Nancy: It's the spring of 1864, and a new kind of fishing vessel is heading north along the Norwegian coast to Finnmark, Norway's northernmost county. The ship is owned and captained by a 55-year-old Norwegian sealer turned whaler named Svend Foyn. His ship is named Spes & Fides, Latin for Hope and Faith. Foyn has hope and faith, but as history has shown, his technological triumphs have been disastrous for whales.

Bristling from the bow of the ship are seven brand new harpoon guns that he himself designed. Unlike the harpoons that had been used by whalers in the past, this design is an

Jennifer: exploding harpoon, so that you can kill the whale really quickly.

Nancy: In spite of the lethal nature of these harpoons, things didn't go that well. There was a rope attached to the harpoon, of course. But when the first harpoon was fired, the rope wrapped itself around Foyn's foot, and tightened as the whale sounded.

Foyn disappeared overboard in a flash.

It looked as if this first experiment would be his last.

But somehow when the whale resurfaced, the line went slack. Foyn, shaken but alive, swam back to the boat. "Damn, I thought the captain drowned!" one of the cabin boys yelled.

Nancy: Foyn caught just 3 whales that season, and spent the next three years perfecting his harpoon. There were more mishaps along the way. At one point, when the crew harpooned a whale, they missed the vital organs and the whale, very much alive, took the Spes & Fides for a 12 hour long ride in a stiff gale before Foyn ordered the line be cut. But by 1868, the exploding harpoon was a success. Instead of three whales that season, Foyn caught 30. In fact, historians date the modern age of whaling to this time.

Jennifer: Our "good friend" Svend Foyn began with a real package of inventions that made whaling in the modern era doable.
So it's a big advance over the sort of Moby Dick stuff that we all know about from the Herman Melville era.

Nancy: These inventions were so effective that by the 1960s, many whale populations worldwide had been driven to the brink of extinction. Technology, courtesy of Norway's Svend Foyn, drove this awful trend. The question now is, can technology help save them?

Cue podcast music

Nancy: I'm Nancy Bazilchuk, and you're listening to 63 degrees North, an original podcast from NTNU, the Norwegian University of Science and Technology.

Whales are the largest living mammals on Earth. They have been hunted over the centuries, and most populations are now endangered.

So how can technology be harnessed to help us protect whales so their populations can recover?

Today, I'm going to tell you two related stories that answer that exact question. One is about an underwater fibre optic cable strung between two remote locations on Svalbard, the Norwegian high-arctic archipelago, with two post-doctoral researchers sitting and combing through 250 Terabytes of data for a whole summer —without seeing an actual physical whale. The second is about a researcher who has travelled around the globe cataloging whale dialects so they can be used, in combination with Artificial Intelligence, to help prevent ship strikes in heavily travelled shipping lanes.

And we'll let the whales do some talking too.

But first, a little more about the history of whaling and why whales were worth hunting nearly to extinction. Because it turns out that Norway, above and beyond the inventive Svend Foyn, played a huge role in this history as well.

Jennifer: Let's start with the turn of the 20th century. So you're talking about the birth of the really big modern whaling industry....The objective here is whale oil, and it has multiple number of uses in a highly industrialized society.

Nancy: That's

Jennifer: Jennifer L. Bailey, I'm professor of political science at the Norwegian University of Science and Technology in the department of sociology and political science.

Jennifer: It's very good as lubrication. So back in the 70s, when the American anti whaling movement was getting going, the US Department of Commerce had to ask the US Navy, for example, whether there were substitutes for some of the uses of sperm oil in submarines. So there was at least a question raised about the defence applications of this highly useful lubricant.

In modern days, a lot of it is used for food oils, of fats, particularly after World War Two, when there was a worldwide shortage of fats and oils. And suddenly, you needed a lot of fats and oils very quickly. And of course, a lot of the livestock were killed off during the Second World War. So there was a real worldwide need for whaling and that kick started or really helped the whaling industry, which obviously had been depressed by the Second World War to really come on board again, and also led to the modern movement against whaling.

Nancy: But eventually, Norway also recognized that you couldn't simply take whales indefinitely without irreversibly destroying whaling stocks.

Jennifer: As you look at the increase in the number of whales, particularly from the south between, like 1904, and the late 20s, you see, Norway also being a leader and beginning to say that maybe we should put some controls on the takes of whales. Now, a lot of this has to do with the fact that there's an overproduction of whale oil, particularly as you get into the depression. So you have a lot of whale catchers, and a lot of production of whale oil, but a flooding of the market. So Norway starts to actually be taking the lead and trying to reduce the amount of whale oil on the market, if not the number of whales taken.

