Transcript

Martine Lizotte (ML): Welcome to Arctic Minded, a podcast where we discuss life, work and research in the Arctic. Arctic Minded is produced by ArcticNet, a Network of Centers of Excellence of Canada, that brings together scientists, engineers, and other professionals in the human health, natural and social sciences with partners from Inuit organizations, northern communities, federal and provincial agencies, as well as the private sector, to study the impacts of climate and socio-economic change in the Canadian North. From coast to coast to coast, we recognize that our work reaches across the ancestral and unceded territories of all the Inuit, Métis, and First Nations people that call these lands home and who have been protectors of and share connections with these lands since time immemorial.

ML: My name is Martine Lizotte. I am the training and knowledge mobilization coordinator at ArcticNet and your host for today's podcast, which is a follow up on our two-part special episode focused on the celebration of 20 years of research on the Canadian Coast Guard Ship, Amundsen. If you missed that episode, it's now available on different platforms, including links directly on the ArcticNet website. While in the first part of this episode we focused on the iconic Amundsen, the vessel itself, its story and its overall impact in the scientific world, we wanted to dive into the human side of this ship's story. We talked to Dr. Maxime Geoffroy in St. John's, NL, where he works as a research scientist at the Marine Institute of Memorial University. Maxime is an ArcticNet researcher and has participated in the Amundsen scientific cruises since 2009. He has expertise in bioacoustics, marine ecology and biological oceanography, and the goal of his research is to better understand the ecology of North Atlantic and Arctic fish linked to different bodies of water in the context of climate change. In addition to ship-based surveys, he uses all kinds of technology, unmanned vehicles and active acoustic moorings to study marine ecosystems. So, we were definitely curious to find out what a typical day could look like as a scientist on board the Amundsen.

Dr. Maxime Geoffroy (MG): So, I've been working on board that ship since 2009, so it has been for almost 14 years now. Maybe one thing I can describe is what happens when you arrive when you do a crew change and you embark on board the Amundsen. So, we have crew change every four to six weeks, and the ship usually leaves for the science part of its mandate for between 2 and 5-6 months per year. At each of these months, it's divided in in one-month legs, we are having a crew change and then what happens is that we take the plane, a charter plane in Quebec City, and then we arrive on board the plane. We are all excited. We meet all our collaborators and reunite with our friends. And then it's a lot of camaraderie as part of this team, of course. And then we arrive at the airport, we wait, there's always delays. Those of you that work in the North know that we always dependent on the weather so there's always delays. And then we quit Quebec City for the area or the town, the community where we're going to have the crew change. That can be either in Resolute, Cambridge Bay, Iqaluit... it depends on where the ship is at that part of the summer. And then when we arrive there, usually we have a crew change that is by helicopter, and then we, one after the other, we bring out the boxes. Usually, will bring fruits and vegetables on board. We help with the crew carrying the boxes and the luggage. And then we arrive on board. We meet the team that was there before then, so we tried to have an overlap and then discuss what worked, what didn't work, and how we can improve it for the next month coming. And then usually, we'll have the first day, the first thing we do is eat spaghetti because that's the easy thing to do for the crew change, for the cooks. We usually eat more complicated and elaborate meals but the first day we eat spaghetti, and then we'll have our group in safety briefings. We unpack our boxes,

everybody's excited, all motivated to start working. And then usually we start cruising after a few hours and the day after, depending on how long the transit is, we would arrive on station and there the routine embarks, and then we start sampling. And I say the routine, but it's also the lack of routine, because we do sample any time of the day or at night, depending on where we are on station. Often, it's cut with transit as well, so whenever we arrive on station, we will start doing the different activities. So, we will discuss as a team and with the chief scientists about the schedule for the coming days, and then we would follow that schedule. So, we'll deploy often CTD rosette to sample water and measure temperature, salinity, different chemistry components of the water column. This can be followed by zooplankton and trouts of fish and zooplankton sampling and then take samples from the bottom on the sea floor. And then we also can-do different operations, for instance mooring deployments or coring or depending on what the teams want to do, the teams that are on board. And this goes on for about four to six weeks, with frequent meetings, long hours. Again, a lot of camaraderie. And then we leave for the next crew change after four or six weeks. That's the schedule of an at sea scientists aboard the Amundsen.

