

FULL TRANSCRIPT — HETE ZEE (hot sea)

VO: This is a podcast about the sea.

Because I, Threes Anna, I love the sea. But I am also concerned, and sometimes even afraid. What is actually happening in, around, on and beneath that water? Listen.

VO: August 18, 1961. We are in a small coastal town in California. It is very early in the morning and there is a thick fog. Suddenly, out of nowhere, thousands of sooty shearwaters appear. A dark-brown seabird that normally flies over the ocean. The birds had just fed on a huge amount of anchovies. And then something happens. Instead of flying out to sea, they head towards the coast. Suddenly, the residents are woken by terrible noises. The birds come flying out of the fog at full speed, crashing into houses, streetlights and power lines. When daylight comes and the fog has lifted, the streets and cars are covered with dead and injured seabirds. Nobody understands what has happened.

Episode 11. A search. HETE ZEE (Hot Sea).

VO: And then it is May 22, 2026. The weather on Texel is beautiful and the first tourists are on the beach. I go into the water. As always in May, it is still cold. The next day the weather is beautiful again. Back into the sea. Shivering again. The day after that, the weather is even better. When I step into the water, it feels strange. The water is warm. As if it were August.

The sea was warm. I thought, wow, the water is really warm. I had already gone into the sea earlier this week. Then I thought it was really cold. Now I loved it. The temperature was wonderful. It is pretty warm. Yeah.

How can the sea suddenly be warm? What is happening, and what does this mean for fish and other marine life?

VO: I arrange to meet an 85-year-old fisherman who has witnessed all the changes in the sea. Fub Krijnen.

Fub Krijnen: If we start with the Wadden Sea, where my grandfather also fished for years. And my father too. For mackerel, horse mackerel, garfish, sea bass, you name it. Well, there is hardly anything left to see. Here on the mudflats. It is as dead as a doornail. It is barren. You don't see garfish anymore. You don't see horse mackerel anymore. You don't see Atlantic mackerel anymore either. The oysters are gone. The snails, the whelks, they are gone too. The only thing that is still alive is starfish. And you still see sea bass. That is still there. But you do find other species of fish. Ones we had never seen here before. Such as a seabream. A red gurnard. A squid. Maybe another species of fish. From the Mediterranean.

Rob Dekker: Yes, yes, yes. A number of animal species have appeared, and it happens very gradually.

VO: This is Rob Dekker. He has been diving in the Wadden Sea for 50 years and walks along the beach almost every day. He is seeing changes too.

RD: The broad-legged crab is now a very common little crab on the beach. You never used to see it here. And the small hermit crabs. Hundreds of them. Another thing you never used to see was the velvet swimming crab. And just recently I saw another new jellyfish. The pearl jellyfish. What is unusual about this jellyfish is that, apart from underneath, it also has stinging cells on top of its bell. And they sting very badly. If it becomes more common, beachgoers are not going to like it.

FK: Nature, you know. Everyone thinks they understand it. But nature takes care of itself. We don't have to say that cod has gone extinct. Because cod is still there. It is up near Norway and the Shetland Islands. And even farther north. And that is all part of a change. Because we no longer have winters, real harsh winters. The temperature of the North Sea has not dropped below 10 degrees Celsius for the last 25 or 30 years. Whereas it used to be 0 degrees here. Freezing. Yes. And now, if you step into the water behind the dunes, it is 20 degrees.

Couldn't be better. Wonderful. It is so nice. It is warm too. Probably 20 or 21 degrees. You can easily go in. Nice and warm. Wonderful. Yeah, it is actually perfect. I think the swimming pool is colder than the sea. So yes, wonderful.

Katja Philippart: What is going on here? I keep asking myself the same question. What is happening? And then you start with the most basic question: what is the temperature?

This is Katja Philippart. She works at NIOZ and studies the ecosystem of the Wadden Sea.

And then we have this very long time series. Starting in 1861. Someone would go to the dike every day at eight o'clock with a little bucket. A bucket of water, a thermometer placed in it. And they would measure the temperature. Year after year. Year after year. Day after day.

VO: And that scientific time series is still being maintained. Only now it is done with instruments. And 40 times a year with a bucket.

Scene: Do you want to throw the bucket in? Right now? Yes. 20.8. Stir it. 26. 25. 20.5. Yes.

KP: Yes, then you can see that it just keeps getting warmer. And we are talking about degrees. You almost get used to breaking records. You can feel it, you say? I just stepped in. I simply walked straight in. And I dived into the sea like a little seal. Well, that is something I really enjoy in August. But not in May! No. It was really warm. Yes, strange, isn't it? Really warm. Yes. And those are the moments when you suddenly get this shock. You think, huh?

