Life at a wind farm

Wind farms are changing the ecosystem of the North Sea. What sort of impact will that have on seabirds, coral polyps, seals, porpoises and bats? 'We are on the brink of very rapid large-scale change. There is cause for concern there.'

TEXT MARION DE BOO **ILLUSTRATION** JEROEN MURRÉ

'Two Nathusius's pipistrelle bats!' Full of curiosity, Sander Lagerveld takes samples from the contents of a bat nesting box in a deciduous wood along the coast near Petten. 'Both young females,' he says. 'Look, their joints are not fully grown yet. The faces are still very dark and there is not much sign of wear and tear on the teeth.' The captured bats are weighed and measured, and then a miniscule transmitter is stuck on to the middle of their backs. This is done with surgical skin glue which comes off by itself after about three weeks. 'We have now tagged 13 bats with a transmitter, and the aim is to tag 500 of them over the next four years,' says Lagerveld, who has been working at Wageningen Marine Research in Den Helder since 2012.
In ten years' time there will be 100 wind farms in the North Sea. 'Our client, the Ministry of Infrastructure and the Environment (Rijkswaterstaat) wants more of an insight into bat migration routes over the sea. Because wind energy off the Dutch coast can be dangerous for migrating bats,' says Lagerveld. 'They can be killed by a stroke of the blades, or by the rapidly changing air pressure near the rotor, which can be fatal for their lungs or other organs,' he explains. 'And they are inquisitive animals that don't avoid the wind turbines but come towards them to hunt for insects.' The usual estimate on land is that 10 bats die per wind turbine per year. Higher numbers have been reported in the US, sometimes up to 100 bats per turbine per year. Little research has been done yet on the number of victims at offshore wind farms.

> 'A totally new North Sea landscape is emerging'

Every five kilometres along much of the North Holland coast antennae have been set up, which receive a kind of Morse code from the transmitters on the bats. The memory cards are read every few months to see where and when the bats fly, how many of them fly together, along which routes, and in which weather conditions.

BAT MIGRATION

The main species the study focusses on are the Nathusius's pipistrelle and the common noctule. These are migrating bats, which cover distances of up to 2000 kilometres in the spring and autumn on the journey between their breeding colonies and their overwintering habitats, with a cruising speed of 40 kilometres per hour or more.' In the autumn, between the end of August and mid-October, they migrate with their young, mainly from north-east to south-west when there is an east wind and temperatures are high.
Lagerveld: 'Flying by day is too dangerous because of birds of prey and gulls. Bats don't fly non-stop but take breaks along the way to look for food and to rest. They forage on the open sea, too, and use drilling platforms in the middle of the sea as resting places during the day.'
Once the bat migration route has been established, the next question is how many bats fall victim to wind farms and what could be done about it. 'Maybe you can scare them away with unpleasant noises,' suggests Lagerveld. 'And if we can predict exactly when the bats migrate, you could stop the wind turbines for a while at those times. The permit for the new wind farm near Borssele makes provision for that.'

CUMULATIVE EFFECTS

Wageningen Marine Research is analysing the environmental impact of offshore wind farms. Not just on bats, but also on seabirds, seals, porpoises and fish.
According to theoretical ecologist Tobias van Kooten, the coordinator of the wind turbine study, a lot of studies have already been done on the impact of individual farms. 'How many fish congregate around these turbines? From how far away can a porpoise hear the pile driver? But what policymakers need now is insight into the cumulative effects of all those wind farms together,' says Van Kooten. 'Because wind energy is being developed on a massive scale by all the countries around the North Sea. The entire North Sea ecosystem is being manipulated. A totally new landscape is emerging. What is that going to mean for fish stocks, and where are the fisheries supposed to go in future? What steps should we take in order to protect international bird populations? These are the kinds of questions we and our international colleagues will be seeking answers to. We shall also be studying the multifunctional use of wind farms, in which they are combined with fish farming or mussel and seaweed cultivation. And we are going to research the usefulness and necessity of all kinds of measures for mitigating negative impacts, and the development of new nature under water.'

PHOTO UDO VAN DONGEN

Mussels, hydropolyps, soft corals and sea anemones have been found on the bases of wind turbines and drilling platforms.