ML: While life on board, the Amundsen features staple and well-known foods like spaghetti, a lot less is known by the general public about the Arctic ecosystems the Amundsen navigates in. Most people on this planet will never get the chance to visit the Arctic, and many false perceptions remain surrounding the Arctic, namely that it's a desolate and barren place.

MG: The Arctic is a very full, really rich, full of life and vivid place to inhabit, but also to work. It's full of life and also experience rapid changes, not just through climate change and internal changes, but also throughout the seasons. It goes from the polar nights to the midnight sun in a few months, few weeks. So of course, it has an impact the whole ecosystem. One thing that is also important to note about the Arctic it's that it's in an ocean that is surrounded by land and because of that, the marine ecosystems are very important, critical for this this environment, but also the land-ocean exchanges. And then that's really what is modeling the Arctic environment. One example is that in contrast to all other places, the polar bears, the bears, they are considered marine mammals, so even their Latin name is Ursus maritimus, so you can see that this is different from the more land-based habitats that you would have in other areas. One thing that is also showing that it is not a barren and dull place to be is that the diversity in some aspects is higher than other regions. If you look at the benthic diversity for instance, the animals living on the sea floor, it's actually higher diversity than you will have in the Atlantic or the the Pacific. This is not necessarily the case of the animals living in the water column, so we usually see that we have less diversity, pelagic diversity, meaning that the animals that are living in the water column is less than in Atlantic or the Pacific. However, the species that are there are plentiful. There's a lot of life, and they occupy different habitats, different layers of the water column. This is really the work that my team and myself are doing up there, is really trying to understand where the fish and zooplankton are at what time of the year, what influenced their distribution from one year to the other, one season to the other, but also from one location to the other in relation to water masses, so temperature, salinity, but also the currents and the sea ice for instance. So really trying to understand how the environment impacts the distribution of fish and zooplankton across the Canadian Arctic and also to put that in relation with the other regions of the Arctic. So, we do have work and studies that are conducted in the Siberian Arctic or in the European Arctic, for instance, or around mainland with collaborators, and then understanding how these changes from one region to the other, including in the Canadian Arctic, is crucial to really understand what is the current fate and state of the marine

ecosystem in the Arctic, but also to forecast and predict what will happen with climate change in the coming years and decades.

ML: For oceanographers like Maxime, who studies the impacts of climate change on biological components of the ecosystem, such as fish and zooplankton, which are vital food sources for the entire food web, including human beings, having access to a platform like the Amundsen is crucial.

MG: It's a unique platform to give us access to the Canadian Arctic. The ship goes in the Canadian Arctic almost every year since 2003. As I mentioned before, it spends between two and five months per year, plus some years we have overwintering. So that means that the ship spent a full year cycle and then allows us to study the different changes across the season. So, for instance, when I started my Masters in 2008, that was during the International Polar Year, that was in the middle of the CFL project. And then that was in overwintering, the Amundsen spent the year 2007, 2008 in the Arctic continuously with different crew changes. So of course, these provide unique opportunities for multidisciplinary research but also unique opportunities to train students, not only for the science itself, but also the logistics to prepare these cruises, to sample at sea and to conduct science. For instance, our team, what we're doing to assemble the fish and zooplankton, we use net and trials to catch the fish and zooplankton, but also echo sounders and moorings to track them over long time periods. When we talk about echosounders, they are instruments, acoustic instruments that are home mounted on the Amundsen. The Amundsen is a really well-equipped platform for science. It has myriad of different instruments that are mounted on board and one of them is what we call a multi frequency acoustic echo sounder. So, we use sound to measure where the... to monitor where the fish and zooplankton are on the water column, and this instrument is operated continuously. So, every second we send a ping of water, and the ping is a sound wave, and then the reflection of the sound wave on the fish and the zooplankton tells us how many there are and also at what distance. So, at what depth they are located, and we can put that in relation with the water masses, for instance. The benthic water is more at the bottom or the polar surface water that is at the surface, that is less saline but colder. And we try to understand these different habitats in the water column. I mentioned also moorings. So, these are oceanographic moorings, or a line of equipment that we put in the water for full year and these can be deployed from the Amundsen. The Amundsen is a platform for that. The crew from both the scientific and the navigation crew from the Coast Guard have experience of deploying these oceanographic moorings. So, there's mooring monitoring programs where we, in one given year, we would deploy these instruments on a mooring line. We could have some of these sounders mounted on these lines, but other instruments that would also measure temperature, salinity, the flux of particles falling in the water, all that with high resolution throughout the whole year cycle. And then when we come back the year after, also with the Amundsen, we go on site and then we have some beacons that allow us to detect exactly where the mooring is. And then we can trigger it remotely and it pops up at the surface, and then we gather the instruments and download all our data, hopefully that were collected throughout that year. So, this is a good platform to deploy and recover these moorings and this provides additional information for the seasonal changes that we can see in the ecosystem.