Nancy: The International Whaling Commission, the IWC, was established in 1946, right after the end of the Second World War, when there's lots of pressure on whaling stocks, as Jennifer explained. But eventually, given the intense hunting and the development of alternative products, as well as the growing environmental movement, whales became less important commercially. Eventually, in 1982, the Commission proposed a ban on all commercial whaling. Norway protested against the ban because they felt the science behind it was weak.

Jennifer: So what is Norway doing today? Norway is whaling under objection. When the moratorium is adopted, different countries could register an objection because the International Whaling Commission is an international organization and countries retain sovereignty. Norway said, we object to this. They voluntarily stopped commercial whaling for a few years and did some research. And then when they resumed whaling, it was only whaling within the Norwegian 200 mile economic zone. And it was only the Minke whale which is the smallest whale. And they used an algorithm approved by the science committee of the IWC to establish that it be done in a sustainable manner.

Nancy: We'll leave the debate about whether or not it's right for Norway to continue hunting Minke whales to another podcast. Needless to say, most whale populations are so critically low they need help.

And that brings us back to the role that new technologies can play in boosting whale populations, now that they are protected.

Martin: We had this project where we wanted to study the effect of seismic acoustic on whales on marine mammals. In Norway, the main focus has up to then been very much in fish.

Nancy: That's Martin Landrø, a geophysicist at NTNU's Department of Electronic Systems.

He's spent a lot of his career figuring out how to study what's going on under the seabed. Sometimes it's to help petroleum geologists find oil, or to learn more about other geological processes, like plate tectonics. That's the driving process behind earthquakes, volcanoes and mountain building.

One way geophysicists study what's under the sea is by doing something called seismic surveys: They set off explosions in the water using something called airguns and measure how long it takes for the sound to return to the hydrophones strung out behind the boat. Different materials under the seafloor — like, say, porous sandstone filled with petroleum — have different sound signatures. Geophysicists can analyse these signals and figure out what's down there. It's kind of like taking an ultrasound of the ocean bottom.

Nancy: The problem is that these airgun explosions aren't necessarily that nice for the creatures that live in the ocean. So Martin was asked to find out how seismic surveys would affect blue whales because…

Martin: blue whales are communicating in the same frequency range as the seismic

Martin: So they're talking the same language. It's the frequencies between, say, five to 80 Hertz. That's where the blue whales like to talk. So they are bass, they're talking with a very deep voice. So, they are special in that sense. Humpback whales, for instance, they can be quite deep, but they can also go into the kilohertz range, like you and me when we are talking. But blue whales, they are very low frequency.

Nancy: So he headed to Iceland to listen in on blue whales that are known to feed in a bay in northeastern Iceland, called Husavik.

Unfortunately, the blue whales didn't cooperate. Humpbacks, yes, blue whales, no.

Martin: So we got a lot of nice photos of humpback whales and recording of humpback whales, but that was not the purpose.

Nancy: And then he had an a-ha moment.

It turns out at the same time, Martin was experimenting with fibre optic cables to see how well they could pick up sounds from the Earth, from a distance. Remember, he's a geophysicist who is trying to listen to the planet in as many ways as he can. Fibre optic cables are the thin glass fibers that are the backbone of modern internet communication. They transmit information in the form of light. But Martin realized they could also be used to collect other information.

Martin: that's when I got this idea that this can be used for listening to whales.

Nancy: Martin does some experiments in Trondheim fjord to see how good the technology is at picking up sounds in the ocean. He finds a fiber optic cable that extends out to Rissa, about 50 km from Trondheim, out towards the coast.

Martin: We did a small test where we went out with Gunnerus, the University vessel. We had a small small acoustic source on board and we kind of traversed along the fibre.

Martin:Like for seismic, but much weaker, it was not an airgun. It was a source that is just doing a bit higher than this (SNAPS FINGERS) I would say.

Martin: And then we were able to see that even a fairly weak signal was detectable on this cable.

Nancy: And then...the COVID-19 shutdown happened. In Norway, this was March 12, 2020.

Nancy: But talk about turning lemons into lemonade! After some hunting around to find a fiber optic setup in a place where there would be whales, Martin realized that there was a cable in Svalbard that linked the main town, Longyearbyen, to a little research community about 120 km away, called Ny-Ålesund.

And because, well, of COVID, some of the equipment he needed to borrow wasn't in high demand.

One particular piece of equipment has the rather alarming name of "interrogator." And the main job of the interrogator is to send a laser beam through the fiber optic cable and measure the light that comes back. The whole system, the interrogator and the fibre optic cable, is called Distributed Acoustic Sensing, or if you're a scientist, DAS.

So how does that help us detect whale sounds? Martin explains.

Martin: So, distributed acoustic sensing means that you're listening to sound using light that you send in a glass fibre. These fibres are what you are using every day, watching our television, communicating, we use fibre a lot.

And these types of fibre, we can also use to listen to sound.... And the principle is that when the laser light hits small impurities or inhomogeneities in the fibre, some of the light, a very small percentage will be scattered back.