That nature development occurs spontaneously. 'On the bases of the turbines, a complete ecosystem forms with 100 to 200 species per location,' says marine ecologist Joop Coolen of Wageningen Marine Research, who got his PhD in Wageningen in March.
For years Coolen has been diving down alongside the pillars of platforms and wind turbines to get a picture of the biodiversity down there. 'On wind turbines, and also on the bases of oil and gas platforms and on shipwrecks, we found gigantic mussels alongside brightly coloured hydropolyps, soft corals and sea anemones. We found crustaceans and small shrimps, and they attract unusual fish such as the goldsinny wrasse, which finds a food supply on this artificial reef.'
One fifth of the North Sea bed used to be covered in oyster and other shellfish banks, but these have all but disappeared thanks to fishing, diseases and pollution. The underwater platforms make up a little for that loss of hard substrate. Coolen discovered that animals which would not stand a chance on the sandy North Sea bed move on from one platform to the next, thereby conquering more and more of the North Sea.

TEMPORARY HEARING LOSS

For marine mammals, however, offshore wind energy is harmful. Noise pollution from the pile-driving for the foundations of the wind turbines can disturb porpoises and both grey and common seals. 'Pile-driving can lead to temporary hearing loss, changes in distribution patterns and loss of habitat,' explains marine ecologist Geert Aarts of Wageningen Marine Research.
'Piles metres in diameter are thumped into the seabed with hard blows from large pile-driving ships. It takes about two hours to drive one pile into the ground, but creating a complete wind farm can take six months.'
Sound carries much better than light under water. Many animals use sound under water to locate their food. The 30,000 to 80,000 porpoises in Dutch coastal waters – numbers change seasonally – emit short 'clicks' and listen to the reverberation of echoes in order to navigate and find food, as well as to communicate among themselves, between mother and baby for instance. Unnatural underwater sounds can disrupt this echolocation.
Aarts: 'It has been found that porpoises avoid an area of up to 20 kilometres around a location where piles are being driven, resulting in a significant loss of habitat.' The pile-driving at sea could lead to a big reduction in the porpoise population, a model calculation suggests. 'For the Dutch government that was sufficient reason to sharpen up the criteria for issuing permits for new wind farms. This includes setting a limit to the noise that pile-driving machinery is allowed to make. One way of cutting down the noise is to put down a curtain of air >

PHOTO SANDER LAGERVELD.

A red bat with a transmitter.

bubbles around the pile-driving location, which seems to work particularly well for the high frequencies which porpoises make use of. Quieter pile-driving machines are also being developed, and the industry is looking for alternative methods of anchoring the turbines without piles.'

EXTREMELY SENSITIVE

Seals, too, react to the sound of pile-driving from up to tens of kilometres away. Unlike porpoises, seals do not use sonar to hunt, but they are extremely sensitive to the low-frequency sounds released by pile-driving.
Aarts and his colleague Sophie Brasseur are tracking individual seals by sticking small transmitters onto their skins, which fall off after a few months. More than 100 seals have already been tagged with transmitters. 'This enables us to trace exactly where they are, where they dive and how deep,' says Aarts. 'When the pile-driving starts, foraging stops abruptly and they swim away. A lot of our tagged seals seem to avoid the wind farms, too. They can hear the turbines turning underwater and they can also see the rotating blades, and apparently that scares them off. We and some Scottish researchers did notice some seals visiting a wind farm, probably because there were a lot of fish there. But that farm was not yet operational.'

Seals themselves actually make a lot of noise underwater, especially the males. They attract females in the mating season by making roaring underwater sounds. 'We don't know if that courting is disturbed by unnatural underwater sounds,' says Aarts. 'But wind farms have been built close to the German Wadden islands and that noise penetrates right into our Dutch Wadden Sea.'
Ultimately, policymakers are primarily interested in conclusions at the population level. They want more insight into the extent to which the vitality of marine mammal populations goes down when wind farms are built. In a new project funded by the Netherlands Organization for Scientific Research (NWO), the researchers are going to make further calculations of the effects of noise at the population level.