MG: One thing also that is very interesting is that the fact that it has been collecting data for the past 20 years now, really allows us to have comparative study and to start seeing long term observation or trends across the Canadian Arctic. So, for instance, we have a study that recently looked at the decadal trends in the abundance of Arctic cod. Arctic cod being the most abundant fish in the Arctic, which really the fish that transfers the energy between the zooplankton up to the top predators. So, whatever

happens to that species, and the species is focus of interest for my group of research, is whatever happens to that species will have cascading impacts on the whole ecosystem. So understanding what are the drivers, what impacts their abundance from one year to the other is very important and it's very difficult to do if you just go there sporadically or one year here and there. The fact that we now have 20 years of data, we started seeing and that's worked by one of my PhD students, Jennifer Herbig that recently published a paper showing that the main driver of the abundance of that species are long term decadal trends, so the main factors that explain this variation for the Arctic oscillation and Atlantic oscillation, which are differences in pressure that drives the main current and circulation in the Arctic and the Atlantic. And this is really having impact on the abundance of the fish, and in turn, on the abundance of their predators in a given region. This would not have been possible to observe or study without this long-term series of the same platform going up in the Canadian Arctic with the same instrument year after year.

MG: Another thing that it allows us to do, because we have strong credibility and capacity for Canadian research with this platform, is to be invited or to lead comparative studies. For instance, I was talking about Arctic cod, this very important fish species in the Canadian Arctic. We just published, it was actually published an hour ago, a big review on the distribution and the impact of climate change and anthropogenic activities, activities from humans, on the different stocks of Arctic cod population, not just in the Canadian Arctic, but also comparing what's happening in the Canadian Arctic with the central Arctic Ocean, the Greenland stocks, the stocks in the Barents Sea, in Siberian Arctic. And we were actually leading that review because we have the credibility of all the studies that we've been able to conduct from the Amundsen in the Canadian Arctic. So really, we can bring our piece of the puzzle for now large-scale comparative studies based on how the data sets that were collected and impactful studies that were conducted from that platform.

ML: Ultimately, observations made during science campaigns on the Amundsen, fuel papers and other knowledge transfer initiatives that allow information to become useful and usable by larger groups of people, including the wide public, the decision makers, and also the people who actually live in the North. While reading some of these publications, I stumbled upon a paper by Maxime's team that was a tribute to Louis Fortier, a founding father of the Amundsen, as we found out from Alexandre Forest in the first segment of this two-part episode. So, I asked Maxime to share with us his vision of Louis Fortier and of his legacy in the field of Arctic oceanography.

MG: So, Louis Fortier was a professor at the Department of Biology at Université Laval. He was also my Masters and PhD supervisor, and for me, and for many others working in the Arctic, he has been a very impactful mentor for us and for Arctic researchers in general. He was the founder of the Amundsen as a scientific vessel, so that platform before was called the Franklin. It was the decommissioned in the early 2000s and then he mounted and led this big proposal where he showed that Canada, to set the forefront of Arctic research, needed to have a research icebreaker that was dedicated to academic research, at least for part of the year. So, he led that proposal and got that funded to create and refurbish the Amundsen, which again was then re-christened as the Amundsen. And he liked to say that one of the reasons he wanted to name it the Amundsen is because in memory of that, of course, very impressive explorer, was that when he was trying to get that proposal funded and get the maiden voyage, he of course faced a lot of obstacles and he kept the end goal in mind and that was inspired a bit by Amundsen. So that's one of the reasons he wanted to name it that, with the same name. So, that's one of the main large projects that he led. Another one is the creation of ArcticNet, which of course is