Nancy: So the researchers aren't actually listening to sound, but are measuring how a sound causes a fibre to move, just a teeny bit.

Martin: When you have a strong or weaker signal that hits the fibre, these small inhomogeneities, they move a bit, and you're able to measure that small movement, which is a stretch or a strain. So the measure is a strain in the fibre.

Once you have something that is changing; a person walking by, a whale, or an explosion, or a ship, that will create a strain change in the fibre. And that we can measure down to a position of nanometers. So it's very precise, because we use light to measure this.

Nancy: While the technology isn't new, it has developed rapidly over the past five years. And because it is very precise, a fibre optic cable can measure sound along distances of up to 220 kilometres.

Nancy: Martin was able to collect 40 days of data from the Svalbard set up in the summer of 2020. It generated an enormous amount of information — 7 Terabytes a day. So he set two postdoctoral researchers working on this project. One of them was

Léa: Léa Bouffaut.

Nancy: Léa is French, and did her PhD at the Naval Academy Research Institute in Brest, France. She studied Antarctic Blue Whales in the Indian Ocean, and came to NTNU to work with Martin.

Léa: Initially we were working on the impact of air guns on the behaviour of marine mammals. Well, turns out we had DAS and this fibre optic work to start with, and this is mostly what we've been doing.

Nancy: and here is some of what they heard

PLAY WHALE SOUNDS

Nancy: So how do they know this is actually a whale?

Léa: I get this question a lot actually, even from bioacousticians, like, how do you know this is a whale?.... I always tell them if you don't think about technology, how do you know it's a whale when you've recorded from a hydrophone? From frequency, from the pattern, from the repetition, from when you listen to it. And, you know, like, and the literature, ...you look for patterns that are known initially, at least initially.

Nancy: During 40 days of listening in on these signals picked up by the fibre optic cable, the researchers identified hundreds of different sounds. A lot of them were caused by storms, earthquakes and ships passing over or near the cable. But one day, Lea hears what she has been waiting for.

Léa:I think the day I knew I had a blue whale stereotyped signal, these are the one that you cannot be wrong about. And you know what it is when you see them? I was just like, Well, that's it. That's it. Like, that's, that's what we were looking for. At this moment, I was like, This is my happiest day.

Martin:I think it's the first time that DAS has been used to listen to blue whales.

Nancy: So how does eavesdropping on whales help protect them? Well, most whale species are critically endangered, as we know. It’s really hard to track their numbers, because there aren’t a lot of them to begin with, and they live in the ocean. Yes, you can go on cruises and deploy hydrophones,you can monitor them from the air, you can attach tags to them, but all of these approaches have their limitations.

But here’s the thing: right now, there are more than 1.2 million kilometers of fibre optic cables that have been laid in all the world’s oceans. So this is a potential global network!

Léa: The fact that fibre optic cables are all around the world, it makes them accessible. So there are hurdles, they belong to companies you need agreements. For now, the interrogator is still quite expensive.

Nancy: Remember, the interrogator is the gadget that sends the laser signal through the fibre optic cable.

Lea: But in the long run, it gives access to a wide variety of scientists, it gives them access to in situ recordings. And I think this is very important, because whales, well, when we talk about whales, which is what I'm interested in, they are migratory species.

Nancy: Léa points out that whales don’t recognize international boundaries. So it doesn’t help if only a few countries try to protect them if they spend half the year in areas where they are not so protected. That means we need to know lots more about their movements over the course of the year. Or what about in the Arctic, where whales already spend a lot of their time? What happens as the Arctic gets warmer?

Léa: Svalbard is a perfect example. It is changing very fast. And both animal use of this area and human use of the area is changing as basically as fast as the ice melts. And those species like what we call baleen whales, the large whale such as Blue Whales and fin whales, and maybe humpbacks and sei whales, they're not year long residents of that location, but because the ice is melting away, those species have been seen to go every year more up north there. So we're talking about a poleward shift of a lot of baleen whale species. And they might actually at some point come there all year round. There are already evidences that fin whales do stay around quite a long time of the year. Longer than before.

And so at the same time, our use is changing of those locations we have with the ice melting, there are discussions about across Arctic shipping routes, that would be year long shipping routes. But if those species are changing, and maybe using this area for more than for foraging or for activities where they're very vulnerable, then having this type of technology can help us.

Nancy: Martin and his colleagues are still working with this idea — in fact, this year they have nearly real-time monitoring of that stretch of cable to see what they can see.

The idea is that at some point this Arctic fibre optic cable network could allow real-time detection of whales. As more and more ships travel to the Arctic, whether for transport or with tourists, that information could be used to warn ships away from where the whales are. Because with the moratorium on whaling, one of the major causes of whale mortality is by being struck by ships.