SEABIRDS WILL DIE

As part of this project, Mardik Leopold, a researcher at Wageningen Marine Research, is studying the impact of offshore wind farms on seabirds. 'If an individual entrepreneur wants to set up an offshore wind farm, the environmental impact assessment always trots out the conclusion that just that one farm won't have a significant effect on seabird populations. But there are already 100 of them planned between now and 2030. You can be sure all those wind farms together *will* have an impact on bird populations. Model calculations suggest that many tens of thousands of seabirds will die.'
According to Leopold, wind farms are harmful to birds in two ways. 'They can die from a blow from a blade, especially at night when they can't see the turbines. And they also lose habitat because they are scared to come near the wind farms.'
'Collision models' have been worked out for all the bird species over the North Sea, partly based on visual and radar observations. The axis of a turbine is about 90 metres high and the blades are 60 metres long. So the risk of collision is mainly in the flight zone from 30 to 150 metres high. The chances of crashing into a blade depend on the size and flight behaviour of the birds. Most species will reroute, while some fast birds fly in between the turbines or swerve away from the blade at the last minute. Birds which mainly swim or swoop low over the water are rarely hit by the blades.
Another factor to take into account in establishing the effects at population level is how fertile a species is. The scoter, which starts to brood at the age of two and has

eight ducklings per year, is much less vulnerable as a species than the northern fulmar, which only lays one egg per year, and only from the age of 10 or 15. It takes a very long time to 'replace' a northern fulmar. Also, timid birds probably lose out more than bold birds.
In explanation, Leopold says, 'Altogether, it seems that the black-throated loon, for instance, which has a small population, lays few eggs and cannot manoeuvre easily in the air, is more vulnerable as a species that the small, fast-moving and fertile black-legged kittiwake. Some species of gull fly freely in and out of the wind farm, and the great cormorant loves it there. It sits on the turbines to dry its wings, and they add quite a big area to its habitat. Northern gannets, on the other hand, always fly around the wind farms, running little risk of collision, but losing quite a bit of their habitat.'
Loss of habitat can affect the fitness of a population. In order to calculate that effect, the international rule of thumb is that one in ten exiled birds will die. The Wageningen researchers are now trying to get more precision about that rule of thumb. In general, the model calculations suggest that the main species that are approaching the danger zone at population level are the black-throated loon, the red-throated loon, the velvet scoter and the common eider.

MANY TOURISTS

Meanwhile, the Wageningen bird researchers have drawn up a map of the North Sea. In the red zones, wind turbines pose a serious threat to bird populations. In green zones there is less risk for birds. Leopold: 'The bird-rich Dutch coast, with its many overwintering scoters and its foraging seagulls and terns, is mainly coloured red. But because a lot of tourists come here too, the wind turbines are not too close to the coast. That is a happy coincidence. The idea of stopping the turbines at the height of the bird migration season is being considered. New wind farms will probably be equipped with bird and bat radars.'
Leopold is also interested to see how birds will evolve when the sea is full of wind farms. 'We are on the brink of very rapid large-scale change. There is cause for concern there. The fisheries will have to give up fishing grounds because wind farms will soon fill the North Sea. Some bird species will avoid the farms, while others might learn to live there. The stupid birds will be pushed out, the smart and the bold ones will survive.' ■

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'The goldsinny wrasse finds its food on these artificial reefs'

WIND TURBINES TAKE OVER THE NORTH SEA

Offshore wind energy is indispensable to achieving the targets of the Paris Climate Conference of 2015, aiming at limiting global warming to a maximum of 2 and preferably 1.5 degrees Celsius. According to the Energy Agreement of 2013, the wind energy capacity in the Dutch section of the North Sea has to grow to 4.3 gigawatts (GW) by 2023. One gigawatt is 1000 megawatts, or 1000 million watts. By 2015 production of offshore wind energy had only reached 357 megawatts. In the period up to 2050, the Netherlands has plans for at least 50 GW of wind capacity offshore, on top of 15 GW on land. In contrast to land-based wind farms, which are subject to restrictive noise norms, both the turbines and the wind farms offshore are getting steadily bigger.
Several North Sea countries have big plans for expansion. A consortium of Dutch, German and Danish grid operators, led by European electricity transmission system operator TenneT, is working with the gas infrastructure company Gasunie on plans for an artificial island on Dogger Bank, 300 kilometres from the Dutch coast, where 7000 wind turbines, each 200 metres high, will be located.
Placing the wind farms outside the 12-mile zone spares key bird migration routes, and does not spoil the view from the beach, thanks to the earth's curvature. New wind farms will be equipped with a radar system for monitoring bird and bat migration. If necessary the turbines can be stopped for a while.