strong relevance for what we're doing now, being a podcast that is led by ArcticNet. So, he was one of the founders of that movement, and the idea behind creating our ArcticNet, as you know very well, is that it was to create a network of academic scientists in Canada that would put their efforts together to access, but also share their findings and have a broader impact, on the international research in the Arctic. So really the idea was to position ourselves as Canadian, as a leading country in in Arctic research. And I could say that I think a lot of us can say that the objective has been achieved and the legacy is quite under way. So really again, Louis was definitely a locomotive for these large-scale projects.

ML: Creating greater access to Arctic waters for researchers from all over Canada and generating new understanding of its ecosystems and their sensitivity to climate change, have been important outcomes of the existence and journey of the Amundsen. Researchers that measure, map, and survey the Arctic Ocean, but also other knowledge holders who observe, live, hunt, fish, in and around these waters, know it holds surprising and unique features that strike those who have the opportunity to experience them.

MG: So, one of the first thing that strikes you when you arrive in the in the Arctic is how rough, and the ruggedness, of the landscape that you see. And that at first it might seem quite the same from one region to the other. But the more you start looking at it and the more time you spend in it, you realize that it's a complexity of habitats. This rough landscape is not just bare rocks, snow and ice and water, but when you start looking more into detail into it, and then closely, you start seeing a myriad of different habitats, not just for animals, but also for plants and also for humans. For instance, I mentioned before, that we're studying the zooplankton. If you just look at one cast of nets in the water column, you will realize that different layers, either from a few thousands of meters to a few hundred of meters, will host different zooplankton species and become different habitats. This is true also for birds that would prefer certain cliffs to others, to go and nest. Or even for seals, if we go to marine mammals, they would prefer a different type of ice that is a bit thinner, but with leads and holes where they can dive and access their prey from, versus really thick, multi-layer ice, or two thin ice, where they cannot stand on to rest. And so really these different habitats really model and drive the different distribution of the animals and also what they are, how they will interact with their environment.

MG: One thing that is also driving the Arctic of course, there's a temperature and the seasonality. That's one thing that is driving the habitat of the Arctic. This is a unique ecosystem where you will have partly ice-covered seas for some time, you have multi-layer ice in some regions less and less, but it's still one of the habitats of the Arctic, and other regions that are now becoming ice free for most of the year. So that's one aspect driven mainly by temperature, but another one that is unique to this environment, our polar environment is the extreme light regime. So, you really go from a polar night period, where you don't have any sun or almost no sun for most of the day. So, if you go far North enough, we do some surveys in in the Barents Sea, in Svalbard during the winter, and there we're at 82 degrees north, and it's pitch black for the whole day and night, so we never see the sun. And then you go back there six months later, and then it's 24 hours of daylight, where you'll have all these different light spectrums. And then as the sun is going up and down, even though it never goes below the horizon, you will have the different light, sometimes the day will be more pink, other times will be more yellow. So, you have this variation in the spectra of the light that also impact the distribution, and yet the habitats of the animals there. And it also creates some fascinating sceneries and changes in the scenery from one hour to the other, from one month to the other, from one year to the other depending on where the sun is, but also how much ice there is, how much reflection you have. And that's not just true when the sun is there,

when it's below the horizon, it's really long pink areas of lights are fantastic to observe. And then when you're there during the polar night, you have the reflection, on a clear night you will have the... or on a clear day, even though we don't have sun, we have the reflection of the moon on the sea ice. You can have Northern Lights that are also reflected that will create some really unique light patterns. So all these are very important at modeling the habitat, but also very interesting and fascinating to observe as a Southerner coming to visit and experience this landscape. And I have one anecdote that I like to bring back is one night we were just having a break by the side of the boat in between two nets and it was pitch black, and then we realized that there were Northern Lights in the sky. So that's always a nice show to have when you're just standing there at night. But then we realized that we had bioluminescence in the water at the same time. So, we have these green moving patterns and red patterns in the sky, and then you have the same thing in the water, but from the organisms that were producing this light when they're stressed, for instance when the boat is passing by. So really you have the light, even though it was a pitch-dark night, the light that you would observe and then when you start looking closer, the different like sources and like colors that you would have both in the sky and the ocean were, again, it was very, very fascinating and a beautiful, beautiful spectacle to observe.