Sea music

KP: You once told me about cockles. Yes, that was in 2018. The first year with the first real heatwave. And all kinds of things happened; we didn't see many of them. But we did see the cockles. They died in huge numbers. Something like 60 to 80 percent died, and in some places as much as 90 percent. Especially the older cockles. They are cold-blooded animals. So when it gets warmer, their metabolism speeds up. They also need to take in more food so they don't starve to death. On top of that, when it is warm here in the Wadden Sea, we mainly get easterly winds. And with easterly winds, the mudflats stay exposed for longer.

Research was carried out afterwards, and they start crawling, they start moving around. That means they also need extra energy. They can manage all that. But if it lasts too long, they become exhausted. And then they die. What does a cockle feel like when it is dying? How? I once heard the heartbeat of a cockle. Wow! Ever since then, a cockle has seemed like a completely different creature to me.

VO: At this very moment, a similar study is also being carried out at NIOZ. It looks at what differences in temperature mean for mussels. Intern Anna Nobel is working here for researcher Tjitske Kooistra.

Anna Nobel: Here you have a container with control mussels. They experience a temperature of about 20 degrees. And you can see that their heart rate is a little slower than that of a mussel experiencing a higher temperature. You can see that too. Every mussel actually has its own little personality, so to speak. Every mussel is different. And tomorrow I am going to do an experiment that is actually a little sad. To see how long they can really survive at the highest temperature. Forty degrees.

VO: Forty degrees!

KP: I still don't know exactly how they feel, but I can see signs of stress in cockles. At a certain point you can see them starting to snap their shells a little. It is almost as if they are trying to get something quickly. At some point, of course, they need to take in some oxygen. The heart-rate measurements show that they actually get palpitations. They experience a great deal of stress before they die. I mean, all the classic signs of stress: in their behaviour, in their heart rate, in the movement of their shells. And all of it driven by temperature. Yes.

I really like this temperature. Fantastic. Absolutely fantastic. I think, yes, another lovely summer. And we are enjoying it.

VO: But not everyone is enjoying it, because for life in the shallow Wadden Sea, which falls dry every day, it is simply becoming too hot. And what about the North Sea? What is happening there? Online, I read articles by a scientist from the Royal Netherlands Meteorological Institute about marine heatwaves. His name is Frank Stelten.

Frank Stelten: At the KNMI, we are actually not a North Sea institute; we are a weather institute.

VO: But their measurements show that the North Sea is getting warmer and warmer. And that, in turn, has a major influence on the weather. He then explains to me what a marine heatwave is.

FS: If it is abnormally warm, you take the 10 percent warmest days. If the temperature rises above that threshold and stays above it for five days, we call it a marine heatwave. *Warm.* If you look at the satellite image from these days, you can see that it is abnormally warm right now, across virtually the whole North Sea. *Warm. Warm.* What we see is that the North Sea is warming in every season. So over 25 years, it has warmed by one degree in every season. *Warmer. Warmer.* It is getting faster and faster. Yes, it is getting faster and faster. *Warm. Warm. Warm. Warmer. Too hot. It is much too hot.* Yes, marine life has been experiencing

these temperatures for quite some time now. We have actually been seeing abnormally warm conditions since around February.

VO: So the North Sea is too warm too. I know beachgoers love it, but how do fish feel now that there are also marine heatwaves? I take a chance and approach the world's leading expert. The 80-year-old fish biologist Daniel Pauly, who works in Canada. We have a Zoom call.

Daniel Pauly: Heatwave for us, it's sweating, it is everything, but it doesn't prevent us from breathing. It does that to water breathers.

VO: What he is saying now is crucial. All aquatic animals that breathe through the water—crabs, lobsters, shellfish, jellyfish and all fish—have trouble breathing during a marine heatwave.

DP: Because they live in a world that has far less oxygen than we get on top of Mount Everest, far less.

VO: Fish live in a world where there is very little oxygen. And when water gets warmer, it contains even less oxygen.

Two!

DP: We, as mammals, can live in temperatures from minus 20 to plus 40 or 50 in a desert. We can adapt to all kinds of temperatures, but fish, they cannot.

VO: They can only tolerate a difference of a few degrees. And there is something else.

Three

VO: As the water gets warmer, metabolism also speeds up.

DP: And then they need more oxygen. And so, if you push them a bit, tok, kaput!

VO: Four.

Hold on.

DP: As fish get bigger and bigger, they have less gill area per volume. Because the big fish will be the first affected by so-called hypoxia. Whether you remove the oxygen or increase the temperature. You go now so detailed that for me. No, no! In a minute, in a second. Okay! You have to understand that. This movement breaks the structure of water.... (Words become unclear)... And so, if you have a heatwave, all of a sudden, the body falls apart.

VO: Let me sum it up. Fish take oxygen from water through their gills. But as a fish grows, its gills do not grow proportionally. That means large fish can absorb relatively less oxygen. In addition, cells break down at higher temperatures and need to be replaced. That also takes energy, and therefore extra oxygen. And all of this is happening in warm water, which itself contains less oxygen.

DP: So they are squeezed and they choke to death.

VO: When he said that the consequences of a marine heatwave include fish suffocating, I recoiled.

