echo sounders and use wind and solar power to follow programmed transects.

In April, our scientists took over the famous Bergen restaurant Lysverket for one evening. On the menu there were little known, unused delicacies from the sea that can become part of Norwegian food culture in the future. The trained chefs prepared the food, while the scientists served up both the food and stories about it.

In early summer, a harmful algal bloom killed large numbers of farmed salmon in the northern counties of Nordland and Troms. For two weeks, scientists from the IMR worked closely with the authorities and fish farmers to monitor the marine environment and predict the spread of the algal bloom. This made it possible to evacuate some fish.

Skagerrak: Big cohorts of newly hatched cod larvae are not reflected in the cod population the following year. Food shortages may be a factor. Gobies and small shrimps are the favourite foods of juvenile cod. In 1999, researchers caught 50,000 of them in their beach seine. In their most recent beach seine haul, they caught only 500.



The central bank of Norway, Norges Bank, launched the new one thousand kroner note on board the research vessel Johan Hjort *in Bergen. The wave on the banknote illustrates how the sea is a driving force for, and counterforce to, Norway's progress.*

Geir Ottersen of the IMR is one of the lead authors of the IPCC special report on the ocean and cryosphere, which warns of the dangers of ocean warming. Sea levels are rising faster than expected due to land ice melting in the High North. One of the consequences of this is that the Polar cod is struggling. It spawns under the shrinking sea ice.

Over 60 million tonnes of krill

That's the marine scientists' estimate of the stock in the Southern Ocean fishing zone. The estimate is a result of the first international krill survey in Antarctica in 19 years. The IMR led the survey by the brand new icebreaker, research vessel *Kronprins Haakon*. As the leading krill fishing nation in the Southern Ocean, Norway also has a responsibility to monitor the unique resources found there.

OBSERVE FISH THROUGH UPS AND DOWNS

Each year, the IMR advises the authorities on the sustainable harvest of 22 fish stocks, five shellfish stocks and five sea mammal stocks.

To estimate how much fish there is in the sea, we need good time series – credible data that goes far back in time. One source of that is our surveys. In 2019 we spent 2,600 days at sea on our own and on leased vessels. We often sail on set routes, "counting" fish using an echo sounder. We trawl for fish at fixed stations to find the quantity of young and old individuals. The age of the fish is important to determine how stocks will develop in future years.

THE SNOW CRAB IS MIGRATING HERE

In addition to the well-known fishery resources, there are also some quite new ones: the snow crab has probably migrated into our waters of its own accord. The population has increased significantly since 2010. Researchers believe that it is now present in all suitable habitats on the Norwegian continental shelf in the Barents Sea. The IMR issued its fourth quota recommendation for the species in 2020, of up to 5,500 tonnes.

Sound also pollutes

The oceans are not only being contaminated by toxins and heavy metals. Seas such as the North Sea are full of sound pollution caused by shipping, blasting, construction, wind turbines and seismic surveys to locate oil.

Fish and sea mammals can be affected because they use their hearing to locate food, mates and enemies. We therefore evaluate the possible harmful impacts of human noise in our advice to the authorities. For the moment, the IMR advises against offshore wind farms in the spawning grounds of important fish stocks and seismic surveys during their spawning seasons.

CONCERN ABOUT THE WARMING OF THE HIGH NORTH

Geir Ottersen is one of the lead authors of the IPCC special report on the ocean and cryosphere. It brings together all of the available information on sea level rise, ice melt, changes in ecosystems and ocean acidification.

Climate change is already well underway, and it is occurring faster than previously thought. The researchers are particularly concerned about the High North. Species that have adapted to the environment at the ice edge over thousands of years are struggling since the ice edge is now on the move.

FØRDEFJORDEN: **DOCUMENTING CONDITIONS BEFORE WASTE DISPOSAL**

The IMR has advised against depositing mine tailings in Førdefjorden, most recently in 2019. But if the mining plans do go ahead, we want to use the opportunity to learn more about the potential impacts. Marine scientists have therefore taken a snapshot of the "before" conditions in the fjord by taking samples of tusk, cod, langoustines and mussels. They found low levels of toxins in line with typical values for coastal areas.

The Institute of Marine Research

Funding:
Of our revenues of around NOK 1,627 million in 2019, over 1,059 million came from the Ministry of Trade, Industry and Fisheries. Just under NOK 564 million came from the Research Council of Norway, the EU and other bodies that fund research.

Who we are:
The Institute of Marine Research has a total of 1,076 employees: 673 at our head office in Bergen, 76 in Tromsø, 43 at the Flødevigen research station, 44 at the Austevoll research station, and 40 at the Matre research station. In addition, we employ 200 sailors.

Vessels:
The Institute of Marine Research's vessel department crews and operates *G.O. Sars, Johan Hjort, G.M. Dannevig* and *Kristine Bonnevie*, as well as *Hans Brattström* (owned by the University of Bergen), *Dr. Fridtjof Nansen* (owned by Norad) and *Kronprins Haakon* (owned by the Norwegian Polar Institute). The 36 fishing vessels in the reference fleet also supply us with fishing data on a regular basis.

Laboratories:
The Institute of Marine Research has ten laboratories. Six of them are in Bergen, and the others are at our research stations.

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Photos by Erling Svensen (under water on front page, kelp on p. 2, polar cod p. 7), Paul S. Amundsen (portrait of Sissel Rogne p. 2, Rogne and Solberg p. 6), Peter Tubaas (p. 3), Oda Linnea Brekke Iden (Antarctica on front page, p. 6 and 9), Per Eide (purse seine p. 7), Michael Ulriksen (dead salmon p. 6), Øyvind Gravås/Equinor (offshore wind turbines p. 11). Remaining photos by the IMR.

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