ML: While it's true that the Arctic offers unparalleled light shows for those lucky people who are there to see them, it has also been under immense pressure from climate change related processes. Maxime shares with us some of the changes he's seen over the past 14 years, since he started working on the Amundsen.

MG: So, the main changes we've observed in the Arctic, I would say, there are a few over the past 14 years, even though it doesn't seem that long, the changes are so fast. A recent study showed that the changes related to climate change in the Arctic are three to four times faster than in the rest of the planet. So of course, it changes quickly. One of the main things that you can observe is a reduced ice cover. From one decade to the other, we really reached a new low average level, so the ice is becoming more thin. You have less and less multiyear ice. And of course, you have less and less predictability and more and more variation. That's something we see at our latitude for the South as well. But then as you go further North, you really see it. So, from one year to the other, there's an area at the same time you will not be able to access at all, and the year after you have no ice at all. So, you always have this inter-annual variation, but now it's amplified with the quick impacts of climate change in the Arctic. You also have more storms, more winds in the Arctic compared to what was there few decades ago.

MG: One thing that we see, especially looking at fish and zooplankton as we do in my group of research, is the more abundance of boreal species. So you have, for instance, more capelins coming up North, you have more sand lances. These are small fish that would interact and compete with the Arctic cod, this really abundant and mixed species, the real typical Arctic species only inhabiting these regions. And now and now, more in competition with species coming from the South. Again that changes from one year to the other, there's a lot of variability, but the trend is clearly towards changes. There's not just changes from one year to the other, but from one region to the other. Some regions are impacted faster than others. What we call the gateway regions, for instance, in Baffin Bay at the border with the Labrador Sea, this is the rate of change that is faster than if you go in the Central Canadian Arctic in the archipelago where the conditions are still relatively extreme and Arctic. Same thing if you go on the Norwegian side, in the Barren Sea on the Pacific side, these gateways are really changing, really quick. So that's really where we see these changes from almost one year to the other. So, that's one aspect on the environment. Another one is more on the, I would say, maybe more geopolitical. So, there's more and

more, for the past 14 years, and with reasons, we've seen more and more Inuit and communities taking ownership of the work, of the research that is being conducted in the Arctic, and with reason. And then being more proud about their heritage and what they can bring for science and then their vision of science. And we really need to take more of this aspect into consideration, and this being, of course now being done as part of the research being conducted in the Arctic. So that's one thing that has been changing over the past decades and continues to change on the side. And then another thing that I've seen again, if we increase the spectrum of geopolitics, you see an increase in interest from southern countries. For instance, Korea, France, Germany, which always had an interest in polar regions, but you really see that it's taking more and more importance. Everybody wants to have a foot in the place now and you have new large research icebreaker being built by Korea, by China, for instance.

ML: From positive changes, such as the increase in the self determination of research conducted by Indigenous communities in the Arctic, to more intricate and challenging changes, such as a renewed geopolitical interest in the Arctic, humans are driving activities that affect the Arctic and writing the story of its future. The qualities that make us human, including compassion, curiosity and creativity, are at the center of the research that is being led on the Amundsen.