DP: I will put you in contact with a colleague. And he can respond in Dutch, even though he's German.

VO: I hesitated. A heatwave in the North Sea was already depressing enough. What more could he tell me? Because sometimes you simply don't want to know any more. But I contacted Johannes Muller from Leiden University anyway. Also via Zoom.

Johannes Muller: Why does it have a different effect in the North Sea, or why do one or two degrees make such a big difference? Here on land, if we get a few degrees warmer, we still have small refuges where it is cooler. You can simply sit under a tree. If you are in the water, it very quickly becomes the same temperature everywhere. What fish then do is go deeper. But that does not always work. Especially in the North Sea, which is very shallow. So those fish cannot retreat far enough. And then large fish have a very big problem.

VO: By large fish he means adult fish, and by small fish he means young fish.

JM: The small fish can survive longer because they can take up oxygen much more easily and also need much less of it. If a fish does not get enough oxygen, what does it do? First, it ventilates its gills very rapidly. Another thing they do is come to the surface and gulp. Yep, yep. That does not mean they literally breathe air, but they try to mix the water with air.

Music: sea, are you my friend or enemy?

DP: A heat wave in the sea is for fish the same thing as a forest fire.

VO: The same as a forest fire.

DP: You see, when a forest burns, the animals are not cooked. The animals die of choking.

More than 140,000 residents have been evacuated. 60,000 people fled the fire. More than 250,000 people have been ... Warm, warm. Tropical warm. For me personally, I find it comfortable, but for nature I find it hard. I am worried about it. Concerning. Yes.

JM: Fish will not go extinct as a taxonomic group. But which fish are we talking about? We are seeing a shift of species towards the poles, towards the north. *Cod, herring, mackerel*. And many tropical species are moving our way. *Gilthead seabream, squid, octopus*. But what happens there, where these species used to live? And what happens to the truly Arctic species, which need very low temperatures? In the North Sea here, there is a future for fish, but for smaller individuals.

DP: Big fish, they are already at the edge in terms of not getting enough oxygen.

JM: Exactly, yes. We will not see large fish as often anymore. Because they cannot grow as easily to the size they used to reach in the past.

DP: Over several generations...

VO: So in order to survive in warmer water, fish remain smaller. But that does not happen overnight. Real changes take time and cannot happen within a single fish's lifetime.

DP: In the course of millions of years, evolution, fish can adapt to higher temperatures. But...

VO: A species can adapt to a warmer climate, but that takes many generations. And the current warming is happening faster than evolutionary adaptation can take place.

DP: It's happening faster and faster. The animals cannot handle it anymore.

VO: Back to the fisherman from the beginning.

FK: What do you think? Oh, a fisherman will always exist. Really. You can say whatever you want, but there will always be fishing.

DP: Depends on what they want to fish!

JM: There will still be some fish swimming around, but not with the diversity we know today.

VO: Yes, we still have diversity today, but there are more and more examples of mass mortality at sea, especially in shallow coastal waters. Like the one that occurred in Canada a few years ago.

DP: This heat wave killed all the beach animals, billions of animals, such that the whole coastline stank, because a change of three or four degrees for a week is something fish cannot adapt to.

Well, lately it has occasionally been tropical hot, but generally it is not too bad. I think the whole fuss about it being warm or not warm is a bit exaggerated. Yes, I don't think it is alarming, no, no.

DP: You can pretend it doesn't happen, right. And you can pretend it will go away. But the temperature keeps on increasing. And then it will happen every year. And every year they are going to be worse.

VO: So if it continues to warm, the sea will become the enemy of fish!

DP: What else can you expect.

VO: Marine heatwaves occur around the world and have become more frequent and longer-lasting over the past century. Such warm seas have enormous consequences. They not only cause mass fish deaths, but also kill coral reefs and make kelp forests disappear. Jellyfish and algal blooms, on the other hand, are increasing. And now, back to the beginning.

So what was happening with the sooty shearwaters? At that time too, the seawater was abnormally warm and a massive algal bloom developed. The algae produced a toxin that

ended up in the anchovies, which were then eaten by the shearwaters. This caused the birds to become disoriented and lose their way.

It was therefore a combination of a hot sea, toxic algae caused by it, dense fog and the illuminated coast that created this bizarre night. The news was widely reported in Californian newspapers and inspired Hitchcock. Two years later, his famous film *The Birds* was released.

While making this podcast, the subject caught up with me. The warming North Sea was rarely in the news until, this summer, it reached its highest temperature ever recorded. As long as we continue to emit greenhouse gases, the sea will continue to warm. The North Sea is shallow, so one day mass mortality will occur here too—an awful thought. That is why we need to make our voices heard and give politicians and major emitters the courage to stop looking away, stand up, take responsibility and act.

Hot Sea is the 11th episode in the Sea series. I try to make four podcasts a year, but because I do everything myself and already have a plan for the next podcast that will take a lot of time, the gap between this episode and the next one will be a little longer.

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