And that's where another NTNU researcher comes into the picture.

Ana: My name is Ana Sirovic. And I'm an associate professor at the Norwegian University of Science and Technology.

Ana: So the Benioff Ocean Initiative was looking for manageable conservation problems to try to help and resolve and that's how Whale Safe came about. The goal of the project is to reduce the risk of ship strikes to large baleen whales.

Nancy: Baleen whales are whales that have baleen in their mouths instead of teeth, which they use to filter krill out of the water.

Ana: And Whale Safe is a tool that uses a variety of inputs, one of which is acoustic input, to provide information on the likelihood of whale presence in shipping lanes off the US West Coast off of California.

Nancy: One of the key pieces of information that Ana was able to bring to this project was an extensive library of whale calls, because much of her research has been in the Pacific. Turns out whales have their own dialects!

Nancy: The west coast of California is home to the busiest port in all of the US, the Port of Los Angeles. It's estimated that about 80 whales, mostly blue, fin and humpback whales, are killed every year in this area because of ship strikes. That may not seem like a lot, but there are only an estimated 10000 to 25000 blue whales in the whole world.

Humpback WHALE call

Ana: We started this project about three years ago. And two years ago, the first setup went operational. I'm part of a team with Mark Baumgartner of Woods Hole Oceanographic Institution, and he had developed buoys that send near real time data to provide information on presence of calling whales.

Ana:Mark had developed this tool that worked on the East Coast of the United States and while some of the species are similar on the west coast, the calls that they produce are very different, they each have their own dialect. So we had to adapt his AI tools, his automated detector tools to work on those new dialects.

And I had spent a lot of time working on the species on the in the Pacific. And so we combined our libraries, and allowed it to annotate and kind of learn how to detect those calls. So now, the process is not fully automated, we still have an analyst who reviews those data every day and verifies that there is in fact, whale present calling, because we don't want to be the boy who's crying wolf, right? You want to make sure that if you're telling ships that they need to slow down that there are whales there.

Nancy: Ana has only been at NTNU since 2021, so she's just getting started listening to the waters off of Norway.

Ana: I think Norway is a super exciting place to be for bioacoustics because there's such a long coastline and so much diversity along the coastline. And there has been relatively little effort To collect recordings along this whole area, the I think there's there's currently there's a lot of increased awareness about noise and the impact of noise on marine life. And, and that's where there's a lot of funding that I see coming. So I will have two projects starting next year to look at impacts of various aspects of anthropogenic sounds on different parts of the marine ecosystem and zooplankton and fish. But also, I'm personally interested in these long term changes that are happening in our ecosystems everywhere. And so starting a library, long term library of underwater recordings, I think is really going to be a valuable thing.

Nancy: Like Léa, Ana sees the value of being able to keep an eye on what is happening to the creatures living in the oceans as the climate changes over the next decades. Ana says a long term library of recordings is a little like saving audio snapshots of the past. They can remind us of how the oceans have changed over time.

Ana: Acoustics are a very good tool for getting long term records. And I keep coming back to this theme of long term records. But I think we're at this point now where we're experiencing so many changes in our environment. And it's very easy to forget how things were. Because you forget, and having long term records will allow us to go back and then compare how things are today versus how they were 10 or 15 or more years ago, and I think we'll need records like that to actually keep reminding ourselves of where we're going and how the planet is changing. And if I can actually add one more thing. The cool thing about it is we know so little about underwater sounds that just about anytime I put a recorder in a new place, I hear something that just is wild and amazing and that i've never heard before and I usually have no idea what's making that sound. But I think it's really exciting that there's still so much to explore and learn.

Nancy: And what of Svend Foyn, whose fiendish technologies made whaling so efficient? By 1881, Foyn, who suffered from rheumatism, liked to spend time in the baths in Sandefjord. He was at this point a wealthy man, 72 years old, with no children. When a competing whaling company was established in Sandefjord at that time, Foyn decided to invest. And the name of the company ? "Haabet" — The Hope.

I don't think I can end an episode on whales without quoting from the great American writer, Herman Melville, and his novel, Moby-Dick. Even though the book is really about one man's obsessive pursuit of a whale that crippled him, it's also a treatise on the ocean itself, on whales, on the environment and much more. Melville could have spoken for many a curious acoustician when he wrote: "There is, one knows not what sweet mystery about this sea, whose gently awful stirrings seem to speak of some hidden soul beneath."

Nancy: I'm Nancy Bazilchuk, and you've been listening to 63 Degrees North, an original podcast from the Norwegian University of Science and Technology.

My guests on today's episode were Martin Landrø, Jennifer Bailey, Léa Bouffaut and Ana Širović. If you want to know more about the research discussed in this episode, check out our show notes. And if you've enjoyed today's show, consider leaving us a review. Sound design, and editorial help from Historiebruket. Thanks for listening.