MG: The human side of Arctic journeys, especially on research, large research vessels like the Amundsen is central to what we are doing. When we leave on the Amundsen, we are forty scientists and forty crew members from the Coast Guard. All these people have to work in close collaboration for several weeks at a time and it has been a very successful experience over the past 20 years. It is a really well functioning system at the moment because of what everybody can bring to the team and we need to recognize the input that different persons can bring. I personally started, as I mentioned, as a Masters student, coming from an engineering, and then not knowing anything about the North and I wanted know a bit more about this ecosystem, so I decided to go back to school, to do Masters and the PhD, and of course the North being an ocean, oceanography was the good way to get into that world. And then after that, I did a postdoc in Norway where I enlarged my vision of the Arctic, and studied different ecosystem and enlarged my scientific network as well. And then I came back to the Memorial University in Newfoundland to lead my own research projects in my own lab, and then take graduate students in turn. So, I went from being a Masters on board, to now being a supervisor on board, and I can see the different aspects of it. And in any case, I think one thing that is obvious for everybody, is that this is a unique training platform. Also, the fact that you're sharing this capacity and this instrumentation and the sampling with your colleagues, with your peers, makes it extremely valuable as an experience as a graduate student, to go and sample in the Arctic. It's not many platforms where you can have your times as being a researcher, or if you compared to other disciplines where you would be more limited to the laboratory or to your office, maybe from 9:00 to 5:00 or a bit longer, but where you end up spending weeks and months at a time with your colleagues, with your supervisors, with experts in your field, where you can share your observations, share their observations, and learn from the experience as well. So, really, this this experience of being a long time with your peers and simply working on common objectives on board are key to the success of the research we're doing in the Arctic, but also to the observed success of the Amundsen as a scientific platform over the past 20 years.

ML: Working in the Arctic and on the Amundsen specifically, although very labor intensive, definitely is exciting, combining passionate people, cutting edge technology and breathtaking land, ice, and seascapes. For those of you listening today who might now be considering a career in oceanography,

Maxime, as an early career scientist, shares with us his tips and tricks on how to get involved in this type of career.

MG: First, don't be afraid to have a different background and to navigate through different disciplines. So, that's what I've done on my side and I think it served me well because you end up having a more different background than the others. So, I came on my site for mechanical engineering, and then Masters in Biology, and then my PhD in Oceanography. And I think that using these different pieces of the puzzle to create and research projects and bring different insight on what we observe is a plus. So, having diverse groups of expertise among your team and in your background is actually a big plus, that it is a good thing. So don't be afraid to come back to a career in oceanography if you've done something else in the past but it's interests you. The other one is to take the opportunities that present themselves. If you have the chance to participate in a cruise or go in the different projects that you've been invited to participate in, if you have the capacity to do it, take that opportunity. You never know where its going to lead you. And I would say that to finish, never underestimate the importance of establishing a good relationship with your peers, and to nourish that relationship. Your peers from today will be your collaborators from later, and they'll be the one that will make it fun for you to work with, and also to mount these larger projects on which you're going to build to develop your career.

ML: Nurturing diverse relationships definitely leads to remarkable achievements. It's undeniable that the Amundsen crew and scientists have achieved great success over the past 20 years by expanding beyond the primary scientific mission and providing opportunities for students and proposing education and youth involvement initiatives. The ship has now navigated over 250,000 nautical miles. That's a little less than 12 times around the Earth. It's spent over 2,300 research days at sea, and its welcome people from 26 Canadian universities and 98 international organizations. Without a doubt, it has played, and continues to play, a significant part in educating a new generation of researchers, but also contributing to the expansion of our knowledge of the Arctic.

ML: Before we say goodbye, I want to invite those of you who are interested in learning more about Amundsen Science and some of the research being conducted on the ship, including by our guest, Maxime Geoffroy, to consult the show notes where you'll find links to published papers and a few websites. If you liked this episode of Arctic Minded, please stay tuned for other episodes in our series. You can find all the details on the ArcticNet website. To everyone, take care.

Show Notes

Zooplankton assemblages along the North American Arctic: Ecological connectivity shaped by ocean circulation and bathymetry from the Chukchi Sea to Labrador Sea

https://online.ucpress.edu/elementa/article/10/1/00053/194647/Zooplankton-assemblages-along-the-North-American

Evidence of temperature control on mesopelagic fish and zooplankton communities at high latitudes

https://www.frontiersin.org/articles/10.3389/fmars.2022.917985/full

The circumpolar impacts of climate change and anthropogenic stressors on Arctic cod (Boreogadus saida) and its ecosystem

https://online.ucpress.edu/elementa/article/11/1/00097/196994/The-circumpolar-impacts-of-climate-change-and